100th Anniversary of the Republic Turkey

# INTERNATIONAL EGE AGRICULTURE CONGRESS

November 01-03, 2023 Ege University, Izmir-Türkiye



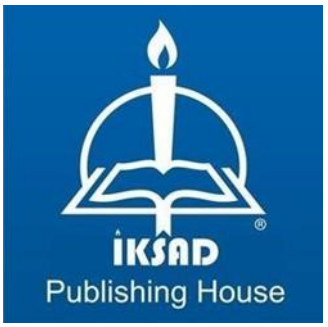
## CONFERENCE PROCEEDINGS BOOK


EDITORS

Prof. Dr. Banu YÜCEL

Assoc. Prof. Dr. Seyithan SEYDOŞOĞLU

# 100th ANNIVERSARY OF THE REPUBLIC TURKEY INTERNATIONAL EGE AGRICULTURE CONGRESS

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**100th ANNIVERSARY OF THE REPUBLIC TURKEY INTERNATIONAL EGE AGRICULTURE CONGRESS**

**100th ANNIVERSARY OF THE REPUBLIC TURKEY INTERNATIONAL EGE AGRICULTURE CONGRESS**

**November 01-03, 2023 / Ege University, Izmir, Türkiye**

# PROCEEDINGS BOOK
# (Abstracts & Full Texts)

**EDITORS**

**Prof. Dr. Banu YÜCEL**
**Assoc. Prof. Dr. Seyithan SEYDOŞOĞLU**

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# 100th ANNIVERSARY OF THE REPUBLIC TURKEY INTERNATIONAL EGE AGRICULTURE CONGRESS

## EVALUATION PROCESS and POLICIES

All applications have undergone double blind peer review process. In addition, each paper was accepted and the process of publishing in the book was carried out through editorial oversight. The published papers were presented and discussed at the meeting.

Full texts and abstracts published in accordance with the Symposium Policy have been prepared in accordance with ethical rules and APA standards. Authors of all papers are both ethically and legally responsible.

## PARTICIPANTS COUNTRIES

Türkiye, Turkish Republic of Northern Cyprus, Algeria, Brazil, Bulgaria, China, Ethiopia, Bangladesh, France, Greece, Georgia, Germany, Hungary, India, Iran, Kosovo, Macedonia, Malaysia, Morocco, Nigeria, Pakistan, Philippines, Poland, Romania, Russia, Spain, Ukranie, United Arab Emirates, United Kingdom, Vietnam.

## TOTAL ACCEPTED ARTICLES: 306

The Number of Accepted Papers from Türkiye: 118
The Number of Accepted Full Papers from Other Countries: 134
The Number of Total Papers:252

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**100th ANNIVERSARY OF THE REPUBLIC TURKEY**
**INTERNATIONAL EGE AGRICULTURE CONGRESS**

**100th ANNIVERSARY OF THE REPUBLIC TURKEY**
**INTERNATIONAL EGE AGRICULTURE CONGRESS**

**November 01-03, 2023**

**İzmir, Türkiye**

# SYMPOSIUM SCHEDULE

100th Anniversary of the Republic of Türkiye

# International Ege Agriculture Congress

**NOVEMBER**
**01-03, 2023**

EGE UNIVERSITY
FACULTY OF AGRICULTURE
IZMIR, TÜRKİYE

TÜRKİYE YÜZYILI

MİLLİ MÜCADELE'NİN YÜZÜNCÜ YILI

## Congress Program

**Online & In-person**

iksad47@gmail.com
www.iksadkongre.com/ege

# IMPORTANT, PLEASE READ CAREFULLY

- To be able to attend a meeting online, login via **https://zoom.us/join** site, enter ID "Meeting ID or Personal Link Name" and solidify the session.
- The Zoom application is free and no need to create an account.
- The Zoom application can be used without registration.
- The application works on tablets, phones and PCs.
- The participant must be connected to the session 5 minutes before the presentation time.
- All congress participants can connect live and listen to all sessions.
- Moderator is responsible for the presentation and scientific discussion (question-answer) section of the session.

**Points to Take into Consideration - TECHNICAL INFORMATION**

- Make sure your computer has a microphone and is working.
- You should be able to use screen sharing feature in Zoom.
- Attendance certificates will be sent to you as pdf at the end of the congress.
- Requests such as change of place and time will not be taken into consideration in the congress program.

# ÖNEMLİ, DİKKATLE OKUYUNUZ LÜTFEN

- Kongremizde Yazım Kurallarına uygun gönderilmiş ve bilim kurulundan geçen bildiriler için online (video konferans sistemi üzerinden) sunum imkanı sağlanmıştır.
- Online sunum yapabilmek için **https://zoom.us/join** sitesi üzerinden giriş yaparak "Meeting ID or Personal Link Name" yerine ID numarasını girerek oturuma katılabilirsiniz.
- Zoom uygulaması ücretsizdir ve hesap oluşturmaya gerek yoktur.
- Zoom uygulaması kaydolmadan kullanılabilir.
- Uygulama tablet, telefon ve PC'lerde çalışıyor.
- Her oturumdaki sunucular, sunum saatinden 5 dk öncesinde oturuma bağlanmış olmaları gerekmektedir.
- Tüm kongre katılımcıları canlı bağlanarak tüm oturumları dinleyebilir.
- Moderatör – oturumdaki sunum ve bilimsel tartışma (soru-cevap) kısmından sorumludur.

**Dikkat Edilmesi Gerekenler- TEKNİK BİLGİLER**

- Bilgisayarınızda mikrofon olduğuna ve çalıştığına emin olun.
- Zoom'da ekran paylaşma özelliğine kullanabilmelisiniz.
- Kabul edilen bildiri sahiplerinin mail adreslerine Zoom uygulamasında oluşturduğumuz oturuma ait ID numarası gönderilecektir.
- Katılım belgeleri kongre sonunda tarafınıza pdf olarak gönderilecektir
- Kongre programında yer ve saat değişikliği gibi talepler dikkate alınmayacaktır

# -OPENING CEREMONY-

Date: 01.11.2023
Time: 09:30-10:30
Venue: Ege University, Faculty of Agriculture, D Blok Feyzi Önder Hall

**Prof. Dr. Banu YÜCEL**
Vice-Rector of Ege University
CONGRESS PRESIDENT

**Prof. Dr. Yusuf KONCA**
Erciyes University, Agriculture Faculty, Kayseri, Türkiye

**Kanat GALYMBEK**
Abai Kazakh National Pedagogical University, Kazakhistan

***

**Dr. Merko VAGA**
Swedish University of Agricultural Sciences, Uppsala, Sweden

***

**Assoc. Prof. Maghsoud BESHARATI**
Department of Animal Science, Ahar Faculty of
Agriculture and Natural Resources, University of Tabriz, Iran

***

**Dr. Kaldygul Adilbekova**
General Secretary of IKSAD Institute

***

**Prof. Dr. Necdet BUDAK**
Rector of Ege University
CONGRESS HONORARY PRESIDENT

**01.11.2023**

Ankara Local Time: 11:$^{00}$-13:$^{00}$

Ege University, Faculty of Agriculture, D Blok, Hall-1

## HEAD OF SESSION: Prof. Dr. Mustafa KIZILŞİMŞEK

| Authors | Affiliation | Presentation title |
|---|---|---|
| Fatma Akbay<br>Tuğba Günaydin<br>Eylül Nezahat Kizilyar<br>Zehra Korkmaz<br>Seda Arikan<br>Seda Temiz<br>Mustafa Kizilşimşek | *Kahramanmaraş Sütçü İmam University* | Effect of addition of increasing doses of carob flour to alfalfa silage on silage fermentation and silage quality |
| Emre Kara<br>Mustafa Sürmen | *Aydın Adnan Menderes University* | Economic analysis of different organic fertilizer applications in double-annual forage crop rotations |
| Tuğba Günaydin<br>Fatma Akbay<br>Zehra Korkmaz<br>Seda Arikan<br>Mustafa Kizilşimşek | *Kahramanmaraş Sütçü İmam University* | Effect of some grain cultivation in different ratios with fodder peas on silage quality |
| Emre Kara<br>Mustafa Sürmen | *Aydın Adnan Menderes University* | Possibilities of using annual forage crops as green manure |
| Hüseyin Özpinar<br>Melek Akça Pelen<br>Ergül Ay<br>Hülya Okkaoğlu | *Aegean Agricultural Research Institute* | Aegean region lucerne studies |
| Merko Vaga<br>Muazzez Cömert Acar<br>Nagehan Nur Altan | *Swedish University of Agricultural Sciences* | New proteins for ruminants: insect proteins and microalgae |
| Gamze Ertem<br>Banu Yücel | *Ege University* | Evaluation of efe ecotype f1 hybrid in terms of hygienic behavior selection |
| Kübra Sivri<br>Özer Hakan Bayraktar<br>Elif Babacanoğlu Çakir | *Ege University* | In ovo feeding practices in broiler breeder eggs |

(All speakers required to be connected to the session 10 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.

**01.11.2023**

Ankara Local Time: 11:$^{00}$-13:$^{00}$

Ege University, Faculty of Agriculture, D Blok, Hall-2

## HEAD OF SESSION: Dr. Öğr. Üyesi Deniz İŞTİPLİLER

| Authors | Affiliation | Presentation title |
|---|---|---|
| Bedirhan Artun<br>Gülay Bozoğlan Bingöl<br>Esra Aydoğan Çifci<br>Köksal Yağdı | *Bursa Uludağ University* | Evaluation of some agricultural characteristics of bread wheat varieties (*Triticum aestivum* L.) in augmented experimental design in Bursa ecological conditions |
| Onur Koç<br>Yakup Onur Koca<br>Osman Erekul | *Aydın Adnan Menderes University* | Effect of different phosphorus doses on yield and yield components of bread wheat (*Triticum aestivum* L.) varieties under Muğla-Dalaman conditions |
| Sertaç Tekdal<br>Mahir Başaran<br>Uğur Bilge<br>Mehmet Bariş<br>Mustafa Okan<br>Ali Tekin<br>Mustafa Serdar Doğan<br>Mehmet Düzgün | *GAP Uluslararası Tarımsal Araştırma ve Eğitim Merkezi* | Examination of yield and quality values in some durum wheat genotypes |
| Neslihan Yildiz<br>Sevdiye Yorganci<br>Serap Açikgöz | *Aydın Adnan Menderes University* | Detection of virus resistance genes and the use of bulk secretant analysis in the detection of resistance genes |
| Fatma İnci<br>Veli Delen<br>Halise Kaya<br>Fatma Aykut Tonk<br>Deniz İştipliler | *Ege University* | The effect of sowing norms and nitrogen applications on yield characteristics of common buckwheat (*Fagopyrum esculentum Moench.)* |
| Özlem Akbaş<br>Aliye Yildirim Keskinoğlu<br>Emre İlker | *Ege University* | Polyploidy studies in field crops |
| Merve Kabakci<br>Cansu Dindar<br>Uğur Şirin | *Aydın Adnan Menderes University* | The effects of different bap and naa dose combinations on shoot regeneration and some morphological characteristics on micropropagation of *Aronia melanocarpa* L. ‘Viking’ variety |
| Gülhan Kaygusuz<br>İsmail Can Paylan | *Ege University* | Molecular methods in determınıng genetıc dıversıty in seeds |
| Onur Koç<br>Yakup Onur Koca<br>Osman Erekul | *Aydın Adnan Menderes University* | The effect of different phosphorus doses on the quality characteristics of bread wheat (*Triticum aestivum* L.) varieties under muğla-dalaman conditions |

(All speakers required to be connected to the session 10 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.

**01.11.2023**

Ankara Local Time: 11:$^{00}$-13:$^{00}$

Ege University, Faculty of Agriculture, D Blok, Hall-3

## HEAD OF SESSION: Prof. Dr. Hatice ÖZAKTAN

| Authors | Affiliation | Presentation title |
|---|---|---|
| Pınar Yildirim<br>Hatice Özaktan | *Ege University* | Molecular investigation of tomato bacterial speck disease causal agent pseudomonas syringae pv. tomato in terms of copper tolerance and genetic variation |
| Fatih Pekcan<br>Hatice Özaktan | *Ege University* | Using possibilities of bacteriophages in plant protection |
| Kanat Galymbek<br>Aigul Madenova<br>Serik Bakirov<br>Kadir Akan<br>Dinara Kaldybayeva<br>Balnur Kabylbekova<br>Zhangeldi Aitymbet<br>Munira Bolat | *Abai Kazakh National Pedagogical University* | Monitoring apple scab (V*enturia inaequalis*) disease in apple farm in Kazakhstan |
| Nimet A. Albeyoğlu<br>Necip Tosun | *Ege University* | Evaluating various fungicide programmes for internal fruit rot in pomegranates using electrostatic and conventional spraying |
| Ramazan Çoşkun<br>Necip Tosun | *Ege University* | Evaluating the efficacy of qoi-fungicides in the management of olive leaf spot disease through conventional and electrostatic spray techniques |
| Gizem Özgün<br>Yunus Korkom<br>Ayhan Yildiz | *Aydın Adnan Menderes University* | Different media effects on endophyte fungi isolation from citrus species |
| Mehmet Saban<br>Erkan Yilmaz<br>Firdevs Ersin<br>Ergül Ay<br>Hülya Okkaoğlu<br>Melek Akça Pelen<br>Ferit Turanli | *Ege University* | Determination of damage of sesamia nonagrioides (lefebvre) (lepidoptera: noctuidae) and ostrinia nubilalis hbn., (lepidoptera: crambidae) on some maize genotypes |
| Çiğdem Özkan Kahraman<br>Figen Yildiz | *Ege University* | A research on determination of fungal root and crown rot diseases in some outdoor ornamental plants in İzmir province |

(All speakers required to be connected to the session 10 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.

**01.11.2023**

Ankara Local Time: 14:$^{00}$-16:$^{00}$

Ege University, Faculty of Agriculture, D Blok, Hall-1

## HEAD OF SESSION: Prof. Dr. Metin ARTUKOĞLU

| Authors | Affiliation | Presentation title |
|---|---|---|
| Ali Selim Alpaslan<br>Murad Yercan<br>Meriç Halide Kasapoğlu | *Ege University* | The importance of local government supports in rural development: a case of İzmir province |
| Melike Bahçeci<br>Sait Engindeniz | *Batı Akdeniz Agricultural Research Institute* | The production, consumption and marketing structure of pitaya in Turkey |
| Betül Öztürk | *Izmir University of Economics* | Conceptual study on sustainable gastronomy and agriculture |
| Oguzhan Soltekin<br>Turcan Teker | *Manisa Viticulture Research Institute* | Effects of different trellis systems and irrigation regimes on vegetative growth patterns of 'beyra' table grape variety |
| Cemre Akturk<br>Hulusi Kıyı | *Ege University* | Effects of special modified atmosphere and dynamic controlled<br>atmosphere storage on storage quality of late peach varieties for export |
| Hero Saleh Abdulah Ali<br>Hamid Paya<br>Hamid Mohammadzadeh<br>Ali Hosseinkhani | *University of Tabriz* | Effect of extracted tannin from pomegranate by-products on methane emission by in-vitro techniques |

(All speakers required to be connected to the session 10 min before the session starts)
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**01.11.2023**

Ankara Local Time: 14:$^{00}$-16:$^{00}$

Ege University, Faculty of Agriculture, D Blok, Hall-2

## HEAD OF SESSION: Assoc. Prof. Dr. Gülcan DEMİROĞLU TOPÇU

| Authors | Affiliation | Presentation title |
|---|---|---|
| Melis Sevval Bahar<br>Banu Yucel | *Ege University* | The interaction of aggression behaviour in bee venom production in honey bee colonies |
| Pınar Özsari | *Ege University* | Studies of some plant defense stimulants on the damage of leptinotarsa decemlineata (say) (coleoptera: chrysomelidae) (potato bug) larvae |
| Nurdan Güngör Savaş | *Manisa Viticulture Research Institute* | Investigation of secondary metabolites and antagonistic activities of local trichoderma species against diaporthe ampelina |
| Eda Ceylan<br>Meltem Aydin<br>Derya Ayral-Çinar | *Gebze Technical University* | Comparison of N2O emissions from soil following the application of synthetic fertilizer and the adjustment of organic matter |
| Funda Koçer<br>Başar Sevindik<br>Özhan Şimşek<br>Ademi Fahri Pirhan | *Ege University* | Investigation of in vitro propagation of *Campanula leblebici* via plantform temporary immersion system |
| Gizem Toyğar<br>Hatice Özaktan | *Ege University* | The effect of different corn varieties and bacteria on drought stress |
| Melike Kizilşimsek<br>Gülcan Demiroğlu Topçu | *Ege University* | The effect of different mixing ratios of maize (*Zea mays* L.) and sunn hemp (*Crotalaria juncea* L.) on some silage quality characteristics |
| Gülcan Demiroğlu Topçu<br>Faik Erol | *Ege University* | The role and importance of cover crops in organic farming |
| Hamed Talebi<br>Saeed Samadianfard | *University of Tabriz* | Enhancing water resource management through satellite-based remote sensing analysis |

(All speakers required to be connected to the session 10 min before the session starts)
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**01.11.2023**

Ankara Local Time: 14:$^{00}$-16:$^{00}$

Ege University, Faculty of Agriculture, D Blok, Hall-3

## HEAD OF SESSION: Assoc. Prof. Dr. Arzu YAZGI

| Authors | Affiliation | Presentation title |
|---|---|---|
| Aysu Şen<br>Soner Duran<br>Derya Kiliç<br>Selim Çetin<br>Yasin Coşkun<br>Veli Çelikyürek<br>Ali Emre Eroğlu<br>Ahmet Bebek | *Kayhan Ertuğrul Makina Sanayi ve Ticaret A.Ş.,* | Design and development of three-row maize chopper |
| Derya Kiliç<br>Soner Duran<br>Aysu Şen<br>Selim Çetin<br>Yasin Coşkun<br>Veli Çelikyürek<br>Ali Emre Eroğlu<br>Ahmet Bebek | *Kayhan Ertuğrul Makina Sanayi ve Ticaret A.Ş.,* | New rotor design, easy to assemble and disassemble, used in the baler |
| Sema Aysal Keskin<br>Sevtap Erdoğan | *Karabuk University* | Investigation of the chemical and morpholohical structure of microencapsulated water-soluble wood preservatives |
| Onur Keser | *Istanbul University-Cerrahpaşa* | The use of chitosan nanoparticles as a feed additive in fish farming |
| Safiye Nur Dirim<br>Gülşah Çalişkan Koç | *Eşme Vocational School* | Utilization of red lentil puree in bread production and determination of bread quality |
| Leyla Eken<br>Uğur Şirin | *Aydın Adnan Menderes University* | Bulblets formation and development in lily under stress conditions related to irrigation regimes |
| Volkan Gürce<br>Özgül Başar<br>Mehmet Ali Ul | *Republic of Türkiye Ministry of Agriculture and Forestry* | Programming the irrigation of cotton plants with cropwat in soke plain |
| Nilgün Doğan<br>Hakan Adanacioğlu | *Gumushane University* | Examining of the prices received by the farmers and input prices for dry bean in Turkey |
| Arash Javanmard<br>Behzad Sepheri<br>Sadegh Alijani<br>Karim Hasanpour<br>Hossein Janmohammadi | *University of Tabriz* | Building bridge from genome to phenome across multiple biological traits in honey bee |

(All speakers required to be connected to the session 10 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.

**01.11.2023**

Ankara Local Time: 16:$^{00}$-18:$^{00}$

Ege University, Faculty of Agriculture, D Blok, Hall-1

## HEAD OF SESSION: Prof. Dr. Nayil DİNKÇİ

| Authors | Affiliation | Presentation title |
|---|---|---|
| Nermin Yaraşir<br>Yakup Onur Koca<br>Osman Erekul | *Aydın Adnan Menderes University* | The effect of arid conditions on nitrogen fixation in soybean (*Glycine max*. l. merr.) |
| Gulay Zulkadir | *Mersin University* | Investigation of the effects of using different doses of iba on bean plants |
| Özgül Başar<br>Refiye Refika Akçali Giachino | *Ege University* | Legacy from ancient times to present: naturally coloured cotton |
| Cansu Dindar<br>Uğur Şirin<br>Doğa Aysu Şakar<br>Lütfü Yayalar | *Aydın Adnan Menderes University* | Effects of some plant extracts and chestnut puree added in ms medium on shoot proliferation on micropropagation of *Peperomia obtusifolia* l. in in vitro culture |
| Gülşah Çalişkan Koç<br>Canan Ekinci Akpinar<br>Sevcihan Boyaci<br>Safiye Nur Dirim | *Eşme Vocational School* | Research on the utilization of whey in kefir production |
| Vildan Akdeniz<br>Melisa Ünal<br>Nayil Dinkçi | *Ege University* | Therapeutic potential of whey proteins |
| Senem Öztuğcu<br>Mahmut Yildiztekin<br>Mehmet Fırat Baran | *Muğla Sıtkı Koçman University* | Toxicity of nanoparticles used in agriculture |

(All speakers required to be connected to the session 10 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.

**02.11.2023**
**THURSDAY / 10.00-12.30**

Zoom Meeting ID: **897 0755 8402**
Zoom Passcode: **010203**
**SESSION-1, HALL-1 / OTURUM-1, SALON-1**

## MODERATOR: Assoc. Prof. Dr. Ilias GIANNENAS

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Gülfem Arslan<br>Gülcan Demiroğlu Topçu | *Ege University* | Possibilities of using some thorn species as feeding |
| Parisa Faraji<br>Hamid Paya<br>Akbar Taghizadeh<br>Hamid Mohammadzadeh | *University of Tabriz* | Metabolizabe energy and organic matter digestibilty of tomato plant used in ruminantdiets |
| Hatice Kübra Gören<br>Öner Canavar | *Aydın Adnan Menderes University* | Effects of foliar fertilizer on cotton yield and fiber quality under deficit irrigation conditions |
| Yunus Emre Uslu<br>Serap Açikgöz | *Aydın Adnan Menderes University* | Use of crispr/cas9 technology to develop resistance against plant viruses |
| Stylianos Vasilopoulos<br>Ilias Giannenas<br>Ifigenia Mellidou<br>Ioanna Stylianaki1<br>Efthimia Antonopoulou<br>Athina Tzora<br>Ioannis Skoufos<br>Eleftherios Bonos<br>Christos G. Athanassiou<br>Elias Papadopoulos<br>Paschalis Fortomaris | *Aristotle University of Thessaloniki* | Diet with whole t. molitor larvae affects the intestinal morphology and microbiome of broiler chicken |
| Berk Tutka<br>Zekeriya Kıyma | *Eskişehir Osmangazi University* | Determination of culling rates in holstein and simental herds |
| Ajaydesouza V<br>Vignesh K<br>Lokesh R<br>Sathiya Aravindan V<br>Sabari Grish P | *Annamalai University* | Eco-friendly approach to mitigate macrophomina phaseolina in groundnut using streptomyces spp. |
| Asmau Abbas Ibrahim<br>Aliyu Danmusa Mohammad<br>Sama'ila M Batagarawa | *Umaru Musa Yar'adua University* | Influence of carboxymethylation on the hydrolysis of crosslinked potato starch |
| Masoumeh Niazifar<br>Akbar Taghizadeh | *University of Tabriz* | The effect of biological processing on the chemical composition and in vitro fermentation characteristics of sugar beet pulp |

**02.11.2023**
**THURSDAY / 10.00-12.30**

Zoom Meeting ID: **897 0755 8402**
Zoom Passcode: **010203**
**SESSION-1, HALL-2 / OTURUM-1, SALON-2**

## MODERATOR: Prof. Dr. Aristide MAGGIOLINO

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Emre Yılmazoğlu | *Istanbul University-Cerrahpasa* | Extraction of hypericin from *Hypericum perforatum* L. using a battery-type extractor |
| Melis Çerçioğlu | *Izmir Katip Celebi University* | Soil health and sustainable management: an overview |
| Buse Sergek<br>A.Engin Özçelik | *Selçuk University* | Investigation of the physical properties of aspir oil and 15w40 engine lubricating oil and mixtures |
| Sedat Behrem<br>Yunus Arzik<br>Mehmet Kizilaslan | *Aksaray University* | Optimizing growth: unraveling the inluential enviromental factors in the grazing and development periods of akkaraman lambs |
| S. Can Cengiz<br>Mustafa Okant<br>M. İzzet Türkoğlu | *Harran University* | Determınatıon of the effect of dıfferent plant densıty on some yıeld values ın gap pembesı fodder pea (*Pisum arvense* L.) varıety grown as wınter ıntercrop |
| Ayisha Siddiqkha.A,<br>R.Srinivasan,<br>M.K.Vijayalakshmi | *Bharath Institute of Higher Education And Research* | Pharmacological action of plant-derived natural products on respiratory inflammation and related disease – a review |
| Safaa Khattabi Rifi<br>Khadija Zahidi<br>Salah Souabi<br>Ilham Nassri<br>Latifa Mouhir | *University Hassan II* | Exploring the impact of industrial discharges on soil contamination by heavy metals: a case study in the soil of mohammedia, morocco |
| Muhammed, Y.,<br>Ajayi, O. J.,<br>Tsado, J. H.,<br>Umar, I. S. | *Federal University of Technology* | Factors influencing utilization of agricultural technologies transfer among participants of adopted village extension project in kaduna and niger state, nigeria |
| Pooja Rasal<br>Gaurav Kasar<br>Aman Upaganlawar | *SNJB'S SSDJ College of Pharmacy* | Ameliorative effect of lycopene alone and in combination with co-enzyme q10 in streptozotocin-induced diabetic nephropathy in experimental rats |
| Seyithan Seydoşoğlu<br>Nizamettin Turan | *Siirt University* | Restoration of Semi-Natural Grasslands - Should I Stay or Should I Go? |

**02.11.2023**
**THURSDAY / 10.00-12.30**

Zoom Meeting ID: 897 0755 8402
Zoom Passcode: 010203
**SESSION-1, HALL-3 / OTURUM-1, SALON-3**

## MODERATOR: Assoc. Prof. Dr. Gazel SER

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Büşra Yapici<br>Ezgi Gürsoy<br>Beyza Nur Yildiz<br>Emre Ipek<br>Süleyman Kavak<br>Ertan Sait Kurtar | *Petektar Tohum Sanayi Ticaret Limited Şirketi* | Effect of caesium-sourced gamma irradiation on haploidization in powdery mildew and zymv resistant summer summer summer (*Cucurbita pepo* L.) lines. |
| Fatih Pek<br>Mehmet Demir Kaya | *Eskişehir Osmangazi University* | Effects of an als inhibitor herbicide on weed density and yield in sugar beet |
| Gazel Ser | *Van Yuzuncu Yil University* | Efficient resource utilization in sustainable agriculture: a statistical power analysis |
| Nur Koç Koyun | *Selçuk University* | The advice for combating climate change in meadow, pasture, and forage crop agriculture |
| Radhiyah M. Aljarrah<br>Ali M. Aljawdah | *University of Kufa* | Fabrication and characterization of co3o4:ce gas sensor prepared by chemical spraying pyrolysis technique |
| Akankwasa Eunice<br>Amos Ronald Kalukusu | *Nkumba University* | Exploring the adoption of energy-efficient technologies around bwindi impenetrable national park in kisoro district, uganda |
| Maghsoud Besharati | *University of Tabriz* | Effect of treated alfalfa silage with whey and microbial additive on charactristics, chemical composition and in vitro degradability |
| Rida Zulfiqar | *University of Szeged* | Leveraging data science and artificial intelligence for proactive pandemic response: a comprehensive review |
| Vidya Padmakumar<br>Murugan Shanthakumar | *Bangalore University* | Advancements in mitigating micropollutants in agriculture: towards sustainable crop production |
| Orhan Ermetin | *Yozgat Bozok University* | Heat stress and its effects on dairy cattle |

**02.11.2023**
**THURSDAY / 10.00-12.30**

Zoom Meeting ID: 897 0755 8402
Zoom Passcode: 010203
**SESSION-1, HALL-4 / OTURUM-1, SALON-4**

## MODERATOR: Prof. Dr. Yusuf Konca

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Uğur Tan<br>Olcay Arabaci | *Aydin Adnan Menderes University* | Comparative evaluation of mint cultivars: chlorophyll content, some morphological traits and fertilization impact |
| Mehmet Altuğ Küçükosmanoğlu | *Istanbul University-Cerrahpaşa* | Criminological analysis of forest fires: a case of izmir forest regional directorate |
| Ayşen Arslan<br>Zeynep Hazal Tekin Çakmak<br>Selma Kayacan Çakmakoğlu<br>Salih Karasu<br>Osman Sağdiç | *Istinye University* | Evaluation of bioactive compounds of different salep species growing in turkey |
| Haluk Kulaz<br>Ishak Baran | *Van Yüzüncü Yıl University* | Effects of various salt concentration applications on seedling development of cowpea |
| Birsena Duljević<br>Jelana Vitomir<br>Slobodan Popović | *University of Megatrend in Belgrade* | Decision-making of top management and establishment of internal form of control in relation to the tourism economy like the republic of serbia |
| Birsena Duljević<br>Jelana Vitomir<br>Slobodan Popović | *University of Megatrend in Belgrade* | Tourism as an economic branch which can contribute to the possible improvement of top management decision-making |
| Zeba Ali Mumtaj<br>Abdul Rahman Khan<br>Saimah Khan | *Integral University* | Review on removal of agricultural and pharmaceutical waste from wastewater using constructed wetland |
| Saiqa Andleeb<br>Iram Liaqat<br>Shaukat Ali | *University of Azad Jammu and Kashmir* | Role of earthworm based-products in agriculture, environment, and health |
| Lawal, I<br>Abdulkarim, B. | *University of Stirling* | Exposure of nile tilapia (oreochromis niloticus) prefeeding larvae to aroclor 1254 and benzo(a) pyrene in a laboratory upregulate cyp p450 (a1) gene through ahr pathway |

**02.11.2023**
**THURSDAY / 10.00-12.30**

Zoom Meeting ID: 897 0755 8402
Zoom Passcode: 010203
**SESSION-1, HALL-5 / OTURUM-1, SALON-5**

## MODERATOR: Assist. Prof. Dr. İsmail Tahtawy

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Ece Kesici Meço<br>Ece Ünür Yilmaz<br>Mete Yilmaz | *Bursa Technical University* | Electrochemical biosensor for monitoring interaction between saxitoxin and dna |
| Özge Siyahli<br>Ahmet Şükrü Demirci | *Tekirdağ Namık kemal University* | Microbiological quality of demijohnwater and the effect of pump use |
| Neslihan Özkaya<br>Tolga Aysal<br>Derya Şenal | *Directorate of Pest Control Central Research Institute* | Determination of the status of the coccinellidae (coleoptera) family in kirklareli province |
| Ezgi Aydoğmuş | *Balıkesir University* | Potato farming according to dr. n. kiryako |
| Elena Sierikova<br>Elena Strelnikova<br>Kirill Degtyarev<br>Nataliia Vnukova | *National University of Civil Defence of Ukraine* | Engineering solutions to reduce environmental hazards of storage tanks |
| Haruna Danyaya Abubakar<br>Ismaila Abdullahi<br>Murtala Sa'idu | *Department of Science Laboratory Technology* | Assessment of the impact of abattoir effluent on the water quality of kazaure dam jigawa state, nigeria |
| Adefalu, L.L.,<br>Ibrahim-Olesin, S.,<br>Adrinoye-Abdulwahab, S. A.,<br>Akanbi, S. O.,<br>Olowoyo, A. V.,<br>Olaitan, T. R. | *University of Ilorin* | Assessment of cocoyam utilization patterns among rural households in ekiti state, nigeria |
| Saghouri El Idrissi Imane<br>Kettani Rajae<br>Khalfi Chemsdoha<br>Ferrahi Moha<br>El Fechtali Mohamed<br>Ziri Rabea<br>Brhadda Najiba | *University of Ibn Tofail* | Assessing the influence of climate change on morocco's reserve resources for durum wheat land |
| Abdeljalil Hamdi<br>M'hamed Ahari<br>M. Koudad<br>Said Dadou<br>A.El Aatiaoui | *Abdelmalek Essaadi University* | Synthesis, characterization of new tri-substituted imidazole's derivatives and biological activity |

**02.11.2023**
**THURSDAY / 13.00-15.30**

Zoom Meeting ID: 897 0755 8402
Zoom Passcode: 010203
**SESSION-2, HALL-1 / OTURUM-2, SALON-1**

## MODERATOR: Ecem KARA

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Duygu Alpaslan<br>Selma Kıpçak Bitik<br>Tuba Erşen Dudu<br>Nahit Aktas | *Van Yüzüncü Yıl University* | In vitro determine of antifungal activity of natural particles against pathogenic fusarium oxysporum |
| Cevat Filikci | *Kırşehir Ahi Evran University* | Determination of biogas amount and biomethanization energy potential of animal and agricultural wastes, the case of Kırşehir-çiçekdağı |
| Ecem Kara<br>Gökhan Baktemur | *Sivas Bilim ve Teknoloji University* | Determination of the tolerance level of arugula (*Eruca sativa* L.) plant to nutrient media containing different concentrations of nacl under in vitro conditions |
| Ecem Kara<br>Gökhan Baktemur | *Sivas Bilim ve Teknoloji University* | Determination of the tolerance level of onion (*Allium cepa* L.) plant in nutrient media containing different concentrations of nacl under in vitro conditions |
| Major Gheorghe Giurgiu<br>Manole Cojocaru<br>Scires I, Eusplm | *Titu Maiorescu University* | Microbiota modulation as therapeutic approach in the neuropathic pain in dog with spinal cord injury: impact of polenoplasmin |
| Olawale Oyemade Oyekanmi | *University of Ibadan* | Food security: paradigm shift in philosophy of sustainability in the 21st century and beyond |
| Mustafa Kizilşimşek<br>Eylül Nezahat Kizilyar | *Kahramanmaraş Sütçü İmam University* | Effect of different salinity levels on germination and seedling development of some lawn lolium (*Lolium perenne*) cultivars |
| Syed Ali Raza Naqvi<br>Sumaira Naz<br>Sadaf Ul Hassan | *Government College University* | Comparative assessment of antioxidant and antibacterial activities of different black tea belong to regions of different ecology |
| Olurinde, Kingsley O.,<br>Agboola, Luqman W.,<br>Oladunni, Olufemi A. | *Agricultural and Rural Management Training Institute* | Determinants of willingness to adopt farm service centre model among farming households in abia state, Nigeria. |

**02.11.2023**
**THURSDAY / 13.00-15.30**

Zoom Meeting ID: 897 0755 8402
Zoom Passcode: 010203
**SESSION-2, HALL-2 / OTURUM-2, SALON-2**

## MODERATOR: Assist. Prof. Dr. Veysel BAY

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Yasemin Torlak | *Pamukkale University* | Effects of some herbal essential oils grown under organic conditions against agricultural diseas and pests |
| Erkan Eren<br>Ceren Öztürk | *Ege University* | Use possibilities of biological preparations in mushroom cultivation |
| Ceren Öztürk<br>Erkan Eren | *Ege University* | The importance of edible and medicinal mushrooms on human health |
| Mizgin Karahan<br>Canan Abay<br>Seiki Kiyono | *Niigata University* | Examining the challenges faced by organic raisin producers and their willingness to sustain organic agriculture |
| Shivani Yadav<br>D.K. Chauhan<br>Ruhi Tomar<br>Priya | *Chaudhary Charan Singh University* | Plant mediated based biosynthesis and characterization of copper oxide nanosized particles from murraya koenigii and their biomedical application in albino rat |
| Granit Baca<br>Nail Reshidi | *University of Prishtina* | Enhancing bank employee empowerment and brand equity through internal marketing |
| Akintola, Akinwumi Kabir<br>Akintola, Kafayat Adenike | *The Polytechnic* | Analysis of outsourcing services as a tool for organizational sustainability |
| Mohamed El Fadili<br>Mohammed Er-Rajy<br>Hamada Imtara<br>Mohammed Kara<br>Sara Zarougui<br>Najla Altwaijry<br>Omkulthom M. Al Kamaly,<br>Aisha Al Sfouk<br>Menana Elhallaoui | *Sidi Mohamed Ben Abdellah University* | 3D-QSAR, ADME-Tox in silico prediction and molecular docking studies for modeling the analgesic activity against neuropathic pain of novel NR2B-Selective NMDA receptor antagonists |
| Hamida Zafar | *Jinnah University* | Challenges and opportunities for women as academic leaders' in Public Universities, Karachi, Pakistan |

**02.11.2023**
**THURSDAY / 13.00-15.30**

Zoom Meeting ID: **897 0755 8402**
Zoom Passcode: **010203**
**SESSION-2, HALL-3 / OTURUM-2, SALON-3**

## MODERATOR: Assist. Prof. Dr. Yeter ÇİLESİZ

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Beşir Koç<br>Büşra Gökşenli | *Bitlis Eren University* | Ice cream consumption preferences of consumers according to their socio-economic status |
| Ahmet Refik Önal<br>Mahmut Özkan | *Namık Kemal University* | The effect of somatic cell count on raw milk compositional quality of cow milk of dairy farms in İzmir |
| Beşir Koç<br>Zübeyde Güçden | *Bitlis Eren University* | Analysis of the processed local food products market: the example of bingöl soguk Çesme roast |
| Alaattin Yiğit<br>Ayhan Yıldız | *Aydın Adnan Menderes University* | The effectiveness of some copper fungicides for olive peacock eye disease (spilocaea oleagina) |
| Gökhan Ovalıoğlu<br>Yeter Çilesiz | *Sivas University of Science and Technlogy* | Soılless farmıng as an alternatıve method for the sustaınabılıty of agrıcultural productıon |
| Gautham Ravisankar<br>Diffyan Darshanan<br>Herman Shah Anuar | *Universiti Utara* | Seaport 4.0: comparative analysis between singapore port and port klang |
| Herman Shah Anuar<br>Nur Aqilah Balqis Binti Ishak<br>Nur Ain Shahirah Binti Rusle<br>Siti Nor' Zulaifah Binti Radzali | *Universiti Utara Malaysia* | Free trade zone: issues and challenges on employment opportunity for young graduates |
| Muhammad Waqas<br>Hafiz Qadeer Ahmed | *University of Agriculture* | Isolation of e. coli and staphylococcus from clinical endometritis and antimicrobial susceptibility in dromedary she camels (camelus dromedarius) |
| K.R. Padma<br>K.R. Don<br>P. Josthna | *Sri Padmavati Mahila Visvavidyalayam (Women's) University* | Integration and evolution of smart cities with artificial intelligence, internet of things and blockchain technology |
| Izuogu, Chibuzo Uzoma<br>Njoku, Loveday Chukwudi<br>Azuamairo, Gillian Chidozie | *Alex Ekwueme Federal University* | Access and utilisation of agricultural credits by women in ikwo local government area, ebonyi state, Nigeria |

**02.11.2023**
**THURSDAY / 13.00-15.30**

Zoom Meeting ID: 897 0755 8402
Zoom Passcode: 010203
**SESSION-2, HALL-4 / OTURUM-2, SALON-4**

## MODERATOR: Prof. Dr. Sibel AKALIN

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Adil Karanfil<br>Pervin Kinay Teksür | *Ege University* | Recent developments in precision agriculture and crop protection |
| Ahmed Karahan<br>Mehmet Ali Kutlu<br>Halil Selçukbiricik<br>Ismail Karaca | *Afyonkarahisar Directorate of Provincial Agriculture and Forestry* | Control methods of Afyonkarahisar province beekeepers against varroa pest |
| Merve Tuncay<br>A. Sibel Akalin | *Ege University* | Probiotic viability in milkshake powder and quality characteristics of milkshake drink |
| Pelin Işinibilir<br>Aycan Yiğit Çınar<br>Zehra Irem Yıldız | *Bursa Teknik University* | Antibacterial effects of gelatin nanofibers produced by electrospinning method |
| Donna Laili Octaviana<br>Ryan Andni | *Institut Agama Islam Negeri Kudus* | Peran digital marketing terhadap peningkatan pendapatan umkm alam tani hydrofarm di Kudus |
| Blessy V Rajan | *St Xavier's College* | Nutritive value of trash fishes of vembanad lake over the delicacies |
| Luluk Rahmawati | *Tirtayasa University* | Efektivitas penerapan e-goverment sebagai media di dalam upaya peningkatan pelayanan berbasis |
| C.Vijai,<br>M.Elayaraja | *St.Peter's Institute of Higher Education and Research* | Impact of climate change on Indian agriculture |
| Luiza Bernardi Provensi<br>Rosecler Maschio Gilioli<br>Maria Emilia Camargo<br>Mariane Camargo Priesnitz | *University of Caxias do Sul* | Personal finance: a study on the financial behavior of individuals |
| Gizem Nur Küçükköroğlu<br>Pervin Kınay | *Ege University* | Control of diseases after illness, the importance of fruit microbiome and new techniques |

**02.11.2023**
**THURSDAY / 13.00-15.30**

Zoom Meeting ID: 897 0755 8402
Zoom Passcode: 010203
**SESSION-2, HALL-5 / OTURUM-2, SALON-5**

## MODERATOR: Assist. Prof. Dr Ali YİĞİT

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Berkay Arbay<br>Mustafa Gümüş | *Ege University* | Determination of weeds that are potential intermediate hosts of tomato spotted wilt virus (tswv) in tomato and pepper growing areas in İzmir province and its surroundings |
| Sher Ali Jawar<br>Ömer Faruk Yilmaz<br>Mehmet Akif Çam | *Ondokuz Mayıs University* | Effects of climate change on animal production |
| Ali Yiğit | *Aydın Adnan Menderes University* | Whole grain health benefits: grain color and antioxidant properties |
| Cansu Ercan<br>Eyüp Şişman | *Yildiz Technical University* | The climate change impact on drought characteristics in Antalya basin |
| Maria Emilia Camargo<br>Mariane Camargo Priesnitz<br>Walter Priesnitz Filho<br>Angela Isabel Dos Santos Dullius<br>Marta Elisete Ventura Da Motta | *Federal University of Santa Maria* | Relationship between technostress and organizational behavior |
| Rita Fabíola Roduit<br>Diego Luís Bertollo<br>Maria Emilia Camargo<br>Mariane Camargo Priesnitz<br>Angela Isabel Dos Santos Dullius<br>Angela Pelegrin Ansuj | *Federal University of Santa Maria* | Fleuriet dynamic model: a case study applied to educational services companies listed on the stock exchange (b3) |
| Maghsoud Besharati | *University of Tabriz* | Use of additive in alfalfa silage production: a review |
| Parvez Shorab<br>Rahima Prodhan<br>Rasheedul Haque | *MAHSA University* | Comparative analysis and development practices in food industry – nestlé Malaysia |
| Rahima Prodhan<br>Parvez Shorab<br>Rasheedul Haque | *MAHSA University* | Comparative analysis of training and development practices in fast food segment –mcdonalds and Kfc |

**03.11.2023**
**FRIDAY / 10.00-12.30**

Zoom Meeting ID: 897 0755 8402
Zoom Passcode: 010203
**SESSION-3, HALL-1 / OTURUM-3, SALON-1**

## MODERATOR: Prof. Dr. Nayil DİNKÇİ

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Hüseyin Yildiz<br>R. Refika Akçali<br>Giachino | *Ege University* | Assessment of bread wheat landraces based on yield and some agronomic characteristics |
| Aytekin Ekincialp<br>Çeknas Erdinç<br>Selma Kıpçak Bitik<br>Suat Şensoy | *Van Yüzüncü Yıl University* | Determination of polyphenolic content in tomato fruits harvested in different development periods of different fertilizer combinations |
| Fazilet Parlakova Karagöz<br>Atilla Dursun<br>Sedanur Aksoy | *Atatürk University* | Problems encountered in lisianthus (*Eustoma grandiflorum* (raf.) schinn.) seedling production |
| Ahmet Çelik<br>Korkmaz Bellitürk | *Adıyaman University* | The importance and management of biochar and compost for land degraded and organic matter-poor soils |
| Ana Batariuc<br>Silvia Mironeasa | *Stefan cel Mare University* | Processing technologies of sorghum grains and their effects on the sorghum flour characteristics |
| Anni Mafaticha<br>Riyan Andni | *Institut Agama Islam Negeri Kudus* | Analisis swot dalam strategi pengembangan umkm petani selada (studi kasus umkm alam tani hidrofarm kudus) |
| Nina Khromykh<br>Olena Liashenko | *Oles Honchar Dnipro National University* | Phytochemical constituents and antibacterial ability of inflorescences of the genus sorbus plants |
| Ganya, Adamu Hauni<br>Dauda, Hauwa<br>Ango, Monica<br>Asabe Ibrahim | *Usmanu Danfodiyo University* | Environmental impact assessment (eia) and its significance |
| Sochi Otisi Anaga<br>Funke Mary Olabanji<br>Obianuju Patience Ilo | *National Biotechnology Development Agency Abuja* | Sustainable technology for effective wastewater management: a review article |

**03.11.2023**
**FRIDAY / 10.00-12.30**

Zoom Meeting ID: 897 0755 8402
Zoom Passcode: 010203
**SESSION-3, HALL-2 / OTURUM-3, SALON-2**

## MODERATOR: Assoc. Prof. Dr. Muazzez CÖMERT ACAR

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Korkmaz Bellitürk<br>Ahmet Çelik | *Adıyaman University* | Determination of plant nutrition capacities of agricultural areas by soil analysis: the case of hayrabolu district of Tekirdağ province |
| Ahmet Refik Önal<br>Mahmut Özkan<br>Zeynep Önal | *Namık Kemal University* | Structural characterıstıc of the daıry farms in Izmır |
| Salih Sezer<br>Esra Bilici | *Uşak University* | Laminitis |
| Zeliha Üstün Argon<br>Hatice Banu Keskinkaya<br>Süleyman Doğu<br>Turan Akdağ | *Necmettin Erbakan University* | Antioxidant activity, phenolic and flavonoid content of curcuma longa extracted with supercritical Co2 extraction method |
| Delbi Rizka Adik Azhari<br>Riyan Andni | *Institut Agama Islam Negeri Kudus* | Evaluasi dampak perubahan iklim terhadap UMKM hidroponik selada (Studi Kasus Alam Tani Hidrofarm Kudus) |
| Saima Shaheen<br>Nabila Sher<br>Mashal Zafar<br>Kalsoom Tariq<br>Sosan Rauf | *Khyber Girls Medical College* | Effect of lipid-based multiple micronutrients supplementation in underweight primigravida pre-eclamptic women on maternal and pregnancy outcomes: randomized clinical trial |
| Sunil Kumar Agrawal | *People's University* | A study of the effects of technological changes on society and the environment |
| Purushottam Kumar<br>Bp Singh | *Dr. Bhimrao Ambedkar University* | Study of thermal behavior of lithium-ion batteries: a review on, management systems, electrode materials and thermal runway- perspective and future directions |
| Aamina Tarique<br>Abdul Rahman Khan<br>Saimah Khan | *Integral University* | Removal of pharmaceutical compounds from synthetic wastewater using activated carbons derived from citrus fruits peel |

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**FRIDAY / 10.00-12.30**

Zoom Meeting ID: **897 0755 8402**
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**SESSION-3, HALL-3 / OTURUM-3, SALON-3**

## MODERATOR: Assoc. Prof. Dr. Özgür TATAR

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Ali Amer<br>Ali Kasra<br>Mehmet Ali Bal | *Kahramanmaras Sutcu Imam University* | The physical and fermentation properties of various silages produced in commercial farms from different provinces of Kahramanmaras |
| Neslinur Atay<br>Yakut Gevrekçi<br>Çiğdem Takma | *Ege University* | Polymorphic genes affecting milk production and quality in dairy cattle |
| Betül Süeltürk<br>Çiğdem Coşkun Hepcan | *Ege University* | Plant and pollinator biodiversity assessment of urban parks in Bariş Neighborhood, Bursa, Türkiye |
| Sebiha Erol<br>Murat Dede<br>Kutay Avci<br>Emine Budakli Çarpici | *Bursa Uludağ University* | Determination of silage quality in bagasse and bagasse+leaf of some sweet sorghum varieties |
| Omar Benamari<br>Hassan Amhamdi | *Abdelmalek Essaadi University* | Biodiversity of Cistus Ladaniferus (Cl) extracts and Essential Oils (Eos): a review of their ınsecticidal activity against various ınsects |
| Iqbal Harbi Mohammed Al_Zaidi<br>Shurook M.K. Saadedin<br>Taif Abedulhussein | *University of Baghdad* | Essential oils gas chromatography-mass-spectroscopy (Gc-Ms) analysis and potential in breast cancer treatment |
| Y.M. Blessy<br>B.Kaviyadharshini<br>B.Mahalakshmi<br>J.Kavipriya | *R.M.K. Engineering College* | A microprocessor and micro controller project on s0lar automatic railway track crack detecting vehicle |
| Soheila Abachi<br>Chung-Ho Lin | *University of Missouri* | An undervalued folklore source of pharmaceutical, nutraceutical and cosmeceutical ingredients; osage orange |
| Fraiha Oumaima<br>Ahari M'hamed | *The Faculty of Science & Technology at Al Hoceima* | Removal of pharmaceuticals from wastewater by adsorption process |

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**SESSION-3, HALL-4 / OTURUM-3, SALON-4**

## MODERATOR: Assist. Prof. Dr. Veysel BAY

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Yüksel Bayram | *Pamukkale University* | Sustainable agri-food systems |
| Veysel Bay | *Ege University* | Genetic transformation: crispr's impact on animal traits in agriculture, biomedicine, and conservation |
| Arturo Hernandez-Colina<br>Veysel Bay<br>Merit Gonzalez-Olvera<br>Adrian Josue Guel-Cortez<br>Silvino Kazim<br>Laura Romero<br>Özer Hakan Bayraktar | *Ege University* | A multidisciplinary approach to wild bird diseases: from avian flu to novel diagnostic techniques |
| Ilker Atik<br>Gökhan Akarca<br>Azize Atik | *Afyon Kocatepe University* | Chemical properties and antifungal effects of cold press seed oils of different fig varieties |
| Ancuța Petraru<br>Sonia Amariei | *Ștefan cel Mare University* | A novel approach to valorizate sesame oilcake |
| Faniyi, Tolulope Oreoluwa,<br>Amusan, Elizabeth Toluwani,<br>Anifowoshe, Isaac Olaolu<br>Fanifosi, Gbenga Emmanuel | *Ajayi Crowther University* | Evaluation of grazing livestock destructive ability on horticultural sites in Nigeria: a review |
| Sahana S,<br>Blessy Y.M | *RMK engineering college* | Large range soil moisture sensing for inhomogeneous environments using magnetic induction networks |
| Freeha Hafeez<br>Ameer Fawad Zahoor<br>Shagufta Kamal<br>Asim Mansha<br>Zohaib Raza | *Government College University Faisalabad* | Piperazine based dithiocarbamates as potent tyrosinase inhibitors: synthesis, in vitro and in silico studies |
| Joseph Oluwabusayo Amao<br>Ezekiel Akinkunmi Akinrinde | *University of Ibadan* | Use of biochar for remediation of heavy metal-contaminated alfisols grown to corchorus olitorious |

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## MODERATOR: Assit. Prof. Dr. Valiollah PALANGI

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Azize Atik<br>Gökhan Akarca<br>Ilker Atik | *Afyon Kocatepe University* | Antifungal and antibacterial properties of wheat germ oil |
| Hüseyin Güngör<br>Mehmet Fatih Çakır | *Duzce University* | Germination viability of popcorn M1 seeds (*Zea mays* everta Sturt.) after gamma-ray irradiation |
| Halise Kaya<br>Fatma Aykut Tonk | *Ege University* | Investigation of Spike Traits in $F_2$ and $F_3$ Generations of Different Bread Wheat Combinations |
| Hatice Tuğcu<br>Nesrin Örçen | *Ege University* | Effect of humic acid doses on barley yield and quality components |
| Stojan Manolev<br>Nadica Bliznakovska | *High School "Goce Delchev* | School and learning for a healthy environnment-activities |
| Arash Javanmard<br>Karim Hasanpour<br>Seyad Abass Rafat | *University of Tabriz* | Perspective of molecular determination for the mechanism of high reproductive efficiency in romanov sheep and their cross breeds based on candidate genes approach |
| Gabor Szabó | *Budapest University of Technology and Economics* | The effect of war on alcohol consumption among soldiers and civilians |
| Muhammad Jabbar | *Cholistan University of Veterinary and Animal Sciences* | Nanoemulsions as food ingredients |
| Gabriela Hernández-García<br>Ethel Caterina García y González<br>Kevin Steve Castro-Bautista<br>Edgar Valencia-Franco<br>Ivan Hidalgo-Parra<br>Maricela Ruiz-Ortega<br>María de la Luz Barrios-Moreno<br>José Luis Ponce-Covarrubias | *Universidad Autónoma de Guerrero* | Effect of heat stress on Blackbelly ewes in the Mexican tropics during summer |

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**SESSION-4, HALL-1 / OTURUM-4, SALON-1**

## MODERATOR: Assist. Prof. Dr. Deniz İŞTİPLİLER

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Hicham Yazid<br>Aziz El Kassimi<br>Lekbira El Mersly<br>El Mountassir El Mouchtari<br>Mamoune El Himri<br>Salah Rafqah<br>Mohammadine El Haddad | *Université Cadi Ayyad* | Optimization study of pharmaceuticals pollutants adsorption onto large surface area walnut shells activated carbon: experimental design, mechanism and DFT calculations |
| Andhika<br>Sugeng P. Harianto<br>Dian Iswandaru<br>Arief Darmawan | *University of Lampung* | Analysis of forest patrol findings regarding wildlife poaching using smart patrol, at pemerihan resort, bukit barisan selatan national park |
| Sahar El Maazouzi<br>Adil Asfers<br>Mohammed Ezziyyani | *Biological engineering, agri-food and aquaculture* | Biological methods for post-harvest control of r. stolonifer rot in peaches and nectarines |
| Ruhollah Kianfar<br>Navid Daliri<br>Hossein Janmohammadi | *University of Tabriz* | The effects of different dietary levels of black seed (*Nigella sativa*) on laying hens eggs cholesterol and triglyceride |
| Haidar Nassur Said Ali | *Hassan II University of Casablanca* | Assessment of water quality in the Nfifikh river and Oued El Maleh dam using the generic diatom index |
| Maliha Gohar | *Kohat University of Science and Technology* | Classification of second order ordinary differential equations using lambda symmetries |
| Nadia Al-Muslimawi<br>Dhia Ibrahim | *University of Baghdad* | Effect of early acclimatization and ginseng (*Panax Ginseng*) extract on some physiological traits of broiler chickens under heat stress |
| Valiollah Palangi<br>Gökhan Kilinç | *Ege University* | Establishing a national feed composition database for ruminant animals in Türkiye |
| Aidin Dokht Niknia<br>Reza Vakili | *Islamic Azad University* | Performance and gut health in coccidiosis challenged broilers fed diet supplemented with a blend of thymol and carvacrol |
| Daniel Kallinger<br>August Starzinger | *GGP GmbH* | Comprehensive growth trials with novel fertilizers of cannabis plants |

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**SESSION-4, HALL-2 / OTURUM-4, SALON-2**

## MODERATOR: Prof. Dr. Aristide MAGGIOLINO

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Maryam Nazir<br>Bilal Aslam<br>Muhammad Naeem Faisal<br>Muhammad Rehan Sajid<br>Asif Hussain<br>Ifraha Abbas | *University of Agriculture Faisalabad* | Evaluation of antidiabetic activity of *Xnthium strumarium* leaves in wistar rats |
| Mohammad Hossein Banakar<br>Mohammad Javad Babaie Zarch<br>Amir Parnian | *National Salinity Research Center* | Effects of different seed treatments on germination rate and germination percentage of nitraria schoberi |
| Mehdi Karimi<br>Mohammadhossein Banakar<br>Amir Parnian | *National Salinity Research Center* | Feasibility of five forage halophyte production in Iran |
| Toumi Meriem<br>Abdelli Islem Safia<br>Abdelmalek Fatiha<br>Addou Ahmed | *Abdelhamid Ibn-Badis University* | Estimation of biogas emission produced by solid waste from blida dumpsite using ipcc empirical model |
| Ivan Pavlovic<br>Slavica Zivkovic<br>Bojana Mijatovic<br>Natalija Kostic | *Scientific Institute of Veterrinary Medicine of Serbia* | Measures to control parasıtıc infectıons of small rumınants kept on pastures |
| Fatima Zahrae Laaboudi<br>M'hamed Ahari | *University Abdelmalek Essaadi* | Cannabis cultivation and its environmental impact |
| Mohamed Rejdali<br>M'hamed Ahari<br>Hassan Amhamdi | *Abdelmalek Essaadi University* | Characterization of the essential oil of Cannabis sativa from the Al-Hoceima region in northen Morocco |
| Andrey Popatanasov | *Bulgarian Academy of Sciences* | Effects of hormopriming with cytokinins on the germination of *Lactuca sativa* cv. Gentilina |

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## MODERATOR: Dr.Ali Reza BAYAT

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Vidya Padmakumar<br>Murugan Shanthakumar | *Bangalore University* | Interactions of the bearded vulture with symbionts, parasites, predators, and competitors: implications for health and fitness |
| Ali Abbas<br>Syed Ali Raza Naqvi | *Govt college University Faisalabad* | Evaluation of antioxidant, antibacterial and anti-fungal activities of Salvia macrosiphon extracts |
| Andrey Popatanasov | *Bulgarian Academy of Sciences* | Effects of hormopriming with cytokinins on the germination of *Helianthus annuus* cv. Favorit |
| Laila Ouardi<br>Abdelmajid Haddioui<br>Hasna Zinelabidine<br>Zahra El Kettabi<br>Jamal Charafi | *Sultan Moulay Slimane University* | Physicochemical, morphological and pomological characteristics of a grape (*Vitis vinifera* L.) germplasm collection |
| Saddam Hussain | *University of Agriculture* | Use of plant-based superabsorbent polymers for enhancing agricultural productivity in marginal and stress-prone areas: overview and prospects |
| Mohammad Javad Babaie-Zarch<br>Mohammad Hossein Banakar<br>Hasan Zare-Zardini | *National Salinity Research Center* | Investigatıng the productıon of forage and seed of blue panıc grass (*Panıcum antıdotale* Retz.) in the first year of plant establıshment |
| Maximilian Lackner<br>Wieland Schmid-Schmidsfelden<br>Martin Melinz<br>Qiang Fei<br>Shuqi Guo<br>Ning Yang<br>Xiaoping Guan<br>Peng Hu | *Circe Biotechnologie GmbH* | Valorization of waste agricultural biomass through gasification and gas fermentation to value-added products by gas fermentation |
| Ana Sheikhalipoor<br>Ali Hosseinkhani | *University of Tabriz,* | Insects as new feed in animal nutrition |
| Moses Adeolu Agoi<br>Oluwadamilola Peace Agoi<br>Oluwanifemi Opeyemi Agoi | *Lagos State University of Education* | Assessing the efficacy of iot-based animal health monitoring system: a survey for precise agricultural practices |

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**SESSION-4, HALL-4 / OTURUM-4, SALON-4**

**MODERATOR: Maghsoud BESHARATI**

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Irfan Baboo<br>Hamid Majeed<br>Khalid Javed Iqbal | *Cholistan University of Veterinary and Animal Sciences* | Neem (Azadirachta Indica) extract and nano- emulsion loaded anti-pest tablets to tackle wheat pest |
| Soukayna Baammi | *Mohammed VI Polytechnic University* | Harnessing African botanical diversity: exploring natural compounds as VEGFR-2 inhibitors for anti-angiogenic cancer therapeutics |
| Yusuf, A.A., | *College of Agriculture* | Uses of dehydrated food waste as halal energy source in village chicken layers diet for weight gain and improvement of egg quality traits |
| Shalva Zarnadze<br>Irine Zarnadze | *Aging Medicine* | Nutritional characteristics of the Black Sea region and modern challenges |
| Tabinda Waheed<br>Muhammad Asad | *University of Education* | Exploring the protective role of cheena (*Panicum miliaceum*) seed extract against carbon nao-tubes toxicity in cirrhinus mirigala |
| Mette Vaarst | *Aarhus University* | Future perspectives on cow-calf contact systems in dairy farming |
| Marcos Paulo Carvalho de Santana Silva<br>Sávio Torres Melo | *Centro Universitário UniFacid Wyden* | Analysis of a degraded areas recovery plan (Darp) in the municipality of balsas - Ma |
| Maria Eduarda Freire Magalhães Silva<br>Sávio Torres Melo | *Centro Universitário UniFacid Wyden* | Application of olive pit in construction for environmental reserve areas |
| Isadora de Sousa Oliveira<br>Sávio Torres Melo | *Centro Universitário UniFacid Wyden* | The ecological icms as an environmental conservation encouragement: reduction in the incidence of burns outbreaks in piauiense municipalities |
| Maghsoud Besharati | *University of Tabriz* | Use of additive in alfalfa silage production: a review |
| Alireza Bayat<br>Tomasz Stefański<br>Enyew Negussie<br>Martin Lidauer<br>Pekka Huhtanen | *Natural Resources Institute Finland* | Methods to measure enteric methane production of ruminants; some comparisons |

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**SESSION-4, HALL-5 / OTURUM-4, SALON-5**

## MODERATOR: Assist. Prof. Dr. Sevdiye Yorganci

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Mesut Yüceyurt<br>Asuman Kaplan Evlice | *Sivas Science and Technology University* | Wheat landraces and their importance |
| Sevdiye Yorganci<br>Serap Açikgöz | *Aydın Adnan Menderes University* | Identification of a new plant virus agency using molecular methods |
| Paula Oros<br>Maria Cantor<br>Corina Cătană | *University Of Agricultural Sciences and Veterinary Medicine Cluj-Napoca* | Rapid clonal micropropagation of Passiflora caerulea |
| Muhammad Faisal | *Allama Iqbal Open University* | Distinguish some popular sap modules with will propose a nice sap course for pakistani students and it experts |
| Stanislava Stateva | *Agricultural Academy* | Development of methods and technologies for in vitro propagation and storage of wild plant species |
| Dang Hoang Xuan Huy<br>Vo Dinh Quyet<br>Hoang Van Tuan | *Nha Trang University* | Assessing the effectiveness of productivity utilization in white leg shrimp farming in khanh hoa and phu yen regions, Vietnam |
| Olawepo, Gabriel Kehinde<br>Olanipekun, Taiwo Zainab | *University of Ilorin* | Influence of zinc oxide nanoparticles and cadmium uptake on growth of jute (*Corchorus olitorus* L.) |
| Khaoula Mkhayar<br>Souad Elkhattabi<br>Kaouakeb El khattabi | *Sidi Mohamed Ben Abdellah-Fez University* | Discovery of new anti-cancer agents for the human breast cancer cell line using 3D QSAR and molecular docking studies on a series of 1,4 disubstituted-1,2,3-triazoles |
| S.Sakthi<br>R. Devi<br>R. Srinivasan | *Bharath Institute of Higher Education and Research* | Nanoemulsion |
| Lütfiye Can<br>Süleyman Bilgiç<br>Salih Odabaşi<br>Muzaffer Ipek<br>Şeyma Arikan | *Selçuk University* | The effect of perlan, herbagreen, and seaweed applications on fruit quality and yield in some apple varieties |
| Abdullah Küçük<br>Ahmet Bozoğlu<br>Mert Ramazan Sarioğlu<br>Burcu Turan<br>Şeyma Arikan<br>Muzaffer Ipek | *Selçuk University* | The effect of some organic preparations on plant growth and fruit quality characteristics in rubygem strawberry variety |

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**SESSION-4, HALL-6 / OTURUM-4, SALON-6**

## MODERATOR: Vaibhav Kant Singh

| AUTHOR | AFFILITION | ABSTRACT TITLE |
|---|---|---|
| Vaibhav Kant Singh<br>Varun Pandey | *Central University* | Decision tree for agriculture |
| Vaibhav Kant Singh<br>Kapil Kumar Nagwanshi<br>Satyendra Singh Thakur<br>Varun Pandey | *Central University* | Computer vision for agriculture |
| Vaibhav Kant Singh<br>Varun Pandey | *Central University* | RDBMS for food management |
| Vaibhav Kant Singh<br>Varun Pandey | *Central University* | Machine Learning for Animal Husbandry |
| V.Selvakumar<br>R Saravanan<br>R.Srinivasan | *Bharath Institute of Higher Educational and Research* | Bubonic Plagu (Black Dead) |
| R. Selvakumar,<br>K. Pushpa raj,<br>R. Jothi lakshmi,<br>R. Srinivasan | *Polyherbal Formulation for Antidiabetic Activity: A Comprehensive Review* | Polyherbal formulation for antidiabetic activity: a comprehensive review |
| Safdar Ali | *University of Agriculture Faisalabad* | Exogenous utilization of nano-biomass of carthamus oxyacantha to improve yield and drought tolerance of wheat under rainfed conditions |
| J. Yeshwanth,<br>R. Devi,<br>R. Jyothi Lakshmi,<br>S. Kalaivanan.<br>R. Srinivasan | *Bharath Institute Of Higher Education And Research* | Acute toxicity studies of medicinal plants: a short review |
| Masoumeh Niazifar<br>Akbar Taghizadeh | *University of Tabriz* | Use of processed rumen fluid as a feed additive in animal nutrition on in vitro fermentation characteristics |

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# ABSTRACT

# DIET WITH WHOLE T. MOLITOR LARVAE AFFECTS THE INTESTINAL MORPHOLOGY AND MICROBIOME OF BROILER CHICKEN

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**Abstract**
In this study we evaluated the inclusion of Tenebrio molitor larvae on intestinal trach of chickens. In recent years, we find a low availability of conventional feeds with increasing costs that cast major problems in poultry farming and deteriorate future sustainability. A promising dietary source of protein and fat may come from Tenebrio molitor (TM) larvae. In

a 35-day trial, we used 120 broiler chicks, divided into 3 groups: "Control", "TM5" and "TM10", the former feeding on conventional feed while treated groups received partially replaced feed with whole dried TM larvae at 5 and 10%, respectively. Partial replacement with whole TM larvae affected intestinal microbiota and morphology of the broilers, showing an increased a-diversity index, which is a possible indicator of improved intestinal health and a higher Chao-1 index, especially in the TM10 group. Broilers maintained the physiological intestinal development, with a higher Vh:Cd ratio in the duodenum where primary physical, chemical and hormonal activities take place, without any adverse effects on the jejunum. Part replacement led to a decrease in the Firmicutes/Bacteroidota ratio, mainly in the TM5 group, while a significant increase in Bacteroidota and Campilobacterota was observed in the ileum ($P<0.05$). At the genus level, a higher relative abundance of Lactobacilli was evident in the caecum, together with an increase in Staphylococci ($P<0.05$), the latter, however, owed to species limiting fatty acid oxidation. The increase in populations of the genera Clostridium, Lactobacillus, Oscillospira, Faecalibacterium especially in the caecum of the TM10 group, could be associated with improved formation of the intestinal epithelium. Regarding the latter, the 10% replacement had a lesser effect on gut morphology compared to the 5%, mainly in the duodenum and ileum, suggesting that the lower replacement rate may be preferable for broilers as a more influential feed additive. The research was funded by the National Action "RESEARCH-CREATE-INNOVATE - Cycle B", Project code T2EDK-02356, ACRONYM: InsectFeedAroma.
**Keywords**: Tenebrio molitor, intestine, morphology, microbiome, diversity, broiler

# PERFORMANCE AND GUT HEALTH IN COCCIDIOSIS CHALLENGED BROILERS FED DIET SUPPLEMENTED WITH A BLEND OF THYMOL AND CARVACROL

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## Abstract
The objective of this study was to investigate the performance and gut health in coccidiosis challenged broilers fed diet supplemented with a blend of thymol and carvacrol. The experiment was carried out in a completely randomized design. Chickens were fed starter (1-10 d), grower (11-24 d) and finisher (25-42 d) diets. During the experiment the chicks were allocated to 3 experimental groups: $T_1$) negative control (NC) diet: without challenge and additive; $T_2$) positive control (PC) diet: with *Eimeria tenella* challenge and without additive; and $T_3$) with mentioned challenge+a blend of thymol and carvacrol (0.01 g/kg). Each experimental group was divided into 5 replicates consisting of 12 chicks each. At the end of experiment, body weight gain (BWG), feed intake and FCR were recorded and also two birds/replicate were randomly selected and euthanized by cervical dislocation to assess the intestinal histomorphology, microflora and coccidial lesion scores. Data showed that in comparison with the PC group, the BWG and FCR were improved ($P<0.05$) when the blend of thymol and carvacrol was added. Dietary supplementation of the phytogenic essential oil increased the beneficial population of ileal *lactobacilli* and *bifidobacteria* and decreased *E.coli* pathogen ($P<0.05$) as compared to PC group. Coccidiosis challenged birds treated with the essential oil mixture demonstrated ($P<0.05$) the longer and wider villus accompanying deeper crypt and more goblet cells than the PC-treated birds. Inclusion of this additive to the PC diet suppressed ($P<0.05$) the intestinal lesion scores. However, the NC group induced the highest BWG and lowest FCR, the favorite ileal microflora, the optimal villus growth and the least intestinal lesion scores in birds due to this group was not exposed to the challenge. In conclusion, the application of the blend of thymol and carvacrol was efficient in coccidiosis challenged birds by enhancing performance and gut health ($P>0.05$).
**Keywords:** broiler, carvacrol, coccidiosis, performance, thymol

# COMPREHENSIVE GROWTH TRIALS WITH NOVEL FERTILIZERS OF CANNABIS PLANTS

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**Abstract**
Cannabis (hemp) cultivation has gained increasing importance due to its diverse applications in medicine, industry, and recreation. To ensure robust and sustainable cannabis growth, it is imperative to develop effective and environmentally responsible fertilizer formulations. The study focused on formulating a fertilizer that enhances cannabis growth while maintaining environmental sustainability. The fertilizer composition consisted of a balanced mix of essential nutrients, including nitrogen (N), phosphorus (P), potassium (K), as well as secondary and micronutrients (Si). Additionally, the study incorporated organic matter and beneficial microorganisms to enhance soil health, nutrient uptake, and overall plant resilience. A series of growth trials were conducted to assess the effectiveness of the developed fertilizer composition on cannabis plants. These trials encompassed various stages of growth, from seedling to flowering, and were conducted under controlled environmental conditions. Different soils (sand, clay) were tested. Key findings from the growth trials include: Enhanced Plant Growth: The optimized fertilizer composition significantly promoted cannabis plant growth, resulting in healthier plants with increased biomass. Improved Nutrient Uptake: Cannabis plants treated with the fertilizer exhibited improved nutrient uptake and utilization, leading to increased flowering and higher yields. Soil Health Enhancement: The inclusion of organic matter and beneficial microorganisms in the fertilizer contributed to improved soil health, reducing the need for excessive synthetic inputs. Eco-Friendly Approach: The study emphasizes the importance of environmentally responsible practices, highlighting the potential for reduced environmental impact through the use of balanced, sustainable fertilizers. Effective microorganisms: Soil-enhancing bacteria were found to stimulate additional growth.
**Keywords:** Cannabis cultivation, hemp, fertilizer composition, growth trials, nutrient uptake, sustainable agriculture, soil health, eco-friendly practices.

# METHODS TO MEASURE ENTERIC METHANE PRODUCTION OF RUMINANTS; SOME COMPARISONS

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## Abstract

In order to mitigate greenhouse gas emissions from ruminants, it is crucial to quantify enteric methane emissions. The selection of method to be used in practice to measure enteric methane emissions from ruminants depends on many factors including availability, required investment, and labor intensity. The most used techniques include respiration chambers, GreenFeed, SF6 technique, CO2-based techniques (Sniffer) and in vitro gas production which are based on different principles. The respiration chambers, considered as 'gold standard', are accurate if maintained properly but have limited capacity and are rather labor intensive. Therefore, other alternative methods are needed for large-scale measurements. In a study comparing in vitro and in vivo (respiration chambers) directly, in vitro technique had significantly lower methane production (20.3 vs 30.2 g/kg digested organic matter) whereas no diet effect on the results was detected which was in line with the in vivo results. In a comparison between respiration chambers and Sniffer technique based on carbon dioxide as a tracer, using 21 primiparous cows, the average methane emissions were 396±69 and 418±47 g/d for Sniffer and chamber techniques, respectively. Concordance correlation coefficient between combined weekly methane output estimates of Sniffer and chambers was 0.84. In a study comparing simultaneously ruminal SF6 tracer technique and chambers for 3-5 days using 29 cow/period, the average methane emissions were 482±63 and 510±55 g/d, respectively. Concordance correlation coefficient between two techniques was 0.76. Another study compared two GreenFeed units with chambers using 32 cows. Methane was measured

in Greenfeed 2 weeks before and 2 weeks after chambers. Methane production measured using GreenFeed and chambers were 465±51 and 453±55 g/d, respectively. The concordance correlation coefficient between two techniques was 0.82. Compared methods when measured in a reasonable time provided satisfactory results but the variability of measurements were greater for Sniffer and SF6 techniques and lower for GreenFeed than the respiration chambers.

**Keywords**: enteric methane; ruminants; measuring method

# ANALYSIS OF FOREST PATROL FINDINGS REGARDING WILDLIFE POACHING USING SMART PATROL, AT PEMERIHAN RESORT, BUKIT BARISAN SELATAN NATIONAL PARK

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**Abstract**
Monitoring, managing and maintaining conservation areas are challenges faced by various parties. Human activities in the area include logging, land clearing and hunting of wild animals. Spatial Monitoring and Reporting Tool (SMART) is an application used to measure, collect, evaluate and improve the effectiveness of location-based monitoring and conservation activities. SMART-based patrol activities were carried out in September 2020 – June 2022 at Pemerihan Resort, Bukit Barisan Selatan National Park. The aim of this research is to implement a security system at the Pemerihan Resort, Bukit Barisan Selatan National Park with SMART Patrol. With SMART patrol, you can find discovery points in the form of animals, threats, plants and natural landscapes. The data processed is data on animal findings and threat findings during patrols at Pemerihan Resort, Bukit Barisan Selatan National Park. The results of SMART implementation from 2020-2022 resulted in 841 animal encounters, including 23 species of animal with the highest encounter being Sambar Deer. There were 143 threats found, with the highest threat being animal poaching with 56 findings.
**Keywords**: SMART Patrol, Security, Animals, Threat

# EGE BÖLGESİ YONCA ÇALIŞMALARI

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**Özet**
Yonca çalışmaları Ege Tarımsal Araştırma Enstitüsünde adaptasyon çalışmaları ile bölgemize uygun genotiplerin belirlenmesi amacı ile başlamıştır. Dormant olmayan çeşitlerin bölge koşullarına uygun olduğu ve yüksek verim değerlerine sahip oldukları belirlenmiştir. Bu doğrultuda 1990 yılında ıslah çaşımalarına da başlanmıştır. Islah çalışmalarının hedefi yüksek verimli, hastalıklara dayanıklı, Akdeniz iklim koşullarına ve tarla ürün desenine uyumlu yonca çeşitlerini geliştirmektir. Bu güne kadar 3 adet dormant olmayan yonca çeşidi geliştirilmiş ve tescil edilmiştir. Çalışmanın materyalini, Türkiye'nin farklı bölgelerinden toplanan yerel populasyonlar, yerel çeşitler ve ticari çeşitler oluşturmuştur. Sentetik çeşit geliştirme yöntemi kullanılmıştır. Islah çalışmalarının ilk çıktısı 2008 yılında tescil edilen Alsancak yonca kamu ıslah kuruluşları tarafından geliştirilen ilk dormant olmayan yonca çeşitlerindendir. Bunu 2013 yılında Özpınar ve 2022 yılında Hüseyin Aga çeşidi takip etmiştir. Yüksek verimli çeşitlerin üreticiler tarafından daha yoğun tercih edilerek ekiliş alanlarında önemli derecede artış olması ve sertifikalı tohumluk üretimine katkı sağlaması umut edilmektedir.
**Anahtar Kelimeler**: Islah, yem bitkileri, yonca, *Medicago sativa* L.

# AEGEAN REGION LUCERNE STUDIES

**Abstract**
Lucerne studies wereinitiated at the Aegean Agricultural Research Institute with the aim of determining genotypes suitable to our region through adaptation studies. It was determined that non-dormant varieties are suitable to regional conditions and have high yield values. Therefore, breeding works was also started in 1990. The aim of breeding studies is to develop alfalfa varieties that are highly productive, resistant to diseases, and adapted to Mediterranean climate conditions and field crop patterns. Three non-dormant lucerne varieties have been developed and registered so far. The material of the study consisted of local populations, local varieties collected from different regions of Turkey and commercial varieties. Synthetic variety development method was used. Alsancak variety was the first output of the breeding studies which was registered in 2008. Alsancak is one of the first non-dormant alfalfa varieties developed by public breeding institutions. This was followed by the Özpınar variety in 2013 and the Hüseyin Aga variety in 2022. It is hoped that high-yielding varieties will be preferred more by producers, resulting in a significant increase in planted areas and contributing to certified seed production.
**Keywords**: Breeding, forage crops, Lucerne, *Medicago sativa* L.

# DETERMINATION OF DAMAGE OF SESAMIA NONAGRIOIDES (LEFEBVRE) (LEPIDOPTERA: NOCTUIDAE) AND OSTRINIA NUBILALIS HBN., (LEPIDOPTERA: CRAMBIDAE) ON SOME MAIZE GENOTYPES

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**Abstract**
Sesamia nonagrioides and Ostrinia nubilalis the most destructive pests of maize. They cause high crop losses, especially in second crop maize production. For this reason, the damage status of these pests on 10 maize genotypes of FAO 500-670 maturity group, which are cultivated in the Aegean Agricultural Research Institute Directorate in 2022 and suitable for use as a second crop in our region, were investigated. Pheromone and light traps were used to determine the pests status in the experimental field. In addition, agronomic values such as flowering time (days), plant height (cm), cob height (cm), number of cobs (pcs/parcel), grain to cob ratio (%), grain moisture at harvest (%), grain yield (kg/ha), maturity period (days) were examined. In order to determine the damage caused by S. nonagrioides and O. nubilalis, the percentage of damaged grain, the number of holes in the stem under the cob and on the cob. The length of the gallery caused by the pest, the number of live larvae in the stem and cob were examined and recorded also. According to the results, that the most damaged and preferred maize genotype was DKC 6664. The genotype LG31.630 was found to be the least damaged and preferred maize genotype in terms of many parameters. Maize genotype M16S45 was damaged above average in all parameters except cob damage and it was the

genotype that reached the highest value in terms of yield. This suggests that genotype M16S45 can tolerate these pests damage more than other genotypes.

**Keywords:** Sesamia nonagrioides, Ostrinia nubilalis, Determination of damage, Maize

# EVALUATION OF EFE ECOTYPE F1 HYBRID IN TERMS OF HYGIENIC BEHAVIOR SELECTION

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## Abstract
Due to its unique phytogeographic location, Anatolia is home to many endemic plant species and rich honey bee genetic diversity. However, environmental pollution, decrease in natural habitats, diseases and parasites, pesticides, climate change and the spread of wild species threaten the honey bee population that is living in Anatolia. The Efe ecotype of the Anatolian bee, also called the Muğla honey bee, in the region starting from Western Anatolia southwards to Antalya, was registered after many years of breeding studies. Aiming to develop resistance mechanisms against diseases and pests through breeding studies of different honey bee ecotypes in our country is important for the sustainability of Turkey's honey bee populations, which have evolved by adapting to the local climatic conditions and flora of Anatolia. Hygienic behavior is one of the honey bee defense mechanisms and is a hereditary behavior developed through long-term breeding studies against *Varroa destructor* and the viral diseases it causes. Hygienic behavior is represented by two behavioral mechanisms. This mechanism basically consists of opening the diseased brood cells and removing the diseased larvae from these cells and throwing them out of the hive. Breeding for hygienic behavior to reduce Varroa populations is considered a sustainable way to reduce the impact of *Varroa destructor* on honey bee health. Hygienic behavior contributes to honey bee disease and mite resistance and ensures the formation of hygienic colonies by increasing the colony defense mechanism against pests with high economic damage such as *Varroa destructor*. Developing disease-resistant breeds by ensuring the protection of ecotypes in our country, which has a wide diversity in terms of genetic diversity through hygienic behavior selection, is important for Turkish beekeeping. In this study, the evaluation of hygienic behavior as a breeding parameter in the Efe honey bee, an ecotype specific to our region, was discussed.
**Keywords:** honey bee, hygenic behavior, *Varroa destructor*

# EVALUATION OF SOME AGRICULTURAL CHARACTERISTICS OF BREAD WHEAT VARIETIES (*Triticum aestivum* L.) IN AUGMENTED EXPERIMENTAL DESIGN IN BURSA ECOLOGICAL CONDITIONS

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**Abstract**
The study was conducted in the experimental fields of Bursa Uludağ University Faculty of Agriculture Agricultural Application and Research Center during the 2022-2023 growing season, considering the ecological conditions of Bursa. The aim of this research was to determine the performance of various foreign wheat varieties in Bursa conditions and to select suitable bread wheat varieties for yield trials and breeding programs. The study was conducted in a 3-replication augmented design. In the research, 60 bread wheat varieties of foreign origin were used, along with 6 commercial varieties grown in our country as controls. Plant height, spike length, spikelet number per spike, grain number and weight per spike, 1000 grain weight, and hectoliter weight were examined as agricultural traits. According to the results obtained in the research, all the examined traits were found statistically significant at a 1% probability level. Based on the examined traits, the minimum and maximum values were as follows: plant height ranged from 52.11 - 128.76 cm, spike length from 6.37 -12.09 cm, spikelet number per spike from 11.94 - 23.89, grain number per spike from 15.17 - 64.25, spike grain weight from 0.43 - 2.66 g,,1000 grain weight from 15.84 - 58.70 g, and hectoliter weight between 60.37-74.72 kg/hl. According to the correlation analysis, positive and significant association between plant height and spike length, spikelet number, grain number per spike, 1000 grain weight, and hectoliter weight; spike length and spikelet number, grain number per spike; spikelet number and grain number per spike; grain number per spike and hectoliter weight; grain weight per spike and hectoliter weight; and 1000 grain weight and hectoliter weight. Asa result of the study, it was observed that there were varieties with superior characteristics compared to the control varieties, and these varieties were selected for use in yield trials and breeding programs.
**Keywords**: Bread wheat, augmented design, agricultural traits

# BAZI DURUM BUĞDAY GENOTİPLERİNDE VERİM VE KALİTE DEĞERLERİNİN İNCELENMESİ

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**Özet**
Makarnalık buğday, dünyanın belli bölgelerinde yetiştirilebilmektedir. Güneydoğu Anadolu Bölgesi de, makarnalık buğday yetiştirmeye uygun ve en kaliteli ürünün elde edildiği bir bölgedir. Bu çalışma, 2019-2020 yetiştirme sezonunda Diyarbakır'ın yağışa dayalı koşullarında verim ve kalite özellikleri bakımından öne çıkan makarnalık buğday hatlarının belirlenmesi amacıyla yürütülmüştür. Araştırmada 20 hat ve 5 standart çeşit olmak üzere toplam 25 genotip materyal olarak kullanılmıştır. Deneme, tesadüf blokları deneme desenine göre 2 tekerrürlü olarak kurulmuş ve tane verimi, hektolitre ağırlığı, bin tane ağırlığı, protein içeriği, irmik rengi ve SDS değeri incelenmiştir. Yapılan analiz sonucunda tüm özellikler yönünden genotipler arasında önemli farklılıklar görülmüştür. Elde edilen sonuçlara göre; 20, 22, 26 ve 33 nolu hatlar, çeşit adayı olmak üzere bölge verim denemelerine alınmıştır.
**Anahtar Kelimeler:** Durum buğday, Verim, Kalite

# EXAMINATION OF YIELD AND QUALITY VALUES IN SOME DURUM WHEAT GENOTYPES

**Abstract**
Durum wheat can be grown in certain regions of the world. Southeastern Anatolia Region is a region suitable for growing durum wheat and producing the best quality product. This study was carried out to determine the durum wheat lines that stand out in terms of yield and quality characteristics in the rainfed conditions of Diyarbakır in the 2019-2020 growing season. In the research, a total of 25 genotypes, 20 lines and 5 standard varieties, were used as material. The experiment was set up with 2 replications according to the randomized block trial design and grain yield, test weight, thousand kernel weight, protein content, semolina color and SDS value were examined. As a result of the analysis, significant differences were observed between genotypes in terms of all characteristics. According to the obtained results; lines 20, 22, 26 and 33 were taken into regional yield trials as candidate varieties.
**Keywords**: Durum wheat, Yield, Quality

# THE EFFECT OF SOWING NORMS AND NITROGEN APPLICATIONS ON YIELD CHARACTERISTICS OF COMMON BUCKWHEAT (*Fagopyrum esculentum* Moench.)

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**Abstract**
Buckwheat (*Fagopyrum esculentum* Moench.), originating from Central Asia, is an annual and herbaceous plant that can reach a plant height of 60-150 cm. It can reach harvest maturity in a short period of 10-14 weeks and is grown as an alternative culture plant in high altitude areas. Buckwheat, which is used in many areas, does not contain chemically free gluten. With this feature, buckwheat is an extremely important plant for celiac patients who are sensitive to gluten. One of the important factors for efficiency in crop production is the sowing norm, which is the amount of seeds to be sown per unit area. Nitrogen is one of the primary elements used by plants for growth. Using the right amount of nitrogen application improves the yield and quality of the plant. In this study, it was aimed to determine the effects of different sowing norms and nitrogen applications on the yield characteristics of buckwheat in Bornova climatic conditions. For this purpose, Aktaş and Güneş varieties were used as plant material in the trials conducted in 2022 and 2023. The experiment in the first year was carried out with three replications, according to the split plot design with complete blocks, with two sowing norm (20 cm, 40 cm between the rows) and three nitrogen doses (0 kg/da, 5 kg/da, 10 kg/da). The second year of the experiment was conducted with two sowing densities (8 kg/da, 12 kg/da) and three nitrogen doses (3 kg/da, 6 kg/da, 9 kg/da) with three replications. According to the findings; In the first year, statistical differences were found in stem diameter and total seed weight in terms of sowing norm. It was concluded that in the second year, the number of internodes was maximum at a nitrogen dose of 9 kg/da. The number of cymes increased as the sowing norm and nitrogen dose increased. In both years, no effects were observed on measurement parameters such as plant height, branching, single plant seed number and seed weight.
**Keywords:** buckwheat, sowing norm, nitrogen dose, yield, gluten-free.

# POLYPLOIDY STUDIES IN FIELD CROPS

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## Abstract
The term "ploidy" refers to changes in the chromosome number or set of a plant. Plants are classified differently based on their ploidy levels. Polyploidy is defined as the presence of more than two sets of chromosomes in plant somatic cells and is considered one of the breeding methods applicable to all plants. The polyploidy technique is widely used in plants for various purposes, including increasing leaf, flower, fruit, and seed sizes, enhancing plant resilience to abiotic and biotic stress factors, intensifying colors, increasing the content of various chemical compounds, and promoting the emergence of new combinations by increasing genetic diversity. Various studies have shown that polyploidy affects the morphological, chemical, physiological, and ecological characteristics of plants. Polyploidy can occur naturally in plants, with examples such as wheat (*Triticum aestivum*), cotton (*Gossypium hirsutum*), tobacco (*Nicotiana tabacum* L.), and potatoes (*Solanum tuberosum*). Additionally, researchers can artificially induce polyploidy to improve various traits in plants. Different chemicals such as colchicine, oryzalin, trifluralin, chloral hydrate, ether, chloroform, and phenylurethane, as well as heat shocks, are used to promote polyploidy. This review summarizes some polyploidy breeding studies in the field of field crops and aims to be helpful to researchers aspiring to work in this area.
**Keywords:** Ploidy, polyploidy, chromosome, colchicine, plant breeding, field crops

# THE EFFECTS OF DIFFERENT BAP AND NAA DOSE COMBINATIONS ON SHOOT REGENERATION AND SOME MORPHOLOGICAL CHARACTERISTICS ON MICROPROPAGATION OF *Aronia melanocarpa* L. 'VIKING' VARIETY

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**Abstract**
Although the production of aronia, which is one of the grape fruit species, is achieved by rooting the cuttings, this production method is time consuming. Production under in vitro conditions has important advantages such as fast, mass production and obtaining clean plants from viruses and similar disease agents. In in vitro culture, the addition of auxin and cytokinin group plant growth regulators to the nutrient medium is very effective for shoot formation, organ formation and tillering. In this context, it was aimed to determine the effects of different BAP and NAA dose combinations added to MS (Murashige and Skoog, 1962) nutrient medium on plant growth and development in in vitro culture of Aronia melanocarpa L. For this purpose, explants were cultured for 8 weeks in prepared MS medium to which different doses of BAP (0.7 ppm, 0.6 ppm, 1 ppm, 2 ppm, 3 ppm, 4 ppm) and NAA (0.05 ppm, 0.01 ppm, 0.5 ppm, 0.1 ppm, 1 ppm) concentrations were added. At the end of the culture, the changes in the morphological characteristics of the cultured plantlets were examined. Within the scope of morphological characteristics; longest shoot length (cm), shoot length (cm), number of shoots per explant (tillering) (number), longest root length (cm), number of leaves per shoot (number), chlorophyll density, rooting explant ratio (%) and callus forming explant ratio (%) parameters were measured. In this context, the best results were found shoot length in MS medium containing 3 ppm BAP and 0.5 ppm NAA; the number of shoots per explant (tillering) in MS medium containing 2 ppm BAP and MS medium containing 3 ppm BAP and 0.1 NAA; the longest root length in MS medium containing 0.7 ppm BAP and 0.005 NAA and the best rooting explant ratio in MS medium containing 1 ppm BAP and 0.5 ppm NAA. However, the rate of callus forming explant, chlorophyll density, number of leaves per shoot and longest shoot length were not found to be different with the doses of BAP and NAA added to the nutrient media. As a result, it was determined that BAP dose added to MS nutrient medium was higher than NAA dose and contributed to shoot formation and organ formation and development.
**Keywords:** *Aronia* sp., BAP, NAA, Micropropagation

# MOLECULAR INVESTIGATION OF TOMATO BACTERIAL SPECK DISEASE CAUSAL AGENT *PSEUDOMONAS SYRINGAE* PV. *TOMATO* IN TERMS OF COPPER TOLERANCE AND GENETIC VARIATION

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## Abstract
Tomato (*Solanum lycopersicum* L.) is a commercially important crop plant belonging to the Solanaceae family and widely distributed in the world. Bacterial speck disesase of tomato is one of the biggest problems in tomato cultivation areas. Bacterial speck disease agent *Pseudomonas syringae* pv. *tomato* (Pst) causes significant yield losses in tomato cultivation areas in Aegean Region. Copper based compounds are the most commonly used to control of Pst. However, due to the unconscious use of copper compounds, the causal agent has started to gain resistance to this compounds in recent years. The aim of this study is to determine the tolerance status of Pst isolates to copper at different copper concentrations, to identify the genetic variation between the isolates by using REP-PCR method and to investigate the relationship between genetic variation and copper tolerance in bacterial causal agents obtained from plants showing bacterial speck symptoms in tomato cultuvation areas in Aegean Region. As a result of this study, it has been observed that there is a high copper tolerance between Pst strains from Izmir, which is collected in 2014. It has been determined that there was genetic variation among Pst isolates in REP-PCR.
**Keywords:** Tomato, *Pseudomonoas syringae* pv. *tomato*, Copper tolerance, REP-PCR

# USING POSSIBILITIES OF BACTERIOPHAGES IN PLANT PROTECTION
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**Abstract**
Viruses whose specific host is bacteria are called "bacteriophages". Bacteriophages are used extensively in medicine and veterinary medicine for diagnosis and phage therapy. In plant production, copper based chemicals are used intensively in the control of bacterial pathogens that cause plant diseases, but bacterial pathogens may develop resistance to copper preparations. So, copper based chemicals have been considered as insufficient for controlling the plant pathogenic bacteria. In recent years, the commercial use of bacteriophages in the control of plant pathogenic bacteria has been increasing. Since phages are specific to their host, they do not cause any risk to non-target organisms and the environment. Another positive effect of phages is the possibility of their use in the diagnosis of plant pathogenic bacteria. The aim of this paper is to present and discuss concrete examples of these two issues in practice.
**Keywords:** plant pathogenic bacteria, bacteriophage, biological control, identification.

# THE EFFECT OF DIFFERENT CORN VARIETIES AND BACTERIA ON DROUGHT STRESS

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## Abstract
Corn (*Zea mays* L.), which belongs to the Poaceae family, is an annual warm climate cereal. It can be grown in tropical and subtropical regions, as well as in agricultural areas worldwide. One of the major challenges in corn cultivation is drought stress, which leads to a decrease in yield and quality. The use of microorganism applications to mitigate the negative effects of drought and other abiotic stress factors, promote plant growth, and increase yield has become a popular research topic. For this purposes, the use of plant growth promoting rhiozbacteria (PGPR) and other biological preparations that promote plant growth has beeing increased. In this study, the reaction of different corn varieties and rhizobacteria strains, which were selected from a wide bacterial culture collection in the stocks of Bacteriology laboratory of Plant Protection Department of Faculty of Agriculture of Ege University to drought stress was investigated. In the first stage, commonly used commercial corn varieties were tested for their reaction to drought stress, and drought-tolerant and sensitive corn varieties were selected. In the second stage, the reactions of these bacterial strains against drought stress were tested by creating osmotic stress with PEG (polyethylene glycol, 20 %) under *in-vitro* conditions. Bacterial strains that showed tolerance to drought stress created by PEG were selected for *in vivo* tests. Our study continues with the investigation of the effects of selected bacterial isolates and sensitive / tolerant corn varieties on drought stress *in vivo*.
**Keywords:** Corn plant, plant growth promoting rhizobacteria, drought stress

# MONITORING APPLE SCAB (*Venturia inaequalis*) DISEASE IN APPLE FARM IN KAZAKHSTAN

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**Abstract**
*Venturia inaequalis* (Cooke) G. Winter, the apple scab pathogen, causes significant damage to fruit production, reducing product quality and yield by up to 70%. Favourable conditions for the development of apple scab are abundant rainfall in the last month of spring and early summer Almaty, Turkestan and Zhambyl regions are the main apple growing areas of Kazakhstan. In 2023, phytosanitary surveillance for apple scab was carried out in apple orchards in these regions. During the research, samples of diseased leaves and fruit were collected from orchards in different regions and a herbarium was created. Monitoring was

carried out in the apple orchards of the "Akkazin" and "Ermek" farms on a 14-hectare field in the Enbekshikazak district of the Almaty region. These orchards are located at the foot of Ile Alatau. In the Almaty region, the prevalence of scab disease in the varieties Starkgrimson, Golden Presvets and Aidaret was about 23-31%, the rate of development was 1-2.84%. No symptoms of the disease were observed in the varieties Americanka and Aydaret. In the next stage of the research, apple orchards in the Turkestan region were monitored. The total monitored area was 288 ha. In apple orchards of Kazygurt district, Turkestan region, the prevalence of scab disease in Samurai and Starkrimson varieties was about 3-3.71%, the development was 0.50-0.81%. The prevalence of apple scab in the varieties Idared and Gala was 16-17%, development was at a low level of 0.13-1.25%. Fuji was recognised as resistant to apple scab, no symptoms of the disease were observed.

**Keywords:** *Venturia inaequalis*, Apple, Monitoring, Kazakhstan

# EVALUATING VARIOUS FUNGICIDE PROGRAMMES FOR INTERNAL FRUIT ROT IN POMEGRANATES USING ELECTROSTATIC AND CONVENTIONAL SPRAYING

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**Abstract**
Fruit internal rot disease poses a significant pathogenic challenge to global pomegranate production, and there is no fungicide registered specifically for its direct mitigation. In this study, we used fungicides to control fruit rot pathogens in several other crops to explore alternative control strategies. Our comparative analysis of the efficacy of fungicides applied by electrostatic and traditional spraying methods highlights the critical role of application techniques in chemical control. In the first spray program, using the active ingredients (fluxapyroxad 75 g/L+ difenoconazole 50 g/L), (trifloxystrobin 50%, phosphorous acid 400 g/L) and copper sulfate (equivalent to 65.82 g/L metallic copper), we achieved a biological efficacy of 40% using the electrostatic spraying method, surpassing the other methods. Conventional spraying, on the other hand, resulted in a lower efficacy rate of 34.62%. In the second application program, which included (fluxapyroxad 75 g/L + difenoconazole 50 g/L), (cymoxanil 30% + famoxadone 22.5%), and copper sulfate (65.82 g/L metallic copper equivalent), the efficacy rates were 20% and 26.92% for the electrostatic and traditional spraying methods, respectively. In conclusion, electrostatic spraying demonstrated improved performance against pomegranate internal rot disease, achieving effective mitigation with a reduced pesticide+water mixture. In particular, the biological efficacy of the active ingredients used, especially (fluxapyroxad 75 g/L + difenoconazole 50 g/L), (trifloxystrobin 50%, phosphorous acid 400 g/L) and copper sulfate in electrostatic spraying, reached a remarkable efficacy of 40%. The research demonstrates that employing electrostatic spraying techniques can enhance pesticide application efficiency, resulting in reduced water and pesticide usage. This study provides valuable insights into pomegranate farming practices in Turkey, primarily concerning the problem of internal fruit rot.
**Keywords:** *Punica granatum*, fungicide, application programs, chemical control, electrostatic techniques, biological efficacy.

# EVALUATING THE EFFICACY OF QOI-FUNGICIDES IN THE MANAGEMENT OF OLIVE LEAF SPOT DISEASE THROUGH CONVENTIONAL AND ELECTROSTATIC SPRAY TECHNIQUES

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**Abstract**
Effective management of olive leaf spot disease has been a long-standing challenge in Turkey, frequently yielding suboptimal outcomes when using registered plant protection products. Therefore, recent research efforts have investigated the promise of systemic fungicides in combatting this disease with encouraging results. Moreover, the potential of enhancing the efficacy of disease control measures through the adoption of electrostatic spraying techniques has gained attention. This study presents a noteworthy progression in the battle against olive leaf spot disease in Turkey; it is the first instance of employing systemic fungicides and the electrostatic spraying method. The study conducted an exhaustive evaluation to appraise the efficacy of diverse treatments. Of the treatments tested, utilizing an electrostatic spraying method, the combination of boscalid at a concentration of 25.2% and pyraclostrobin at 12.8% exhibited optimum efficacy, with an impressive success rate of 91.26%. Other noteworthy products were Bordeaux mixture with 124 g/L metallic copper equivalent (84.10%), 50% trifloxystrobin (80.17%), and boscalid with pyraclostrobin at 25.2% and 12.8% respectively (76.86%). All demonstrated superior disease control outcomes in comparison to traditional techniques. This pioneering study not only emphasises the capabilities of systemic fungicides in managing olive leaf spot disease but also highlights the considerable benefits provided by the electrostatic spraying method. The findings of this study have significant implications for the implementation of sustainable and effective disease management practices in Turkish olive agriculture. In addition, it is expected that this study will serve as an influential point of reference for future research ventures and contribute to ongoing efforts to improve disease control measures and the holistic health of olive farms in the area.
**Keywords:** *Spilocaea oleagina*, fungicide, application programs, electrostatic, biological efficacy.

# DIFFERENT MEDIA EFFECTS ON ENDOPHYTE FUNGI ISOLATION FROM CITRUS SPECIES

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**Abstract**
In 2020, the citrus production area was composed of 45% oranges, 35% tangerines, 15% lemons, and 4% grapefruit in the world. Türkiye exported 1.9 million tons of citrus fruits in 2021. Pre- and post-harvest biotic and abiotic factors can cause significant economic losses in citrus fruits. Endophytic fungi are significant biological control agents that have an ecological role in the development of the host plant. In this study, the effects of five different media on the isolation of endophytic fungi from plants were investigated. Isolation was made from healthy leaf and fruit tissues from tangerine and orange trees. Five different media were used in this study: potato dextrose agar (PDA), corn meal agar (CMA), water agar (WA), Czapek dox agar (CDA), and Sabouroud agar (SB). The effectiveness of five media was determined using principal component analysis (PCA) in endophyte fungi isolation. PCA was carried out using the MVSP program (version 3.22). PCA analysis showed that three media can be used to isolate endophytic fungi: PDA, SB, and CDA, respectively. The Bray-Curtis similarity index was drawn from the UPGMA dendrogram. PDA was in the same group as the SB and CDA, while WA and CMA formed separate groups. A total of 69.7% of the forty-three endophytic fungi obtained were isolated from the leaves. According to the morphological identification, the fungi obtained belonged to the genera *Trichoderma*, *Alternaria*, and Botryospheriaceae species. The findings of this investigation indicated the effect of various media on the isolation of endophyte fungus from various plant tissues.
**Keywords:** endophyte, *Trichoderma*, medium, PCA, *Citrus x sinensis*

# A RESEARCH ON DETERMINATION OF FUNGAL ROOT AND CROWN ROT DISEASES IN SOME OUTDOOR ORNAMENTAL PLANTS IN IZMIR PROVINCE

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**Abstract**
In this study, surveys were carried out in 6 different districts of Izmir, where outdoor ornamental plant production is most intense. Surveys were conducted for shrub-form plants that have economic importance and hold an important place in terms of production and marketing. A total of 150 shrub-form plants, showing disease symptoms and asymptomatically without symptoms, were sampled from 35 different nurseries in Balcova, Bayındır, Odemis, Tire, Torbalı and Urla districts. As a result of the initial isolations, a total of 128 isolates were obtained: 24 from Balcova, 9 from Odemis, 35 from Bayındır, 15 from Torbalı, 28 from Urla and 17 from Tire. Of the Balcova isolates, 58.33% *Fusarium* spp., 25% *Macrophomina* spp., and 8.33% *Cylindrocarpon* spp. has been obtained. All isolates were *Rhizoctonia* spp. in Odemis. Of the Bayındır isolates, 42.85% *Fusarium* spp., 37.14% *Pestalotiopsis* spp. and 20.00% *Cylindrocarpon* spp. has been obtained. Of the Torbalı isolates, 93.33% *Fusarium* spp. and 6.66% *Cylindrocarpon* spp. has been obtained. Of the Urla isolates, 67.85% *Rhizoctonia* spp. and 32.14% *Fusarium* spp. has been obtained. Of the Tire isolates, 70.58% *Fusarium* spp. and 29.41% *Cylindrocarpon* spp. has been obtained. Morphological and molecular identification of fungal pathogens that cause root and crown rot diseases in shrub-form plants were made. After morphological diagnosis was made, pathogenicity testing was performed to determine the virulence of the isolates. As a result of the molecular diagnostics performed after the pathogenicity test, the most virulent isolates were confirmed as *Fusarium oxysporum* and *Fusarium solani*. In the molecular identification performed for Rhizoctonia species, the isolates were found to be *Rhizoctonia solani*. After the molecular identification phase, the identified isolates were entered into the NCBI gene database, their similarities with world isolates were determined, and phylogenetic analysis was performed.
**Keywords:** Outdoor ornamental plants, *Fusarium* spp., *Rhizoctonia* spp., root and crown rot diseases

# CONCEPTUAL STUDY ON SUSTAINABLE GASTRONOMY AND AGRICULTURE

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**Abstract**
Throughout the gastronomic chain, ranging from agricultural production to retail sales and all stages in between, including processing, procurement, pre-preparation, cooking, serving, delivering and waste generation, global food systems are accountable for the generation of greenhouse gas emissions, which ultimately contribute to climate change. Environmental consequences, such as the misuse of water and energy resources, pollution, and loss of biodiversity, are evident in food production. Additionally, consumers of food desire greater transparency regarding the production and delivery of their meals with regards to the sustainable practices that contribute towards preserving the planet. Access to food is a significant issue in less developed countries worldwide, whereas developed countries are concerned about food waste. Therefore, consumers seek assurance regarding the origin of their food, production conditions, and timely delivery to their table. Recently, there has been an increase in consumer interest in food safety and efficiency, as well as in environmentally friendly farming practices to reduce gas emissions and waste. For these objectives to be met, it is vital to have a sustainable gastronomy system in place. This study examines the role, significance, and impact of agriculture within the context of sustainable gastronomy and its contribution towards achieving the objectives of sustainable development.
**Keywords:** sustainable gastronomy, agriculture, sustainable development, gastronomy network, local development

# EFFECTS OF DIFFERENT TRELLIS SYSTEMS AND IRRIGATION REGIMES ON VEGETATIVE GROWTH PATTERNS OF 'BEYRA' TABLE GRAPE VARIETY

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**Abstract**
Developing new table grape varieties with high commercial value and demand in international markets has become increasingly important in recent years. In the current study, it is aimed to investigate the effects of different trellis systems and irrigation regimes on some vegetative development parameters were studied in the 'Beyra' table grape variety, newly developed and registered by the Manisa Viticulture Research Institute. There were two factors in the study: (i) Trellis systems and (ii) Irrigation regimes. Trellis systems consisted of 'V shape' and 'Pergola' systems while irrigation regimes applied as 'Full Irrigation' (FI:100%) and 'Partial Rootzone Drying' (PRD:50%). Trellis systems and irrigation regimes had significant effects on total leaf area and higher values were obtained under Pergola sytems and FI treatment. Additionally, trellis systems had significant impacts on leaf area:fruit ratio values while irrigation treatments had no significant effects. According to the shoot elongation rates between bud break and harvest, the Pergola system x FI interaction had the highest values. Moreover, trellis sytems had significant effects on pruning wood weight (PWW), vigour and puissance values of Beyra table grape variety but irrigation treatments had no significant differences. In this regard, the Pergola system had 26.9%, 23.2% and 6.6% higher values compared to the V shape system in terms of PWW, vigour and puissance, respectively. On the other hand, both factors had no significant effects on Ravaz index values. Consequently, it was determined that trellis systems were statistically more effective on the vegetative growth patterns of vines compared to irrigation regimes. Also, no similar study has been conducted before on the newly developed Beyra grape variety. Therefore, the results of this study will be useful tool to ensure higher yield and quality in table grape production.
**Keywords:** *Vitis vinifera*, grapevine performance, vigour, table grape.

# EFFECT OF EXTRACTED TANNIN FROM POMEGRANATE BY-PRODUCTS ON METHANE EMISSION BY *IN-VITRO* TECHNIQUES

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**Abstract**
Ruminants play an important role in the livelihood of farmers and other people, and the meat and milk produced in addition to cash income play a very important role in providing food for people. Ruminants are physiologically adapted to obtain their required nutrients from forages that humans cannot use them. They can convert low-quality and high-fiber feeds into high-quality proteins (meat and milk). Ruminant breeding systems significantly contribute to methane emissions. On the other hand, the increasing trend of agricultural waste is one of the serious challenges of most countries, especially developing countries. Burying, burning and abandoning waste and agricultural residues are among the environmental problems of the country. Processing and conversion of by-products, agricultural waste and their reuse in the production cycle is a suitable solution for the economic use of these types of products, especially in the feeding of ruminants. One of the agricultural wastes produced in the production of fruit juice used by humans is pomegranate juice extraction waste, which contains very high amounts of bioactive substances, especially polyphenols such as flavonoids and tannins. In the present research, the effect of adding tannin extract extracted from pomegranate waste to the amount of 2% DM of the diet on methane production was investigated by laboratory method. Rumen liquor samples were obtained from the 2 wethers and for each treatment (diet without and with extract containing tannin) it was done in three repeat in a completely randomized design and the data were statistically analyzed with SAS software. Pomegranate waste extract significantly reduced the amount of methane gas produced compared to the control treatment ($P<0.05$). The amount of methane gas produced after 24 hours of feed incubation in the rumen liquid was 15.7% and 15.5% of the total gas produced for the control treatment and the treatment containing pomegranate waste extract, respectively.
**Keywords:** By-products, Methane, Pomegranate, Ruminant, Tannin

# METABOLIZABE ENERGY AND ORGANIC MATTER DIGESTIBILTY OF TOMATO PLANT USED IN RUMINANTDIETS

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**Abstract**
Due to the increase in population and lack of food, it is necessary to produce more livestock products. Hays is the most important source of food for ruminants, but in developing countries with dry weather conditions, there is a lack of hay for feeding of livestock. The use of agricultural by-products in ruminant's nutrition can reduce the costs of feed and reduce the risks of environmental pollution. One of the by-products of agriculture is the tomato bush, which is the second vegetable crop after potatoes in the world, but few studies have been done on determining the nutritive value of the tomato bush in animal nutrition. The purpose of this study was to investigate the nutritional value of tomato plant silage in laboratory conditions using the gas production method. Tomato plants obtained from greenhouse farms were cut into 3 to 5 cm pieces and silage was done. Metabolizable energy (ME) and organic matter digestibility (OMD) of tomato plant were determined using in vitro gas production and the chemical composition of feeds (CP, ether extract, and OM). Sample were incubated in triplicate with 20 mL of rumen liquor and McDougall's buffer solution (1:2). Gas production was measured in each vial after 24 h of incubation by using a water displacement apparatus (Fedorak and Hrudey (1983). ME and OMD (%DM) content of tomato bush silage were calculated using the equations of Menke and Steingass (1988) and Menke et al. (1987). Dry matter, crude protein and crude fat and organic matter of tomato plant silage were 20%, 16.1%, 4.4% and 78.5% and 40%, respectively. ME and OMD of tomato plant silage were 7.16 (MJ/kg of DM) and 68 (%DM), respectively. According to the obtained results and also the high production of tomato plant waste, this by-product can be used in livestock feeding.
**Keywords:** Feed additives, Gas production, Ruminant, Silage, Tomato palnt

# INVESTIGATION OF SECONDARY METABOLITES AND ANTAGONISTIC ACTIVITIES OF LOCAL *TRICHODERMA* SPECIES AGAINST *DIAPORTHE AMPELINA*

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**Abstract**
*Trichoderma* strains isolated from diseased plant tissues were tested for their ability to control a highly virulent isolate of *Diaporthe ampelina* (Syn: *Phomopsis viticola*), the causal agent of rod and leaf spot disease of grapevine. The antagonistic effect of the tested *Trichoderma* strains against *D. ampelina* (MBAE91) was first determined by a dual culture test. Subsequently, the *Trichoderma* strains were first grown in liquid culture under static conditions at 28°C for 25 days to produce metabolites. Their ethyl acetate extracts were tested for their ability to reduce disease symptoms of *D. ampelina* on *Vitis vinifera* L. Sultani seedless cuttings under controlled conditions. The chemical profiles of *Trichoderma* strains and major secondary metabolites were also analyzed by GC-MS. Among the antagonists tested, *T. gamsii* and *T. afroharzianum* strains showed 91.63% and 94.95% activity against *D. ampelina* isolate in dual culture tests, respectively. All the extracts showed high inhibitory activity against *D. ampelina* on Sultani seedless cuttings. Chromatographic examination of ethyl acetate extracts of the cultures resulted in the identification of some common metabolites such as lidocaine, pyrido[2,3-d] pyrimidine, 2-ethylacridine, 1H-indole-6-carboxylic acid. The extracts of's contain a variety of metabolites previously reported to be active against various pathogens. The metabolites produced in liquid culture contained antifungal compounds and were shown to be effective in preventing disease symptoms of stick and leaf spot in grapevine under controlled conditions. Optimization and further research are needed for the production of secondary metabolites by antagonistic *Trichoderma* strains.
**Keywords:** *Trichoderma*, pathogen, dual culture, fungal extracts, secondary metabolite

# COMPARISON OF $N_2O$ EMISSIONS FROM SOIL FOLLOWING THE APPLICATION OF SYNTHETIC FERTILIZER AND THE ADJUSTMENT OF ORGANIC MATTER

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**Abstract**
Due to the increasing population, the demand for food is also increasing. This situation has led to the use of more fertilizer in the fields than necessary to increase crop yield. Although increasing agricultural efficiency, fertilizer use is regarded as one of the main source of $N_2O$ emissions. $N_2O$ is an important greenhouse gas because the global warming potential 300 times more than $CO_2$. Nitrogen added into soil by nitrogenous fertilizers can be converted to $N_2O$ if conditions are not sufficient for full denitrification-reduction to $N_2$. The soil organic carbon content is found one of the most important parameter that affects agricultural efficiency as well as $N_2O$ emissions. Generally, low organic matter content are detected in Turkey's soil where high organic carbon content can promote microbiologically denitrification to last step so $N_2O$ is reduced to $N_2$ form. Therefore, $N_2O$ contributions of a synthetic fertilizer in the presence of organic matter additive were determined and compared.
Control soil (2% organic content) was compared with soil at organic matter content 8%, soil at organic matter content 2% including urea (%46 total N), and soil at organic matter content 8% including urea. The soil organic matter was adjusted to %8 by peat (%0.2 total N). According to the results of the study, the peat application as organic soil amendments (8% OM) had no effect on $N_2O$ emissions by comparison with control (%2 OM). The cumulative $N_2O$ emissions in soils at 2% OM where only urea was applied increased 110 times compared to the control. Moreover, in the case both the peat and fertilizer application (8% OM), the cumulative $N_2O$ emissions increased 200 times compared to the control. The results show higher organic matter content cannot be the source of $N_2O$ emissions alone but it can elevate $N_2O$ emissions in the presence of fertilizers.
**Keywords:** climate change, greenhouse gas, agriculture, mineral nitrogenous fertilizer, soil organic matter, $N_2O$ emissions, soil.

# INVESTIGATION OF IN VITRO PROPAGATION OF *CAMPANULA LEBLEBICI* VIA PLANTFORM TEMPORARY IMMERSION SYSTEM

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**Abstract**
The family *Campanulaceae* exhibits a cosmopolitan distribution from tropical to cold regions across all continents. *Campanulaceae* is divided into three subfamilies *Campanula leblebicii*, discovered by Yıldırım, is found only in the village of Ovacık in the Kemalpaşa district of İzmir province and it is one of the valuable endemic species for Turkey flora. Biotechnological methods are very effective for preserving and sustainability of genetic resources. Tissue culture is one of the important methods for this purpose. Petiole and leaf explants were cultured on full strength MS medium containing 30 $gL^{-1}$ sucrose, 4 $gL^{-1}$ gelrite, different concentrations of 6-benzyladenine (BA) (0. 0.5, 1, 2, 3 $mgL^{-1}$) for callus initiation. Different immersion (10, 15, 20 min) and ventilation (5, 10, 15 min) time was investigated on efficient regeneration of *C. leblebici*. Efficient callus and shoot proliferation were observed on MS medium including 3 $mgL^{-1}$ BA +0.1 $mgL^{-1}$ NAA as 100%. Callus were transferred to the Plantform Temporary Immersion bioreactor including 3 $mgL^{-1}$ BA +0.1 $mgL^{-1}$ NAA after solid medium. Adventive root formations were observed spontaneously on MS medium 3 $mgL^{-1}$ BA +0.1 $mgL^{-1}$ NAA. Callus volume increased, shoot formations and root formations increased in temporary immersion system. Efficient callus, shoot and roots were observed on 15 min immersion and 10 min ventilation time.
**Keywords:** Campanula, MS, Plantform, Temporary immersion system, NAA

# THE EFFECT OF DIFFERENT MIXING RATIOS OF MAIZE (*Zea mays* L.) AND SUNN HEMP (*Crotalaria juncea* L.) ON SOME SILAGE QUALITY CHARACTERISTICS

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## Abstract
Using silage as animal feed is a very common option in many parts of the world. Digestibility, protein and dry matter (DM) content as well as fibre fractions are main features determining the quality of silage. It is a fact that many studies have shown that higher quality silage can be obtained by mixing corn and legumes causing rise protein content and increase in DM yield of corn silage. Sunn hemp (*Clorataria juncea* L.) from Fabaceae family is considered as a candidate to be a new alternative forage crop for our country. It is thought that when the sunn hemp is grown mixed with silage maize, like legumes, and ensiled together, the protein content and nutritional value of the silo feed may increase. The research was carried out in the experimental areas of Ege University Faculty of Agriculture, Department of Field Crops. Maize (*Zea mays* L.) (M) and Sunn hemp (S) mixtures, (100% M, 80% M + 20% S, 60% M + 40%S, 40%+60%S, 20%+80%S and 100%S) were carried out in the summer intermediate crop growing period of 2022-2023 in order to determine their effects on silage quality. For this aim; the physical properties of silage (color, odor, structure, DLG) and silage quality properties such as, dry matter ratio, silage pH, crude protein ratio, ADF and NDF were determined. According to the research results; the color, odor, structure and DLG scores of silages varied between 1-2, 11.5-13.5, 3.50-4 and 17-19.5, respectively. pH value of silages varied between 4.01-4.63, DM 26.72-36.47%, DDM 52.01-68.78%, DMI 2.11-2.94%, CP 7.29-12.20%, NDF varied between 40.87-55.82%, ADF 25.83-47.36% and RFV varied between 86.31-156.95.
**Keywords:** Silage, Maize, *Crotalaria juncea*, Sunn Hemp, Mixture, Alternative forage crop

# ENHANCING WATER RESOURCE MANAGEMENT THROUGH SATELLITE-BASED REMOTE SENSING ANALYSIS

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**Abstract**
In order to manage water resources effectively, satellite images provide important indicators. It is critical for water resources management to be able to estimate reference evapotranspiration with high degree of accuracy. As a result, estimating $ET_0$ with high accuracy using remote sensing indicators is an important advance in this field. So, the purpose of this study is to determine the relationship between several remote sensing indicators and $ET_0$. Moghan is an important agricultural region in Iran and is commonly referred to as Azerbaijan's grain store. Farmers in this region have been experiencing water shortages in recent years. Using satellite imagery, this study examines the changes in the Moghan Plain's monthly reference evaporation. For this purpose, the monthly average of vegetation condition index (VCI), thermal condition index (TCI), enhanced vegetation index (EVI), land surface temperature (LST), Normalized Difference Vegetation Index (NDVI), Leaf Area Index (LAI) and Fraction of photosynthetically active radiation absorbed by vegetation (FPAR) are obtained through MODIS sensor using Google Earth Engine system for the time period of 2010-2021. In contrast, for these years, $ET_0$ was calculated using meteorological parameters. From the highest value to the lowest value, the correlation between remote sensing indices and $ET_0$ is equal to LST (0.944), LAI (0.441), FPAR (0.411), EVI (0.318), NDVI (0.191), TCI (0.119) and VCI (0.117). It can be concluded that in terms of water resources management and the analysis of evaporation, LST and LAI are valuable indicators.
**Keywords:** evapotranspiration, Moghan Plain, satellite images.

# NEW ROTOR DESIGN, EASY TO ASSEMBLE AND DISASSEMBLE, USED IN THE BALER

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**Abstract**
The baler plays an important role in the agricultural sector and is one of the basic equipments used in baling products such as feed, hay and grass. The rotor design used in the feeding section of the baler has a significant impact on the efficiency of baling, energy consumption and product quality. The use of rotors results in denser and heavier bales due to shorter average particle length. For both hay and silage bales, there is an advantage to reducing the average particle length of a bale. When dealing with silage, it is advantageous to reduce the amount of air pockets in the bale as it aids the fermentation process. Short straw length allows the bale to spread more easily and increases its absorbency. Regardless of the crop being baled, rotor use increases bale density, resulting in fewer bales per field and fewer bales transported to storage. Scientific studies on the rotor design used in the baler feeding section increase the potential to offer more efficient, durable and energy-saving machines to producers and machine users in the agricultural sector. The results of these studies contribute to making the agricultural sector more sustainable and efficient. In this study, although the

rotor system in all machines is welded, in order to prevent workmanship and welding distortions, a new rotor design that is easy to assemble and disassemble without welding and tightened with nuts was made using the Solidworks program. This study was supported by the Ministry of Industry and Technology for R&D activities under Law No. 5746 with the Ministry Project Code AGTMPR66225 and TÜBİTAK 1507 SME R&D Startup Support Program with the project number "7191069".
**Keywords:** Bale, Baler, Rotor.

# DESIGN AND DEVELOPMENT OF THREE-ROW MAIZE CHOPPER

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**Abstract**
One of the most important conditions for efficient livestock farming is to ensure that the animals have a balanced diet. Animals fed with fresh green and water-rich plants also have high fattening and milk values. However, in recent years, the number of pastures where animals can access fresh green plants has decreased considerably, and in addition, it is not possible to find green fodder in summer and winter. For this reason, breeders need to provide silage feed in order to feed their animals adequately. Silage feed is a feed obtained by fermenting green feed by wrapping it with stretch, compressing it in an airless environment. Ruminants eat this feed with pleasure and appetite due to its pleasant smell and taste. Silage can be made from any green plant eaten by ruminants. Corn silage machine is one of the agricultural equipment used to harvest corn plants and make silage. Corn silage is obtained by harvesting the corn plant when it is green, correctly cutting, shredding, compressing and storing it. These processes preserve the feed value of the corn plant and provide a valuable feed source for cattle, sheep or other livestock. Corn silage is an important feed source for

cattle and other ruminants. Harvesting the corn plant fully and storing the silage correctly helps the animals meet their nutrition needs in winter or throughout the year. In this study, the design of the drawbar, main chassis, roller unit, drum unit, chopper unit and chimney unit of the Three Row Maize Chopper was made with the Solidworks program. Field trials were conducted around Burdur, Izmir-Tire and Aydın-Karpuzlu.This study was supported by the Ministry of Industry and Technology with the Ministry Project Code AGTMPR104033 for R&D activities within the scope of Law No. 5746.
**Keywords:** Silage, Corn Silage, Maize Chopper.

# INVESTIGATION OF THE CHEMICAL AND MORPHOLOHICAL STRUCTURE OF MICROENCAPSULATED WATER-SOLUBLE WOOD PRESERVATIVES

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**Abstract**
In this study, the feasibility of microencapsulation of zinc chloride and borax, which are preservative chemicals that have a wide range of uses in wood preservation but still have not solved the problem of washing out, was investigated as a potential method to reduce the leaching of wood materials. Zinc chloride and borax used as core materials were surrounded by a gelatin shell, a biopolymer. FT-IR analysis of the obtained microcapsules was performed by examining their chemical bond structures. Their morphological structures were examined by scanning electron microscopy. Finally, inhibition tests were performed at 3 different concentrations by using two different decay fungi. FT-IR analysis of zinc chloride/gelatin microcapsules and zinc chloride alone revealed new peaks in the microcapsules. Decreases in some peak depths suggest that zinc chloride is surrounded by gelatin. Similar conditions were also observed for borax. When their morphological structures were examined, it can be said that zinc chloride/gelatin microcapsules have a more pronounced sphericity. As a result of the inhibition test, both capsules did not show any inhibitory effect against the growth of white rot fungus, but it was observed that there was a slight inhibitory effect against the growth of brown rot fungus at the concentrations determined. It is thought that this effect can increase above 25% with increasing the concentration.
**Keywords:** microencapsulation, wood, preservation, decay, fungi.

# BULBLETS FORMATION AND DEVELOPMENT IN LILY UNDER STRESS CONDITIONS RELATED TO IRRIGATION REGIMES

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## Abstract
Many factors such as soil, growing media, fertilization, temperature and irrigation affect the production and development of lily bulblets. Lilies need a regular and balanced watering regime. Lack or excess of water has an effect on the formation and development of bulblets. This research was carried out to evaluate the effect of different water levels on the formation and development of bulblets in lily cultivation. The study was established according to the randomized block design with 5 different irrigation levels (25%, 50%, 75% and 0% (without water), 3 replicates and 12 lily bulbs in each replicate. The study was conducted in the autumn periods of 2017-2018 in Aydın Adnan Menderes University and Lilium LA hybrids "Trebbiano Gerrit Zalm" and Lilium LA hybrid "Pedara" varieties were used as plant material. In order to determine the characteristics related to bulblet formation and development, some parameters such as bulblet number, bulblet weight, bulblet diameter were examined. When the measurements on the formation of bulblets were evaluated in general, the number of bulblet varies according to irrigation levels. Considering the weight values of bulblet, the highest value was found in the 75% water level treatment.
**Keywords:** Lily, Bulblet, Water level, Irrigation regime

# PROGRAMMING THE IRRIGATION OF COTTON PLANTS WITH CROPWAT IN SOKE PLAIN

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**Abstract**
Climate change taking place in the world and in our country threatens all natural resources, especially water. Climate change causes the traditional agricultural methods preferred by farmers in previous years to be replaced by new methods and practices. Especially in this period when access to usable water resources for agricultural purposes becomes difficult, determining product-based irrigation needs and scheduling irrigation becomes essential. The cotton plant, which has an important place in the industrial plants class in our country, is seriously affected by drought due to climate change. Accordingly, the amount of cotton production is decreasing because there is not enough water source for the cultivation areas. In this study, it was aimed to create a cotton irrigation program in the Söke Plain with the CROPWAT program developed by the Food and Agriculture Organization of the United Nations (FAO) by using parameters such as meteorological data, soil volume weight, field capacity and wilting point.
**Keywords:** CROPWAT, Cotton, Irrigation

# INVESTIGATION OF THE EFFECTS OF USING DIFFERENT DOSES OF IBA ON BEAN PLANTS

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## Abstract
Indole-3-butyric acid (IBA), which is in the auxin group of growth regulators, is known to promote the rooting process and is widely used in propagation by cuttings. However, its effects on existing roots have not been clarified. For this purpose, the development of Önceler and Topçu bean varieties was observed by watering them every two days with different doses of IBA solution (0, 50, 100 and 150 uM) two weeks after emergence. One month after emergence, plant height (BB), plant fresh weight (BW), plant dry weight (BW), root length (KU), root fresh weight (WW), plant dry weight (WW) and number of nodules in the roots (NS) were determined.) was determined. When the data obtained is evaluated; The BB and BKA values of the varieties and the KKA values of the IBA concentration x variety interaction were found to be statistically significant at the 5% significance level, and all other parameters were found to be statistically significant at the 1% significance level. As a result of the study, it was observed that IBA applications at different doses affected many properties of the root and therefore the plant. It has been observed that these effects cause positive changes depending on the properties, plant species and varieties, application amount and dosage. It is anticipated that it would be beneficial to try different plant groups and different IBA doses in order to obtain more detailed information.
**Keywords:** plant development, root morphology, root length, number of nodules.

# EFFECTS OF SOME PLANT EXTRACTS AND CHESTNUT PUREE ADDED IN MS MEDIUM ON SHOOT PROLIFERATION ON MICROPROPAGATION OF *Peperomia obtusifolia* L. IN *IN VITRO* CULTURE

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## Abstract

Peperomia is an economically important indoor plant. *In vitro* culture plays a crucial role for rapid production of such an important plant. In addition to the climatic conditions required for growing plants under *in vitro* conditions, the content of the nutrient medium is also an extremely important parameter. However, excessive use of chemicals on micropropagation increases costs. Therefore, the use of plant extracts as plant growth promoters and as an alternative to chemicals against infection risks has started to gain importance. In this context, the aim of this study was to determine the effects of different plant extracts and chestnut puree added to MS medium on plant growth and development (strong shoot formation, large leaf formation, suppression of infection etc.) in in vitro culture of *Peperomia obtusifolia* L. In this study, bazal MS medium supplemented with 2 ppm BAP+0.5 ppm NAA used at all treatments and this medium constituted the control group (PE1), while coconut water (10%) was added to PE2 medium, clove extract (10%) to PE3 medium and chestnut puree (10%) to PE4 medium. Each treatment was planned with 3 replicates and it was aimed to determine the effect of the plant extracts used in this framework on shoot development. In this context, the changes in morphological parameters such as number of shoots per explant (number), shoot length per explant (cm), number of leaves per shoot (num.), leaf length (cm), number of roots per explant (num.), rooting explant ratio (num.), shoot forming explant ratio (%) and infection rate (%) were examined. As a result of the study, the number of shoots per explant was highest in the nutrient media supplemented with coconut water (PE2) (41.40±1.20 num.), control (PE1) (32.68±4.07 num.) and clove extract (PE3) (29.22±7.59 num.), respectively. When the number of roots per explant was analyzed, the highest value was obtained from the medium supplemented with clove extract (PE3) with 3.85±0.63 pieces. The highest values for the proportion of rooted explants were obtained from the media supplemented with clove

extract (PE3), control (PE1) and coconut water (PE2) with 93.33±3.84, 72.71±14.46 and 63.74±14.80 number, respectively.

**Keywords:** Peperomia, plant extract, *in vitro*, tissue culture, micropropagation

# THERAPEUTIC POTENTIAL OF WHEY PROTEINS

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**Abstract**
Sustainability in food production has become one of the most important issues with the increasing world population. In this context, waste management has become one of the important issues in the food industry. The most important waste in dairy industry is whey, which also represents 85-90% of milk volume. The discovery of whey as a functional food with nutritional applications elevated whey to a co-product in the manufacturing of cheese. Meanwhile as a result of consumer awareness and interest in nutritious and healthy foods, there is an increasing trend towards the functional foods including whey proteins. Although whey proteins are found in small quantity, they have high protein efficiency ratio, net protein utilization and biological value as compared to other protein sources. Whey proteins are also rich in essential amino acids needed daily by the body and they are the richest natural source of branched chain amino acids which are important in muscle tissue growth and repair. They can be separated into primary and secondary proteins. Primary proteins are β-lactoglobulin (β-LG), α-lactalbumin (α-LA), serum albumin, immunoglobulins and glycomacropeptides and secondary proteins are lactoferrin, lactoperoxidase and lysozyme. β-Lactoglobulin has the highest proportion in composition, followed by α-Lactalbumin and immunoglobulin, respectively. Most of these components have broad spectrum antimicrobial and immune-enhancing properties. Whey proteins have various beneficial properties on human health such as prevention of some diseases, improving abnormality of the body weight. In addition, whey is such a valuable product with having high nutritional value, anticarcinogenic, antimicrobial, antithrombotic, antihypertensive, antioxidant, angiotensin-converting enzyme inhibition activities, positive effects on the human nervous system, stimulative effect on the human immune system and controlling effects on chronic diseases. Whey proteins are used in a variety of products such as infant formulas, food supplements, sports bars and beverages, due to the various factors and compounds they contain that can improve health and prevent disease. Whey proteins are potent, promise and active components, which have many various nutritional and therapeutic benefits. There is an increasing commercial interest in the use of whey proteins in the production and development of health-promoting functional foods.
**Keywords:** whey, health benefits, functional foods.

# TOXICITY OF NANOPARTICLES USED IN AGRICULTURE

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## Abstract
The synthesis of nanoparticles used in agricultural processes is carried out using three different methods. These methods are referred to as physical, chemical, and biological (green) synthesis. Compared to the other two synthesis methods, biological synthesis is considered environmentally friendly and has lower toxicity due to production from natural extracts (such as plants, bacteria, fungi). While nanoparticles produced through green synthesis and their increasing use contribute to efficient plant cultivation, they can also lead to toxicity in plants. Especially metal-based nanoparticles can pose more risks due to the release of metal ions or atoms after their degradation. Nanoparticles can cause adverse changes in plants in seed germination, root growth, transpiration, photosynthesis, imbalance in water and nutrient uptake, and biomass. Direct or indirect genotoxic effects can also occur. Interactions between DNA and nanoparticles can harm DNA repair mechanisms and alter gene regulation and expression. They can achieve all these adversities due to their bioactive surfaces and small sizes, allowing them to easily pass through cell membranes and interact with different cellular structures and molecules. They can penetrate the plant through stomata, cuticles, hydathodes, wounds, and microscopic openings. To overcome the stress caused by nanoparticles, plants employ different reactive oxygen species (ROS) scavenging pathways. During this process, an increase in antioxidant activity, proline levels, MDA contents, and a decrease in chlorophyll and carotenoid contents can occur as a plant response. Nanoparticles exhibit lower phytotoxicity in combined applications compared to individual applications, likely due to lower metal concentrations used in combined applications. Additionally, plant cytotoxicity may not only depend on nanoparticle properties but also on organism characteristics. The aim of this literature review is to reveal the toxicity of nanoparticles in plants.
**Keywords:** Nanoparticles, Phytotoxicity, ROS, Metal Ions

# DETERMINATION OF CULLING RATES IN HOLSTEIN AND SIMENTAL HERDS

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## Abstract
This study aimed to determine the reasons for culling rates and the risk factors affecting the culling rates in Holstein Friesian and Simmental cows. The study was carried out in the dairy operations in Eskişehir, Konya, Adana, and İzmir. The data of 2749 dairy cows from 7 Holstein Frisian (n = 2343) and 2 Simental (n: 406) dairy operations were used in the study. The reasons for culling and culling rates in association with factors affecting them such as average daily milk yield, number of insemination per lactation, and number of lactation per pregnancy in Holstein Frisian and Simental cows were investigated. The culling rates were 16.04% and 8.86% in Holstein and Simental cows, respectively. While the average rate of culling was 15.06% collectively in all herds examined, the first 3 ranks among the obligatory culling reasons were; infertility, mastitis, and lameness. The total culling rate was not affected by breed (P> 0.05). Mastitis (19.15%) was the most important culling factor in Holstein cows with high milk yield (over 30 L) while breeding problems (24.39%) were the most important breeding cause in low-yield cows. In cows with an insemination number of 3 or more per pregnancy, the highest rate of breeding was due to aging (25.75%). While the culling rates increase in cows with high milk yield and older cows, these animals should be included in the high-risk group and more attention should be paid. As a result, identification of the culling reasons by keeping animal records will help to determine the herd management problems.
**Keywords:** Holstein, Simmental, Culling rates, Milk yield, Lactation number, Number of insemination per pregnancy

# ECO-FRIENDLY APPROACH TO MITIGATE *MACROPHOMINA PHASEOLINA* IN GROUNDNUT USING *STREPTOMYCES SPP.*

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**Abstract**
Groundnut (*Arachis hypogaea*), also known as peanut, is a legume crop grown mainly for its edible seeds. In the tropics and subtropics, it is widely grown and significant to both small and major commercial producers. Groundnuts are a good source of protein, healthy fats, fibre, vitamins, and minerals. Groundnut is a major source of income for farmers in India. It is grown in over 20 states and union territories, and employs millions of people. This paper discusses the biocontrol of dry root rot in groundnut using Streptomyces strains. The study evaluates the antagonistic potential of Streptomyces strains against dry root rot and examines their effectiveness in inhibiting the growth of *Macrophomina phaseolina*, the causal agent of dry root rot. The effectiveness of these strains is assessed through dual culture and metabolite production assays. Metabolite production assays indicate that the tested Streptomyces strains produce hydrolytic enzymes or antibiotics that can inhibit the pathogen the paper also explores the morphological changes in groundnut caused by the Streptomyces strains and highlights the need for further experiments to determine the exact mechanisms of action of these biocontrol agents. The paper also highlights the importance of understanding the mechanisms of action of biocontrol agents for the development of eco-friendly bio-fungicides for the control of dry root rot in groundnut.
**Keywords:** *Arachis hypogaea*, Groundnut, *Macrophomina phaseolina*

# INFLUENCE OF CARBOXYMETHYLATION ON THE HYDROLYSIS OF CROSSLINKED POTATO STARCH.

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**Abstract**
The aim of this study is to determine the influence of carboxymethylation on the hydrolysis of crosslinked potato starch. The method described by kim and lim was used, standard operating procedure for XRD, FT-IR was used, the weight of CMPS decreases as the percentage of citric acid increases in which the 5g of potato starch with 25% of citric acid shows the highest decrease in weight. there is decrease in the weight of crosslinked carboxymethylated potato starch when the percentage of SMCA increases. As reported by many researchers, using 25% of SMCA in 1g of CPS shows highest decrease in weight which gives 0.59g. Also in table 4.3b, despite the changes in the amount of CPS which is raised to 5g, the weight also decreases. The degrees of substitutions (DS) obtained for the carboxymethylated starches were 0.10, 0.17, 0.22, 0.27 and 0.32, CMS was readily dispersed and produced a clear paste in cold (25 °C) water. From visual observation, increasing DS of CMS resulted in increasing clarity of the paste. Swelling power and solubility of native starch and CMS with various degrees of substitution were measured at different temperatures (30 °C, 50 °C, 70 °C, and 90 °C). Carboxymethylation significantly ($P < 0.05$) increased swelling power and solubility of native starch, and generally increasing the DS led to an increase in these values. It is evident that CMS granules swelled readily, even at 30 °C, compared with that of native starch. The reduction in pH for carboxy methylated starches could be due to the carboxymethylation, dilution with HCl solution and the washing steps applied. it is evident that the hydrolysis reaction follows a first-order kinetic model, indicating that the rate of reaction is directly proportional to the concentration of the substrate.
**Keywords**: carboxymethylation, cross linking, hydrolysis.

# USE OF PROCESSED RUMEN FLUID AS A FEED ADDITIVE IN ANIMAL NUTRITION ON IN VITRO FERMENTATION CHARACTERISTICS

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**Abstract**
The excessive generation of rumen fluid in slaughterhouses has contributed to environmental contamination during processing. However, it is possible to mitigate ecological pollution while generating a viable dietary supplement for animal nutrition. Hence, it is imperative to determine the chemical composition and biological activity of desiccated slaughterhouse rumen fluid to achieve maximum usage. In this study, rumen liquid dried using the spray drying technique had its chemical composition examined. After straining, the rumen fluid from the slaughterhouse was spray-dried. After determining their chemical composition, they were incubated with 1, 2, and 3 per cent ratios for 24 hours on alfalfa, wheat straw, rapeseed straw, and bagasse feeds. Their properties, chemical composition, and gas production were estimated. Gas production capability was measured using the laboratory method with five repetitions at 2, 4, 6, 8, 12, 16, 24, 36, 48, 72, 96, and 120 hours. The obtained data were analyzed using a completely random statistical design. The results showed that the amount of gas produced from the incubation of bagasse with processed rumen liquid was significant at all hours after incubation ($P<0.05$). Based on the findings obtained from the empirical data, the spray drying technique effectively preserves the biological activity of rumen fluid. However, further investigation is necessary to determine the optimal treatment strategy.
**Keywords:** Additives, Animal Feeding, Ruminal Fluid, Rumen Fermentation, Processing.

# THE EFFECT OF BIOLOGICAL PROCESSING ON THE CHEMICAL COMPOSITION AND IN VITRO FERMENTATION CHARACTERISTICS OF SUGAR BEET PULP

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**Abstract**
About 70% of the cost of raising livestock is the cost of feed, so preparing a balanced and cheap diet can play an essential role in the usefulness of livestock production. Feed processing to increase performance and reduce production costs has always been the focus of animal nutrition specialists. This experiment investigated the biological processing of chemical compounds and the parameters of sugar beet pulp gas production. Experimental treatments include: 1. Beet pomace without additives (control); 2. Sugar beet pomace processed with microbial and protein supplements was ensiled for 45 days at room temperature. After opening the silos, gas production capability was measured using the laboratory method with five repetitions at 2, 4, 6, 8, 12, 16, 24, 36, 48, 72, 96, and 120 hours. The obtained data were analyzed using a completely random statistical design. Biological processing significantly reduced the pH of ryegrass pomace ($p < 0.05$) compared to the control. The addition of microbial supplements affected the amount of dry matter so that in the processed treatment, the dry matter increased compared to the control. Adding protein and microbial supplements to beet pulp also increased the amount of crude protein ($p < 0.05$). It also significantly ($p < 0.05$) reduced ammonia nitrogen compared to the control treatment. The results showed that the pattern of gas production in processed sugar beet pomace compared to unprocessed beet pomace was different and statistically significant at different hours of incubation ($p<0.001$). In general, beet pomace with and without additives had good quality. Still, in replacing and using processed beet pomace instead of unprocessed sugar beet pomace, one should pay attention to losing dry matter and its higher fermentation speed than dry beet pomace.
**Keywords:** Soluble carbohydrates, Sugar beet pulp, Rumen fermentation, Microbial processing

# EXTRACTION OF HYPERICIN FROM HYPERICUM PERFORATUM L. USING A BATTERY-TYPE EXTRACTOR

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## Abstract
*Hypericum perforatum* L. (St. John's wort), have been used for a long time in folk medicine, is an herbaceous perennial plant growing in many regions in Turkey. It has a significant antidepressant activity thanks to hypericin, one of its bioactive ingredients. The plant was harvested from Istanbul, Turkey. After cleaning, its aerial parts powdered and sieved. Considering to the literature and our previous studies, the solvent was chosen as water-ethanol mixture (50% v/v). The extractor system consists of four jacketed columns can work individually and streams can be seen at Figure 1.

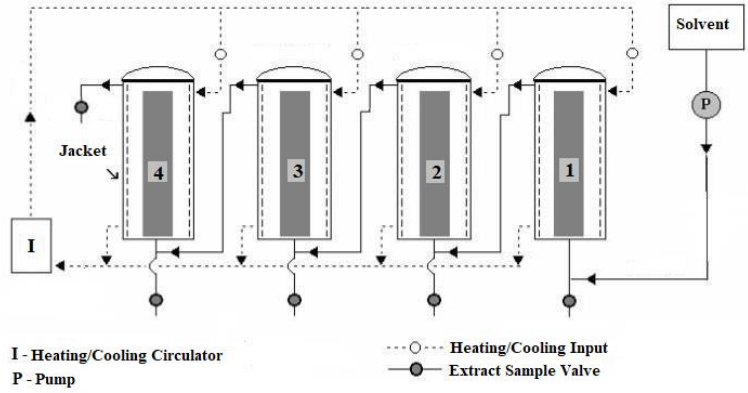


**Figure 1.** Battery-type extractor

Extraction time is adjusted at the solvent flow rate of 62.5 ml/min. For comparing to effects of temperature and column number, it was studied at 35°C, 25°C, and 55°C while using one-, three-, and four-column system, respectively. It was found that while hypericin content were 0.076 g/g% dw with one column in 30 mins at 35°C, 0.403 g/g% dw with three columns in 113 mins at 25°C. After a process for 165 minutes, it was aimed to reach to maximum total hypericin rate. For this, it was worked with four columns at 55°C to avoid thermal degradation. At this condition, total hypericin content of the final product was 2.34% g/g beside that the content of the third column was 0.51% g/g still. It was seen that the findings proved the theorical expectations:

1. Hypericin content was highly influenced by solvent flow rate.
2. Hypericin percentages increased with the process time at first and then decreased.
3. The multi-column systems were efficient than the one-column system.
4. It was understood that temperature is more operative parameter than the column quantity for the aim.

With the battery-type extractor that was used, it was seen that a semi-continuous production of hypericin-rich extract can be possible at preferable and changeable process times and solvent flows without thermal degradation.

**Keywords:** St. John's Wort, *Hypericum perforatum* L., Extraction, Hypericin.

# SOIL HEALTH AND SUSTAINABLE MANAGEMENT: AN OVERVIEW

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## Abstract
Soil health is sometimes used interchangeably as a term of soil quality. The term of "soil health" recognizes soil as a dynamic living system and emphasizes the multiple functions of a soil necessary to sustaining agricultural production: crop production, water retention and availability, nutrient cycling, and biological diversity. Soil health is defined as the continued capacity of a soil to function, sustain biological activity, maintain, or enhance environmental quality and encourage crops, animal, and human health. It focuses on soil parameters and indication of a soil's ability to protect a range of ecological functions in its appropriate ecosystem, supporting sustainability for long term. Soil health is composed of physical, chemical, and biological properties related to functional soil processes. It has a major role in agricultural productivity, food quality, environmental resiliency, and ecosystem sustainability. The management of soil health is necessary to enhancing food and nutritional security, critical to mitigating and adapting to changing and uncertain climate, important to decreasing nonpoint source pollution, and eutrophication, pertinent to improving biological diversity of soil, and required to sustainable intensification of agroecosystems through improving use efficiency of inputs (water, nutrients) and decreasing losses. There are several strategies to enhance soil health: reducing tillage, keeping the soil surface covered by cover crops or mulches, maximizing the duration of living roots (cover cropping, including perennial crops in rotations), and maximizing plant diversity within rotation. Management practices that improve soil health frequently decrease plant pest pressures. Besides, healthier soils have more diverse and active populations of soil organisms. Overall, this paper highlights soil health benefits and demonstrates research findings on the potential soil health management practices.
**Keywords:** conservation, soil health, soil management, sustainability.

# PHARMACOLOGICAL ACTION OF PLANT-DERIVED NATURAL PRODUCTS ON RESPIRATORY INFLAMMATION AND RELATED DISEASE – A REVIEW

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**Abstract**
A wide range of problems that affect the respiratory system, including the airways, lungs, and related structures, are included in the category of respiratory inflammation and illnesses. Asthma, Chronic Obstructive Pulmonary Disease (COPD), Bronchitis, Pneumonia, Interstitial Lung Disease (ILD), Allergic Rhinitis (Hay Fever), Cystic Fibrosis, and Lung Cancer are a few examples of frequent respiratory inflammation and disorders. Infectious agents, environmental exposures, allergens, autoimmune reactions, genetic predispositions, gastroesophageal reflux disease (GERD), chemical exposures, fungus infections, irritants, and other variables can all contribute to respiratory inflammation and illnesses. Natural substances originating from plants have been investigated for their pharmacologic effects in treating respiratory inflammation and associated conditions. These include anti-inflammatory properties, antioxidant effects, bronchodilation, mucolytic properties, anti-asthmatic effects, and immunomodulation, to name a few. It's crucial to remember that while substances produced from plants may have medicinal advantages, they should only be used under a doctor's supervision. These substances' efficacy varies, and combinations with drugs or allergies need to be taken into account. Additionally, more studies are frequently required to confirm their effectiveness in particular respiratory disorders. Numerous naturally occurring substances with plant origins have been used for centuries and are currently being researched for their potential to treat respiratory conditions and inflammation. Examples include eucalyptus oil, ginger, turmeric, honey, licorice root, peppermint, pelargonium sidoides (Umckaloabo), butterbur, and others. The use of natural medicines produced from plants or complementary therapies is occasionally combined with medical treatments to effectively manage respiratory inflammation and related disorders. To create individualized treatment plans and obtain the right care, people with chronic diseases must collaborate closely with medical specialists.

**Keywords:** Airways and Lungs, Chronic Obstructive Pulmonary Disease, Anti inflammatory properties, Pelargonium sidoides.

# EXPLORING THE IMPACT OF INDUSTRIAL DISCHARGES ON SOIL CONTAMINATION BY HEAVY METALS: A CASE STUDY IN THE SOIL OF MOHAMMEDIA, MOROCCO

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**Abstract**
The Mohammedia region, near Casablanca, has become increasingly industrialized. The industrial activities in the area release liquid, solid, and gaseous waste into the environment, underscoring the need to assess soil pollution caused by this industrial activity. The objectives of this study include collecting and synthesizing available data, analyzing the study area's characteristics, and evaluating metallic contamination of Mohammadia soils due to industrial activity. Ten soil samples were taken at a depth of 20 cm from three sites in the city. Seven trace metals (cadmium, lead, copper, chromium, zinc, nickel, and cobalt) were analyzed. Four physico-chemical parameters (pH, conductivity, organic matter, and the total limestone content) were also assessed for each sample. The results show that an alkaline pH, low salinity, and a low concentration of organic matter characterize the soils in the study area. The concentrations of heavy metals in the soils studied varied as follows: from 27.16 to 99.17 mg/kg for Zn, from 12 to 31 mg/kg for Pb, from 14 to 36 mg/kg for Ni, from 9 to 36 mg/kg for Cu, from 48 to 151 mg/kg for Cr and from 11 to 20 mg/kg for Co. Specific pollution indices for each metal revealed moderate soil contamination by copper (Cu), chromium (Cr) and cobalt (Co). The pollution index showed that the industrial zones adjacent to the freeway (ZI and AR2) are the region's most heavily affected by heavy metals.
**Keywords:** Contamination, soil, Heavy Metals, industrial pollution, Mohammedia.

# FACTORS INFLUENCING UTILIZATION OF AGRICULTURAL TECHNOLOGIES TRANSFER AMONG PARTICIPANTS OF ADOPTED VILLAGE EXTENSION PROJECT IN KADUNA AND NIGER STATE, NIGERIA

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**Abstract**
This study assessed the factors influencing utilization of agricultural technologies transfer among participants of Adopted Village Extension Project (AVEP) in Kaduna and Niger State, Nigeria. A Multi-stage sampling procedure was employed to select 246 participants of AVEP for the study comprising of 131 and 115 beneficiaries from Kaduna and Niger States, respectively. Primary data were collected with the aid of structured questionnaire complemented with an interview schedule. Data were analyzed using descriptive statistics, Technology Adoption Index (TAI) and Tobit regression analysis. The results reveal that the mean age of the participants in Kaduna and Niger States were 45 and 48 years, with a mean household size of 8 and 7 people, and mean farming experience of 17 and 21 years, respectively. In terms of various agricultural technologies transferred to the beneficiaries, improved planting materials (92.4%), weed management techniques (89.6%) and furrow planting practice (88.2%) ranked 1$^{st}$, 2$^{nd}$ and 3$^{rd}$ respectively, among crop production technologies, while improved poultry breeds (87.6%), improved feed formulation (81.3%) and fish feeding management (78.8%) ranked 1$^{st}$, 2$^{nd}$ and 3$^{rd}$ among the livestock technologies. Respondents' age (-2.05), education (1.76), awareness of technology (2.16), compatibility (4.35), relative advantage (1.98) and cost (3.22) statistically significant at 10%, 5% and 1% level of probability were found to influence agricultural technologies transferred. It was therefore recommended that, for efficient transfer of agricultural technologies, there is need for improved sensitization by the research institutes on relative advantages of technologies for easy adoption.
**Keywords:** Adopted village, Agricultural technologies, Factors influencing, Participants

# AMELIORATIVE EFFECT OF LYCOPENE ALONE AND IN COMBINATION WITH CO-ENZYME Q10 IN STREPTOZOTOCIN-INDUCED DIABETIC NEPHROPATHY IN EXPERIMENTAL RATS

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**Abstract**
Diabetic nephropathy (DN) has become an utmost reason for long-standing renal dysfunction and end-stage renal disease globally. Oxidative stress induced by persistent hyperglycaemia is considered a fundamental element in the evolution of DN. The goal of this research was to discover the outcome of appendages of natural antioxidants such as lycopene and co-enzyme Q10 (CoQ10) in DN rats and to observe the preventive effects in DN. A diabetes model was developed in a Wistar strain of male rats (200 – 250 gm) by subcutaneous injection of streptozotocin (55 mg/kg). Development of nephropathy was assessed by renal function tests including blood glucose, creatinine, albumin, total protein, total bilirubin, uric acid, total cholesterol, triglycerides, and CRP level. Oxidative stress markers such as LPO and GSH content and activity of membrane-bound $Na^+/K^+$ ATPases were measured in kidney homogenate. Renal damage was assessed by performing a histopathological analysis. DN rats showed a significant elevation in creatinine, albumin, total protein, total bilirubin, uric acid, total cholesterol, triglycerides, CRP, and LPO levels whereas a significant reduction in creatinine clearance and GSH level. Treatment with antioxidants such as lycopene (5mg/kg/p.o.) and CoQ10 (10 mg/kg/p.o.) along with their combination for 4 weeks notably altered the level of renal function biomarkers and oxidative stress markers. These antioxidants and their combination also protected the kidney from abnormal morphological changes. The present findings suggest that the combined administration of lycopene and CoQ10, which are antioxidants, exhibits synergistic effects in mitigating renal injury by reducing hyperglycaemia, oxidative stress markers, and histopathological alterations.
**Keywords:** Antioxidants, CoQ10, Diabetic nephropathy, Lycopene, Oxidative stress, Streptozotocin

# EFFECT OF TREATED ALFALFA SILAGE WITH WHEY AND MICROBIAL ADDITIVE ON CHARACTRISTICS, CHEMICAL COMPOSITION AND *IN VITRO* DEGRADABILITY

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## Abstract
The purpose of this study was to determine the effect of fresh whey and commercial bacterial additive of Lassel (*Lactobacillus boucheri*) on the characteristics, chemical compositions and laboratory degradability of alfalfa silage. At first, the characteristics, chemical compositions and laboratory degradability of alfalfa silage (china II) with fresh whey cheese were tested at 4 levels of 0, 30, 60 and 90 g/kg of alfalfa fresh weight with bacterial additive. The processed samples were silo for 90 days in a laboratory silo equipped with a drain to remove effluent. This experiment was conducted in a completely randomized design with 8 treatments and 3 replications. The treatments included: 1) alfalfa (control) 2) alfalfa with bacterial additive $3\times10^8$ cfu/g fresh weight of alfalfa, 3) alfalfa with 30 g of fresh whey, 4) alfalfa with 30 g fresh whey + bacterial additive $3\times10^8$ cfu/g fresh weight of alfalfa, 5) alfalfa with 60 g fresh whey, 6) alfalfa with 60 g fresh whey + bacterial additive $3\times10^8$ cfu/g fresh alfalfa weight , 7) Alfalfa with 90 g fresh whey and 8) Alfalfa with 90 g fresh whey + bacterial additive $3\times10^8$ cfu/g fresh weight of alfalfa. The data were analyzed in a completely randomized design with three replications. At the end of the experimental period, whey and bacterial additive in any of the treatments did not cause significant changes in dry matter compared to the control treatment. The pH of all samples was less than 4.86 but, the pH of the control was higher treatment than other treatments. Due to rapid decrease in pH, the hence better use of food as well as the use of lactose in whey fresh by bacteria ($p<0.05$). The addition of fresh whey and bacterial supplement to alfalfa increased the total of fatty acids (except for AW2 and AW3). The least resistance to corrosion was related to AB treatment and the highest amount was related to AW2 treatment (30 hours and 120 hours, respectively). Adding fresh whey to alfalfa from 2 to 120 hours incubation caused a significant difference compared to the control treatment ($p<0.05$). The reason for this is the addition of fresh whey as an additive due to an increase in the amount of carbohydrates and fermentation energy for the ruminal microbial population, which increases the amount of gas produced, which greatly reduces the amount of proteolysis and increases the soluble carbohydrate, but in A treatment that only contains lactic acid addition, although it improves fermentation, does not have a significant effect on the digestibility process and the volume of produced gas. Dry matter degradability by using nylon bags and in vitro method with addition of fresh whey to alfalfa silage increased significantly compared to control treatment. The highest dry matter degradability was observed for alfalfa treatments with 60 g fresh whey per kg fresh alfalfa weight (AW2), which was observed during 2, 4, 12, 72 and 96 hours of rumen incubation ($p<0.05$). According to the results, it can be concluded that the bacterial additive Lalcile with fresh whey with the availability of fermentable carbohydrates for lactobacilli and rapid reduction of pH and limiting the growth of yeasts and fungi led to increased susceptibility Aerobic and improve the quality of silage. Also, adding fresh whey to alfalfa silage can increase the digestibility and rate of degradability of alfalfa silage.

**Keywords:** *Lactobacillus boucheri*, Dry matter, alfalfa silage

# LEVERAGING DATA SCIENCE AND ARTIFICIAL INTELLIGENCE FOR PROACTIVE PANDEMIC RESPONSE: A COMPREHENSIVE REVIEW

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**Abstract**
In recent times, the world has faced numerous health crises. During these times, the importance of data science and Artificial Intelligence (AI) has grown significantly. These tools have shown great promise in helping to predict, monitor, and manage global pandemics. This research intends to take a thorough look at the role and impact of data science and AI in enhancing the effectiveness of global pandemic responses. The focal point of this study is to integrate diverse data analytics tools and AI algorithms. These instruments are used to analyze data from pandemics in a dynamic manner. This analysis aids in creating valuable insights. These insights can be used to develop strategies that respond proactively to health crises. In this research, we aim to assess the existing frameworks and models in depth. These are the structures that make use of extensive data analytics, machine learning, and predictive modeling. These tools are essential in keeping track of infectious disease spread, understanding public sentiment, and making early interventions possible. Furthermore, the study looks at the ways AI can help in making the allocation of resources optimal and improving the delivery of healthcare services during health crises. This optimization process is vital in strengthening the readiness and resilience of healthcare systems around the world. An additional goal of this research is to pinpoint potential drawbacks and limits of heavily depending on strategies driven by AI. This includes concerns about data privacy and biases in algorithms. This research encourages a cross-disciplinary approach, fostering collaboration among data scientists, healthcare experts, and policy makers. This collaboration aims to use the power of AI in a responsible and effective manner. The methodology for this research combines a qualitative review and quantitative analysis to offer a comprehensive perspective. Initially, a systematic 2 review of existing literature, case studies, and reports will be undertaken to gather substantial background information on the role of data science and AI in pandemic responses. Subsequently, a quantitative analysis involving the use of statistical tools will be carried out to scrutinize the available pandemic data and derive meaningful patterns and insights. Primary data will be collected through surveys and interviews from stakeholders in healthcare and technology sectors to incorporate real-time perspectives and firsthand experiences. This mixed-method approach ensures a thorough examination of the topic, fostering a robust and comprehensive analysis. This study hopes to deepen the understanding of the transformative potential held by data science and AI in the management of global health crises. It seeks to identify the best methods and areas that could be improved upon. This contribution is aimed at encouraging discussions about updating pandemic response strategies with the help of technology-driven approaches. This modernization process is important in guaranteeing a future that is safer and healthier for all.
**Keywords:** health crises, pandemic, modernization process

# ADVANCEMENTS IN MITIGATING MICROPOLLUTANTS IN AGRICULTURE: TOWARDS SUSTAINABLE CROP PRODUCTION

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**Abstract**
Micropollutants in agriculture pose environmental and health risks. This paper explores innovative approaches and technologies for mitigating micropollutants in agriculture, promoting sustainable crop production. The need for effective management strategies to address micropollutants in agriculture is discussed. It highlights precision agriculture as a promising solution, utilizing technologies like remote sensing, geographic information systems (GIS), and drones to optimize pesticide application. By reducing pesticide use, precision agriculture minimizes micropollutant introduction into the environment. Integration of machine learning and artificial intelligence enhances precision and accuracy. Emerging technologies for micropollutant removal and remediation are explored. Advanced wastewater treatment systems, including constructed wetlands and biofiltration, effectively remove micropollutants from agricultural runoff. Novel adsorbents like activated carbon and nanomaterials capture and remove micropollutants from soil and water. The importance of sustainable agricultural practices in micropollutant mitigation is highlighted, with a focus on integrated pest management (IPM). IPM combines biological control agents, crop rotation, and habitat diversification to reduce reliance on chemical pesticides. This minimizes micropollutant introduction while maintaining crop productivity. The work concludes by emphasizing interdisciplinary collaborations between researchers, policymakers, and agricultural stakeholders. It highlights the importance of education and awareness campaigns to promote environmentally responsible agricultural practices. In summary, the paper provides an overview of innovative approaches and technologies for mitigating micropollutants in agriculture. Precision agriculture, advanced treatment systems, sustainable practices, and interdisciplinary collaborations contribute to sustainable crop production while safeguarding the environment and human health.
**Keywords:** Integrated pest management; Micropollutants; agriculture; sustainable crop production; pesticides

# INTERACTIONS OF THE BEARDED VULTURE WITH SYMBIONTS, PARASITES, PREDATORS, AND COMPETITORS: IMPLICATIONS FOR HEALTH AND FITNESS

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## Abstract
The Bearded Vulture *(Gypaetus barbatus*) engages in a variety of ecological relationships with symbionts, parasites, predators, and competitors, which significantly influence its health and fitness. This abstract provides a concise overview of these interactions, specifically focusing on the implications for the well-being and reproductive success of the Bearded Vulture population. Symbiotic relationships play a vital role in the life of the species. Mutualistic symbionts, such as certain bacteria or fungi, contribute to enhanced digestion and disease resistance, ultimately promoting the overall health and fitness of the bird. These symbiotic associations are crucial for the Bearded Vulture's ability to thrive in its environment. Parasitic organisms pose challenges to the species. Ectoparasites and endoparasites, such as mites and gastrointestinal worms, can negatively impact the bird's reproductive output, immune function, and overall survival. Understanding the dynamics of these avian-parasite interactions is essential for managing and conserving the Bearded Vulture population. Predators, including raptors and mammals, exert selective pressures on the Bearded Vulture. The presence of predators influences the bird's behavior, reproductive decisions, and habitat selection, ultimately affecting its fitness and survival. Bearded Vultures have evolved anti-predator strategies, such as vigilance behaviors and aerial evasion, to mitigate predation risk. Competition with conspecifics and other species also affects the bird's fitness. Limited resources, such as food, nesting sites, and mates, are subject to competition. Competitors can drive changes in foraging behavior, territoriality, and reproductive success, influencing the population dynamics of the Bearded Vulture. The consequences of these interactions for the Bearded Vulture's health and fitness are multifaceted. Positive symbiotic relationships enhance its fitness, while parasitic infections and predation risk can have negative impacts on survival and reproductive success. Competition for resources can affect the bird's ability to secure food and reproduce successfully. Understanding the intricate interactions between the Bearded Vulture and its symbionts, parasites, predators, and competitors is crucial for comprehending the ecological dynamics of this species. Further research is necessary to delve into the specific mechanisms underlying these interactions and their implications for the health and fitness of the Bearded Vulture. This knowledge is essential for informing conservation strategies to safeguard the Bearded Vulture population, particularly in the face of environmental changes and anthropogenic threats.
**Keywords:** Bearded Vulture; Mutualistic symbionts; parasites; predators; competitors

# EVALUATION OF BIOACTIVE COMPOUNDS OF DIFFERENT SALEP SPECIES GROWING IN TURKEY

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## Abstract

Salep is a drug recorded in ancient medical books and is a substance with therapeutic properties. Salep is obtained by drying and grinding the tubers of wild orchid species belonging to the *Orchidaceae* family. It is known that Turkey has the highest number of orchid species in Europe and the Middle East. Today, fifty orchid species are used in traditional Chinese medicine and are also used as Ayurvedic medicines in India. Alkaloids, flavonoids, glycosides, bibenzyl derivatives and terpenoids in the chemical structure of orchids are natural secondary metabolites and sources of antioxidants. For this reason, orchid species are known to be rich in bioactive compounds. The aim of this study was to investigate the bioactive compounds of salep species obtained from 10 different wild orchid species collected from different regions of Turkey. For this purpose, firstly, dried salep species were obtained. Two different solvents (methanol, ethanol) were used to extract the bioactive compounds of the saleps and then the total phenolic compounds (TFC) of the salep species was determined. Antioxidant activity of salep species were analyzed by DPPH (2,2,-Diphenyl-1-picrylhydrazyl) and CUPRAC (Cu (II) Ion Reducing Antioxidant Capacity) methods. TFC methanol and ethanol extracts of salep species were determined in the range of 7.93±0.01-25.84±0.18 and 8.06±0.01-26.09±0.18 mg gallic acid equivalent/g dry matter, respectively ($p \leq 0.05$). DPPH antioxidant activity percentages of salep species were between 5.02-11.04% and 6.43-13.22% for methanol and ethanol extracts, respectively, and the results were statistically significant ($p \leq 0.05$). Antioxidant activity values calculated by CUPRAC method were 0.81-4.25 and 1.71-5.45 mg/g dry matter for methanol and ethanol extracts, respectively. The TFC and antioxidant activities of ethanol extracted samples were found to

be higher than methanol extracts. In conclusion, the bioactive components of different species of salep orchids growing in Turkey were compared and the effect of the use of different solvents on the extraction of bioactive substances in salep species was evaluated.

**Keywords:** Salep orchids, total phenolic compounds, antioxidant activity

# REVIEW ON REMOVAL OF AGRICULTURAL AND PHARMACEUTICAL WASTE FROM WASTEWATER USING CONSTRUCTED WETLAND

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**Abstract**
Constructed wetlands (CWs) have emerged as a sustainable and cost-effective solution for treating wastewater contaminated with agricultural and pharmaceutical pollutants. This review provides an overview of the application of CWs in the removal of these contaminants from wastewater. Agricultural activities, such as crop cultivation and animal husbandry, often contribute to the release of various pollutants; include pesticides, fertilizers, and animal waste, into water bodies. Similarly, pharmaceuticals and personal care products (PPCPs) are frequently detected in wastewater due to their widespread use. These contaminants pose significant risks to aquatic ecosystems and human health, necessitating the development of effective treatment strategies. CWs are engineered systems that mimic natural wetlands and utilize various physical, chemical, and biological processes to remove contaminants from wastewater. The design and operation of CWs can be tailored to target specific pollutants, including agricultural and pharmaceutical compounds. Key mechanisms involved in contaminant removal within CWs include sedimentation, filtration, adsorption, microbial degradation, and plant uptake. Several studies have demonstrated the effectiveness of CWs in removing agricultural and pharmaceutical contaminants. The presence of vegetation, particularly emergent plants, enhances contaminant removal by providing a suitable habitat for diverse microbial communities that can degrade or transform pollutants. Additionally, the rhizosphere of wetland plants plays a crucial role in the uptake and transformation of contaminants, further improving treatment efficiency. Various factors influence the performance of CWs for removing agricultural and pharmaceutical contaminants, including hydraulic loading rates, residence times, vegetation types, and nutrient availability. Optimization of these factors can maximize pollutant removal efficiency and ensure the long-term sustainability of CW systems. Moreover, CWs offer additional environmental benefits such as habitat creation, carbon sequestration, and aesthetic value. However, challenges remain in terms of monitoring and managing potential risks associated with the release of treated effluent, including the potential for the development of antibiotic resistance in wetland microbial communities.
**Keywords:** Constructed wetland, Agricultural waste, Pharmaceutical waste, Wastewater, Pollutants.

# ROLE OF EARTHWORM BASED-PRODUCTS IN AGRICULTURE, ENVIRONMENT, AND HEALTH

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## Abstract
Earthworms are eminent ecosystem engineers, detritivores, vital soil-dwelling invertebrates, and important components of soil biodiversity. Research has been done on the diversity, distribution, abundance, and agricultural importance of earthworms worldwide but these micro-creatures are badly neglected in Pakistan and even limited research has been done on the earthworms in Pakistan. Therefore, the current study aimed to explore the significant role of earthworms in various fields of vermitechnologies such as vermicomposting, vermifilteration, vermiremediation, and vermi-based therapeutic analysis. Currently, 1) Vermicompost was prepared using *Eisenia fetida*, and the impact of vermicompost was evaluated on the development of ornamental plants; 2) Therapeutic values of various earthworm species as antibacterial, anticoagulant, and antioxidant agents were screened; 3) *Eisenia fetida*, and *Pheretima lignicola* (earthworm species) were used for the remediation of cadmium, lead, and chromium from both artificial prepared and naturally contaminated soil; 4) Vermifiltration eco-technology was developed for the remediation of heavy metals from aquifers and utilization of vermiwash for crops production. It was concluded that Vermi-technologies verify very cost-effective and eco-friendly technologies and could play a major role in agriculture, environment, and health/pharmaceutical industries.
**Keywords:** Earthworms, *Eisenia fetida*, Vermifiltration

# EXPOSURE OF NILE TILAPIA (*Oreochromis Niloticus*) PREFEEDING LARVAE TO AROCLOR 1254 AND BENZO(A) PYRENE IN A LABORATORY UPREGULATE CYP P450 (A1) GENE THROUGH AHR PATHWAY

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**Abstract**
Many organisms, including fish, respond to pollutant insult by changing the expression of genes, particularly those for xenobiotic metabolism. Nile tilapia (*Oreochromis niloticus*) prefeeding larvae (6-7 days post fertilization/dpf) was used as a model species and exposed to different sublethal concentrations of two model chemicals Aroclor 1254 at a concentration of 16 mg/l and Benzo[a]pyrene, at a concentration of 1.6 mg/l in the laboratory using a quantitative polymerase chain reaction (qPCR) with power SYBR Green II master mixes. Primers sequences of the already selected and optimised gene that passed quality criteria were used in the assay (*CYP 1A* forward and reverse). Transcript expressions of gene was measured using RT-qPCR. The expression profile of the gene of interest *Cytochrome P450 1A* (*CYP IA*) was normalized to that of reference genes *Ribosomal Protein S5* and *S7* (*RPS5 and RPS7*) based on the $2^{-\Delta\Delta Ct}$ method (Pfaffl, 2001). The results showed that each chemical induced significant *CYP 1A* mRNA gene expression patterns after 24hrs exposure, involving biological signaling pathway of aryl hydrocarbon receptor pathways, which is known to respond to chemicals such as PCBs and PAHs compared to control. Thus, each chemical generated different level of fold change of gene expression in prefeeding larvae of Nile tilapia. This indicates that a standard PCR array such as the one described here, could be used to extend these studies to wild samples (samples from different wate bodies), in order to determine whether particular contaminants are likely present in harmful concentrations.
**Keywords:** CYP 1A, Prefeeding, xenobiotics, Aroclor, B(a)P, Nile tilapia, RT-QPCR, Primers.

# ELECTROCHEMICAL BIOSENSOR FOR MONITORING INTERACTION BETWEEN SAXITOXIN AND DNA

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## Abstract
Sustainable agriculture aims to reduce environmental impact, conserve biodiversity, and ensure food security in long term. The quality of freshwater is crucial for sustainable agriculture. However, eutrophication and the presence of cyanobacterial toxins threaten agricultural irrigation. Cyanobacterial toxins produced by cyanobacteria such as microcystins, cylindrospermopsin, anatoxin and saxitoxin have harmful effects on organs and the nervous system. Saxitoxin (STX) also has been found to have genotoxic effects when accumulated in water, agricultural products, and aquatic life. It is important to detect the presence of STX in water. Biosensor technology allows continuous monitoring of water quality.
In this work, genotoxic effects of STX on DNA was studied by electrochemical methods for the first time. DNA coated pencil graphite electrode (DNA-PGE) was immersed in STX solution to allow DNA-toxin interaction, then the changes in electrochemical characteristics were observed by cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). Experimental parameters, such as DNA concentration, STX concentration, and interaction time were optimized by EIS to reach the lowest detection limit. The experimental procedure is summarized in **Figure 1**.

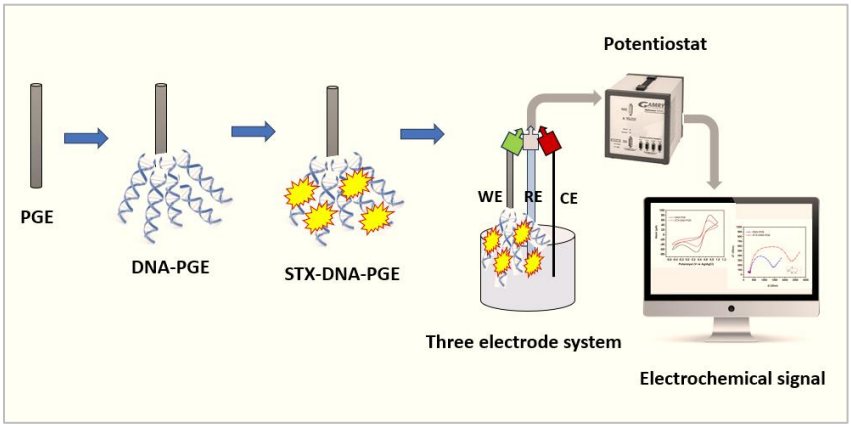


**Figure 1.** Schematic illustration of the interaction between STX and DNA.

Electrochemical detection of STX is based on biomolecular interactions. In EIS, a significant change in charge carrier resistance (Rct) was observed upon STX-DNA interactions, proving

that the PGE-DNA based electrodes can be used for rapid, accurate and safe detection of cyanotoxins. Toxin analyses for environmental monitoring, public health, and food safety can be conducted by highly sensitive, reproducible, simple, and disposable electrochemical biosensors.

**Keywords:** Sustainable agriculture, Electrochemical biosensor, Toxin-DNA interaction, Saxitoxin.

# DETERMINATION OF THE STATUS OF THE COCCINELLIDAE (COLEOPTERA) FAMILY IN KIRKLARELI PROVINCE

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**Abstract**
Species of the Coccinellidae family are known as natural enemies of aphids. For this reason, many survey studies have been carried out to determine their situation in the world and in our country. There is no research in the literature on the situation of this family in Kırklareli Province. For this purpose, survey studies were carried out in Babaeski, Lüleburgaz, Merkez and Vize districts of Kırklareli Province. In the study conducted, 28 species belonging to 18 genera were identified. Among these species, the most common and abundant species are *Harmonia axyridis* (Mulsant), *Stethorus gilvifrons* (Weise), *Coccinella septempunctata* (Linnaeus). The least common species are *Platynaspis luteorubra* (Redtenbacher) and *Oenopia lyncea agnata* (Mulsant). The study is the first for Kırklareli Province, so it is the first record of many Coccinellidae species for the province. The findings obtained form the basis for studies on the Coccinellidae family in our country, especially in the Thrace Region. Among the species detected, *H. axyridis* is a species recently recorded in our country. It is also the first record for the province. Since it is an invasive, polyphagous and new species, it is thought that its effect on the regional fauna should be investigated as a priority.
**Keywords:** Coccinellidae, Kırklareli, *Harmonia axyridis*, *Stethorus gilvifrons*, *Coccinella septempuctata*

# ENGINEERING SOLUTIONS TO REDUCE ENVIRONMENTAL HAZARDS OF STORAGE TANKS

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## Abstract

The source of technogenic impact on the environment is regular operation, pre-repair and repair work on tanks, as well as spillage of oil products and other flammable liquids under the influence of seismic loads, fires and explosions on tanks. Therefore, the treatment of the effect of oscillations and vibrations on tanks for storing environmentally hazardous liquids and the assessment of the impact reduction on nature is a very relevant scientific and practical problem to increase the environmental safety of the territories adjacent to the tanks. In various authors' papers, sloshing in tanks of various shapes for oil products storage has been investigated, a number of engineering solutions have been proposed to reduce sloshing of environmentally hazardous liquid and ensure environmental safety of the territory adjacent to the tanks. The obtained results indicate the necessity to reduce the sloshing level. For this, various damping devices have been applied. Among them the horizontal and vertical partitions have been proposed in. Installation of partitions leads to a shift in the frequency spectrum (Fig. 1.). But the frequencies of excitation forces as a result of artificial earthquakes could have a wide spectrum.

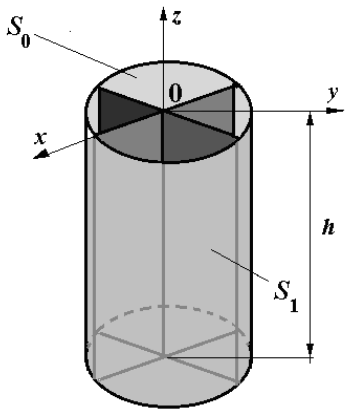


Fig. 1. A cylindrical tank with a partition

Vertical partitions installation shifts the spectrum of resonance frequencies towards high-frequency oscillations. This will allow tuning from unwanted excitation frequencies at the design stage and prevent stability loss. Paper shows that the installation of a floating cover

leads to a significant change in frequencies, to a decrease in sloshing. A vertical cylindrical storage tank for hazardous liquids works like this. During an earthquake, near-explosion, or other event involving seismic loads, the hazardous liquid in the tank begins to oscillate. Fluid fluctuations lead to the waves formation and sloshes on its free surface. In the other papers of the authors, it has been proposed to install a flexible cover-membrane made of a composite material that floats on the liquid surface, dampens surface vibrations and removes the sloshing effect. The proposed solution significantly improves the storage conditions of hazardous liquids. The technical solution makes it possible to reduce the amplitude of fluctuations of the liquid surface under seismic loads and to reduce the amount of localized pressure of the liquid on the tank walls. At the same time, protection has been provided against foreign objects and substances getting into the dangerous liquid. In addition, the weight of the cover and the tank as a wholedecreases, which improves the conditions of its transportation, installation and operation. Fluid fluctuations in solid and elastic reservoirs have been considered. Installation of a floating membrane leads to a decrease in both the level of the free surface and the pressure on the tank walls. These results make it possible to prevent the destruction of tanks and extend their service life with the help of a floating membrane cover. Thus, the future research concerned with free and forced liquid vibrations in elastic tanks with elastic baffles. The geometry of the tank also could be easily changed, so the results will be obtained for conical, spherical and compound shells with and without baffles. It will allow giving recommendations about installation of protective elements (covers, partitions). The use of composite materials with nanoinclusions in tanks for storing environmentally hazardous liquids has been also investigated, which allows to increase the reliability of tanks under seismic loads and to extend their service life under the influence of natural and technogenic influences of various nature (Fig.2.). The calculation results have been shown that the use of composite materials with nanoinclusions in the form of steel spheres is the best option for environmentally safe operation of tanks under seismic loads.

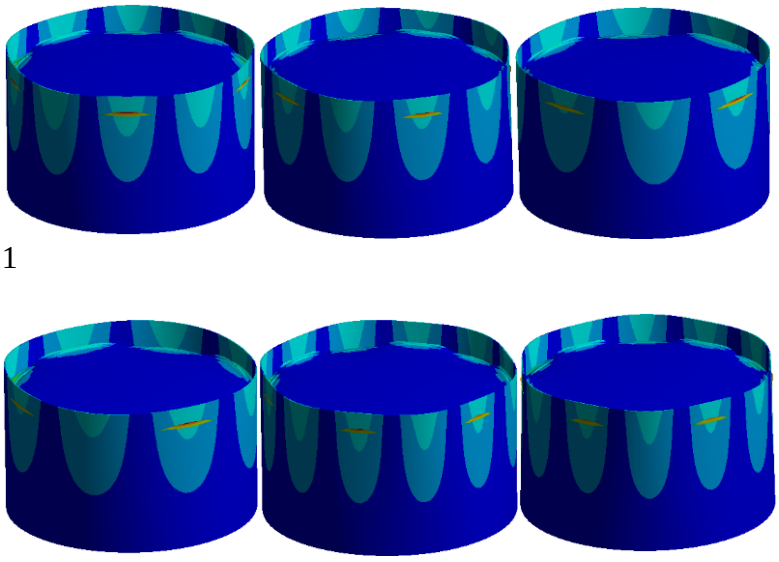


Fig. 2. Oscillation forms of the shell taking into account the walls elasticity

The research results prove that the use of carbon nanofibers to create a high-quality nanocomposite is feasible and could be used to neutralize static electrical charges that occur in oil reservoirs and could lead to emergency situations. Thus, the work proposes an innovative design of an oil storage facility with improved characteristics. These engineering solutions, supported by the mathematical modeling results, will increase the environmental

safety level of the territories adjacent to the reservoirs and prevent the occurrence of emergency situations.

**Keywords:** environment safety, storage tanks, seismic loads, nanocomposite, technogenic impact, environmentally hazardous liquids.

# ASSESSMENT OF COCOYAM UTILIZATION PATTERNS AMONG RURAL HOUSEHOLDS IN EKITI STATE, NIGERIA

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**Abstract**
Cocoyam has been identified for its nutritional superiority over other tubers and its huge potential in the prevention of major diseases. Unfortunately, research and support for this food crop have received little attention. This study however assessed the utilization patterns of cocoyam among rural households in Ekiti State, Nigeria. It adopted a multi-stage sampling technique to select respondents across identified communities in the three Agricultural Development Project (ADP) zones of the state. Findings showed that its indigenous uses, including direct consumption of tubers (3.77); as porridge (3.51); as ruminant feed (3.26); and as chips (3.18), ranked highest, followed by medicinal uses as treatment of snake bites (2.44); treatment of yellow eye diseases (1.95); and as an anti-poison (1.71). While the last category is industrial uses in the productions of feeds (3.40); production of beverage flour (1.52); production of poultry feeds (1.51); and production of baking powder (1.48). They were majorly constrained by poor farming techniques, poor information, inadequate labour, and a lack of government support. Education, household size, farm size, and income all determine their cocoyam utilization patterns. This study concludes that cocoyam has a low level of utilization, which is mainly indigenous to the area, with medicinal and industrial uses having high prospects.
**Keywords:** nutrition; tubers: attitude, industrial uses, indigenous uses, medicinal uses.

# ASSESSING THE INFLUENCE OF CLIMATE CHANGE ON MOROCCO'S RESERVE RESOURCES FOR DURUM WHEAT LAND

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**Abstract**
The objective of this study was to perform a comparative analysis of physiological, biochemical responses and yield parameters of durum wheat (Triticum durum Desf.) in the semi-arid region. Thirteen INRA-Morocco durum wheat lines were evaluated under rain conditions during two cropping seasons (2019/20, 2020/21). The trials were conducted in the experimental field of the National Institute of Agricultural Research of Douyet Fès (34°2 N, 5°W, 416 m). Various agro-physiological and biochemical parameters were studied: relative water content, chlorophyll content, leaf surface, leaf temperature, proline content, yield and yield components. A rainfall deficit was found to significantly increase proline content and leaf temperature and decrease relative water content, chlorophyll content, leaf area and yield ($P<0.01$). According to these parameters and rainfall indices, our results indicated that field-induced precipitation variations caused contradictions in the response of assessed traits to drought-related interactions between the two growing seasons (2020-2021) the identification of genotypes in the presence and absence of precipitation using a combination of drought-related traits.
**Keywords:** Durum wheat, drought, proline, relative water content, yield.

# SYNTHESIS, CHARACTERIZATION OF NEW TRI-SUBSTITUTED IMIDAZOLE'S DERIVATIVES AND BIOLOGICAL ACTIVITY

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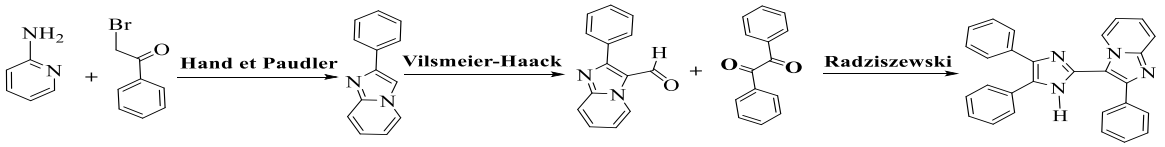
## Abstract
The topic given to me is in the framework of the search for new polyheterocyclic bioactive molecules. So our work has focused on the synthesis of new compounds based on imidazopyridine according Paudler and Valmeyer-Haak then Debus-Radziszewski by using a simple effective and inexpensive methodology, These products are known for their great therapeutic activity. The chemical structures of all the synthesized compounds were confirmed by 1H, 13C NMR spectral data, mass spectroscopy; and by X-ray diffraction. These new molecules have been tested for their biological activities as antioxidant, antibacterial and antifungal agents. Some of these compounds synthesised have shown important biological activities. Then an experimental evaluation of some new compounds to extract the metals was carried out and theoretical studies (DFT and Virtual Screening by Docking) were carried out to understand the mechanism of action of these molecules.




**Keywords :** Synthesis, 2-phenylimidazo[1,2-a]pyridine-3-carbaldehyde, benzil , Antioxydant, Antibactérien, Antifongique, DFT, Virtual Dock Screening.

# MICROBIOTA MODULATION AS THERAPEUTIC APPROACH IN THE NEUROPATHIC PAIN IN DOG WITH SPINAL CORD INJURY: IMPACT OF POLENOPLASMIN

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## Abstract
Background Studies have demonstrated the presence of gut dysbiosis (alterations in gut bacterial homeostasis) secondary to spinal cord injury in dogs. The dysbiosis is thought to impair recovery by decreasing the production of short-chain fatty acids which play a role in suppressing inflammation within the central nervous system. Objective Therefore, targeting gut dysbiosis could have significant therapeutic value in the management of spinal cord injury. The purpose of this study is to determine if gut dysbiosis occurs in dogs with spinal cord injury. Another area of potential intervention interest is in situations of spinal injury where there is an urgent need to generate new neurons. To arrive at these observations, the authors examined how Polenoplasmin and diet solve paralysis in dogs. Materials and methods The most common cause of spinal problems in dogs is trauma. We are currently assessing whether indoles can also stimulate formation of neurons in dogs with paralysis. Results We found that gut microbes that metabolize tryptophan-an essential amino acid-secrete small molecules called indoles, which stimulate the development of new brain cells in dogs, also demonstrated that the indole-mediated signals elicit key regulatory factors known to be important for the formation of new neurons. Conclusion This study is another intriguing piece of the puzzle highlighting the importance of lifestyle factors and diet. The link between the health of the microbiome and the health of the brain shows how microorganisms in the gut solve paralysis, gut microbe secreted molecule linked to formation of new nerve cells in paralyzed dogs.
**Keywords:** gut dysbiosis, indole, paralyzed dog, Polenoplasmin.

# COMPARATIVE ASSESSMENT OF ANTIOXIDANT AND ANTIBACTERIAL ACTIVITIES OF DIFFERENT BLACK TEA BELONG TO REGIONS OF DIFFERENT ECOLOGY

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**Abstract**
Long-term shelf-life and quality of fermented black tea depends on the packaging style. The air-tight packing is considered more favorable to retain the quality of tea as compared to non-air-tight packing. This study aimed to evaluate key quality parameters of six commercially available loosely packed black tea samples marketed in the markets of Faisalabad, Pakistan. For comparison, two air-tight packed multi-national brand of black tea (MNB-BT1&2) samples were also evaluated. The extraction was performed in distilled water and methanol at room and boiling temperatures. The extracts were analyzed to assess total phenolic contents (TPC), total flavonoid contents (TFC), in vitro antioxidant potential, and antibacterial activities. MNB-BT2 sample showed highest TPC (1093.90 µg/g sample) while aqueous extract of Indian black tea showed TPC 1,008.69 µg/g sample. MNB-BT2 showed TFC 336.23 µg/g sample followed by MNB-BT1 (TFC 214.73 µg/g) and Kenya black tea sample extract (TFC 26.22 µg/g). Highest α,α-diphenyl-β-picrylhydrazyl (DPPH) free radical scavenging activity, 64.95 %, was shown by MNB-BT2 extract while Kenya black tea aqueous extract showed 62.03% activity. Highest reducing power activity was noted using MNB-BT2 extract followed by Tanzania black tea sample extract. MNB-BT2 extract at 48h incubation period showed highest linoleic acid inhibition (absorbance value 0.17) followed by Sri-Lankan black tea methanol extract (absorbance value 0.12). Antibacterial activities were determined using Gram-positive and Gram- negative bacteria. Black tea packed in air-tight packing showed good antibacterial activity as compared to loosely packed black tea sample extracts. The multivariate statistics based on OPLS-DA multivariate statistics outlined the potential correlations among the region of black tea cultivation, extraction condition, and biological activities. This study concluded that the loosely packed black tea quality hampers on absorbing moisture, oxygen or light for a long time.
**Keywords:** camellia sinensis, black tea, infusion, fermentation, theaflavins, tea beverage

# DETERMINANTS OF WILLINGNESS TO ADOPT FARM SERVICE CENTRE MODEL AMONG FARMING HOUSEHOLDS IN ABIA STATE, NIGERIA

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**Abstract**
Uptake of new agricultural technologies/innovations is not devoid of some challenges in Nigeria. However, in order to increase productivity in the sector, there is the need to enhance the adoption of new technologies/innovations. Therefore, this study examined the determinants of willingness to adopt farm service center model among farming households in Abia State, Nigeria. The study collected primary data from 300 farming households with the aid of questionnaire using a three-stage sampling procedure. Analyses of the collected data were executed with the aid of descriptive statistics and binary logistic regression model. Result of socioeconomic characteristics revealed that farming activities in the area were male dominated (58.7%), mostly married (82%) with mean age of 50±9.7, having 10.5±5.8 mean years of formal education, operate on 0.87±1.3 hectares with 21years of farming experience. Binary logistic model result revealed that age, level of education and farming experience were the factors determining the willingness to adopt farm service center model in the area. Need to boost farmers' knowledge through adult literacy programme, and involvement of relatively old farmers in empowerment programme as well as encouraging farmer participation in farmers' associations/ cooperatives in the study area were hereby recommended.
**Keywords**: Innovation, Adoption, Determinants, Farm Service Centre, Farming Households and Willingness

# USE POSSIBILITIES OF BIOLOGICAL PREPARATIONS IN MUSHROOM CULTIVATION

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**Abstract**
Although the development in the cultivated mushroom sector has shown itself positively in terms of production area and quality, it has also brought with it many problems, especially diseases and pests. Especially, the majority of pesticides used to combat diseases and pests encountered in cultivation are not licensed for the product; In addition, not applying the correct usage times and doses of the drugs used causes serious pesticide residues in the product. The most common diseases encountered in cultivation are cobweb disease (*Cladobotryum dendroides*), dry bubble (*Lecanicillum fungicola*), wet bubble (*Mycogone perniciosa*), bacterial blotch (*Pseudomonas tolaasii*), and green mold (*Trichoderma spp*.). In our country, only chemical drugs with active ingredients Prochloraz and Metrafenone against cobweb disease are licensed for cultivated mushrooms, and there are no chemically licensed pesticide against any other diseases encountered in cultivated mushroom production. Mushroom flies (Sciarids, Phorids and Cecids) take the first place among cultivated mushroom pests, and a chemical pesticide with the active ingredient Acrinathrin was licensed for this pesticide in 2020. The fact that the residues left behind by pesticides used within the scope of chemical control create health problems, pollute nature, disrupt the natural balance, and over time, disease and harmful factors gain resistance to these chemicals, in other words, the decrease in the effects of these chemicals has enabled the formation and development of biological control. Studies to reduce the use of chemical pesticide all over the world have increased the studies on the use of biological preparations, especially in production areas. In our country, the use of biological preparations in cultivated mushroom cultivation has begun in the last 10 years. In this review, the usage possibilities of many biological preparations consisting of entamopathogenic nematodes (*Steinernema feltiae*), many beneficial bacteria (*Pseudomonas fluorescens*, etc.) and fungi (*Beauveria bassiana*, etc.), whose use has become widespread in recent years, in cultivated mushroom production are explained.
**Keywords:** Biological preparations, biological control, cultured fungal diseases and pests

# THE IMPORTANCE OF EDIBLE AND MEDICINAL MUSHROOMS ON HUMAN HEALTH

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## Abstract
In addition to containing high-quality proteins in terms of their nutritional content, mushrooms are also rich in vitamins such as thiamine, riboflavin, ascorbic acid, ergosterol and niacin. Moreover, while they contain abundant amounts of polyunsaturated fatty acids, which are important for human health, and their low calorie content thanks to their low fat content, mushrooms have become noteworthy in recent years when healthy nutrition has become popular. The fact that many drugs used in modern medicine for cancer-like diseases do not have the expected effect and often have side effects has encouraged scientists to look for different ways. Through pharmacological studies, the presence of polysaccharides, an important bioactive component in mushrooms, has been discovered. β-glucans found in mushrooms are used in cancer treatments due to their immune system strengthening and anti-tumor effects. Ganoderma lucidum is one of the most well-known mushroom species because it negatively affects the development of cancer cells, has an anti-inflammatory effect and strengthens the immune system. Many studies have been conducted showing that the Ganoderic acids, Kaemferol, Genistein and Ergosterol it contains negatively affect the development of cancerous cells. In addition, Pleuran obtained from Pleurotus ostreatus is a β-glucan compound. It has been reported in various studies that this compound inhibits the proliferation of prostate cancer, breast cancer and colorectal cancer cells. Lentinan compound isolated from another species of medicinal mushroom, Lentinula edodes, plays an important role in increasing the effectiveness of cancer treatments as a natural tumor inhibitor. It has been proven that the polysaccharides of many medicinal mushrooms such as Hericium erinaceus, Morchella, Inonotus obliquus, Schizophyllum commune, Phellinus linteus prevent tumor development and support human health in many different ways. In addition, mushrooms are seen as an alternative option in cancer treatments because they reduce discomfort such as anemia, fatigue and nausea seen in cancer patients. However, more studies are needed on the bioactive components found in mushrooms. In this way, the benefits of mushrooms against many diseases, especially cancer, will be discovered. In this review, studies on the possibilities of using edible and medicinal mushrooms in terms of human health and nutrition have been compiled.
**Keywords:** Medicinal mushrooms, exotic mushrooms, bioactive components, immune system

# PLANT MEDIATED BASED BIOSYNTHESIS AND CHARACTERIZATION OF COPPER OXIDE NANOSIZED PARTICLES FROM *MURRAYA KOENIGII* AND THEIR BIOMEDICAL APPLICATION IN ALBINO RAT

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**Abstract**
Plants can be used in biological, inexpensive, and environmentally friendly nanoparticle production. Plant extract is utilized as a naturally occurring precursor. We used medicinal plant in our research, named Murraya koenigii leaves, which are widely accessible and simple to grow. The aqueous extract of Murraya koenigii (AE-MK) was used to create CuO nanoparticles (CuO NPs), which were then characterized using various analytical methods. Aqueous extracts of M. koenigii were combined in a 1:4 (v/v) ratio with 2 mM of CuSO4.5H2O solution, heated to 50°C, followed by washing and drying. Utilising several analytical methods, including scanning electron microscopy (SEM), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), and UV visible spectroscopy, the synthesized CuO NPs were subjected to characterization. Further, the plant extract was given to albino rats to study the histopathological changes. According to the findings, it is reasonable to assume that greenly synthesised CuO NRs will have potential uses in the area of nanomedicine.
**Keywords:** CuO NPs, Scanning electron microscope: UV Spectrophotometer: Murraya koenigii

# ENHANCING BANK EMPLOYEE EMPOWERMENT AND BRAND EQUITY THROUGH INTERNAL MARKETING

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**Abstract**
This study explores the pivotal role of internal marketing in the banking sector, focusing on its impact on bank employees and brand equity. The study conducted in Kosovo, employs structural equation modeling (SEM) to dissect the intricate dynamics of internal marketing strategies within the banking industry. The study reveals a robust positive correlation between employee empowerment and job satisfaction, highlighting the value of strategies that grant autonomy and decision-making involvement. This research underscores the theoretical importance of internal marketing in shaping the banking sector, adding to the understanding of its role in enhancing employee experiences and brand equity. The study provides actionable insights for banks in Kosovo and beyond. Implementing effective internal marketing strategies can empower employees, increase satisfaction, boost involvement, and improve retention rates, thereby strengthening brand equity and market competitiveness. This study offers a unique and comprehensive perspective on internal marketing's role in the banking sector, shedding light on the complex relationships between empowerment, satisfaction, involvement, and retention, particularly within Kosovo's banking industry.
**Keywords:** Internal marketing, marketing strategies, brand equity, empowerment

# 3D-QSAR, ADME-TOX IN SILICO PREDICTION AND MOLECULAR DOCKING STUDIES FOR MODELING THE ANALGESIC ACTIVITY AGAINST NEUROPATHIC PAIN OF NOVEL NR2B-SELECTIVE NMDA RECEPTOR ANTAGONISTS

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**Abstract**
A new class of selective antagonists of the N-Methyl-D-Aspartate (NMDA) receptor subunit 2B have been developed using molecular modeling techniques. The three-dimensional quantitative structure–activity relationship (3D-QSAR) study, based on comparative molecular field analysis (CoMFA) and comparative molecular similarity index analysis (CoMSIA) models, indicate that steric, electrostatic and hydrogen bond acceptor fields have a key function in the analgesic activity against neuropathic pain. The predictive accuracy of the

developed CoMFA model (Q2 = 0.540, R 2 = 0.980, R 2 pred = 0.613) and the best CoMSIA model (Q2 = 0.665, R 2 = 0.916, R 2 pred = 0.701) has been successfully examined through external and internal validation. Based on ADMET in silico properties, L1, L2 and L3 ligands are non-toxic inhibitors of 1A2, 2C19 and 2C9 cytochromes, predicted to passively cross the blood–brain barrier (BBB) and have the highest probability to penetrate the central nervous system (CNS). Molecular docking results indicate that the active ligands (L1, L2 and L3) interact specifically with Phe176, Glu235, Glu236, Gln110, Asp136 and Glu178 amino acids of the transport protein encoded as 3QEL. Therefore, they could be used as analgesic drugs for the treatment of neuropathic pain.

**Keywords:** 3QEL, silico properties, NMDA

# CHALLENGES AND OPPORTUNITIES FOR WOMEN AS ACADEMIC LEADERS' IN PUBLIC UNIVERSITIES, KARACHI, PAKISTAN

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**Abstract**
Gender inequality remains a pervasive issue in many parts of the world, including Pakistan. Despite significant progress towards gender equality in recent years, women still face significant challenges in pursuing leadership positions, including in academia. According to a recent report by the Higher Education Commission (HEC) of Pakistan, women hold only 18% of senior faculty positions and a mere 7% of top administrative positions in Pakistani universities. One of the major challenges faced by women in academic leadership roles in Pakistan is cultural and societal norms. The aims of this study are to examine the barriers and challenges faced by women in pursuing academic leadership positions in Pakistani universities, such as gender bias, lack of mentorship and networking opportunities, and work-life balance issues. This study reveals institutional or cultural practices that explicitly favor male candidates for leadership roles, such as gender stereotypes or gender-based discrimination in hiring or promotion processes. The methodology of this study will be qualitative research, semi structured questions for interview and focus group discussion will be developed followed by thematic analysis approach to identify and categorize key themes and issues related to gender biasness in academic leadership in our universities. Qualitative data analyze software such as NVivo to organize and analyze the data. It also uses iterative data analysis, comparing data with emerging themes, and using a coding framework to establish categories. The population will be public universities in Karachi and purposive sampling will be use to identify potential participants, such as female chancellors, deans, department chairs, and directors. The findings will be beneficial to propose practical solutions for promoting gender equity in academic leadership in Pakistan, including recommendations for policymakers, university administrators, and academic leaders to create networks and support with inclusive work environments that enable women to succeed in leadership roles. In conclusion, while there are undoubtedly significant challenges facing women in academic leadership roles in Pakistani universities, there are also a number of opportunities available to them. Recommendations should address the cultural and societal norms that reinforce gender bias, providing greater institutional support, and mentorship opportunities for women leaders, Pakistani universities can help to create a more inclusive and equitable academic culture that benefits all members of their communities.
**Keywords:** Gender inequality, gender bias, professional development, work culture

# İŞLENMİŞ YÖRESEL GIDA ÜRÜNLERİ PAZARININ ANALİZİ: BİNGÖL SOĞUK ÇEŞME KAVURMASI ÖRNEĞİ

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**Özet**
Araştırmanın kaynağını birincil veriler oluşturmaktadır. Bu anlamda Bingöl ilinin Merkez ilçesinde yer alan iki adet kavurma işletmesinin yöneticisiyle anket yapmak suretiyle veriler elde edilmiştir. Bu çalışmada Bingöl ilinde kavurma sektörünün iki önemli ana firmasıyla görüşülmüştür. Dolayısıyla tam sayım yöntemiyle anket çalışmaları tamamlanmıştır. Ankette firma kimliği, soğuk çeşme Kavurmasının tarihçesi, et tedarik yöntemleri, kavurmanın hazırlanma aşamaları, firmaların pazarlama stratejileri ele alınmıştır. Dolayısıyla anket ve görüşmelerden elde edilen bilgiler harmanlanarak yorumlanmıştır. Çalışmada ayrıca konu ile ilgili olan bilimsel çalışmalar, kitaplar, dergiler ve diğer basın yayın organlarından da yararlanılmıştır. Soğuk Çeşme Kavurması üreten iki adet firma bulunmaktadır. Firmaların Bingöl merkez ve ilçelerinde olmak üzere toplamda 6 adet şubede faaliyet gösterdikleri söylenebilir. Firmaların web siteleri bulunmakla birlikte etkin bir şekilde kullanmadıkları belirlenmiştir. Soğuk çeşme kavurması üreten her iki firma toplamda 85 adet daimî istihdam sağladıkları belirlenmiştir. Her iki firmanın üye olduğu kuruluşlar, Ticaret ve Sanayi Odası, TOBB ve Esnaf ve Sanatkârlar Odası olarak sıralanabilir. Her iki firmanın yıllık toplam kavurma üretimi 816 ton ve günlük ciro ise 85.000 TL olarak hesaplanmıştır. İşletmeler et tedarikini, sözleşmeli çiftçilerden ve işletmelerin kendi çiftliğinde yetiştirdikleri hayvanlardan sağladıkları belirlenmiştir. Kavurma için kesilen hayvanlar bölgede özellikle meşe ağacıyla beslenen hayvanlardan seçilmiştir. Seçilen hayvanların hem cinslerinin uyumu hem de yaşları oldukça önem arz etmektedir. Kavurma için tercih edilen hayvanlar; oğlak (2-2,5 yaş), Çepiç (1 yaşına kadar), dana (1-2,5 yaş), kuzu (1-2 yaş), sığır (5-6 yaş) olarak sıralanabilir.
**Anahtar Kelimeler:** Soğuk çeşme, kavurma, Bingöl

# ANALYSIS OF THE PROCESSED LOCAL FOOD PRODUCTS MARKET: THE EXAMPLE OF BINGÖL SOGUK ÇESME ROAST

**Abstract**

The source of the research is primary data. In this sense, data was obtained by conducting a survey with the managers of two roasting businesses located in the Central district of Bingöl province. In this study, two important main companies of the roasting industry in Bingöl province were interviewed. Therefore, the survey studies were completed with the full count method. In the survey, company identity, history of Cold Fountain Roasting, meat supply methods, roasting preparation stages, and marketing strategies of the companies were discussed. Therefore, the information obtained from the survey and interviews was blended and interpreted. In the study, scientific studies, books, magazines and other media related to the subject were also used. There are two companies producing Cold Fountain Roast. It can be said that the companies operate in a total of 6 branches in Bingöl center and districts. It has been determined that although companies have websites, they do not use them effectively. It has been determined that both companies producing cold fountain roasting provide a total of 85 permanent jobs. The organizations of which both companies are members include the Chamber of Commerce and Industry, TOBB and the Chamber of Tradesmen and Craftsmen. The total annual roasting production of both companies is calculated as 816 tons and the daily turnover is 85,000 TL. It has been determined that businesses supply meat from contracted farmers and from animals raised on their own farms. Animals slaughtered for roasting were selected from animals that feed on oak trees in the region. Both the breed compatibility and the age of the selected animals are very important. Preferred animals for roasting are; They can be listed as kid (2-2.5 years old), Çepiç (up to 1 year old), calf (1-2.5 years old), lamb (1-2 years old), cattle (5-6 years old).

**Keywords:** Cold fountain, roasting, Bingöl

# TÜKETİCİLERİN SOSYO-EKONOMİK STATÜLERİNE GÖRE DONDURMA TÜKETİM TERCİHLERİ

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**Özet**
Çalışmada Bingöl İlinde dondurma tüketicilerinin dondurma tüketim alışkanları incelenmiştir. Çalışmada birincil veriler kullanılmıştır. Buna göre dondurma tüketicileriyle yüz yüze anket yapılmıştır. Örnek hacmi "Ana kitle Oranlarına Dayalı Kümelendirilmemiş Tek Aşamalı Tesadüfi Olasılık Örneklemesi" yöntemiyle örnekleme için yeterli örnek sayısı 385 adet olarak belirlenmiştir. Verilerin analizinde Cluster analizi kullanılmıştır. Çalışmada tüketiciler kendilerini hissettikleri sosyoekonomik sınıflara göre kümelere ayrılmıştır. Buna göre tüketicilerin %24,15'i yüksek düzey sosyoekonomik statüye sahip oldukları (93 tüketici), %38,18'i orta sınıf sosyoekonomik statüye (147 tüketici) ve son olarak %37,66'sı ise düşük düzey sosyoekonomik statüye (145 tüketici) sahip oldukları belirlenmiştir. Tüketicilerin sosyoekonomik statüleri arttıkça buna paralel olarak gelirlerinin de arttığı söylenebilir. Tüketicilerin sosyo-ekonomik statüleri yükseldikçe dondurma harcamalarının da arttığı söylenebilir. Buna göre yüksek düzey sosyo-ekonomik grubunda yer alan tüketicilerin aylık dondurma harcamaları 24,59 TL iken, orta düzey sosyo-ekonomik grubunda yer alan tüketicilerin 2,55 TL olarak hesaplanmıştır. Söz konusu harcama türü düşük düzey sosyo-ekonomik grubunda 22,90 TL olarak gerçekleşmiştir. Tüketiciler büyük oranda ambalajsız yani açık dondurma tüketmeyi tercih etmişlerdir. Üst düzey sosyo-ekonomik grubundan düşük düzey sosyo-ekonomik grubuna doğru gidildikçe ambalajsız dondurma tüketenlerin oranları gittikçe azalmıştır. Buna göre ambalajsız dondurma tüketmeyi tercih eden tüketicilerin yüksek düzey sosyo-ekonomik grubundaki oranı %64,5 iken bu oran orta düzey sosyo-ekonomik grubunda %53,7 ve düşük düzey sosyo-ekonomik grubunda ise %50,30 olarak gerçekleşmiştir.
**Anahtar Kelimeler:** Dondurma Tüketimi, Kümeleme Analizi, Tüketim Davranışları, Bingöl

# ICE CREAM CONSUMPTION PREFERENCES OF CONSUMERS ACCORDING TO THEIR SOCIO-ECONOMIC STATUS

**Abstract**

In the study, ice cream consumption habits of ice cream consumers in Bingöl Province were examined. Primary data was used in the study. Accordingly, a face-to-face survey was conducted with ice cream consumers. Sample volume: The sufficient number of samples for sampling was determined as 385 with the "Non-Clustered Single-Stage Random Probability Sampling Based on Population Proportions" method. Cluster analysis was used to analyze the data. In the study, consumers were divided into clusters according to the socioeconomic classes they felt themselves in. Accordingly, 24.15% of the consumers have a high level socio-economic status (93 consumers), 38.18% have a medium level socio-economic status (147 consumers) and finally 37.66% have a low level socio-economic status. It was determined that they had socioeconomic status (145 consumers). It can be said that as the socioeconomic status of consumers increases, their incomes increase accordingly. It can be said that as the socio-economic status of consumers increases, their ice cream expenditures also increase. Accordingly, monthly ice cream expenditures of consumers in the high socio-economic group were calculated as 24.59 TL, while consumers in the middle socio-economic group were calculated as 2.55 TL. This type of expenditure was 22.90 TL in the low socio-economic group. Consumers largely preferred to consume unpackaged, that is, open ice cream. As we move from the upper socio-economic group to the lower socio-economic group, the proportion of people consuming unpackaged ice cream gradually decreases. Accordingly, while the rate of consumers who prefer to consume unpackaged ice cream in the high socio-economic group is 64.5%, this rate is 53.7% in the middle socio-economic group and 50.30% in the low socio-economic group.

**Keywords:** Ice Cream Consumption, Cluster Analysis, Consumption Behaviors, Bingöl

# STRUCTURAL CHARACTERISTIC OF THE DAIRY FARMS IN IZMIR

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**Abstract**
This research was carried out by consulting with dairy farms that were selected by chance from the analyzed farms registered in the Dairy Cattle Breeders Associations in İzmir. 46 farm datas evaluated in study. The farms were selected through İzmir and its counties, thus it was aimed to find accurate results. The survey questions are about the general characteristic features of the farm owners, their educational degrees, their existing breeding status, their practical experiences in breeding cattle, their aims and expectations, the condition of the animal sheds and equipments, distribution and marketing of their products. The rate of literacy in the farms that were members of the Cattle Breeding Association is 100%. The avarege milk production was 1.674.523,1 tons and the big parts of production were in Odemis, Tire and Kiraz counties. The dairy cattle breeding was made for providing subsistence income by 76,1% of the farms and it was made for gaining supplementary budget by the rest of the farms. The rate of working in the farms as owners of the farms and members of their family was 100%. Average animal stock 30 heads of cattle in 26.1% of the farms. 36,9 per cent of the farm areas were in the residential areas, 17.4 per cent of the farms consist of bound-standstill type farms and 54.3% of those consist of free-stall type farms. The rate of the milking with the milking machine was 96,5 % and in 73.9% of farm the average production of milk per cattle 20 -25 liters/day in the farms.
**Keywords:** İzmir, Tire, Dairy Farm, Cow Milk, Free-stall

# THE EFFECT OF SOMATIC CELL COUNT ON RAW MILK COMPOSITIONAL QUALITY OF COW MILK OF DAIRY FARMS IN IZMIR

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## Abstract
Aim of this study was determine that somatic cell count (SCC) which were taken from Holstein and Simental cattles and its' change according to some factors and with this change, investigate to this change's effects to milk yield and quality in important dairy cattle industry city, İzmir. For this aim, different number of the milk samples collected from two dairy farm which were members İzmir Dairy Cattle Breeders Association for a twelve months period and analyzed by Bentleymerkim Nexgen Series Model 1 device. According to analyses results, there was no statistically significant difference determined between Holstein cattles and Simental cattles about milk fat contents ($p>0.05$), also there was statistically significan difference between seasons ($p<0.01$). About milk protein contents, there was statistically insignificant difference between two breeds lactation numbers ($p>0.05$), thus there was statistically significant difference between seasons ($p<0.01$). Utilized two races' milk lactose content, there was statistically significant difference between lactation breeds, in case between seasons, there was statistically significant difference ($p<0.05$) in Holstein cattles and ($p<0.01$) in Simental cattles. About dry matter contents, there was statistically insignificant difference between lactation numbers on both breeds ($p>0.01$), however there was statistically significant difference between seasons ($p<0.01$). About Holstein cattles' milks' SCC contents, there was statistically significant difference between lactation numbers ($p<0.01$), as for Simental cattles, there was statistically insignificant difference ($p>0.01$) determined. In general, there was negative correlation between SCC and milk yield determined.
**Keywords:** Somatic Cell Count (SCC), Holstein Friesian, Simental Cattle, Milk quality

# THE EFFECTIVENESS OF SOME COPPER FUNGICIDES FOR OLIVE PEACOCK EYE DISEASE (*Spilocaea oleagina*)

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**Abstract**
Copper-containing fungicides are recommended for olive peacock eye disease. However, there is not enough evidence on the success rate of treatments containing copper as the active ingredient. Therefore, in our study, the effectiveness of 10 copper fungicides with different active ingredients, ratios, dosages and formulations Oliver peacock disease was evaluated on 10 aged cv Gemlik. November January and April 3 spraying with motorised backpack sprayer were performed according to the standard Pesticide Trial Method, taking into account the spore dispersal 7, 14 and 21 days after each spraying, leaf samples were taken from four direction of each tree and the severity of visible and latent infections were evaluated. in the 2020-2021 production season, the first spore was determined on 25.12.2020, and it reached the highest value with 22 spore on 27.02.2021. in the 2021-2022 production season, the first spore was determined on 27.11.20221 and reached the highest value with 5 spore on 11.12.2021. According to the results of apparent infection and latent infection severity in 2020-2021 and 2021-2022, the disease was quite mild in both years, especially due to climatic conditions, spore flights were both quite low and 1. December of the year, 2. it is observed that the year starts quite late, such as November. In both years (6.11.2020-5.11.2021), the latent infection severity was generally high, while the visible infections were lower, and the visible infection severity was higher compared to the latent infection after the counts made after the second and third spraying. In the evaluations, there was no statistical difference in the effectiveness of different effective substances, ratios and formulations against the disease.
**Keywords**: Latent infection, visible infection, chemical control, copper fungicides, spore dispersal

# ISOLATION OF E. COLI AND STAPHYLOCOCCUS FROM CLINICAL ENDOMETRITIS AND ANTIMICROBIAL SUSCEPTIBILITY IN DROMEDARY SHE CAMELS (CAMELUS DROMEDARIUS)

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## Abstract
With increasing human population, food security has been a major concern throughout the world and there is no exception in Pakistan regarding this. Camel has the ability to significantly contribute to Pakistan's food security and economy. This unique potential remains unexplored in Pakistan. Uterine infections, abortion, ovulation failure, and management failures are major problems affecting camel reproductive efficiency. Endometritis is one of the major infertility issues in she camels. This study explored the bacterial species of Escherichia coli and Staphylococcus aureus involved in endometritis in she camels, and antibiotic sensitivity was assessed using the disc diffusion method. Samples were taken form she camel throughout the district Faisalabad. A total of 58 uterine samples from she camels were assessed. A questionnaire was used to acquire the reproductive history. After the collection of uterine secretions in plastic rods, both ends of the insemination rod were sealed instantly and sent to the Department of Theriogenology at the University of Agriculture Faisalabad. The samples were cultured on the nutrient broth and then transferred to the selective media i.e MacConkey agar for E.coli and Mannitol salt agar for Staphylococcus aureus, for the growth of microbes. The morphology, shape and staining properties of microorganisms were checked by microscopic examination. Further biochemical identification was performed with biochemical tests. Bacterial species isolated from these samples were E. coli (pathogenic) (27.6%), E. coli (nonpathogenic) (6.9%), S. aureus (19%) and other mixed type of infection (46.5%). E. coli was the mostly found bacteria (27.6%) followed by Staphylococcus aureus (19%). In-vitro antibiotic susceptibility was checked by disc diffusion method. By comparing the diameter of the zones of inhibition of antibiotics it was revealed that antibiotic susceptibility of E. coli was Gentamicin (81.2%), Amoxicillin (68.7%), Streptomycin (31.2 %), Kanamycin (50%), Oxytetracycline (25 %), Penicillin G (18.8%), and Lincomycin (18.8%). While Antibiotic sensitivity to Staphylococcus aureus was Penicillin G (36.4%), Lincomycin (18.2%), Kanamycin (45.4%), Oxytetracycline (18.2 %), Amoxicillin (72.7%) Streptomycin (27.2 %) and Gentamicin (81.8%). Results indicated that Gentamycin and Amoxycillin were the most effective drugs, while Kanamycin, Streptomycin, Penicillin, Oxytetracycline and Lincomycin were least effective.

**Keywords:** Camel, Endometritis, Antibiotic sensitivity, Escherichia coli, Staphylococcus aureus

# INTEGRATION AND EVOLUTION OF SMART CITIES WITH ARTIFICIAL INTELLIGENCE, INTERNET OF THINGS AND BLOCKCHAIN TECHNOLOGY

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**Abstract**
The network architecture of smart cities is being revolutionized by new advanced technologies, notably the Internet of Things (IoT), blockchain technology, and artificial intelligence (AI). Blockchain and IoT applications offer interesting options for drug traceability and cryptocurrencies with the fusion of AI technologies. The development of "smart cities" is a key indicator of how citizens' social and economic well-being will progress. Our article's main objective is to give readers enough information about 5G and 6G network connectivity, which is important for all areas of life, including health care, transportation, education, business, security, and power dissipation for ideal smart sustainable cities with comfortable lifestyles. We have also shown how big data, cloud computing, blockchain, the Internet of things, and artificial intelligence technologies may be used to create sustainable smart cities. Our paper aims to enlighten readers and academics about the new technical breakthrough and how it affects choices made in "smart cities". Therefore, we have provided enough information, and further highlighted the gap that still exists, as well as limits and the ways in which these interfaces demonstrate their influence on social innovation and wise decision-making for clever governance systems.
**Keywords:** Sustainable smart cities, Big data, Internet of Things (IoT), Artificial Intelligence, 5G&6G Connectivity.

# ACCESS AND UTILISATION OF AGRICULTURAL CREDITS BY WOMEN IN IKWO LOCAL GOVERNMENT AREA, EBONYI STATE, NIGERIA

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**Abstract**
This study evaluated women's access and utilization of agricultural credits in Ikwo Local Government Area, Ebonyi state, Nigeria. It described the socioeconomic characteristics of women farmers, ascertained their sources of agricultural credit information, determined women's sources of agricultural credit, described their' perception of agricultural credit as well as their perception of factors affecting access to agricultural credits. Multistage purposive sampling procedure was used in selecting 100 respondents for the study while data was collected using structured questionnaire. Data was analysed using frequencies, mean score and regression analysis. Results showed that 27% of the respondents are within the ages of 40-49 years with a mean age of 39 years and a mean household size of 8 persons. Cooperative societies (43%) was the main source of agricultural credit information for women while majority (87%) of them sourced their agricultural credit from personal savings. On a 5-point Likert-typed scale, mean scores of ($\bar{x}$ = 4.1) and ($\bar{x}$ = 3.6) show that respondents agreed that difficulty in official documentation and high interest rate respectively were among their challenges in accessing agricultural credits while identifying interest rate charged ($\bar{x}$=3.7), fear of rejection ($\bar{x}$=3.6) and complex bank procedures ($\bar{x}$=3.3) as factors affecting their choice of source of agricultural credit. Marital status (0.004), household size (0.042) and farm size (0.065) where positively related to women access to credit at 10 % significance level. The study concludes that several constraints affects respondents' access to credit and recommends that women should be encouraged by making the credit procurement process less cumbersome.
**Keywords:** Access, utilization, Agricultural credits, interest rate, sources of credit.

# RECENT DEVELOPMENTS IN PRECISION AGRICULTURE AND CROP PROTECTION

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## Abstract
There are many factors affecting agricultural production nowadays. Some of those; population growth, urbanization, decrease in the amount of agricultural land, greenhouse effect, global warming, drought, agricultural environmental pollution, need for healthy nutrition, need for sustainable use of natural resources (soil, water), reduction of agricultural inputs (fertilizer, pesticides, water, etc.), the demand for higher efficiency is the demand for higher profitability. In addition, electricity, electronics, informatics, sensors, internet, data storage (cloud technology), big data analysis, artificial intelligence, internet of things, life cycle analysis and autonomous vehicle technologies are developing rapidly. Depending on these developments, many new methods and technologies have been implemented in agriculture. Precision Agriculture Technologies may include sensors, remote sensing technologies, satellite imagery, high throughput image-based phenotyping, variable rate application equipment, autonomous vehicles, machine learning and drones. The precision agriculture provides agricultural production process in which the processes on the farm can be measured in every possible area, and in which data and modern tools are used to make it sustainable and highly efficient. In our country, there are many products used through signals and sensors under the umbrella of Precision Agriculture Technologies. Some of these are automatic steering systems that prevent excessive seed and fertilizer per decare, insect tracking traps using pheromone and camera integration using 3G technology, disease early warning systems using sensors that analyze climate data, and cameras that analyze the normalized difference vegetation index (NDVI) in the field. Satellites and drones that enable abnormal situation monitoring. Thanks to these technological devices, the products are monitored onsite and the efficiency obtained per unit area is increased with immediate intervention.
**Keywords:** Precision Agriculture, NDVI, Drone.

# AFYONKARAHİSAR İLİ ARICILARININ VARROA ZARARLISI İLE MÜCADELE YÖNTEMLERİ

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## Özet

Varroa ülkemiz ve ilimizde bulunan arıcıların neredeyse hepsinde görülen önemli bir zararlıdır. Varroa arıların larva, pupa ve erginlerine zarar verdiği için mücadele edilmezse çok büyük miktarda ekonomik kayıplara neden olmaktadır. Bu çalışmada İlimiz arıcılarında varroanın ne zaman görüldüğü, varroa zararlısı ile ne zaman ve nasıl mücadele ettiği, yılda kaç kez ve hangi ilaçları kullandığı, arılarına varroanın dışında hangi etmenlerin zarar verdiği sorulmuş ve elde edilen veriler kullanılmıştır. Çalışma için Afyonkarahisar ilinde bulunan 315 (TÜİK, 2022) arıcının %25'ine yani 80 tanesine anket uygulanmıştır. Ankette kullanılan sorular ildeki arıcılık yapısını belirlemek ve arıcıların varroa zararlısı hakkında nasıl mücadele ettiğini belirlemeye yöneliktir. Çalışmanın sonucuna göre ankete katılan arıcıların %92,5'inin kimseden yardım almadan varroayı tespit edebildiği, varroanın en fazla yaz döneminde (%60) görüldüğü ve arıcıların %87.5 gibi büyük bir oranının kimyasal ilaç kullanarak mücadele ettiği belirlenmiştir. Ayrıca arıcıların tamamında son 3 yılda eşek arısı, %98,75'inde varroa, %97,5'inde arı kuşu, %92,5'inde kirpi, %90'ında Nosema (yöresel adı Sürüngeç hastalığı), %88,75'inde mum güvesi, % 83,75'inde yavru çürüklüğü hastalıkları, % 37,5'unda kireç hastalığı, % 12,50'unda taş hastalığı görüldüğü tespit edilmiştir. Ankete katılan arıcıların varroa ile an fazla yaz döneminde (% 36,25) mücadele ettiği, bu mücadelede de en fazla amitraz (%85) etken maddeli ilaçları kullandığı belirlenmiştir. Ankete katılan arıcıların %50'ınden fazlası kimyasal ilaçların yanında varroa ile mücadelede kekik yağı, formik asit ve ceviz yağı ile yapraklarını kullandığı belirlenmiştir. Ankete katılan arıcıların %63,75'i bir yılda 8 ve üzerinde ilaçlama yaptığını, %20'si 4 ile 8 arasında ilaçlama yaptığını, %16,25'ide 1 ile 4 arasında ilaçlama yaptığını belirlenmiştir.

**Keywords:** Bal arısı, *Apis mellifera*, arı zararlıları, varroa

# CONTROL METHODS OF AFYONKARAHISAR PROVINCE BEEKEEPERS AGAINST VARROA PEST

**Abstract**

Varroa is an important pest seen in almost all beekeepers in our country and province. Since Varroa damages the larvae, pupae and adults of bees, it causes huge economic losses if not struggled. In this study, beekeepers in our city were asked when varroa was seen, when and how they struggled the varroa pest, how many times a year and which drugs they used, what factors except varroa harmed their bees, and obtained data were used. For the study, a survey was applied to 25%, that is, 80 of the 315 (TUIK, 2022) beekeepers in Afyonkarahisar province. The questions used in the survey are aimed at determining the structure of beekeeping in the province and how beekeepers struggle against the varroa pest. According to the results of the study, it was determined that 92.5% of the beekeepers who participated in the survey were able to detect varroa without any help from anyone, varroa is seen most in the summer period (60%) and a large proportion of beekeepers, 87.5%, struggle it by using chemical pesticides. In addition, it was determined that all of the beekeepers had wasp, 98.75% had varroa, 97.5% had bee bird, 92.5% had hedgehog, 90% had Nosema (locally known as Sürüngeç disease), 88.75% had wax moth, 83.75% had foulbrood, 37.5% had lime disease, and 12.50% had stone disease in the last 3 years. It was determined that the beekeepers participating in the survey struggled against varroa mostly in the summer (36.25%) and that they mostly used drugs containing the active ingredient amitraz (85%) in this struggle. It was determined that more than 50% of the beekeepers participating in the survey used thyme oil, formic acid, walnut oil and leaves in the fight against varroa, in addition to chemical pesticides. It was determined that 63.75% of the beekeepers participating in the survey sprayed 8 or more times in a year, 20% sprayed 4 to 8 times, and 16.25% sprayed 1 to 4 times.

**Keywords:** Honey bee, *Apis mellifera*, bee pests, varroa

# ELEKTROEĞİRME (ELEKTROSPİN) YÖNTEMİ İLE ÜRETİLEN JELATİN NANOLİFLERİNİN ANTİBAKTERİYEL ETKİLERİ

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**Özet**
Doğal polimerler, makromoleküller olarak isimlendirilmekte olup; proteinler (kolajen, jelatin, hyaluronik asit, zein, ipek) ve polisakkaritler (nişasta, selüloz, aljinat, kitosan) olmak üzere temelde iki grupta sınıflandırılır. Doğal polimerler, kimyasal yapılarından dolayı çevreye uyumluluk sağlayarak, doğada çözünebilme kabiliyetlerine sahiptir. Ayrıca toksik etki göstermediği için kullanımları çok avantajlıdır. Jelatin; özellikle domuz, sığır, balık gibi hayvansal kaynaklardan elde edilen protein kökenli kolajenin, asidik ve bazik koşullardaki ortamlarda parçalanmasıyla elde edilen yüksek moleküler ağırlığa sahip bir proteindir. Ortama asit katılarak kolajenin parçalanmasıyla elde edilen jelatin A tipi olarak adlandırılırken, kolajenin bazik ortamda parçalanmasıyla elde edilen jelatin ise B tipi olarak adlandırılır. Nanolifler, çapı nanometre aşamasında değişen lifler olarak adlandırılmakta olup sahip olduğu eşsiz özellikleri nedeniyle başta gıda endüstrisi olmak üzere farklı birçok alanda kullanılmaktadır. Nanolif üretiminde yaygın olarak elektroeğirme metodu kullanılmaktadır. Bu metod ile elektrik alan kuvvetleri vasıtasıyla polimerden nano boyutta lif oluşumu sağlanır. Jelatin, nanolif eldesinde sıklıkla tercih edilen doğal polimerler arasındadır. Elektroeğirme yöntemi ile elde edilen biyobozunur jelatin nanolifleri çaplarının oldukça düşük olması bu yüzden daha yüksek yüzey alanı göstermesi nedeniyle tercih edilmektedir. Literatür incelendiğinde elektroeğirme yöntemiyle üretilen jelatin nanoliflerine çeşitli maddelerin eklenmesiyle aktif özellik kazandırıldığını gösteren birçok çalışma olduğu görülmektedir. Bu çalışmalarda özellikle biyoaktif maddeler, uçucu yağlar, çeşitli bitki ekstraktlarının kullanıldığı bildirilmiştir. Sonuç olarak belirtilen aktif bileşenler ile jelatin nanoliflerine, antibakteriyel ve antifungal özellik kazandırıldığı ifade edilmiştir. Aktif özellik kazanmış bu jelatin nanoliflerin, gıda sanayiinde potansiyel ambalaj materyali olarak değerlendirebileceği öngörülmektedir. Bu konuda daha detaylı çalışmalara gerekesinim olduğu düşünülmektedir.
**Anahtar Kelimeler:** Jelatin nanolifleri, elektroeğirme, biyoaktif madde, antibakteriyel

# ANTIBACTERIAL EFFECTS OF GELATIN NANOFIBERS PRODUCED BY ELECTROSPINNING METHOD

**Abstract**

Natural polymers are called macromolecules and are mainly classified in two groups: proteins (collagen, gelatin, hyaluronic acid, zein, silk) and polysaccharides (starch, cellulose, alginate, chitosan). Natural polymers have the ability to dissolve in nature, providing environmental compatibility due to their chemical structure. In addition, their use is very advantageous as they do not show toxic effects. Gelatin is a protein with high molecular weight obtained by the breakdown of protein origin collagen obtained from animal sources such as pigs, cattle and fish in acidic and basic conditions. Gelatin obtained by the breakdown of collagen by adding acid to the environment is called type A, while gelatin obtained by the breakdown of collagen in basic environment is called type B. Nanofibers are fibers that vary in diameter in the nanometer stage and are used in many different fields, especially in the food industry, due to their unique properties. Electrospinning method is widely used in nanofiber production. With this method, nano-sized fibers are formed from the polymer by means of electric field forces. Gelatin is one of the most preferred natural polymers for nanofiber production. Biodegradable gelatin nanofibers obtained by electrospinning method are preferred because their diameters are quite low and therefore show higher surface area. When the literature is examined, it is seen that there are many studies showing that gelatin nanofibers produced by electrospinning method are given active properties by adding various substances. In these studies, especially bioactive substances, essential oils, various plant extracts were reported to be used. As a result, it was stated that antibacterial and antifungal properties were added to gelatin nanofibers with the active ingredients mentioned. It is predicted that these gelatin nanofibers with active properties can be used as potential packaging materials in the food industry. It is thought that more detailed studies are needed on this subject.

**Keywords:** Gelatin nanofibers, electrospinning, bioactive substance, antibacterial

# PERAN DIGITAL MARKETING TERHADAP PENINGKATAN PENDAPATAN UMKM ALAM TANI HYDROFARM DI KUDUS

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**Abstract**
This research was conducted due to the acceleration of globalization which has driven the rapid development of digital technology, providing opportunities for businesses to enter the digital marketing market. Therefore, UMKM Alam Tani Hydrofarm can increase their income through digital marketing strategies. The purpose of this research is to understand the role of digital marketing in increasing the income of UMKM Alam Tani Hydrofarm in Kudus. This study uses a qualitative descriptive approach, which aims to provide facts and data regarding the effect of digital marketing on the income of UMKM Alam Tani Hydrofarm. The results of this study indicate that digital marketing implemented by UMKM Alam Tani Hydrofarm has a significant impact. These UMKM actors can continue to develop their business while meeting consumer needs through digital marketing strategies. The transition to purchasing through digital marketing will also facilitate market expansion for UMKM. Current technological developments optimize the potential of UMKM and promote sustainable growth. Social media and e-commerce platforms are important means of increasing UMKM sales.
**Keywords:** Digital Marketing, Income, UMKM

# NUTRITIVE VALUE OF TRASH FISHES OF VEMBANAD LAKE OVER THE DELICACIES

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## Abstract

Vembanad lake is the second largest Ramsar site in India. Many poor people living on the coasts of Vembanad lake depend on fish resources for their dietary protein requirements. Fish and shellfish are the primary sources of animal protein and valuable in the diet because they provide a good quantity (usually 70% or more) of protein of high biological value, particularly sulphur containing amino acids. Fishes often described as rich food for poor people provides essential nutrients especially proteins of high biological values and fat. Fish is highly nutritious, tasty and easily digestive. It is much sought after by a broad cross-section of the world's population. A knowledge of proximate biochemical composition of fish is essential in order to compare its value as food with other protein food. The present study focus on finding out the biochemical constitution of selected edible fishes in Vembanad lake. Seven different species of fishes were selected for the study. The fish species selected for the study were Etroplus suratensis, Etroplus maculatus, Stolephorus indicus, Mugil cephalus, Gerres setifer, Arius subrostratus and Oreochromis niloticus.10 fishes from each species was collected from local fishermen near Thanneermukkom, in Alappuzha district, for the study.The glycogen and protein content of these fishes were analysed using standard procedures. The protein content was estimated by Folin-Ciocalteau method and glycogen estimation was carried out using anthrone method. The study proved that the nutritional value does not depend on the size or cost of the fish.Small fishes like Gerres setifer and Stolephorus indicus had almost equal nutritional value as that of Etroplus suratensis . It was found that Stolephorus indicus possessed high protein content and Arius subrostratus showed the lowest. This finding throws light to the fact that protein content does not depend on the size of the fish. Moreover some fishes which are available in markets at lower costs were found to have equal or higher nutritional status than that of delicacies.

**Keywords:** Vembanad lake, Fish

# EFEKTIVITAS PENERAPAN E-GOVERMENT SEBAGAI MEDIA DI DALAM UPAYA PENINGKATAN PELAYANAN BERBASIS

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**Abstract**
This study aims to analyze the effectiveness of implementing e-government in licensing services at DPM-PTSP Jepara Regency. This type of research is qualitative descriptive with data collection techniques using observation, interviews and documentation. The data analysis technique used is data reduction, data presentation and conclusion. The results of this study state that with the launch of the official DPMPTSP website it is expected that the implementation of licensing services will no longer take months but only take a matter of hours, however DPMPTSP must be able to make more efforts because there are still several obstacles in the implementation of e-government.
**Keywords**: Effectiveness, public services, licensing.

# PERSONAL FINANCE: A STUDY ON THE FINANCIAL BEHAVIOR OF INDIVIDUALS

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## Abstract
This study seeks to identify how people manage their personal finances and what practices/tools can be used to help control spending. The specific objectives are: to survey the practices used by people in their finances; to identify the main factors/influencers that compromise people's financial peace of mind; to present practices/tools that can help control spending; to create recommendations for people on the importance of personal financial planning and organization, as well as practices that can help control spending. The methodology of this study is: quantitative, level: descriptive, strategy: survey, population and sample, pre-test, data collection process and data analysis process. An important factor that emerged from the research is the lack of investment of the money that is saved during the month, due to a lack of knowledge or habit. This is why it is necessary for everyone who wants to have an effective financial organization with results to learn about financial education and investments, which is essential for achieving financial independence. However, in order to achieve financial stability, it is necessary to change the way you think about money, learn to plan well, save whenever possible, invest capital in profitable alternatives, and, most importantly of all, establish a standard of living that meets your real needs, which means never spending more than you earn. In this way, anyone will be able to achieve financial tranquillity in their life. Although the results showed that most people are in the habit of saving money throughout the month, studies on investments would be very important in order to get to know the profile of investors and, with more in-depth research, find out why most people are not in the habit of investing their savings.
**Keywords:** Personal finance, Spending control, Planning, Financial organization

# RELATIONSHIP BETWEEN TECHNOSTRESS AND ORGANIZATIONAL BEHAVIOR

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**Abstract**
Due to the highly competitive nature of the market, organizations have embraced information and communication technologies (ICTs) to maximize the organization's results and productivity. As such, technology has benefited both quality and productivity in employees' routines. However, excessive use of ICTs can trigger technological stress, which is known as technostress. Many aspects of technological stress are related to constant connectivity and information overload, which are known as technoinvasion and technooverload. Due to the intense competition in the market, organizations have incorporated Information and Communication Technologies (ICTs) as a means of optimizing the company's results and efficiency. As a result, technology has contributed to both quality and productivity in employees' day-to-day work. However, excessive use of ICTs can result in an aspect known as technological stress, also called technostress. Many of the factors that cause this technological stress are related to constant connectivity and information overload, which are identified as technoinvasion and technooverload. The research is classified as quantitative and the data was collected using an online survey instrument. The questionnaire consisted of 17 Likert scale questions. 175 questionnaires were returned. The data was analyzed using an artificial neural network approach. The results show that technooverload and technoinvasion influence organizational commitment intentions.
**Keywords:** Technostress, Techno-invasion, Techno-overload, Affective Commitment

# FLEURIET DYNAMIC MODEL: A CASE STUDY APPLIED TO EDUCATIONAL SERVICES COMPANIES LISTED ON THE STOCK EXCHANGE (B3)

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**Abstract**
The analysis of accounting or financial statements is of great importance for decision-making in company management. The Dynamic Model, or Fleuriet Model, aims to analyze the financial situation of companies from the perspective of the Dynamic Model of working capital analysis, thus being a tool that diagnoses decision-making from a financial point of view. In turn, this study aims to analyze the financial situation of educational services companies listed on B3 between 2013 and 2020, from the perspective of the Dynamic Model. The methodology is characterized as descriptive, with a qualitative and quantitative approach and, in terms of procedures, a multi-case study. The results show that ANIMA's financial structure was classified as "Solid" in most periods, with two "Excellent" structures and one "High Risk" structure. Bahema had two "Very Bad" financial structures, two "Excellent" structures, three "High Risk" structures and only one "Solid" structure. COGNA presented results that included five periods of "Solid" financial structure, a drop to "Unsatisfactory" and two "Excellent" periods. Estácio showed the greatest variations, going through four different types of financial structure during the study. Finally, Ser had a "Solid" financial structure in all the periods observed, and was the only company not to suffer any variations in its financial structure classification.
**Keywords:** Dynamic model. Traditional financial analysis. Analysis of financial statements. Fleuriet Dynamic Model.

# HASAT SONRASI HASTALIKLARIN KONTROLÜNDE MEYVE MİCROBİOMUNUN ÖNEMİ VE YENİ TEKNİKLER

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## Abstract
Meyvelerde, patojenler nedeniyle hasat sonrası ortaya çıkan çürüklükler önemli kayıplara yol açmaktadır. Mikroorganizmalar meyve ve sebzelerin önemli bileşenini oluşturur. Meyveler yararlı ve bozulmaya neden olan patojenik mikroorganizmaları içeren spesifik bir mikrobiyota barındırır. Mikroorganizmalar meyve yüzeyinde epifit olarak veya dokularda endofit olarak bulunabilirler. Mikrobiomlar, çeşitli biyotik ve abiyotik streslere karşı bitki direncini artırabilir potansiyele sahiptirler. Meyve mikrobiomunun hasat sonrası patoloji ve fizyoloji üzerindeki etkisi hakkında yapılan çalışmalar az olmasına karşın, yeni eğilimler umut vermektedir. Meyve mikrobiomunun araştırılması ve anlaşılmasındaki artan çalışmalar, hasat sonrası biyolojik kontrolün tam potansiyeline ulaşmasında önemli olan yeni yaklaşımlar geliştirme fırsatı sunmaktadır. Hastalık belirtisi görülen meyveler, sağlıklı meyvelere göre daha düşük mikrobiyal çeşitliliğe sahiptir. Çünkü hastalıklı dokularda bulunan fungal ve bakteriyel patojenler daha fazla ve baskın durumda bulunmaktadır. Hasat sonrası hastalıkları önlemek ve kontrol altına almak için kullanılan başlıca yöntemler, genellikle kimyasal fungisit uygulamalarıdır. Meyve ve sebzelerde bulunan kimyasal kalıntıların insan sağlığı ve ekolojik çevre üzerinde olumsuz etkileri olabileceğinden kimyasal fungisitlerin yerine farklı yöntemlere ihtiyaç duyulmaktadır. Hasat sonrası meyve hastalıklarına karşı mücadelede, antagonistik mikroorganizmaların çoğu epifitik mikrobiyal topluluklarda tanımlanırken, endofitik mikroorganizmalar da biyokontrol stratejileri için önemlidir. Hasat sonrası depolama koşullarında endofitik mikrobiomun biyokontrol ajanı (BCA) olarak kullanılması, son yıllarda kimyasal pestisitlere uygun bir alternatif olarak kullanılmaktadır. Epifitik ve endofitik mikrobiomun daha iyi bilinmesi, hasat sonrası koşullarda meyve patojenlerine karşı güvenli biyolojik kontrol sistemlerinin daha da geliştirilmesine yardımcı olmaktadır. Bu bağlamda, hasat sonrası hatalıklar ile mücadelede doğal biyoaktif bileşikler ve patojen arasındaki moleküler etkileşimi incelemek için omik ve metagenomik tekniklerin uygulanması önemlidir. Entegre omik uygulamaları, hasat sonrası ürünler için daha uzun raf ömrüne ve patojenlere karşı etkili moleküler mekanizmaların aydınlatılmasına katkıda bulunmaktadır.

**Anahtar Kelimeler:** Mikrobiom, Metaomik, Endofit

# CONTROL OF DISEASES AFTER ILLNESS, THE IMPORTANCE OF FRUIT MICROBIOME AND NEW TECHNIQUES

**Abstract**

Post-harvest rots in fruits due to pathogens cause significant losses. Microorganisms constitute an important component of fruits and vegetables. Fruits harbor a specific microbiota that includes beneficial and spoilage pathogenic microorganisms. Microorganisms can be found as epiphytes on the fruit surface or as endophytes in the tissues. Microbiomes have the potential to increase plant resistance to various biotic and abiotic stresses. Although studies on the impact of the fruit microbiome on post-harvest pathology and physiology are scarce, new trends are promising. Increasing work in research and understanding of the fruit microbiome provides the opportunity to develop new approaches that are important in reaching the full potential of post-harvest biological control. Fruits with disease symptoms have lower microbial diversity than healthy fruits. Because fungal and bacterial pathogens in diseased tissues are more abundant and dominant. The main methods used to prevent and control post-harvest diseases are generally chemical fungicide applications. Since chemical residues found in fruits and vegetables may have negative effects on human health and the ecological environment, different methods are needed instead of chemical fungicides. In the fight against post-harvest fruit diseases, most antagonistic microorganisms have been identified in epiphytic microbial communities, while endophytic microorganisms are also important for biocontrol strategies. The use of the endophytic microbiome as a biocontrol agent (BCA) under post-harvest storage conditions has been used as a suitable alternative to chemical pesticides in recent years. A better knowledge of the epiphytic and endophytic microbiome helps to further develop safe biological control systems against fruit pathogens in post-harvest conditions. In this context, it is important to apply omics and metagenomic techniques to study the molecular interaction between natural bioactive compounds and the pathogen in combating post-harvest blemishes. Integrated omics applications contribute to longer shelf life for post-harvest products and to the elucidation of molecular mechanisms effective against pathogens.

**Keywords**: Microbiome, Metaomics, Endophyte.

# DETERMINATION OF WEEDS THAT ARE POTENTIAL INTERMEDIATE HOSTS OF *Tomato spotted wilt virus* (TSWV) IN TOMATO AND PEPPER GROWING AREAS IN İZMİR PROVINCE AND ITS SURROUNDINGS

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## Abstract
In recent years, *Tomato Spotted Wilt Virus* (TSWV) has been causing production and economic losses in both greenhouse and open areas in many vegetable groups, especially in tomato and pepper fields. It is one of the viruses that cause the most losses to cultivated plants worldwide. Since the cultivated plants, which are the hosts of *Tomato spotted wilt virus* (TSWV), are grown on the same field every year, an increase in symptoms has been observed. Samples of weeds, which are potential intermediate hosts of TSWV, were taken from different regions, both in winter and summer, in Izmir province and its surroundings. In the surveys conducted in 2023, a total of 203 weed samples were collected from tomato and pepper fields, greenhouses and open fields. 100 of these samples were taken from pepper and 103 from tomato fields and tested with DAS-ELISA. As a result of the surveys, 10 of the weed samples that were obtained were found to be infected with TSWV. In addition to that, 8 of the TSWV infected weeds were found in the samples that were taken from tomato fields and 2 from the pepper fields. However, tests conducted on winter weed samples have no positive outcomes. On the other hand, all infected weed samples were observed in summer weeds. The research also shows that there is not any infected weed in the greenhouse fields.
**Keywords:** virus, TSWV, weed, tomato, pepper

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# THE CLIMATE CHANGE IMPACT ON DROUGHT CHARACTERISTICS IN ANTALYA BASIN

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## Abstract
This study was conducted in the Antalya Basin to investigate the effects of climate change on drought. According to researches, the Antalya Basin is located in the Mediterranean Basin, which is one of the region expected to be most affected by climate change. It is estimated that the losses of drought events rely on climate change will increase depending on the drought characteristics. To keep drought's adverse effects and economic dimensions under control and reduce them the minimum levels, it is essential to calculate drought frequency, severity, duration, and affected area as priority tasks and conduct temporal and spatial analyses of drought characteristics. This study used the Standardized Precipitation Index (SPI) to identify and characterize drought events in the Antalya Basin. Meteorological stations with precipitation records from 1969 to 2022 (54 years) were used for drought analysis in the Antalya Basin. The effects of global climate change on drought indices and characteristics in the last years have been investigated using the Mann-Kendall (MK) and Innovative Trend Analysis (ITA) methods. The analyses revealed that climate change has caused significant increases in drought events' duration, severity, and frequency. It is emphasized that the Mediterranean Basin will be one of the most sensitive regions in the future due to climate change. As a result of this study, changes in drought characteristics due to climate change also reveal similar sensitivity for the Antalya Basin. Increasing temperature and decreasing precipitation in the basin, which is highly sensitive to drought, will further reduce the use of limited water resources. These research results of the Antalya Basin obtained that drought and climate change should be taken into consideration more than ever in the future when planning and managing of water resources.
**Keywords:** Climate change, Drought, Antalya Basin, Standardized Precipitation Index (SPI), Mann-Kendall (MK), Innovative Trend Analysis (ITA).

# USE OF ADDITIVE IN ALFALFA SILAGE PRODUCTION: A REVIEW

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**Abstracts**
Forage is an important part of the diet of ruminants, among which the leguminous family is of special importance, of which alfalfa is more important. Alfalfa plant due to its good quality, palatability and having reserves of nutrients such as minerals, protein and vitamins, especially vitamin A, is very important. Alfalfa (*Medicago sativa*) has spread in most regions of the world and is known as the queen of fodder plants. In countries where the growing season is limited, dry fodder and silage play an important role in providing food resources for ruminants, which is one of the ways to prevent the reduction of the nutritional value of silage. Alfalfa loses most of its nutritional value during ensiling due to its low soluble carbohydrates and hollow stems. Alfalfa silage has a low quality due to its high buffering capacity and low fast-fermenting carbohydrates. Silage additives can be classified as fermentation promoters, feed spoilage inhibitors and water-soluble sugar suppliers. These ingredients are very important in producing good silage from alfalfa forage. The additive like molasses, bacteria inoculant, apple pomace, citrus by-product, whey and essential oil improved alfalfa silage and its fermentation characteristics.
**Keywords:** Alfalfa, Bacteria inoculant, Ensiling, Ruminant, Silage.

# COMPARATIVE ANALYSIS OF TRAINING AND DEVELOPMENT PRACTICES IN FAST FOOD SEGMENT –MCDONALDS AND KFC

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## Abstract
The term "fast food" lacks a universally accepted definition, but it generally refers to food that is served quickly and on demand (Sherwood, Story and Neumark-Stainer, 2001). The Ministry of Health Malaysia defines fast-food as food prepared in large quantities, served rapidly in standardized procedures at restaurants, and promoted through electronic and print media (Xiao, Yang and Iqbal, 2018). The fast-food industry has become a global phenomenon, transforming the way people consume food and reshaping the culinary landscape. Among the prominent players in this industry, KFC and McDonald's have established themselves as giants, captivating the taste buds of millions around the world. In this report, I delve into a comprehensive analysis of these two industry leaders, focusing on various aspects that contribute to their success and compare customer satisfaction level towards KFC and McDonalds. To begin, we introduced KFC and McDonald's, shedding light on their origins, history, and their significant contributions to the fast-food sector. Next, we explored the demand and supply scenario within the fast-food sector. Following the examination of demand and supply, we delved into the reasons behind the substantial growth on both the demand and supply sides of the fast-food sector. Moving further, we analysed the production strategies employed by KFC and McDonald's. By examining their pricing strategies, cost of ingredients, labour costs, and overhead expenses, we gained insights into their financial performance and competitive advantage within the fast-food industry. Furthermore, we investigated the market structure of KFC and McDonald's, examining the competitive landscape they operate in. We analysed their market share, market concentration, and barriers to entry, providing a comprehensive overview of their positioning within the industry. In order to gain a holistic understanding of the strengths, weaknesses, opportunities, and threats faced by KFC and McDonald's, we conducted a SWOT analysis. Moreover, we discussed their competitors, analysing the key players in the fast-food industry who pose a challenge to the market dominance of KFC and McDonald's. Lastly, we explored risk assessment strategies employed by KFC and McDonald's to mitigate potential threats and ensure business continuity.

**Keywords:** Fast food industry, Customer Satisfaction, demand and supply, pricing strategies, cost of ingredients, labour costs, and overhead expenses, McDonald’s.

# COMPARATIVE ANALYSIS AND DEVELOPMENT PRACTICES IN FOOD INDUSTRY – NESTLÉ MALAYSIA

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## Abstract

Since 1912, a Nestlé S.A. subsidiary called Nestlé (Malaysia) Behead has been conducting business in Malaysia; in 2022, it will celebrate 110 years of business. With a wide range of well-known brands, including MILO, MAGGI, NESCAFÉ, and KIT KAT, the company has developed through time to become a household name (Hoi, 2023). The company's operational and financial plans serve to illustrate its objectives. Due to growth in both its domestic and export sectors, it reported a rise in sales of 16.2% year over year to RM6.7 billion in 2022 (Hoi, 2022). Nestlé Malaysia operates in several market segments, including Infant Nutrition, Health Science, Food and Beverages, and Confectionery, offering a diverse range of products designed to meet the varied needs and preferences of Malaysian consumers (*Innovation, Science and Technology*, 2023). The Infant Nutrition segment provides products designed specifically for the nutritional needs of infants and young children, including infant formula and cereals, focusing on supporting healthy growth and development during early life stages. Bhd., the business additionally shown its dedication to expansion, increases its market share in Malaysia's infant milk category from 10.0 percent to 19.5 percent (Hoi, 2023). As seen by its borrowing to support the business's inventory during supply chain disruptions and for capital expenditures, Nestlé Malaysia also upholds a strategy of investment and expansion. In order to seize prospects in Malaysia and Asia, the business has allocated RM1 billion for capital expenditure over the coming years (Nestlé Malaysia, 2021). Nestle Malaysia is a subsidiary of the multinational food and beverage company, Nestle S.A. which is headquartered in Switzerland, has a substantial presence in Malaysia(Binti Mohamad Nasir, 2022). The company sells a variety of foods and beverages, from coffee to infant formula to candy to dairy. In this essay, we will analysis Nestle Malaysia utilizing PESTLE, Porter's Five Forces, CPM and Swot analysis.

**Keywords:** Food and beverage industry, consumer goods industry, leading, competitive, nutrition, health, and Wellness industry.

# PROCESSING TECHNOLOGIES OF SORGHUM GRAINS AND THEIR EFFECTS ON THE SORGHUM FLOUR CHARACTERISTICS

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**Abstract**
Sorghum is the world's most widely grown cereal, fifth after maize, wheat, rice, and barley, due to its agronomic advantages, being resistant to drought, diseases, and pests. Sorghum is an excellent source of starch, protein, minerals, and fiber, and contains phenolic compounds such as flavonoids that prevent tumor development, phenolic acids, and tannins. Starch and sugar are released more slowly from sorghum than other grains, which is a benefit for people with diabetes. Sorghum being a potential source of resistant starch and β-glucans can be used as a probiotic food ingredient in value-added food products. Antinutritional factors in sorghum grains such as tannins, phytate, enzyme inhibitors, and protein cross-linking agents are responsible for inhibiting protein digestibility and mineral bioavailability. The inhibitory effect of tannins occurs due to their ability to form complexes with other molecules, especially proteins. Thus, processing sorghum grains by soaking, germination, fermentation, wet heat treatments, dry heat treatments, steaming treatments, extrusion, and roasting, can reduce the negative effect of those anti-nutritional factors, and therefore enhance their nutritional composition. In addition, the functional properties of sorghum flour may change due to the processing technologies, depending on the sorghum source, compositional and molecular structure, protein quality, and interaction with other components. Therefore, the knowing of the sorghum flour characteristics plays an essential role in the selection of the types of products that can be manufactured.
**Keywords:** functional properties, gluten-free products, nutritionalvalue, processing technologies, sorghum flour.

# ANALISIS SWOT DALAM STRATEGI PENGEMBANGAN UMKM PETANI SELADA (STUDI KASUS UMKM ALAM TANI HIDROFARM KUDUS)

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**Abstract**
Penelitian ini bertujuan untuk mengetahui kekuatan, kelemahan, peluang, dan ancaman yang mempengaruhi Alam Tani Hidrofarm Kudus. Metode yang digunakan dalam penelitian ini adalah kualitatif. Data yang digunakan dalam penelitian ini adalah data primer dengan melakukan wawancara dan observasi di UMKM Alam Tani Hidrofarm Kudus. Hasil penelitian ini menunjukkan bahwa kekuatan yang dimiliki oleh Alam Tani Hidrofarm Kudus adalah mengurangi ketergantungan pada lahan pertanian yang luas, produk memiliki kualitas yang baik, segmentasi pasar yang sesuai. Kelemahan tersebut antara lain ketersediaan selada hidroponik yang tidak stabil untuk memenuhi permintaan sayuran, variasi produk sayuran yang kurang, dan resiko kegagalan teknis pada sistem hidroponik yang dapat mengganggu produksi. Sedangkan peluang yang dimiliki adalah loyalitas pelanggan, permintaan pasar yang tinggi terhadap produk pertanian yang lebih bersih, dan jaringan pemasaran yang lebih luas. Ancaman tersebut adalah munculnya persaingan dengan produk pertanian yang mungkin lebih murah, ketidakpastian dalam pemasaran, perubahan iklim yang tidak pasti, dan tingkat permintaan yang tidak stabil. Berdasarkan hasil analisis matriks SWOT faktor internal (kekuatan dan kelemahan) dan faktor eksternal (peluang dan ancaman) Alam Tani Hidrofarm Kudus diperoleh dua belas alternatif strategi yang terdiri dari strategi SO, strategi W-O, strategi S-T dan strategi W-T yang dapat dilaksanakan.
**Keywords**: SWOT, Strategi, dan UMKM

# PHYTOCHEMICAL CONSTITUENTS AND ANTIBACTERIAL ABILITY OF INFLORESCENCES OF THE GENUS *SORBUS* PLANTS

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## Abstract
The health-protective properties of plants have always been the important object of study and use for humans. Currently, one of the serious challenges is the microbial resistance to classical antibiotics, which stimulates the search for new antimicrobial agents. Phytochemicals can exert potential antibacterial activities via different mechanisms. The most promising are the extracts of traditional medicinal plants, which contain biologically active substances. Plants of the genus *Sorbus* L. (rowans) are well known for their ethnopharmacological importance, but are underestimated today. The aim of the work was to identify bioactive compounds of rowan inflorescences and evaluate their antibacterial ability. The fully blooming inflorescences of *Sorbus domestica* L., *S. latifolia* (Lam.) Pers., *S. hybrida* L., *S. torminalis* (L.) Crantz, *S. intermedia* (Ehrh.) Pers., *S. aria* (L.) Crantz., and *S. aucuparia* L., were collected in Botanical Garden of Oles Honchar Dnipro National University (48°26'7" N, 35°2'34" E; Dnipro city, Ukraine). Constituents of the floral extracts were identified by GC-MS assay using Shimadzu-GC-MS (QP 2020 El, Japan). In rowan inflorescences, the most common phytochemicals having the known bioactivity were linoleic, oleic and hexadecanoic acids, pentadecyl acrylate, and different terpenes and terpenoids, including urs-12-ene, olean-12-en-3-one, lupeol, ethyl isoallocholate, alpha Amirin, 24-norursa-3,12-diene. Growth-inhibiting activity of the floral extracts was exhibited against Gram-negative bacteria *Erwinia dissolvens* B170 (the highest by *S. latifolia* and *S. hybrida*), *Pseudomonas aeruginosa* B907 (*S. domestica, S. torminalis, S. aucuparia* and *S. latifolia*), *Klebsiella pneumoniae* B920 (*S. aria, S. latifolia* and *S. domestica*), and Gram-positive bacteria *Staphylococcus aureus* B209 (*S. hybrida, S. aria* and *S. domestica*), *S. epidermidis* ATCC149 (*S. latifolia, S. torminalis* and *S. hybrida*) and *S. epidermidis* B919 (by *S. hybrida, S. torminalis* and *S. aucuparia*). The results obtained indicate the inflorescences of the *Sorbus* plants as a rich source of biologically active compounds with potentially antibacterial ability.
**Keywords:** rowans, inflorescences, phytochemical profilling, antimicrobial potential

# ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND ITS SIGNIFICANCE

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**Abstract**
Environmental Impact Assessment (EIA), is the assessment of the environmental consequences of a plan, policy, program, or actual projects prior to the decision to move forward with the proposed action. In this context, the term "environmental impact assessment" is usually used when applied to actual projects by individuals or companies and the term "strategic environmental assessment" (SEA) applies to policies, plans and programmes most often proposed by organs of state. It is a tool of environmental management forming a part of project approval and decision-making. Environmental assessments may be governed by rules of administrative procedure regarding public participation and documentation of decision making, and may be subject to judicial review. The purpose and significance of the assessment is to ensure that decision-makers consider the environmental impacts when deciding whether or not to proceed with a project. The International Association for Impact Assessment (IAIA) sees an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments. EIAs are unique in that they do not require adherence to a predetermined environmental outcome, but rather they require decision-makers to account for environmental values in their decisions and to justify those decisions in light of detailed environmental studies and public comments on the potential environmental impacts. Conclusively, Environmental Impact Assessment is a crucial tool for promoting sustainable development and ensuring the protection of the environment. It systematically assesses potential environmental impacts, integrates environmental considerations into project planning, and enables public participation. While challenges and criticisms are associated with the EIA process, efforts are being made to improve its effectiveness through legal reforms, capacity-building, and the adoption of international best practices.
**Keywords:** Environmental, Impact, Assessment and Significance

# SUSTAINABLE TECHNOLOGY FOR EFFECTIVE WASTEWATER MANAGEMENT: A REVIEW ARTICLE

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**Abstract**
The discharge of wastewater not properly treated into natural water bodies can have insidious impacts on the environment, aquatic ecosystem, causing serious damage to natural habitat and human health. Heavy-metal pollution is considered as one of the leading sources of environmental contamination due to their non-biodegradable, bio-accumulative nature and persistence in the environment. Conventional treatment technologies employed to remove pollutants from wastewater usually require a high maintenance cost are labour intensive, time-consuming, environmentally destructive and mostlyinefficient. These drawbacks led to the emergence of phytoremediation which is a cost effective green technology, efficient, ecofriendly, solar-driven technology with long-lasting applicability. Phytoremediation makes use of floating aquatic weed plants to take up contaminants. Water hyacinth (*Eichhornia crassipes*), Water lettuce (*Pistia stratiotes*), Water fern (Salvinia molesta) and Duck weed (*Lemna minor*) have been widely used for the treatment of agricultural, domestic and industrial wastewater. The plants have been widely applied due to their availability, resilience in a toxic environment, bioaccumulation potentials, invasive mechanism and biomass potentials. They have the capacity to absorb excess contaminants such as organic, inorganic, heavy metals and pharmaceuticals present in wastewater. Molecular tools are also used to better understand the mechanisms of metal uptake, translocation, sequestration and tolerance in plants. It presents the opportunity of using suitable plant species to detoxify and clean up contaminants from the environment.
**Keywords**: Wastewater, Heavy Metal, Phytoremediation, Floating Aquatic Weed Plants, Ecofriendly.

# EVALUASI DAMPAK PERUBAHAN IKLIM TERHADAP UMKM HIDROPONIK SELADA (STUDI KASUS ALAM TANI HIDROFARM KUDUS)

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**Abstract**
Changes in climate have a significant impact on various aspects of work, especially in the modern agricultural sector. Therefore, the Alam Tani Hidrofarm Kudus Sector faces new challenges in the produktion process. This study aims to describe and evaluate the effect of climate change on the growth of vegetable plants in Alam Tani Hidrofarm Kudus. The research method used is qualitative research with a case study approach. Data obtained through observation, in-depth interviews, and document collection. The result showed that climate change produces various impacts such ass desreased productivity and quality in hydroponic lettuce plants. Factors such as temperature exstremes, pests and fungi play a role. Howefer, this study also identified various evaluastions for increasing the produktivity and quality of hydroponic lettuce. Solutions include implementing regular irigation systems, careful monitoring, using technology, and so on. This effort aims to deal with climate hange both now and in the future.
**Keywords**: climate change, MSMes, Hydroponic, lettuce.

# EFFECT OF LIPID-BASED MULTIPLE MICRONUTRIENTS SUPPLEMENTATION IN UNDERWEIGHT PRIMIGRAVIDA PRE-ECLAMPTIC WOMEN ON MATERNAL AND PREGNANCY OUTCOMES: RANDOMIZED CLINICAL TRIAL

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## Abstract

Background and Objectives: In pre-eclampsia, restricted blood supply due to the lack of trophoblastic cell invasion and spiral artery remodeling is responsible for adverse pregnancies and maternal outcomes, which is added to by maternal under nutrition. This study was designed to investigate the effects of lipid-based supplements (LNS-PLW) on pregnancy and maternal outcomes in underweight primigravida pre-eclamptic women. Materials and Methods: A total of 60 pre-eclamptic, underweight primigravida women from the antenatal units of tertiary care hospitals in the Khyber Pakhtunkhwa Province, Pakistan, were randomly divided into two groups (Group 1 and Group 2). The participants of both groups were receiving routine treatment for pre-eclampsia: iron (60 mgs) and folic acid (400 ug) IFA daily. Group 2 was given an additional sachet of 75 gm LNS-PLW daily till delivery. The pregnancy outcomes of both groups were recorded. The clinical parameters, hemoglobin, platelet count, and proteinuria were measured at recruitment. Results: The percentage of live births in Group 2 was 93% compared to 92% in Group 1. There were more normal vaginal deliveries (NVDs) in Group 2 compared to Group 1 (Group 2, 78% NVD; group 1, 69% NVD). In Group 1, 4% of the participants developed eclampsia. The frequency of cesarean sections was 8/26 (31%) in Group 1 and 6/28 (22%) in Group 2. The number of intrauterine deaths (IUDs) was only 1/28 (4%) in Group 2, while it was 2/26 (8%) in Group 1. The gestational age at delivery significantly improved with LNS-PLW supplementation (Group 2, 38.64 ± 0.78 weeks; Group 1, 36.88 ± 1.55 weeks, p-value 0.006). The Apgar score (Group 2, 9.3; Group 1, 8.4) and the birth weight of the babies improved with maternal supplementation with LNS-PLW (Group 2, 38.64 ± 0.78 weeks: Group 1, 36.88 ± 1.55; p-value 0.003). There

was no significant difference in systolic blood pressure, while diastolic blood pressure (Group 2, 89.57 ± 2.08 mmHg; Group 1, 92.17 ± 5.18 mmHg, p-value 0.025) showed significant improvement with LNS-PLW supplementation. The hemoglobin concentration increased with the LNS-PLW supplement consumed in Group 2 (Group 2, 12.15 ± 0.78 g/dL; Group 1, 11.39 ± 0.48 g/dL, p-value < 0.001). However, no significant difference among the platelet counts of the two groups was observed. Conclusions: The pregnancy and maternal outcomes of underweight pre-eclamptic women can be improved by the prenatal daily supplementation of LNS-PLW during pregnancy, along with IFA and regular antenatal care and follow-up.
**Keywords:** pre-eclampsia; lipid-based nutritional supplements; pregnancy outcome; maternal outcome; Khyber Pakhtunkhwa Province of Pakistan

# STUDY OF THERMAL BEHAVIOR OF LITHIUM-ION BATTERIES: A REVIEW ON, MANAGEMENT SYSTEMS, ELECTRODE MATERIALS AND THERMAL RUNWAY- PERSPECTIVE AND FUTURE DIRECTIONS

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**Abstract**
Lithium-Ion Batteries (Li-ion) are the advance form of batteries recently utilized in various applications. Li-ion batteries are the preferred technology for hybrid and fully electric vehicles, power tools, and portable gadgets due to their unmatched combination of high energy and power density. In this battery the electrolyte acts as a conduit for the ion exchange that generates electricity. Batteries of all shapes and sizes are thought to be one of the best methods for storing energy; nonetheless, the environmental effects of widespread battery use continue to be a significant issue that needs further research. The high-energy materials and the organic components of a Li-ion battery are unstable at temperatures above 130–150 °C and are prone to produce greater heat. The battery temperature will rise further and the heat-releasing process will quicken if the created heat is not expelled. The main Li-ion battery components are presented and contrasted in this study, along with the accompanying battery management systems and methods for enhancing battery efficiency, capacity, and lifespan. The thermal runaway mechanism is discussed in this work, along with a number of thermal runaway mitigation strategies, such as separators, flame retardants, and safety vents.
**Keywords:** Battery efficiency, Li-ion batteries, Battery Management Systems, Electrode Materials, and Thermal Runaway

# REMOVAL OF PHARMACEUTICAL COMPOUNDS FROM SYNTHETIC WASTEWATER USING ACTIVATED CARBONS DERIVED FROM CITRUS FRUITS PEEL

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**Abstract**
The escalation of pharmaceutical compounds in wastewater has become a pressing concern, demanding innovative strategies for efficient removal. This study delves into a sustainable solution by utilizing activated carbons derived from citrus fruits peel for the removal of pharmaceutical compounds from synthetic wastewater. The research meticulously outlines the process of activation, characterizing the resulting materials to understand their surface properties and composition. Through a series of systematic experiments, critical parameters such as adsorbent dosage, contact time, and initial concentration of pharmaceutical compounds were investigated to optimize the adsorption process. The study explores the kinetics and thermodynamics of adsorption, elucidating the mechanisms underlying the interaction between the activated carbons and pharmaceutical compounds. Furthermore, the research assesses the practicality of the method by evaluating the reusability and regeneration potential of the activated carbons, emphasizing their sustainability and economic viability. The findings reveal the exceptional efficacy of activated carbons derived from citrus fruits peel in removing diverse pharmaceutical compounds from synthetic wastewater. High adsorption capacities, coupled with environmentally friendly sourcing, make these materials a promising alternative for water treatment applications. The study's outcomes not only contribute valuable insights into the efficient removal of pharmaceutical compounds but also highlight the importance of utilizing agricultural waste products, fostering sustainable practices in environmental remediation. This research significantly advances the field of wastewater treatment, offering a viable and eco-friendly solution for pharmaceutical compound removal. The study's outcomes have far-reaching implications for researchers, policymakers, and practitioners, emphasizing the potential of citrus fruits peel-derived activated carbons in addressing water pollution challenges, thereby promoting cleaner water resources and a more sustainable future.
**Keywords:** Pharmaceutical Compounds, Citrus fruit peel, Activated Carbon.

# PLANT AND POLLINATOR BIODIVERSITY ASSESSMENT OF URBAN PARKS IN BARIŞ NEIGHBORHOOD, BURSA, TÜRKİYE

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**Abstract**
Pollinators support healthy ecosystems and indispensable ecosystem functions. Identifying plant and pollinator diversity and understanding plant-pollinator interaction in urban landscapes is essential for healthy and ecologically sustainable landscapes. Pollinators in urban landscapes would also support urban agriculture for food production. This study aims to calculate plant and pollinator diversity of three urban parks in Barış neighborhood, in Bursa, Türkiye. Plant and pollinator species of the parks are defined by field observations between March and June 2023. The plant, and pollinator biodiversity of three parks are assessed by using Simpson Diversity Index. The results show that Park 1 has the highest plant richness with 0.164 index value while Park 3 has the lowest plant richness with 0.473 followed by Park 2 with 0.176 index value. On the other hand, Park 3 has the highest pollinator richness with 0.446 index value while Park 2 has the lowest pollinator richness with 0.638 followed by Park 1 with 0.506 index value. These outputs indicate that not all plants in the parks are pollinator friendly. The findings of this research provide evidence-based data for decision makers and practitioners for planning and sustainable management of urban landscapes in Bursa in neighborhood scale. Based on the outputs some recommendations are developed to increase biodiversity.
**Keywords:** urban biodiversity, neighborhood parks, flowers, pollinators.

# DETERMINATION OF SILAGE QUALITY IN BAGASSE AND BAGASSE+LEAF OF SOME SWEET SORGHUM VARIETIES

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**Abstract**
This study was carried out to determine of silage quality in bagasse and bagasse+leaf of some sweet sorghum varieties. Experiment was conducted in 2022 Bursa Uludag University Agriculture Faculty Agricultural Application and Research Center experiment areas and laboratories of Department of Field Crops. In the research, two sweet sorghum varieties (Uzun and Gülşeker) and two different mixture combinations (bagasse and bagasse + leaf) were used. The bagasse was obtained by squeezing the leafless stems of sweet sorghum. The experiment was planned as randomized complete parcel design with four replications. Sweet sorgum varieties were harvested at the milking-dough stage and silages were opened after a 60-day ensiling period. Several parameters such as dry matter rate, pH, crude protein, ADF and NDF contents, relative feed value and fleig point have been examined in the experiment. According to the results obtained from the research, differences determined among the varieties in terms of silage dry matter ratio and Fleig score. Dry matter ratio, pH value and crude protein ratio of bagasse + leaf silages were higher than bagasse silages. Addition of leaf caused the ADF and NDF contents of the silages to decrease. While the felig score of bagasse silages was 105, this value was 112 for bagasse + leaf silages. Although the pH values of bagasse + leaf silage are higher than the values of bagasse silage, they are among the pH values recommended for a quality silage.
**Keywords:** Sweet sorghum, bagasse, leaf, silage quality.

# BIODIVERSITY OF CISTUS LADANIFERUS (CL) EXTRACTS AND ESSENTIAL OILS (EOs): A REVIEW OF THEIR INSECTICIDAL ACTIVITY AGAINST VARIOUS INSECTS.

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**Abstract**
Since the Green Revolution, the development of insect-resistant crops has opened up a promising field for the use of aromatic and medicinal plant extracts in pest management strategies, as plant-based biopesticides have the potential to control harmful insects and could therefore prove to be a good alternative to synthetic pesticides, which are harmful to human health and the environment and whose use could ultimately be greatly reduced. Focusing on plant-insect interactions can be a useful approach to finding a new generation of green insecticides. For example, plants produce allelochemicals such as phenolic compounds, flavonoids, alkaloids, tannins, and terpenoids that target the behaviour and physiology of arthropods. Thus, several compounds belonging to the above chemical classes may be ideal ingredients for the development of anti-insect activity. The present review is bibliographical research on the insecticidal and biological properties of EOs and various solvent extracts of CL. According to literature studies, these findings showed many biological activities, such as insecticidal and antibacterial. In common uses, CL branches are used to capture houseflies (Musca domestica L., Diptera: Muscidae), which are attracted by their intense odor and become trapped in the sticky leaves. Recent studies have demonstrated that the extracted oils from CL have insecticidal activity for female weevils studied (such as Bruchus rufimanus and Callosobruchus maculatus). Also, some of the authors referred to a possible antifeeding activity of C. ladanifer leaves related to small herbivores, such as insects. This effect may be linked to favonoids present in leaves. In addition, the methanol extract of C. ladanifer's aerial parts reduced the weight of the Plodia interpunctella larvae by as much as 18% after 8 days of treatment. It also completely inhibited the emergence of adults. This study has demonstrated the insecticidal activity of essential oils and extracts of CL against many harmful insects; it is undoubtedly of great interest in vector control.
**Keywords:** Cistus ladanifer L., essential oils, solvent extracts, insecticidal activity.

# ESSENTIAL OILS GAS CHROMATOGRAPHY-MASS- SPECTROSCOPY (GC-MS) ANALYSIS AND POTENTIAL IN BREAST CANCER TREATMENT

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## Abstract
Cancer is a major public health problem worldwide, breast cancer is the second highest cancer-related death worldwide. The treatment of breast cancer is via chemotherapy; however, occurrences of multidrug resistance, unselective targets, and physicochemical problems suggest that chemotherapy treatment is ineffective. Therefore, there is a need to find better alternatives natural compounds and their structural analogues to develop new drugs useful in the treatment of various diseases, including cancer. Essential oils are natural volatile products made up of a complex mixture of low molecular weight compounds with recognized biological and pharmacological properties investigated also for the prevention and treatment of cancer. In this study, the cytotoxic and antitumor (anti-Breast cancer) effects of Tea tree, Absinthe, Frankincense and Lemongrass, essential oils were evaluated which was qualitatively and quantitatively characterized using Gas Chromatography-Mass Spectroscopy (GC–MS) to identify the components of each essential oils. According to the GC-MS analysis, the major components of the essential were in Tea tree (L-4-terpineneol 33.31%), Absinthe (Sabinyl propionate 25.04%), and Frankincense α-pinene (35.1%) and Lemongrass (Tea tree 45.43%). Lemongrass and Tea tree essential oils significantly reduced the viability of both MCF-7 and WRL68 cells in a concentration dependent manner. However, Frankincense and Absinthe oils showed less inhibitory effects against both cell lines. The Lemongrass essential oil was more cytotoxic than Tea tree oils. Lemongrass shows a significant decrease in the survival rate of MCF-7 cells, 75% cell death rate at 400 µg/mL the $IC_{50}$ determined at 64.10 µg /mL. While shows weak cytotoxicity in normal cell line WRL-68 and the $IC_{50}$ 125.2 µg /mL. Therefore, Lemongrass might have a good potential as an active anti-breast cancer drugs candidates with the highest efficiency and fewest side effects.
**Keywords:** Essential oils, Cytotoxicity, Anticancer activity, Breast cancer

# A MICROPROCESSOR AND MICRO CONTROLLER PROJECT ON S0LAR AUTOMATIC RAILWAY TRACK CRACK DETECTING VEHICLE

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**Abstract**
Indian railways is the fourth largest railway network in the world which runs around 11,000 trains every day, of which 7,000 are passenger trains transporting over 6 billion passengers annually. Safety measures employed now is not effective especially in the method of crack detection of rails. Our project "SOLAR AUTOMATIC RAILWAY TRACK CRACK DETECTING VEHICLE" is a concept of detection of cracks in railway tracks automatically and prompts to adopt the required steps to avoid accidents. We use infrared light to sense the crack in the railway track automatically The signal is received at the nearest railway station automatically.
**Keywords:** accidents, automatically, Indian railways

# AN UNDERVALUED FOLKLORE SOURCE OF PHARMACEUTICAL, NUTRACEUTICAL AND COSMECEUTICAL INGREDIENTS; OSAGE ORANGE

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## Abstract
Osage Orange (*Maclura pomifera*), a tree native to the United States, has been traditionally used for its wood, but its seeds and flesh have been reported to be edible by many consumers. This article will discuss the bioactive compounds found in the fruit of the tree, such as pomiferin, osajin, and other prenylated molecules, which have been shown to have health-promoting properties in vitro and in vivo (e.g., antimicrobial, antioxidant, antitumor and anticancer, anti-inflammatory, antinociceptive, neuroprotection, antifungal, antidiabetic, antiulcer, and cardioprotective attributes). It will also discuss the health functions of the bioactive compounds, their mechanism of action, and extraction methods. This review is intended to provide readers, including members of the general public, with the necessary information before processing, consuming, discarding, or wasting the fruit. Osage Orange, especially its fruit, could potentially be used in the development of functional foods and/or design of medicinal products to prevent and treat certain diseases. To date no clinical or human intervention studies have examined the health effects of this plant.
**Keywords;** hedge apple, phytochemicals, medicinal plants

# REMOVAL OF PHARMACEUTICALS FROM WASTEWATER BY ADSORPTION PROCESS

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**Abstract**
This extensive annual consumption of pharmaceutical materials has led to the widespread contamination of aquatic ecosystems, affecting both wastewater treatment plant discharges, groundwater, and even drinking water samples. Pharmaceuticals, due to their resistance to biodegradation, tendency to accumulate, and their diverse applications across various sectors, pose significant environmental and human health risks. Our research holds importance as it addresses a global challenge in preserving water resources against the increasing threat posed by the presence and persistence of pharmaceutical substances. Conventional approaches for managing these issues in wastewater treatment have been plagued by several notable limitations. Within the scientific community, there is a growing favor for adsorption as a method due to its outstanding efficacy, cost-effectiveness, straightforward handling, and the wide array of available adsorbents.
**Keywords:** Pharmaceuticals – Wastewater – Adsorption – Adsorbents.

# FARKLI GÜBRE KOMBİNASYONLARININ FARKLI OLUM DÖNEMLERİNDE HASAT EDİLEN DOMATES MEYVELERİNDE POLİFENOLİK İÇERİKLERİNİN BELİRLENMESİ

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**Özet**
Bu çalışma, dünya sebze üretiminde önemli bir yere sahip olan domates yetiştiriciliğinde farklı gübrelerin etkisini belirleme amacıyla yürütülmüştür. Çalışmada, kimyasal gübreler (20:20:20 (N:P:K) ve organomineral (11:11:11), organik gübre (katı solucan) ve bu gübrelerin 10 farklı kombinasyonları (kontrol, kimyasal gübre (KG) %100, organomineral (OG) %100, katı solucan (KS) %100, KG %75 + KS %25, KG %50 + KS %50, KG %25 + KS %75, OG %75 + KS %25, OG %50 + KS %50, OG %25 + KS %75) uygulanmıştır. Çalışma tesadüf blokları deneme desenine göre 3 tekrarlı ve her tekrarda 20 bitki ile yürütülmüştür. Gübre uygulaması toprak analizi sonucuna göre yapılmıştır. Kimyasal gübre uygulamasında azot 3 dönemde, organomineral ve katı solucan gübresi ise dikimden önce toprağa uygulanmıştır. Çalışmada yeşil olum, pembe olum ve kırmızı olum dönemlerinde hasat edilen domates meyvelerinde, polifenolik bileşikler (HPLC) içeriğine bakılmıştır. Çalışma sonunda polifenolik bileşiklerde HPLC analizi sonucu yeşil olum döneminde hasat edilen domateslerde en yüksek değerden en düşük değere doğru sırasıyla klorojenik asit, gallik asit, rutin, ferulik asit ve hidroksisinamidin asit; pembe olum döneminde en yüksek değerden en düşük değere doğru sırasıyla gallik asit, klorojenik asit, rutin, plorodizin, hidroksisinamidin ve ferulik asit ve kırmızı olum döneminde en yüksek değerden en düşük değere doğru gallik asit, klorojenik asit, rutin, hiroksisinamidin, plorodizin, kuersetin, ve ferulik asit tespit edilmiştir. Gübre uygulamaları içinde değerlendirilme yapıldığında uygulamalarla beraber kontrole göre yeşil olum döneminde KG %100, KG %50 4 KS %50 ve KS %100, pembe olum döneminde OG %50 + KS %50, OG %100 ve OG %25 + KS %75 ve kırmızı olum döneminde ise OG %50 + KS %50, OG %75 + KS %25, KG %100 ve KG %75 + KS %25 gübre kombinasyonlarının ön plana çıktığı saptanmıştır.
**Anahtar Kelimeler:** Domates, Gübre, Polifenolik İçerikler, Olum Dönemleri
Bu çalışma, Van YYÜ Bilimsel Araştırma Projeleri Başkanlığı tarafından FDK-2021-9646 No'lu proje olarak desteklenmiştir.

# DETERMINATION OF POLYPHENOLIC CONTENT IN TOMATO FRUITS HARVESTED IN DIFFERENT DEVELOPMENT PERIODS OF DIFFERENT FERTILIZER COMBINATIONS

**Abstract**

This study was conducted to determine the effect of different fertilizers in tomato farming, which has an important place in world vegetable production. In the study, chemical fertilizers (20:20:20 (N: P: K) and organomineral (11:11:11), organic fertilizer (solid worm) and 10 different combinations of these fertilizers (control, chemical fertilizer (KG) 100%, organominal (OG) 100%, solid worm (KS) 100%, KG 75% + KS 25%, KG 50% + KS 50%, KG 25% + KS 75%, OG 75% + KS 25%, OG 50% + KS 25% were applied. According to the trial pattern, the study coincidence blocks were conducted with 3 repeats and 20 plants in each repetition. The fertilizer application was based on the soil analysis result. In chemical fertilizer application, nitrogen 3 was applied to the soil during the period, while organomineral and solid worm fertilizer were applied to the soil before planting. In the study, the polyphenolic pictures (HPLC) content of tomato fruits harvested in green, pink and red stages were examined. At the end of the study, as a result of HPLC analysis in the polyphenolic images, chlorogenic acid, gallic acid, routine, ferulic acid and hydroxycinnamidine acid, from the highest to the lowest values in tomatoes harvested during the green stage; The pink formation period, from the highest value to the lowest value, includes gallic acid, chlorogenic acid, Rutin, pylorodizin, hydroxycinnamidine and ferulic acid, and the red formation period, from the highest value to the lowest value, gallic acid, chlorogenic acid, Rutin, hydroxycinnamidine, pylorodizin, quercetin, and ferulic acid was detected. When the fertilizer applications are evaluated, compared to the control along with the applications, KG is 100%, KG 50%, 4 KS 50% and KS 100% in the green maturation period, OG 50% + KS 50%, OG 100% and OG 25% + KS 75% in the pink maturation period. It was determined that in the red and red maturity period, OG 50% + KS 50%, OG 75% + KS 25%, KG 100% and KG 75% + KS 25% fertilizer combinations came to the fore.

**Keywords:** Tomato, Polyphenolıc Content, Maturity Periods

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# SUSTAINABLE AGRI-FOOD SYSTEMS

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**Abstract**
Agriculture is the starting point of the food chain and a pillar of the economy. Increasing agricultural productivity by protecting the soil, natural resources, farmers, and the environment and ensuring the production of high-quality, healthy, and safe food are the main goals of sustainability in agri-food. Sustainability goals should be set with a holistic approach in collaboration with the agriculture and food sectors. Sustainable agri-food systems are systems that provide safe food and healthy nutrition produced without pesticides, chemicals, unnecessary antibiotics, or growth-promoting hormones. The global demand for food is expected to increase in line with the growing population. Nevertheless, on the one hand, industrialization is depleting natural resources such as drinking water, forests, biodiversity, etc., while on the other hand, almost one-third of the crops produced in traditional agriculture are damaged by pests, microbial spoilage, and natural disasters. To overcome these problems, more innovative agricultural technologies are needed. Food production requires the processing of raw materials from sustainable agriculture, the efficient use of water and energy, the selection of appropriate packaging, and the proper assessment of waste generated. At the same time, production must be done in a safe and healthy way without harming the environment. Implementing sustainability in agri-food systems for the production and consumption of healthy, nutritious, and safe food by protecting the ecosystem and natural resources is extremely important to protect future generations and prevent future crises.
**Keywords:** sustainable agriculture, food, agri-food, waste, nutrition, healthy, sustainability.

# GENETIC TRANSFORMATION: CRISPR'S IMPACT ON ANIMAL TRAITS IN AGRICULTURE, BIOMEDICINE, AND CONSERVATION

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**Abstract**
Clustered Regularly Interspaced Short Palindromic Repeats, or CRISPR for short, has transformed the study of animals by providing specialized tools for altering their genetic makeup. This powerful gene-editing technique has opened up new possibilities in modifying animal traits, with significant implications for agriculture, healthcare, and conservation. CRISPR technology may be able to solve enduring challenges in agriculture. Scientists are using it to create animals with desirable characteristics, including disease resistance, better-tasting meat, and higher milk production. For example, it is possible to modify dairy cows to produce more milk, which could have a significant effect on the dairy business. Pigs that have been genetically modified to withstand particular diseases require less antibiotics and are treated with less cruelty. CRISPR in animal traits has also proven to be quite useful in biomedical studies. It enables the development of animal models that have been genetically altered to investigate human diseases. For example, modifying mice to have certain genetic abnormalities linked to diseases like cancer or neurological disorders is possible, allowing the discovery of novel medications and treatments. Additionally, CRISPR is vital for protecting wildlife. Genetic modifications that improve an endangered species' capacity to adapt to shifting environmental conditions, fend off disease, or boost reproductive rates are advantageous. It provides hope for the survival of species that are in danger of going extinct.
CRISPR's use to modify animal features has enormous potential but poses moral and legal concerns. A major focus of current discussions is the well-being of animals, unforeseen effects, and ecological impacts. Getting the balance between responsible use and scientific advancement just right is crucial. In conclusion, CRISPR technology is revolutionizing the field of animal science by permitting precise genetic alterations in living organisms, providing solutions to agricultural problems, advancing biomedical research, and giving hope to endangered species. It is crucial to carefully analyze the field's ethical and ecological consequences as it develops.
**Keywords:** CRISPR technology, animal traits, genetic modification.

# A NOVEL APPROACH TO VALORIZATE SESAME OILCAKE

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## Abstract
Oilseeds are seeds used mainly as a source of vegetable oils. After the extraction process, large amounts of residues and by-products are available. Their use allows the successful implementation of the circular economy concept. Possible methods of valorisation of oilcakes cakes include their use in animal feed, compost, substrate in the production of enzymes, antibiotics and biosurfactants and in the recovery of bioactive compounds for further use in the creation of new value-added products. Moreover, due to their composition, which is rich in proteins (amino acids), fatty acids, minerals and polysaccharides, they are promising ingredients for ecological, edible biopolymers that could be used as packaging materials. Food packaging plays an important role in the food supply chain. Proper packaging can help reduce risk and guarantee food quality during storage. Most of the materials are low-cost plastics but unfortunately, they affect the environment. To address this situation, various efforts and actions have been taken by governments, companies and researchers. The numerous campaigns carried out rely on collecting and recycling these materials rather than replacing them with sustainable solutions. There is a great expectation for natural, ecological, biodegradable and edible materials. Sesame oilcake obtained after cold extraction process was analysed regarding the main physicochemical characteristics (proteins, lipids, ash, fibers, fatty acids, amino acids and minerals). The oilcakes led to an increase in film properties and their nutritional value (the addition of oilcake decreased the moisture, solubility and water vapor permeability and increased the color, thickness, water activity and time of solubility, while the light, oxygen and oil permeability properties were good). The films presented also high microbiological stability thus can be consumed together with the food products.
**Keywords:** oilcake, edible films, circular economy.

# EVALUATION OF GRAZING LIVESTOCK DESTRUCTIVE ABILITY ON HORTICULTURAL SITES IN NIGERIA: A REVIEW

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**Abstract**
Grazing livestock pose a significant challenge to horticultural sites and locations due to destructive abilities recorded. This paper examines the multifaceted impacts of livestock on horticultural areas, encompassing grazing damage, trampling, soil erosion, disease spread, weed dispersal, and nutrient management issues. Grazing livestock can diminish crop yields and harm ornamental plants, leading to economic losses. The impact of trampling of large animals on soil compact topsoil, impairing root growth and soil health. Soil erosion becomes a concern when livestock disrupt topsoil, making it susceptible to wind and water erosion. Livestock can also carry and transmit diseases, jeopardizing the growth and potential of horticultural crops. Inadvertent weed seed dispersal by livestock complicates weed control efforts. Additionally, improper livestock manure management can result in nutrient imbalances and environmental pollution. To mitigate these adverse effects, various management practices are necessary. Fencing and controlled access can prevent livestock from entering horticultural areas. Rotation grazing systems help manage grazing pressure and avoid overgrazing. Proper manure management, following guidelines, maximizes the benefits while minimizing environmental risks. Disease monitoring and preventive measures are crucial to curb disease transmission. Soil conservation practices, such as cover cropping and erosion control, protect soil health. In summary, this paper underscores the destructive potential of livestock on horticultural sites and the importance of adopting appropriate management strategies to safeguard crop yields, soil quality, and the overall health of horticultural locations. Effective management is essential for sustaining the productivity and aesthetics of these valuable sites.
**Keywords:** Livestock, horticultural locations, environmental pollution, nutrient management issues, destructive ability

# LARGE RANGE SOIL MOISTURE SENSING FOR INHOMOGENEOUS ENVIRONMENTS USING MAGNETIC INDUCTION NETWORKS

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**Abstract**
Water resource has become one of the most precious resources in recent decades. Agriculture accounts for about 80% of the total water usage in US. There is a demanding need for efficient irrigation and water management systems built for sustainable water utilization in smart agriculture. Real-time insitu soil moisture sensing is a vital part for smart agriculture. Traditional electromagnetic (EM) based soil moisture sensing relies on EM based wireless sensor or ground penetrating radar (GPR) system. Based on the receiving signal strength and delay, tomographic techniques are used to derive the dielectric parameters of the soil, which are then into soil moisture distribution using empirical model. However, the EM signal attenuate sharply during underground propagation because of high operating frequency and lossy medium. In order to counter the disadvantage for underground sensing, we propose a Magnetic Induction (MI) based large range soil moisture sensing scheme in inhomogeneous environments. Here, we present the topology of the sensing system and analyze the channel model. The sensing process is based on transformed model, the conductivity and permittivity distribution are derived using SIRT algorithm. Through COMSOL simulation and analytical results, our proposed soil moisture sensing method achieves a root mean square error (RMSE) of 0.06 $m^3/m^3$ in 40 m 2D scale inhomogeneous environment range. We suggest a Magnetic Induction (MI) based large range soil moisture detection system in inhomogeneous situations to address the drawback of underground sensing. Here, we discuss the sensing system's architecture and conduct a channel model analysis. The SIRT algorithm is used to obtain the conductivity and permittivity distribution from the modified model, which forms the basis for the sensing process. Our suggested soil moisture sensing method achieves a root mean square error (RMSE) of 0.06 m 3 / m 3 in a 40 m 2D scale inhomogeneous environment range using COMSOL simulation and analytical results.
**Keywords:** Ground penetrating radar, Magnetic Induction, electromagnetic

# PIPERAZINE BASED DITHIOCARBAMATES AS POTENT TYROSINASE INHIBITORS: SYNTHESIS, IN VITRO AND IN SILICO STUDIES

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**Abstract**
In the current study, novel piperazine based scaffolds (4a-j) have been prepared via an environmentally friendly synthesis method. The synthesized molecules were evaluated for cytotoxic and tyrosinase inhibition studies. Among all synthetic targets, compound (4d) showed great tyrosinase inhibition efficacy ($IC_{50}$ = 6.88 ± 0.11 µM) that was superior to the reference drugs ascorbic acid (11.5 ± 1.00 µM) and kojic acid (30.34 ± 0.75 µM). The results were further supported by in-silico simulation using induced-fit docking (IFD). All other compounds also showed good tyrosinase inhibition. Among all, compound (4e) was found to be a better thrombolytic agent and scaffold 4b displayed greater hemolytic potential.
**Keywords:** Tyrosinase, piperazine, cytotoxic effects, thrombolytic.

# HUMİK ASİT DOZLARININ ARPA VERİM VE KALİTE KOMPONENTLERİ ÜZERİNE ETKİSİ

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**Özet**
Gün geçtikçe azalmakta olan tarım topraklarını ve artan dünya nüfusunu yeterli ve dengeli besleyebilmek için birim alandan alınan ürün miktarının arttırılması ve tarım arazilerinin verimliliklerinin ve miktarının korunması oldukça önemlidir. Verim ve kaliteyi arttırmak için kimyasal gübre kullanımı uzun yıllardan beri kullanılan en etkili yöntemlerden biridir. Son yıllarda, kimyasal gübre kullanımının yer altı sularına ve ekolojik denge üzerindeki olumsuz etkilerinin azaltılması amacı ile kimyasal gübrelerin yanında kontrollü olarak toprak iyileştiricilerin (Humik asit, Fulvik asit) ya da organik gübrelerin kullanımı gündeme gelmiştir. Bu çalışmada humik asitin, farklı arpa çeşitlerinin verim ve kalite kompanentleri üzerindeki en etkin dozun belirlenmesi amaçlanmıştır. Deneme, Ege Üniversitesi Tarla Bitkileri uygulama ve araştırma arazisi üzerinde gerçekleştirilmiştir. Ege bölgesinde yaygın olarak yetiştirilen ticari çeşitlerden (Alhisar, Azizbey, Atabeyi) 3 farklı arpa çeşidi seçilmiş ve Ege Tarımsal Araştırma Enstütüsünden temin edilmiştir. 3 farklı arpa çeşiti ve 5 farklı humik asit dozu (0 (kontrol), 100 ml/da, 150 ml/da, 200 ml/da, 250 ml/da) 3 tekerrürlü olarak tesadüf bloklarında bölünmüş parseller deneme desenine göre ana parsellere humik asit uygulamaları ve alt parsellere arpa çeşitleri gelecek şekilde 45 parsel kurulmuştur. Arpada verimi belirleyen; başak boyu, başakta başakçık sayısı, başakta dane sayısı, başak ağırlığı, başakta dane ağırlığı gibi özellikler üzerinde etkileri incelenmiştir. Hümik asitlerin ilave bitki besleme ürünü olarak kullanılmasının bitki başak özellikleri üzerinde olumlu etkileri saptanmıştır.
**Anahtar Kelimeler:** Humik asit, Verim, Arpa

# EFFECT OF HUMIC ACID DOSES ON BARLEY YIELD AND QUALITY COMPONENTS

**Abstract**

In order to adequately and balancedly feed the decreasing agricultural lands and the increasing world population, it is very important to increase the amount of product taken per unit area and to protect the productivity and quantity of agricultural lands. The use of chemical fertilizers to increase yield and quality is one of the most effective methods used for many years. In recent years, in order to reduce the negative effects of chemical fertilizer use on groundwater and ecological balance, the controlled use of soil improvers (Humic acid, Fulvic acid) or organic fertilizers in addition to chemical fertilizers has come to the fore. This study aimed to determine the most effective dose of humic acid on the yield and quality components of different barley varieties. The experiment was carried out on the Ege University Field Crops application and research land. Three different barley varieties were selected from commercial varieties (Alhisar, Azizbey, Atabeyi) commonly grown in the Aegean region and were obtained from the Aegean Agricultural Research Institute. 3 different barley varieties and 5 different humic acid doses (0 (control), 100 ml/da, 150 ml/da, 200 ml/da, 250 ml/da) were added to the main plots according to the split plot trial design in random blocks with 3 replications 45 parcels were established, with doses applications and barley varieties in the sub-parcels. Determining the yield in barley; Its effects on characteristics such as spike height, number of spikelets per spike, number of grains per spike, spike weight, grain weight per spike were examined. The use of humic acids as additional plant nutrition products has been found to have positive effects on plant spike characteristics.

Keywords: Humic acid, Yield, Barley

# SCHOOL AND LEARNING FOR A HEALTHY ENVIRONNMENT-ACTIVITIES

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**Abstract**
At this international congress on agriculture, environment and veterinary studies, we would like to introduce you to where, how and what our school is doing to raise awareness of a healthy environment. As a school, we have our own economy for the production of pomegranates, Japanese apples (Diospyros kaki), grapes, horticultural and cereal crops, primarily teaching students to produce healthy food. In that context, they are also involved in many environmental protection project
**Keywords:** agriculture, environmenet, activities.

# THE EFFECT OF WAR ON ALCOHOL CONSUMPTION AMONG SOLDIERS AND CIVILIANS

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**Abstract**
The main topic of my research is the effect of the war on the residents' alcohol consumption. The goal of my presentation is proving that both the residents and soldiers' alcohol consumption has increased in areas affected by the war. Because of the continuous stress, destruction, sound and light effects, worrying and anxiety people try to attenuate it with alcohol. Method: The method of my research is collecting literature sources, for example scientific surveys, statistics and different types of press organs, especially about the ukraine-russian war. Results: As my hypothesis, people using the alcohol's narcotic effect to attenuate the negative impacts of the war. Among those who live in these areas more and more people are getting alcoholic. Conclusion: In view of the above it would be necessary to use specialized, psychological people both among the military and residents of war-affected areas besides medical care and environmental safety.
**Keywords:** alcohol consumption, narcotic effect, environmental safety

# NANOEMULSIONS AS FOOD INGREDIENTS

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**Abstract**
Nanoemulsions (NEs) as innovative food additives, have transformed the food industry by offering opportunities to enhance texture, encapsulate flavors, and prolong the shelf life of food products. These minuscule droplets, a hallmark of Nes, create a smoother mouthfeel and greater creaminess in foods, mitigating issues related to phase separation and ingredient compatibility. Flavor encapsulation is a standout feature of NEs. They protect and preserve volatile compounds responsible for taste and aroma, resulting in an intensified and more stable flavor profile. Controlled flavor release during consumption enhances the overall eating experience. Additionally, NEs contributes significantly to extending the shelf life of food items. By encapsulating bioactive compounds, antioxidants, and antimicrobial agents, they enhance product stability and reduce spoilage, minimizing food waste and ensuring product safety and quality. This review covers recent developments in Ne technology, including various preparation methods and suitable emulsifying agents. It also discusses regulatory considerations and safety aspects related to incorporating NEs into food applications. In summary, NEs have revolutionized food formulation and development. They offer opportunities to enhance sensory attributes, intensify flavor delivery, and extend the shelf life of various food products, holding immense promise for the future of food innovation.
**Keywords:** Nanoemulsions, Food Preservation, Bioactive compounds, Antioxidants, Antimicrobial Agents.

# EFFECT OF HEAT STRESS ON BLACKBELLY EWES IN THE MEXICAN TROPICS DURING SUMMER

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**Abstract**
The aim of the present study was to evaluate the effect of heat stress on Blackbelly ewes by time of day and climate during summer in the tropics. To this end, in 13 ewes during the last 15 days of the first third of gestation, the physiological constants [Breathing frequency (BF) and rectal temperature (RT)] and skin temperatures (eye, snout, ear, neck, scapula, flank, abdomen, udder, haunch, leg, anus and vulva). Measurements were carried out in the morning (6:00 a.m.), midday (12:00 p.m.) and afternoon (6:00 p.m.). In the study, a significant difference was found for the physiological constants (BF and RT) due to the effect of time of day (morning, noon and afternoon), effect of weather (sunny vs rainy) and in the time of day*climate interaction ($p<0.001$). Indeed, the highest BF (103.24±2.977 breaths per minute (bpm)) and RT (39.25±0.223°C) occurred at midday in sunny weather ($p<0.001$). On the other hand, the lowest BF (51.6±6.656 bpm, 56±3.78 bpm and 52.2±6.656 bpm) and RT (37.87±0.223°C, 38.803±0.223°C and 39.08±0.091°C) occurred in the three hours of day (morning, noon and afternoon) on rainy days ($p<0.001$). For its part, skin temperatures (eye, ear, neck, scapula, flank, abdomen, rump and leg) were higher in the afternoon ($p<0.001$). The anatomical region of the snout (35.65±0.552°C), anus (36.368±0.312°C) and vulva (36.752±0.2°C) were greater at midday with sunny weather ($p<0.001$). Finally, it was observed that skin temperatures decreased in the three hours of the day during rainy days ($p<0.001$). It is concluded that in heat-stressed ewes, physiological constants and skin temperatures decrease during rainy summer days.
**Keywords:** ewes, female lambs, thermoregulation, environmental temperature, physiological constants, skin temperatures.

# VALORIZATION OF WASTE AGRICULTURAL BIOMASS THROUGH GASIFICATION AND GAS FERMENTATION TO VALUE-ADDED PRODUCTS BY GAS FERMENTATION

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**Abstract**
In agricultural production, waste biomass is produced. The residue-to-crop ratio can be as low as 0.1 (beetroots, sugarcane), around unity (rice, wheat) or above 3 (rapeseed, cotton), to give a few examples. These side streams have to be managed, and inappropriate dumping can lead to $CH_4$ emissions detrimental to the climate. Anaerobic digestion to obtain biogas is one means of valorizing such residual biomass. It is particularly suited for wet waste biomass. That biogas can be converted into electricity and heat, or be purified and fed into the natural gas grid. Another route, for dry (waste) biomass, is gasification, which yields synthesis gas suitable for combustion in a gas engine, likewise giving benefits or revenue via electricity and heat. Compared to biomass combustion, biomass gasification can yield a higher electrical efficiency. A novel route of valorizing biogas and synthesis gas from waste biomass is gas fermentation. This process uses gaseous feedstocks to produce value-added materials. $CH_4$ can be fermented aerobically by methanotrophic bacteria, to yield bioplastics materials (polyhydroxyalkanoates, PHA) and bacterial single cell protein (SCP), and synthesis gas (CO, $H_2$, $CO_2$) can be converted by anaerobic bacteria (acetogens), to yield e.g. acetic acid. Residual biomass after PHA extraction can also be used as SCP for feed application. An additional byproduct from gasification can be biochar. Compared to classic fermentation processes that utilize sugar as raw material, complex (enzymatic) pretreatment of the

(lignocellulosic) feedstocks is avoided by using the carbon in gaseous form. SCP is an promising alternative protein source, which can be fed to chicken and fish, e.g. in aquaculture systems, to replace non-sustainable fishmeal. By combining aerobic and anaerobic gas fermentation, all carbon in the feedstock can be converted into products. A further optimization of agricultural residue utilization is to extract compounds of interest firstly and then subject the remaining material to anaerobic digestion or gasification.

**Keywords**: gas fermentation, biomass gasification, waste biomass valorization, bacterial single cell protein (SCP), polyhydroxyalkanoates (PHA)

# OPTIMIZATION STUDY OF PHARMACEUTICALS POLLUTANTS ADSORPTION ONTO LARGE SURFACE AREA WALNUT SHELLS ACTIVATED CARBON: EXPERIMENTAL DESIGN, MECHANISM AND DFT CALCULATIONS

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**Abstract**
the ketoprofen (KTP), diclofenac (DCF), and sulfamethoxazole (SMX) removal is discussed. The adsorption process used a bio-sourced activated carbon (AC) with high surface area (2256 $m^2/g$) prepared from walnut shells (Ws) from Morocco. The AZURAD® software is used to elaborate an experimental design methodology to study the effect of pH, the dose of AC-Ws, and temperature (T), on the PPs elimination efficiency. with pH=4, AC-Ws dose of 0.28g/L, and a Temperature of 22 °C, the removal efficiency was 99.95%, 99.16%, and 99% for DCF, SMX, and KTP, respectively. Also, the thermodynamic analysis revealed that the adsorption was spontaneous and exothermic for KTP and SMX, while for DCF, it was

random and endothermic. Additionally, the Freundlich model effectively describes the adsorption behavior of SMX and DCF, whereas the Langmuir model is better suited for characterizing the adsorption of KTP. The organic functions present on the surface of the adsorbent is determined using the Boehm method and the adsorption mechanism over AC-Ws surface sites was further evaluated using the density functional theory (DFT) method.
**Keywords*:*** Walnut shells, Activated carbon, Optimization, Adsorption, DFT.

# BIOLOGICAL METHODS FOR POST-HARVEST CONTROL OF R. STOLONIFER ROT IN PEACHES AND NECTARINES

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**Abstract**
"Combatting stolon rot (*R. stolonifer*) in peaches and nectarines after harvest is crucial for preserving fruit quality. This study examines various biological methods aimed at minimizing post-harvest losses. We explore the use of biopesticides based on antagonistic microorganisms, such as Trichoderma spp. and Bacillus spp., which have demonstrated their effectiveness in reducing the growth of R. stolonifer on stored fruits. Additionally, enhancing storage microbiology by introducing beneficial microorganisms has been studied to enhance the resistance of peaches and nectarines to stolon rot. Furthermore, approaches involving natural predators to control disease vectors after harvest have been examined. Lastly, sustainable agronomic practices, such as crop rotation and integrated pest management in warehouses, have been evaluated to reduce disease pressure. This research highlights the increasing importance of biological methods in preserving the quality of peaches and nectarines after harvest, providing environmentally friendly solutions for the fruit preservation industry."
**Keywords**: R. Stolonifer, Peaches, Nectarines, Biological Control, Post-Harvest

# ASSESSMENT OF WATER QUALITY IN THE NFIFIKH RIVER AND OUED EL MALEH DAM USING THE GENERIC DIATOM INDEX

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**Abstract**
Water quality and availability are increasingly alarming due to climate change and anthropogenic activities. Biomarkers, such as invertebrates and micro-algae, including diatoms, are used to assess the ecological quality of aquatic environments. In this preliminary study, we used the generic diatom index (IDG) to assess the water quality of two sites in the Greater Casablanca region, Morocco. The two sites, the Nfifikh River in Mohammedia and the Oued El Maleh Dam in Jemaa Fedalate, are located in potentially opposite zones in terms of water quality. Diatoms were isolated from sediment samples by successive sedimentation and then chemically cleaned using 30% hydrogen peroxide (H2O2 ) to digest organic contaminants, and sulfuric acid (H2SO4 ) and hydrochloric acid (HCl) to dissolve carbonates and phosphates and reveal the ornamentation of the frustules. The ornamentation is used to determine the genus of the diatoms using identification keys. The frequency and distribution of the genera found were then used to determine the IDG. The results showed that the Oued El Maleh dam had a high diversity of diatoms, including bioindicators of good ecological quality, such as Cymatopleura, Cymbella, and Stauroneis. The IDG value of 15.4 for the Oued El Maleh dam indicates moderate eutrophication. In contrast, the Nfifikh River had a low diversity of diatoms and the presence of pollution indicators, such as Nitzschia and Bacilarias. The IDG value of 2.6 for the Nfifikh River indicates very poor ecological status with severe eutrophication. This study will be complemented by physicochemical parameters, the biological diatom index (BDI), and the pollution sensitivity index (PSI), and then extended to other sites in the Greater Casablanca region.
**Keywords:** diatoms, water quality, IDG, bioindicators, Greater Casablanca

# CLASSIFICATION OF SECOND ORDER ORDINARY DIFFERENTIAL EQUATIONS USING LAMBDA SYMMETRIES

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**Abstract**
This research investigates the application of differential equations (DEs) in modeling dynamic phenomena across scientific domains. Nonlinear DEs, common in natural processes, pose significant challenges, but Lie symmetries offer effective solutions by transcending order, linearity, and homogeneity constraints. Identifying symmetries simplifies both partial and ordinary DEs, streamlining problem-solving. The study also delves into λ-symmetries, which extend Lie symmetries and provide new avenues for tackling nonlinear ODEs and PDEs. It conducts a comparative analysis of Lie and λ-symmetries, focusing on categorizing second-order linear and nonlinear ODEs through symmetry identification. By solving equations using both approaches, the research enhances our understanding of the interplay between Lie and λ-symmetries in solving complex differential equations.
**Keywords:** Lie symmetries; Lambda Symmetries; Nonlinear Dynamics; Classification.

# EFFECT OF EARLY ACCLIMATIZATION AND GINSENG (*PANAX GINSENG)* EXTRACT ON SOME PHYSIOLOGICAL TRAITS OF BROILER CHICKENS UNDER HEAT STRESS

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**Abstract**
The current experiment was conducted to study the effect of early acclimatization and the addition of *Panax ginseng* extract to the drinking water on some physiological traits of heat stressed broiler chickens. A total of 540, one day old un sexed Ross 308 ,broiler chicks were randomly allocated in to 12 sub treatment groups in 4 ×3 factorial experiment to evaluate the interaction between four types of early acclimatization by exposing the five day old chick to 38-40c$^{o}$ for 0,2,4 and 6hours (assigned P0,P2,P4 and P6 resp.) and three type of ginseng extract supplemented to the drinking water and mineral G0 (control),ginseng extract alone (G1) and ginseng extract with vitamins and mineral mixture (G2) .The statistical Analysis for the experiment data showed that. Early acclimatization were significantly ($p<0.05$) affected on the RBC count but had no effect on WBC count , hemoglobin , PCV ,total protein ,Cl , Na, K, and the concentration of AST,ALT and ALP in blood serum also addition of *Panax ginseng* extract to the drinking water had no effect on physiological traits mentioned above. We concluded that early acclimatization periods and ginseng extract addition alone and with minerals and vitamins did not give a significant effect so we suggest to increased acclimatization periods and ginseng extract addition in another experiments.
**Keyworld**s: early acclimatization; ginseng (*Panax ginseng)* extract ; broiler chickens under heat stress.

# ESTABLISHING A NATIONAL FEED COMPOSITION DATABASE FOR RUMINANT ANIMALS IN TÜRKIYE

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**Abstract**
Ruminant animals consume a large amount of roughage, which is more susceptible to environmental conditions. Despite the success of feeds and animal nutrition in Türkiye, a fundamental connection with the animal sector has not been established due to the fact that research information is hidden in theses and books. It is imperative to collect data on the actual ingredients in feed raw materials in order to be able to meet the demands of animals. Despite the success of feeds and animal nutrition in Türkiye, a fundamental connection with the animal sector has not been established due to the fact that research information is hidden in theses and books. To achieve this, the project involved collecting the chemical composition of feeds available in Türkiye. The project will collect the chemical compositions of all feeds whose compositions have been specified so far and create a database.
**Keywords:** national feed composition; ruminant animals and database

# EVALUATION OF ANTIDIABETIC ACTIVITY OF XANTHIUM STRUMARIUM LEAVES IN WISTAR RATS

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**Abstract**
One of the common chronic diseases named Diabetes Mellitus spreads in all over the world and significantly changes the life of a normal man. Currently, it becomes a main cause of death due to a remarkable increase in a number of heart diseases. Nowadays, instead of traditional way of treatment like insulin and other therapies, some herbal medicines also get significance. *Xanthium strumarium* is a plant which plays vital role in reducing diabetes. One of the main qualities of this plant is that it has low toxicity and minor side effects. *Xanthium strumarium* possess anti hyperglycemic and antidiabetic properties. The study aimed to provide the activity of Xanthium *strumarium* leaves for antidiabetic medicinal purpose. To investigate this activity, fraction of leaves along with extract of methanol were taken and identify the effect of this herbal medicine on the rats having diabetes and without having diabetes in wistar rats. The experiment was conducted for 15 days on wistar rats. After day 15 of study, blood and organ samples of pancreas, liver and kidney were collected for hematological (CBC) and biochemical analysis such as serum insulin, liver function tests, renal function tests and profiles of proteins and lipids. Data was statistically analyzed by applying one-way and two-way analysis of variance (ANOVA) followed by post-hoc Tukey's multiple comparison test using GraphPad Prism® statistical software.
**Keywords:** Diabetes mellitus, antidiabetic, *Xanthium strumarium*, hematological, biochemical

# EFFECTS OF DIFFERENT SEED TREATMENTS ON GERMINATION RATE AND GERMINATION PERCENTAGE OF *Nitraria schoberi*

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**Abstract**
Arid and semi-arid regions are expanded in the center regions of Iran. Close to ninety percent of the country is semi-arid, arid and hyper-arid. The shortage of fresh water resources and land salinization are the most limiting factors for conventional crop production. The rise of increasing population has also caused a great demands of food, but due to existence a shortage in our suitable resources for proper crop production, well organized programs for reassessing our resources and utilizing degraded resources are necessary to combating desertification and then to overcome on human needs at the shortage of food production in dry land areas. Land salinization is a major limiting factor for crop production. But, there are many poorly considered economic salt tolerant plants in these areas. One of these plants is *Nitraria schoberi* grown on severe dry and saline conditions. This medicinal plant can be used either for rehabilitation of degraded lands or for control of soil erosion. It contains many rare and new alkaloids specially Triptamine. Recently, a great number of *Nitraria* seeds has been cultivated on different desert regions of the country but unfortunately, its cultivation has not been well succeeded due to having low seed vigor and also lack of applying some suitable treatments on seeds. To evaluate the effect of different treatments on seed germination, an experiment was conducted In National Salinity Research Center, Yazd, Iran. The experimental design was complete randomize block with three replications. Treatments were socking seeds in concentrated sulfuric acid 90% for five minutes, cold treatment (placing seeds for 20 days at 4 $^{o}$C) and placing in wet and dry conditions (one, three and five times for 24 h, periodically). Seeds were cultured in dishes filled with cleaned sand and transferred to a germinator (25 $^{o}$C, 90% RH and dark conditions). Results showed that applying wet and dry conditions periodically, had a significant effect on seed germination. The highest percent of germination was obtained from five times placing in altering wet and dry conditions (84.2% compared to control).In contrast, acid treatment resulted in the lowest seed germination (45.8%). Moreover, in comparing to other treatments, the rate of germination and also the uniformity of the seedlings were too high for the noted treatment. This is very important for establishing Nitraria schoberi on saline lands.
**Keywords:** Germination, Seed, Priming, Emergence, seed vigor

# FEASIBILITY OF FIVE FORAGE HALOPHYTE PRODUCTION IN IRAN

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**Abstract**
The current three years study was aimed to elucidate the performance of five forage halophytes including *Atriplex canescens*, *A. halimus*, *A. lentiformis*, *A. nummularia* and *Kochia indica* under saline conditions in National Salinity Research Center. The treatments were arranged in a complete randomized block design with three replicationsin the form of split plot experiment with two factors; year (as a main factor) and halophyte species (as a sub main one). Plants were irrigated with irrigation water with electrical conductivity of 14 ds/m using bubler irrigation system. The results showed that salinity and aging reduced forage production of all halophyte species (except that of *Kochia indica*). While the highest forage production achieved from *Atriplex canescens* and *Kochia indica* (23.68 and 40.22 ton $ha^{-1}$, respectively) the lowest foraged obtained from *A. lentiformis*, *A. nummularia*. (7.7 and 8.97 ton $ha^{-1}$, respectively). Regarding forage quality, *A.lentiformis and A.nummularia* had 14.02 and 13.2 percent protein content while that of *A.halimus and A.canescens* were 9.66 and 10.47 percnet respectively. In conclusion, *A.canescens* and *Kochia indica* production as forage is recommended for haloculture in saline conditions.
**Keywords:** Haloculture, Saline water, Kochia and Atriplex

# ESTIMATION OF BIOGAS EMISSION PRODUCED BY SOLID WASTE FROM BLIDA DUMPSITE USING IPCC EMPIRICAL MODEL

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**Abstract**
One of the major factors contributing to greenhouse gas emissions in the environment is the generation of hazardous gases in municipal landfills. Due to the potential negative impacts of these emissions, it is mandatory to estimate the quantity and type of landfill gases to design and implement an appropriate gas collection system. Landfill gas emissions are influenced by various factors such as the type of waste, its biodegradability, methane emission potential, degree of separation, and other miscellaneous factors. In our study, we used the IPCC model to predict the quantity of gases produced in the landfills of Blida. According to the results, a significant amount of CH4 (methane) has been released from 2010 to 2023, contributing to global warming. This energy loss can potentially be converted into a source of energy, allowing for the possibility of a self-sustaining landfill that produces electricity.
**Keywords:** solid waste, energy potential, biogas, IPCC.

# MEASURES TO CONTROL PARASITIC INFECTIONS OF SMALL RUMINANTS KEPT ON PASTURES

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## Abstract
Parasitic infections are a constant presence in livestock production, which is especially pronounced in the semi-free and free way of keeping animals. The control and prevention of parasitic infections on pastures breeding must be approached from two aspects - eradication of pastures and health control of animals that live on them. In the first case, the infection is cut during the grazing season and the pastures are freed from contaminants for shorter or longer periods. Interventions on pastures can be a good prerequisite for controlling and preventing parasitic diseases. Drainage of pastures is extremely effective in suppressing certain parasitosis, the development of which requires a sufficient amount of moisture (flukes, gastrointestinal and pulmonary strongyloidosis). The population pressure on the pasture (number of animals per unit area) and the method of grazing - whether it is forced or stationary also affect the load on the pasture and the degree of its infection. That is why one of the solutions that is successfully used in the form of grazing - it can be persecution, mixed, and also the limitation of the number of individuals on the pasture can be applied. The cultivation of pastures directly depends on the geological and pedological composition of the soil, hydrological conditions and microclimatic conditions. The main goal is to obtain a pasture that contains a minimum of infectious agents in the soil, which is maximally free from vectors and infectious forms of parasites that can be found on the grass. Health care has two basic goals of preventing pasture contamination and then treating and controlling parasitic infections in herds. Both components are indispensable in the proper control and suppression of parasitic infections, especially in the semi-free keeping of animals on pastures.
**Keywords:** pasture, parasites, small animals, control

# CANNABIS CULTIVATION AND ITS ENVIRONMENTAL IMPACT

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## Abstract
Cannabis sativa stands as a remarkably versatile plant boasting a multifaceted history serving medicinal, industrial, and recreational purposes. The recent wave of legalization and decriminalization of cannabis has spurred an upswing in cultivation practices. Concurrently, scientific research has intensified, focusing on optimal growing conditions, cultivation techniques, and the pivotal role of genetic variation in cannabis plants. This research aims not only to harness the plant's benefits but also to navigate potential challenges and adverse environmental impacts associated with its cultivation. A thorough exploration of the plant's lifecycle, emphasizing key growth stages, nutrient requirements, and pest management strategies, empowers cannabis producers to adopt a proactive approach. By meticulously understanding these intricacies, producers can address the environmental implications linked to cannabis cultivation. Key areas of focus include water usage, soil health, and biodiversity preservation. Water, a valuable resource, is prudently managed through the implementation of water-efficient irrigation systems, ensuring its conversation. Concurrently, soil health is nurtured and preserved, emphasizing the significance of sustainable farming practices. Concerning biodiversity preservation, cannabis cultivation cannabis pivots towards adopting eco-conscious methodologies. Organic farming principles are embraced, replacing harmful chemicals with natural alternatives, thereby fostering a healthier ecosystem. Additionally, eco-friendly pest control methods are deployed, reducing the reliance on synthetic pesticides that can disrupt the delicate balance of local fauna and flora. These practices collectively aim to mitigate the environmental footprint of cannabis cultivation, promoting a harmonious coexistence between agricultural activities and the natural environment. In essence, the contemporary cultivation of Cannabis sativa is not merely a scientific pursuit; it embodies a conscientious endeavor to balance human needs with environmental stewardship. Through the amalgamation of rigorous research, sustainable practices, and a profound environmental respect, cannabis cultivation emerges as a model of responsible agriculture, paving the way for a greener and more sustainable future.
**Keywords:** Cannabis sativa, cultivation practices, environmental impact, sustainable agriculture, biodiversity preservation,

# CHARACTERIZATION OF THE ESSENTIAL OIL OF CANNABIS SATIVA FROM THE AL-HOCEIMA REGION IN NORTHEN MOROCCO

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**Abstract**
Hemp is an important industrial plant known botanically as Cannabis sativa L. The essential oil (EO) of Cannabis sativa L. is a valuable product especially in terms of commercial values and potential applications in medicine, cosmetics ... However, little is known about the chemical composition of Cannabis sativa essential oil grown in Morocco. In this research work, we were interested in studying the chemical composition of the volatile fraction of cannabis sativa essential oil known by the vernacular name 'Beldiya' in the AL-HOCEIMA region. The essential oil of cannabis sativa was isolated by hydrodistilled inflorescences using a Clevenger-type, and subjected to chemical analysis using Gas Chromatography - Mass Spectrometry (GC-MS). The results showed that EO of cannabis sativa was characterized by the predominance of caryophyllene, α-humulene and β-myrcene... These results suggest that C. sativa EO can be considered a potential source of natural antioxidants and antimicrobials, to overcome the intensive use of antibiotics against certain infectious diseases.
**Keywords :** Cannabis sativa, Essential oil, Hydrodistillation, Mass Spectrometry.

# EFFECTS OF HORMOPRIMING WITH CYTOKININS ON THE GERMINATION OF HELIANTHUS ANNUUS CV. FAVORIT

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**Abstract**
Although Helianthus annuus L. was introduced and utilized as agriculture crop in Bulgaria about a century ago, it rapidly was accepted by the local farmers. And soon it became the major oil producing agriculture species countrywide and gradually Bulgaria became world top producer. Consequently research started and breeding programs were developed for this crop so that the useful traits to be improved and adapted to the local conditions. As result of these decades long efforts were developed and patented many sunflower cultivars. One of them is the cultivar Favorit, which became the main cultivar used for producing seeds for direct consumption in the country. It produces large seeds with good balanced nutritional value, which consequently made it popular beyond the borders of Bulgaria. Because of this high interest by the farmers it is grown in diverse local conditions and scenarios, some of them not the most optimal for the plant. It is known from other crops that pre-sowing treatments with some plant growth regulators can have beneficiary effects on the plant development under normal and stress conditions. Therefore in this study was placed as goal to investigate the effects of some cytokinin type plant growth regulators, on the early ontogenetic stages and on some important for the farmers parameters, since the stages of the early plant development are among the most important ones for the long term survival, growth and yield for the crop. The results revealed that there is improvement of the germination rate compared with the non-treated controls with all tested plant growth regulators. But, the results from the other parameters can have different trends depending on the application scenario of the used plant growth regulators.
**Keywords**: cytokinin, hormopriming, phytohormone, *Helianthus annuus,* cv. Favorit

# EVALUATION OF ANTIOXIDANT, ANTIBACTERIAL AND ANTI-FUNGAL ACTIVITIES OF SALVIA MACROSIPHON EXTRACTS

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**Abstract**
Plant based medicines continue to gain fame on global scale. Besides, there is basic need for discovering new natural products that could be used as antioxidant and antimicrobial agents. In this respect, the purpose of current study was to explore the phenolics, flavonoids, antioxidant, antifungal and antibacterial potential of medicinal plant (*salvia macrosiphon*) grow in south west of (Baluchistan) Pakistan. Extracts are prepared in methanol, butanol and water by using ultrasonic assisted extraction technique (UAET). The standard methods were applied to assess the phenolis and flavonoids determined by Folin-Ciocalteu reagent and aluminum colorimetric method respectively. The antioxidant potential was measured by reducing power method and DPPH free radical techniques and compared with control value of ascorbic acid and BHT respectively. In addition to measure the antifungal and antibacterial potential of all active extracts by well diffusion method. The highest value of TPC (203.80±1.96 mg gallic acid equivalent /g of DW of extract) and TFC (144.03±0.95 mg catechin equivalent/ g of DW of extract) was obtained in butanol and methanol extract respectively. Higher antioxidant potential was observed in butanol extract 80.00±1.00 % and methanol extract 0.63±0.008 using DPPH free radical and reducing power assay respectively. The butanol extract was very sensitive against bacterial and fungal stains such as *P. aeruginosa*, *S. aureus* and F. *brachygibbosum* respectively. our results indicate that the butanol extract of *salvia macrosiphon* stems was more likely to responsible and effective for antioxidant, antibacterial and antifungal activities.
**Keywords:** Antibacterial, antioxidant, antifungal, *Salvia macrosiphon,* Ultrasonic assisted extraction technique

# EFFECTS OF HORMOPRIMING WITH CYTOKININS ON THE GERMINATION OF *LACTUCA SATIVA* CV. GENTILINA

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**Abstract**
Lactuca sativa is common leaf vegetable for year round production domesticated at least since the Antiquity in the Mediterranean region. Bulgaria being at the northern border of this region has more temperate climate and the crop ca be grown only in the warmer seasons outside the greenhouses and commonly grown cultivars are Batavia and Lolo. In the recent years the cultivar Gentilina started to gain popularity among the local growers and farmers, and the consumers as well, due to its showy and tender leaves and good yield. Because of this increased interest by the growers and farmers it is grown in variety local conditions and scenarios, some of them not the best for the plant. It is known from the literature that in other crops that hormopriming with some plant growth regulators can have beneficiary effects on the plant growth and yield under normal and stress conditions. Therefore in this study was placed the task to explore the effects of some plant growth regulators of cytokinin type, on the early ontogenetic stages and on some important parameters for the farmers, since the stages of the early plant development are among the most important ones for the long term survival, growth and yield for the crop. The results revealed that generally there is at the germination compared with the non-treated controls with all tested plant growth regulators. But, the results from the other parameters may have different tendencies depending on the application scenario of the used plant growth regulators.
**Keywords**: cytokinin, hormopriming, phytohormone, *Lactuca sativa*, cv. Gentilina

# PHYSICOCHEMICAL, MORPHOLOGICAL AND POMOLOGICAL CHARACTERISTICS OF A GRAPE (*Vitis Vinifera L.*) GERMPLASM COLLECTION

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**Abstract**
Grapevine (*Vitis vinifera*), with estimated of 5000 to 15,000 cultivars, is one of the most important perennial crops with long history of cultivation in the world (Lopes et al., 1999). Grape, represented by numerous table and raisin cultivars used in the production of juices, canned food, medicines, and various fermentation products, as well as grown for ornamental purposes, holds a special place in the world market. In the current study, physicochemical, morphological and pomological characterizations of 10 grape cultivars were investigated. In order to study genetic diversity, 10 cultivars of *Vitis vinifera* were evaluated for 22 characters. Vines were planted in a density of 2m × 4m (vine × row). The experiment was conducted in a randomized complete block design with four-vine replications. Characteristics related to the bunch (weight, width, length, length of pedicel and compacity), berry (number, width, length, weight, shape, pigmentation and color), seed (weight, number / berry), composition (soluble solids, titratable acidity, pH) were evaluated. The results showed that 68,6% of observed variability in characteristics related to the bunch, berry and composition is explained by cultivar. Significant differences were observed among the studied cultivars for the measured characters. Bunch weight ranged from 152,5–644,3 g, while berry weight ranged from 3,58 to 9,77 g. In addition, four types of berry skin color were observed and white (6 cultivars) and black (2 cultivars) colors were predominant.
**Keywords:** *Vitis vinifera*, cultivar, pomology, physicochemical, genetic diversity.

# EXOGENOUS UTILIZATION OF NANO-BIOMASS OF CARTHAMUS OXYACANTHA TO IMPROVE YIELD AND DROUGHT TOLERANCE OF WHEAT UNDER RAINFED CONDITIONS

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**Abstract**
Carthamus oxyacantha is the noxious weed of Pothwar Region of Pakistan. This weed has excellent growing and surviving characteristics even under extreme stress conditions that may be due to its higher level of phenolic compounds. Similarly, utilization of nanotechnology is a novel and innovative field. So, it was hypothesized that the exogenous application of nano-biomass of aforesaid weed as catalytic agent may improve the drought tolerance of wheat. The Fourier Transform Infrared Spectroscopy spectrum of Carthamus oxyacantha nano-biomass showed the presence of seven functional groups (alcohols, phenols, alkanes, 1-amines, aromatics, aromatic amines and alkyl halides). Results showed that there were 55.55 and 68.75% increase in the crop growth rate of wheat in 2020 and 2021 by three applications of nano-biomass compared to control. Similarly, 61.27 and 53.97% increase in the grain yield of wheat was recorded with nano-biomass application compared to control in 2020 and 2021 respectively. The minimum proline contents were 1.00 and 1.03 (µ mole $g^{-1}$) in 2020 and 2021 respectively accumulated in the treatment where nano-biomass was applied by three times whereas, the Proline content of control treatment was higher (2.50 and 2.60 µ mole $g^{-1}$ in 2020 and 2021) compared to all other treated plots of nano-biomass which confirmed the presence of drought stress in control treatment but mitigation in treated plots. So, results of this study clearly exhibited that the application of this technology would be useful to mitigate drought stress under rainfed conditions.
**Keywords**: Nano-biomass; *Carthamus oxyacantha*; Growth; Yield; Wheat; Drought tolerance

# USE OF PLANT-BASED SUPERABSORBENT POLYMERS FOR ENHANCING AGRICULTURAL PRODUCTIVITY IN MARGINAL AND STRESS-PRONE AREAS: OVERVIEW AND PROSPECTS

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**Abstract**
Agriculture is considered as the backbone of Pakistan's economy and millions of people in the country directly rely on this sector for their food and livelihoods. Nevertheless, the rapidly increasing population, shrinkage of land and water resources, climate change, and stagnant agricultural growth are threatening the food security and livelihood of the rural population. In Pakistan, approximately 6 mha area is affected by soil salinity, while 5 mha area is covered by Cholistan and Thal. The crop yields in these areas are quite low, and a big yield gap exists between the potential yields and actual yields attained at the farm level. However, these areas may contribute a significant share towards national agricultural production and the economy of Pakistan, by adopting appropriate and cost-effective technologies that support soil water conservation, reduce direct evaporation losses, enhance stress tolerance, and improve soil water balance. Biodegradable and superabsorbent polymers (BSPs) can be used as an efficient, sustainable, and environment-friendly approach to ensure the profitable cultivation of crops in marginal and stress-prone areas. Application of BSPs may increase the water and nutrient holding capacity, reduce irrigation requirement, ensure uniform water consumption, facilitate rapid root growth, minimize nutrient losses, and enhance soil physical properties. Nevertheless, most of the superabsorbent polymers particularly from synthetic sources are too costly and are difficult to apply on a field-scale by resource-poor farmers. Moreover, synthetic polymers are not easily degraded in soil and may cause environmental pollution. It is, therefore, inevitable to focus on the production of BSPs with plants/microbes, and their hybrids which are environmentally and economically acceptable for the farming community. Dr. Saddam Hussain is the pioneer scientist working on the synthesis of novel plant-based BSPs from agricultural waste. He has successfully tested the efficacy of these polymers under different abiotic stresses including salinity and drought. Here, he will comprehensively discuss the potential use of BSPs for enhancing crop productivity and resource use efficiency in marginal and stress-prone areas. He will highlight the current state of knowledge, new progress made along with future research trends, and major challenges hindering the wide-scale application of BSPs in Pakistan.
**Keywords:** Abiotic Stresses; Biodegradable and superabsorbent polymers; Crop Productivity; Sustainability

# INVESTIGATING THE PRODUCTION OF FORAGE AND SEED OF BLUE PANIC GRASS (PANICUM ANTIDOTALE RETZ.) IN THE FIRST YEAR OF PLANT ESTABLISHMENT

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**Abstract**
Blue Panic Grass (*Panicum antidotale* Retz.) is a perennial plant from the poaceae family. This plant has a high ability to grow under environmental stress conditions such as salinity and drought stress and also can produce acceptable fresh and dry forage yield in different years. This research was conducted with the aim of investigating the production of forage and seed of this plant in the absence of environmental stress in Yazd province (Iran) in 2022. At first, Blue Panic Grass transplant was prepared. Blue Panic Grass transplants were planted on April 12 at a distance of 30 cm on the planting rows (6 plant/$m^2$). The plots were irrigated once every ten days with a salinity of 3.5 dS/m. During the first year of establishment, three forage and seed harvests were peformed on July 5, August 25, and October 29. The results showed that the plant height in the first, second and third harvest was 105.2, 172.2 and 178 cm, respectively. Also, the results showed that the fersh forage yield for the first, second and third harvest was 16.33, 36.70 and 35.96 t/ha respectively, and the dry forage yield was 5.14, 12.22 and 9.24 t/ha respectively. and the seed yield was 17, 88 and 760 kg/ha, respectively. In general, the results showed that in the first year of establishment, Blue Panic Grass is able to produce 89 t/ha of fresh forage, 26.6 t/ha of dry forage and 865 kg/ha of seeds.
**Keywords:** Seed, Fresh forage, Dry forge, Blue Panic Grass.

# NEEM (*AZADIRACHTA INDICA*) EXTRACT AND NANO- EMULSION LOADED ANTI-PEST TABLETS TO TACKLE WHEAT PEST

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## Abstract
User and eco-friendly approaches to manage storage pests red flour beetle (*Tribolium castaneum*) are urgently needed in order to minimize the undesirable impact of synthetic pesticides on nature and mankind. Plant-derived pesticides are considered as user and environmental friendly. *Azadirachta indica* aqueous extract and nanoemulsion was tested under laboratory conditions for their effectiveness in destroying red flour beetles. Because of its diverse nature, Neem is known around the world as the wonder tree. Red flour beetles are among the most destructive pests of grain storage. Based on GC-MS analysis of Neem extract, the presence of biological compounds is evident. Neem extract has the most active compound, Azadiractin, which is suspected to have insecticidal properties. There were five levels of concentration of Neem extract: 10%, 20%, 30%, 40% and 50%V/V and five levels of nanoemulsions in liquid form: 0.005%, 0.01%, 0.15%, 0.20% and 0.25%V/V. The results demonstrated that the death rate and insensible behavior of beetles was increased when the concentration of extract and nanoemulsion increased. In this study, also attempts have been made to develop neem (*Azadirachta indica*) extract and nano-emulsion loaded anti-pest tablets to tackle wheat pest. The tablet dispersion exhibited 80% mortality against red flour beetle (*Tribolium castaneum*) after 15days of exposure. Therefore, the results suggested that bio-pesticides are more effective in removing *T. castaneum* infestations in preserved items.
**Keywords:** Neem, Nanoemulsion, Azadiractin, Anti-pest tablets, Bio-pesticides

# HARNESSING AFRICAN BOTANICAL DIVERSITY: EXPLORING NATURAL COMPOUNDS AS VEGFR-2 INHIBITORS FOR ANTI-ANGIOGENIC CANCER THERAPEUTICS

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**Abstract**
Angiogenesis, the development of new and abnormal blood vessels from existing ones, is a defining feature of cancer. This process initiates when VEGF binds to its receptor, VEGFR. These new vessels provide the nutrients essential for cancer cell growth. In this context, VEGFR2 plays a crucial role in the formation of new vessels. Therefore, targeting VEGFR2 can effectively combat angiogenesis in cancer therapies. Our research aimed to discover new VEGFR-2 inhibitors by performing a virtual screening of 13,313 natural compounds from African plants, using various computational techniques. Through molecular docking techniques and ADMET property evaluations, we identified four compounds with binding affinities ranging from -11.0 kcal/mol to -11.5 kcal/mol when interacting with VEGFR-2. These four compounds were further investigated through 100 ns simulations to evaluate their stability and their binding energy using the MM-PBSA method. In a comparative analysis with Regorafenib, an FDA-approved anti-angiogenesis drug, we found Abyquinone B, Naringenin 7-p-coumaroylglucoside, and chrysoeriol 7-p-coumaroylglucoside compounds had similar ability to effectively target VEGFR-2, while Lettowifuraquinone was an exception. Therefore, we recommend these three molecules for anti-angiogenesis therapy, as they are likely to deactivate VEGFR-2 and thus inhibit angiogenesis. However, it is important to note that the safety and suitability of these agents for clinical use require further investigation, as our computer-assisted study did not include in vitro or in vivo trials.
**Keywords:** VEGF receptor, virtual screening, molecular simulations, ADMET analysis, MMPBSA

# NUTRITIONAL CHARACTERISTICS OF THE BLACK SEA REGION AND MODERN CHALLENGES

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**Abstract**
Introduction: Food behavior and food traditions are one of the important characteristics of the Black Sea region. Each country has traditional food products, the way of cooking, and also that the cuisine of each country is related to the centuries-old history of these countries, climatic and ecological environment, and the activities of the population. Aim of research: The aim of the research was to assess the nutritional characteristics of the countries of the Black Sea region and to outline modern challenges. Research Methods: Observational Study, retrospective study. Results: A combination of traditional Georgian dishes and drinks that have been formed over the centuries. There is a wide and rich diversity of regional cuisines. There is an excess of meat, wine, puree and animal fats in eastern Georgia, while the cuisine of western Georgia is distinguished by the dishes of sauces mixed with walnuts and pepper, meat and dairy products. Georgia is the homeland of wine, vines grow here almost everywhere, they put Georgian wine in pitchers. The main products of Turkish cuisine are: meat (mostly lamb). Turkey is surrounded by four seas, so fish and seafood are abundant in the country. Bulgarian cuisine is influenced by Mediterranean cuisine in Southeastern Europe. Romania a diverse mix of different dishes from several traditions that he was associated with. It is mainly influenced by Turkish and European cuisine, Austrian cuisine, German cuisine, Greek or Hungarian cuisine, as well as culinary elements originating from the East Central European Slavic language From the kitchens of the countries. Ukrainian cuisine is known for its diversity and high taste characteristics Conclusion: Based on the findings and analysis, Nutritional philosophy is focused on providing sufficient and necessary nutrients for humans, according to the traditions, culture and lifestyle of the population.
**Keywords:** Nutrition characteristics of Black Sea region

# EXPLORING THE PROTECTIVE ROLE OF CHEENA (*Panicum miliaceum*) SEED EXTRACT AGAINST CARBON NAO-TUBES TOXICITY IN C*irrhinus mirigala*

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**Abstract**
This research investigated the therapeutic potential of *Panicum miliaceum (*Cheena) seed extract in alleviating carbon nanotube (CNT) toxicity in *Cirrhinus mrigala* and addressed concerns about CNT effects on aquatic organisms. For experimental purposes, fish were collected and kept in the lab with all standard aquatic parameters maintained. During Phase I of the experiment, mortality rates were observed after oral CNT doses ranging from 0, 50, 100, 150, 200, 250, 300, 350, and 400 mg/kg, monitored at 96-hour intervals, resulting in an LC50 value of 327.65 mg/kg. Three fractions of LC50 were made, including Fraction 1 (10.92 mg/kg), Fraction 2 (16.38 mg/kg), and Fraction 3 (32.76 mg/kg). The higher fraction was used in Phase II of the experiment. The experimental groups included the Control (C) group with no exposure to CNTs and plant extract, Test Group (G*) exposed to 32.76 mg/kg of CNTs with no extract, Test Group 1 (G1) with 32.76 mg/kg of CNTs + 30 mg/kg extract, Test Group 2 (G2) with 32.76 mg/kg of CNTs + 40 mg/kg extract, and Test Group 3 (G3) with 32.76 mg/kg of CNTs + 50 mg/kg extract, with each group observed for 96 hours. Fish organ histology was assessed to show CNT impact: the brain exhibited congested vessels, enlarged pyramidal cells, and vacuolation; gills displayed fibrous tissue and edema; the heart had cardiovascular issues. The therapeutic effects of Proso millet were also noted. High-Performance Liquid Chromatography (HPLC) analysis identified several bioactive components, including Ferulic acid, Chlorogenic acid, Gallic acid, P-coumaric acid, Quercetin, Caffeic acid, Sinapic acid, Kaempferol, oxalic acid, methyl malonic acid, Citric acid, Fumaric acid, Succinic acid, with malic acid being the most abundant. The findings suggest that *Panicum miliaceum* seed extract offers protection against CNT toxicity in *Cirrhinus mrigala,* providing a potential solution for mitigating CNT-related environmental concerns.

**Keywords:** Cheena millet seeds, Panicum miliaceum, Carbon nanotube toxicity, Cirrhinus mirigala, Therapeutic potential

# FUTURE PERSPECTIVES ON COW-CALF CONTACT SYSTEMS IN DAIRY FARMING

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**Abstract**
Early separation of a cow and her calf in dairy production has been a growing issue among citizens, and dam–rearing systems have increasingly been explored as a possible solution in Denmark and other European countries over the past few years. Cow-calf contact systems (CCC systems) include dam-rearing but are broadly understood as any housing or management system that permits a cow and a calf to be in physical contact, be it a dam and her own calf (dam-rearing) or a foster cow and her foster calf (foster cow-rearing), which many farmers perceived as a more feasible option than dam-rearing. It is argued that CCC systems, including foster cow systems, generally allow calves to meet their natural needs better than conventional calf systems. This presentation is based on different studies over the past 6 years, involving interviews, case studies, controlled trials and on-farm studies. CCC systems are practiced in a wealth of different ways. Four main angles are used to view these systems: calf, cow, farmers and farming system. Cows and calves experience to various degree three different benefits of these systems: 1) nutrition, 2) care, and 3) learning. Farmers with no experience in dam-rearing feared the 'loss of control' over the calf, and farmers with CCC systems generally enjoy viewing their behavior and working with them on premises that are different from what they previously experienced with calves and cows. There was a repeated questioning of 'naturalness' in relation to CCC-systems, and organizing a herd around such systems require rethinking and change of the entire system. One project included farmer-advise-farmer groups to learn about and develop CCC systems. The results showed that social learning took place across a wide variety of areas, including animal care, housing, equipment, and grazing practices needed for cow-calf contact systems.
**Keywords:** CCC systems, dam–rearing systems

# ANALYSIS OF A DEGRADED AREAS RECOVERY PLAN (DARP) IN THE MUNICIPALITY OF BALSAS - MA

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**Abstract**
The Degraded Area Recovery Plan (DARP) is a study that serves as an instrument for the environmental regularization of your property, based on a set of techniques and measures that are carried out in order to recover areas that have suffered environmental degradation. Its objective was to identify the places that need to be recovered, as well as to propose the measures to be adopted by the entrepreneur so that its effectiveness can be observed over the next few years, the recovery of the banks around the weir and along the banks and the flow of the Riacho Tucano, the elevation of water storage of the dam and mainly with the maintenance of its water flow. The development of the work brings, in a clear way, the analysis of a PRAD at Fazenda Gleba Cabeceiras, located in Balsas - MA. That, as a result of maintenance works on the existing dam at the headwaters of the Farm, problems occurred in its area and volume of water, a considerable reduction in its volume of water was observed, a fact that assumes that it is due to the alteration of the local water table and due to the lack of adequate vegetation to maintain the stream.
**Keywords**: Degenerate Environment. Management. Control.

# APPLICATION OF OLIVE PIT IN CONSTRUCTION FOR ENVIRONMENTAL RESERVE AREAS

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## Abstract
Sustainability, a topic widely discussed nowadays, is the mainstay of the policies that govern a country, being relevant from economic development to education, health, leisure, and is also a concern of engineering. The insertion of sustainable practices in construction is a trend movement. Thus, the work consists of substantiating an addition of the stone in the concrete, in order to observe the advancement of the organic material within the composition and its proper strength, so as to impose a conditioning before the advancement of the laws along with the tests developed in the laboratory, verifying the possibility of application in the construction of environmental areas, aiming specifically to contribute with the environmental laws along with the Brazilian biome in the constructive requirement within an environmental reserve. The methodology applied in this study is characterized in some experiments conducted in the construction laboratory, before the addition of 1% of olive stone within the concrete mix, in order to analyze the performance and resistance over a given time. Given all the research presented, it can be observed that the application of olive stone in construction does not present structural stability, thus providing a very specific purpose in small elements, if necessary. On the other hand, the point corresponds to a positive option for the environmental, because in a certain way, the standardization of this type of resource would favor the performance and protection.
**Keywords:** Sustainability. Civil Construction. Environmental Engineering.

# THE ECOLOGICAL ICMS AS AN ENVIRONMENTAL CONSERVATION ENCOURAGEMENT: REDUCTION IN THE INCIDENCE OF BURNS OUTBREAKS IN PIAUIENSE MUNICIPALITIES

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**Abstract**
It is notorious that human actions have brought negative externalities to the environment, in such a way that they systematically modify natural spaces. Among the externalities, fires are major causes of environmental destruction, being considered one of the main problems faced by municipalities in Piauí, such that from January to August 2021, there was an increase of more than 100% in fire outbreaks, compared to the same period in 2020. Within this perspective, there are structures in Brazil that involve multiple social actors and political-administrative articulations, aiming at sustainable development, including the Tax on Circulation of Goods and Services - ICMS Ecological. Therefore, the present work is based on evaluating the use of the Ecological ICMS in the state of Piauí, to promote a reduction in the incidence of fire outbreaks. The methodological procedures started with a bibliographic survey to form the conceptual basis, followed by the inference and crossing of information from the Kernel interpolator, resulting in the elaboration of the heat density map. In summary, it was observed that there are few municipalities that present measures related to the reduction in hot spots, especially those in the Southwestern Mesoregion, but the great inefficiency regarding the implementation of environmental actions and measures presented to SEMAR is notorious, to obtain the Environmental Seal. It can also be inferred that the fact is directly related to the traditional actions of the population, being considered a problem with cultural roots.
**Keywords**: Environmental Seal. Mesoregions. Provisions. Spots of Heat.

# USE OF ADDITIVE IN ALFALFA SILAGE PRODUCTION: A REVIEW

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**Abstracts**
Forage is an important part of the diet of ruminants, among which the leguminous family is of special importance, of which alfalfa is more important. Alfalfa plant due to its good quality, palatability and having reserves of nutrients such as minerals, protein and vitamins, especially vitamin A, is very important. Alfalfa (*Medicago sativa*) has spread in most regions of the world and is known as the queen of fodder plants. In countries where the growing season is limited, dry fodder and silage play an important role in providing food resources for ruminants, which is one of the ways to prevent the reduction of the nutritional value of silage. Alfalfa loses most of its nutritional value during ensiling due to its low soluble carbohydrates and hollow stems. Alfalfa silage has a low quality due to its high buffering capacity and low fast-fermenting carbohydrates. Silage additives can be classified as fermentation promoters, feed spoilage inhibitors and water-soluble sugar suppliers. These ingredients are very important in producing good silage from alfalfa forage. The additive like molasses, bacteria inoculant, apple pomace, citrus by-product, whey and essential oil improved alfalfa silage and its fermentation characteristics.
**Keywords:** Alfalfa, Bacteria inoculant, Ensiling, Ruminant, Silage.

# RAPID CLONAL MICROPROPAGATION OF PASSIFLORA CAERULEA

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**Abstract**
The present research proves the rapid regeneration capacity through micropropagation of *Passiflora caerulea* species, appreciated for the decorative effect of its impressive flowers. *In vitro* cultures were initiated using 1 cm nodal segments from young shoots. The explants were aseptically treated with 70% EtOH for one min, followed by a 15% NaClO treatment for 20 min. Culture initiation was performed in Murashige and Skoog, 1962 (noted MS) medium with vitamins included (Murashige & Skoog, 1962), 30 g/l sucrose and 2.5 g/l Gelrite. MS medium was also supplemented with 6-benzylaminopurine (BAP) (0.5-3 mg/l) or in a mixture with kinetin (KIN) (1 or 2 mg/l). MS culture medium with 2 mg/l BAP and 1 mg/l KIN stimulated the regeneration at 88.22% of the explants, producing 2.42 shoots per explant with an average length of 2.10 cm. In the multiplication stage, three types of culture medium recommended in the literature for good results in passionflower multiplication were tested. Subcultivation was performed with a rhizogenesis rate of more than 80% in the sixth subculture on MS medium supplemented with 2 mg/l BAP + 0.5mg/l ANA, a situation that allowed to skip the *in vitro* rhizogenesis induction stage and introduce the seedlings directly into the acclimatization stage. Each experiment was carried out in three replicates.
**Keywords:** regeneration protocol, axillary shoots, culture media, *Passiflora caerulea.*

# DISTINGUISH SOME POPULAR SAP MODULES WITH WILL PROPOSE A NICE SAP COURSE FOR PAKISTANI STUDENTS AND IT EXPERTS

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## Abstract

It's a significant expertise in the business world, so the venture is many times worth the effort. SAP Frameworks, Applications, and Items in Information Handling offers a large number of modules to take care of various business capabilities and enterprises. This module is utilized for monetary administration and bookkeeping undertakings, including general record bookkeeping, creditor liabilities, debt claims, and resource bookkeeping. SAP CO is firmly connected with SAP FI and centers around cost bookkeeping, inward orders, and benefit investigation. It helps in checking and controlling monetary cycles. This module is liable for acquisition, stock administration, and materials arranging inside an association. SAP SD handles deals, request handling, and dissemination. It's imperative for overseeing client arranges and conveying items or administrations. This module is utilized for creation arranging and booking, including Bill of Materials the executives and work focus upkeep. SAP HCM oversees HR processes, including work force organization, finance, using time effectively, and hierarchical administration. SAP CRM centers around client related processes, like advertising, deals, and administration. This module streamlines inventory network tasks, including request arranging, supply network arranging, and creation arranging. SAP BW is utilized for information warehousing and business insight. It helps associations store and examine information for detailing and independent direction. SAP BI, or Business Items, offers instruments and applications for detailing, questioning, and information representation. This module manages plant support exercises, for example, gear and upkeep arranging. SAP QM is fundamental for overseeing quality control and quality confirmation processes inside an organization. SAP PS helps in project the executives, including project arranging, execution, and checking. This module centers around overseeing resources across their lifecycle, from procurement to removal. SAP WM upgrades stockroom activities, including products receipt, stockpiling, and stock administration. SAP TM is utilized for enhancing transportation and strategies processes. SAP GRC assists associations with overseeing gambles, guarantee consistence, and administer their tasks really. This module is explicitly intended for human resources the board, zeroing in on ability the executives, labor force examination, and worker execution. These are only a portion of the famous SAP modules, and SAP ceaselessly grows new answers for meet the changing necessities of organizations in different ventures. While picking a module to learn, consider your profession objectives and the particular necessities of the business you're keen on. I can't give constant or explicit course suggestions on the grounds that the accessibility and nature of SAP courses might change over the long haul. Consider taking courses straightforwardly from SAP or SAP-approved preparing accomplices. These courses are in many cases exhaustive and in the know regarding the most recent SAP advances. Sites like Coursera, Udemy, edX, LinkedIn Learning, and Pluralsight offer an assortment of SAP courses. Understand audits and think about courses with high evaluations and positive criticism. SAP offers its true internet learning stage called SAP Learning Center point. It gives admittance to an extensive variety

of preparing materials, including digital books, recordings, and virtual labs. Search for courses that deal SAP accreditation planning. Acquiring an authority SAP affirmation can help your profession possibilities. Research the capabilities and experience of the course educators. Experienced teachers with industry information can give important bits of knowledge. Audit the course prospectus to guarantee it covers the particular SAP module or point you are keen on. It ought to remember pragmatic activities and hands-for experience. Think about your timetable and learning style. Assess the expense of the course. While free courses are accessible, putting resources into a very much organized paid course might be worth the effort for the nature of guidance and materials. Search for courses that offer an emotionally supportive network or local area where you can get clarification on some pressing issues and interface with individual students. Really take a look at the length of the course to guarantee it accommodates your timetable. Some SAP courses can be very broad, while others might be more engaged and more limited. If accessible, consider attempting a free preliminary or a set of the course to survey the substance and educator's instructing style.

**Keywords**: creditor, zeroing, ceaselessly, extensive, broad, preliminary.

# ASSESSING THE EFFECTIVENESS OF PRODUCTIVITY UTILIZATION IN WHITE LEG SHRIMP FARMING IN KHANH HOA AND PHU YEN REGIONS, VIETNAM

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**Abstract**
This article summarizes the application of the non-parametric DEA (Data Envelopment Analysis) method to evaluate the efficiency of production capacity utilization in the shrimp farming industry in the Khanh Hoa and Phu Yen regions of Vietnam, based on microeconomic theory. The research results indicate that the average efficiency of production capacity utilization among shrimp farming households is approximately 66%. This suggests that if shrimp farming households maintain their production technology and the utilization of farming area remains constant, shrimp production could increase by up to approximately 51.5% compared to the current level. Using the performance decomposition model for production capacity utilization, this study reveals that the inefficient use of input resources in the shrimp farming industry, especially in managing changing factors, is the primary factor affecting the efficiency of production capacity utilization among shrimp farming households
**Keyword:** Shrimp farming, white leg shrimp, Khanh Hoa, Phu Yen, Vietnam

# DISCOVERY OF NEW ANTI-CANCER AGENTS FOR THE HUMAN BREAST CANCER CELL LINE USING 3D QSAR AND MOLECULAR DOCKING STUDIES ON A SERIES OF 1,4 DISUBSTITUTED-1,2,3-TRIAZOLES

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**Abstract**
In this study, we conducted a quantitative structure-activity relationship (3D QSAR) investigation using a set of 17 compounds to explore the potential for discovering novel 1,4-substituted derivatives of disubstituted 1,2,3-triazoles with promising anticancer properties. Our CoMFA analysis yielded notable outcomes with an R-squared value of 0.943 and a Q-squared value of 0.642. Additionally, we utilized contour maps to assess the impact of steric and electrostatic fields on the compounds' activity. These compelling findings provide strong motivation for the development of new molecules based on 1,2,3-triazole scaffolds. Molecular docking was employed to investigate the binding mode and interaction between these designed molecules (ligands) and a specific protein, namely the EGFR protein kinase (PDB code: 4WKQ). These lead compounds show promise for the development of innovative drugs for targeting breast cancer, particularly with a focus on human breast cancer cells. The insights gained from this research hold significant potential for advancing the field of anticancer drug development.
**Keywords**: 1,2,3 triazoles; 3D QSAR; CoMFA; Docking

# NANOEMULSION

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**Abstract**
AIM & OBJECTIVE: Nanoemulsion is used for the greater stability, absorption, therapeutic effect, less toxicity and solubility of oil and water. One liquid is not miscible in another liquid, it forms droplets on the liquid, it can be miscible by using emulsifying agent or surfactant to form a single agent called nanoemulsion. The size of the droplets ranges from 20 to 200 nm. METHOD:The methods that are used to miscible the two liquids are high and low-energy methods. In high-energy methods, high force is provided by means of machine that is microfluidizer, high-shear stirring, homogenizers and ultrasonicators. In low-energy methods, there is no need for force by using phase inversion method. Combining these two methods are also used to prepare the nanoemulsion. RESULTS: It improves thermodynamics stability of drugs, produces more therapeutic effects, non irritant and decreases their toxicity. It resulted in preventing creaming, flocculation, coalescence and sedimentation in the nanoemulsion. These drugs are increase their absorption, bioavailability, and unstable drugs are protected from enzymatic degradation, photolysis and oxidation. CONCLUSIONS: Nanoemulsion is mostly used to mask unpleasant taste of oily liquid, soluble the lipophilic drug, mucosal vaccine, cell culture technology, cancer treatment, non toxic disinfectant cleaner and target therapy in pharmaceutical industries. At the present time, nanoemulsion is used in various types of treatment like anticancer and also for providing long term effects. More drugs are designed based on nanoemulsion methods to increase the concentration of the drug, decrease the adverse effect and help to bind the drug to the target site.
**Keywords:** Emulsifying agent, sedimentation, creaming, flocculation, coalescence, solubility of oil and water.

# DECISION TREE FOR AGRICULTURE

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**Abstract**
Agriculture is the backbone of the Economy in the Country like India. In India majority of the population lives in Village and have occupation Farming majorly for their livelihood. We in the paper address the issue of Agriculture to be more precise how to get good crop productivity, how to ensure safety of the crop through various problems like pest and irregular weather and so on. Today we are living in the Time of Machine Learning. Machine Learning is a paradigm that has encompassed almost all the different streams of life and Agriculture is also one area where Machine Learning has shown promising results. We in the current paper will look in one Machine Learning technique that is Decision Tree for the proper productivity of Agriculture. In the current work we will acknowledge the Decision Tree application from the Problem perspective addressed as Indian Farmers and Agriculture in India.
**Keyword:** Python, Agriculture, Farmer, Machine Learning, Decision Tree.

# COMPUTER VISION FOR AGRICULTURE

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**Abstract**
India is now one of the Leading countries in the Field of Space Research Technology. Especially after the successful mission of Chandrayaan we can say that we are now growing in Space technology. One area that is deeply connected with the current space research technology in terms of its applicability is the Remote Sensing application. We are having various Geo-stationary satellites now orbiting the Earth and looking the country India continuously for various aspects. We in the current paper are going to address the utility of the pictures taken by the Satellites on the Farming Land and based on the pictures do Interpretation that is a Computer Vision activity and may take care of the various if's and but's that Agriculture Industry may face in order to give the best to the market that it is supposed to serve. We in the paper will look into Computer Vision as a Technology for Rural Development.
**Keyword:** AI, CV, Agriculture, Rural, Technology.

# RDBMS FOR FOOD MANAGEMENT

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**Abstract**
We human beings are having various necessities and several desires. Desires are endless and no person in this World in his lifetime is going to accomplish all his or her desire. We in the current paper are going to make a focus on one necessity that is very basic for livelihood that is Food. In the current paper we propose the use of the Technology that had most of its onset during the 1970s but till then is one of the most basic Computer Science and Engineering subject that serve several problems related to the data present in the form of Tables. We in the current paper will raise the issue of food around the globe and would propose the usage of RDBMS that is relational database system for the management of food products across the Globe to have a good productivity. In the paper we would see as to how DBMS could be used to make a management of the Food.
**Keyword:** Data, Food, Management, RDBMS, Computer.

# MACHINE LEARNING FOR ANIMAL HUSBANDRY

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**Abstract**
Machine Learning is essentially the state of the art paradigm for taking care of a number of problems faced across the world. Machine Learning is essentially a sub-class of the bigger Technology that is Artificial Intelligence. AI sits on four cornered bed having AI programming languages, AI hardware, KR and IE as the four corner pillars. We in the current paper are having a notion of Machine Learning especially the technique called ANN for the solution of the Animal Husbandry problem. We will make utilization of the use cases for making a Model that is going to help the people involved in the field of Animal Husbandry. Our Machine Learning approach for Animal Husbandry prove to be an optimal Computer oriented approach that gives great productivity in the field of Animal Husbandry.
**Keyword:** ANN, Backpropagation, Animal, Husbandry, ML.

# POLYHERBAL FORMULATION FOR ANTIDIABETIC ACTIVITY: A COMPREHENSIVE REVIEW

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## Abstract
Diabetes mellitus, a chronic metabolic disorder characterized by elevated blood glucose levels, has reached epidemic proportions worldwide, with a growing demand for safe and effective treatments. Herbal remedies, particularly polyherbal formulations, have gained significant attention in recent years for their potential antidiabetic properties. This abstract provides an overview of the current research on polyherbal formulations used in the management of diabetes. Polyherbal formulations combine multiple plant-based ingredients, each with its unique phytochemical profile, thereby potentially enhancing their efficacy in controlling blood glucose levels. This comprehensive review synthesizes findings from various studies exploring the antidiabetic activity of polyherbal formulations. The use of herbs in the treatment of diabetes is deeply rooted in traditional medicine systems. Many cultures have historically employed a combination of herbs to manage diabetes, and modern research is validating these traditional practices. The bioactive compounds found in various herbs included in polyherbal formulations, such as flavonoids, alkaloids, and polyphenols, play a crucial role in regulating glucose metabolism, insulin secretion, and improving insulin sensitivity. Polyherbal formulations often target multiple pathways involved in diabetes, including reducing oxidative stress, enhancing pancreatic β-cell function, inhibiting carbohydrate-digesting enzymes, and improving insulin signaling, leading to better glycemic control. Numerous clinical studies and trials have explored the effectiveness of polyherbal formulations as an adjunct or alternative to conventional antidiabetic medications. Positive outcomes in terms of glucose regulation, HbA1c reduction, and improved quality of life have been reported. Polyherbal formulations are generally considered safe with fewer side effects compared to synthetic antidiabetic drugs. However, rigorous safety assessments and long-term studies are necessary to confirm their safety profile.
**Keywords:** Traditional Knowledge, Phytochemical Composition, Mechanisms of Action, Clinical Efficacy, Safety and Tolerability.

# BUBONIC PLAGU (BLACK DEAD)

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**Abstract**
Bubonic plague is one of three types of plague caused by the bacterium Yersinia Pestis. One to seven days after exposure to the bacteria, flu-like symptoms develop. These symptoms include fever, headaches, and vomiting as well as swollen and painful lymph nodes. The dark discoloration of skin, is another symptom. Occasionally, swollen lymph nodes, known as “buboes”, may break open. The bubonic form of plague, the bacteria enter through the skin through a flea bite and travel via the lymphatic vessels to a lymph node, causing it to swell. Diagnosis is made by finding the bacteria in the blood, sputum, or fluid from lymph nodes Diagnosis Laboratory testing is required in order to diagnose and confirm plague. Ideally, confirmation is through the identification of Y. Pestis culture from a patient sample. Confirmation of infection can be done by examining serum taken during the early and late stages of infection. To quickly screen for the Y. Pestis antigen in patients, rapid dipstick tests have been developed for field use. Gram-Negative Yersinia pestis bacteria. The culture was grown over a 72-hour time period. Several classes of antibiotic are effective in treating bubonic plague. These include aminoglycosides such as streptomycin and gentamicin, tetracyclines (especially doxycycline), and the fluoroquinolone ciprofloxacin. Mortality associated with treated cases of bubonic plague is about 1–15%, compared to a mortality of 40–60% in untreated cases.
**Keywords:** Bubonic plague, Buboes, Blackdeath

# ACUTE TOXICITY STUDIES OF MEDICINAL PLANTS: A SHORT REVIEW

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**Abstract**
Since ancient times, medicinal plants have been a crucial part of both conventional and complementary medical systems, providing a wide range of organic substances with possible medical uses. Their toxicity and safety profiles, however, are still crucial factors to take into account prior to their clinical application. An overview of studies on acute toxicity carried out on several medicinal herbs is given in this abstract. In order to ascertain whether these plants are safe to consume, acute toxicity studies are essential since they assist identify any possible dangers. Plant extracts or chemicals are administered at different doses to experimental animals, usually rats, in acute toxicity studies. The possible negative consequences are evaluated by recording observations of alterations in behaviour, physiology, and histopathology. It is common practice to estimate toxicity using parameters like LD50, or lethal dose for 50% of the population. The plant type chosen, the portion of the plant used, the extraction techniques used, and the animal models used are some of the elements that affect the results of these investigations. Chemical standardisation is crucial because variations in acute toxicity profiles can also depend on the chemical makeup of the plant. Since acute toxicity studies help determine safe dosages, direct regulatory choices, and aid in the creation of safe and effective herbal medicines, this abstract emphasises the significance of these studies in the assessment of medicinal plants. In addition, it emphasises the necessity of additional study and standardisation to improve the security and effectiveness of medicinal plants in medical and therapeutic settings.
**Keywords:** Acute toxicity, Medicinal herbs, LD50, Safe dosages, Histopathology.

# THE INTERACTION OF AGGRESSION BEHAVIOUR IN BEE VENOM PRODUCTION IN HONEY BEE COLONIES

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**Abstract**
Bee venom is a secretion produced from the venom glands in the abdominal cavity of honey bees. The chemical structure of bee venom is mainly composed of mellitin, apamin, MCD-peptide, histamine, hyaluronidase, phospholipase-A2. Bee venom production has gained momentum in recent years. Bee venom has possibilities of use in human and animal health within the scope of apitherapy as well as in cosmetics. Bee venom production is nowadays using electric shock method, which provides venom milking without harming the bees. In this method, different machines are used in front of the hive and on the hive. The venom milking machine works on the principle of passing electric current through the wires on the glass plates. After 30 minutes of venom milking, the glass plate is removed and the venom is scraped off. In the colony, bee venom is secreted by worker bees for defence purposes. Bees release venom through their stingers during stinging behaviour. In honeybee colonies, the defence power constitutes the aggression behaviour. The measure of colony defence is the aggression behaviour parameter. In the aggression behaviour test, a black suede covered tennis ball is swung at the entrance of the hive at the same speed for 1 minute and the number of needles on the ball is recorded at the end of the time. In this study, 15 colonies of Anatolian Bee (*Apis mellifera anatoliaca*) with similar population and same queen age were selected as treatment group and 5 colonies as control group. Changes in aggression behaviour of colonies before and after venom production were examined. The aggression test was measured before, after and 24th hour of production. In the data obtained in this thesis, it was observed that aggression behaviour varied during the venom production process.
**Keywords:** Aggression behaviour, bee venom, colony defence, honey bee
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# FARKLI EKMEKLİK BUĞDAY MELEZ KOMBİNASYONLARININ $F_2$ VE $F_3$ GENERASYONLARINDA BAŞAK ÖZELLİKLERİNİN İNCELENMESİ

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**Özet**
Buğdayda verim, birim alandaki başak sayısı, başaktaki tane sayısı ve başak ağırlığındaki değişimler ile belirlenir. Başak özellikleri kantitatif kalıtım gösteren önemli verim komponentleri arasında yer almaktadır. Bu çalışmada Ege Bölgesinde yaygın olarak yetiştirilen Masaccio ve Ziyabey 98 ekmeklik buğday çeşitleri arasında yapılan melez, protein oranı yüksek ve farklı protein allellerine sahip 6, 27, 41, 48 ve 51 nolu hatlarla melezlenerek beş farklı melez kombinasyon elde edilmiştir. Bu melez kombinasyonların $F_2$ ve $F_3$ generasyonları sırasıyla 2021-2022 ve 2022-2023 buğday yetiştirme mevsiminde Ege Üniversitesi Ziraat Fakültesi Tarla Bitkileri Bölümü deneme alanlarında yetiştirilmiştir. Çalışmada beş kombinasyonun $F_2$ generasyonlarındaki tüm bitkilerde ve bu tek bitkilerin $F_3$ döllerinde başak uzunluğu, başakta başakçık sayısı, başakta tane sayısı, başakta tane ağırlığı ve başak indeksi özellikleri ölçümlenmiştir. Yapılan analizler sonucunda incelenen tüm kombinasyonların genel olarak başak özelliklerinin $F_3$ generasyonlarında daha büyük ortalama değerlere sahip olduğu, $F_3$ generasyonlarında varyasyonlarının azaldığı, başak özelliklerinin hesaplanan kalıtım derecelerinin genel olarak oldukça yüksek olduğu ve bu nedenle yapılacak seleksiyonun başarısının yüksek olacağı sonucuna varılmıştır.
**Anahtar Kelimeler:** Buğday, başak özellikleri, kalıtım derecesi, $F_2$ ve $F_3$ generasyonu.

# INVESTIGATION OF SPIKE TRAITS IN F2 AND F3 GENERATIONS OF DIFFERENT HYBRID COMBINATIONS IN BREAD WHEAT

**Abstract**

Yield in wheat is determined by the number of ears per unit area, the number of grains in the spike and the changes in the weight of the spike. spike traits are among the important yield components that show quantitative inheritance. In this study, five different hybrid combinations were obtained by crossing the hybrid between Masaccio and Ziyabey98 bread wheat varieties, which are widely grown in the Aegean Region, with lines 6, 27, 41, 48 and 51, which have high protein content and different protein alleles. F2 and F3 generations of these hybrid combinations were grown in the trial fields of Ege University Faculty of Agriculture Department of Field Crops in the 2021-2022 and 2022-2023 wheat growing seasons, respectively. In the research, plant height, spike length, number of spikelets per spike, number of grains per spike, grain weight per spike, spike index and 1000 grain weight were measured in all plants in the F2 generations and F3 offspring, which consisted of five combinations. from these single plants. The average, minimum and maximum values of the traits examined in the F2 and F3 generations of the hybrids and some statistical parameters were determined. As a result of the analysis, it was determined that the hybrid combinations showed significant differences in terms of all examined characteristics. In addition, the heritability and genetic progression values of the examined traits were also determined.

**Keywords:** Wheat, agricultural characteristics, spike characteristics, F2 and F3 generation.

# LEGACY FROM ANCIENT TIMES TO PRESENT: NATURALLY COLOURED COTTON

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**Abstract**
Cotton fiber is a product with high added value that is of interest to the sectors as it is a commodity exchange and produces many products after processing. Naturally coloured cotton, on the other hand, has existed from ancient times to the present day, and is an indicator of biodiversity in the universe, with fibers in different colors apart from white cotton. Studies have shown that naturally colored cotton fiber consumes less water in yarn and fabric production processes, reduces production costs by using less energy and less chemicals in dyeing processes, and therefore has a low carbon footprint. Today, naturally colored cotton fibers with green, brown, reddish brown, camel hair and orange hues are available. Low color stability and quality are among the reasons why it is not preferred in production. Improving the color and fiber quality by expanding the color range of naturally colored cotton will be possible through physiological, genetic and breeding studies. In this way, naturally colored cotton production will become sustainable and the production potential will be increased. By carrying out the necessary adaptation studies and creating marketing policies, a supply-demand balance will be created. In this context, this review draws attention to the production of naturally colored cotton and brings together the studies carried out in the world and in our country.
**Keywords:** natural colored cotton, sustainable, biodiversity.

# FULL TEXT

# SÜT SIĞIRLARINDA SICAKLIK STRESİ VE ETKİLERİ

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**Özet**
Süt sığırlarından beklenen verim ancak onlara optimum çevre koşullarının sağlanmasıyla elde edilir. Süt sığırları için en uygun çevre koşulları 13- 18 ºC'lik çevre sıcaklığı, %60-70 oransal nem, orta derecede solar radyasyon ve saatte 5-8 km'lik rüzgâr hızı olarak belirtilir. Hayvanların sıcaklık stresi altındaki ilk belirgin tepkileri, yem tüketimindeki ve bunun sonucunda, süt verimindeki düşmedir. Yüksek çevre sıcaklığına maruz kalan hayvanlar çevre sıcaklığının olumsuz etkilerini giderebilmek için hem fizyolojik hem de metabolik olarak çeşitli tepkiler verirler. Hayvanlarda kalp atım hızı ve solunum hızında artış, süt verimi ve üreme performansında düşmeler, kronik açlık ve susuzluk ile ileri zamanlarda stress, agresiflik ve ayak rahatsızlıkları görülmektedir. Çevre sıcaklığı ile birlikte bağıl nem oranı, solar radyasyon ve rüzgâr hızı gibi meteorolojik özelliklerin çevre sıcaklığının hissedilme derecesini etkilediği belirlenmiştir. Bu çalışmada süt sığırı yetiştiriciliğinde büyük ekonomik kayıplara sebep olan sıcaklık stresi ve olumsuz etkilerinden korunmak amacıyla alınacak tedbirler konusunda bilgi verilmiştir.
**Anahtar Kelimeler:** Süt sığırı, Sıcaklık stresi, Süt verimi, Döl verimi

# HEAT STRESS AND ITS EFFECTS ON DAIRY CATTLE

**Abstract**

The expected yield from dairy cattle can only be achieved by providing them with optimum environmental conditions. The most suitable environmental conditions for dairy cattle are indicated as an ambient temperature of 13-18 ºC, relative humidity of 60-70%, moderate solar radiation, and a wind speed of 5-8 km per hour. High ambient temperature, direct or indirect solar radiation, and high relative humidity are important factors that cause stress on animals. The first obvious response of animals to heat stress is a reduction in feed consumption and, as a result, in milk yield. Animals exposed to high environmental temperatures react physiologically and metabolically to overcome the negative effects of environmental temperature. In animals, an increase in heart rate and respiratory rate decreases in milk yield and reproductive performance, chronic hunger and thirst, and stress, aggression, and foot disorders are seen in the future. It has been determined that meteorological features such as relative humidity, solar radiation, and wind speed, together with the ambient temperature, affect the degree of perception of the ambient temperature. In this study, information is given about the measures to be taken to protect from heat stress and its negative effects, which cause significant economic losses in dairy cattle breeding.

**Keywords:** Dairy cattle, Heat stress, Milk yield, Fertility

## Giriş

Süt sığırlarının verimlerine etki eden çevre faktörleri arasında sıcaklık, nem, hava hareketleri ve havanın temizliği öne çıkan unsurlardır (Mutaf ve Sönmez, 1984; Alkoyak ve Çetin, 2016). Sığırlar için ideal sayılan iklim koşullarının dışına çıkıldığında hayvanlar bu çevre koşullarına belirli sınırlar içinde adapte olabilmektedirler. Ancak iklimsel değerlerin aşırı yükselmesi veya düşmesi durumlarında, hayvanlar için stres oluşmakta ve bu stres durumuna verilen tepkiler hayvanın, yaşına, ırkına, verim düzeyine ve bireysel farklılıklara göre değişmektedir (Atasever ve ark. 2004). Hayvanlarda normal vücut sıcaklığının yükselmesine neden olan etkenlerin bileşkesine 'Sıcak stresi' denir (Dinçel ve Dikmen, 2013). Sıcaklık stresi; hava sıcaklığının yüksekliği ve yüksek nispi nemin bir arada olması ile oluşan durumun hayvanlarda meydana getirdiği strestir. Yüksek süt verimli hayvanlar metabolik faaliyetleri daha fazla olduğu için çevresel etkilerden (sıcaklık stresi) daha fazla etkilenirler (Alkoyak ve Çetin, 2016). Yüksek çevre sıcaklığı, nispi nem değerleri ya da solar radyasyon sıcaklık stresine sebep olduğundan, çiftlik hayvanlarını olumsuz etkilemektedir. Ortam sıcaklığı vücut sıcaklığını aştığında, hayvanların ısı düzenleme tepkilerinin eksikliğine yol açan, buharlaşmaya bağlı olarak sıcaklık kaybında başarısızlığa sebep olmaktadır. Sıcaklık stresine maruz kalan hayvanlarda, vücut sıcaklığının düzenlenmesi bir öncelik haline gelmektedir. Bu nedenle, hayvanlar dengelenmiş bir vücut sıcaklığına ulaşmaya çalışırken, diğer bazı fizyolojik fonksiyonları bozulmaktadır. Sıcaklık stresi hayvanlarda büyüme, üreme, hayvan refahı, fizyolojk ya da metabolik gibi birçok özellik üzerinde olumsuz etki göstermektedir (Romo-Barron ve ark., 2019; Çakmakçı, 2013, Kulaz, 2021). Genel olarak, solunum sayısı ve rektal sıcaklıkta artış, terleme, aktivitelerinde azalma, döl veriminin düşmesi, yem tüketiminde azalma, süt üretimi ve süt içeriğinde değişikliklere neden olabilmektedir (Öten ve ark., 2004).

## Sıcaklık Stresinin Belirlenmesi

Süt sığırları özellikle süt sentezi gibi metabolik faaliyetler sonucu ısı üretir. Üretilen ısı, çevreden kazanılan ısı ile birleşir ve hipotalamusta termostat gibi görev yapan bir ısı merkezi tarafından yönetilerek sıcak veya soğuk durumlara göre vücudu ayarlamaya çalışır (Atasever ve ark. 2004). Hayvanların kendilerini rahat hissettikleri, ısı kaybının ve ısı üretiminin yaklaşık olarak aynı olduğu çevre sıcaklığına "Termonötral bölge" adı verilmektedir. Süt inekleri için termonötral bölge 5-25$^{o}$C arasında olup (Roenfeldt, 1998), alt sıcaklık değeri -13,9°C, üst kritik sıcaklık ise 27,2°C'dir (Spiers, 2003; Köse ve Saçaklı, 2021). Süt

sığırlarında normal vücut sıcaklığı (rektal sıcaklık) 38.5-39.3°C olup bu derecelerin üstünde meydana gelen değişikliklere hayvanlar terleme ve solunum sayısını arttırıp yem tüketimini ve süt verimini azaltarak tepki verir ve daha ileri aşamalarda ise ölümle sonuçlanabilir. (Akman ve Yener, 1997; Atasever ve ark. 2004).

Artan çevre sıcaklığına karşı hayvanın bu artışı karşılamak için ortaya koyacağı tepkiler;

- Damarlardaki kan akışı değişmeleri,
- Terlemenin başlatılması,
- Solunum sayısının artışı,
- Hormon salgılanması veya endokrin aktivitesi değişmeleri,
- Davranışsal değişmeler, huzursuzluk,
- Su tüketiminin artışı,
- Vücut sıcaklığının yükselmesi,
- Vücuttaki suyun kullanımına ilişkin değişmeler ile su kaybı (dehidrasyon) derecesindeki değişimler şeklinde ortaya çıkmaktadır (Jones ve Stallings, 1999: Üçeş, 2005). Sıcaklık sitresini yoğun yaşayan hayvanlarda terleme ve solumun sayısı artar, yem tüketimi azalır. Gerekli tedbirler alınmazsa daha ileri seviyelerde ölümler meydana gelebilir (Akman ve Yener, 1997; Atasever ve ark. 2004).

Hayvanların kendilerini rahat hissettikleri Termonötral bölge, hayvanın türüne, ırkına, vücuttaki yağ dokusuna, yaşına, tükettiği yem kompozisyonu ve miktarına, barınak özellikleri gibi birçok faktörden etkilenir (Yousef, 1985; Atasever ve ark. 2004). Sığırlar yüksek çevre sıcaklığının etkisini elimine etmek için terleme, nefes sayısını artırma, gölgede yatma gibi tedbirler alır ancak yüksek nispi nem vücudun serinletici mekanizmalarını azaltarak vücut sıcaklığını yükseltmektedir. O yüzden sıcaklık stresinde, güneş ışınlarından kaynaklanan ısınma yanında ortam nispi nemi de çok önemlidir.

Süt verimi yüksek inekler düşük verimlilere göre sıcaklık stresine karşı daha hassastır. Hayvanların vücut sıcaklıkları bireysel olarak ölçülebilse de çok pratik bir uygulama değildir. Ortam sıcaklığı ve nispi nemi ile hesaplanan sıcaklık-nem indeksinin kullanılmasının çok daha pratik bir uygulama olacağını McDowell ve ark. (1976) bildirmiştir. Sıcaklık Nem İndeksi-SNİ (Termal Humidity Index -THI) =((0,8x Sıcaklık °C) + ((% Nispi Nem/100) x (Sıcaklık °C -14,4)) + 46,4) formülüyle belirtilir (Broucek ve ark. 2006; Köse ve Saçaklı, 2021). Günümüzde süt sığırcılığında sıcaklık stresini değerlendirmek ve sıcaklık stresinden dolayı oluşan performans kayıplarının ölçümünde sıcaklık-nem indeksi (SNİ) yaygın olarak

kullanılmaktadır (Hill ve Wall, 2015; Ravagnolo ve ark., 2000; De Rensis ve ark., 2015; Işık ve ark.,2016; Erzurum ve Erzurum, 2020; Köse ve Saçaklı, 2021).

Süt sığırlarında stresin ortaya çıkmasında sıcaklık-nem indekslerinin farklı eşik değerlerinin etkili olduğunu belirtilmekte olup, genel olarak 72'den büyük olan SNİ değerleri ısı stresinin başlangıcı olarak kabul edilmektedir. 72'den küçük SNİ değerlerinde stres oluşmadığı, 72-79 arasında hafif bir stres başladığını, 80-89 arasında orta düzeyde ve 90'ın üzerinde yoğun stres oluştuğunu ve ölümle sonuçlanabileceğini belirtilmektedir (Armstrong, 1994; Alkoyak ve Çetin, 2016; Pinto ve ark., 2020). Çizelge1'de sıcaklık stresi eşik değerleri verilmiştir.

**Çizelge 1.** Sıcaklık stresi eşik değerleri

| SNİ | Stres Düzeyi |
|---|---|
| < 72 | Stres yok |
| 72-79 | Hafif stres |
| 80-89 | Orta derecede stres |
| > 90 | Şiddetli stres ve ölüm |

Sıcaklık stresi, hayvan sağlığı ve üretkenliği üzerinde büyük zararlı etkilere sahip olabilir ve ortam sıcaklığı yüksek bölgelerdeki sürüler için özel zorluklar teşkil eder. Sıcaklığın yanı sıra bağıl nemin de sıcaklık stresi üzerinde önemli bir etkisi vardır ve sıcaklık-nem indeksi genellikle süt sığırlarında stres derecesini belirtmek için kullanılır (Çizelge 2). Süt sığırları için en uygun sıcaklık 5°C- 25°C arasında olan Termonötral bölgedir ve bu sıcaklık aralığı, hayvanların vücudu ısıtmak veya soğutmak için hiçbir ek enerjinin harcanmadığı sıcaklık bölgesini temsil eder.

**Çizelge 2.** Sıcaklık-nem indeks (SNİ) tablosu (Anonim, 2021)

| Temp | % Relative Humidity | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| °F | °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 |
| 72 | 22.0 | 64 | 65 | 65 | 65 | 66 | 66 | 67 | 67 | 67 | 68 | 68 | 69 | 69 | 69 | 70 | 70 | 70 | 71 | 71 |
| 73 | 23.0 | 65 | 65 | 66 | 66 | 66 | 67 | 67 | 68 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 71 | 72 | 72 |
| 74 | 23.5 | 65 | 66 | 66 | 67 | 67 | 67 | 68 | 68 | 69 | 69 | 70 | 70 | 70 | 71 | 71 | 72 | 72 | 73 | 73 |
| 75 | 24.0 | 66 | 66 | 67 | 67 | 68 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 72 | 73 | 73 | 74 | 74 |
| 76 | 24.5 | 66 | 67 | 67 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 |
| 77 | 25.0 | 67 | 67 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 76 |
| 78 | 25.5 | 67 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 76 | 76 | 77 |
| 79 | 26.0 | 67 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 73 | 73 | 74 | 74 | 75 | 76 | 76 | 77 | 77 | 78 |
| 80 | 26.5 | 68 | 69 | 69 | 70 | 70 | 71 | 72 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 76 | 77 | 78 | 78 | 79 |
| 81 | 27.0 | 68 | 69 | 70 | 70 | 71 | 72 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 77 | 77 | 78 | 78 | 79 | 80 |
| 82 | 28.0 | 69 | 69 | 70 | 71 | 71 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 77 | 77 | 78 | 79 | 79 | 80 | 81 |
| 83 | 28.5 | 69 | 70 | 71 | 71 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 80 | 81 | 82 |
| 84 | 29.0 | 70 | 70 | 71 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 80 | 81 | 82 | 83 |
| 85 | 29.5 | 70 | 71 | 72 | 72 | 73 | 74 | 75 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 83 |
| 86 | 30.0 | 71 | 71 | 72 | 73 | 74 | 74 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 84 | 84 |
| 87 | 30.5 | 71 | 72 | 73 | 73 | 74 | 75 | 76 | 77 | 77 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 84 | 85 | 85 |
| 88 | 31.0 | 72 | 72 | 73 | 74 | 75 | 76 | 76 | 77 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 84 | 85 | 86 | 86 |
| 89 | 31.5 | 72 | 73 | 74 | 75 | 75 | 76 | 77 | 78 | 79 | 80 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 86 | 87 |
| 90 | 32.0 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 86 | 87 | 88 |
| 91 | 33.0 | 73 | 74 | 75 | 76 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 86 | 87 | 88 | 89 |
| 92 | 33.5 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 85 | 86 | 87 | 88 | 89 | 90 |
| 93 | 34.0 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 80 | 81 | 82 | 83 | 85 | 85 | 86 | 87 | 88 | 89 | 90 | 91 |
| 94 | 34.5 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 86 | 86 | 87 | 88 | 89 | 90 | 91 | 92 |
| 95 | 35.0 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 |
| 96 | 35.5 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 |
| 97 | 36.0 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 91 | 92 | 93 | 94 | 95 |
| 98 | 36.5 | 76 | 77 | 78 | 80 | 80 | 82 | 83 | 83 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 |
| 99 | 37.0 | 76 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 |
| 100 | 38.0 | 77 | 78 | 79 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 98 |
| 101 | 38.5 | 77 | 79 | 80 | 81 | 82 | 83 | 84 | 86 | 87 | 88 | 89 | 90 | 92 | 93 | 94 | 95 | 96 | 98 | 99 |
| 102 | 39.0 | 78 | 79 | 80 | 82 | 83 | 84 | 85 | 86 | 87 | 89 | 90 | 91 | 92 | 94 | 95 | 96 | 97 | 98 | 100 |
| 103 | 39.5 | 78 | 79 | 81 | 82 | 83 | 84 | 86 | 87 | 88 | 89 | 91 | 92 | 93 | 94 | 96 | 97 | 98 | 99 | 101 |
| 104 | 40.0 | 79 | 80 | 81 | 83 | 84 | 85 | 86 | 88 | 89 | 90 | 91 | 93 | 94 | 95 | 96 | 98 | 99 | 100 | 101 |
| 105 | 40.5 | 80 | 80 | 82 | 83 | 84 | 86 | 87 | 88 | 89 | 91 | 92 | 93 | 95 | 96 | 97 | 99 | 100 | 10 | 102 |
| 106 | 41.0 | 80 | 81 | 82 | 84 | 85 | 87 | 88 | 89 | 90 | 91 | 93 | 94 | 95 | 97 | 98 | 99 | 101 | 102 | 103 |
| 107 | 41.5 | 80 | 81 | 83 | 84 | 85 | 87 | 88 | 89 | 91 | 92 | 94 | 95 | 96 | 98 | 99 | 100 | 102 | 103 | 104 |

Stress threshold
Mid-moderate stress
Moderate-severe stress
Severe stress

**Süt Sığırlarında Sıcaklık Stresinin Verim Özelliklerine Etkileri**

Çevre sıcaklığı yüksek ortamlarda bulunan süt sığırları, sıcakla baş edebilmek için terleme, solunum sayısını artırma, su tüketimini artırma, yem tüketimini azaltıp, serin zamanlarda beslenme, gölgelik arama, süt verimi ve döl veriminde azalma şeklinde fizyolojik ve davranışsal tepkiler gösterirler (De Rensis ve Scaramuzzi, 2003; West, 2003). Sıcaklık stresine maruz kalan hayvanlarda refah düzeyi azalarak, verimleri de düşmektedir.

**Beslenme ve Yem Tüketimine Etkisi**

Sıcaklık stresi altındaki hayvanlarda ilk olarak yem tüketiminde ve süt veriminde azalma görülmektedir (West, 2003; Arieli ve ark., 2004; Atasever ve ark., 2007). Atasever ve ark., (2007) belirttiğine göre günde 30 litreden fazla süt veren ineklerde, 25°C'nin üzerindeki sıcaklıklarda iştah azalırken, 30°C'nin üzerinde yem tüketiminde düşme gözlenmekte, 40°C'nin üzerinde ise yem tüketimi tamamen durmaktadır. Ayrıca verilen rasyon tipine göre hayvanlara serbest yemleme şeklinde kuru ot, silaj ve kesif yem veriliyorsa, 25°C'nin üzerinde önce kuru ot tüketiminin azaldığı, 30°C'nin üzerinde silaj tüketiminin düştüğü belirtilmiştir. Kesif yem tüketimi 35°C'yi geçinceye kadar normal olarak devam eder. Sıcaklığın yem tüketimine etkisi, vücut sıcaklığını ayarlayan merkezlerin doğrudan regülasyonu, ısı üretiminin düşmesi, solunum sayısındaki artış, yem kaynaklarından uzaklaşarak gölge arama gibi etkenlerden kaynaklanır (Atasever ve ark., 2007; Sarı, 2013).

Sıcaklık stresi altındaki sığırlar yem tüketim davranışlarını değiştirerek gündüz yerine akşam saatlerinde yem tüketme eğilimindedirler. Ancak saatlerinde tüketilen yemler hayvanın ihtiyacını karşılamaya yetmez ve süt verimi düşüklüğüne sebep olur. Bu durumu önlemek için yemliklere yakın yerlerde yapılan serinletme araçları (Fanlar, fıskiye vb.) kurularak gündüz saatlerinde yem tüketimi sağlanabilir. Meralarda otlatılan hayvanlar ise sabah, akşam gibi serin saatlerde otlatılma yapılmalı, sıcak saatlerde uzun süre güneş altında kalmamalıdırlar (West, 1996; Yavuz ve Biricik, 2009).

Maust ve ark. (1972) çevre sıcaklığının 30°C'nin üzerine çıkması ile kesif yem tüketimi %5, kuru ot tüketimini ise %22 azaldığını belirtmişlerdir. Kaba yem tüketiminin çok daha fazla oranda azalması asidozis oluşumuna sebep olabilir. TMR yem karması şeklinde yemleme yapılması yem seçimini engelleyerek asidozisi önleyebilir. Sıcaklık stresi altındaki hayvanlar su tüketimini arttırırlar. Su, bünyede ve süt yapısında önemli rol oynadığı gibi vücudu serinletme ve sıcaklığın uzaklaştırılmasında da önemli görev alır (Yavuz ve Biricik, 2009; Sucu ve ark. 2015).

Çizelge 3'de görüldüğü gibi hava sıcaklığı arttıkça kuru madde tüketimi azalarak su tüketimi artmaktadır.

**Çizelge 3.** Süt sığırlarında kuru madde ve su tüketiminin hava sıcaklığına göre değişimi (West, 1996)

| *Sıcaklık (℃)* | *10 ℃'de ihtiyaç duyulan yaşama payı (YP) (%)* | *Kuru Madde (kg) tüketimi, (YP + 27 kg süt için)* | | *Su Tüketimi (lt/gün)* |
|---|---|---|---|---|
| | | **İhtiyaç (kg/gün)** | **Sıcaklığa göre Beklenen (kg/gün)** | |
| *-20* | 151 | 21,3 | 20,4 | 53 |
| *0* | 110 | 18,6 | 18,6 | 64 |
| *20* | 100 | 18,1 | 18,1 | 68 |
| *30* | 111 | 19 | 16,7 | 79 |
| *35* | 120 | 19,5 | 16,7 | 120 |
| *40* | 132 | 20,4 | 10,4 | 105 |

**Süt Verimine Etkisi**

Sıcak havanın özellikle yaz mevsimlerinde süt sığırlarında fizyolojik zorlanmalara neden olduğunu ve süt verimini olumsuz etkilediğini Mutaf ve ark. (2002) belirtmişlerdir. Özellikle yüksek süt verimli inekler, sıcak havalara karşı daha hassas olup, düşük süt verimlilere göre daha sert tepki vermekte ve süt veriminde keskin bir düşüş meydana gelmektedir. Yüksek verimli ineklerde Haziran-Ağustos arası süt veriminde %16,1 Mayıs-Ağustos döneminde %26,2 düşüş varken, düşük verimli ineklerde bu dönemlerde sırayla %11,6 ve %15,2 oranında düşüş görülmektedir (Tapkı ve Şahin, 2006; Alkoyak ve Çetin, 2016).

Bouraoui ve ark. (2002) SNİ'nin 68'den 78'e çıkması durumunda kuru madde tüketimini %9.6, süt verimini ise %21 oranında azaldığını bildirmişlerdir. Kadzere ve ark. (2002) ise yüksek SNİ, sadece süt veriminde düşmeye sebep olmayıp, süt kompozisyonunu da etki ederek süt yağında %39,7, yağsız kuru madde de %18,9, proteinde ise %16,9 oranında azalmalara sebep olduğunu belirtmişlerdir. Bouraoui ve ark. (2002) yaz mevsimlerinde sıcak havalara bağlı olarak süt verimi ile süt yağ ve protein oranlarının düştüğünü bildirmişlerdir. Nardone ve ark. (2006) ise SNİ değerinin 72'nin üzerine olduğu durumlarda kazein, laktalbumin, IgG ve IgA seviyelerinde azalmalar gözlemlemişlerdir. Keister ve ark. (2002), gün içinde SNİ değerinin (>75) yüksek olduğu saatlerde süt veriminde 2,8 kg'lık düşüş tespit etmişler ve SNİ değerinin (<75) düşmesiyle ancak ertesi günkü süt veriminde artış gözlemlemişlerdir.2006 yılında yapılan bir çalışmada Padilla ve ark. (2006) SNİ değeri

yüksek ortamda bulunan süt sığırlarında ortalama 7,7 kg'lık bir düşme görüldüğü, hayvan başına yemden yararlanmada ise 5 kg'lık bir azalış görüldüğünü belirtmişlerdir (Sarı, 2013). Nasr ve El-Tarabany (2017) Siyah Alaca sığırlarda yaptıkları çalışmada sıcaklık-nem indeksi artışında süt yağında %0,17 oranında azalış ve somatik hücre sayısını da ise %36 oranında artış olduğunu bildirmişlerdir (Koç ve Uğurlu, 2019).

**Döl Verimine Etkisi**

Yüksek çevre sıcaklığının hayvanlarda döl verimine de olumsuz etkileri bulunmakta olup, bunlar;

• Döl verimi düşüklüğü, kızgınlık döngüsünde aksamalar,

• Embriyonik ölümler ve buzağıların düşük canlı ağırlıkta doğmaları,

• Üreme etkinliğinde (buzağılama aralığı, servis periyodu ve buzağılamadan sonra ilk tohumlama arası sürelerde uzama ) ve gebe kalma oranında düşme, .

• İç üreme organları işlevinde ve hormonal fonksiyonlarda aksama

• Sperma kalitesi ve miktarında azalma (Smith ve Harner,1996; West, 2003; Atasever ve ark. 2004).

Altınçekiç ve Koyuncu (2012), süt sığırlarında değişik mevsimlerdeki hava şartlarında gebelik oranları ile ilgili yaptıkları çalışmada, çevre sıcaklığı 21°C'de barındırılan ve vücut sıcaklığı 38,5°C olan ineklerde %48 oranında gebelik elde ederken, çevre sıcaklığı 32,2°C ve vücut sıcaklığı 40°C olan ineklerde gebelik oranının %0'lara kadar düştüğü bildirmişlerdir. 1991-2000 yılları arasında İspanya'da, kış aylarında yapılan ilk tohumlamalarda %44,4 oranında gebelik elde edilirken, yaz aylarında gerçekleştirilen tohumlamalarda ise %27,4 oranında gebelik oranı elde edildiği bildirilmiştir (Lopez-Gatius 2003; Kirdenci, 2015).

Küresel ısınmanın etkisiyle dünyanın tropikal ve subtropikal iklim kuşağında yetiştirilen inekler sıcaklık stresine daha fazla maruz kalacaklardır. Diğer bölgelerde sıcaklık stresinden kaynaklı dölverim performansındaki düşüklükler yaz aylarında görülmektedir (Rensis and Scaramuzzi, 2003; Jordan, 2003; Morton ve ark. 2007). Son 60 yılda yüksek süt veren ineklerde gebelik oranının %35'lere kadar azaldığını (Lucy, 2001), ileriki yıllarda süt sığırcılığında üreme faaliyetlerinin düşmesinde en önemli faktör olarak sıcaklık stresinin olacağı bildirilmiştir (García-Ispierto ve ark., 2007). Rensis ve Scaramuzzi (2003) ise sıcaklık stresi altındaki süt ineklerinde kızgınlık belirtilerinin belirgin olmaması ve kızgınlık tespitinin zamanında yapılamamasından dolayı gebelikler arası sürenin uzadığını bildirmişlerdir.

Arechida ve ark. (1998) sıcaklık stresine maruz kalan süt ineklerinin östrus tespitinin zorlaşması gibi problemleri ortadan kaldırabilmek için uygun bir senkronizasyon protokolünün uygulanması gerektiğini bildirmiştir (Kirdenci, 2015). Suni tohumlama başarı oranı kış mevsimlerinde ortalama %40-60 oranında iken bu oran yaz mevsiminin sıcak gün ve saatlerinde %20'lere kadar düşmektedir (Cavestany ve ark. 1985). Amundson ve ark. (2006) ise SNİ'nin 72'nin üzerinde olduğu yaz aylarında gebe kalma oranının %62 oranında azaldığını bildirmişlerdir (Köse ve Saçaklı, 2021).

**Sıcaklık Stresini Azaltma Yöntemleri**

Sıcaklık stresinin üstesinden gelmenin en kolay yolu açık yetiştiricilikte gölgeliklerin sayısını arttırmak ve serinletici fanlar kullanmaktır. Sıcaklık stresi altındaki bir ineğin günde 100 litreye yakın su tüketeceği düşünülerek yeterince suluk sayısı ile temiz ve serin su bulundurmak gerekmektedir. Suluklar gölgeliklerin altına ve sağımhane yoluna yerleştirmek, hayvanların yürüme mesafeleri kısaltmak da ek tedbir olarak alınabilir. Portatif gölgelikler mümkün ise kullanılabilir. Barınak içinde dışkı biriktirilmemeli, sık sık dışkıların uzaklaştırılması gerekmektedir (Pennington ve VanDevender, 2006).

Sağımhane önünde bekleme alanları ile sağımhaneler havasız ve sıkışık olmamalı, gerekirse fanlar veya yukardan fıskiye şeklinde serinletme yapılmalıdır. Sağımhanelerde sağım esnasında sprey şeklinde havaya su verilmesi ve fanlar ile bu suyun buharlaştırılması hayvanları serinletmede çok etkili bir yöntem olarak kullanılır (Sarı, 2013).

Güneyli ve Özkütük (1994), yaz aylarında duş sağlamanın süt verimine etkileri konulu araştırmalarında, süt veriminde %14,6 iyileşme olduğunu ve %16,7 daha fazla yem tükettiklerini bildirmektedirler. Araştırmacılar fotosel ile çalışan duşların bulunduğu padoklarda ineklerin kendi kendilerine yıkanarak serinlemeleri sağlanarak süt üretiminin yıkanmayanlara göre %17 oranında fazla olduğu ve %15 daha fazla yem tüketildiğini bildirmişlerdir (Üçeş, 2005)

Özellikle sıcak mevsim veya sıcak bölgelerde sıcaklık stresinden korunmak amacıyla süt sığırlarının rasyonlarında değişikler yapılmalıdır. Rasyonda sodyumu %0,5'den %0,6'ya, potasyumu %1,3'den %1,5'e ve magnezyumu %0,3'den %0,4'e çıkarmak sıcaklık stresini azaltmak için etkilidir. Proteinin sindirilebilmesi için fazladan enerji kullanıldığı ve dolayısıyla vücutta ısı artışına sebep olacağı için rasyonda protein oranını azaltmakta bir tedbir olarak değerlendirilmelidir (Pennington ve VanDevender, 2006; Sarı, 2013).

Süt sığırcılığında rasyonda kuru madde miktarı ve tüketimi süt üretimi ile direkt ilgili olduğu için kuru madde miktarının dengeli olması gerekmektedir. Rasyonun enerji yoğunluğunu

artırmak ve yemleme aralığını azaltmak kuru madde tüketimini arttıracaktır (Harris, 1992). Sıcaklık stresi oluştuğu durumlarda rasyona yağ ilavesi enerji tüketimini arttıracaktır. Rasyona ilave edilen yağ, hem rasyonun enerji içeriğini ve hem de yem tüketimini arttıracaktır. Sıcak havalarda sıkça ter ve idrarla atılan mineraller ilave olarak yerine koymak gerekir. Bu amaçla rasyona en az %1,5 potasyum, %0,45 sodyum, %0,35 magnezyum ilave edilmelidir (Bülbül, 2006). Sıcaklık stresi altındaki hayvanlara kaliteli kaba yemler verilerek ilave vitamin vermeden vitamin ihtiyaçları bu yemlerden sağlanabilir (Alkoyak ve Çetin, 2016).

**Sonuç ve Öneriler**

Süt sığırlarından beklenen verim ancak onlara en uygun çevre şartlarında yetiştirilmesiyle sağlanır. Süt sığırları için en uygun iklim şartları; 5-25°C'lik çevre sıcaklığı, %60-70 oransal nem, orta derecede solar radyasyon ve saatte 5-8 km'lik rüzgar hızı olarak belirtilir. Hava sıcaklığı ve nispi nem ile birbirlerine oranları hayvanların sıcaklık stresine girmeleri veya termonötral bölge dediğimiz konfor alanında normal refah şartlarında yaşamalarına sebep olur. Havadaki nem oranının yüksekliği ile vücut ısısının dengelenmesi ters orantılıdır. Günümüzde entansif üretim koşullarında yetiştirilen yüksek süt verimli hayvanlar çevre koşullarına karşı daha hassa olup sert tepkiler vermektedir. Yüksek miktarda süt üretimi için ıslah ve beslenme konuları genelde ön plana gelirken barınaklar ve çevre şartlarını düzeltecek faktörler göz önüne alınmamaktadır. Küresel ısınmanın eşiğinde olan dünyamızda yeterli çevre denetimi olmadan yüksek verim ve sürdürülebilirlik mümkün görünmemektedir. Özellikle sıcak bölgelerde veya yazı sıcak geçiren yerlerde başarılı ve sürdürülebilir süt sığırcılığı için iklim koşullarına uygun barınak yapıları kullanılmalı ve barınak içerisinde hayvanlar için uygun olan iklim şartları oluşturulmalıdır. Barınaklar, duraklı açık ya da duraksız açık barınak şeklinde planlanarak sıcaklığın ve nemin hayvanlar üzerindeki olumsuz etkilerini en aza indirmeyi sağlamalıdır. Bol miktarda gölgelikler yapılmalı, duş ve fan serinletme olanakları kullanılmalıdır.

Sıcaklık stresinden kaynaklı yem tüketiminde azalma ve dengesiz beslenmeyi önlemek amacıyla, kaliteli kaba yem, ilave mineraller ve enerji-protein dengeli beslenme yapılmalıdır. Sabah erken ve akşam nispeten serin saatlerde ve sık yemleme yapılmalı, yemlikler etrafına fanlar ve fıskiyeler konumlandırılmalıdır. Suluklar barınak içerisine hayvanların kolay erişebilecekleri sıklıklarla yerleştirilmeli ve içinde daima soğuk ve temiz sular bulundurulmalıdır.

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# COMPARATIVE EVALUATION OF MINT CULTIVARS: CHLOROPHYLL CONTENT, SOME MORPHOLOGICAL TRAITS AND FERTILIZATION IMPACT

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## Abstract
Peppermint is extensively cultivated in subtropical and temperate climate regions. It has adapted well to temperate climates with high precipitation patterns. Plant nutrition is one of the most important factors that increase plant production. In order to meet these nutritional requirements, fertilizers are classified into organic fertilizers and chemical fertilizers based on the forms they contain and used accordingly. In this study, it was aimed to compare some morphological characteristics of three *Mentha piperita* cultivars and determine the effect of microbial fertilizer and commercial fertilizer on these characteristic features. In the study, three cultivars of *Mentha piperita* were used as the plant material. These varieties are Multimentha, Chocolate and Swiss. The research was conducted in the 2019-2020 growing season in the experiment field of the Field Crops Department of Aydın Adnan Menderes University. Leaf length (cm), leaf width (cm) stem diameter (mm) and chlorophyll (SPAD) values were measured. The results showed significant variation among the Swiss, Multimentha and Chocolate cultivars. These results highlight the importance of considering genetic factors when evaluating and comparing different *Mentha* cultivars, which may have implications for breeding programs, cultivation practices and use of these cultivars in various industries. Further research is required to explore the underlying mechanisms driving these variations and their potential impact on the quality and yield of *Mentha* cultivars.
**Keywords**: Multimentha, Chocolate, Swiss, chlorophyll, leaf, SPAD, *Mentha piperita.*

## Introduction

Peppermint (*Mentha piperita* L., *Lamiaceae*.) is a high-demand aromatic and medicinal crop that is vegetatively propagated through stolon and rhizomes (Verma et al. 2013). Peppermint is a sterile hybrid plant derived from a cross between M. *aquatica* and M. *spicata* (Abbaszadeh et. al., 2009). Peppermint oil is used both as a medicinal and flavoring agent in foods and confectionery (Ayyobi et. al., 2014; Milovanovic´ et. al., 2009). Peppermint is a perennial crop grown by transplanting in the spring and has an average lifespan of about 6 years (Ayyobi et al. 2014).

Peppermints have structures both underground and above ground called rhizomes and stolons. Flowering usually occurs between July and September (Arslan, 2018). Peppermint is extensively cultivated in subtropical and temperate climate regions. It has adapted well to temperate climates with high precipitation patterns. While it is not selective regarding soil requirements, it thrives best in moist and humus-rich soils, which are considered ideal for cultivation (Karakaplan, 2017).

Peppermint is a long-day plant that blooms when exposed to daylight for 14 hours or more. Under short-day conditions, it forms numerous stolons. Medicinal mint is a freeze-resistant plant. Its above-ground parts die off during winter, and it produces numerous new shoots in spring. All mint species can be propagated vegetatively, either through stolons, rhizomes or stem cuttings. Generative propagation, on the other hand, can be used in breeding programs for mint varieties that produce seeds (Arslan, 2018).

Plant nutrition is one of the most important factors that increase plant production. Nitrogen (N) is the most recognized in plants for its presence in the structure of the protein molecule. Accordingly, N plays an important role in the synthesis of the plant constituents through the action of different enzymes (Leghari et. al., 2016).

The application of nitrogen (N) contributes to the development of leaf area and overall plant assimilation and increasing yield (Bhardwaj and Kaushal, 1989;). Consequently, soil is the primary source of essential nutrients for plants, including nitrogen and phosphorus. The nutritional requirements of plants are obtained through chemical or natural plant nutrition products known as fertilizers. Chemical fertilizers are solid or liquid substances containing one or more plant nutrients, produced using chemical methods. They are directly applied to the soil by dilution or dissolution, or sprayed onto the foliage and above-ground parts of plants (Kovacs et. al., 2012).

Fertilizers are classified into organic fertilizers and chemical fertilizers based on the forms of they contain. Organic fertilizers primarily include the solid and liquid manure of large and small livestock. Chemical nitrogen fertilizers are derived from ammonia, and all nitrogen-based chemical fertilizers are produced from ammonia. Microbial fertilizers, which enhance plant productivity, are a relatively new application in many countries (Kovacs et. al., 2012). There is a growing demand for naturally derived agrochemicals to support sustainable farming systems, and organic production restricts the use of synthetic chemicals (Ayyobi et al., 2014).

In this study, it was aimed to compare some morphological characteristics of 3 *Mentha piperita* cultivars and to determine the effect of microbial fertilizer and commercial fertilizer on these characteristics.

## Materials and Methods

### Material

In the study, three cultivars of *Mentha piperita* were used as the plant material. These varieties are Multimentha, Chocolate, and Swiss. Stolons were obtained from previously propagated seedlings in pots under greenhouse conditions. After stolons were rooted seedlings were planted in the field.

The research was conducted in the 2019-2020 growing season in the Medical Plants Experiment area of the Field Crops Department of Aydın Adnan Menderes University Faculty of Agriculture Research and Application Farm.

The experiment was established on 15.05.2019 with 3 replications according to the split-plot experimental design, with different fertilizer treatments (control, commercial fertilizer, microbial fertilizer) in the main plots and mint cultivars (Multimentha, Swiss, Chocolate) in the sub-plots. Each plot consisted of an area of 3.2 m², 2 m long and 1.6 m wide.

The 10-15 cm long stolons of the varieties were removed from the pots and were planted at 17.05.2019 in the rows opened at a depth of 5-8 cm in the soil. Stolons were planted 40 cm between rows and 20 cm above rows.

### Measured Parameters

**Leaf length (cm):** The length of 10 plant leaves was taken randomly and measurement was made where the petiole ends to the very tip of the leaf.

**Leaf width (cm):** The distance of the widest parts of the leaves of 10 selected plants was measured.

**Stem diameter (mm):** The diameter of 10 selected plants was measured with caliper.

**Chlorophyll value (SPAD):** One leaf from each of the 3 randomly selected plants was measured and averaged.

**Evaluation of the data**

The experiment was established according to the split-plot design. Analysis of variance was performed according to Jmp Pro statistical package program. Statistically significant traits were grouped according to LSD test.

**Findings and Discussion**

In this study, the values obtained from the investigated traits and the results of variance analysis of these values are given in Table 1. As a result of the analysis of variance, LSD test was applied to determine the significance of the factors. According to the results, LL, LW, SD and SPAD values were found to be significant at **P<0.01 level among cultivars. There was no statistically significant effect of fertilizers and fertilizer*cultivar application.

**Table 1.** Variance Analysis Table

| Variation Sources | Mean Square | | | |
|---|---|---|---|---|
| | LL | LW | SD | SPAD |
| Repition | 0.314 | 0.031 | 0.110 | 11.47 |
| Fertilizer | 0.720ns | 0.0372ns | 0.111ns | 4.2956ns |
| Error-1 | 0.367 | 0.027 | 0.077 | 99.01 |
| Cultivar | 3.770** | 0.606** | 2.046** | 687.913** |
| Fert*Culttivar | 0.349ns | 0.019ns | 0.065ns | 12.235ns |
| Error | 0.266 | 0.018 | 0.102 | 297.27 |

(**P<0.01, *P<0.05)

Regarding the impact of various types on leaf measurements, Swiss cultivar had a leaf length of 3.67 cm and was grouped separately from the Multimentha and Chocolate cultivars. Multimentha variety had the highest leaf width value of 2.01 cm, followed by Swiss with 1.69 cm and Chocolate with 1.50 cm. Each variety was distinguished from the others by being in a separate statistical group.

Multimentha cultivar had the highest leaf stem diameter measurement of 2.55 mm, followed by Chocolate with 1.82 mm and Swiss with 1.66 mm. The Multimentha cultivar was statistically separated from the other two cultivars and was classified into a different group. Regarding the SPAD value, Multimentha and Chocolate cultivars had the highest measurements of 55.91 and 51.04, respectively. The Swiss cultivar had the lowest value with 38.93 value (Figure 1).

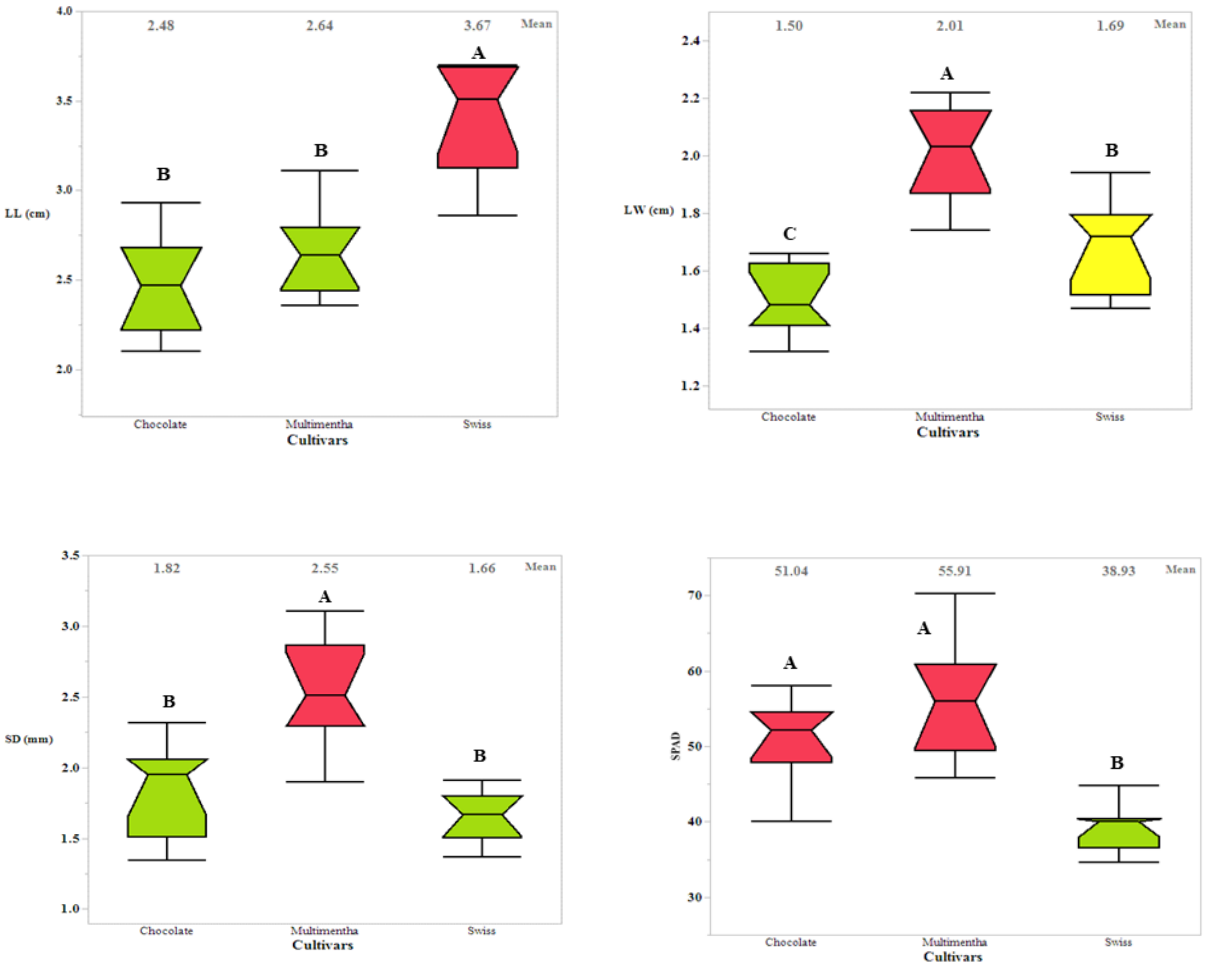


**Figure 1.** Mean values of leaf length (LL), leaf width (LW), stem diameter (SD) and SPAD parameters of different cultivars of *Mentha piperita*.

Abbaszadeh et al. (2009) investigated the leaf length of different *Mentha* species grown under similar environmental conditions. *M. piperita* exhibited the highest leaf length (4.01 cm), while *M. longifolia* exhibited the lowest (2.02 cm). The research suggests that leaf length may be correlated with environmental adaptation. According to Zeinali et al.'s (2004) study, the leaf width ranged from 1.30 cm to 2.33 cm, and the leaf length ranged from 3.3 cm to 5.1 cm within the Mentha species. Mohammadi and Asadi-Gharneh's (2018) study revealed that the highest leaf length was 5.08cm while the lowest was 0.76cm and stem diameter ranged from 0.31 to 0.76cm. Likewise, the highest leaf width was 2.83cm while the lowest was 0.96cm. Jiang et al.'s (2022) study found that *Mentha piperita* 'chocolate' and *Mentha* spicata exhibited a mean leaf width of 2.30 and 2.08 cm, respectively. Karkanis and et al. (2018) and and et al. (2021) found that the SPAD values of *Mentha piperita* species were between 39.48-53.15 and 35.40-47.45 respectively. Comparing our results with previous studies, Abbaszadeh et al. (2009) found variations in leaf length among different *Mentha* species, suggesting a potential

correlation between leaf length and environmental adaptation. Zeinali et al. (2004) also reported variations in leaf width and length within *Mentha* species, highlighting the diversity in these traits. Mohammadi and Asadi-Gharneh (2018) further supported this variability by presenting a wide range of leaf measurements across different *Mentha* species.

Moreover, Jiang et al. (2022) specifically noted the leaf width of *Mentha piperita* 'chocolate' and *Mentha spicata*, shows the variability even within closely related species. Additionally, Karkanis et al. (2018) and Chrysargyris et al. (2021) reported a variation of SPAD values for *Mentha piperita* species.

**Conclusion and Recommendations**

Our study investigated the impact of different *Mentha* varieties on leaf measurements, specifically focusing on leaf length, leaf width, stem diameter and SPAD values. The results demonstrated notable variations among the Swiss, Multimentha and Chocolate cultivars in these aspects. Swiss variety exhibited a leaf length of 3.67 cm, while Multimentha had the highest leaf width at 2.01 cm. Additionally, Multimentha displayed the largest stem diameter with a measurement of 2.55 mm. In contrast, the SPAD values revealed that Multimentha and Chocolate had higher chlorophyll content, with measurements of 55.91 and 51.04, respectively, while Swiss had a lower SPAD value of 38.93. These findings indicate that different *Mentha* varieties possess distinct morphological and physiological characteristics, which could be attributed to genetic factors, environmental conditions, or a combination of both. In summary, our study contributes to the growing knowledge on the morphological and physiological diversity of *Mentha* varieties. These findings emphasize the importance of considering genetic factors when assessing and comparing different *Mentha* cultivars, which can have implications for breeding programs, cultivation practices and the utilization of these varieties in various industries. Further research is needed to explore the underlying mechanisms driving these variations and their potential impacts on the quality and yield of *Mentha* plants.

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# EFFECTS OF SOME HERBAL ESSENTIAL OILS GROWN UNDER ORGANIC CONDITIONS AGAINST AGRICULTURAL DISEAS AND PESTS

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**Abstract**
Due to the increase in the world population and the increase in the need for food, intensive production has also brought about an increase in diseases and pests in plants. Chemical control has been seen as a solution to these increases, but this has caused environmental pollution, residues in the food chain, and toxicity and various negative effects on living things. In organic agriculture, there has been a trend towards alternative control methods in order to minimize chemical inputs. The search for alternative natural compounds for the control of plant protection factors, including weeds, has gained momentum. In recent studies, it has come to the fore that herbal extracts and essential oils obtained from medicinal and aromatic plants are effective in combating due to their allelopathic effects. In addition, it is thought that extracts and essential oils of some plants can be used easily against the larvae of various insects and pests in controlled areas where organic farming is carried out. In our country, which is rich in plant biodiversity, it is of great importance to examine the effects of some medicinal and aromatic plants containing essential oil against agricultural diseases and pests and to include them in the fight. It is necessary to optimize the doses that can be used for the application of some vegetable essential oils grown under organic conditions and to enrich the literature on application methods. In this study, information about how some herbal essential oils can be used in the fight against agricultural diseases and pests as herbicide, insecticide, acaricide, nematicide, antifungal, antibacterial and antiviral and the results obtained were compiled.
**Keywords:** Essential oil, organic farming, pesticidal effects, agricultural diseases and pests

## Introduction

Organic farming is an area of activity that employs the majority of the population, meets the nutritional needs of them and other living creatures, provides raw materials to the industrial sector, and constitutes a large part of the national economy, especially in recent years.(Bayar, 2018) (Bayar, 2018) Some activities in the field of agriculture can cause negative consequences such as environmental pollution, decrease in biodiversity, global warming and depletion of the ozone layer. Negative changes are quite high in agricultural areas. Instead of increasing the yield and quality products per unit area, meadows and pastures are used for non-agricultural purposes such as industry and urbanization. (Tan *et al.*, 2022)

Nowadays, modern environmentalism and sustainable organic farming practices come to the fore and it is emphasized that nature is not an unlimited source of production. In contrast to conventional agriculture with high inputs, it is important to use organic farming practices where inputs are kept at a controlled and minimal level. Considering the use of more intense chemical applications and their negative effects in conventional agriculture compared to organic agriculture, alternative control methods are of great importance in agricultural production. (Fenibo, Ijoma and Matambo, 2021) It is seen that chemical inputs are mostly used in agricultural production to combat diseases and pests. There is a trend towards biological control in order to prevent both environmental and health problems arising from the use of pesticides. There is a need to improve existing methods or research new methods in biological control.(Boz, 2019)(Tariq *et al.*, 2020) Plant essential oils are used in these alternative control methods. and herbal extracts. Today, the plant kingdom is represented by approximately 300 families, and one third of them contain essential oils. Important families containing essential oil-containing species are Asteraceae, Apiaceae, Brassicaeae, Compositaceae, Chenopodiaceae, Cupressaceae, Lauraceae, Lamiaceae, Myrtaceae, They are Ridaceae, Rutaceae, Rosaceae, Pineaceae, Poaceae and Zingiberaceae.(Kesdek *et al.*, 2015)(El Khetabi *et al.*, 2022)

Essential oils are frequently preferred in areas such as cosmetics, food and perfumery due to their additive, preservative, fragrance and disinfectant properties. Studies have reported that more than two hundred plant species have the potential to be used as pesticides, but only 1% of this has been evaluated today. Many researchers have obtained positive results on the use of essential oils in combating diseases and pests in agricultural production. Alternative control methods have gained importance due to the side effects of chemicals on both the environment

and health. The use of essential oils has come to the fore. (Kar, Gupta and Gupta, 2018)(Dhifi *et al.*, 2016)

In this study, essential oils types and areas of use according to the area used, in the fight against diseases and pests information on topics such as the active ingredients used is given. Essential oils from aromatic, fragrant plants. It is obtained by various methods, is in liquid form at room temperature, can easily evaporate and crystallize. They are volatile, pungent-smelling, oily substances that can be carried with water vapor and give their scent to many plants. Plants have the ability to synthesize two types of oils; fixed oils and essential oils. While fixed oils consist of esters of glycerol and fatty acids (triglycerides or triacylglycerols), essential oils are complex mixtures of semi-volatile and volatile organic compounds from a single botanical source that give the plant its unique aroma and scent. Essential oils are mixtures with strong odors that are produced from plants using different methods, are in liquid form at room temperature.

**Properties sof essential oils**

They don't become bitter because they don't contain fatty acids and glycerol in their structure. They are dragged by water vapor and they do not leave stains. They are mostly colorless, but sometimes they can be light yellow and sometimes colored (such as medicinal chamomile and clove oil). Many of them are fragrant. Plants containing essential oils are rich in bioactive components such as terpenoids, alkaloids and flavonoids that can be used against pests. The most studied group regarding their effects on harmful insects has been terpene compounds. Especially monoterpenoid compounds have been considered as potential pest control agents due to their toxicity to insects and their repellent and anti-eating properties. For example; most coniferous plants produce monoterpenes and thus resist the attack of bark beetles. Extensive research has been carried out for the last 30 years to investigate plant-based pesticide sources. It has been determined that essential oils obtained from many plant species widespread in our country have insecticidal effects against different insect species. The limonoid contained in Melia vollkensii is a plant that is toxic to a wide range of pests such as Diptera, Lepidoptera and Coleoptera.

Pyrethrin-based preparations obtained from the Chrysanthenum cineraria (Silver button) plant have been used against biting and sucking insects for years. Mint, pine and cumin oils are used as insecticides and acarici

des. The essential oil obtained from the Cymbopogon nardus (Sweet herb) plant has been shown to be an effective repellent against mosquitoes. Containing essential oil containing substances such as saponin, tannin, thymol, kavrakrol. By sprinkling thyme (Thymus sp.) around vegetables, squash fleas, potato bugs and various lepidopter larvae seen on tomatoes are removed.

**Chemical Structure of Essential Oils**

Essential oil is a natural product obtained from the leaves, fruits, barks or roots of plants, is liquid at room temperature, can easily crystallize, is generally colorless or light yellow, volatile, with a strong odor. It is called essential or essential oil because of its pleasant smell. They are used as oil because they do not mix with water. Although they are defined, they are different from fixed oils.(Akhtar, Swamy and Sinniah, 2019)(Butnariu and Sarac, 2018)

Terpenes constitute the largest group in the chemical structures of essential oils. However, it also contains small amounts of alcohols, aldehydes, esters, phenols, nitrogen and sulfur-containing compounds.(Álvarez-Martínez *et al.*, 2021)(Hyldgaard, Mygind and Meyer, 2012) Oxygenated derivatives formed by the oxidation of terpenes are substances with odor, taste and therapeutic properties. Essential oils, which are lighter than water, are optically active and generally have high refractive indexes. Therefore, when some essential oils are stored for a long time, they should be kept in dark colored bottles with their mouths closed, as they resinize under the influence of light and oxygen.(Masyita *et al.*, 2022)

In recent years, interest in aromatherapy, which is seen as a branch of alternative medicine, has also increased the use of essential oils. Essential oils are used in therapeutic massages or relaxing baths. Apart from this, essential oils are widely used in perfume, cosmetics, food and beverage industries, and household cleaning products.is used. Since some oils such as cedar and lavender attract attention with their insect repellent properties, research has been concentrated on this subject.(Linskens and Amherst, 1999)

**Obtaining Methods of Essential Oils**

Water distillation (Hydrodistillation) is a widely used traditional method for obtaining volatile compounds. The distillation process, which is carried out with a Clevenger type apparatus in small-scale production, is carried out in large distillation boilers in industrial applications.(Mokheimer *et al.*, 2019)(Linskens and Amherst, 1999)

The production technique is based on boiling water and plant material in a glass flask connected to a cooler for a period of two to eight hours, and oil molecules moving with water vapor are condensed in the cooler and separated from the water. The amount of essential oil

obtained is expressed volumetrically. The best results in water distillation are obtained with powdered materials such as root or wood flour.(Tan *et al.*, 2022)As high temperature is applied in this technique, the amount of oil obtained increases. At the same time, some thermal reactions occur during boiling of water. As a result, artifact formation, hydrolysis and isomerization events occur. As seen in Figure 1, a thermal degradation occurs due to the effect of temperature and is frequently encountered in distillation methods. The composition of essential oils varies depending on the pH level. However, in the water distillation technique, the pH value of the liquid is generally not controlled.

Another technique used is the extraction method. In this method, plant material can be directly immersed in the solvent at room temperature or boiled with organic solvent in a soxhlet. Hexane and ethanol as organic solvents in industrial studies; in analytical laboratory studies, ether and pentane-dichloromethane (2:1) are used. After the extraction process is completed, the organic solvent is removed from the environment by distillation and recycled. It is obtained as volatile compounds in the remaining oily part.(Sethunga *et al.*, 2020)(Airase, 2015)

Supercritical fluid extraction technique (Supercritical fluid extraction), which consumes less solvent, has a shorter extraction time and has the ability to separate compounds that dissolve at high temperatures under normal conditions, is attracting great attention in terms of both environment and health. This technique is actually a solvent extraction process. Instead of organic solvents, substances that have supercritical fluid properties are used as solvents. While it can dissolve many substances with the dissolving power of liquid solvents, it also rapidly disperses the dissolved substance with its diffusion coefficient close to gases.(da Silva, Rocha-Santos and Duarte, 2016)(Herrero *et al.*, 2010)

In the cold pressing technique, raw materials are turned into powder by mixing, grinding and compressing at room temperature. Since no heat treatment is applied in the cold press method, high quality essential oil is generally obtained. These oils are generally suitable for direct consumption and do not require refining. Because this technique is preferred due to its wide usage areas, simple use, no need for manpower, low cost, environmental friendliness, absence of harmful organic solvents and quality production opportunities. (Çakaloğlu, Özyurt and Ötleş, 2018)(Li *et al.*, 2021)

**Mechanism of effect of essentia oils against pests**

Essential oils have the following effects against pests: through fumigant effect, through contact effect, through nutrition.

**Fumigant effect:** It is a method mostly applied on warehouse and greenhouse pests, since the volatile compounds in essential oils are effective on pests through respiration. 22 essential oils Acanthoscelides obtectus (Bean seed bug) has been observed that it has fumigant effects on humans. 3 different doses of 6 different plant essential oils have an insecticidal effect of 16.6-100% on *Callosobruchus maculatus* (cowpea seed bug) *Satureja hortensis, Origanum basilicum and Thymus vulgaris*.(Ketoh *et al.*, 2005) It was observed that the effects of plant essential oils were toxic to *Bemisia tabaci* adults and *Tetranychus urticae* Koch adults and nymphs, and they stated that the essential oils obtained from these 3 plants could be used as potential control agents in greenhouse conditions.(Cathérine Regnault-Roger, A. Hamraoui, M.Holeman, E. Theron, 1993)

**Contact effect:** It is effective by spraying essential oils on the pest and taking in the essential oil concentration through the cuticle. *Thaumetopoea pityocampa* (Pine processionary beetle), which damages forests, especially pine trees, causes 100% death from 8 plant essential oils in its 2nd, 3rd and 4th larval stages.(Kanat and Alma, 2004) 12 pure oxygen monoterpenes, at 2 different doses, caused 20-100% mortality in the 2nd and 3rd larval stages of the potato beetle.(Hikal, Baeshen and Said-Al Ahl, 2017)

**Nutritional inhibitory mechanism of action:** Antifeedants are compounds that, when tasted by insects, stop feeding permanently or temporarily. Azadirachtin, which has commercial preparations today, is a limonoid obtained from the seeds of the *Neem tree* (Azadirachta indica, Meliaceae) and is used as an effective feeding inhibitor and growth inhibitor against many insects.(Isman, 2002) Larvicidal effects of essential oils of *Satureja spinosa, S. parnassica, S. thymbra and S. montana* plants were tested against Culex pipiens biotype molestus. According to the analysis results, the oils were found to have significant larvicidal effects, and researchers reported that their mixture with natural substances could be used as inexpensive potential sources for the control of mosquito larvae.(Kilani-Morakchi, Morakchi-Goudjil and Sifi, 2021)

**Insecticidal Effect Mechanism of Essential Oils**

Insecticidal action mechanisms of essential oil and its components are focused on acetylcholinesterase activity and octopaminergic system in insects. Essential oils on cockroaches, after the application, the insects started to become hyperactive, their heartbeat

accelerated, and then excessive tension appeared in the legs and abdomen. Following these, the insect quickly fell to the ground, became immobile, and died. It is reported that these symptoms are caused by octopomin receptors.(Enan, 2001) The reasons for focusing on essential oils obtained from plants and their main components are that they do not release toxic substances into nature, do not break down in a short time and cause soil and water pollution, and do not create long-term residues on products that may threaten human health. Studies conducted to date have shown that essential oil components are effective against pests such as insecticide (insecticide), egg killer (ovicide), attractant, repellent. It has been shown that it has effects such as inhibiting nutrition (antifeedant) and inhibiting development and reproduction.(Corrêa *et al.*, 2023)(Jankowska *et al.*, 2017)

**Conclusions**

There is great interest in combating diseases and pests that significantly affect productivity and quality in agricultural production. At the same time, there is a strong opinion that the use of chemical methods should be reduced and the fight against environmentally friendly plant-based inputs should be supported. In recent years, underground and aboveground resources have been rapidly depleted, and in order to prevent this situation, the use of synthetic products must be controlled and restricted. Therefore, it is necessary to develop alternative methods to combat diseases and pests, which constitute a large part of the use of chemicals in organic agriculture. Although it is known that essential oils have properties such as insecticides, fungicides, nematicides and herbicides in organic agriculture, their practical applications are very few. It is important to implement laboratory experiments for the practical use of essential oils in production areas and to enrich literature research in this field. It is thought that the essential oils used in the studies can be an alternative to insecticides used in the fight against insects, and since they are friendly to nature and the environment, they can be used easily in organic farming areas, greenhouses, cold storages, small gardens, that is, in controlled environments. Studies should be carried out to clarify the structures of essential oil components so that they can be produced synthetically or even structurally modified to increase their effectiveness against pests. The side effects of plant-based pesticides in terms of the environment and human health must be investigated and their reliability must be demonstrated through scientific studies.

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# LISIANTHUS (*Eustoma grandiflorum* (RAF.) SCHINN.) FİDE ÜRETİMİNDE KARŞILAŞILAN SORUNLAR

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**Özet**
Lisianthus (*Eustoma grandiflorum* (Raf.) Shinn.), süs bitkileri pazarı için nispeten yeni bir kesme çiçek türüdür. Lisianthus, gül benzeri çiçekleri, uzun çiçek sapları ve uzun vazo ömrü nedeniyle dünyanın en popüler on kesme çiçeğinden biri haline gelmiştir. Bu derlemenin amacı, Lisianthus yetiştiriciliğinde fide aşamasında karşılaşılan sorunların temel nedenlerini ayrıntılı bir literatür taramasına dayanarak ortaya koymak ve çözüm önerilerinin kısa bir özetini sunmaktır. Tohumları ile çoğaltılan kesme çiçek türülerinden biri olan Lisianthus'un tohum çimlenme süreci, çimlenen tohumları korumak için kontrollü bir ortam (optimum ışık, sıcaklık ve nem seviyesi) gerektirmesi gibi nedenler bu türün çimlenme ve fide dönemini zahmetli ve maliyetli kılmaktadır. Lisianthus fide dönemi çeşide bağlı olarak yaklaşık 3 ay sürmekte ve fide aşaması da oldukça zordur. Lisianthus fidelerinin tohumdan yetiştirilmesinin uzun zaman alması nedeniyle üretici doğrudan hazır fide almayı tercih etmektedir. Bu derlemede, Lisianthus fide üretiminde kullanılan materyallerden bahsedilerek yaşanan sorunlar tartışılmıştır. Ayrıca Lisianthus fidesi dikimi ve bakımı konuları ele alınarak karşılaşılan sorunlar sıralanmıştır. Lisianthus kesme çiçek yetiştiriciliğinde hazır fide kullanımına dikkat çekilmiştir. Bu derlemenin Lisianthus fide üretmeyi planlayan üreticilere yol gösterici olabileceği kanaatindeyiz.
**Anahtar Kelimeler:** Lisianthus, rozet, fide, kesme çiçek, süs bitkileri.

# PROBLEMS ENCOUNTERED IN LISIANTHUS (*EUSTOMA GRANDIFLORUM* (RAF.) SCHINN.) SEEDLING PRODUCTION

**Abstract**

Lisianthus (*Eustoma grandiflorum* (Raf.) Shinn.) is a relatively new cut flower species for the ornamental market. Lisianthus has become one of the ten most popular cut flowers in the world due to its rose-like flowers, long flower stems and long vase life. The aim of this review is to reveal the main reasons for the problems encountered at the seedling stage in Lisianthus cultivation, based on a detailed literature review, and to present a brief summary of solution suggestions. The seed germination process of Lisianthus, one of the cut flower species propagated by seeds, requires a controlled environment (optimum light, temperature and humidity level) to protect the germinating seeds, making the germination and seedling period of this species difficult and costly. Lisianthus seedling period lasts approximately 3 months depending on the variety, and the seedling stage is quite difficult. Due to the long time it takes to grow Lisianthus seedlings from seed, the producer prefers to purchase ready-grown seedlings directly. In this study, the materials used in the production of Lisianthus seedlings were mentioned and the problems experienced were discussed. Additionally, the issues of planting and care of Lisianthus seedlings are discussed and the problems encountered are listed. Attention has been drawn to the use of ready-made seedlings in Lisianthus cut flower cultivation. We believe that this review can be a guide for producers who plan to produce Lisianthus seedlings.

**Keywords:** Lisianthus, rosetting, seedling, cut flower, ornamental plants.

**Giriş**

Kesme çiçekler; kesilerek toplanan, buket, sepet, çelenk yapımında kullanılan, dünyada en çok ticareti yapılan süs bitkileri grubudur. Kitlesel olarak üretilebilmesi, taşıma kolaylığı gibi nedenlerden dolayı dünya süs bitkileri ticaretinin yarısı kesme çiçeklere aittir (Doğaka, 2015). Dünyada yaklaşık 50'den fazla ülkede kesme çiçek üretimi yapılmaktadır (Anonim, 2015). Uluslararası ticareti yapılan en yaygın kesme çiçek türleri gül, karanfil, krizantem, gerbera, glayöl, gypsophila, orkide, antoryum, lale ve zambaktır (Naing & Kim 2020).

Süs bitkileri pazarı için nispeten yeni bir kesme çiçek türü olan (Hankins & Mullins, 2019) Lisianthus (*Eustoma grandiflorum* (Raf.) Shinn.), 1800'lerin ortalarından beri Amerika Birleşik Devletleri'nde ticari kesme çiçek olarak yetiştirilmektedir. Lisianthus, Güney Amerika Birleşik Devletleri ve kuzey Meksika'nın sıcak bölgelerinde ortaya çıkan Gentianaceae familyasına ait bir türdür. Lisianthus sistematikte; Magnoliopsida sınıfı, Gentianales takımı, Gentianaceae familyası, Eustoma cinsi, *Eustoma grandiflorum* (Raf.) Shinners türü olarak tanımlanmaktadır (Özkan, 2017). Bitki, Amerika Birleşik Devletleri'nde 1980'lerin başında tohum kataloglarında ilk listelendiğinde genellikle *Lisianthus russellianus* olarak bilinmekteydi. Bilimsel adının *Eustoma grandiflorum* (Raf.) Shinn olduğu kısa bir süre önce anlaşılmıştır (Bailey & Baily, 1976; Everett, 1981). Yetiştiriciler "Lisianthus" cinsi adını kullanmaya alıştıkları için, bugün hala *Eustoma grandiflora* için yetiştirici ve halk Lisianthus ismini kullanmaktadır (Harbaugh, 2007). Lisianthus, son 30 yıl içinde, dünyadaki en popüler on kesme çiçekten biri haline gelmiştir (Azadi et al., 2016; Fang et al., 2018). Lisianthus'a dünya çapında hem ekonomik hem de kültürel açıdan ilgi artmaktadır. Artan bu ilginin temel nedenleri, gül benzeri çiçekleri, uzun çiçek sapları, uzun vazo ömrünün olmasıdır (Uddin et al., 2015; Li et al., 2022). Lisianthus, saksılı bitki olarak da kullanılabilmektedir (Hankins & Mullins, 2019). Kesme çiçek olarak yetiştiriciliğinde çiçekler kademeli olarak hasat edilebilmekte bu da türün hasat süresinin nispeten uzun olmasını sağlamaktadır. Lisianthus henüz Türkiye'de yeterince tanınmamakta ancak, giderek tanınması ve talebi artmaktadır. Bu bağlamda, 2022 yılında 14 978 100 adet ile Lisianthus Türkiye kesme çiçek sıralamasında yedinci sırada yer almıştır (TÜİK, 2023). Lisianthus, 20 ile 40 arasında değişen çiçek sayısına, 50 ile 70 cm yüksekliğe ulaşan çiçek sapı uzunluğuna sahip ve genellikle yaz mevsiminde çiçek açan kesme çiçek türlerinden biridir (Cantor et al., 2013). Mavimsi yeşil yapraklı, bazen dik ve tek gövdeli veya dallı gövdeli otsu yapıda bir bitkidir. Kontraktil kökler bitkiyi toprağa bağlamada ve saçak kökler ise besin maddelerinin alımında etkilidir. Lisianthus'ta iyi bir kök sistemi sağlamak için nispeten yüksek bir toprak pH'sı

gerekmektedir. Çiçeğin çapı 5 cm'ye kadar büyüyebilmekte ve çeşitli renklerde bulunabilmektedir (Shah et al., 2018). *Lisianthus*'un yabani türü, hem kendi kendine hem de çapraz tozlaşma yeteneğine sahip diploid bir türdür. Türün bu döllenme biyolojisi çeşit zenginliğine neden olmaktadır (Harbaugh et al., 2000). Lisianthus süs bitkisinin çeşitlerinin renk yelpazesi parlak ve pastel tonlarında toplamda 15 renk seçeneği ile üretilmektedir. Özellikle iki renkli olan çeşitlerin çiçeklerinde beyaz renkli petal ve mavi / mor kenar şeritleri çiçeğe oldukça estetik bir görünüm kazandırmaktadır. Çiçek renklerinin yanı sıra çiçek şekli, büyüklüğü ve çiçeklerin yalın kat ve katmerli olmaları bakımından da çeşit sayısı artmaktadır (Şekil 1). Yalın kat çiçekler tek sıralı taç yapraklara sahipken; katmerli çiçekler, iki, üç hatta dört sıralı olarak taç yapraklara sahiptirler (Melgares de Aguilar, 1996). Türkiye'de daha çok katmerli Lisianthuslar tercih edilmektedir (Haspolat ve ark., 2020).




**Şekil 1**. Farklı çiçek rengi, taç yaprak şekli ve sayısına sahip geliştirilen Lisianthus çeşitleri (Miyoshi Flower, 2018)

Kesme çiçekler üretim şekillerine göre tohumdan çoğaltılan kesme çiçekler (1), aşı, çelik veya doku kültürü ile çoğaltılan kesme çiçekler (2), soğanlı kesme çiçekler (3) ve kesme yeşillikler

(4) olmak üzere 4 ana grup olarak sınıflandırılmaktadır. Tohumdan çoğaltılan kesme çiçek türlerinden biri Lisiantus (*Eustoma grandiflorum*)'tür (Akat ve ark., 2017). Hazırlanan bu derlemede çiçekçilik pazarı için nispeten yeni bir süs bitkisi olan Lisianthus'un fide yetiştiriciliği ve özellikle fide döneminde karşılaşılan sorunlar hakkında bilgiler derlenmiştir.

**Süs Bitkileri Üretiminde Fide Kullanımının Avantajları**

Fide üretimi, özellikle sebze ve süs bitkilerinde, bitkisel üretimden ayrı bir sektör haline gelmiştir (Tüzel et al., 2021). Süs bitkisi fidesinin tanımı, tohumun çimlenmesi ile oluşan ve birkaç adet gerçek yaprak oluşturduğunda asıl yetiştirme yerlerine nakledilen genç bitki şeklinde yapılabilir. Tüzel et al., (2021) tarafından belirtilen sebze üretiminde fide ile başlamanın avantajları süs bitkisi fideleri için aşağıdaki şekilde uyarlanmıştır:

- Süs bitkisi fidesi ile üretime başlandığında tohum çimlenmesi ile ilgili olumsuzluklar ortadan kaldırılır ve bu konudaki aksaklıklar ile karşılaşılmaz.
- Tohum çimlenme ve çıkışında olumsuz toprak koşullarının neden olduğu sorunlara maruz kalma ortadan kalkmaktadır.
- Süs bitkisi fidesi ile üretime başlanması erkencilik sağlamaktadır. Sağlanan bu erkencilik Lisianthus türü için çok önem arz etmektedir.
- Fide ile üretime başlamak, bitkilerin yetiştirme yerlerinde kalma süresini kısaltmakta, bu da yetiştirme alanının daha etkin kullanılmasını sağlamaktadır.
- Fide ile üretime başlamak tohum, işgücü ve enerji tasarrufu sağlamaktadır.
- Üremin başlangıcında hastalıklı, cılız, özellikle Lisianthus için rozetleşmiş ve sağlıksız bitkiler ayrılmakta, homojen gelişmiş sağlıklı fideler ile üretime başlanmaktadır.
- Özellikle topraklı koşullarda yapılan üretimde yabancı ot kontrolü kolaylaşmaktadır.
- Tek hasat yapılan türlerde tüm alanda bitkiler aynı zamanda hasada gelir; hasat tarihinin daha doğru tahmin edilmesi sağlanır ve bu da iş gücünün planlanması ve yönetimi konularının düzenli olmasına katkı sağlar.
- Kesme çiçek hasatı, pazarlanması programlanabilir ve istenilen zamanda gerçekleştirilebilir.

**Lisianthus Fide Üretimi**

Lisianthus fide üretiminde önemli faktörler aşağıda alt başlıklar halinde tartışılmıştır.

**a) Substrat (Yetiştirme ortamı)**

Lisianthus tohumlarının ekildiği yetiştirme ortamı, iyi drenaja ve iyi neme sahip steril substratlardan hazırlanmalıdır. Substrat, saksı ve/veya kaplarda bitki yetiştirmek için kullanılan herhangi bir katı organik, inorganik veya karışık ortam olarak kabul edilmektedir. Abad ve ark. (1997)'e göre, bir substrat, saf veya karışık biçimde bir kap içine yerleştirilmiş, mineral veya organik, kök sistemi için destekleyici bir rol oynayan doğal katı malzemedir. Substrat, bitkilere gelişmeleri için yeterli koşulları sağlamanın yanı sıra besin solüsyonunun bitki tarafından alınabilir olmasına izin vermelidir (Burés, 1997). Torf, Lisianthus fide yetiştiriciliğinde tek halde kullanılabileceği gibi vermikülit, perlit gibi ortamlar ile harç karışımları hazırlanarak da kullanılabilmektedir.

Lisianthus yetiştiriciliğinde kaliteli çiçeklerin eldesi için kullanılan yetiştirme ortamının pH'sı önemli bir faktördür. İyi bir kök sisteminin geliştirilmesi için Lisianthus'un optimum yetiştirme ortamı pH'sı 6.3-6.7 aralığında olmalıdır (Harbaugh and Woltz, 1991). Yetiştirme ortamının pH düzeyinin 6.2'nin altında olması özellikle çinko olmak üzere mikro element toksisitelerinin ortaya çıkmasına neden olabilmektedir. Ayrıca, pH aralığının 6.2 nin altında olması bitki büyümesinde sınırlanma, yaprak sararması ve nekrozlara yol açabilmektedir (Haspolat ve ark., 2020).

Lisianthus yetiştiriciliğini kısıtlayan bir diğer yetiştirme ortamı faktörü ortamın içerdiği tuz miktarıdır (Anonim 2013). Lisianthus bitkisi için uygun büyüme ve gelişme için substrat EC'si genellikle 1 dS/m civarında veya daha düşük olmalıdır. Bununla birlikte, Lisianthus "Raf Shinn" çeşidinin, 8 dS $m^{-1}$'ye kadar tuzluluk toleransı gösterdiği, 8 dS $m^{-1}$ olan tuzlu su ile sulandığında ölçülebilir etkiler olmaksızın karlı bir şekilde yetiştirilebileceği bildirilmiştir (Valdez-Aguilar et al., 2013). Çeşit bakımından zengin olan Lisianthus türünün yetiştirme ortamındaki tuz tolerans aralığının çeşitlere göre farklılıklar gösterebileceği belirtilebilir.

Yetiştirme ortamının organik madde içeriğinin zengin olması Lisianthus yetiştiriciliği için bir diğer önemli faktördür. Lisianthus kesme çiçek, saksılı bitki ve dış mekan bitkisi olarak farklı kullanım alanlarında yetiştirildiğinde değişen gübreleme ihtiyacı olan süs bitkilerinden biridir (Harbaugh et al., 1998). Kesme çiçek kalitesinin arttırılmasında 1 Nitrojen: 1,5 potasyum oranı gübreleme gereksinimi olarak önerilmektedir (Haspolat ve ark., 2020). Ayrıca, kalsiyum (Frett et al., 1988) ver bor (Haspolat ve ark., 2020) kullanımı neticesinde güçlü çiçek sapları oluşmaktadır.

Lisianthus birçok toprak kaynaklı bitki patojenine karşı hassastır (McGovern ve Harbaugh 1998). *Rhizoctonia* sp., *Fusarium* sp., *Pythium* ve *Botrytis cinerea (kurşuni küf)* gibi

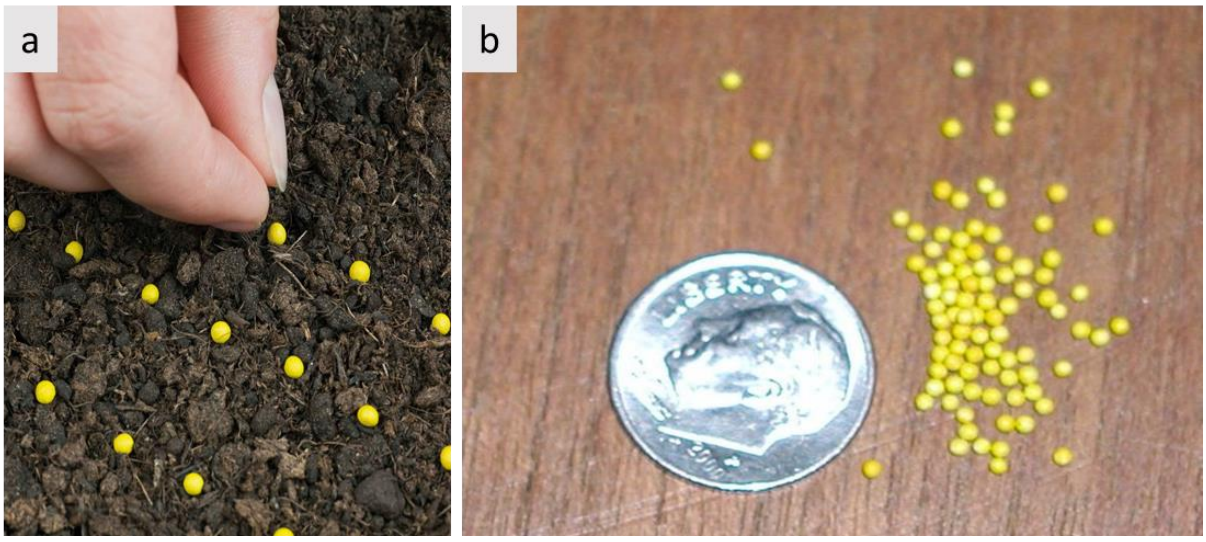
hastalıklar kaliteyi etkileyen temel etkenlerdendir (Doğan ve ark., 2018). Bu nedenle kullanılan yetiştirme ortamı hem tohum ekimi öncesi hem de fide dikimi öncesi dezenfekte edilmelidir.

Lisianthus tohum ekiminde ve fidesinin yetiştirilmesinde kullanılacak substrat, 20 °C ile 24 °C arasında bir sıcaklığa, çimlenme işlemi sırasında iyi bir neme ve 6,0 ila 6,5 arasında bir pH değerine sahip ve EC seviyesi 0.7 ile 1.0 mmhos aralığında olmalıdır (Sakata, 2020).

**b) Lisianthus tohumu ve tohum ekimi**

Tohum, bitkilerde neslin yayılmasını, çoğalmasını ve devamını sağlayan generatif bir organdır. Tohumlu bitkilerde bu, tohumun çimlenme süreci yoluyla yeni bir bireye dönüştürülmesiyle yapılmaktadır. Tohumun yapısı ve fizyolojisi, yeni fideyi fotosentetik olarak ototrofik bir organizma haline gelene kadar besleyecek rezervlere sahiptir (Azcón ve Talón 2000). Bitki materyalinin tohumla üretilmesi ve çoğaltılması, yüksek hacimli üretim için önemli bir yaklaşımdır. Lisianthus genellikle tohumla çoğaltılır. Kök çelikleri veya doku kültürüyle de çoğaltımı yapılabilmektedir.

Lisianthus tohumu, ticari kesme çiçeklerin en küçüklerinden biridir. Lisianthus tohumları çok küçük ve toz gibi görünmektedir. Tohumlar ortalama 303-450x270-370 µm büyüklüğündedir (Bouman et al., 2002) ve 1 g'da 10,000-22.000 arasında tohum bulunmaktadır (Dole ve Wilkins 2005). Tohumlar elips – dairesel şekle sahiptirler.




**Şekil 2.** Sarı renkli kaplama materyali ile kaplanan tohum ekimi (a) (Eden Brothers 2023); kaplanan tohumların ebat büyüklüğü (b) (Good Scents Gardens, 2014)

Lisianthus tohumları tohum iriliğinin arttırılması ile kolay ekim ve yüksek çimlenme oranı için peletlenmiş olarak ekilmektedir. Lisianthus tohumları genel olarak işlemeyi kolaylaştırmak için şekillerini ve boyutlarını değiştiren katı ve inert malzemelerle kaplanmış

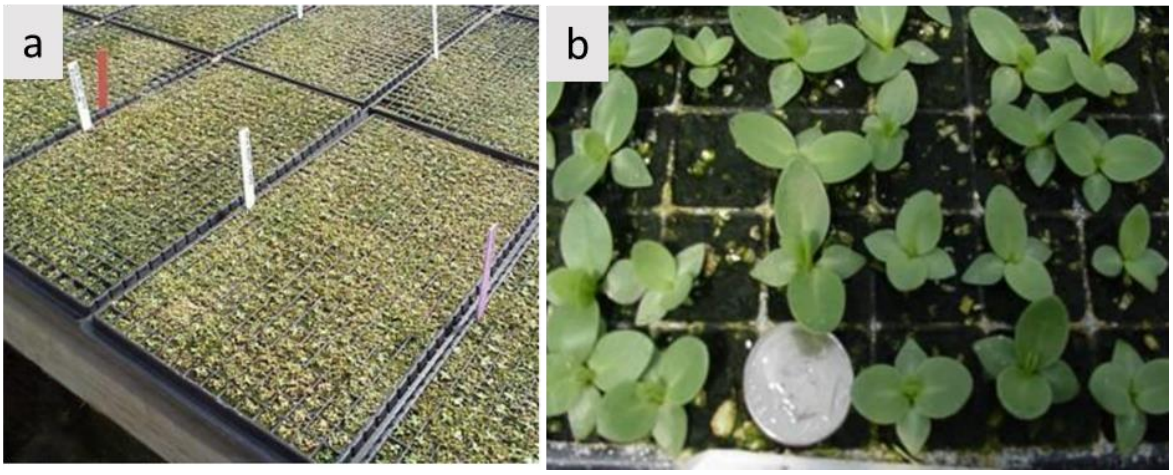
peletlenmiş formda ticarileştirilmiştir (Bhatia ve Sindhu, 2019) (Şekil 3a, b). Peletlenmiş Lisianthus tohumları, yüksek bir saflık ve canlılık standardı, çimlenmede daha fazla hassasiyet ve tekdüzelik sağlamakta, işçilik maliyetlerini ve tohum miktarını azaltmakta, aynı zamanda besinler, büyüme düzenleyiciler ve fungisitlerin tohumun dış kısmına dahil edilmesini sağlamaktadır. Toprakta veya substratta daha fazla sayıda canlı tohum korunduğu için ekim hızı ve verimlilik de artmaktadır (Sakata, 2011). Kaplanan tohumlar bu halleri ile de oldukça küçüktür (Şekil 2b). Tohum paketinin içinde ayrıca küçük bir şişede de paketlenebilmektedir (Şekil 3a).




**Şekil 3.** Kaplanmış Lisianthus tohumları (Jackson, 2023)

Pelletlenmiş tohumlar kasalara veya viyollere tek tek el ya da makine ile ekilmektedir (Şekil 2a; Şekil 4a). Kasalara Lisianthus tohum ekimi yapılacaksa kullanılacak kasalar ekimden önce dezenfekte edilmelidir. Lisianthus tohumları çok küçük olduklarından ekim esnasında çok dikkat edilmeli ve sık ekimden kaçınılmalıdır.

Peletlenmiş tohumlar, çimlenmeleri için viyollere (her boşlukta bir tane) ekilecek ise, kapak örtüsü kullanılmadan ekilir ve yeterli nemde tutulur (Sakata 2004). Hem tohumlar küçük olduklarından hem de çimlenmek için tohumların ışık ihtiyacının olmasından dolayı üzerlerine kapak atmaya gerek yoktur.




**Şekil 4.** Viyollere ekilen lisianthus tohumlarının çıkış aşaması (a); fide gelişim aşaması (b) (Sakata, 2020)

**c) Tohum çimlenmesi**

Lisianthus tohumları için optimum çimlenme sıcaklığı 20-25°C"dir ve 10-15 gün içerisinde tohumlar çimlenmektedir (Dole ve Wilkins (2005). Çimlenme döneminde sıcaklık korunmazsa çimlenme gecikmektedir (Kpczyska ve ark., 2006; Norsworthy ve Oliveira, 2006). Ayrıca, yüksek sıcaklıklar birincil aşamada fide üretimini engellemektedir (Ohkawa ve ark.,1991). Çimlenmeden sonra bitkiler 21 °C ile 24 °C gündüz ve 16°C ile 18°C sıcaklıkta gece tutulmalı, sırasıyla; 15 ile 30 gün sonra sıcaklıklar gece ve gündüz 21 ve 16 °C'ye düşürülmelidir.

Yüksek sıcaklık tohum çimlenmesini azaltmakta (Roni ve ark. 2017), rozet oluşumuna neden olmakta (Roni ve ark. 2017) ve Lisianthus'un tohum çimlenmesi ve fide büyüme aşamalarında mantar hastalıklara yakalanmasına neden olabilmektedir. Rozet oluşumu şu şekilde tarif edilmektedir; boğum araları çok kısa olan bir gövde üzerinde üst üste binen yapraklar gül çiçeği görünümü alır, nadiren uzar ve yapraklar yerde sürünürken açılırlar (Sakata, 2022). Ayrıca Lisianthus'un tohum çimlenme süreci, çimlenmiş tohumları korumak için kontrollü bir ortama (optimal ışık, sıcaklık ve nem seviyesi) ihtiyaç duymalarından dolayı oldukça zahmetlidir (Harbaugh 1995; Harbaugh ve Deng 2006) ve bu nedenle geleneksel topraklı yetiştirme koşullarında çiçek homojenliğini korumak, büyüme, gelişme ve çiçeklenme zamanını programlamak oldukça zordur (Roni ve ark. 2017).

Lisianthus tohumlarında genotiplere bağlı olarak tohum dormansisi görülebilmektedir (Haspolat ve ark., 2020). Bazı genotiplerin soğuklanma uygulaması yapılmadan çimlendiği; mutlak tohum dormansisi gösteren genotiplerin çimlenmesi için tohumların çimlenme ön aşamasında soğukta bekletilme işlemine ihtiyacı bulunmaktadır. Mutlak dormansi görülen

Lisianthus tohumlarına su emdirilerek 3 °C'de 10-11 gün ön soğutma uygulandığında dormansinin kırıldığı bildirilmiştir (Ecker et al., 1994a, b). Lisianthus'taki yüksek genetik çeşitlilik nedeniyle, tohum vernalizasyonu için etkili bir sıcaklık aralığı bilinmemektedir, 1 ° C ile 10 ° C arasında düşük sıcaklıklara birkaç hafta maruz kalma türe ve çeşide bağlı olarak değişmektedir (Kim ve ark., 2009).

Lisianthus'un çimlenmesi, 1.000 ila 3.000 lux ışık gerektirmektedir (Sakata, 2004). Lisianthus tohumlarının çimlenmesi için, fidecikler ortaya çıkana kadar, 16 saatlik bir ışık periyodunun gerektiği belirtilmektedir (Harbaugh, 1995). Bir başka araştırma sonucunda aydınlık/karanlık koşullarının sağlandığı ve 27.5°C sıcaklıkta *Eustoma grandiflorum* fideleri üretmek için iklim odasında uygun ışık süresinin 20 saatin üzerinde olduğu sonucuna varılmıştır (Fukushima et al., 2019).

Lisianthus bitkisinde çimlenmeyi ve bitki gelişimini arttırmada harmonal primingin etkili yöntem olduğu bildirilmektedir (Shah et al., 2018). Lisianthus'un tohumdan fide yetiştirme süresinin uzun olması nedeniyle üretici doğrudan hazır yetişmiş fide satın almayı tercih etmektedir (Şekil 5a).




**Şekil 5.** Normal gelişen Lisianthus fidesi (a); kayık yaprak şekilli rozetleşmiş fide (b); kesme çiçek için dikim yastığına dikilen fidenin rozetleşmesi (c) (Sakata, 2020)

**d) Fidelerin bakımı ve dikimi**

Ülkemizde Lisianthus yetiştiricilerinin çoğunluğu hazır fideleri kullanmakta, bu fideler ile erkencilik ve daha uzun çiçek saplı kesme çiçekler elde edebilmektedirler. Fideler dikim anına kadar özenli bir bakım istemektedir. Lisianthus türünün fide aşamasında sıcaklık, çeşit, gün uzunluğu gibi koşullar rozetleşmeyi etkilemektedir. Çimlenmeden itibaren 4 yapraklı oluncaya kadar gündüz 30-35 °C, gece ise 20-25 °C sıcaklıklar bitkide rozetleşmeye neden olmaktadır. Boğum araları kısalmış ve rozet adı verilen yaprak kümeleri olan bitkiler geç çiçek açmakta veya hiç çiçek açmamaktadır (Şekil 5). Lisianthus'un ticari üretiminde, rozet oluşumunu önlemek için tohum ve fide vernalizasyonu kullanılmaktadır (Şekil 6a). Çeşit

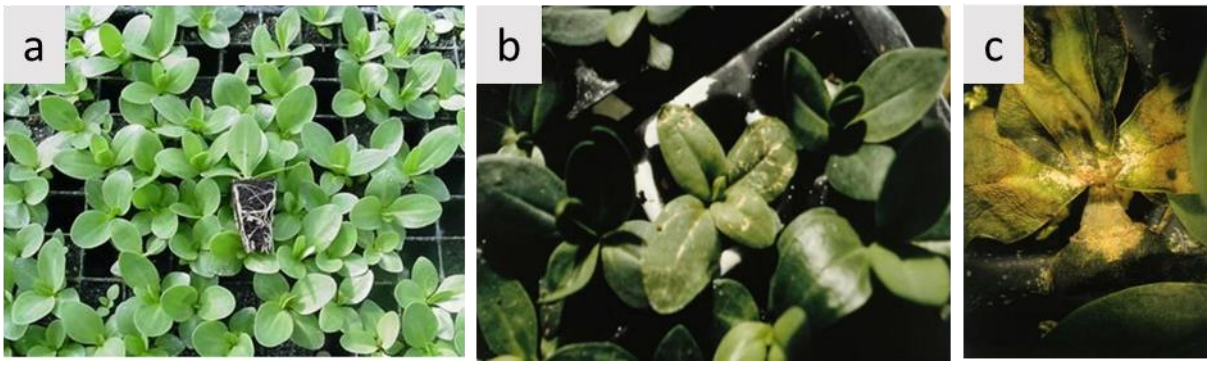
özelliğine de bağlı olarak değişmekle birlikte Lisianthus fideleri 25 °C'nin üzerindeki sıcaklıklara maruz kalırsa rozetleşme eğilimi göstermektedirler (Haspolat ve ark., 2020).

Özellikle Japonya'da Lisianthuslarda rozetleşme, esas olarak 1990'lardan 2000'lerin başına kadar ciddi bir sorun haline gelmiştir. Daha sonra soğutma uygulaması ve fidelerin düşük sıcaklıklarda yetiştirilmesi (özellikle sıcaklığın yüksek olduğu dönemlerde serada iklimlendirme sistemi kullanılarak sıcaklığın gündüz 25°C, gece ise 15°C olarak ayarlandığı ortamda fidelerin yetiştirilmesi) gibi yetiştirme teknikleri kullanılarak rozet oluşumunu önleyecek teknolojiler geliştirilmiştir. Bununla birlikte, fide aşamasında hassas sıcaklık yönetimi Lisianthus için önemlidir. Diğer bir ifade ile Lisianthus üretiminde kapsamlı sıcaklık kontrolü gereksinimi bu türün tohum çimlenmesi ve fide gelişimi aşamasında yaşanan önemli zorluklardan birini oluşturmaktadır (Sakata, 2022).

Dört yapraklı aşamaya gelen fideler, rozet hallerinin kırılması amacı ile, 4-5 hafta boyunca 5-10 µmol/m²/s ile aydınlatılan 12±1°C'deki serin bir ortamda bekletilebilmektedir. Bu teknik uygun çeşitlerin kullanılması ile çiçeklenme oluşumunu ve fide ve kesme çiçek tekdüzeliğini sağlayabilmektedir (Ohkawa ve ark, 1991; 1993, 2003a, b; Fukuda ve ark, 1994). Bu türün yetiştiriciliğinde uygulanması gereken bu teknik başta enerji maliyetini arttırmaktadır.

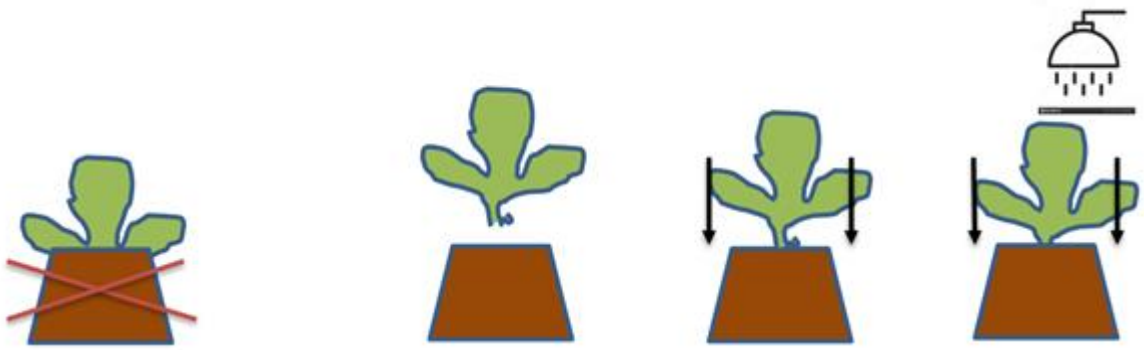
Fidelerin çiçeklenme dönemine geçmeleri ve erken çiçeklenme için ışıklanma önemli bir faktördür. Yetersiz ışık almaları durumunda çiçek sayısında azalma, yeşil yaprak sayısında fazlalaşma olmaktadır. Yeterli ışık sağlanmalı; fazla ışık alımının önlenmesi için ise gölgeleme yapılmalıdır. 4860 lux ve üzerindeki ışık yoğunluğu Lisianthus'un çiçek saplarında yanma ve nekrozlar şeklinde zararlanmalara neden olabilmektedir. Çok düşük yoğunluktaki (120-1020 lux) ışık koşulları yapraklarda yoğun enfeksiyonların ortaya çıkmasına neden olabilmektedir (Shpialter et al., 2009).

Örtüaltı koşullarında yapılan fide yetiştiriciliğinde uygun nem oranı sağlanmalı, nem düzeyinin fazla olması bitkilerde hastalık artışına neden olmaktadır (Şekil 6b, c). Sera için havalandırmasına özen gösterilmeli ve sera içi nem düzeyinin %70-80 aralığında olması sağlanmalıdır. Her gün düzenli olarak fidelerin mutlaka havalandırılması gerekir. Ayrıca, özenli ve bitki ihtiyacı kadar sulama yapılmalıdır. Fazla su bitki hastalıklarına davetiye çıkarabilmektedir.




**Şekil 6.** Dikim büyüklüğüne gelen ve sağlıklı Lisianthus fideleri (a); Fusarium enfekteli Lisianthus fidelerin görünümü (b ve c) (Sakata, 2020)

Fidelerin bakımında diğer önemli bir konu da ilaçlama uygulamalarıdır. Fidelerin hassaslığı göz önünde tutularak her hafta mutlaka düzenli olarak koruyucu amaçlı ilaçlama yapılmalıdır. Tohum ekiminden iki ile üç ay sonra veya dördüncü veya beşinci çift yaprak oluştuğunda fidelerin dikimi asıl yerlerine yapılabilir (Dole ve Wilkins, 2005). Doğru dikim büyüklüğü fidelerin 3-4 gerçek yapraklı dönemde olmalarıdır. Dikim sırasında kökleri çok uzamışsa hafiften kısaltılabilir. Kök boğazı toprakla aşırı şekilde doldurulmamalıdır. Dikim işlemi bittikten sonra mutlaka can suyu verilmelidir (Şekil 7).



**Şekil 7.** Lisianthus fidelerinin doğru dikim şekli (Sakata, 2020)

**Lisianthus Fide Üretim Döneminde Karşılaşılan Sorunlar ve Çözüm Önerileri**

- *E. grandiflorum*'un tohum ile çoğaltımında çok küçük ve büyümesi zor olan tohumlar kullanılmaktadır. Tohumların çok küçük olması makineli tohum ekimini zorlaştırmakta ve elverişsizleştirmektedir. Bu sorun için peletlenmiş tohumlar kullanılmaktadır. Peletlenmiş tohumları ticarileştirilmiştir. Bu tohumların satış fiyatı, kaplı olmayan tohumlara göre oldukça pahalıdır. Ayrıca, bu tohumların temin edilebileceği firma sayısının sınırlı olması, yabancı kökenli firmalar olması da süs bitkisi tohum temini konusundaki başlıca sorunlardandır.
- Peletlenmemiş tohumların ekimi neticesinde tohum çimlenmesi eş zamanlı değildir.

- Süs bitkilerinin neredeyse tamamına yakınının özellikle F1 tohumları yurt dışı kaynaklıdır. Hali ile çok yüksek fiyatlara tohumlar temin edilmektedir. Hazır fide alan üreticinin aldığı fidenin ücretini öderken çimlenmeyen ya da sağlıklı olmayan fidenin ücretini ödemesi gerekmemektedir.
- Uygun olmayan çevre koşulları neticesinde Lisianthus tohumlarının çimlenmesi ve fide büyüme aşamaları gecikebilir bu durum mantar istilasına neden olabilir. Çevre koşullarının Lisianthus'un isteklerine uygun olmasına özen gösterilmelidir.
- Çimlenme süreci, çimlenmiş tohumları korumak için kontrollü bir ortama (optimal ışık, sıcaklık ve nem seviyesi) ihtiyaç duyduğu için zahmetli ve maliyetlidir.
- Üretim döngüsünün uzun olması, özellikle rozetleşme probleminin sık yaşanması ve rozetleşmenin engellenmesi için üretim maliyeti artmakta bu da fide fiyatını yükseltmektedir.
- Lisianthus'taki yüksek genetik çeşitlilik nedeniyle, tohum vernalizasyonu için etkili bir sıcaklık aralığı bilinmemektedir. Lisianthus'un ticari üretiminde, rozet oluşumunu önlemek için tohum ve fide vernalizasyonu gerekmektedir. Çeşitlere göre bu vernalizasyon gereksinim değerlerinin belirlenmesi önem arz etmektedir.
- Lisianthus tohumlarının çimlenmesi için, en azından fideler ortaya çıkana kadar, 16 saatlik bir ışık periyodu gereklidir. Uygun fotoperiyod sağlanmalıdır. Bunun sağlanması da fide maliyetini arttırmaktadır.
- Özel ışığa ek olarak tohum çimlenmesi 20–25ºC arasında sabit bir sıcaklık gerektirmektedir. Ayrıca, yüksek sıcaklıklar birincil aşamada fide üretimini engellemektedir. Gündüz ve gece sıcaklıkları arasındaki büyük dalgalanmalar, toprak ortamında yetişen Lisianthus tohumlarının rozet oluşturmasına neden olarak, fide büyümesini ve gelişimini etkilemektedir. Sıcaklığın sabit tutulması için de kontrollü koşullar sağlamanın bedeli de fide üretim maliyetini arttırmaktadır.
- Rozet oluşturan bitkiler gecikmiş çiçeklenme sergilemekte ya da hiç çiçek açmamaktadırlar. Bu oluşum kesme çiçek ve/veya çiçekleri ile etkili süs bitkileri için arzu edilmeyen ve direkt olarak verim ve kaliteyi etkilemektedir.
- Lisianthus'ta bitki zararlısı ve bitki hastalıkları kaliteyi etkileyen temel etkenlerdendir. Bu etkenler Lisianthus ticari üretimini sınırlandırmaktadırlar. Öncelikle Lisianthus üretiminde bitki zararlı ve hastalıklarına dayanıklı çeşitler ile üretime başlanmasına ya da hassasiyetle koruma amaçlı ilaçlamalara önem verilmelidir. İlaçlama maliyetleri de diğer türlere kıyasla yüksek olmaktadır.

- Geleneksel sistemler kullanılarak fide üretimi genellikle verimli değildir ve kök gelişimi zayıf heterojen fideler elde edilir (Barbaro et al., 2009). Aynı zamanda hasat işlemlerinin, depolamanın ve pazarlamanın yapılması için homojen fidelerin dikimi önemlidir. Ayrıca sezonlara göre pazarlama plan ve yönetimi için de plana uyulması konusunda homojen fide gelişimi önemlidir. Modern sitemler ile fide yetiştirilmesi gerekliliği bulunmaktadır.
- Köklü çeliklerle yetiştirilen Lisianthus bitkisi tohumdan yetiştirilen bitkiler karşılaştırıldığında, daha iyi performans göstermektedir (Bhatia et al., 2019). Ancak, kitlesel üretim bakımından tohumdan fide eldesi oldukça avantajlı olmaktadır. Bu kapsamda, Lisianthus'un tohum yapısını, çimlenmesindeki zorlukları değerlendirerek dikkate alınması gerekenler yapılırsa sağlıklı ve kaliteli fidelere ulaşılabilmektedir.

**Sonuç**

Bu derlemede Lisianthus'un tohum yapısı, çimlenmesindeki zorluklar ve fide aşamasında ihtiyaç duyduğu faktörler üzerinde durulmuştur. Lisianthus fide üretiminde kullanılan tohumlar yüksek kaliteli olmalıdır. Doğru sıcaklık koşulları sağlanmalı, ışık gereksinimleri mutlaka karşılanmalı, drenajı iyi bir yetiştirme ortamı kullanılmalıdır. Çimlenme süreci düzenli olarak takip edilmelidir. Lisianthus üretiminde bitki zararlı ve hastalıklarına dayanıklı çeşitler ile üretime başlanmasına ya da hassasiyetle koruma amaçlı ilaçlamalara önem verilmelidir. Homojen Lisianthus fidelerinin eldesi için modern sistemlerle fide yetiştiriciliğinin yapılması önem arz etmektedir. Böylece, kaliteli Lisianthus kesme çiçeklerinin elde edilmesi, hasat işlemlerinde, depolama ve pazarlama plan ve yönetimi için plana uyulması konularında başarı sağlanabilecektir.

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# UTILIZATION OF RED LENTIL PUREE IN BREAD PRODUCTION AND DETERMINATION OF BREAD QUALITY

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## Abstract
In this study, the addition of high-nutrient (rich in protein, vitamins, and minerals especially Fe) red lentils to bread formulations aims not only to offer consumers an alternative flavor but also to develop a healthier functional product. In line with this objective, red lentils were soaked for 1 hour in salted water and then boiled for 15 minutes at 100°C. The boiled lentils were mashed into a puree by removing the boiling water and used in the bread formulation, replacing 5, 10, 15, and 20 % of wheat flour based on weight. The bread formulation included 377g of wheat flour, 202.4g of water, 10g of salt, 5.4g of yeast, 20g of sugar, and 18.8g of sunflower oil. After the ingredients were added to the bread-making machine and preliminary processes such as mixing and fermentation were completed, the bread was obtained and cooled to room temperature. The cooking loss and yield, moisture and protein contents, color, and specific volume values of bread were determined. Texture profile (hardness, springiness, cohesiveness, gumminess, and chewiness) and sensory analysis were also conducted. The moisture and protein contents of the bread samples ranged from 28.94% to 35.19% (on a wet basis, wb) and from 8.49% to 11.92% (db), respectively. With the addition of red lentil puree L* and b* values have generally increased depending on the concentration ($p>0.05$). The highest specific volume value was observed in bread containing 20% red lentil puree. The baking loss of breads ranged from 11.54% to 20.08%, with the highest baking yield (88.47%) observed in breads containing 10% red lentils, which had the lowest baking loss. The lowest hardness value was found in the sample containing 15% red lentil puree, while the highest hardness value was observed in the sample containing 5% red lentil puree. According to the sensory analysis results, bread made with 10% red lentil puree has been the most preferred bread by the panelists.
**Keywords:** Bread, red lentil, protein, baking yield, sensory evaluation.

## Introduction

In recent times, there has been a noticeable enhancement in the diversity, quality, and nutritional content of food products, reflecting evolving consumer preferences and demands. With a heightened awareness of the profound impact of nutrition on health, people are increasingly looking for foods that not only offer improved bioavailability but also boast enhanced nutritional attributes. These enhancements can pertain to the inherent qualities of the food itself, or they can be achieved through the incorporation of external ingredients or the removal of harmful components from the food (Kaya & Asir, 2022; Bakshi et al., 2020; Maxim et al., 2019). The rising consumer interest in healthier bread options has led to a surge in research focused on creating functional bread that not only enhances the sensory attributes of bread but also boosts its bioavailability. The goal is to enrich staple foods like bread, which form the foundation of nutrition in developing and underdeveloped nations, in order to elevate their nutritional content. Traditional bread typically consists of wheat flour, yeast, salt, and water, and it is prepared through a process of mixing, kneading, and cooking after fermentation (TGKY, 2012). This food item is known for its neutral aroma and its ability to serve as an excellent vehicle for other food components (Betoret & Rosell, 2020; Dirim et al., 2014; Ulziijargal et al., 2013).

Red lentils are rich in easily digestible protein and fiber. Additionally, they are known for their high mineral content, including, but not limited to, vitamin B and iron, as well as calcium, manganese, sodium, copper, zinc, and phosphorus (Faris et al., 2013; Chelladurai & Erkinbaev, 2020). Combining red lentil with bread provide a more nourishing alternative for individuals. This may be especially valuable in preventing and treating common health issues like iron deficiency anemia. Moreover, their high fiber content supports digestion and promotes a sense of fullness, aiding in weight management. By increasing the protein content in bread, red lentils also serve as an important protein source, particularly for vegetarians. For the above mentioned reasons, this study aims to enhance the nutritional quality of bread by incorporating red lentils, which are rich in protein, vitamins, and minerals. The objective is to provide consumers with not only a different flavor but also a more nutritious product.

## Materials and Methods

### Materials

Wheat flour (Söke Değirmencilik San. ve Tic. A.Ş.), red lentils (Değirmen Bakliyat A.Ş.), sugar (Keskinkılıç Gıda San. ve Tic. A.Ş.), sunflower oil (Küçükbay Yağ ve Deterjan Sanayi

A.Ş.), water (Pınar Su San. ve Tic. A.Ş.), yeast (Özmaya San A.Ş.), and salt (Rafine Billur Tuz San. A.Ş.) were purchased from a local supermarket in İzmir, Turkey.

**Methods**

**Preparation of Lentils**

The red lentils were soaked in salted water containing 10% salt for one hour. The water used for soaking was drained. The red lentils were boiled in a water bath at 100ºC for 15 minutes. The boiled red lentils were pureed using a household blender (K1261, RHB, Arçelik, Türkiye).

**Preparation of Bread Dough**

The red lentil puree was added to the bread formulation in accordance with pre-determined proportions (%0 (control), %5, %10, %15, and %20) by substituting wheat flour in preliminary trials. Water (202.4g) was added to a large mixing bowl, followed by wheat flour (377g), salt (10g), sugar (20g), sunflower oil (18.8g), and yeast (5.4g) in sequence (Dirim et al., 2015) and mixed to obtain the dough.

**Baking**

The bread dough was placed in a bread-making machine (Sinbo, SBM-4715, Turkey) and underwent preliminary processes like mixing and fermentation before the baking process to produce bread. The prepared bread was allowed to cool to room temperature, and the specified analyses were conducted.

**Analysis**

**Physicochemical characteristics of dough and bread samples**

The moisture content of wheat flour, red lentil puree, bread dough, and bread samples were determined according to AOAC (2000). The protein content of the samples was determined using Leco FP-528 Protein/Nitrogen Determinator, USA. The crumb color of the bread samples was also measured by using Konica Minolta CR 400 Chromometer (Konica Inc, Japan) obtaining L*(brightness), a*(redness/greenness), and b* (blueness/yellowness).

**Baking Analysis and Specific Volume**

Baking loss was determined by the reduction in weight observed during the baking process as well as during the subsequent cooling of the bread loaves (Karaoğlu & Kotancılar, 2006). Baking yield was defined as the post-baking weight of the bread dough divided by the pre-baking weight multiplied by 100. Specific volume ($cm^3/g$) was measured based on displacement by rapeseed.

**Textural characteristics of bread samples**

The hardness, springiness, cohesiveness, gumminess, and chewiness of the bread samples were measured with TA.XTplus Texture Analyser, USA. Texture profile analysis was performed by compressing the bread samples twice in a row under the pressure plate of the texture analyzer. Breads (30x30x30mm) were compressed 25 mm at a speed of 2 mm/s under a 36 mm diameter pressure plate and 5 seconds waited between two compressions (Ulziijargal et al., 2013).

**Sensory Evaluation**

Sensory evaluation was performed on bread samples within 3 hours of baking. The served samples were sliced with a bread slicer (1.5 cm thick) and evaluated by students of the Department of Food Engineering, Ege University (10 panelists). Color, odor, flavor, porosity, and overall acceptance were measured using a five-point hedonic scale where 1=very bad, 3=medium, and 5=very good (Altuğ and Elmacı, 2005).

**Statistical Analysis**

Two repetitions of two parallel productions and the results of the analysis will be the mean ± standard deviation recorded in the SPSS 16.0 package program (SPSS Inc., USA) and analysis of variance at 95% confidence interval (ANOVA).

**Findings and Discussion**

When the studies in the literature were examined, studies on bread produced with the addition of red lentil powder (Rouhi et al., 2023; Zhang et al., 2021; Pradhan et al., 2021; Boeriu et al., 2020; Dirim et al., 2014; Man & Păucean, 2013; Savage et al., 1989) were found, but no study was found in which red lentil puree was added to the bread formulation. All breads with the addition of red lentil puree have been successfully produced in terms of visual, structural, and sensory aspects.

The moisture and protein contents of the red lentil puree were found as 52.90±2.61% (wet base, wb) and 13.61±1.17% (dry base,db), respectively. The moisture and protein contents of bread dough samples are given in Table 1. The moisture content of wheat flour is 10.76±1.61% (wb), the protein content is 11.58±0.89 (db). It has been observed that red lentil purees, used as an alternative to wheat flour, have higher moisture and protein contents compared to wheat flour.

The moisture and protein contents of the bread dough with red lentil puree are given in Table 1. According to Table 1, it can be stated that the moisture content of the bread has varied

between 38% and 44%. Upon examining the results, it can be concluded that the protein content increases as the quantity of added red lentil puree increases ($p<0.05$). As expected, the addition of red lentil, which has a higher protein content compared to wheat flour, increased the protein content of the bread doughs. This increase was found to be statistically significantly higher after 10% concentration ($p<0.05$).

**Table 1.** The moisture and protein contents of the bread dough samples

| Analysis | Control (Bread Dough With 0% Red Lentil Puree) | Bread Dough With 5% Red Lentil Puree | Bread Dough With 10% Red Lentil Puree | Bread Dough With 15% Red Lentil Puree | Bread Dough With 20% Red Lentil Puree |
|---|---|---|---|---|---|
| Moisture Content (%, wb) | 42.96±1.17$^{b}$ | 38.16±0.42$^{a}$ | 44.59±0.54$^{b}$ | 44.62±1.58$^{b}$ | 41.07±1.44$^{b}$ |
| Protein Content (%, db) | 9.22±0.83$^{a}$ | 10.01±0.58$^{a}$ | 11.50±1.05$^{ab}$ | 11.89±0.34$^{b}$ | 11.93±0.23$^{b}$ |

a-e Means with different letters in the same row are statistically different at P<0.05

Bread quality and staling are significantly influenced by its moisture content (Karaoğlu & Kotancılar, 2006). The moisture and protein contents of the bread with red lentil puree are given in Table 2. According to the Turkish Food Codex, the maximum moisture content for bread is specified as 38%, but there is no limitation for other types of bread (TGKY, 2012). Therefore, it is thought that the moisture content values of red lentil puree-enriched breads ~~are~~ can be considered as in accordance with the Turkish Food Codex. The reduction in moisture content during baking can be explained by the evaporation of water as it turns into steam. Table 2 shows that the moisture content of the breads containing red lentil puree was higher than the control ($p<0.05$). This is thought to be due to the high moisture content of red lentil puree. The constant cooking time may have caused more water to remain in the bread. In addition, red lentil was found to be higher in protein content compared to wheat flour. The possibility that proteins or fibers of the red lentil may have absorbed water may have caused the high moisture content. As the red lentil puree content increased, the protein content of the samples increased. This is expected. The protein content of red lentil was found to be higher than that of wheat flour. As a result of the study, it can be concluded that the protein content of the breads can be increased by 26% to 40% compared to the control sample by adding red lentil puree.

**Table 2.** The moisture and protein contents of the bread samples

| Analysis | Control (Bread with 0% red lentil puree) | Bread with 5% red lentil puree | Bread with 10% red lentil puree | Bread with 15% red lentil puree | Bread with 20% red lentil puree |
|---|---|---|---|---|---|
| Moisture Content (%, wb) | 24.53±2.63$^{a}$ | 30.25±2.80$^{a}$ b | 35.19±2.97$^{c}$ | 32.96±4.09$^{bc}$ | 28.94±4.77$^{a}$ |
| Protein Content (%, db) | 8.49±0.58$^{a}$ | 10.71±0.47$^{b}$ | 11.18±0.36$^{ab}$ | 11.23±0.44$^{b}$ | 11.92±0.58$^{b}$ |

a-e Means with different letters in the same row are statistically different at P<0.05

The color values of red lentil puree-enriched bread dough and breads are given in Figures 1 and 2, respectively. When the color values of the bread doughs were evaluated in general, it was observed that the addition of red lentil puree did not change the color values much and the * values initially increased with the increase in the amount of puree and then decreased. However, the b* value of the bread doughs has increased for concentration. When the color values of the bread crumbs were examined in general, it was observed that the addition of red lentil puree did not change the L* and b* color values much ($p>0.05$). A statistically significant decrease in the brightness value of breads has been observed after a concentration of 15% ($p<0.05$). The a* value of the breads has generally increased with the concentration ($p<0.05$). It is expected that the orange-red color of red lentils will cause an increase in the a* value of bread.

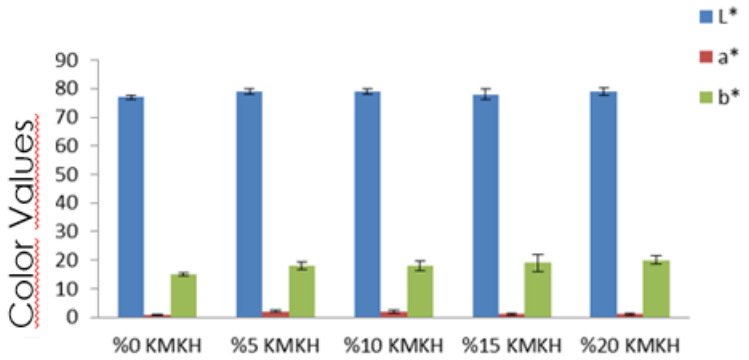


**Figure 1.** Color values of bread doughs
(%0 KMKH: Control (Bread dough with 0% red lentil puree); %5KMKH:Bread dough with 5% red lentil puree; %10 KMKH: Bread dough with 10% red lentil puree; %15 KMKH: Bread dough with 15% red lentil puree; %20 KMKH: Bread dough with 20% red lentil puree)

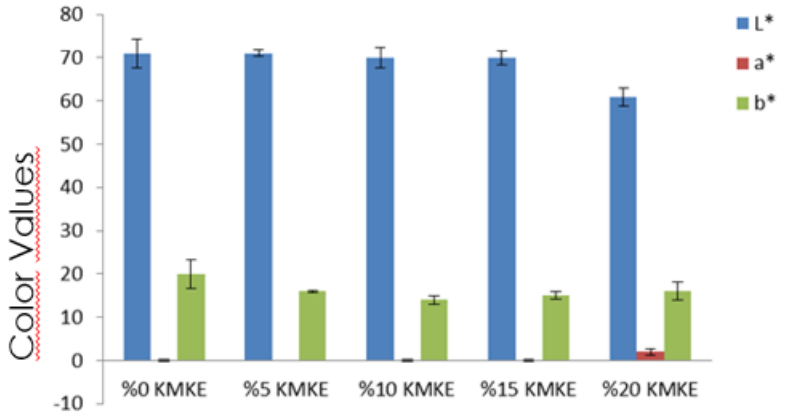


**Figure 2.** Color values of bread crumbs
(%0 KMKE: Control (Bread with 0% red lentil puree); %5KMKE: Bread with 5% red lentil puree; %10 KMKE:Bread with 10% red lentil puree; %15 KMKE: Bread with 15% red lentil puree; %20 KMKE: Bread with 20% red lentil puree)

**Baking Analysis and Specific Volume**

The baking loss and yield, and specific volume values of breads are given in Table 3. The baking loss and yield of the breads ranged 11.54-20.08% and 79.92-88.47%, respectively. The highest baking yield was observed in breads containing 10% red lentils, which had the lowest baking loss. There is an inverse relationship between cooking yield and cooking loss. When the relationship between baking loss and moisture content was examined, it was observed that the samples with low moisture content generally had high baking loss. It can be concluded that as the amount of moisture removed increases, the baking loss is high and the baking yield is low (Karaoğlu & Kotancılar, 2006). The highest specific volume value was observed from the bread with 20% red lentil puree. Similar to the baking loss result, it can be stated that there was an inverse relationship between moisture content and specific volume of the samples, whereas there is a direct proportion between specific volume and baking loss. Similar findings were also obtained by (Karaoğlu & Kotancılar, 2006). The specific volume of standard bread is in the range of 3.5–6 $cm^3/g$ (CGPRDI, 1983). However, all breads do not meet the passing level of specific volumes.

**Table 3.** The baking loss and yield, and specific volume values of breads

| Analysis | Control (Bread dough with 0% red lentil puree) | Bread dough with 5% red lentil puree | Bread dough with 10% red lentil puree | Bread dough with 15% red lentil puree | Bread dough with 20% red lentil puree |
|---|---|---|---|---|---|
| Baking Loss (%) | 13.38±2.96$^{ab}$ | 12.25±0.33$^{a}$ | 11.54±1.72$^{a}$ | 13.01±0.69$^{b}$ | 20.08±1.56$^{c}$ |
| Baking Yield (%) | 86.71±2.81$^{b}$ | 87.75±0.33$^{b}$ | 88.47±1.72$^{b}$ | 87.00±0.69$^{b}$ | 79.92±1.56$^{a}$ |
| Specific Volume ($cm^3/g$) | 3.41±0.33$^{b}$ | 2.91±0.00$^{a}$ | 3.29±0.35$^{b}$ | 3.05±0.13$^{ab}$ | 3.76±0.56$^{b}$ |

a-e Means with different letters in the same row are statistically different at P<0.05

**Textural characteristics of bread samples**

The results of texture profile analysis of breads are given in Table 4. Hardness is a widely used indicator of bread quality, and changes in it are often linked to a decrease in resilience during storage (Spices, 1990). The higher hardness, gumminess, and chewiness values were observed from control samples. The hardness, gumminess, and chewiness values of the breads have generally decreased with the increasing concentration of red lentils ($p<0.05$). The addition of red lentil puree to bread may increase elasticity and reduce hardness. Additionally, Sych et al. (1987) stated that the increase in hardness may be due to moisture loss. In this study, with the increase in the amount of red lentil puree, the moisture content generally increased and the hardness value decreased. Elasticity and stickiness of the samples are caused by dimensionless variables called cohesiveness and springiness, respectively (Ulziijargal et al., 2013). The difference between the springiness values of all breads except the breads containing 5% red lentil puree was found to be statistically insignificant ($p>0.05$). The cohesiveness values of the samples were generally found to be higher than the control. According to Ulziijargal et al. (2013), there may have been less intramolecular interaction and less moisture in the bread's constituents, which contributed to the loss of cohesiveness. However, in this study, higher moisture content values of red lentil puree-enriched breads may be the reason for higher cohesiveness values. The term chewiness describes the energy required to break down food into a form that can be swallowed (Ulziijargal et al., 2013). It can be concluded that less energy is required to swallow red lentil-containing bread.

**Table 4.** The results of TPA

| Analysis | Control (Bread dough with 0% red lentil puree) | Bread dough with 5% red lentil puree | Bread dough with 10% red lentil puree | Bread dough with 15% red lentil puree | Bread dough with 20% red lentil puree |
|---|---|---|---|---|---|
| Hardness (g) | 1117.59±81.52$^{d}$ | 922.92±80.58$^{c}$ | 485.08±7.30$^{b}$ | 346.27±38.43$^{a}$ | 460.66±26.31$^{b}$ |
| Springiness | 1.31±0.16$^{b}$ | 0.95±0.02$^{a}$ | 1.26±0.22$^{b}$ | 1.37±0.12$^{b}$ | 1.44±0.12$^{b}$ |
| Cohesiveness | 0.73±0.11$^{ab}$ | 0.68±0.04$^{a}$ | 0.81±0.05$^{b}$ | 0.82±0.01$^{b}$ | 0.79±0.03$^{b}$ |
| Gumminess | 812.04±67.25$^{d}$ | 626.97±10.66$^{c}$ | 394.81±26.20$^{b}$ | 282.85±31.74$^{a}$ | 362.90±26.94$^{b}$ |
| Chewiness | 1065.41±79.77$^{c}$ | 595.62±69.34$^{b}$ | 505.63±25.96$^{b}$ | 379.08±18.97$^{a}$ | 377.77±70.94$^{a}$ |

a-e Means with different letters in the same row are statistically different at P<0.05

## Sensory Evaluation

With the sensory evaluation, the panelists were able to determine the addition of a higher proportion of red lentil puree and were investigated to find out how much they were liked. The sensory evaluation of breads is given in Figure 3. The bread with a 10% puree addition was the most favored. Bread with 10% red lentil puree was found to be the most preferred bread in terms of color, aroma, taste, and porosity, closely resembling the control group bread.

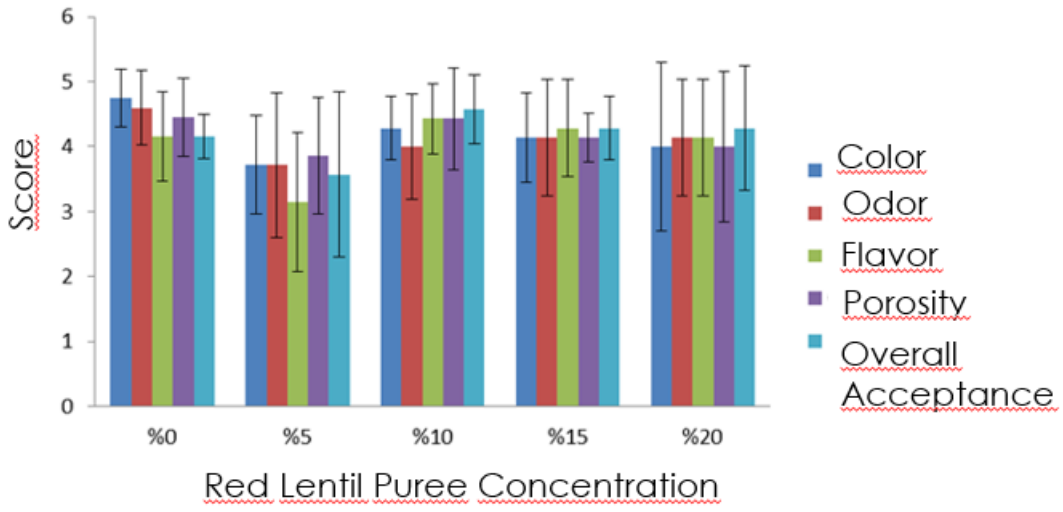


**Figure 3.** Sensory scores of breads

## Conclusion and Recommendations

The moisture contents of the breads ranged from 28.94% to 35.19% (wb). Compared to the control sample; the protein content of red lentil puree-supplemented breads increased by 26.15%, 31.68%, 32.27%, and 40.04% for 5%, 10%, 15%, and 20%, respectively. With the addition of red lentil puree L* and b* values have generally increased depending on the concentration ($p>0.05$). The baking loss of breads ranged from 11.54% to 20.08%, with the

highest baking yield (88.47%) observed in breads containing 10% red lentils, which had the lowest baking loss. The highest specific volume value was observed in bread containing 20% red lentil puree. The lowest hardness value was found in samples containing 15% red lentil puree, while the highest hardness value was observed in samples containing 5% red lentil puree. According to the sensory analysis results, bread made with 10% red lentil puree has been the most preferred bread by the panelists. The effct of storage conditions on the physical and chemical composition of bread enriched with lentil puree can be investigated in future studies.

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# RESEARCH ON THE UTILIZATION OF WHEY IN KEFIR PRODUCTION

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## Abstract
Whey, with its high protein, vitamin, and mineral contents, possesses significant nutritional value and is frequently used as a crucial ingredient in the food industry to enhance the nutritional value and functionality of products. This study was aimed to produce kefir by adding whey, which is a by-producted that has gained value with the development of industrial methods, to milk and to investigate the quality changes in the produced kefir during storage. To achieve this, mixtures of different milk-to-whey ratios were prepared (by weight: % 0:100, 10:90, 20:80, 30:70, 40:60, 50:50, 60:40, 70:30, 80:20, and 90:10) and kefir yeast was added to these mixtures. The mixtures were incubated in sealed glass jars at room temperature (30±2°C) overnight, and the produced kefir samples were stored in the refrigerator. The moisture content, color, pH, and sensory analyses of the kefir samples were conducted, and changes in the specified characteristics of the kefir samples during storage were examined through analyses performed on days 1, 7, 14, 21, and 28 in the refrigerator (+4°C). As the amount of whey increased, it was observed that the L* and b* values of the kefir samples decreased depending on the concentration, while the moisture content increased. The pH value of kefir samples ranged from 4.04 (60% milk: 40% whey) to 4.76 (100% milk). The moisture content of kefir samples with 10-70% milk increased gradually throughout the storage period ($p<0.05$). The water activity and pH values of the samples decreased over time during storage. Throughout the storage period, there was generally no significant change in the brightness (L*) and greenness (a*) values of kefir samples ($p>0.05$). According to the sensory analysis results, the kefir with the highest overall liking was found to be the kefir containing 70% milk and 30% whey.
**Keywords:** Kefir, whey, sensory evaluation, color, storage

## Introduction

Consumer interest in fermented dairy products containing live probiotic lactic acid bacteria has increased because of growing consumer awareness of the value of nutrition for a quality and healthy life (Ender, 2009; Esmek & Güzeler, 2015; Özcan & Delikanlı, 2011). With ever-increasing production and consumption in our country, kefir is a milk fermented milk product, named after Russia's Caucasian mountains, derived from the use of kefir grain and containing a small amount of alcohol as a result of the end products of fermentation (Gündüz, 2017).

According to the Turkish Food Codex Fermented Dairy Products Communiqué, kefir is defined as a fermented dairy product in which kefir grains or starter cultures containing *Lactobacillus kefiri*, various strains of the *Leuconostoc, Lactococcus* and *Acetobacter* genera and lactose-fermenting (*Kluyveromyces marxianus*) and non-lactose-fermenting yeasts (*Saccharomyces unisporus, Saccharomyces cerevisiae* and *Saccharomyces exiguus*) are used in fermentation (Turkish Food Codex, 2009). Kefir granules are formed from a complex symbiosis between acetic acid bacteria, yeasts, and lactic acid bacteria (Esmek & Güzeler, 2015). According to the Turkish Food Codex Fermented Dairy Products Communiqué, in kefir, milk protein is at least 2.7 (wt%), milk fat is not more than 10 (wt%), titratable acidity is at least 0.6 (wt%), total specific microorganisms are at least 107 (cfu/g) and yeasts are at least 104 (cfu/g) is stated to be (Turkish Food Codex, 2009). The chemical composition of kefir grain contains 89-90% water, 0.2% fat, 3.0% protein, 6.0% sugar, and 0.7% ash by weight (w/w) (Şen, 2015). For good kefir, fluid consistency, homogeneity, and a shiny appearance must be achieved. Therefore, it should contain 0.6-0.9% lactic acid, 0.6-0.8% alcohol, and 50% $CO_2$ (by volume) (Yüksekdağ & Beyatlı, 2003).

Kefir is a natural probiotic containing the metabolites of above mentioned microorganisms found in kefir grains, has an extremely important place in human nutrition, and contains essential amino acids and some fatty acids necessary for the body (Esmek & Güzeler, 2015). Kefir is a source of vitamins B1, B2, B6, B12, folic acid, vitamin K, and biotin (vitamin H). It contains macrominerals such as calcium, phosphorus, potassium, and magnesium, and microminerals such as zinc, copper, manganese, iron, and cobalt. By consuming 175 ml of kefir, approximately 20% of the daily calcium and phosphorus needs, 14% of vitamin B12, 19% of vitamin B2 and 5% of magnesium can be met (Kadıoğlu, 2017).

Whey is defined as a translucent and greenish-yellow liquid protein source obtained as a result of the precipitation of casein in cheese or casein production (Özcan & Delikanlı, 2011). Whey, a milk by-product, contains mainly lactose, serum proteins, mineral matter, and a small

amount of fat. As a result of cheese production in our country, approximately 2 million tons per year of whey are released as a by-product (Türkmen et al., 2017).

Whey proteins are used in many foods to improve sensory and textual properties and increase endurance. Furthermore, whey proteins are known to have functional properties such as increasing shrinkage, strengthening gel formation, creating emulsions, water retention, and preventing serum separation. It is used as an additive for a variety of purposes in athletic's nutrition and special nutrition foods and beverages, baby food and the food industry, while a significant portion is left unnoticed in sewerage (Özcan & Delikanlı, 2011). It is therefore important to evaluate this by-product in the best possible way without harming the environment, to prevent economic losses and to generate added value (Esmek & Güzeler, 2015).

This study aimed to evaluate the usability of whey in kefir production in order to evaluate whey waste containing valuable components in the dairy industry and to determine the acceptability of the resulting whey-added kefir by the consumer. The effect of the storage process on produced kefir samples was also studied.

**Materials and Methods**

The fat-free whey used in the research was obtained from Pınar Süt Mamulleri San. A.Ş., Izmir, Turkey. It was kept in cold conditions (refrigerator, +4°C) during the studies. Dry kefir yeast (Danem Süt ve Süt Ürünleri Amb. Dan. San. ve Tic. Ltd.) was used to ensure standardization in kefir production. Altınkılıç brand kefir product (Altınkılıç Gıda ve Süt San. Tic A.Ş.) was used as a control kefir sample.

Mixtures containing different proportions (%) of milk and whey were prepared and kefir production was carried out (Table 1). The mixtures were prepared as 1 liter and kefir yeast was added to these mixtures keeping the ratio of yeast to mixture as indicated on the package and incubated overnight in closed glass jars at room temperature (30±2 $^{0}$C) in an incubator (Kutay Laboratuar Malzemeleri Ticaret A.Ş., Türkiye) and the kefir taken the next morning was stored in the refrigerator to reduce moisture, total-soluble solid content, color, pH and sensory analyses were performed. All samples were shaken before the analyses were performed.

**Table** *Hata! Belgede belirtilen stilde metne rastlanmadı.***1 The trial plan applied for the production of the kefir sample (volume:volume)**

| Milk (%) | Whey(%) |
|---|---|
| **100** | 0 |
| **90** | 10 |
| **80** | 20 |
| **70** | 30 |
| **60** | 40 |
| **50** | 50 |
| **40** | 60 |
| **30** | 70 |
| **20** | 80 |
| **10** | 90 |

Storage: In order to determine the changes that would occur in the physical and chemical properties of the produced kefirs during storage, the kefirs were stored in glass jars with their lids closed under refrigerator conditions (+4ºC) for 28 days. At the end of the 1st, 7th, 14th, 21st, and 28th days, kefir samples were analyzed for total-soluble solid content, color, pH, and moisture determination. Sensory analysis was also performed on the samples on day 1.

Moisture Content (%): Approximately one gram of kefir samples were placed in moisture containers that were brought to constant weighing, kept in the oven at 105 °C for 4 hours, and then taken into a desiccator and brought to room temperature. The samples that came to room temperature were weighed with a precision balance.

Total Soluble Solid Content: The total-soluble solid content of kefirs were determined by digital refractometry (ATAGO 1T).

pH: pH values of kefir were measured at room temperature with a pH meter (WTW InfoLab pH720, Germany).

Color Analysis: The color values of kefir sample: L*, a*, and b* values were measured with the Konica Minolta Chroma Meter CR-400 model colorimeter.

Sensory Analysis: For this purpose, a scoring test was conducted on 23 semi-trained panelists. The products were given to the panelists in coding, but the panelists were not given information about the products. Panelists were informed about how to evaluate the products. Properties such as color, smell and consistency are explained using commercial kefir as an example. With the scoring test of the kefirs on the 1st day, color, smell, homogeneous structure, sourness, consistency, gel-like structure, sweetness/flavor, foreign flavor/yeast taste,

and overall liking characteristics were questioned (Altuğ & Elmacı, 2005). Score test form shown in Table 2.

**Table 2 Score test form**

Name: Date:

Please rate the samples from 1 (lowest) to 5 (highest) depending on how you like them.

| Sample code | Color | Smell | Sourness | Consistency | Homogeneous structure | Gel-like structure | Phase distinction | Sweetness | Flavor | foreign flavor /yeast taste | Overall liking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

Statistical analysis: All results obtained were tested by ANOVA with 95% confidence interval using IBM SPSS Statistics 25 package program. The statistical analysis of the produced kefir samples was evaluated separately for both the variable milk:whey ratio and the storage period.

**Findings and Discussion**

The quality of the milk used, the amount of dry matter, the types of microorganisms found in the kefir culture, fermentation temperature and duration, kefir production technology, and the time between production and consumption affect the composition of kefir (Dinç, 2008).



**Figure 1 Kefir samples made with milk at the end of the 1st day**

In this study, kefir was produced using milk and cheese juice in certain proportions, and the effect of the storage process on the product was studied. The objective of these kefir samples is to determine the best kefir sample by comparing moisture, total soluble solid content, pH analysis, color analysis and sensory analysis.

As a result of the analysis made at the end of the first day, the moisture content of commercial kefir was calculated at 88.48±0.11% (Shown in Table 3). The closest result to this value was found in kefir containing 100% milk with a moisture content of 88.52±0.02%. The moisture content of kefir produced using 70% and 80% milk was found to be close to the value of commercial kefir. It is seen that the moisture content of kefir produced using 90%, 60%, 50%, 40%, 30%, 20% and 10% milk is gradually increasing. As the amount of moisture increases, the product will gain a more fluid structure. According to the analysis results at the end of the seventh day, the moisture content of commercial kefir was calculated as 89.21±0.23%, and the kefir with the moisture content closest to this value was the kefir produced with 90% milk, with 89.49±0.05%. In addition, kefirs produced with 80% milk and 100% milk also have similar values. It has been observed that there is a regular decrease in the moisture content of the kefir produced as it goes from kefir using 10% milk to kefir using 100% milk. The reason for this is the decrease in the amount of whey used. Increasing the amount of whey increases the moisture content of the product. In the results obtained at the end of the fourteenth day, the moisture content of commercial kefir was found to be 88.35±0.11%. While kefir produced using 100% milk, with a moisture content of 85.02±0.26%, has the lowest moisture content compared to commercial kefir, it has been observed that the moisture content of kefirs made using 20% milk and 10% milk is high. At the end of the twenty-first day, the moisture content of commercial kefir was calculated at 89.07±0.52%. Among the produced kefirs, it was observed that the moisture content of kefirs containing 100%, 90%, and 80% milk was close to that of commercial kefir. In addition, it was determined that the moisture content of kefir containing 70% or less milk was higher than the moisture content of commercial kefir. Among the kefirs produced, it was observed that the kefir samples produced with 20% and 10% milk had the highest moisture content. With the twenty-eighth-day analysis, the moisture content of commercial kefir was determined to be 88.96±0.14%. The product closest to this value was kefir, which contains 100% milk with a moisture content of 89.45±0.03%. Generally, as the milk content decreases, the moisture content increases.

When the results of the moisture content of the samples on the 1st, 7th, 21st and 28th days are examined, there is a significant difference within the columns ($p<0.05$). However, there is no significant difference between the results of day 14 ($p>0.05$). The moisture content during storage does not represent a statistically significant difference for kefir samples containing 30%, 90% milk and commercial kefir ($p>0.05$). However, there is a statistically significant difference between the results of other kefir samples ($p>0.05$).

**Table** *Hata! Belgede belirtilen stilde metne rastlanmadı.***3 Moisture content of kefir samples**

| Moisture Content (%) | | | | | |
|---|---|---|---|---|---|
| | Storage Days | | | | |
| **Milk: Whey Ratio (by weight)** | 1 | 7 | 14 | 21 | 28 |
| **10:90** | 93.83±0.01$^{e,k}$ | 93.70±0.01$^{ı,k}$ | 98.01±0.28$^{b,m}$ | 95.33±0.19$^{e,l}$ | 95.06±0.26$^{f,l}$ |
| **20:80** | 93.03±0.03$^{d,e,k}$ | 93.17±0.08$^{h,k}$ | 98.61±0.23$^{b,n}$ | 95.47±0.12$^{e,m}$ | 94.64±0.41$^{e,f,l}$ |
| **30:70** | 92.91±0.11$^{d,e,k}$ | 93.04±0.06$^{h,k}$ | 78.02±22.04$^{a,k}$ | 93.70±0.04$^{d,k}$ | 92.86±0.14$^{c,d,e,f,k}$ |
| **40:60** | 92.24±0.34$^{c,d,e,l}$ | 92.65±0.06$^{g,l}$ | 89.78±0.23$^{a,b,k}$ | 94.43±0.51$^{d,e,n}$ | 93.53±0.02$^{d,e,f,m}$ |
| **50:50** | 92.12±0.84$^{c,d,e,l}$ | 92.23±0.48$^{f,l,m}$ | 87.66±0.08$^{a,b,k}$ | 93.84±0.93$^{d,m}$ | 92.29±0.19$^{c,d,e,l,m}$ |
| **60:40** | 90.93±0.04$^{b,c,l}$ | 91.15±0.02$^{e,l,m}$ | 91.54±0.33$^{a,b,m}$ | 90.17±0.15$^{b,k}$ | 91.04±0.01$^{b,c,d,l}$ |
| **70:30** | 90.25±0.21$^{a,b,k}$ | 90.31±0.01$^{d,k}$ | 90.63±0.14$^{a,b,k}$ | 91.38±0.01$^{c,l}$ | 91.34±0.25$^{b,c,d,l}$ |
| **80:20** | 89.91±0.01$^{a,b,l}$ | 89.83±0.16$^{c,k,l}$ | 89.65±0.18$^{a,b,k,l}$ | 89.59±0.06$^{a,b,k}$ | 90.38±0.06$^{b,c,m}$ |
| **90:10** | 91.23±2.43$^{b,c,d,k}$ | 89.49±0.05$^{b,c,k}$ | 89.63±0.08$^{a,b,k}$ | 89.01±0.82$^{a,k}$ | 87.78±3.54$^{a,k}$ |
| **100:0** | 88.52±0.02$^{a,l}$ | 88.72±0.03$^{a,l,m}$ | 85.02±0.26$^{a,b,k}$ | 89.19±0.56$^{a,b,l,m}$ | 89.45±0.03$^{a,b,m}$ |
| **Commercial Kefir** | 88.48±0.11$^{a,k}$ | 89.21±0.23$^{b,l}$ | 88.35±0.11$^{a,b,k}$ | 89.07±0.52$^{a,b,k,l}$ | 88.96±0.14$^{a,b,k,l}$ |

*The statistical analysis of the columns itself is expressed by the letters a, b, c, d, e, f, g, h and i, while the statistical analyses for the storage period are expressed with the letters k, l, m and n.*

As a result of the removal of water from foodstuffs, only dry matter remains in the environment. Dry matter is divided into water-soluble and insoluble. Sugars and organic acids constitute the water-soluble dry matter (Türkiye Ministry of National Education, 2018). The total-soluble solid content recorded during storage processes is given in Table 4. At the end of the first day and the seventh day, the total soluble solid content (◦Brix) of commercial kefir is 6.5±0.2 and 6.3±0.3, respectively. It was observed that the ◦Brix values of the kefir produced on the 1st and 7th days of storage were similar and there was no statistically significant difference between them ($p>0.05$). At the end of the fourteenth, twenty-first, and twenty-eighth days, the ◦Brix value of commercial kefir is 6.4±0.2, 6.2±0.0 and 6.1±0.1, respectively. No similarity could be established within the columns of the 14th, 21st and 28th day results of kefir produced using milk and whey, and a statistically significant difference was found ($p<0.05$).

Statistically, a significant difference was observed between the total-soluble solid content of dry matter in kefir samples containing 10%, 40%, 60%, 90% and 100% of milk during the storage period ($p<0.05$). Other kefir samples showed no significant difference in storage time ($p>0.05$).

**Table** *Hata! Belgede belirtilen stilde metne rastlanmadı.***4 Total soluble solid content of kefir samples**

| Total Soluble Solid Content (°Brix) | | | | | |
|---|---|---|---|---|---|
| **Milk: Whey Ratio (by weight)** | Storage Days | | | | |
| | 1 | 7 | 14 | 21 | 28 |
| **10:90** | $6.4\pm0.2^{b,c,m}$ | $6.1\pm0.2^{a,b,m}$ | $5.4\pm0.2^{b,c,l}$ | $4.5\pm0.1^{a,k}$ | $4.8\pm0.2^{a,k}$ |
| **20:80** | $6.3\pm0.2^{b,c,l}$ | $6.4\pm0.3^{b,l}$ | $5.3\pm0.3^{b,c,k}$ | $4.5\pm0.1^{a,k}$ | $4.7\pm0.2^{a,k}$ |
| **30:70** | $6.3\pm0.2^{b,c,k}$ | $6.2\pm0.1^{a,b,k}$ | $6.1\pm0.2^{c,d,k}$ | $6.2\pm0.0^{c,k}$ | $6.4\pm0.1^{c,d,k}$ |
| **40:60** | $6.5\pm0.3^{b,c,k}$ | $6.0\pm0.2^{a,b,k}$ | $8.3\pm0.6^{e,l}$ | $5.6\pm0.2^{b,k}$ | $6.0\pm0.3^{b,c,d,k}$ |
| **50:50** | $6.3\pm0.5^{a,b,c,k}$ | $6.1\pm0.2^{a,b,k}$ | $6.7\pm0.0^{d,l}$ | $6.2\pm0.1^{c,k}$ | $6.3\pm0.0^{b,c,d,k}$ |
| **60:40** | $6.4\pm0.2^{a,l}$ | $6.1\pm0.2^{a,b,l}$ | $5.1\pm0.2^{b,k}$ | $6.1\pm0.1^{c,l}$ | $6.5\pm0.2^{d,l}$ |
| **70:30** | $6.1\pm0.1^{a,b,k}$ | $5.6\pm0.3^{a,k}$ | $5.4\pm0.1^{b,c,k}$ | $5.3\pm0.2^{b,k}$ | $5.8\pm0.2^{b,k}$ |
| **80:20** | $6.1\pm0.3^{a,b,k}$ | $6.2\pm0.1^{a,b,k}$ | $6.5\pm0.0^{d,l}$ | $6.2\pm0.0^{c,k}$ | $6.5\pm0.0^{d,l}$ |
| **90:10** | $6.2\pm0.1^{a,b,c,l,m}$ | $5.9\pm0.2^{a,b,l}$ | $3.6\pm0.1^{a,k}$ | $6.7\pm0.2^{d,m}$ | $6.4\pm0.1^{c,d,l,m}$ |
| **100:0** | $6.4\pm0.1^{a,l}$ | $6.3\pm0.1^{a,b,l}$ | $3.9\pm0.5^{a,k}$ | $5.5\pm0.1^{b,l}$ | $5.9\pm0.2^{b,c,l}$ |
| **Commercial Kefir** | $6.5\pm0.2^{c,k}$ | $6.3\pm0.3^{a,b,k}$ | $6.4\pm0.2^{d,k}$ | $6.2\pm0.0^{c,k}$ | $6.1\pm0.1^{b,c,d,k}$ |

*The statistical analysis of the columns itself is expressed by the letters a, b, c, d, and e, while the statistical analyses for the storage period are expressed with the letters k, l, and m.*

pH is expressed as the minus logarithm of the hydrogen ions present in a solution. Measurement is made according to the density of acidic hydrogen ions in the substance. The pH value varies between 0 (zero) and 14, and as it decreases from 7 to 0 (zero), the acidity increases, and as it increases from 7 to 14, the alkalinity increases. There is no standard specified for the pH value of kefrin in the Turkish Food Codex Fermented Dairy Products Communiqué. It has been stated that the pH value of kefir varies between 4.2 and 4.6 (Dinç, 2008). At the end of the first day, the pH value of commercial kefir is 4.65±0.1 (Shown in Table 5). In general, the pH values of produced kefir were found to be close to those of commercial kefir. While kefir containing 60% milk (4.04±0.01) has the lowest pH, kefir containing 100% milk (4.76±0.05) has the highest pH. At the end of the seventh day, the pH value of commercial kefir is 4.42 ± 0.05. Among the produced kefirs, the pH values of kefirs containing 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80% and 90% milk are lower than commercial kefir. In addition, kefir containing 100% milk has the same pH as commercial kefir. At the end of the fourteenth day, the pH value of commercial kefir is 4.55±0.1. Among the produced kefirs, except for the kefir containing 100% milk, the pH values of the kefirs using milk are lower than the commercial kefir. The pH of commercial kefir and kefir containing 100% milk (4.55±0.2) is the same and has the highest value. The lowest pH belongs to kefir, which contains 80% milk, with 3.82±0.04. At the end of the twenty-first day, the pH value of commercial kefir is 4.51±0.08. Among the kefir sample produced, kefir containing 100% milk (4.43±0.05) has the highest pH value. The lowest pH belongs to kefir, which contains 80% milk, with 3.89±0.02. At the end of the twenty-eighth day, the pH value

of commercial kefir is 4.46±0.2. Among the kefirs produced, kefir containing 100% milk (4.44±0.1) has the highest pH value. Kefir, which contains 80% milk and has a pH of 3.85±0.1, has the lowest pH. The results of the 1st, 14th and 28th days in the pH values of kefirs indicate a statistically significant difference within the column ($p<0.05$). However, there is no statistically significant difference within the result column on the 7th and 21st day ($p>0.05$). While the pH results of the kefir sample containing 30% milk show a statistically significant difference during the storage period ($p<0.05$), the pH results of the other kefir samples do not show a significant difference ($p>0.05$).

**Table** *Hata! Belgede belirtilen stilde metne rastlanmadı.***5 pH values of the kefir samples**

| pH | | | | | |
|---|---|---|---|---|---|
| **Milk: Whey Ratio (by weight)** | Storage Days | | | | |
| | 1 | 7 | 14 | 21 | 28 |
| **10:90** | $4.14\pm0.00^{b,c,l}$ | $3.99\pm0.04^{a,k}$ | $3.97\pm0.10^{d,k}$ | $4.03\pm0.10^{a,b,k,l}$ | $4.06\pm0.20^{d,k,l}$ |
| **20:80** | $4.19\pm0.10^{c,l}$ | $3.99\pm0.10^{a,k}$ | $3.93\pm0.10^{b,c,d,k}$ | $4.01\pm0.20^{a,b,k,l}$ | $4.01\pm0.10^{c,d,k,l}$ |
| **30:70** | $4.16\pm0.06^{b,c,m}$ | $3.96\pm0.02^{a,l}$ | $3.88\pm0.20^{b,k}$ | $3.97\pm0.10^{a,b,l}$ | $4.00\pm0.10^{b,c,d,l}$ |
| **40:60** | $4.15\pm0.08^{b,c,k}$ | $3.96\pm0.08^{a,k}$ | $3.95\pm0.10^{c,d,k}$ | $3.99\pm0.12^{a,b,k}$ | $4.02\pm0.20^{c,d,k}$ |
| **50:50** | $4.18\pm0.02^{c,k}$ | $3.97\pm0.17^{a,k}$ | $3.91\pm0.10^{b,c,d,k}$ | $4.00\pm0.08^{a,b,k}$ | $4.02\pm0.10^{c,d,k}$ |
| **60:40** | $4.04\pm0.01^{a,k}$ | $3.90\pm0.05^{a,k}$ | $3.88\pm0.20^{b,k}$ | $3.89\pm0.02^{a,b,k}$ | $3.89\pm0.10^{a,b,k}$ |
| **70:30** | $4.14\pm0.00^{b,c,k}$ | $3.96\pm0.11^{a,k}$ | $3.90\pm0.10^{b,c,k}$ | $3.94\pm0.11^{a,b,k}$ | $3.91\pm0.20^{a,b,c,k}$ |
| **80:20** | $4.08\pm0.02^{a,b,m}$ | $3.87\pm0.07^{a,l}$ | $3.82\pm0.04^{a,k}$ | $3.89\pm0.02^{a,k,l}$ | $3.85\pm0.10^{a,k,l}$ |
| **90:10** | $4.13\pm0.03^{b,c,k}$ | $3.97\pm0.21^{a,k}$ | $3.97\pm0.10^{d,k}$ | $3.98\pm0.03^{a,b,k}$ | $3.95\pm0.10^{a,b,c,d,k}$ |
| **100:0** | $4.76\pm0.05^{e,l}$ | $4.42\pm0.09^{b,k}$ | $4.55\pm0.20^{e,k,l}$ | $4.43\pm0.05^{a,b,k}$ | $4.44\pm0.10^{e,k}$ |
| **Commercial Kefir** | $4.65\pm0.10^{d,l}$ | $4.42\pm0.05^{b,k}$ | $4.55\pm0.10^{e,k,l}$ | $4.51\pm0.08^{b,k,l}$ | $4.46\pm0.20^{e,k}$ |

*The statistical analysis of the columns itself is expressed by the letters a, b, c, d, and e, while the statistical analyses for the storage period are expressed with the letters k, l, m and n.*

The color of food is one of the most important sensory characteristics in terms of the acceptability of the product by consumers. Color measurement is an important quality factor that shows the quality and sensory appeal of the producted (Quek et al., 2007).

L* value indicates the brightness of the color (0: black, 100: white), a* value indicates the redness-greenness (-:green, +: red) and b* value indicates the yellowness-blueness (-: blue, +: yellow). represents (Keskin et al., 2017). Looking at the color measurement results, it was seen that the kefir sample containing 100% milk had the L* value closest to the commercial kefir at the end of the first and seventh days of storage (Shown in Table 6). In addition, it was determined that these kefir samples were brighter when the columns were compared among themselves. L* values show a statistically significant difference on the first and seventh days ($p<0.05$). On the fourteenth and twenty-first days, it is seen that L* values increase as the milk rate increases and it represents a statistically significant difference ($p<0.05$). On the twenty-eighth day, the closest sample to the commercial kefir (84.75±0.06) is the kefir containing

90% milk (83.89±0.18). There is a statistically significant difference between L* values throughout storage ($p<0.05$).

**Table 6 Color L* values of kefir samples**

| L* | | | | | |
|---|---|---|---|---|---|
| **Milk: Whey Ratio (by weight)** | Storage Days | | | | |
| | 1 | 7 | 14 | 21 | 28 |
| **10:90** | 65.04±2.34$^{a,m}$ | 65.03±1.14$^{a,m}$ | 50.41±1.78$^{b,k}$ | 59.66±1.99$^{a,l}$ | 69.59±1.12$^{a,n}$ |
| **20:80** | 68.20±1.41$^{b,l}$ | 71.45±0.74$^{b,m}$ | 59.51±4.83$^{c,k}$ | 71.95±1.28$^{b,m}$ | 78.75±0.60$^{d,n}$ |
| **30:70** | 73.84±1.25$^{c,l}$ | 74.48±1.21$^{c,l,m}$ | 68.14±1.68$^{d,k}$ | 75.55±0.59$^{d,m}$ | 74.69±0.81$^{c,l,m}$ |
| **40:60** | 75.28±0.99$^{d,m}$ | 77.48±0.37$^{d,n}$ | 57.63±0.52$^{c,k}$ | 74.67±1.25$^{c,d,m}$ | 70.21±0.92$^{a,l}$ |
| **50:50** | 78.22±0.57$^{e,m}$ | 78.51±0.78$^{e,m}$ | 45.36±0.52$^{a,k}$ | 73.88±1.35$^{c,l}$ | 80.76±0.97$^{e,n}$ |
| **60:40** | 81.58±0.12$^{f,m}$ | 82.36±0.13$^{f,o}$ | 81.90±0.33$^{f,g,n}$ | 80.78±0.17$^{e,l}$ | 72.01±0.25$^{b,k}$ |
| **70:30** | 83.13±0.07$^{g,n}$ | 83.31±0.14$^{g,n}$ | 80.55±0.25$^{f,k}$ | 81.76±0.28$^{e,f,l}$ | 82.19±0.08$^{f,m}$ |
| **80:20** | 83.44±0.15$^{g,m}$ | 83.58±0.30$^{g,m}$ | 82.56±0.32$^{f,g,l}$ | 82.26±0.12$^{f,k}$ | 82.63±0.09$^{f,l}$ |
| **90:10** | 83.65±0.06$^{g,h,m}$ | 84.08±0.07$^{g,m}$ | 82.56±0.16$^{f,g,l}$ | 82.12±0.48$^{f,k}$ | 83.89±0.18$^{g,m,n}$ |
| **100:0** | 84.78±0.08$^{h,i,l}$ | 85.76±0.15$^{h,m}$ | 83.79±0.15$^{g,k}$ | 83.85±0.36$^{g,k}$ | 83.64±0.18$^{g,k}$ |
| **Commercial Kefir** | 85.26±0.05$^{i,n}$ | 85.79±0.31$^{h,o}$ | 83.28±0.06$^{e,k}$ | 83.53±0.04$^{g,l}$ | 84.75±0.06$^{h,m}$ |

*The statistical analysis of the columns itself is expressed by the letters a, b, c, d, e, f, g, h and i, while the statistical analyses for the storage period are expressed with the letters k, l, m, n, and o.*

When the results of the first day were examined, it was seen that the a* values were similar to each other and there was no statistically significant difference ($p>0.05$) (Shown in Table 7). When the milk content increased in the produced kefir samples on the seventh day, the redness decreased and the results indicate a statistically significant difference ($p<0.05$). There is a statistically significant difference when a* values are evaluated in columns on days fourteen, twenty-one and twenty-eight ($p<0.05$). During storage, there is a significant difference between the a* values of the samples except the kefir sample containing 40% milk ($p<0.05$).

**Table 7 Color a* values of kefir samples**

| a* | | | | | |
|---|---|---|---|---|---|
| **Milk: Whey Ratio (by weight)** | Storage Days | | | | |
| | 1 | 7 | 14 | 21 | 28 |
| **10:90** | -2.68±0.08$^{a,b,l}$ | -2.99±0.09$^{a,k}$ | -2.40±0.11$^{b,c,m}$ | -2.18±0.08$^{f,n}$ | -2.33±0.07$^{g,m}$ |
| **20:80** | -2.87±0.15$^{a,b,k}$ | -2.89±0.03$^{b,k}$ | -2.28±0.17$^{b,c,l}$ | -2.26±0.07$^{f,l}$ | -2.31±0.05$^{g,l}$ |
| **30:70** | -2.99±0.10$^{a,b,l}$ | -2.88±0.08$^{b,l,m}$ | -3.42±0.15$^{a,k}$ | -2.84±0.06$^{d,e,m}$ | -2.98±0.14$^{b,l,m}$ |
| **40:60** | -3.11±0.18$^{a,k}$ | -2.87±0.01$^{b,k,l}$ | -1.78±2.17$^{d,l}$ | -2.72±0.08$^{e,k,l}$ | -3.32±0.09$^{a,k}$ |
| **50:50** | -2.98±0.06$^{a,b,k}$ | -2.82±0.08$^{b,l,m}$ | -2.70±0.03$^{a,b,m}$ | -2.89±0.13$^{c,d,k,l}$ | -2.70±0.07$^{c,m}$ |
| **60:40** | -2.91±0.02$^{a,b,l}$ | -2.57±0.01$^{c,n}$ | -2.66±0.03$^{a,b,m}$ | -3.08±0.02$^{a,b,k}$ | -2.54±0.02$^{f,o}$ |
| **70:30** | -2.52±0.08$^{b,l}$ | -2.42±0.10$^{d,e,l}$ | -3.15±0.04$^{a,b,k}$ | -3.19±0.39$^{a,k}$ | -2.58±0.01$^{e,f,l}$ |
| **80:20** | -2.82±0.02$^{a,b,l}$ | -2.34±0.04$^{f,o}$ | -2.72±0.05$^{a,b,m}$ | -3.01±0.04$^{b,c,d,k}$ | -2.68±0.01$^{c,d,n}$ |
| **90:10** | -2.65±0.14$^{a,b,m}$ | -2.35±0.02$^{e,f,o}$ | -2.79±0.05$^{a,b,l}$ | -3.08±0.05$^{a,b,k}$ | -2.56±0.02$^{e,f,n}$ |
| **100:0** | -2.76±0.02$^{a,b,l}$ | -2.28±0.08$^{f,n}$ | -2.79±0.05$^{a,b,l}$ | -3.08±0.08$^{a,b,k}$ | -2.69±0.01$^{c,d,m}$ |
| **Commercial Kefir** | -2.70±0.02$^{a,b}$ | -2.44±0.02$^{d}$ | -2.95±0.02$^{a}$ | -3.04±0.02$^{a,b,c}$ | -2.62±0.01$^{d,e}$ |

*The statistical analysis of the columns itself is expressed by the letters a, b, c, d, e, f, g, and h, while the statistical analyses for the storage period are expressed with the letters k, l, m, n, and o.*

Generally, the b* values of the samples increased as the milk content increased, and it can be interpreted that yellowness decreased (Shown in Table 8). The columns show a statistically significant difference within themselves ($p<0.05$). There is a statistically significant difference between b* values during storage ($p<0.05$)

**Table 8 Color b* values of kefir samples**

| b* | | | | | |
|---|---|---|---|---|---|
| **Milk: Whey Ratio (by weight)** | Storage Days | | | | |
| | 1 | 7 | 14 | 21 | 28 |
| **10:90** | $1.09\pm0.44^{a,m}$ | $1.25\pm0.10^{a,m}$ | $-1.36\pm0.32^{a,c,k}$ | $-0.73\pm0.24^{a,d,l}$ | $1.20\pm0.11^{a,c,m}$ |
| **20:80** | $2.67\pm0.38^{b,m}$ | $2.90\pm0.10^{b,m}$ | $-0.37\pm0.13^{c,k}$ | $2.00\pm0.44^{b,l}$ | $4.79\pm0.39^{c,n}$ |
| **30:70** | $4.07\pm0.07^{c,m}$ | $3.36\pm0.11^{c,l}$ | $2.78\pm0.13^{d,k}$ | $3.99\pm0.22^{d,m}$ | $3.93\pm0.15^{b,m}$ |
| **40:60** | $4.80\pm0.49^{c,d,m}$ | $4.96\pm0.26^{d,m}$ | $-0.68\pm0.32^{b,k}$ | $3.97\pm0.21^{d,l}$ | $5.08\pm0.09^{d,m}$ |
| **50:50** | $5.68\pm0.16^{d,e,m}$ | $5.38\pm0.45^{e,m}$ | $-1.23\pm0.08^{a,k}$ | $3.50\pm0.37^{c,l}$ | $6.45\pm0.38^{f,n}$ |
| **60:40** | $5.51\pm0.02^{d,e,l}$ | $5.52\pm0.06^{e,f,l}$ | $5.94\pm0.05^{e,m}$ | $5.96\pm0.06^{e,m}$ | $5.00\pm0.01^{d,k}$ |
| **70:30** | $5.26\pm0.17^{d,e,k}$ | $5.68\pm0.23^{f,g,k}$ | $6.50\pm0.05^{g,l}$ | $6.65\pm0.12^{f,l}$ | $6.19\pm0.02^{e,l}$ |
| **80:20** | $6.15\pm0.01^{e,m}$ | $5.79\pm0.10^{g,k}$ | $6.01\pm0.13^{e,l}$ | $6.49\pm0.07^{f,o}$ | $6.29\pm0.03^{e,f,n}$ |
| **90:10** | $6.03\pm0.32^{e,k}$ | $6.15\pm0.07^{h,k}$ | $6.04\pm0.15^{e,k}$ | $7.25\pm0.08^{g,l}$ | $7.41\pm0.10^{g,l}$ |
| **100:0** | $6.14\pm0.03^{e,k}$ | $6.09\pm0.24^{h,k}$ | $6.15\pm0.09^{e,f,k}$ | $7.17\pm0.06^{g,l}$ | $7.20\pm0.28^{g,l}$ |
| **Commercial Kefir** | $6.16\pm0.01^{e,m}$ | $6.05\pm0.04^{h,k}$ | $6.33\pm0.04^{f,g,o}$ | $6.10\pm0.01^{e,l}$ | $6.27\pm0.02^{e,f,n}$ |

*The statistical analysis of the columns itself is expressed by the letters a, b, c, d, e, f, and g, while the statistical analyses for the storage period are expressed with the letters k, l, m, n, and o.*

The samples produced were evaluated by semi-trained panelists, consisting of 23 people, on a color, odor, homogeneous structure, sourness, consistency, gel-like structure, sweetness, flavor, foreign flavor/yeast taste, and overall liking characteristics. The samples are divided into drinkable (kefirs containing 60%, 70%, 80%, 90%, 100% milk, and commercial kefir) and non-drinkable (kefirs containing 10%, 20%, 30%, 40%, and 50% milk). Non-drinkable kefirs were evaluated only in terms of color, odor, homogeneous structure, phase separation, and overall liking. Semi-trained panelists gave scores from 1 (lowest) to 5 (highest) for each of the examples, depending on their liking (Shownn in Table 8).

Panelists were asked to visually evaluate the color of kefir. As a result of these ratings, the average value closest to commercial kefir among the drinkable samples was 100% milk, followed by 70% milk-blend kefir. As a result of the panelist evaluation, it was seen that the colors of the kefir samples containing 10%, 20%, 30%, 40% and 50% milk were similar and there was no statistically significant difference. However, as a result of phase separation, the

whiteness clearly disappeared and was replaced by a yellowish color. It is thought that this also affects color values in sensory evaluation. In the odor rankings, the panelists were asked to rate the kefir samples that had bad odors for the nose and the kefir samples that were good for the nose. In the odor evaluation, the 80% milk-mixed kefir sample received the highest appreciation. Considering the color and odor evaluation, there is a statistically significant difference between drinkable and non-drinkable kefir samples. ($p<0.05$). The taste in the mouth of drinkable kefir samples was evaluated. Panelists generally found the highest sourness in the kefir sample containing 80% milk and the least sourness in the kefir sample containing 100% milk. In consistency rankings, panelists were asked to rate these kefir samples based on their spreadability in the mouth. The most consistent kefir sample in the mouth was ready kefir for the panelists and the closest value was the kefir sample containing 70% milk. There is a statistically significant difference between the sourness and consistency results of drinkable kefirs ($p<0.05$). Inhomogeneous structure rankings, panelists were asked to evaluate whether there was a lumpy structure in the product and give points to these kefir samples. The most homogeneous sample was found by the panelists to be kefir using 70% milk, and it was observed that this kefir sample was statistically similar to the samples with 60% and 100% milk additives. There was a difference in scoring between drinkable and non-drinkable samples, and it was found to be a statistically significant difference ($p<0.05$). For the drinkable samples in the gel-like structure order, the panelists were asked to evaluate them according to commercial kefir. Considering the milk ratios, the kefir sample made from 100% milk was expected to receive the highest approval for its gel structure, but as a result of the panelist evaluations, it was found that the containing 80% milk product had a better gel structure than ready-made kefir and other drinkable samples. As expected, the kefir sample containing 60% milk received the least appreciation for its gel-like structure. There is no statistically significant difference between the gel structures of the samples ($p>0.05$). Phase separation was evaluated by panelists for both drinkable and non-drinkable samples. As a result, as expected, phase separation is seen to be greater in non-drinkable milk samples. Drinkable and non-drinkable kefir samples gave similar results, but a statistically significant difference was found between all samples ($p<0.05$). The closest value to ready-made kefir, where phase separation was observed the least, was the kefir sample containing 70% milk. The sweetness, flavor, and foreign flavor/yeast in the products were evaluated by the panelists for drinkable kefir samples, and no significant difference was seen between these results ($p>0.05$). The kefir with the most sweetness was the kefir containing 100% milk, while the

kefir with the least sweetness was the kefir containing 60% milk. As a result of the panelist evaluations, there is no statistical difference between the taste values ($p>0.05$). The foreign flavor taste was felt more in the kefir sample containing 90% milk compared to the others. However, no statistical difference was seen between all results ($p>0.05$). The yeast taste was preserved better in the ready-made kefir sample compared to the kefir sample we produced during our study. This may vary depending on the environmental conditions and the yeast sample used.

The panelists were asked to make an overall evaluation, and the kefir sample containing 70% milk was liked at a similar rate to the commercial kefir. The reason for this may be that the phase separation is less than the others, the consistency and homogeneous structure are better, and the sourness is felt less. A statistically significant difference was found between the overall liking results ($p<0.05$).

**Table 7 Sensory analysis of kefir**

| Milk: Whey Ratio (by weight) | Color | Smell | Sourness | Consistency (mounth) | Homogeneous structure | Gel-like structure | Phase distinction | Sweetness | Flavor | foreign flavor /yeast taste | Overall liking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **10:90** | $2.0\pm0.9^{a}$ | $3.0\pm0.9^{a}$ | - | - | $1.0\pm0.6^{a}$ | - | $4.0\pm1.3^{b}$ | - | - | - | $2.0\pm08^{a}$ |
| **20:80** | $2.0\pm0.9^{a}$ | $3.0\pm1.1^{a}$ | - | - | $1.0\pm0.4^{a}$ | - | $4.0\pm1.3^{b}$ | - | - | - | $2.0\pm0.9^{a}$ |
| **30:70** | $2.0\pm0.9^{a}$ | $3.0\pm1.1^{a}$ | - | - | $1.0\pm0.7^{a}$ | - | $4.0\pm1.2^{b}$ | - | - | - | $2.0\pm1.0^{a}$ |
| **40:60** | $2.0\pm0.8^{a}$ | $3.0\pm1.1^{a}$ | - | - | $1.0\pm0.4^{a}$ | - | $4.0\pm1.3^{b}$ | - | - | - | $2.0\pm0.7^{a}$ |
| **50:50** | $2.0\pm0.6^{a}$ | $3.0\pm0.9^{a}$ | - | - | $1.0\pm0.6^{a}$ | - | $4.0\pm1.1^{b}$ | - | - | - | $2.0\pm0.9^{a}$ |
| **60:40** | $4.0\pm0.6^{b}$ | $4.0\pm0.8^{b}$ | $3.0\pm1.2^{c}$ | $4.0\pm0.8^{c}$ | $4.0\pm0.8^{c,d}$ | $3.0\pm1.3^{a}$ | $2.0\pm1.3^{a}$ | $2.0\pm1.2^{a}$ | $4.0\pm0.8^{a,b}$ | $2.0\pm1.2^{a}$ | $4.0\pm0.8^{b,c}$ |
| **70:30** | $5.0\pm0.5^{b}$ | $4.0\pm0.8^{b}$ | $3.0\pm1.1^{c}$ | $4.0\pm1.1^{c}$ | $4.0\pm1.0^{c,d}$ | $3.0\pm1.4^{a}$ | $2.0\pm1.1^{a}$ | $3.0\pm1.3^{a}$ | $4.0\pm1.0^{c}$ | $2.0\pm1.1^{a}$ | $4.0\pm1.0^{c}$ |
| **80:20** | $4.0\pm0.7^{b}$ | $4.0\pm0.9^{b}$ | $3.0\pm1.1^{c}$ | $4.0\pm1.0^{c}$ | $4.0\pm0.9^{c}$ | $4.0\pm1.2^{a}$ | $2.0\pm1.3^{a}$ | $3.0\pm1.4^{a}$ | $4.0\pm0.8^{a,b}$ | $2.0\pm1.1^{a}$ | $4.0\pm0.8^{b,c}$ |
| **90:10** | $4.0\pm0.7^{b}$ | $4.0\pm0.9^{b}$ | $3.0\pm1.0^{b,c}$ | $3.0\pm1.2^{a}$ | $3.0\pm1.1^{b}$ | $3.0\pm1.4^{a}$ | $2.0\pm1.2^{a}$ | $3.0\pm1.2^{a}$ | $3.0\pm1.0^{a,b}$ | $3.0\pm1.4^{a}$ | $3.0\pm0.9^{b,c}$ |
| **100:0** | $5.0\pm0.6^{b}$ | $4.0\pm1.0^{b}$ | $2.0\pm0.9^{a}$ | $3.0\pm1.2^{a,b}$ | $4.0\pm0.9^{c,d}$ | $3.0\pm1.4^{a}$ | $2.0\pm1.3^{a}$ | $3.0\pm1.2^{a}$ | $3.0\pm1.0^{a}$ | $2.0\pm1.3^{a}$ | $3.0\pm0.9^{b}$ |
| **Commercial Kefir** | $5.0\pm0.5^{b}$ | $4.0\pm1.3^{b}$ | $2.0\pm1.2^{b}$ | $4.0\pm1.0^{c}$ | $5.0\pm0.7^{d}$ | $3.0\pm1.6^{a}$ | $1.0\pm1.2^{a}$ | $3.0\pm1.3^{a}$ | $4.0\pm1.1^{a,b}$ | $2.0\pm1.3^{a}$ | $4.0\pm1.3^{c}$ |

## Conclusion and Recommendations

In this study, kefir, which is very important for human nutrition, was produced from very high nutritional whey, often used as waste. This production was carried out with milk-whey in certain proportions and stored for twenty-eight days. Additionally, the produced kefir samples were analyzed on the 1st, 14th, 7th, 21st and 28th days.

In addition to this study, the production of milk powder added kefir was also carried out, but no successful production was achieved. It is thought that whey, which is an important waste in the food industry, was successful in the study and contributed to the literature on this subject.

Usually, as the milk ratio decreases, the moisture content increases. Except for the results of the fourteenth day of the produced kefir samples, there is a significant difference in themselves ($p<0.05$). During storage, the moisture content does not show a statistically significant difference for kefir samples containing 30%, 90% milk and commercial kefir

($p>0.05$). However, there is a statistically significant difference between the results of other kefir samples ($p>0.05$).

It was observed that the total soluble solids contents of the produced kefir samples on the 1st and 7th days were similar and there was no statistically significant difference between them ($p>0.05$). However, no similarity could be established between the results of the 14th, 21st and 28th days and a statistically significant difference was found ($p<0.05$). Statistically, it was observed that there was a significant difference between the water-soluble dry matter contents of kefir samples containing 10%, 40%, 60%, 90% and 100% milk during storage ($p<0.05$). Other kefir samples did not show a significant difference during storage ($p>0.05$).

The pH values of kefir produced from milk and whey were found to be similar to those of commercial kefir. While the results of the 1st, 14th and 28th days in the pH values of the produced kefir samples indicate a statistically significant difference within the column ($p<0.05$), the results of the 7th and 21st days do not indicate a statistically significant difference within the column ($p>0.05$). ). During the storage process, the pH results of the kefir sample containing 30% milk show a statistically significant difference, while the pH results of the other kefir samples do not show a significant difference.

As a result of this study, the kefir sample closest to the commercial kefir in terms of color values (L*, a*, b*) on the first day was the kefir sample made with 100% milk, and as the milk content in kefir increased, the yellowness (b*) increased. While there is a statistically significant difference between the L* and b* values of the samples ($p<0.05$), there is no significant difference between the a* values ($p>0.05$). There is a statistically significant difference between L* and b* values throughout storage ($p<0.05$). However, there is a significant difference in a* values between the samples except the kefir sample containing 40% milk throughout storage ($p<0.05$).

In the sensory analysis, panelists were asked to make a general evaluation and a statistically significant difference was found between the results ($p<0.05$). The highest overall approval score was the kefir sample containing 70% milk.

As a result, this study showed that whey can be used in kefir production. This study contributed to the literature for waste evaluation. In future studies, it may be recommended to produce kefir with different milk:whey ratios. In addition, consumer evaluation can be made by performing sensory analysis during the storage period.

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# THE PHYSICAL AND FERMENTATION PROPERTIES OF VARIOUS SILAGES PRODUCED IN COMMERCIAL FARMS FROM DIFFERENT PROVINCES OF KAHRAMANMARAS[1]

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## Abstract
This study was planned to test the physical (smell, color, structure, aerobic stability) and chemical (moisture, organic matter, protein, ADF, NDF, pH, Flieg's point and Relative feed value) characteristics of various crop silages (corn, sorghum, vetch, triticale, sugar beet pulp) produced in commercial livestock farms in different provinces of Kahramanmaras (n= 31). The silages were collected from Turkoglu (corn and sorghum silages), Pazarcik (corn silage), Center (corn, and vetch+triticale silages), Afsin (sugar beet pulp silage) and Elbistan (corn and sugar beet pulp silages) provinces. Results showed that the physical properties (color, smell, structure), pH (4.10), DM (27.2%), NDF (54.9%), dry matter digestibility (DMD; 65.0%), dry matter intake (DMI; 2.2% of BW) and relative feed value (RFV; 110) of corn silages were optimal (or) better in Center province compared to other provinces. Corn silages from Elbistan province represented an excellent degree of quality in terms of Flieg score (92), and aerobic stability parameters (92 h for reaching maximum temperature). Although sorghum silages had a fair (or) poor physical properties in terms of color and structure, they had fair (or) good fermentation properties in terms of pH (4.05), DM (26.0%), CP (9.8%) and RFV (90) along with an excellent Flieg score (95) and 100 h for reaching maximum temperature. Vetch, triticale and mixture of vetch (25%) and triticale (75%) silages from Center province had a poor color (brown-yellow), smell (bad) and non-separable structure. However, those silages had an optimal CP (19.9, 10.2 and 18.1%, respectively) and DMD values (64.5, 54.1, and 58.5%, respectively). Sugar beet pulp silages from both Elbistan and Afsin provinces represented a good (or) excellent physical properties in terms of color (yellow-green) and smell (not-disturbing or nice). Similarly, sugar beet pulp silages had an optimal pH (3.65), ADF (27.6%), DMD (67.4%) and RFV (104). Sugar beet pulp silages had also a good (or) excellent Flieg scores (75 and 100) along with aerobic stability criteria in terms of reached maximum temperature averaging 27°C. In general, tested all crop silages stayed in optimal physical and fermentation ranges with exceptional out ranges from different provinces.
**Keywords:** Silage, Aerobic stability, pH, Flieg point, Relative feed value

## Introduction

Many plants are used to make forages for ruminant nutrition and the silages are the one of them and being an alternative method for conserving forages. There are different types of silages (legume, grass, corn, sugar beet pulp, etc.) produced for their energy and protein content to meet the needs of the ruminant's nutrient requirement. Water-soluble carbohydrates (WSC) in forages are fermented to organic acids under epiphytic bacteria those perform the silage's future. However, the silage fermentation during ensiling and storage are the key factors effectively related to desired silage quality for livestock production. There are many factors affecting silage quality in such, plant harvesting time, harvesting at proper physical form, silo conditions and feed-out phase. Several silage fermentation parameters are considered for determining the quality in such, moisture, water soluble carbohydrate, fiber, initial microbial population, pH and aerobic stability contents. Among these, aerobic stability is the most important criteria that affect the silage quality and feeding value of silage after fermentation is complete (Filya, 2004). Aerobic stability method is based upon the principle of temperature change (rise) of the material when the silage is exposed to oxygen. After fermentation, under aerobic conditions the aerobic stability will depend on growth of mold in silage that threats the animal production and health by producing mycotoxins (Nout et al., 1993). The quality of forage is defined as its ability to meet the nutritional needs of the animal, such as nutrient digestibility of protein, NDF and starch (Randby et al. 2012). In addition, textural changes, discoloration and other factors reducing palatability and intake by animals may result due to aerobic activity (Weinberg & Muck, 1996). Aerobic spoilage during storage often is responsible for DM loss in silage and may be as high as 30-40% even short time exposure to air. Aerobically deteriorated silages may result in economic loss of nutrients and feeding spoiled silages to animals reduces nutrient intake and decreases the production (Whitlock et al., 2000). In addition, the nutritional value of silages as a consequence of aerobic deterioration can be reduced by degradation of fermentation acids and cell-wall carbohydrates and catabolism of protein to ammonia-N (Rooke & Hatfield 2003). Additionally, there is an increasing risk of proliferation of potentially pathogenic and undesirable microorganisms, such as mycotoxin-producing molds, Bacillus spp. and Listeria monocytogenes for threating the quality and safety of milk and animal health (Driehuis & Oude Elferink 2000). Silage additives have been used to improve the nutritional value of the silages by reducing DM losses. There are several silage additives including bacterial inoculants, enzymes, organic acids (propionic and formic acids) and non-protein nitrogen

sources, such as urea and anhydrous ammonia. These silage additives can decrease pH and production rate of acetic and butyric acids but increase lactic acid concentration and as a result improving stability of ensiled material when it is exposed to air (Bolsen et al., 1995).

In commercial farms of the Center and other provinces of Kahramanmaraş made intensive production of corn silage. In addition, grasses (barley, oats, wheat), legumes (clover, vetch), or mixture silages (vetch-triticale) are uncommon in ruminant animal's feeding. Recently Kahramanmaraş provinces have produced sugar beet, therefore sugar beet pulp silage has been used widely. We aimed to survey the physical, chemical and nutritive quality parameters of corn, sorghum, vetch-triticale and beet pulp silages from different provinces of Kahramanmaraş.

**Materials and Methods**

Silage dry matter (DM), organic matter (OM), crude protein (CP) and ash contents were analyzed according to AOAC (1990) procedure. Dietary fiber (NDF, ADF) analyses were performed based on the alpha-amylase procedure of Van Soest et al. (1991). For pH measurements, 10 gr of fresh silage was mixed with 90 ml of distilled water for 2-3 minutes and then filtered in to a beaker. The pH of the solution was read with a pH meter (Hanna HI 2211). Flieg scores of silage samples were calculated in accordance with the following equation and referenced based on the qualities indicated in Table 1 (Kılıç, 1986)

Flieg Scores= 220 + (2 x %DM - 15) - (40 x pH).

**Table 1**. Flieg scores and degree of quality

| Flieg score | Silage quality |
|---|---|
| <20 | Bad |
| 21-40 | Low |
| 41-60 | Moderate |
| 61-80 | Good |
| 81-100 | Excellent |

Relative feed value (RFV) was used to compare the nutritive quality of respective silages. It is an evaluation point of dry matter digestibility (DMD) from ADF, and calculates the potential DM intake (as a percent of body weight, BW) from NDF (Moore & Undersander, 2002) as indicated in Table 2.

DMD = 88.9 - (0.779 x %ADF)

DMI (% of BW) = 120 / (%NDF)

RFV = (DMD x DMI) / 1.29

**Table 2**. Relative feed value (RFV) and degree of quality

| Relative Feed Value | Degree of Quality |
|---|---|
| Prime (Prime) | >151 |
| 1 (Premium) | 150-125 |
| 2 (Good) | 124-103 |
| 3 (Fair) | 102-87 |
| 4 (Poor) | 86-75 |
| 5 (Reject) | <74 |

For aerobic stability measurements of respective silages, 150 gr of fresh silage samples were weighted and mixed and then placed in the glass bottle. The hole was made in middle of each bottle inside the respective silage and then the sensors were placed in holes and connected to the loggers for recording the temperature. After that, the bottles were put in incubator at 25±1ºC (room temperature) for 5 days. The sensors were recorded the temperature for each 10 minutes till 5 days. Then the loggers were connected to PC and the data for temperature was taken out. The sample which temperature was high 2ºC from room temperature is considered to be spoiled silage and not recommended to feeding animals (Kung et al., 2000).

Silage samples were taken from three different spots of silo face. Each sample (50 gr) was mixed and used for physical characteristics then scored by using 1-4 scale for color, 1-7 scale for smell and 1-4 scale for structure characteristic (Table 3). These physical characteristics are indications of the plant's morphological situations in silage, such as leaf and stem. These characteristics are scored based on the Konigsberg key as described by Bulgurlu & Ergul (1993).

**Table 3**. Konigsberg scale for physical characteristics of silage

| Color | Score | Smell | Score | Structure | Score |
|---|---|---|---|---|---|
| Brown-moldy | 0 | Very bad | 0-1 | Damaged | 0 |
| Brown-yellow | 1 | Bad | 2 | Not Separable | 1-2 |
| Yellow-yellow | 2 | Not disturbing | 3-4 | Separable | 3 |
| Yellow-green | 3 | Nice | 4-5 | Visible | 4 |
| Olive-green | 4 | Like pickle | 6-7 | | |

## Findings and Discussion

### Physical, chemical, nutritive and aerobic stability parameters of corn silages

The physical characteristics of corn silages were scored according to the Konigsberg key as described by Bulgurlu & Ergul (1993). The results are presented in Table 4. The color evaluation of corn silages from Türkoğlu province indicated that there were two farms representing brown-yellow color as an indication of bad quality. Other corn silages appeared yellow-green and olive-green color as an indication of good quality. Only two corn silage samples (A and B) showed a visible structure meaning that particles of corn silages were distinguishable. One out of five corn silages from Pazarcık province did not have a disturbing smell. Corn silages from different farms of Center province in overall represented a good quality of physical features in terms of color, smell and structure. Finally, physical quality evaluation of corn silages from farms in Elbistan province was olive-green in farm A and yellow-green in farm B. However, the smell was nice in farm B but was bad in farm A with visible structure. Ayaşan & Karakozak (2010) reported that the smell of corn silages was nice, structure was visible and the color was yellow in their study. The average DM content of corn silages from Türkoğlu province was 25.3%. This was quite low for a reference corn silage DM (32-35%, Bal et al., 1997). There was only one farm (C) in this range (32.2%). Similarly, low DM trend was also observed for corn silages from other provinces also. This is an indication of poor corn silage harvesting management for entire Kahramanmaras. Except in Center province, the averaged NDF contents of corn silages were quite high in farms from Turkoğlu (62.6%), Pazarcık (66.3%) and Elbistan (62.7%) provinces. This is possibly due to low DM content of whole plant having low starch content in immature ear but higher leaf and stem portion (Miller et al., 2021). The highest and the lowest CP contents of corn silages were observed in Türkoğlu and Center provinces (7.9 vs 6.7%). Santos et al. (2020) surveyed 54 corn silage samples from Brazilian dairy farm and found the CP contents varying from 5.5 to 9.8%. They concluded that variations in plant CP (and other nutrient contents) could be due to harvesting maturity, using fertilizers, silage storage and unloading procedures, and type of grain hybrid. In addition, harvesting the whole-plant corn in an immature stage might be the results of high CP content. All corn silages from the surveyed provinces had an optimal DMD, averaging 63.3%. Ferraretto & Shaver (2015) summarized a corn silage meta-analysis work from 75 studies and reported the total tract DMD's ranging from 52.4 to 79.4% (avg. 66%) having an agreement with our work. Similarly, Di Marco et al. (2005) reported that in vivo and in vitro DM digestibilities of 19 corn silage at two maturity stages (early dent and

half milk line) were 52.9 and 61.6%, respectively. Overall, it is important to harvest the whole-plant corn in an appropriate period due to the desirable chemical and nutritive properties. Early harvesting led to high NDF and ADF contents along with lower DM yield and digestibility (Wiersma et al., 1993). The pH's of corn silages from four different provinces were averaged 4.20. This was quite high for a desirable corn silage. Corn silages should have a pH between 3.8 and 4.2, while hay crop silages have a slightly higher pH at 4.0 to 4.8. Since high pH at high moisture content is associated with proteolysis and low pH with lactic acid production (Chase, 1997). In addition, several researchers (Bal et al., 2000; Mafakher et al., 2010). Higher pH values of corn silages in the present study could be possibly due to improper silage fermentation practices, such as early silo opening, lack of water-soluble carbohydrates or proteolysis. Except one sample, the RFV's of corn silages from Türkoğlu province were in fair quality (91-104). All corn silages from Center provinces represented good RFV (103-121). Four corn silages were considered to be either poor or rejection status of RFV across the provinces. Dunham (1998) studied RFV's of some forages at different growth stages and recommended the RFV of corn silages ranging from 115 (few ears) to 133 (well eared) to consider premium quality. Within this range, there was only one corn silage sample to meet these criteria in the present study.

Flieg score is used as an indicator for silage quality by many researchers. There were 14 out of 19 corn silage samples considered to have an excellent Flieg score (83-109) as shown in Table 5. Denek et al. (2004) determined the Flieg scores of additives (urea, urea + molasses, urea + ground wheat) and non-additive treated corn silages ranging from 29 to 86. Alçiçek et al. (1999) have also reported samples of 16 corn silage Flieg scores varied from 44 to 100. According to these researchers' pH values of studied silages were adequate for palatability but Flieg scores were generally low. This was because of the low DM but comparatively high CP contents. High CP content has a buffer impact so proteins neutralize the acids and prevent the pH fallings (Açıkgöz 2001). The highest spoilage time of corn silages were observed in farms from Elbistan province at 96 and 67 h (Figure 1). However, the highest spoilage time for corn silages from Turkoglu province were 43 h and less (25, 24, 21 and 20 h respectively; Table 5). These values were less than the time lengths reported by Muck (2004) who showed the aerobic stability time for corn silage was between 75-97 h. The difference between these two studies may be related to two factors; silage composition or different corn crops used for making silage. The time for maximum temperature in corn silage from farm A of Turkoglu province was the latest for reaching maximum temperature (56 h) to

spoil. In Pazarcık province, the aerobic stability of corn silage from farm B was "0" which means that this silage was unspoiled by time and was supported to be stable during feet out phase or when silo was opened. Ranjit and Kung (2000) found the aerobic stability of corn silage around 26.5 h. In Center province, the corn silages from farms A, B, and C did not have spoilage by time and the maximum temperatures that reached were 24.4, 24.7, and 25.9ºC, respectively.

**Table 4**. The physical, chemical and nutritive qualities of corn silages from different provinces of Kahramanmaras

| Province | Farm | Color[A] | Smell[B] | Structure[C] | pH | DM, % | Ash, % | NDF, % | ADF, % | CP, % | DMD[D], % | DMI[E], %BW | RFV[F] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Turkoglu | A | 4 | 6-7 | 4 | 4.33 | 28.6 | 6.9 | 62.8 | 33.4 | 7.9 | 62.9 | 1.9 | 93 |
| Turkoglu | B | 4 | 6-7 | 4 | 4.17 | 28.4 | 8.1 | 59.0 | 31.9 | 7.8 | 64.0 | 2.0 | 101 |
| Turkoglu | C | 2 | 2 | 1-2 | 4.25 | 32.2 | 6.6 | 60.8 | 26.6 | 6.9 | 68.2 | 2.0 | 104 |
| Turkoglu | D | 1 | 2 | 3 | 4.60 | 22.7 | 6.6 | 62.2 | 34.1 | 7.3 | 62.3 | 1.9 | 93 |
| Turkoglu | E | 3 | 2 | 1-2 | 4.64 | 24.1 | 6.9 | 63.7 | 34.1 | 8.6 | 62.3 | 1.9 | 91 |
| Turkoglu | F | 4 | 1 | 3 | 3.98 | 15.4 | 7.4 | 69.4 | 43.2 | 8.5 | 55.3 | 1.7 | 74 |
| Turkoglu | G | 4 | 2 | 4 | 4.12 | 25.5 | 5.1 | 60.3 | 31.3 | 8.1 | 64.5 | 2.0 | 100 |
| | | | | **Average** | **4.30** | **25.3** | **6.8** | **62.6** | **25.3** | **7.9** | **62.8** | **1.9** | **94** |
| | | | | **SD** | **0.25** | **5.4** | **0.9** | **3.4** | **5.4** | **0.6** | **3.9** | **0.1** | **9.9** |
| Pazarcik | A | 3 | 3-4 | 1-2 | 4.16 | 28.8 | 8.3 | 59.7 | 30.0 | 7.4 | 65.6 | 2.0 | 102 |
| Pazarcik | B | 4 | 3-4 | 4 | 4.21 | 26.9 | 7.9 | 68.6 | 32.6 | 5.7 | 63.5 | 1.7 | 86 |
| Pazarcik | C | 3 | 4-5 | 1-2 | 4.10 | 25.0 | 7.8 | 70.8 | 33.7 | 6.6 | 62.6 | 1.7 | 82 |
| Pazarcik | D | 2 | 2 | 1-2 | 4.54 | 18.6 | 7.7 | 66.8 | 33.1 | 7.8 | 63.1 | 1.8 | 88 |
| Pazarcik | E | 4 | 3-4 | 4 | 4.51 | 38.3 | 7.0 | 65.7 | 30.2 | 7.3 | 65.3 | 1.8 | 93 |
| | | | | **Average** | **4.30** | **27.5** | **7.8** | **66.3** | **27.5** | **6.9** | **64.0** | **1.8** | **90** |
| | | | | **SD** | **0.21** | **7.1** | **0.5** | **4.2** | **7.1** | **0.8** | **1.3** | **0.1** | **7.6** |
| Center | A | 2 | 3-4 | 3 | 3.94 | 27.4 | 6.9 | 54.8 | 30.1 | 6.4 | 65.4 | 2.2 | 111 |
| Center | B | 3 | 3-4 | 3 | 3.96 | 25.8 | 7.0 | 54.6 | 29.6 | 7.5 | 65.8 | 2.2 | 112 |
| Center | C | 3 | 3-4 | 3 | 3.97 | 26.2 | 7.8 | 57.2 | 31.5 | 5.3 | 64.4 | 2.1 | 105 |
| Center | D | 4 | 3-4 | 3 | 4.44 | 28.0 | 5.0 | 50.6 | 29.3 | 7.5 | 66.1 | 2.4 | 121 |
| Center | E | 2 | 4-5 | 4 | 4.21 | 29.0 | 7.0 | 57.4 | 32.7 | 6.8 | 63.4 | 2.1 | 103 |
| | | | | **Average** | **4.10** | **27.2** | **6.7** | **54.9** | **27.2** | **6.7** | **65.0** | **2.2** | **110** |
| | | | | **SD** | **0.22** | **1.3** | **1.0** | **2.7** | **1.3** | **0.9** | **1.1** | **0.1** | **7.4** |
| Elbistan | A | 4 | 2 | 4 | 4.55 | 26.6 | 6.3 | 61.7 | 31.1 | 6.6 | 64.6 | 1.9 | 98 |
| Elbistan | B | 3 | 4-5 | 1-2 | 3.67 | 25.1 | 8.6 | 63.7 | 33.7 | 7.7 | 57.7 | 1.8 | 82 |
| | | | | **Average** | **4.11** | **25.9** | **7.4** | **62.7** | **25.9** | **7.1** | **61.2** | **1.9** | **90** |
| | | | | **SD** | **0.62** | **1.0** | **1.6** | **1.4** | **1.0** | **0.8** | **4.9** | **0.1** | **10.6** |

[A]0= Brown-moldy, 1= Brown-yellow, 2= Yellow-yellow, 3= Yellow-green, 4= Olive-green
[B]0-1= Very bad, 2= Bad, 3-4= Not disturbing, 4-5= Nice, 6-7= Like pickle
[C]0= Damaged, 1-2= Not separable, 3= Separable, 4= Visible
[D]Dry matter digestible= 88.9-(0.779x%ADF)
[E]Dry matter intake, % Body weight= 120/(%NDF)
[F]Relative feed value and degree of quality= (DMDxDMI)/1.29
Prime (Prime)= >151, 1 (Premium)= 125-150, 2 (Good)= 103-124, 3 (Fair)= 87-102, 4 (Poor)= 75-86, 5 (Reject)= <74

**Table 5**. The Flieg score and aerobic stability parameters of corn silages from different provinces of Kahramanmaras

| Province | Farm | Flieg score[G] | Spoilage time (hours) | Reached maximum temperature (°C) | Time for reaching maximum temperature (hours) |
|---|---|---|---|---|---|
| Turkoglu | A | 89 | 43 | 32.7 | 56 |
| Turkoglu | B | 95 | 24 | 32.0 | 33 |
| Turkoglu | C | 99 | 21 | 36.6 | 31 |
| Turkoglu | D | 66 | 6 | 37.3 | 16 |
| Turkoglu | E | 67 | 9 | 30.4 | 19 |
| Turkoglu | F | 76 | 20 | 39.2 | 30 |
| Turkoglu | G | 91 | 25 | 40.0 | 35 |
| | **Average** | **84** | | | |
| | **SD** | **13.4** | | | |
| Pazarcik | A | 96 | 46 | 33.0 | 59 |
| Pazarcik | B | 91 | 0 | 25.4 | 99 |
| Pazarcik | C | 91 | 39 | 27.7 | 42 |
| Pazarcik | D | 60 | 30 | 29.4 | 41 |
| Pazarcik | E | 101 | 27 | 27.3 | 41 |
| | **Average** | **88** | | | |
| | **SD** | **16.0** | | | |
| Center | A | 102 | 0 | 24.4 | 99 |
| Center | B | 98 | 0 | 24.7 | 99 |
| Center | C | 98 | 0 | 25.9 | 1 |
| Center | D | 83 | 7 | 38.9 | 14 |
| Center | E | 95 | 3 | 36.3 | 7 |
| | **Average** | **95** | | | |
| | **SD** | **7.2** | | | |
| Elbistan | A | 76 | 67 | 28.4 | 78 |
| Elbistan | B | 109 | 96 | 27.9 | 109 |
| | **Average** | **92** | | | |
| | **SD** | **22.9** | | | |

[G]Flieg score and degree of quality= 220+(2x%DM-15)-(40xpH)
Bad= <20, Low= 21-40, Moderate= 41-60, Good= 61-80, Excellent= 81-100

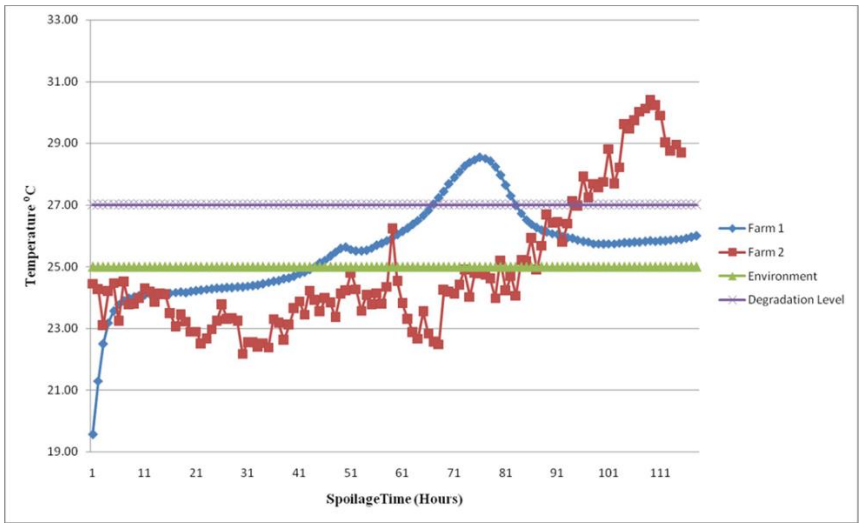


**Figure 1**. Aerobic stability of corn silages from Elbistan province of Kahramanmaras

**Physical, chemical, nutritive and aerobic stability parameters of sorghum silages**

The physical, chemical and nutritive qualities of sorghum silages from Turkoglu province are presented in Table 6. None of the sorghum silages were represent a desirable color (brown-moldy, brown yellow). Similarly, both smell and structure of the respective sorghum silages had an undesirable nature (not disturbing smell and not separable structure). Similarly, Ayaşan & Karakozak (2012) showed that non-inoculated sorghum silages represented bad smell but visible structure. Sorghum quality may be affected by the maturity stage of the plant at harvest and environmental factors (Cakmakci et al., 1999). In our study, sorghum silages had 26.0% DM in average and standing with the literature findings of less than 30% at dough stage (Bolsen, 2004). The NDF, ADF, CP and pH contents of sorghum silages were averaged 61.4%, 38.4% and 9.8% and 4.05 respectively. Other researchers (Keskin et. al., 2005; Miron et al., 2005; Kaplan, 2013) also tested the various varieties of sorghum silages and found the similar NDF (66.4, 57.9 and 52.9%), ADF (40.3, 32.4 and 37.3%), CP (11.8, 5.8 and 8.6%) and pH (4.87, 3.75, 4.04) contents with ours. Crude protein compositions on plants are usually proportional to leaves since the leaves are the main protein contributor in sorghum (Hanna et al., 1981). Pholsen et al., (1998) reported 24 h ruminal in situ DMD of ten different sorghum cultivars ranging from 51.6 to 60.2% (avg. 55.7%). This is an agreement with our results that the DMD of sorghum silages was 58.9%. The pH of sorghum silages from Türkoğlu province was averaged 4.05. Similarly, other researchers reported the pH of sorghum silages ranging between 3.80 to 4.80. (Danner et al., 2003; Colombini et al., 2010; Lima et al., 2010; Ayaşan et al., 2012). Based on the RFV, sorghum silages from Türkoğlu province had either fair or poor quality, averaging 90.

The Fleig score of sorghum silages were ranging from 85 to 105 (Table 7). This range was higher than the range found by (Kaplan, 2013). He reported the Fleig score ranging from 90 to 97. Similarly, Ayaşan et al., (2012) reported the Fleig scores of sorghum silages as 67. High Fleig score is associated with high DM and low pH values since it was estimated by using these two parameters of silages. Sorghum silages from Farms B and C did not spoil, but from Farm A spoiled within 3 hours. For silages reaching the maximum temperature was the highest from Farms B (107 h) and C (90 h) but lowest from Farm A (3 h) indicating the aerobically unstable silage (Figure 2).

**Table 6**. The physical, chemical and nutritive qualities of sorghum silages from Turkoglu province of Kahramanmaras

| Province | Farm | Color[A] | Smell[B] | Structure[C] | pH | DM % | Ash % | NDF % | ADF % | CP % | DMD[D] % | DMI[E] %BW | RFV[F] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Turkoglu | A | 1 | 2 | 1-2 | 4.10 | 27.1 | 10.0 | 65.1 | 40.0 | 8.1 | 57.7 | 1.8 | 83 |
| Turkoglu | B | 0 | 3-4 | 1-2 | 3.76 | 25.4 | 10.4 | 56.1 | 34.8 | 11.0 | 61.8 | 2.1 | 102 |
| Turkoglu | C | 1 | 3-4 | 1-2 | 4.28 | 25.5 | 9.9 | 63.0 | 40.5 | 10.4 | 57.4 | 1.9 | 85 |
| | | | | **Average** | **4.05** | **26.0** | **10.1** | **61.4** | **38.4** | **9.8** | **58.9** | **2.0** | **90** |
| | | | | **SD** | **0.26** | **1.0** | **0.2** | **4.7** | **3.1** | **1.5** | **2.4** | **0.2** | **11.0** |

[A]0= Brown-moldy, 1= Brown-yellow, 2= Yellow-yellow, 3= Yellow-green, 4= Olive-green
[B]0-1= Very bad, 2= Bad, 3-4= Not disturbing, 4-5= Nice, 6-7= Like pickle
[C]0= Damaged, 1-2= Not separable, 3= Separable, 4= Visible
[D]Dry matter digestible= 88.9-(0.779x%ADF)
[E]Dry matter intake, % Body weight= 120/(%NDF)
[F]Relative feed value and degree of quality= (DMDxDMI)/1.29
Prime (Prime)= >151, 1 (Premium)= 125-150, 2 (Good)= 103-124, 3 (Fair)= 87-102, 4 (Poor)= 75-86, 5 (Reject)= <74

**Table 7**. The Flieg score and aerobic stability parameters of sorghum silages from Turkoglu province of Kahramanmaras

| Province | Farm | Flieg score[G] | Spoilage time (hours) | Reached maximum temperature (°C) | Time for reaching maximum temperature (hours) |
|---|---|---|---|---|---|
| Turkoglu | A | 95 | 3 | 28.6 | 3 |
| Turkoglu | B | 105 | 0 | 24.9 | 107 |
| Turkoglu | C | 85 | 0 | 24.6 | 90 |
| | **Average** | **95** | | | |
| | **SD** | **10.0** | | | |

[G]Flieg score and degree of quality= 220+(2x%DM-15)-(40xpH)
Bad= <20, Low= 21-40, Moderate= 41-60, Good= 61-80, Excellent= 81-100

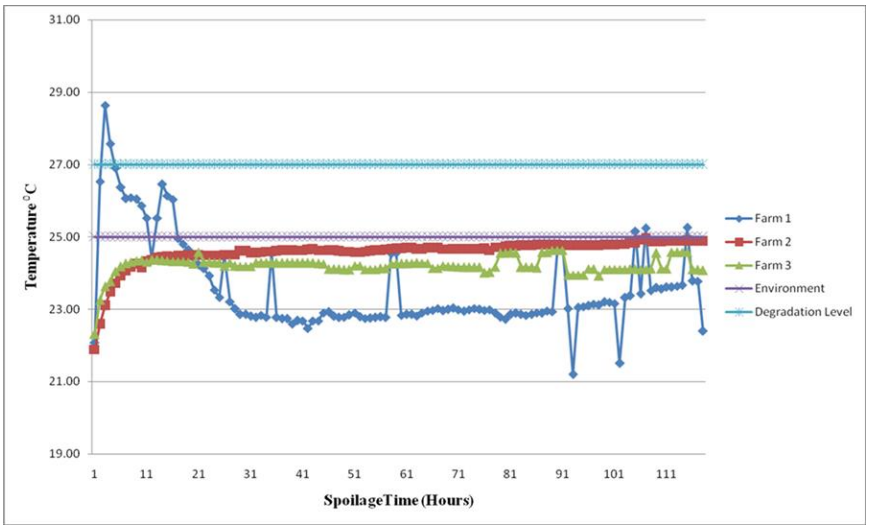


**Figure 2**. Aerobic stability of sorghum silages from Turkoglu province of Kahramanmaras

**Physical, chemical, nutritive and aerobic stability parameters of vetch and triticale silages**

The vetch, triticale and mixture of both (25:75) silage's quality parameters are presented in Tables 8 and 9. Except the smell and structure of the triticale silage, both vetch and mixture of vetch and triticale silages did not have a desirable physical silage quality parameter. The

DM contents of vetch, triticale and mixture of both silages were 25.2, 30.5 and 25.9%, respectively. Many researchers reported that forage crops both alone and grass-legume mixtures have variable DM contents. Çakmakçı et al. (2005) reported that DM content of vetch alone (Vicia sativa L.), grass alone (Lolium perenne L.) and mixture of vetch+grass silages were 22.7, 26.9 and 26.4%, respectively. Geren et al. (2003) have also reported that CP and ash contents of vetch-grass hay mixtures were 21.4 and 12.9%, respectively. These values are higher than the previous vetch-triticale silages in our study (18.1 and 9.3%) possibly due to proportional crop distribution of the individual forages. In addition, Türk et al. (2007) also reported that CP (14.5-16.2%), ADF (24.1-26.8%) and NDF (28.6-34.8%) contents of fresh vetch hays varied based on their maturity stages (beginning of flowering, full flowering and seed filling). Although the harvesting maturity stages of vetch-triticale silages were not known in the present study, the mentioned chemical parameters were higher than the literature values. Kara et al. (2009) determined the physical and chemical properties of three varieties of triticale silages. They found that DM (42.6%), CP (7.9%), ash (12.1%), pH (4.2), Fleig score (121) and physical appearance (good) of respective silages were in desirable range. McCartney & Vaage (1994) studied the chemical and nutritive value of triticale silage at 43.7% DM. The silage CP was higher (11.6%) but ADF (39.1%) and NDF (57.9%) contents were lower than the triticale silage in our study indicating an immature harvesting stage (30.5% DM). The pH was similar to ours (4.42) and total tract DM digestibility in sheep was higher than ours (58.8 vs. 54.1%). This agreed with an unacceptable quality of triticale silage RFV found in our study. Alçiçek et al. (1999) studied the quality parameters of vetch-barley mixture silages at 19-20% DM and found the pH's ranged from 4.00 to 5.20, Fleig scores 37 (low) to 84 (excellent), and physical properties (smell, color, structure) optimal to excellent. This indicate that mixture of legume-grass silage physical and chemical properties varies from farm to farm. In terms of RFV's, triticale silage was a poor quality (73), the vetch silage was premium quality (126), and the mixture of these two were fair quality (102). High NDF and ADF contents are the indication of forage RFV. If these two contents are high in any forage, this forage will be a poor quality.

The vetch, triticale and mixture of triticale and vetch silages had various aerobic stability results (Figure 3.). The triticale did not spoil but vetch spoiled in 6 h. However, mixture of vetch-triticale silage (25:75) spoiled at 26 h and reached maximum temperature to 28.8ºC at 31 h. The vetch silage reached the maximum temperature (28.5ºC) at 11 h, but it was 25.0ºC at 35 h for triticale.

**Table 8**. The physical, chemical and nutritive qualities of vetch and triticale silages from Center province of Kahramanmaras

| Province | Silage | Color[A] | Smell[B] | Structure[C] | pH | DM % | Ash % | NDF % | ADF % | CP % | DMD[D] % | DMI[E], %BW | RFV[F] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Center | Vetch | 1 | 0-1 | 1-2 | 4.22 | 25.2 | 8.0 | 47.8 | 31.3 | 19.9 | 64.5 | 2.5 | 126 |
| Center | Triticale | 1 | 3-4 | 3 | 4.25 | 30.5 | 8.8 | 68.9 | 44.7 | 10.2 | 54.1 | 1.7 | 73 |
| Center | Vetch (25%) + Triticale (75%) | 0 | 2 | 1-2 | 4.37 | 25.9 | 9.3 | 53.5 | 39.0 | 18.1 | 58.5 | 2.2 | 102 |
| | | | | **Average** | **4.28** | **27.2** | **8.7** | **56.7** | **38.3** | **16.1** | **59.0** | **2.2** | **100** |
| | | | | **SD** | **0.08** | **2.9** | **0.6** | **10.9** | **6.7** | **5.2** | **5.3** | **0.4** | **26** |

[A]0= Brown-moldy, 1= Brown-yellow, 2= Yellow-yellow, 3= Yellow-green, 4= Olive-green
[B]0-1= Very bad, 2= Bad, 3-4= Not disturbing, 4-5= Nice, 6-7= Like pickle
[C]0= Damaged, 1-2= Not separable, 3= Separable, 4= Visible
[D]Dry matter digestible= 88.9-(0.779x%ADF)
[E]Dry matter intake, % Body weight= 120/(%NDF)
[F]Relative feed value and degree of quality= (DMDxDMI)/1.29
Prime (Prime)= >151, 1 (Premium)= 125-150, 2 (Good)= 103-124, 3 (Fair)= 87-102, 4 (Poor)= 75-86, 5 (Reject)= <74

**Table 9**. The Flieg score and aerobic stability parameters of vetch and triticale silages from Center province of Kahramanmaras

| Province | Silage | Flieg score[G] | Spoilage time (hours) | Reached maximum temperature (°C) | Time for reaching maximum temperature (hours) |
|---|---|---|---|---|---|
| Center | Vetch | 86 | 6 | 28.5 | 11 |
| Center | Triticale | 96 | 0 | 25.0 | 35 |
| Center | Vetch (25%) + Triticale (75%) | 82 | 26 | 28.8 | 31 |
| | **Average** | **88** | | | |
| | **SD** | **7.2** | | | |

[G]Flieg score and degree of quality= 220+(2x%DM-15)-(40xpH)
Bad= <20, Low= 21-40, Moderate= 41-60, Good= 61-80, Excellent= 81-100

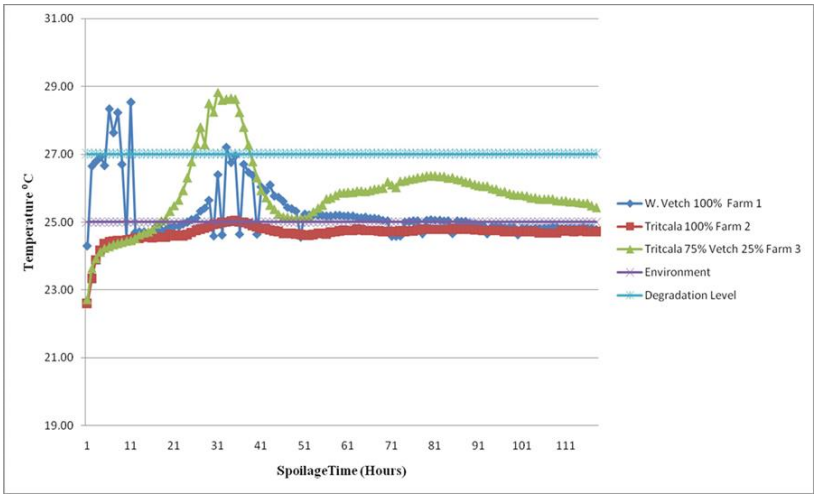


**Figure 3.** Aerobic stability of vetch-triticale silages from Center province of Kahramanmaras

**Physical, chemical, nutritive and aerobic stability parameters of beet pulp silages**

The beet pulp silage quality parameters are presented in Tables 10 and 11. Except two beet pulp silages from Afsin and one from Elbistan provinces, all silages had a proper physical nature in terms of color, smell and structure. The pH of beet pulp silages averaged 3.95 and 3.36 from Elbistan and Afsin provinces, respectively. However, Deniz et al. (2001) and Ulger et al. (2018) reported a higher pH values of beet pulp silages from ours (4.20 and 4.15). The DM contents of beet pulp silages ranged from 13.0 to 17.0%. Previous studies also reported wide range of DM's from 10.0 to 20.0% (Deniz et al., 2001, Altaçlı & Deniz, 2013; Ulger et al., 2018). The NDF content of beet pulps silages from Elbistan farms were higher than Afsin farms (65.3 vs. 56.7%). However, CP contents of beet pulp silages from Afsin farms were higher than Elbistan farms (10.7 vs. 9.8%). The lower NDF content of beet pulp silages from Afsin province was possibly due to higher water-soluble carbohydrate content of those silages as an indication of low silage pH's. The CP content of beet pulp silages in the present study was almost similar with the other study result (Kilic & Saricicek, 2010; Altaçlı & Deniz, 2013; Ulger et al., 2018) ranging from 9.2 to 11.6%. The DMD of beet pulp silages from both provinces were similar and averaging 67.4%. Other researchers also reported similar DM and OM digestibilities of beet pulp silages. Kilic & Saricicek (2010) and Ulger et al. (2018) reported IVOMD of beet pulp silages at 62.4 and 74.4%, respectively. Similarly, Altaçlı & Deniz (2013) found IVDMD and IVOMD of beet pulp silages at 67.1 and 69.9%, respectively.

The Fleig scores of beet pulp silages were exhibited "good" and "excellent" quality degrees from farms of Elbistan (75) and Afsin (100) provinces, respectively (Figure 4). Kilic & Saricicek (2010) were also classified Fleig scores of eight treated and non-treated beet pulp silages ranging from 93 to 110 considering an excellent quality. Similarly, Altaçlı & Deniz (2013) found the Fleig scores of nine different beet pulp silages ranging from 69 to 84 being a "good" quality. Among six different beet pulp silages, there was one silage from Afsin province (Farm C) that did not spoil during the aerobic stability test period (Figure 4). Other beet pulp silages spoiled within 20-25 h in average.

**Table 10**. The physical, chemical and nutritive qualities of sugar beet pulp silages from Elbistan and Afsin provinces of Kahramanmaras

| Province | Farm | Color[A] | Smell[B] | Structure[C] | pH | DM, % | Ash, % | NDF, % | ADF, % | CP, % | DMD[D], % | DMI[E], %BW | RFV[F] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elbistan | A | 3 | 4-5 | 3 | 4.08 | 15.6 | 6.5 | 66.2 | 25.8 | 9.8 | 68.8 | 1.8 | 97 |
| Elbistan | B | 3 | 2 | 1-2 | 3.75 | 13.0 | 4.8 | 64.4 | 25.4 | 9.9 | 69.1 | 1.9 | 100 |
| Elbistan | C | 2 | 4-5 | 4 | 4.01 | 13.1 | 4.5 | 65.4 | 31.5 | 9.8 | 64.3 | 1.8 | 92 |
| | | | | **Average** | **3.95** | **13.9** | **5.3** | **65.3** | **27.6** | **9.8** | **67.4** | **1.8** | **96** |
| | | | | **SD** | **0.17** | **1.5** | **1.1** | **0.9** | **3.4** | **0.1** | **2.7** | **0.0** | **4.1** |
| Afsin | A | 3 | 2 | 3 | 3.06 | 13.0 | 8.5 | 55.0 | 25.5 | 9.7 | 69.0 | 2.2 | 117 |
| Afsin | B | 4 | 3-4 | 1-2 | 3.53 | 17.0 | 5.7 | 51.0 | 27.7 | 11.4 | 67.3 | 2.4 | 123 |
| Afsin | C | 1 | 3-4 | 3 | 3.48 | 14.1 | 4.4 | 64.1 | 29.6 | 11.0 | 65.8 | 1.9 | 96 |
| | | | | **Average** | **3.36** | **14.7** | **6.2** | **56.7** | **27.6** | **10.7** | **67.4** | **2.1** | **112** |
| | | | | **SD** | **0.26** | **2.1** | **2.1** | **6.7** | **2.0** | **0.9** | **1.6** | **0.2** | **14.3** |

[A]0= Brown-moldy, 1= Brown-yellow, 2= Yellow-yellow, 3= Yellow-green, 4= Olive-green
[B]0-1= Very bad, 2= Bad, 3-4= Not disturbing, 4-5= Nice, 6-7= Like pickle
[C]0= Damaged, 1-2= Not separable, 3= Separable, 4= Visible
[D]Dry matter digestible= 88.9-(0.779x%ADF)
[E]Dry matter intake, % Body weight= 120/(%NDF)
[F]Relative feed value and degree of quality= (DMDxDMI)/1.29
Prime (Prime)= >151, 1 (Premium)= 125-150, 2 (Good)= 103-124, 3 (Fair)= 87-102, 4 (Poor)= 75-86, 5 (Reject)= <74

**Table 11**. The Flieg score and aerobic stability parameters of sugar beet pulp silages from Elbistan and Afsin provinces of Kahramanmaras

| Province | Farm | Flieg score[G] | Spoilage time (hours) | Reached maximum temperature (°C) | Time for reaching maximum temperature (hours) |
|---|---|---|---|---|---|
| Elbistan | A | 73 | 23 | 28.2 | 26 |
| Elbistan | B | 81 | 20 | 27.5 | 26 |
| Elbistan | C | 71 | 17 | 27.4 | 22 |
| | **Average** | **75** | | | |
| | **SD** | **5.3** | | | |
| Afsin | A | 109 | 27 | 30.8 | 33 |
| Afsin | B | 98 | 54 | 27.6 | 61 |
| Afsin | C | 94 | 0 | 26.4 | 54 |
| | **Average** | **100** | | | |
| | **SD** | **7.8** | | | |

[G]Flieg score and degree of quality= 220+(2x%DM-15)-(40xpH)
Bad= <20, Low= 21-40, Moderate= 41-60, Good= 61-80, Excellent= 81-100

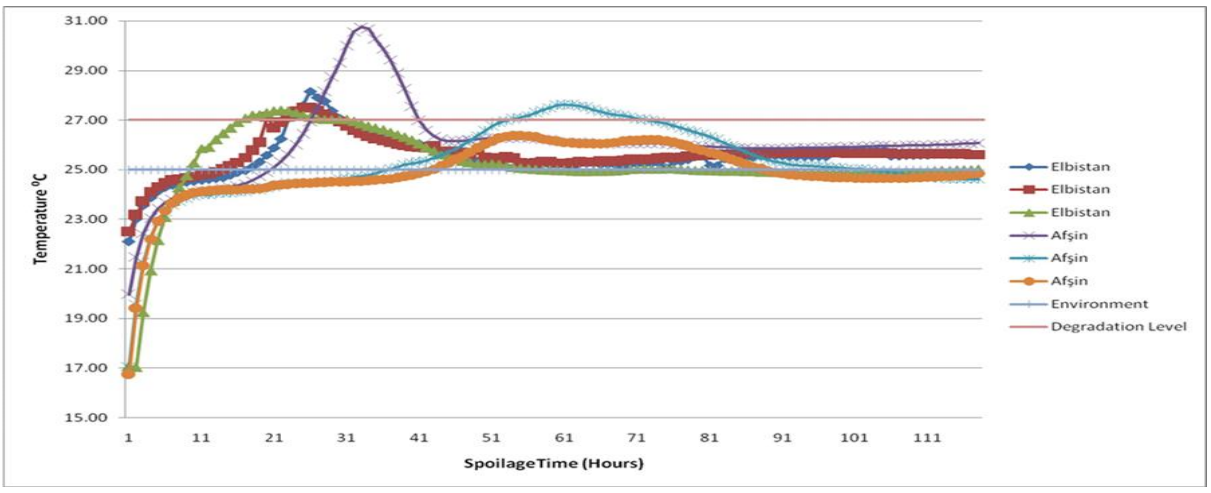


**Figure 4**. Aerobic stability of sugar beet pulp silages from Elbistan and Afsin provinces of Kahramanmaras

**Conclusion and Recommendations**

Although tested corn silages had low DM content (avg. 26.5%), most of them had an optimal physical property (color, smell, structure), high NDF, optimal DMD and reasonable RFV's. These corn silages had also good Fleig score but variable aerobic stability features. However, sorghum silages had poor physical properties, low DMD and variable aerobic stabilities. Similarly, vetch-triticale silages had poor physical properties and DMD's. Beet pulp silages appeared to be desirable color, smell and structure along with very good RFV's and Fleig scores. In general, all these crop silages are recommended to be preserved at proper DM's for quality silage fermentation parameters.

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# EFFICIENT RESOURCE UTILIZATION IN SUSTAINABLE AGRICULTURE: A STATISTICAL POWER ANALYSIS

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**Abstract**
Agriculture is a critical sector when it comes to feeding the world's population and food production. Therefore, the results of agricultural research and experiments are of paramount importance for global food security. The agricultural sector plays a leading role in meeting people's basic nutritional needs, and thus the accuracy and reliability of agricultural studies are of great significance. Power analysis is a critical tool used to assess the scientific validity and significance of these results. This analysis is a fundamental tool for assessing the capacity of agricultural research to produce statistically significant results and provides a more solid foundation for agricultural decision-making by evaluating the reliability of the outcomes. Additionally, power analysis is used to determine the required sample size for the success of planned agricultural research. When the correct sample size is determined, resources can be used more efficiently, making the research process more effective. In situations where resources are limited in the agricultural sector, this analysis provides researchers with the opportunity to optimize data collection processes and experiments. Statistical power analysis is also a critical tool for evaluating the effectiveness of agricultural practices, developing new agricultural strategies, and promoting sustainable farming practices. This analysis not only helps identify the most effective agricultural methods but can also contribute to achieving environmental sustainability goals. Programs like GPower are widely used, especially for determining sample sizes and conducting power analysis calculations. These programs are crucial for obtaining more accurate results in the agricultural sector and optimizing the use of resources. This study aims to contribute to the sustainable and efficient development of the agricultural sector by explaining the use of the GPower program and power analysis with various examples. As a result, approaches like power analysis encourage making better and more scientifically grounded decisions in the field of agriculture.

**Keywords:** Power, Sample size, Sustainability

## Introduction

Statistical power, which refers to the ability of a study to accurately detect a particular effect or relationship, plays an important role in agricultural research. High statistical power in the study ensures that the effects or relationships in the study are accurately identified. Traditional statistical methods enable the interpretation of the results obtained from the sample studied. At this stage, the hypotheses established for the study are tested based on this sample and the results obtained are based solely on the information obtained from the sample. Rejecting the null hypothesis of no difference, which is false, gives the test power. Therefore, the higher the power in a study, the more obvious the signs that the right decision has been made. Statistical power is a concept that relates specifically to reducing the type II error in testing a hypothesis and increasing the probability of finding a true effect. Power is usually related to the sensitivity and accuracy of a test, focusing on the performance of the hypothesis test rather than the results of the study (Abraham & Russel, 2008). When conducting a study, it is typical to set the statistical power (1-β) at 90%. This implies that there is a 10% probability of erroneously retaining the null hypothesis in the test results, even if the null hypothesis is untrue. This is also known as the proportion of Type II error or β. It is an essential parameter for evaluating the ability to make accurate decisions in studies (Columb & Atkinson, 2016). Suppose a researcher aims to determine whether a particular pesticide is effective in controlling a plant disease. To achieve this goal, they employ hypothesis testing to determine whether the pesticide is effective. Statistical power indicates the likelihood that this test will detect the effect of the pesticide in controlling the disease, provided there is a genuine effect. Suppose the researcher has set the statistical power at 80%. In that case, there is a high probability that the pesticide is capable of controlling the disease if there is indeed an effect. However, the second type of error, an error probability of 20%, represents the probability of overlooking an effect when there is, in fact, an effect.

Understanding statistical power is crucial in research. Statistical power is the likelihood of detecting an effect when it exists. It exhibits a functional connection with three variables: significance, sample size, and effect sizes. Effect measure refers to the magnitude of change expected as a result of testing the research hypothesis. Researchers frequently use the three categories defined by Cohen’s for effect size (Cohen's d=0.20), medium (Cohen's d=0.50), and large effect (Cohen's d=0.80). These effect sizes may vary according to different study designs. Smaller effect sizes will usually require a larger sample size. Generally, a larger

sample size means a higher statistical power (Cohen, 1992; Prajapati et al., 2010; (Singh & Masuku, 2014).

Power analysis in studies can be done in two ways. First, the minimum sample size and possible power can be estimated for the planned study by using information from similar literature. The other way is to calculate the power of the study by using information such as the number of samples in the study (Keskin & Aktaş, 2013). There are many package programs such as JMP, SAS, PASS, and Stat-Power used for power analysis calculations. GPower 3.1 (Faul et al., 2009) is one of the programs that is free of charge and easy to use. It was developed to calculate sample size and power for various statistical methods. This study aims to introduce the GPower program and provide information on how to calculate statistical power and sample size.

## Materials and Methods

In the study, the application steps of the GPower 3.1 program for power calculations in the t-test for independent groups are given. GPower can conduct five distinct types of power analysis, encompassing a priori, post hoc, compromise, criterion, and sensitivity power analysis (Faul et al., 2009). In this study, three scenarios were created for sample size and power estimates pre-study and power estimates post-study.

In the first scenario, a reference study sample was created to calculate the number of samples in the planned study with two independent groups. In this reference study sample, an effect size was measured using basic statistics. Then, based on this, the power, effect and sample sizes for the planned study were calculated. In the second scenario, we considered the case where there was no reference study for each planned study. In this scenario, we employed the significance level, power ratio, and Cohen's effect size categories to ascertain the potential sample size, and subsequently calculated the study's power based on this determined sample size. The final scenario was designed to estimate the power of the study to detect true effects after the study was completed.

## Findings and Discussion

Below are the implementation steps and outcomes of the three scenarios we devised for the t-test, employed to compare two independent groups through the GPower program.

*First scenario:* A reference study was created with two independent groups and the basic statistics for power analysis were determined. The steps to determine the statistical power of the planned study and the required sample size are given below. For the study we designed, we want to test whether there is a difference between two different fertilizers in terms of their effect on the growth of maize plants. We targeted 5% significance level and 80% power level for the planned study. With these parameters, we plan to take an equal number of samples in both groups in our study. In light of the information obtained from the reference study (Table 1), we will determine the sample size by a priori power analysis using GPower. In this way, we aim to obtain reliable results and evaluate the effect of conventional and organic fertilizers on maize plant growth in a healthy way.

**Table 1.** Mean, standard deviation and sample sizes obtained from the reference study

| **Group A (Conventional Fertilizer)** | **GroupB (Organic Fertilizer)** |
|---|---|
| Mean length: 150 cm | Mean length: 165 cm |
| Standard deviation: 10 cm | Standard deviation: 12 cm |
| Sample size: 30 plants | Sample size: 30 plants |

In the GPower program, the following steps were followed based on the information in the reference study in Figure 1, which shows the stages of calculating the minimum sample size required for the planned study:

*Test Family and Statistical Test Selection:* Since we have two independent groups in the planned study, independent t test is selected from the "Test family" option. In the statistical test option, "Mean: Difference between two independent means" was selected.

*Determining the Power Analysis Type:* The choice of "a priori" was made to compute both the sample size and the study's power when this specified sample size is utilized.

*Calculation of Effect Size:* Since we wanted to calculate the effect size using the statistics from the reference study, we used the "Determine" option, entered the mean and standard deviation information from the reference study in the pop-up window, and calculated the effect size (d=1.36). The calculated effect size was then transferred to the "Input Parameters" section.

A Priori Analysis Results: The total sample size should be at least 20, with an equal number of samples in each group. If we organize this study with this sample size, the power of the study will be 83%.

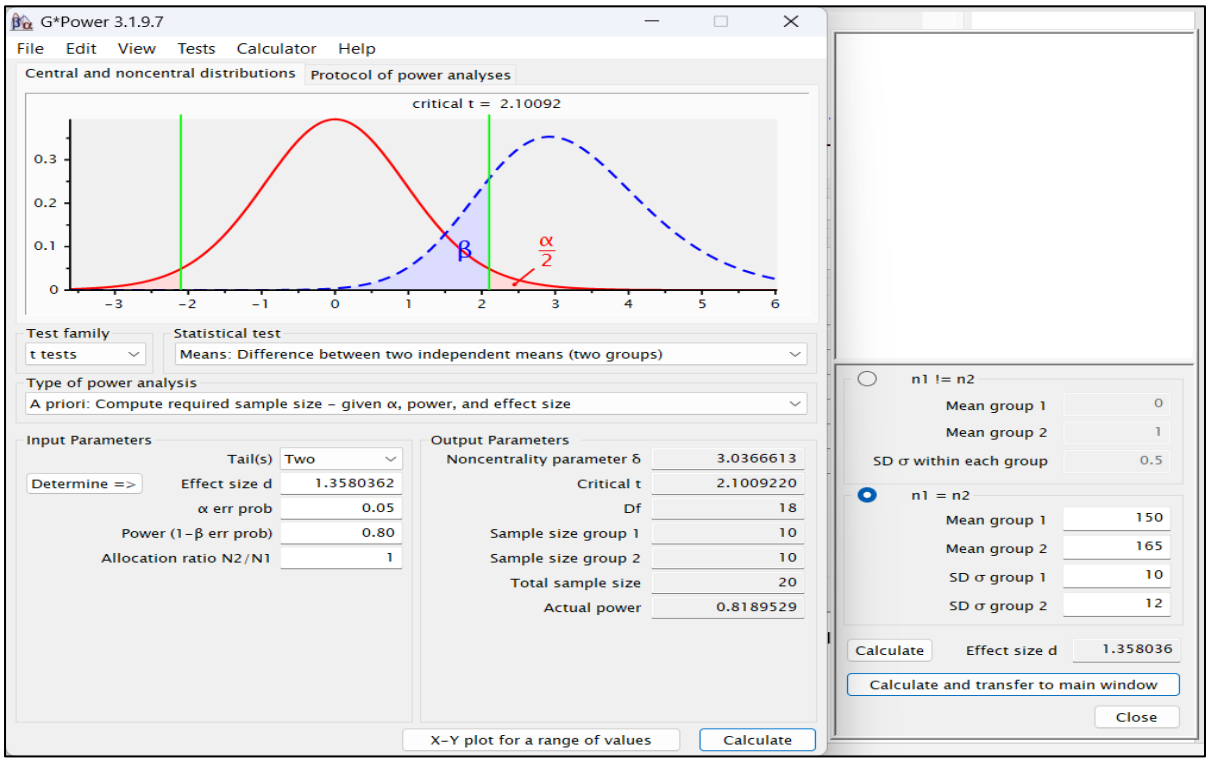


**Figure 1.** Estimation of sample size in GPower based on information from the reference study

Since the power of the study calculated according to the determined sample size is the probability of correctly identifying and finding a significant effect (Abraham & Russel, 2008), we obtained the actual power of the study in our scenario to be approximately 83%. The test to be performed can determine this effect by 83% if there is a real effect. In other words, the higher the true power of the planned study, the more powerful and reliable the test. It is essential to note that the power of the study increases as the number of samples in the study increases (Columb & Atkinson, 2016). For example, if the power is taken as 95% instead of 80% in the "Input Parameters" section, the number of samples and the actual power of the study will increase in direct proportion. These steps outline a thorough a priori power analysis aimed at determining the statistical power of the planned study and achieving the desired level of significance.

*Second scenario:* It was created in case there was no reference study for the planned study. For example, the significance level was set to 5%, the effect size (d=0.50), and the power level to 80% and 95%, respectively, and this information was entered into the input section of the program (Figure 2).

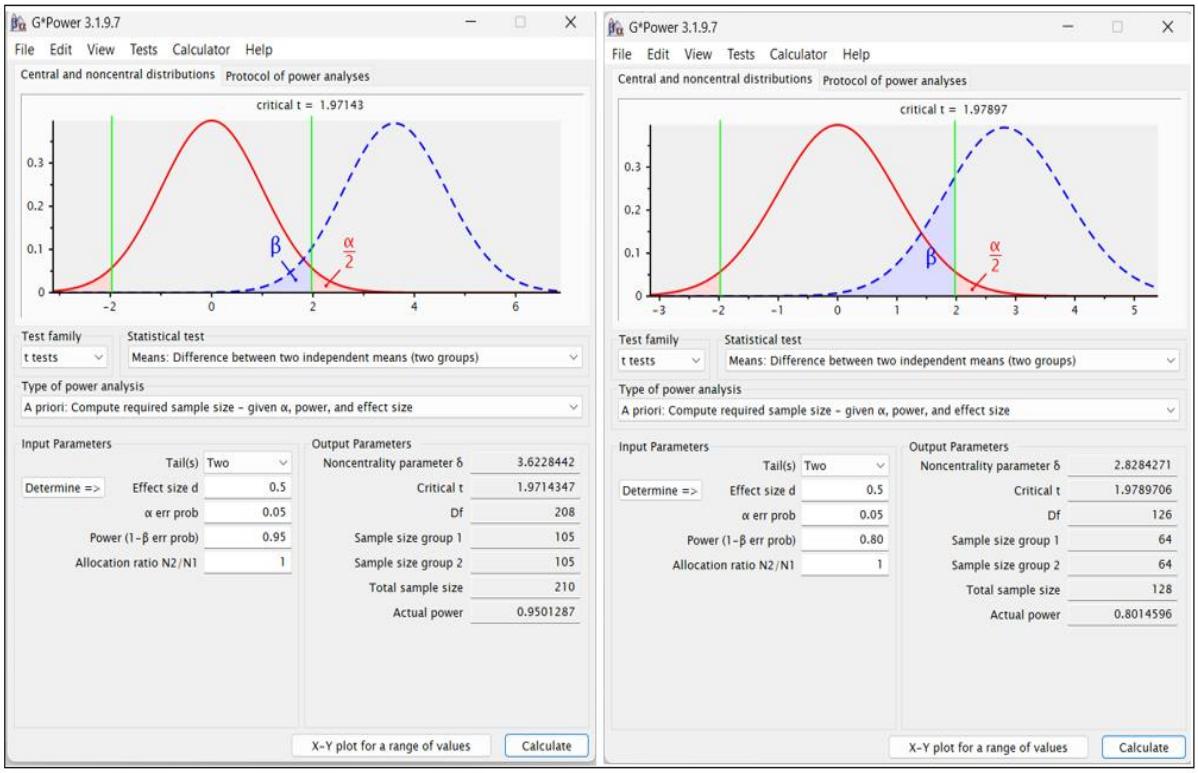


**Figure 2.** Estimation of sample size in GPower using different significance levels and power information with effect size d=0.50

In Figure 2, at the same effect size and 95% power level, the number of samples in each group was set to 105. In this case, a student t-test would have a high probability of identifying a true effect. However, when we reduced the power to 80%, the number of samples in each group dropped from 105 to 64. In this case, it is possible to interpret that the probability of detecting a real effect will also decrease. Because power is the probability of revealing real effects. Therefore, there is a direct proportionality between the power of the study, the number of samples and the probability of detecting real effects. For example, in a study with a 95% power ratio, the probability of not revealing the true effect is 5%, while in a study with an 80% power ratio, the probability of not revealing the true effect will be 20%. When the power ratio is ≥90%, the probability of revealing the true effect will increase significantly. However, working with high power usually requires a larger number of samples, which means more cost and time. Therefore, it is important to find a balance in the choice of power level (Abraham and Russel, 2008).

*Third scenario:* This scenario was created to calculate the post-study power. For example, in a study with 50 samples in the experimental and control groups, the significance level is 5% and the effect sizes of the study are organized as d=0.20, d=0.50, d=0.80, respectively.

Consequently, the power of the studies was computed for the assumed scenarios based on these effect sizes. The post hoc option in GPower was used for this process (Figure 3). In the first case, when d=0.20, the power is about 17%. This indicates that the power of the analysis is low because it is a small effect size. That is, the probability of detecting a difference between the groups is quite low. In the second case, when d=0.50, the power is about 70%. In this case, the power of the analysis increases because the effect size is larger. The probability of detecting the difference between groups is higher than with d=020. When the effect size is taken as d=0.80, which is quite high. In this case, the analysis was performed with a power of about 98%. We can say that the analysis can detect the difference between the groups very strongly. Since there is a very large effect size, the power of the analysis is high and the probability of detecting the difference between the groups is also very high (Prajapati et. al., 2010). In this case, the results obtained are more reliable than other ratios.

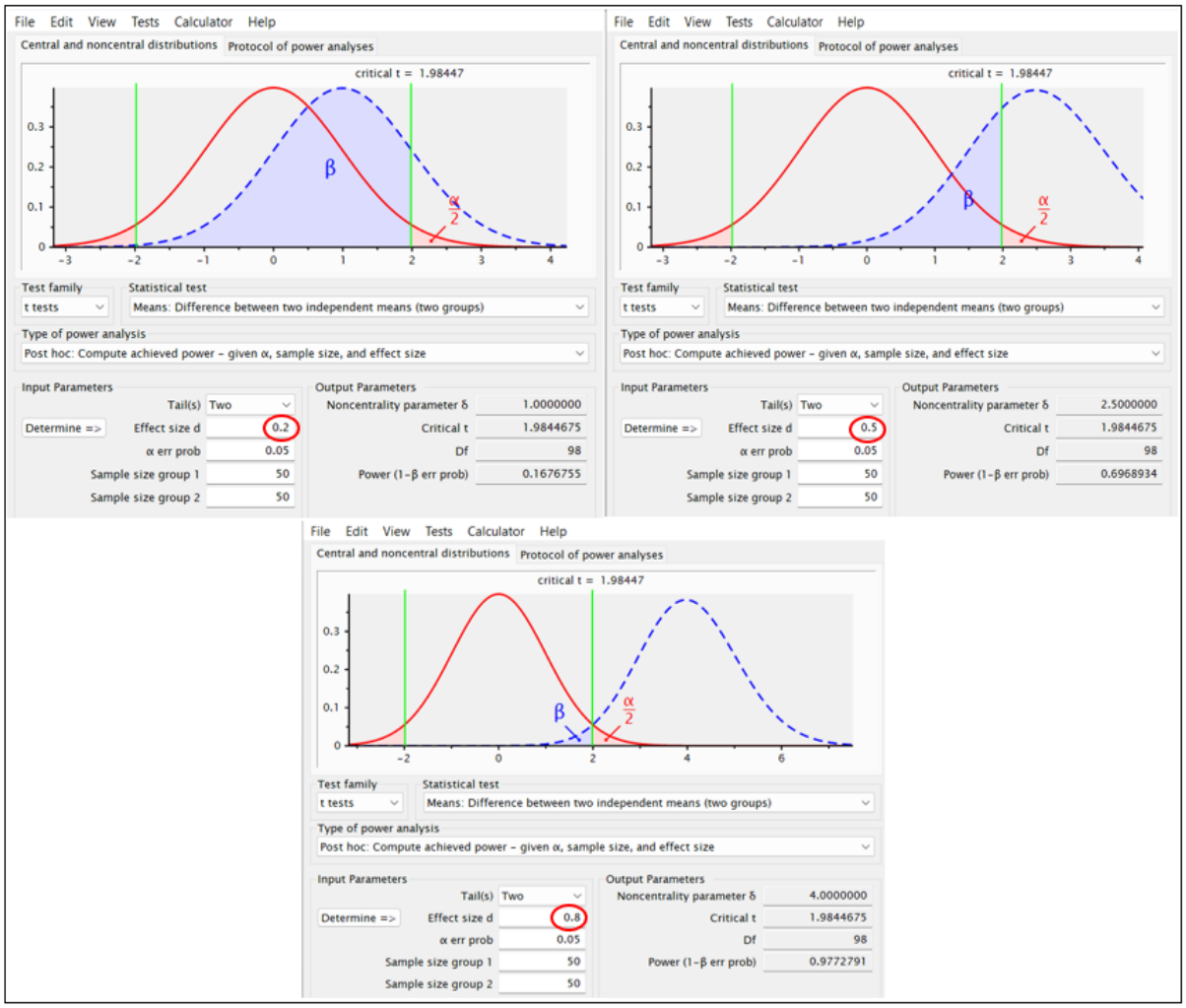


**Figure 3.** Use of the post hoc option in GPower according to different effect sizes

**Conclusion and Recommendations**

In agricultural research, as in many other fields, power analysis is an important part of trials. Power analysis is a means of determining the strengths of the study, whether it is done at the beginning or at the end of the study. Power analysis to be used in agricultural research helps to ensure that statistical analyses are reliable and that costs and resources are managed effectively by ensuring that the sample size is determined correctly. At the same time, an accurate power analysis can also contribute to optimizing the experimental design. A higher power increases the probability of detecting true effects and contributes to more reliable results. As a result, power analysis in agricultural research serves as a crucial tool to enhance the credibility of a study and the reliability of the obtained results. It provides researchers with the opportunity to manage resources effectively while guiding the selection of the right sample size.

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# USE OF CRISPR/CAS9 TECHNOLOGY TO DEVELOP RESISTANCE AGAINST PLANT VIRUSES

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## Abstract
Plant viruses present a serious threat to world agriculture and result in large agricultural economic losses. Pesticides and selective breeding are two traditional ways of viral control; however they have drawbacks in terms of sustainability and efficacy. By enabling precise and effective editing of plant genomes to provide resistance against viral infections. The CRISPR-Cas9 system is made up of Cas9 enzyme, which breaks the targeted DNA sequence into two pieces, and a single guide RNA (gRNA) sequence that may be altered to recognize the DNA target. The main recognition is provided by the binding of the Cas9 enzyme to two cutting sites. A target-specific, adaptable short non-coding RNA called a gRNA is made up of trans-activating and protospacer-containing CRISPR RNA (crRNA) (tracrRNA). Through the use of the guanine-rich PAM sequence and a guide RNA that was specifically created for the target, the Cas9-sgRNA complex detects the DNA double helix. The target DNA is gradually destabilised by the guide RNA that matches the targeted location, and the Cas9 nuclease then initiates a double-strand break in the DNA. Occurrence of double-strand breaks in genes encoding host factors necessary for virus infection and spread prevents the translation of the plant virus. Even if the CRISPR/Cas9 system is incorporated into the genome of the plant, it can still be removed via Mendel segregation after the identification of the plants whose target host factors are controlled. In conclusion, the integration of CRISPR/Cas9 for developing virus-resistant plants offers an innovative and sustainable approach to mitigating the devastating impact of plant viruses on crop yields. With ongoing advancements in genome editing techniques and increasing knowledge of plant-virus interactions, the prospect of creating resilient and virus-resistant crops holds great promise for ensuring food security and agricultural sustainability in the face of evolving viral threats.
**Keywords:** Plant biotechnology, CRISPR/Cas9 technology, plant viruses, resistance

## Introduction

Viruses are obligate parasites that cause infection in almost all organisms. All viruses basically consist of a nucleic acid sequence containing genes encoding several viral proteins and a protein coat surrounding this sequence (Rojas, Gilbertson, & Roossinck, 2008). Plant viruses that cause significant yield losses in plants cause more than 40% crop loss in plants. For this reason, plant viruses impose great restrictions on agricultural production worldwide by reducing both the quantity and quality of plant products that have economic value (Hančinský, Mihálik, Mrkvová, Candresse, & Glasa, 2020; Maksimov et al., 2019). It is known that 25 plant virus families in the world infect various crops of economic value, causing high economic losses (He & Krainer, 2020). Plant viruses generally show two different transmission routes: vertical and horizontal transmission. In vertical transmission, the plant virus is transmitted through vegetative, seed or sexual reproduction, while in horizontal transmission, it is transmitted through insect vectors and physical forms (tools, contacts, etc.) (Gallet, Michalakis, & Blanc, 2018). In plant virus infections, various symptoms such as chlorosis, stunting, necrosis, mosaic and yellowing usually occur in the host plant, and these symptoms cause physical deformations in the host plant (Seo et al., 2018).

Conventional control methods are preferred in the fight against plant virus diseases that cause quality and yield loss in economically valuable plant products and which, unlike other pathogens, cannot be controlled chemically (Goldbach, Bucher, & Prins, 2003) Use of virus-free production materials, crop rotation, cross protection, removal of infected plants that may be a source of inoculum from agricultural areas, chemical control against virus vectors and the use of resistant plant varieties developed against viruses can be given as examples. The negative effects of insecticides used in chemical control against virus vectors on the environment and human health, the emergence of vector races resistant to these chemicals, and the fact that virus-free plants do not show resistance to infections occurring in field conditions, have led researchers to obtain plants resistant to viruses and vectors with molecular biology-based techniques in recent years (Murphy, 2006). New generation gene technologies have emerged in recent years as a promising technology for creating resistance to plant viruses. Among these new generation technologies, CRISPR/Cas9 technology has received special attention due to its usage advantages and effective results. In recent years, studies have been conducted on creating resistance to plant viruses by directly targeting and

dividing viral genes or by targeting translation initiating factors with CRISPR/Cas9 technology (Zaidi, Tashkandi, Mansoor, & Mahfouz, 2016).

This review has been prepared to answer the gaps and outstanding questions in our knowledge about CRISPR/Cas9-mediated viral resistance by examining in detail the main findings from recent studies on the use of CRISPR/Cas9 technology and CRISPR/Cas9-mediated gene silencing in creating resistance against plant viruses.

**Methods of Plant Virus Disease Management**

The most commonly used conventional techniques in the fight against plant viruses focus on physical methods such as chemical control against vectors carrying the virus, the use of natural predators, and the use of mulch and UV absorbing layers. In addition, it is frequently used in cultural practices such as the removal of intermediate host weeds, the use of virus-free production materials, crop rotation and the removal of infected plants. (Legg et al., 2014). However, these combat methods used do not remain stable because the rapid evolution of viruses, the constant change of the virus-vector relationship, and epidemiological factors prevent the use of these strategies in the long term (Loebenstein & Katis, 2014). The inadequacy and expense of conventional methods against plant viruses have led scientists to study the use of virus-resistant genes (Whitham & Hajimorad, 2016). Developing resistant plants for this target and using them in combination with conventional methods have produced effective results. Therefore, ongoing research is ongoing to understand plant cellular mechanisms of virus and virus vector resistance (Mandadi & Scholthof, 2013). Some studies have shown that the virus can gain infection ability by breaking the resistance genes in the target host plant (Chinnaiah et al., 2023; Kabaş, Fidan, & Batuhan Demirelli, 2021).

**Confer Resistance Against Plant Viruses with CRISPR/Cas9 Technology**

The CRISPR/Cas9 system is a natural defense system in prokaryotes and targets the nucleic acids of bacteriophages (Marraffini & Sontheimer, 2008). Bacteria and archaea molecularly recognize a specific region of the viral nucleic acids of bacteriophages and incorporate them into their genomes (Bolotin, Quinquis, Sorokin, & Ehrlich, 2005). After this recognition, when bacteriophages try to re-infect prokaryotic cells, Cas9 endonuclease recognizes and cuts the invading viral sequence. After this cutting, the bacteriophage cannot be transcribed and cannot infect the cell (Nuñez, Harrington, & Doudna, 2016; Wright, Nuñez, & Doudna, 2016).

**CRISPR/Cas9 Technology Against Plant DNA Virus**

DNA viruses, which have the ability to infect not only plants but also almost all organisms, have now been studied using CRISPR technology (Schiffer et al., 2012). For example, resistance studies have been conducted with CRISPR/Cas9 technology against human viruses such as human immunodeficiency virus (HIV) (Hu et al., 2014), Herpes simplex virus (Suenaga, Kohyama, Hirayasu, Arase, & immunology, 2014), Epstein-Barr virus (Wang & Quake, 2014) and hepatitis B virus (Zhen et al., 2015).

CRISPR/Cas9 technology has been used successfully against plant viruses (Ali et al., 2015). The successful use of CRISPR/Cas9 to induce geminivirus resistance in model plants *Nicotiana benthamiana* and *Arabidopsis thaliana* has been reported (Ali, Ali, Tashkandi, Zaidi, & Mahfouz, 2016; Baltes et al., 2015).

**Conclusion**

CRISPR technology has become indispensable for genome editing tools since its emergence. The limitations caused by ZFN and TALEN gene modification techniques have been eliminated with CRISPR technology. This technology, which targets both RNA and DNA, is cheap, reliable and accurately detects the target, thus increasing the range of organisms to be studied and providing the opportunity to target more than one region in a genome.

There are many studies on the use of the CRISPR technique against plant viruses, and today both genome editing and commercial and field trials of the resulting product are being carried out (Hull, 2013; Zaidi et al., 2016). It is assumed that plant viruses are more resistant than dominant R genes due to lower selective pressures on the virus to target the viral genes found in the genome or to target the CRISPR system by targeting the host initiation factors found in the host of the virus and to develop counter-defense strategies (de Ronde, Butterbach, & Kormelink, 2014).

In the coming years, the development of bioinformatics techniques and their combination with interdisciplinary fields will enable more detailed analysis of these technologies, ultimately leading to their use in the development of various marketable crops.

**Thanks and Information Note**

SA provided the outlines of the review and contributed the key ideas. YEU wrote the manuscript and orked on and improved the original draft .

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interes

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# INVESTIGATION OF THE PHYSICAL PROPERTIES OF ASPIR OIL AND 15W40 ENGINE LUBRICATING OIL AND MIXTURES

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**Abstract**
The need for energy has increased due to industrialization and rapid developments in technology. This increase has led to an increase in lubricants. It is thought that bio-lubricants should occupy an important place in meeting this need. For this reason, it was deemed appropriate to conduct a bio-lubricant study using safflower oil, which is a commercial motor oil with a wide range of uses, and safflower oil, which is a renewable oil. In this study, 15W40 engine oil and safflower oil were mixed in 10% (A10), 20% (A20), 50% (A50) ratios. A total of 5 engine oil samples were obtained by adding pure safflower oil (A100) and safflower unmixed engine oil (A0) samples. Viscosity, viscosity index, density, pour point, flash point, water amount tests of A100, A50, A20, A10 and A0 samples were performed. As a result of the examinations, it was concluded that the performance increased in terms of viscosity index and viscosities under cold working conditions with the increase in safflower rate in the samples. This shows that safflower oil has a positive effect on engine oil performance. However, the decrease in viscosity values due to safflower oil is an engine oil feature that needs to be improved for vehicles operating at high speed and temperature. The amount of water, flash point and pour point values have shown to be usable as an alternative to the 15W40 engine oil. Considering that bio-lubricants are environmentally friendly, it can be said that A50 sample is the most suitable engine oil among the samples because it contains more vegetable oil than other samples. As a result of this study, it is seen that the use of safflower oil as an additive in motor oil is a positive result in terms of healing and clean environment.
**Keywords:** Engine oil, safflower oil, friction, wear

## INTRODUCTION

Overall, vegetable oils are highly attractive substitutes for petroleum-based oils, as they are environmentally friendly, renewable, less toxic, and easily biodegradable. Due to environmental concerns and increasing regulations on pollution and pollution, the need for renewable and biodegradable lubricants is expected to increase (Lawal at al., 2012).

The advantages that support the use of vegetable oils as lubricants are that they cannot be toxins and are biodegradable. Figure 1 shows the biodegradability of oils with different ingredients, and it can be said that vegetable oils perform superior in this regard. The fact that vegetable oils are not toxic and biodegradable provides a great advantage for industrial applications that are in contact with the environment or come into contact with the environment as a result of accident, leak into the environment by spilling and create a large amount of waste material after use. The low volatility properties of vegetable oils enable vegetable oils to have a high flash point and provide many advantages, especially lubricant storage with a high flash point (Durak and Bartz, 2003).

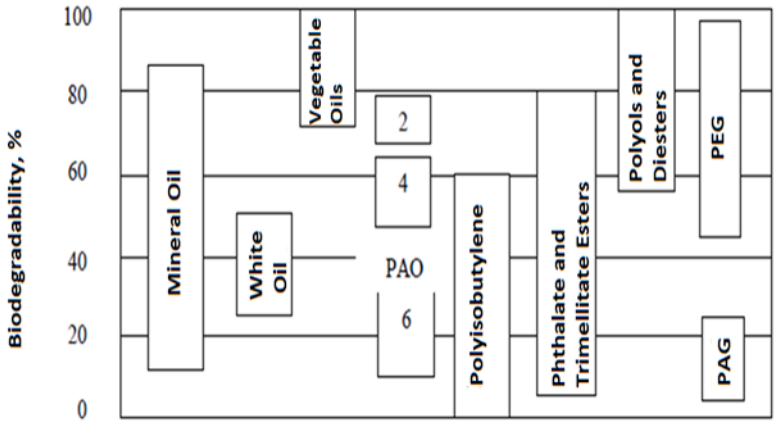


**Figure 1.** Degradability of oils with different ingredients(Durak ve Bartz, 2003)

Safflower oil contains high levels of polyunsaturated fatty acids such as linoleic acid and tocopherol, which are used for dietary purposes. The major unsaturated fatty acids are linoleic and oleic acid, which account for 77.9–79.5% and 9.5–11.3% of the total fatty acids, respectively. Saturated fatty acids, on the other hand, are found in lower proportions, ranging from 9.7% to 10.8% of total fatty acids. The major saturated fatty acids, palmitic and stearic acids, consisted of 7.2-8.6% and 2.0-2.4% content, respectively. Table 1 shows the fatty acid composition of safflower oil reported in different studies (Khalid et al., 2017).

In their study, Khemchandani et al. (2014) evaluated the synergistic approach of phenolic and amine antioxidants in safflower oil. They also incorporated and studied synthetic esters (SEs) for thermo-oxidative stability using rotating pressure vessel oxidation test and differential scanning calorimetry to improve the oxidation properties of plant oil. In addition to thermo-oxidative properties, the tribological properties of pure base stocks were also studied. As a result, it was concluded that safflower oil has excellent lubricity properties, a very high viscosity index and superior biodegradability properties, but is very weak in thermal oxidation properties (Khemchandani et al., 2014).

**Table 1.** Safflower oil fatty acid contents(Khalid ve ark., 2017)

| **Fatty acid** | **Contents (%)** | **Sütun1** | Sütun2 | Sütun3 | Sütun4 | Sütun5 |
|---|---|---|---|---|---|---|
| **Myristic C14:0** | 0.50 | - | - | - | 0.12-0.16 | 0.11-0.13 |
| **Palmitic C16:0** | 4.00 | 6.48 | 6.03-6.66 | 4.90-8.10 | 7.20-8.60 | 6.07-6.32 |
| **Stearic C18:0** | 2.50 | 2.30 | 2.01-2.61 | 1.70-2.80 | 2.00-2.39 | 2.06-2.24 |
| **Oleic C18:1** | 16.60 | 14.17 | 11.22-14.19 | 8.10-13.10 | 9.50-11.29 | 7.51-18.38 |
| **Linoleic C18:2** | 76.00 | 73.87 | 74.60-78.24 | 75.20-83.70 | 77.49-79.98 | 71.56-73.32 |
| **Linolenic C18:3** | - | 0.37 | 0.07-0.08 | 0-0.1 | 0.09 | 0.07-0.09 |
| **Arachidonic C20:4** | - | - | - | 0-0.4 | - | - |
| **Eicosaeonic C20:1** | - | - | 0.17-0.19 | 0.2 | Not detected | 0.13-0.15 |
| **References** | **Kostik et al. (2013)** | **Sabzalian et al. (2008)** | **Al Surni et al. (2015)** | **Mailer et al. (2008)** | **Ben Moumen et al. (2013)** | **Coşge, Gürbüz and Kiralan (2007)** |

The properties of crude safflower oil are given in Table 2.

**Table 2.** Properties of crude safflower oil(Özçelik, 2011)

| Feature | Unit | Value |
|---|---|---|
| Molecular weight | gr/mol | 278 |
| Density (15°C) | kg/m³ | 923 |
| Kinematic viscositie (40°C) | mm²/s | 30…50 |
| Cetane number | - | 41,3 |
| Cloud point | °C | 18,3 |
| Pour point | °C | -6,7 |
| Flash point | °C | 264 |
| İodine value | g iodine/100g | 117,9 |
| Saponification number | - | 185-195 |
| Upper thermal value | MJ/kg | 39,3 |
| Lower thermal value | MJ/kg | 38,22 |

Engine oils generally consist of mineral base oil. This mineral is obtained by refining base oils from crude oil. The refining process is done by repeating the distillation process under vacuum of the product formed by distillation of petroleum by atmospheric distillation (Akyazı, 2015). Engine oils contain 85% base oil, and the rest consists of oil additives. Oil additives are products that are added to improve many features of the engine (Müjdeci, 2009). Anti-wear, viscosity improver, freezing point reducers are some oil additives (Akyazı, 2015). They are available at cheaper prices than synthetic-based motor oils and offer average performance (Halis, 2016).

In this study, samples were obtained as a result of mixing 15W40 engine oil with safflower oil. These samples were evaluated in terms of their physical properties such as viscosity, viscosity indexes, densities, flash and pour points, water ratios with reference to 15W40 engine oil.

## MATERIALS AND METHODS

### MATERIALS

In line with the researches, the use of vegetable-based oils in motor oils is important when positive results such as reducing dependence on petroleum, clean environment and improving engine oil performances are evaluated. While aiming to reduce the negative properties of mineral oils, it has been concluded that mineral engine oil and vegetable-based engine oils should be mixed in order to achieve the best engine oil performance.

In this study, safflower oil was obtained with Petrol Ofisi 15W40 engine oil. The supplied engine oil and safflower oil were mixed as 10% (A10) - 20% (A20) - 50% (A50) by volume in the Fuel Laboratory of Selcuk University Faculty of Technology. Viscosity, density and pH

analyzes were performed in this laboratory. Flash point, water ratio and pour point analyzes were made from Selcuk University Faculty of Agriculture Biodiesel laboratory.

The typical properties of the engine oil used are shown in Table 3.

**Table 3.** Typical characteristics of 15W40 engine oil(PetrolOfisi, 2022)

| | | |
|---|---|---|
| SAE Viscosity class | | 15W40 |
| Density, 15°C, kg/liter | ASTM D4052 | 0,886 |
| Flash point, COC, °C | ASTM D92 | 240 |
| Viscosity, 40°C, mm²/s | ASTM D445 | 114 |
| Viscosity, 100°C, mm²/s | ASTM D445 | 15 |
| Viscosity İndex | ASTM D2270 | 139 |
| Pour point, °C | ASTM D97 | -30 |

## METHODS

### Preparation of samples and determination of their physical properties

This study was carried out with sample oils prepared by mixing safflower oil and 15W40 commercial engine oil. The mixtures were prepared by measuring in beakers and homogenized by mixing in a magnetic stirrer as shown in Figure 2.




**Figure 2.** Mixing samples

- The sample called A0 by using it without adding safflower oil to commercial engine oil,
- A sample called A10 with the addition of 10% safflower to 15W40 engine oil,
- A sample called A20 with the addition of 20% safflower to 15W40 engine oil,
- Sample called A50 with the addition of 50% safflower to 15W40 engine oil,
- By using pure safflower oil, a sample called A100 was obtained.

The prepared specimens are shown in Figure 3. The A0 sample was determined as a sample to be used as a reference value in the evaluation of the measurement results. The A100 sample was determined as a sample to evaluate the performance of pure safflower oil in the use of motor oil. A10, A20 and A50 samples obtained as mixtures were determined in order to observe how the performance of safflower oil is affected in the use of safflower oil as an additive in commercial engine oil.




**Figure 3.** Prepared samples

Density analyses were performed for the samples by maintaining a constant temperature of 15°C and performing 3 identical repetitions. After the density analyzes were performed, viscosity analyzes were performed as shown in Figure 4 by performing 3 identical tests at 40°C and 100°C. After the viscosity analysis, viscosity indices were determined using the viscosities at 40°C and 100°C.




**Figure 4.** Viscosity measurement

After the viscosity measurements, observations were made with the help of a deep freezer and thermometer and the yield points were determined. As shown in Figure 5, the samples were

placed in antifreeze and left in the deep freezer. After observing that the first paraffin wax became visible, the thermometer was placed in the engine oil and the lowest temperature at which the engine oil could flow was determined as the yield point due to the precipitated paraffin crystals.



**Figure 5.** Pour point measurement

Samples were added to the container of the tester as 50 ml to determine the flash point. A graduated cylinder was used and both the cylinder and the sample were pre-cooled in the range of 27±2°C. The sample was heated slowly and at a constant rate. The flash point is the lowest temperature at which the application of the ignition source causes the vapor on the sample to ignite. The temperature at which a large flame appears and suddenly spreads over the entire surface of the test specimen is considered to be the temperature at which the specimen glows (Figure 6).

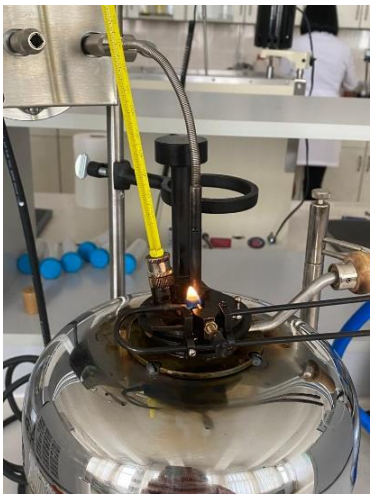

**Figure 6.** Flash point measurement

Finally, water determinations of the samples were made in the water determination measuring device and the physical analyzes to be made within the scope of the study were completed.

## RESEARCH RESULTS AND DISCUSSION

### Density and Viscosity Analysis

All mixtures of apir oil and 15W40 engine oil showed homogeneous phase, i.e., phase separation and precipitation after three months of storage at room temperature.

The results obtained from the density measurements repeated three times for the A0, A10, A20, A50 AND A100 samples obtained by mixing 15W40 engine oil and safflower oil in different proportions are given in Figure 7.

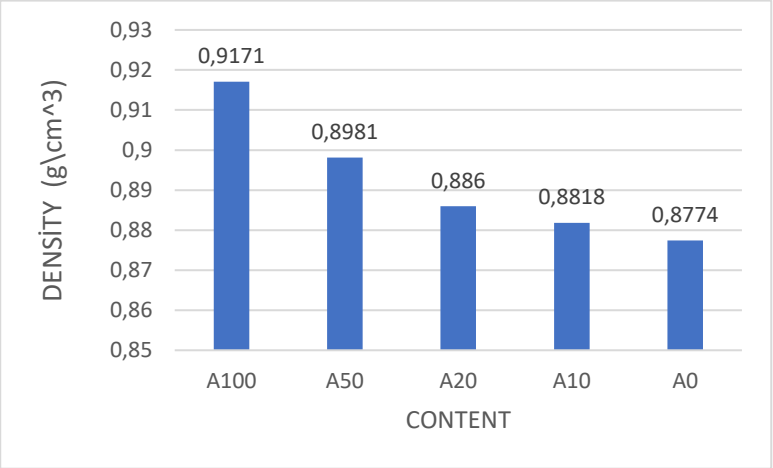


**Figure 7.** Density analysis of samples

When the measurement results were evaluated, an increase in the density of the samples was observed by increasing the amount of safflower. As can be seen in the figure, the lowest density value was observed in engine oil (A0). Compared to engine oil, a very small increase of 0.5% was observed compared to the noumen mixed with 10% safflower oil. The A50 increased by 2.35%. The highest density value was observed in the A100 (safflower oil) sample as 0.9171 g/cm3 and showed an increase of 4.5% compared to the A0 sample with the lowest density.

The viscosity values of the samples obtained as a result of three repetitions at 40°C and 100° are shown in Figure 8. As can be seen in the figure, by increasing the safflower ratio in the samples, there is a decrease in the resistance of engine oils to flow. The lowest viscosity values were observed in the A100 sample. The higher the number of unsaturated fatty acids, the lower the viscosity of fats (Reeves et al., 2015). This is the reason for the decrease in viscosity values with the increase in safflower ratio.

It can be concluded that safflower oil is advantageous for cold working conditions when used as an engine oil or as an engine oil additive. The high viscosity of the engine in cold working

conditions, such as during the first operation, causes damage to the engine parts, so it is advantageous for the use of safflower oil to show a low viscosity value at low temperatures. However, excessive thinning of the lubricant film between engine parts due to temperature in engine oil at high rpm and temperature causes the engine oil to not fully fulfill its task and cannot prevent friction and wear. As a result, low viscosity at high temperature is an undesirable property in engine oils.

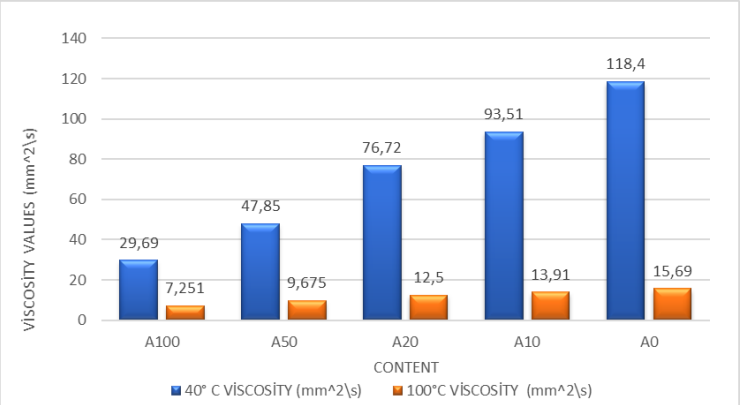


**Figure 8.** Kinematic viscosities of samples

Although there is a decrease in viscosity values, there is an increase in viscosity indices with the increase in the safflower ratio in the samples. Khemchandani et al. (2014) concluded that safflower oil has a very high viscosity index. The viscosity indices of the samples are given in Figure 9.

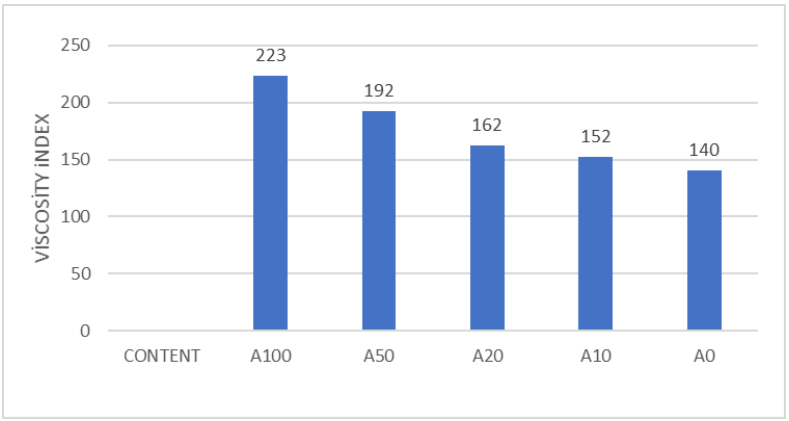


**Figure 9.** Viscosity indices of samples

Oils with a high viscosity index can resist excessive thickening when the engine is cold. This promotes rapid lubrication circulation, leading to better engine starting. It also prevents excessive thinning when the engine is hot, thus providing full lubrication to protect rubbing surfaces. Therefore, it has been concluded that vegetable oil can provide this advantage when used as a base stock for lubricants (Cheenkachorn and Fungtammasan, 2010).

**Flash Point Analysis**

Flash point analyses of safflower oil and 15W40 engine oil samples, which were previously prepared and did not show phase separation, were performed in 3 repetitions.

The results of the analysis are given in Figure 10. When the results are examined, it is observed that with the increase in the safflower rate in the samples, it exhibits a regular decrease in the flash point. The flash point is the lowest temperature at which an ignition source causes the vapors of the sample to ignite under certain conditions. When the conditions of use and storage conditions are evaluated, it can be concluded that the use of safflower oil as an additive is suitable for the flash point feature, but it cannot be said that it has a curative effect for the flash point values, which is an important feature for engine oil.

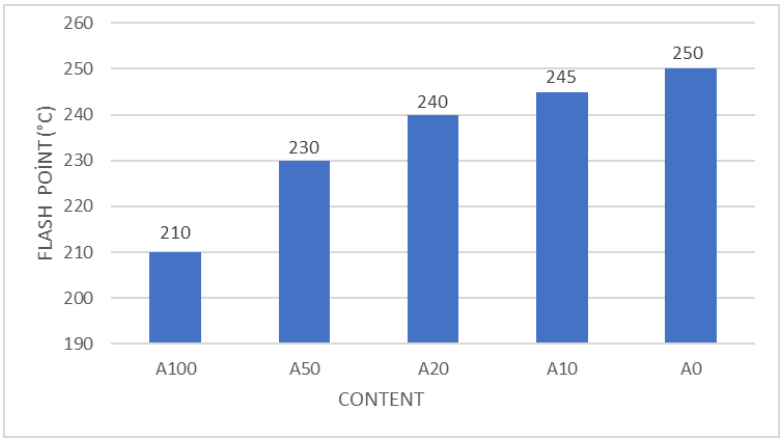


**Figure 10.** Flash point values

**Pour Point Analysis**

The pour point is the lowest temperature at which oil can flow when refrigerated under certain conditions. In engine oils, a wax crystal structure is formed that prevents oil flow at low temperatures. This is a negative feature for engine oils and therefore yield point lowering additives are used in engine oils. Pour point analyses of the samples obtained with safflower oil and 15W40 engine oil mixtures were performed and the results are given in Figure 11.

It is desirable to have a low yield point for engine oils, but when the results of the analyzes made with our samples are examined, it can be concluded that there is an increase in the yield point.

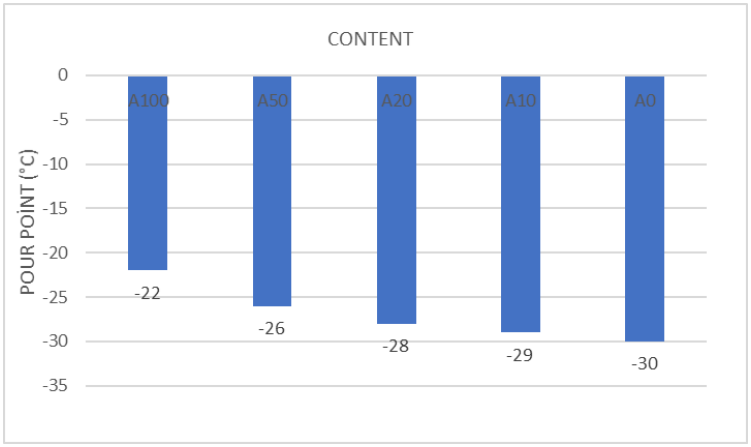


**Figure 11.** Pour point values

**Water Ratio Analysis**

Water ratios of A100, A50, A20, A10 and A0 samples obtained with safflower oil and 15W40 engine oil were analyzed. The results of the analysis are given in Figure 12.

When the results are examined, it is concluded that there is a decrease in the water rate with the increase in the safflower rate. This is a positive feature for engine oil efficiency. It can be concluded that the use of aspirin as an additive in motor oils has a positive effect on engine oil performance. However, it is not appropriate to evaluate the water ratio of safflower oil as a criterion that the water ratio of safflower oil is lower than the water ratio of engine oil, since additives that improve performance properties such as magnesium sulfonate and calcium sulfonate added to engine oils retain water molecules.

As a result, it has been concluded that the water ratio is suitable for the use of safflower oil as engine oil.

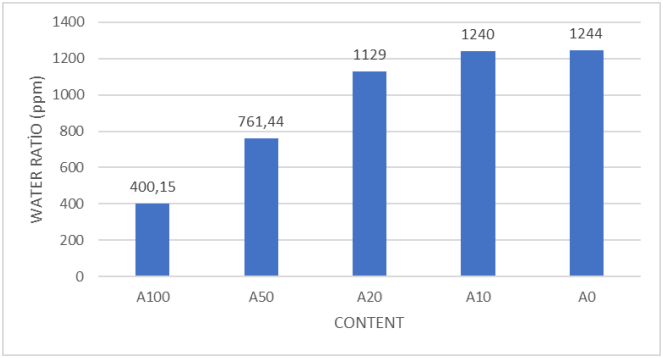


**Figure 12.** Water ratio analysis results

**RESULTS**

In this study, samples were obtained by mixing 15W40 engine oil and safflower oils with 10% (A10), 20% (20), 50% (A50) and 100% A (100) ratios and compared with commercial engine oil (A0). The physical and chemical properties of engine oils were analyzed.

It is seen that safflower oil exhibits more stable performance in viscosity index when used as an engine oil or as an additive. At the same time, we can reach the conclusion that it minimizes wear in the first working wear in the cold.

With the increase in the proportion of safflower oil, the viscosities of the samples decreased in direct proportion. Compared to 15W40 engine oil, which is used as heavy commercial engine oil operating at high speeds and temperatures, it is concluded that it cannot be used as an alternative due to its low viscosity values. However, when the viscosity values of the samples are examined and the high performance in the viscosity index is considered, it can be said that safflower oil can be used as an alternative for passenger car engine oils. As a result of the studies, it is recommended that the use of safflower as engine oil or its use as an additive should be investigated with reference to passenger car engine oils.

As a result of examining its physical properties such as flash point and pour point, it is concluded that safflower oil is suitable for use as an additive in commercial engine oil. There are negligible differences for A10, A20 and A50 samples, so it has been concluded that the more environmentally friendly A50 sample shows the best performance and can be used as an alternative to 15W40 engine oil.

When the water ratio of engine oils was examined, it was observed that the engine oil efficiency increased with the increase in the additive rate of safflower oil and it was concluded that safflower oil can be used as an additive to reduce the humidity rate.

As a result of the studies, it is recommended that the use of safflower as engine oil or its use as an additive should be investigated with reference to passenger car engine oils.

**ACKNOWLEDGMENTS**

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# DEĞİŞİK TUZ KONSANTRASYONU UYGULAMALARININ BÖRÜLCENİN FİDE GELİŞİMİ ÜZERİNE ETKİLERİ

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**Özet**
Bitkisel üretimde verim ve kaliteyi etkileyen en önemli abiyotik stress faktörlerinden birisi hiç kuşkusuz topraktaki tuzluluk seviyesidir. Bu çalışma, iki farklı börülce *(Vigna sinensis (L)Walp.)* çeşidindeki (Karagöz ve Amazon) farklı tuz uygulamalarının bitkilerdeki bazı büyüme ve fizyolojik özellikler üzerine etkilerinin belirlenmesi amacıyla yürütülmüştür. Deneme, tesadüf parselleri deneme desenine göre faktöriyel düzende 3 tekerrürlü olarak tam kontrollü iklim odasında yürütülmüştür. Çalışmada, Kontrol (T0) ile beraber üç farklı tuz (NaCl) (T1 (50 mM), T2 (100 mM) ve T3 (200 mM) uygulaması yapılmıştır. Elde edilen verilere göre yapılan tuz uygulamalarının incelenen parametreler üzerindeki olumsuz etkilerini arttırıcı bir özelliğe sahip olduğu tespit edilmiştir. En fazla gövde uzunluğu (70.33cm), gövde yaş ağırlığı (17.49 g), gövde kuru ağırlığı (1.91g) kök yaş ağırlığı (10.3g) ve kök kuru ağırlığı (0.84g) Kontrol (T0) uygulamasından; kök uzunluğu (28.33cm) T3 uygulamasından; klorofil oranı (50.87µg/cm$^2$) T0, T1 ve T2 uygulamalarından; yaprak alan indeksi (26.93 cm$^2$) ise T0, T1 ve T3 uygulamalarından tespit edilmiştir. Ayrıca, çeşitler arasında, klorofil oranı, yaprak alan indeksi ve gövde yaş ağırlığı parametreleri bakımından istatistiksel olarak farklar önemli olmazken, kök uzunluğu, kök kuru ve gövde kuru ağırlığı bakımından Amazon; gövde uzunluğu ve kök yaş ağırlığı bakımından ise Karagöz çeşidinin tuz stresine kısmen daha dayanıklı olduğu belirlenmiştir.
**Anahtar Kelimeler:** Çeşit, Tuz Stresi, Tolerans, Börülce

# EFFECTS OF VARIOUS SALT CONCENTRATION APPLICATIONS ON SEEDLING DEVELOPMENT OF COWPEA

**Abstract**

One of the most important abiotic stress factors affecting yield and quality in crop production is undoubtedly the salinity level in the soil. This study was carried out to determine the effects of different salt treatments on some growth and physiological properties of two different cowpea cultivars (*Vigna sinensis* (L)Walp.) (Karagöz and Amazon). The experiment was carried out in a fully controlled climate chamber in a factorial arrangement with 3 replications according to the randomized plot design. In the study, three different salts (NaCl) (T1 (50 mM), T2 (100 mM) and T3 (200 mM) were applied together with the Control (T0). According to the data obtained, salt applications have a feature that increases the negative effects of the investigated parameters. The maximum stem length (70.33cm), stem fresh weight (17.49 g), stem dry weight (1.91g), root fresh weight (10.3g) and root dry weight (0.84g) from T0 application, root length ( 28.33cm) from T3 application, chlorophyll ratio (50.87µg/cm2) from T0, T1 and T2 applications, and leaf area index (26.93 cm2) from T0, T1 and T3 applications. In addition, statistically significant differences were not found among the cultivars in terms of chlorophyll ratio, leaf area index and stem fresh weight parameters. In terms of stem length and root fresh weight, it was determined that Karagöz variety was partially more resistant to salt stress.

**Keywords**: Variety, Salt Stress, Tolerance, Cowpea

**Giriş**

Börülce (*Vigna sinensis (L)Walp.*), baklagiller (Fabaceae) familyasına ait olup, günümüzde yetersiz ve dengesiz beslenmenin hala önemli bir sorun olduğu coğrafyalarda (özellikle Afrika'da kıtasında) abiyotik koşullara dayanıklılık özelliklerinden dolayı insan ve hayvan diyetlerinde önemli bir protein kaynağı olarak üretilmektedir (Serdaroğlu, 2009). Afrika kıtasının yanı sıra Güney Amerika, Asya'nın bazı kısımları ile Amerika Birleşik Devletleri'nde genellikle yaygın olarak yetiştiriciliği yapılmaktadır (Xiong ve ark.2016). Taze baklaları sebze olarak tüketilen börülcenin tohumları yüksek oranda protein (%19-27) içermesine rağmen besleyici özelliği olmayan maddeleri içermez (Sharan ve Khetarpaul, 1994).

Tuzluluk, bitkilerin yaşamlarını tehdit eden abiyotik stres kaynaklarının en önemlilerinden birisidir (Toprak ve Tunçtürk, 2018). Toprak tuzluluğu bitkide strese neden olmakla beraber birçok değişime sebep olmaktadır. Bu değişimler; tuz çeşidi, stres seviyesi, strese maruz kalma süresi, bitki genotipinin tuza tolerans seviyesi ve bitkide hangi yaşam sürecine denk geldiğine bağlı olarak değişkenlik göstermektedir. Bu nedenle aynı tuzlu toprakta yetişen farklı bitkilerde stresin etkileri farklılık arz etmektedir. Bazı bitkiler yetiştirildikleri ortamda tuzluluğun artışına bağlı olarak çeşitli morfolojik, fizyolojik, biyokimyasal ve moleküler anlamda değişimler başlatabilir ve stresin zararlarını en aza indirip hayatlarını devam ettirebilirken, bazı bitkilerde stresi tolere edebilecek mekanizmalar yeterli olamamakta ve hayatta kalma şansları azalmaktadır (Çulha ve Çakırlar, 2011). Toprakta tuz artışına bağlı olarak yeterince su alamayan bitki ozmotik strese girmektedir (Reinhardt ve Rost, 1995). Bu durum; hücre büyümesinin yavaşlamasına, sürgün gelişiminin sekteye uğramasına sebep olmaktadır. Toprakta $Na^{+}$ ve $Cl^{-}$ iyonlarının artışı $K^{+}$, $Ca^{+2}$ ve $NO^{-3}$ gibi bazı anyon ve katyonların alınımını engelleyerek bitkide besin elementi eksikliği ve dengesizliğinin meydana gelmesine (Hu ve Schmidhalter, 2005), hücre büyüme ve gelişiminin olumsuz yönde etkilenmesine bağlı olarakda kök ve sürgünlerde hücresel aktivitenin azalmasına sebep olmaktadır (Burssens ve ark., 2000). Tüm bu faktörlere bağlı olarak toprak altı ve üstü aksamlarda uzunluk ve ağırlıkça azalmalar, tuzun etkisini azaltma amacıyla kök bölgesinde ligninleşme, yaprak boyutu, kalınlığı ve sayısında azalmalar (Mohammad ve ark., 1998), çiçeklenme zamanında değişimler ve çiçek sayısında azalmalar (Munns, 2002) meydana gelmektedir. Tuz stresinde bitkilerde aktif oksijen türleri (serbest radikaller) meydana gelerek hücre zarı lipitlerini oksitleyerek, DNA, RNA ve klorofil pigmentlerini bozar (Mittler, 2002) Ayrıca klorofil pigmentlerinde azalmaların ortaya

çıkmasına ve sonuç olarak da fotosentez reaksiyonu sonucu üretilen primer metabolitlerin yeterince üretilememesine sebep olduğu bildirilmiştir (Parida ve Das, 2005).

Tuzlu topraklarda yetiştirilen börülcede çimlenme sorunları, vejetatif ve generatif büyümede gerileme, tohum veriminde azalmaların meydana geldiği bilinmektedir. Bu sebeple börülcenin ilk gelişme döneminde tuza tolerans seviyelerinin belirlenmesi büyük önem arz etmektedir. Bu çalışmada, ülkemizde yaygın tarımı yapılan iki börülce çeşidinin tuz stresine karşı tolerans durumunun tespit edilmesi amaçlanmıştır.

**Materyal ve Yöntem**

Deneme, 2020 yılında Van Yüzüncü Yıl Üniversitesi Ziraat Fakültesi Tarla Bitkileri Bölümü'ne ait tam kontrollü bitki büyütme kabininde yürütülmüştür. Tohumluk materyali olarak kullanılan Karagöz ve Amazon börülce çeşitleri Samsun 19 Mayıs Üniversitesi Tarla Bitkileri bölümünden temin edilmiştir.

Çalışma, Tesadüf Parselleri Deneme Deseni' ne göre faktöriyel düzende 3 tekrarlamalı olarak yürütülmüştür. Araştırmada, bitkilere Kontrol uygulaması ile birlikte 3 farklı tuz (NaCl) konsantrasyonu (T0(Kontrol), T1(50 mM), T2(100 mM) ve T3(200 mM) uygulanmıştır. Çalışmada, börülce tohumları 1/3 perlit ve 2/3 toprak karışımı ile doldurulan 500 cc'lik plastik bardak saksılara 3'er adet ekilmiştir. Ekimden sonra saksılar 16/8 saatlik aydınlık/karanlık fotoperiyotta, $25^0$C sıcaklık %65 neme sahip tam kontrollü iklim odasına yerleştirilmiştir. Çıkıştan sonra her saksıda birer adet bitki olacak şekilde tekleme yapılmıştır. Ekimle birlikte tuz uygulamalarının başlandığı 23. güne kadar (kontrol grubu hasada kadar) saksılara ihiyaç duyuldukça saf su ile sulama yapılmıştır. Tüm bitkilere ekimden 2 hafta sonra temel gübreleme olarak amonyum sülfat (11.4 g/l), triple süper fosfat (2.86 g/l) ve potasyum sülfat (3.45 g/l) gübre solüsyonu sulama suyuna katılarak uygulanmıştır. Kontrol grubu hariç diğer bitkilere ekimden 23 gün sonra 50 mM, 100 mM ve 200 mM tuz solüsyonu gün aşırı olmak üzere toplam 6 kez uygulanmıştır. Bitkilerde fizyolojik sorunlar belirdiğinde (ekimden 34 gün sonra) gerekli analizler yapılmak üzere deneme sonlandırılmıştır. Bitkinin kök ve gövde yaş ağırlıkları alındıktan sonra, kuru ağırlıklarının tespiti amacıyla bitkinin kök ve gövde kısımları ayrı ayrı kese kâğıtlarına konularak $105^0$C sıcaklıkta 24 saat boyunca etüvde kurutulup sabit ağırlığa getirildikten sonra tartım işlemleri yapılmıştır. Yaprak alanı ölçümleri, Easy Leaf Area programı kullanılarak; klorofil içeriği, taşınabilir klorofil metre cihazı (Minolta SPAD-502, Osaka, Japan) yardımıyla Premchandra ve ark. (1990) ve Sairam, (1994) yöntemlerine göre belirlenmiştir.

**Verilerin istatistiksel analizi**

Araştırma sonucunda elde edilen veriler Costat (6.34) paket proğramı yardımıyla, Tesadüf Parselleri Deneme Desenine göre varyans analizine tabi tutulmuştur. Ortalamalar arasındaki farklılıklar LSD çoklu karşılaştırma testine göre yapılmıştır (Düzgüneş ve ark., 1987).

**Bulgular ve Tartışma**

Tuz konsantrasyonlarının fidelerdeki kök uzunluğunun gelişimi üzerine etkisi istatistiksel olarak %5 seviyesinde önemli görülürken, Çeşit ve ÇxT interaksiyonunun etkisi istatistiksel olarak önemsiz bulunmuştur (Çizelge 1). Çeşitler ortalamasına bakıldığında en uzun kök uzunluğu 26.43 cm ile Karagöz çeşidinden, en kısa kök uzunluğu ise 25.54 cm ile Amazon çeşidinden elde edilmiştir. Tuz konsantrasyonları bakımından ise en uzun kök (27.66 cm) T0 uygulamasından elde edilirken, en düşük kök uzunluğu değeri ise 23.66 cm ile T2 uygulamasından tespit edilmiş ve bu uygulamalar farklı grupları oluşturmuştur. Tuz uygulaması ile beraber kök bölgesindeki osmotik basıncın yükselmesine bağlı olarak hücre büyüme ve bölünmesinde azalmaların meydana gelir ve su alınımı düşer. Bu durumda kök uzunluğunda azalmalar meydana gelir (Al-Karaki, 2001). Özkorkmaz ve Yılmaz (2017), farklı tuz dozlarının börülcenin radikula uzunluğunu etkilediğini, 50 mM tuz uygulamasında radikula uzunluğunda artış meydana gelirken artan tuz dozlarında giderek azaldığını belirlemişlerdir.

Çizelge 1'de görüldüğü gibi çeşitler ile tuz konsantrasyonlarının fidelerdeki gövde uzunluğunun gelişimi üzerine etkisi istatistiksel olarak %1 seviyesinde önemli görülürken, ÇxT interaksiyonunun etkisi istatistiksel olarak %5 seviyesinde önemli bulunmuştur. Çeşitler ortalaması açısından en uzun gövde 50.16 cm ile Karagöz çeşidinden elde edilirken, en kısa gövde uzunluğu ise 43.00 cm ile Amazon çeşidinden tespit edilmiştir. Tuz uygulamaları bakımından ise en uzun gövde uzunluğu (69.50 cm) T0 uygulamasından, en kısa gövde uzunluk değeri ise (33.00 cm) T3 uygulamasından tespit edilmiş ve bu uygulamaların farklı grupları oluşturduğu gözlemlenmiştir. Aydınşakir ve ark. (2015), börülcede farklı tuz konsantrasyonlarının (50, 100, 200, 400, 800, 1600 mM) bazı büyüme parametreleri üzerine etkilerini araştırdıkları çalışmada 400 mM' a kadar olan tuz uygulamalarının gövde uzunluğu üzerinde önemli etkisinin olmadığını ancak 400 mM'dan sonraki artan tuz konsantrasyonlarının gövde uzunluğunu azalttığını bildirmişlerdir. Tavili ve Biniaz (2009), farklı arpa türlerindeki tuz uygulamalarının 180 mM yoğunluğa kadar bitki boyunu önemli derecede etkilemediğini, Jampeetong ve Brix (2009), *Salvinia natans* türünde tuz

uygulamalarının gövde uzunluğu üzerindeki etkisinin istatistiksel olarak önemsiz olduğunu bildirirken, Tepe ve Aydemir (2017), mercimek ve mısırda tuz uygulamalarının gövde uzunluğunu azalttığını tespit etmişlerdir.

**Çizelge 1.** Tuz stresinin börülce çeşitlerinde bazı fizyolojik özellikler üzerine etkisi

| **Uygulamalar** | | **Özellikler** | | | |
|---|---|---|---|---|---|
| **Tuz Dozları** | **Çeşitler** | **KU (cm)** | **GU (cm)** | **KYA(g)** | **GYA(g)** |
| **T0** | Amazon | 27.00±0.88 bc | 68.66±2.03ab | 6.17±0.05 | 15.34±0.44bc |
| | Karagöz | 28.33±1.15 b | 70.33±5.61a | 10.3±0.48 | 17.49±0.74a |
| **T0 Ortalama** | | 27.66 B | 69.50A | 8.23A | 16.41 A |
| **T1** | Amazon | 28.30±0.66b | 36.00±0.58d | 5.95±0.44 | 12.58±0.39c |
| | Karagöz | 26,62±1.20b | 55.66±2.73b | 5.4±0.38 | 12.97±0.19c |
| **T1 Ortalama** | | 27.51 BC | 45.83B | 5.67B | 12.77 B |
| **T2** | Amazon | 23.53±0.88 cd | 33.61±2.40e | 3.85±0.11 | 10.95±0.34e |
| | Karagöz | 23.67±2.02 cd | 42.33±3.93bcd | 5.14±0.68 | 11.80±0.55d |
| **T2 Ortalama** | | 23.66 C | 38.00C | 4.49B | 11.37 C |
| **T3** | Amazon | 23.33±1.85a | 33.66±1.20e | 4.25±0.12 | 10.81±0.30e |
| | Karagöz | 27.00±1.73c | 32.33±0.88f | 4.67±0.54 | 10.27±0.80ef |
| **T3 Ortalama** | | 25.16 A | 33.00C | 4.46B | 10.54 C |
| **Çeşit Ortalamaları** | Amazon | 25.54 A | 43.00B | 5.05 B | 12.42 |
| | Karagöz | 26.43 B | 50.16A | 6.37 A | 13.13 |
| **VK (%)** | | 8.77 | 10.74 | 13.13 | 6.98 |
| **Tuz (T)** | | * | ** | öd | ** |
| **Çeşit (Ç)** | | öd | ** | * | * |
| **Ç x T** | | öd | * | öd | * |
| **LSD (0.05)** | | 2.07 | 4.33 | 0.84 | 0.765 |

*P<0.05 düzeyinde, ** P<0.01 düzeyinde önemli, öd: Önemli değil, VK (%): Varyasyon katsayısı

Çeşitlerdeki tuz konsantrasyonlarının gelişim üzerine etkisi Kök yaş ağırlığında istatistiksel olarak %5 seviyesinde önemli görülürken, tuz dozları ve ÇxT interaksiyonu istatistiksel olarak önemsiz bulunmuştur (Çizelge 1). Çeşitler ortalaması açısından en ağır kök yaş ağırlığı 6.37g ile Karagöz çeşidinden elde edilirken, en hafif kök yaş ağırlığı ise 5.05g ile Amazon çeşidinden tespit edilmiştir. Tuz konsantrasyonları bakımından ise en yüksek kök yaş ağırlığı 8.23g ile T0 uygulamasından, en düşük kök yaş ağırlığı ise, 4.46g ile T3 tuz uygulamalarından ölçülmüş ve bu uygulamalar farklı grupları oluşturmuştur. Taffouo ve ark., (2010) börülcede artan tuz dozunun çimlenme oranının yanı sıra kök gelişimini de

engellediğine neden olduğu bildirmişlerdir. Osuagwu ve Udogu (2014), farklı tuz konsantrasyonlarının yerfıstığı üzerine etkilerini araştırdıkları bir çalışmada, tuz konsantrasyonlarının kök yaş ağırlığını azalttığını ancak bu azalmanın istatistiksel olarak anlamlı olmadığını tespit ettikleri çalışma sonuçları ile araştırma sonuçlarımız uyum içerisindedir. Ayrıca, farklı çalışmalarda da tuz stresinin kök yaş ağırlığında azalmaya neden olduğu bildirilmiştir (Hernandez ve ark., 1995; Ali Dinar ve ark., 1999; Chartzoulakis ve Klapaki, 2000).

Çizelge 1'de görüldüğü gibi tuz konsantrasyonlarının fidelerdeki gövde yaş ağırlığı gelişimi üzerine etkisi istatistiksel olarak %1 seviyesinde önemli görülürken, çeşit ve ÇxT interaksiyonunun etkisi istatistiksel olarak %5 seviyesinde önemli bulunmuştur. Çeşitler ortalaması açısından incelendiğinde en yüksek gövde yaş ağırlığı 13.13g ile Karagöz çeşidinden elde edilirken, en düşük gövde yaş ağırlığı ise 12.41g ile Amazon çeşidinden tespit edilmiştir. Tuz konsantrasyonları bakımından ise en yüksek gövde yaş ağırlığı (16.41g) T0 uygulamasından elde edilirken, en düşük gövde yaş ağırlığı değeri ise (10.54g) T3 tuz uygulamalarından ölçülmüş ve bu uygulamalar farklı grupları oluşturmuştur. Tuz dozlarının artışına paralel olarak gövde yaş ağırlığının da önemli derecede azaldığı tespit edilmiştir. Wang ve ark. (2019), hindistan cevizinde, tuz konsantrasyonlarının artışına bağlı olarak gövde yaş ağırlığında azalmaların meydana geldiğini bildirdikleri araştırma sonuçları ile bulgularımızla benzerlik göstermektedir. Tuzluluk stresi özellikle kurak ve yarı kurak alanlarda tarımsal üretimde önemli kayıplara yol açan en yaygın abiotik stres faktörlerinden biridir. FAO'ya göre bütün dünyada tuzluluktan etkilenen alan yaklaşık 800 milyon hektar olduğu görülmektedir. Bu yüzden tuzluluk stresine en iyi cevap veren bitki türlerini tespit etmek için tuzluluk toleransının bilinmesi önemlidir (Hernandez, 2019).

Çizelge 2'de görüldüğü gibi, tuz dozlarının kök kuru ağırlığı üzerine etkisi %1 seviyesinde önemli görülürken, çeşitlere etkisi %5 seviyesinde önemli görülmüştür. Bununla beraber ÇxT interaksiyonunun etkisi ise fidelerdeki kök kuru ağırlığı gelişimi üzerine etkisi istatistiksel olarak önemsiz görülmüştür. Çeşitler ortalaması açısından incelendiğinde en ağır kök kuru ağırlığı 0.56g ile Karagöz çeşidinden elde edilirken, en hafif kök kuru ağırlığı ise 0.55g ile Amazon çeşidinden tespit edilmiştir. Tuz konsantrasyonları bakımından ise en ağır kök kuru ağırlığı 0.81g T0 uygulamasından elde edilirken, en hafif kök kuru ağırlık değeri ise, 0.42g ile T2 tuz uygulamalarından ölçülmüş ve bu uygulamalar farklı gruplar oluşturduğu gözlemlenmiştir. Acar ve ark., (2011) bezelyede, farklı tuz konsantrasyonlarının büyüme parametreleri üzerine etkilerini araştırdıkları çalışmada, değişen tuz konsantrasyonlarının kök

kuru ağırlığı üzerine önemli etkide bulunmadığını tespit ettikleri araştırma bulguları, bu çalışmadan elde edilen sonuçlar ile uyumlu iken, farklı çalışmalarda tuz uygulamalarının kök kuru ağırlığında azalmaya neden olduğunu tespit etmişler. Elkoca ve ark. 2003 yılında yaptıkları çalışmada farklı tuz dozlarının fasulyede çimlenme özelliklerine etkilerini inceledikleri çalışmada artan tuz dozlarının hesaplanan değerlerde düşüş meydana getirdiğini tespit etmişlerdir.

Çizelge 2' de görüldüğü gibi, Tuz ve çeşit konsantrasyonlarının yanı sıra ÇxT interaksiyonunun etkisi fidelerdeki gövde kuru ağırlık gelişimi üzerine etkisi istatistiksel olarak %1 seviyesinde önemli görülmüştür. Çeşitler ortalaması açısından incelendiğinde en ağır gövde kuru ağırlığı 1.55g ile Karagöz çeşidinden elde edilirken, en hafif gövde kuru ağırlığı ise 1.39g ile Amazon çeşidinden tespit edilmiştir. Tuz konsantrasyonları bakımından ise en ağır gövde kuru ağırlığı 1.72g T0 uygulamasından elde edilirken, en hafif gövde kuru ağırlık değeri ise, 1.23g ile T3 tuz uygulamalarından ölçülmüş ve bu uygulamalar farklı gruplar oluşturduğu gözlemlenmiştir. Tuz dozlarının artışına paralel olarak gövde kuru ağırlığı da önemli derecede azaldiği tespit edilmiştir. Çalışma bulgularımızla benzer olarak, Tuz stresinin bitkilerde tohumun çimlenmesi (Çavuşoğlu ve Kabar, 2010) ve fide gelişmesini (Ashraf ve ark., 2002), engelleyerek bütün büyüme safhalarını olumsuz etkilediği tespit edilmiştir. Çalışmamızda tuz seviyesi arttıkça bitkinin kök ve gövde gelişiminin olumsuz etkilendiği, aynı zamanda ağırlık miktarında da azalma olduğu belirlenmiştir.

Çizelge 2' de görüldüğü gibi, Tuz konsantrasyonlarının fidelerdeki klorofil oranı üzerine etkisi istatistiksel olarak %5 seviyesinde önemli görülürken, çeşitler ve ÇxT interaksiyonunun etkisi ise klorofil oranı üzerine etkisi istatistiksel olarak önemsiz görülmüştür. Çeşitler ortalaması açısından incelendiğinde klorofil oranı en yüksek 47.78 ile Amazon çeşidinden elde edilirken, en düşük klorofil oranı ise 46.55 ile Amazon çeşidinden tespit edilmiştir. Tuz konsantrasyonları bakımından ise klorofil oranı en yüksek 48.85 T0 uygulamasından elde edilirken, en yüksek klorofil oranı değeri ise43.53 ile T3 tuz uygulamalarından ölçülmüş ve bu uygulamalar farklı gruplar oluşturduğu gözlemlenmiştir. Tuz dozlarının artışına paralel olarak klorofil oranı da önemli derecede azaldiği tespit edilmiştir. Konu ile ilgili yapılan benzer bir çalışmada; Yakıt ve Tuna (2006), tuz stresi altında yetiştirilen mısır bitkisinin metabolik faaliyetlerinin aksadığını ve klorofil aktivasyonunun olumsuz etkilendiğini bildirmişlerdir.

**Çizelge 2.** Tuz stresinin börülce çeşitlerinde bazı fizyolojik ve özellikler üzerine etkisi

| Uygulamalar | | Özellikler | | | |
|---|---|---|---|---|---|
| **Tuz Dozları** | **Çeşitler** | **KKA (g)** | **GKA (g)** | **KO** | **YA** |
| **T0** | Amazon | 0.77±0.06b | 1.53± 0.24bc | 50.87±2.08 | 25.02±0.39 |
| | Karagöz | 0.84 ±0.05a | 1.90±0.05a | 46.83±3.24 | 26.93±1.10 |
| **T0 Ortalama** | | 0.81 A | 1.72 A | 48.85 A | 25.97 A |
| **T1** | Amazon | 0.59 ±0.03b | 1.38 ±0.06c | 48.3±2.00 | 25.66±0.33 |
| | Karagöz | 0.53 ±0.03bc | 1.62 ±0.06ab | 46.57±0.45 | 24.78±1.12 |
| **T1 Ortalama** | | 0.61 B | 1.50 AB | 47.43 AB | 25.22 A |
| **T2** | Amazon | 0.43 ±0.05d | 1.36 ±0.16c | 47.83±1.59 | 24.45±1.75 |
| | Karagöz | 0.41 ±0.04d | 1.55 ±0.08b | 49.9±2.72 | 24.73±2.36 |
| **T2 Ortalama** | | 0.42 C | 1.45 BC | 48.84 A | 24.09 B |
| **T3** | Amazon | 0.43± 0.03bc | 1.31± 0.04c | 44.13±0.55 | 25.12±1.15 |
| | Karagöz | 0.44 ±0.02cd | 1.15 ±0.11d | 42.93±1.04 | 25.15±1.48 |
| **T3** | | 0.48 C | 1.23 C | 43.53 B | 25.13 A |
| **Çeşit Ortalamaları** | Amazon | 0.55A | 1.39A | 47.78 | 25.31 |
| | Karagöz | 0.56B | 1.55B | 46.55 | 25.64 |
| **VK (%)** | | 11.37 | 13.98 | 7.14 | 9.62 |
| **Tuz (T)** | | ** | ** | * | * |
| **Çeşit (Ç)** | | * | ** | öd | öd |
| **Ç x T** | | öd | ** | öd | öd |
| **LSD (0.05)** | | 0.079 | 0.253 | 4.12 | 2.88 |

*P<0.05 düzeyinde, ** P<0.01 düzeyinde önemli, öd: Önemli değil VK (%): Varyasyon katsayısı

Acar ve ark., (2011) bezelyede, farklı tuz konsantrasyonlarının büyüme parametreleri üzerine etkilerini araştırdıkları çalışmada, değişen tuz konsantrasyonlarının kök kuru ağırlığı üzerine önemli etkide bulunmadığını tespit ettikleri araştırma bulguları, bu çalışmadan elde edilen sonuçlar ile uyumlu iken, farklı çalışmalarda tuz uygulamalarının kök kuru ağırlığında azalmaya neden olduğunu tespit etmişler.

Çizelge 2' de görüldüğü gibi, görüldüğü gibi Yaprak alanı üzerine tuz konsantrasyonları %5 seviyesinde önemli bulunurken, çeşit ve T x Ç interaksiyonunun etkisi istatistiksel olarak önemsiz görülmemiştir. Çeşitler ortalaması açısından incelendiğinde en fazla yaprak alanı bakımından 25.64 ile Karagöz çeşidinden elde edilirken, en az yaprak alanı ise 25.31 ile Amazon çeşidinden tespit edilmiştir. Tuz konsantrasyonları bakımından incelendiğinde en fazla yaprak alanı 25.97 T0 uygulamasından elde edilirken, en az yaprak alanı değeri ise, 24.09 ile T2 tuz uygulamalarından ölçülmüş ve bu uygulamalar farklı gruplar oluşturduğu

gözlemlenmiştir. Araştırma sonuçlarımız, tuz stresine maruz kalan bitkilerde (Kara ve ark., 2019), farklı stres şartlarında yetiştirilen kavun bitkisinde kontrole göre bitki boyu ve çapı, yaprak sayısı ve alanında azalmaların olduğuna dair araştırıcı sonuçları ile uyum içerisindedir.

**Sonuç**

Dünya nüfusunun hızlı artışı, sınırlı üretim kaynakları, sosyo-kültürel, ekonomik etmenler, besin dağılımındaki, teknolojideki ve eğitimdeki yetersizlikler ve olumsuz çevre koulları açlığın en önemli nedenleri arasındadır. Verimsiz topraklarda strese sebep olan, kuraklıkla beraber, tuzluluk, radyasyon, kimyasal maddeler, yüksek sıcaklık veya don gibi abiyotik stresler bitkilerin fizyolojik işlevlerinde farklılıklara neden olduğu görülmektedir. Toprakta biriken tuzlar, toprağın fiziksel ve kimyasal özelliklerini bozmakta ve bitki gelişimini olumsuz yönde önemli derecede etkilemektedir. Tuz stresi bitkilerdeki tüm metabolizmayı, büyümeyi ve gelişmeyi olumsuz etkileyerek yetiştirilen bitkinin veriminde azalmalara neden olduğu görülmektedir. Bu durum, toprak çözeltisinin yoğunluğuna bağlı olduğu kadar, bitkinin tuzluluğa olan toleransı ile ilgilidir. Araştırmada, tuz stresi koşullarında yetiştirilen börülce bitkisinin kök uzunluğu cm, gövde uzunluğu cm, gövde yaş ağırlığı g, kök yaş ağırlık g, kök kuru ağırlık g, gövde kuru ağırlık g, klorofil, yaprak alan indeksi cm2 uygulamalarından olumsuz artışlar tespit edilmiştir. Bu çalışmada kullanılan tuz stresi altında incelenen fizyolojik özellikler üzerinde tuz stresin olumsuz etkisini artırıcı etkiye sahip olduğu tespit edilmiştir. Tüm parametrelerde en yüksek büyüme parametresi Kontrol(T0) grubunda olumlu görülürken, klorofil parametresin de ise T1 de olumlu görülmüştür. Karagöz börülce çeşidinin Amazon çeşidine göre tuz stresine kısmen daha dayanıklı olduğu belirlenmiştir.

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# EXAMINING OF THE PRICES RECEIVED BY THE FARMERS AND INPUT PRICES FOR DRY BEAN IN TURKEY

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**Abstract**
Dry bean is the essential source of plant-origin proteins in Turkey; nevertheless, its self-competence presents variability over the years. Dried bean is in the first place with an agricultural production value of 15 904 426 $ in the world (FAO, 2021) and ranks third in the dried legumes group in Turkey after chickpeas and red lentils with a production value of 270 thousand tons (TURKSTAT, 2022). Looking at the cultivated dry beans areas by year (2000-2021), it is noteworthy that there were decreases especially between 2010 and 2019. While 103 381 hectare dry beans area was cultivated in 2010, 88 939 hectare area was cultivated in 2019 in Turkey. This commodity, which is relatively more profitable than other crop products in most regions where it is grown, has a special importance for farmers. The most important reasons for the variability in dry beans cultivated areas are the prices received by the farmers and the prices of the inputs used in cultivation. Especially in regions where economic life is based on agriculture, monitoring the changes in crop production and making price analysis are considered important for future production forecasts because, it is a determinant of the farmer welfare. Although dry beans remain in the back compared to the agricultural products in which Turkey has an advantage in the foreign market, 149 771 tons of dry beans were exported in 2021. Looking at the domestic consumption in Turkey, it seems that domestic consumption of dry beans has slowed down from 2020 to 2021. While total domestic consumption was 281 528 tonnes in 2020, it was 264 859 tonnes in 2021. In this paper, dry bean cultivation and consumption, prices received by the farmers and input prices were examined between 2010 and 2021. Secondary data was used and the results were interpreted with parity ratios.
**Keywords:** Dry bean, prices received by farmers, input prices, parity rates, Turkey

## Introduction

Edible dry pulses have been cultivated for centuries around the world and they play an important role in human diets. These dry pulses; beans, chickpeas, lentils, broad beans, peas and the like contain high protein, high vitamins-minerals, low fat, compared to other crop products. In human diet 22% of plant proteins and 7% of carbohydrates are provided while in animal feeding 38% of proteins and 5% of carbohydrates by edible legumes (Kün et al., 2005). Dry legumes come after grains in terms of cultivation area and production amount in the world. The production has spread throughout the world, such as Latin America, Africa, the Middle East, Asia, Europe, the USA and Canada and the most produced product among legumes is dry bean. While the world's dry bean cultivation areas were 23 million hectares between 2010 and 2013, it has reached approximately 36 million hectares in 2021 (FAO, 2021). When the dry bean production is considered by countries as percentage India comes first with %21.1, Brazil and Myanmar come second and third with %10.5 and %9.1 respectively. Global dry bean production has reached 27 million ton in 2021 (Agricultural Policy and Development Institute – APDI, 2023). It is also included in the traditional culinary cultures of many countries in Latin America, whereas it is seen as the basic food for the survival of the population in Africa, and is mainly produced for export in Asia. Because, dry bean is less important in Asian cuisine than other legumes.

Dry bean takes part in the traditional Turkish culinary culture; also have an important place economically in terms of providing livelihood for farmers in rural areas. It ranks after chickpeas and red lentils according to the production amount in total dry pulses production in Turkey. According to the data, 270 000-ton dry bean has been produced in 2022 and the same amount in 2023 (Turkish Statistical Institute-TURKSTAT, 2023). While the production amount of red lentils and chickpeas increased by 75.4% and 22.1% in 2022 respectively, compared to 2021, there has been a decrease of 11.5% in dry bean in 2022 (Ministry of Agriculture and Forestry, 2022). On the other hand, dry bean cultivation areas increased by 20% in the last five years and has reached 107 796 hectares and the production amount increased by 28% in the last five years. The provinces with the highest share in dry bean production in Turkey are Niğde (21.3%), Nevşehir (17.4) and Konya (12.3). It is also an important source of protein in human diet and it has economic value in terms of consumption. Therefore, it is preferred because of cheapness comparing to red meat which is another important source of protein and so it is one of the alternative protein sources (Çiftçi et al., 2023). According to Turkish Statistical Institute (TURKSTAT, 2023), the average price of the

dry bean was 18.06 TL/kg in 2022 and the increase in prices continues. Between 2010 and 2021 in Turkey, an average of approximately 255 thousand tons of dry beans was consumed and the consumption amount is 3.2 kg per person.

Considering the share of countries in Turkey's dry bean exports has been made in 2022 and 2023 period, Iraq (73.3%) is in the first place that dry beans are exported. This has been followed by Lebanon (%3, 3) and Syria (%3,1) and approximately, 150 000 ton dry bean has been exported in total (Agricultural Policy and Development Institute-APDI, 2023). This data shows that Turkey has a potential position in dry bean exports so the increase in dry bean production supports not only domestic consumption also exports value. Investigating the change in the cultivated areas of dry beans, which is consumed as the main protein source especially in underdeveloped and developing countries, is important in terms of increasing global demand, domestic supply-demand balance and sustainability of the production. For this reason, determining the dry bean cultivation and consumption, prices received by the farmers and input prices are paramount. In this study, the fluctuations that occurred over the years were examined by taking into account the changes in the cultivating and consumption of dry beans, farmer's current and real prices, and input prices separately. For this purpose, the last eleven-year data (2010-2021) were used and also the results were interpreted with parity ratios.

**Materials and Methods**

The main material of the study consists of the data on dry bean cultivating area, production amount, consumption, fertilizer prices, diesel fuel prices, agricultural labour wages, prices received by the farmers in this study are from the United Nations Food and Agriculture Organization (FAO); loss and consumption amounts, and prices received by farmers (producer prices) and consumer prices Turkish Statistical Institute (TURKSTAT); Agricultural Policy and Development Institute (APDI) and Ministry of Agriculture and Forestry database.

The data obtained in this study were interpreted as proportional as well as numerical expressions. A variable-based (chain) index was used to understand how much dry bean cultivating areas and production amount increased or decreased compared to the previous year. The changes in dry bean prices and input prices were examined in current and real terms.

Formula 1 was used to convert nominal dry bean prices received by the farmers into real prices (Norwood&Lusk, 2008):

$$Real\ Price = \frac{Nominal\ Price}{Producer\ Price\ Index\ of\ Dry\ Bean} X\ (100) \qquad (1)$$

Producer price index data for dry beans were obtained from the price index time series given specifically for dry beans within the Agricultural Products Producer Price Index of the Turkish Statistical Institute (TURKSTAT, 2023a).

Parity price method was also used to reveal the relationship between dry bean prices and input prices. It is the price that allows the producer / a person who sells a unit of his commodity to purchase a unit of other commodities and services according to a certain base year (Yavuz, 1996). The relationship between dry bean prices received by farmers and input prices was compared with parity rates. Index data was used for this purpose. Formula 2 was used when calculating parity rates (Shepherd, 1961; Afzal, 1977):

$$Parity\ Ratio = \frac{Index\ of\ Prices\ received\ by\ farmers}{Index\ of\ Prices\ paid\ by\ farmers} X\ (100) \qquad (2)$$

Data on input prices were obtained from the Agricultural input price index published by the Turkish Statistical Institute (TURKSTAT, 2023b). Input prices were examined within the scope of seeds and planting materials, fuel, fertilizer and soil improvers and agricultural pesticides, as they are the basic inputs used in dry bean cultivation.

## Findings and Discussion

### Dry bean production, consumption and external trade

The change in dry bean production in Turkey during the 2010-2022 period is given as area cultivated, area harvested, production amount and yield in Table 1. While the dry bean cultivated areas were approximately 1 million decare in 2010, it is seen to be approximately 970 thousand decare in 2022. It is seen that the dry bean cultivation areas showed a decreasing situation in the examined period. However, an approximately 4% increase in dry bean cultivating areas was observed in 2020 and 2021. Due to the COVID-19 epidemic that affected the whole world, many people cultivated their fields in rural areas. Apparently, this has caused the cultivation areas to increase in related years. It is also seen that there was an increase in the amount of production in this period. While the amount of dry beans, which was an average of 218 thousand tons between 2010 and 2019, increased by approximately 36% in 2021, cultivated area also increased in the same period.

**Table 1.** Change in Türkiye cultivated area, production amount and yield (2010-2022)

| Years | Cultivated Area (Decare) | Harvested Area (Decare) | Chained Index | Production Amount (tonne) | Chained Index | Yield (Kg/Decare) |
|---|---|---|---|---|---|---|
| 2010 | 1033811 | 1032549 | 100 | 212758 | 100 | 206 |
| 2011 | 946254 | 944980 | 92 | 200673 | 94 | 212 |
| 2012 | 931740 | 930904 | 99 | 200000 | 99 | 215 |
| 2013 | 847630 | 846912 | 91 | 195000 | 97 | 230 |
| 2014 | 911103 | 904496 | 106 | 215000 | 110 | 238 |
| 2015 | 935840 | 935433 | 103 | 235000 | 109 | 251 |
| 2016 | 898197 | 885476 | 95 | 235000 | 100 | 265 |
| 2017 | 897221 | 896778 | 101 | 239000 | 101 | 267 |
| 2018 | 848045 | 847863 | 95 | 220000 | 92 | 259 |
| 2019 | 889385 | 888986 | 104 | 225000 | 102 | 253 |
| 2020 | 1029857 | 1029635 | 115 | 279518 | 124 | 271 |
| 2021 | 1077964 | 1077230 | 104 | 305000 | 109 | 283 |
| 2022 | 970520 | 9704490 | 90 | 270000 | 88 | 278 |

Source: TURKSTAT, (2023); calculated by the author

Dry beans, which are the most cultivated and produced after chickpeas and red lentils in the dry pulses group, are mainly traded for the domestic market. The majority of production is consumed in the domestic market. The use of dry beans in Turkey in 2019 was about 293 thousand tons, 94% of which was consumed and 3.3% was used as seed (TURKSTAT, 2023). The average conversion rate of dry beans produced in the examined period to export is %12. Although Turkey's dry bean imports fluctuate over the years, nearly 118 thousand tons of dry beans were imported in 2018, which is the highest value in 12 years. Table 2 also presents dry bean consumption and foreign trade data by year. As it is seen in Table 2, while there was a 6% decrease in human consumption and an 8% decrease in per capita consumption compared to the previous year in 2021, there was a 50% increase in exports. While dry bean production increased by 30% in 2021 compared to 2010, there was an only 9% increase in losses. It was understood that the average rate of production losses in total losses was 37 in twelve years.

**Table 2.** Türkiye dry beans consumption, loss and external trade (2010-2022)

| Years | Human Consumption (tonne) | Domestic Use (tonne) | Human Consumption per capita (kg year$^{-1}$) | Losses (tonne) | Harvest Losses (tonne) | Harvest Losses in Total Losses (%) | Import (tonne) | Export (tonne) | Conversion Rate of Production to Export (%) |
|---|---|---|---|---|---|---|---|---|---|
| 2010 | 240252 | 257016 | 3,3 | 6425 | 2340 | 36 | 48557 | 1959 | 0,9 |
| 2011 | 222444 | 237853 | 3,0 | 5946 | 2207 | 37 | 40708 | 1321 | 0,7 |
| 2012 | 222554 | 237817 | 2,9 | 5945 | 2200 | 37 | 41408 | 1391 | 0,7 |
| 2013 | 231019 | 245636 | 3,0 | 6141 | 2145 | 35 | 57293 | 4512 | 2,3 |
| 2014 | 231401 | 246679 | 3,0 | 6167 | 2365 | 38 | 44600 | 10556 | 4,9 |
| 2015 | 265041 | 281435 | 3,4 | 7036 | 2585 | 37 | 52918 | 3898 | 1,7 |
| 2016 | 267926 | 284008 | 3,4 | 7100 | 2585 | 36 | 56643 | 5050 | 2,1 |
| 2017 | 269668 | 285785 | 3,3 | 7145 | 2629 | 37 | 66573 | 17159 | 7,2 |
| 2018 | 284981 | 301856 | 3,5 | 7546 | 2420 | 32 | 117921 | 103129 | 46,9 |
| 2019 | 275794 | 292900 | 3,3 | 7323 | 2475 | 33 | 28232 | 10064 | 4,5 |
| 2020 | 281528 | 300365 | 3,4 | 7509 | 3075 | 41 | 75088 | 73934 | 26,5 |
| 2021 | 264859 | 282706 | 3,1 | 7068 | 3355 | 47 | 87886 | 149771 | 49,1 |

Source: TURKSTAT, (2023)

## Dry beans' nominal and real prices

Table 3 presents the nominal and real prices received by the dry bean farmers. As it is seen, the nominal prices of dry beans are constantly increasing between 2009 and 2022. However, for making a meaningful price comparison over the years, the dry bean prices received by the farmers were converted into real prices. In terms of real prices calculated based on 2010, the prices of dry beans received by producers are increasing except for the years 2011, 2014 and 2015. This upward trend in real prices is even higher, especially after 2016. Based on 2010, dry bean prices in real price terms increased between 44.44% and 71.25% in 2016 and 2022 respectively.

**Table 3.** Nominal and real prices of the dry bean by years (TURKSTAT,2023)

| Years | Nominal Price (TL/kg) | Index of prices Received (2010=100) | Real Price (TL/kg) | Fixed base index (2010=100) | Chain Indices |
|---|---|---|---|---|---|
| 2009 | 2,49 | 103,39 | 2,41 | 100,35 | 100,00 |
| 2010 | 2,40 | 100,00 | 2,40 | 100,00 | 99,65 |
| 2011 | 2,51 | 116,24 | 2,16 | 89,97 | 89,97 |
| 2012 | 2,91 | 94,74 | 3,07 | 127,99 | 142,26 |
| 2013 | 3,28 | 111,39 | 2,94 | 122,69 | 95,86 |
| 2014 | 3,69 | 171,41 | 2,15 | 89,70 | 73,11 |
| 2015 | 3,39 | 167,45 | 2,02 | 84,35 | 94,04 |
| 2016 | 3,44 | 99,23 | 3,47 | 144,44 | 171,23 |
| 2017 | 3,98 | 110,49 | 3,60 | 150,08 | 103,91 |
| 2018 | 4,80 | 124,94 | 3,84 | 160,08 | 106,66 |
| 2019 | 6,42 | 160,65 | 4,00 | 166,51 | 104,01 |
| 2020 | 8,16 | 207,96 | 3,92 | 163,50 | 98,19 |
| 2021 | 8,89 | 229,78 | 3,87 | 161,21 | 98,60 |
| 2022 | 18,06 | 439,42 | 4,11 | 171,25 | 106,23 |

**Parity ratio between dry bean and agricultural input prices**

The parity ratio, defined as the ratio between the prices farmers receive and the prices they pay, is commonly used to measure the economic situation of agriculture. If the parity ratio is under 100, it is considered as an indication that the prices the farmer receives are too low compared to what the farmer pays (Shepherd, 1961). As stated before, the relationship between dry bean prices received by farmers and input prices was compared with parity rates. For this purpose, analyses were carried out within the scope of seed and planting material, fuel, fertilizer and soil improvers and agricultural pesticides, as they are basic inputs in the dry beans cultivation.

The parity rates between dry bean prices received by the farmers and seed - planting material prices calculated for the period between 2016 and 2023 are given in Table 4. According to the findings, it is seen that parity rates remained above 100 in other years except 2016 and 2017. In other words, the prices received by the dry bean farmers were mostly above the prices of seeds and planting materials. The prices of dried beans received by the farmers were between 0.2% and 85.3% higher than the prices of seeds and planting materials.

**Table 4.** Parity ratio between dry bean and seeds and planting material prices

| Years | Index of Prices Received (2015=100) | Index of Prices Paid (2015=100) | Parity Ratio (2015=100) | Percentage Change in the Average Level of Parity Prices |
|---|---|---|---|---|
| 2016 | 99,92 | 104,66 | 95,5 | -4,5 |
| 2017 | 111,26 | 113,24 | 98,3 | -1,7 |
| 2018 | 125,80 | 125,55 | 100,2 | +0,2 |
| 2019 | 161,76 | 149,92 | 107,9 | +7,9 |
| 2020 | 209,40 | 159,59 | 131,2 | +31,2 |
| 2021 | 231,37 | 174,68 | 132,5 | +32,5 |
| 2022 | 442,46 | 277,52 | 159,4 | +59,4 |
| 2023* | 772,65 | 416,96 | 185,3 | +85,3 |

*2023: Covers the period between January and August.

The parity rates between the dry bean prices received by the farmers and the diesel prices calculated for the period between 2016 and 2023 are presented in Table 5. According to the findings in Table 5, it is understood that the parity ratios between the dry bean prices received by farmers and the prices of diesel fuel, which is an important input in dry beans production, generally remain below 100. In other words, the prices received by the dry bean farmers were mostly below diesel prices. The prices of dry beans received by the farmers were between

0.1% and 24.3% lower than diesel prices. The parity ratio between dry bean prices received by the farmers and the diesel prices is at its worst in 2022 (-24.3%). On the other hand, the years when parity rates are in favour of farmers are 2020 (+33%), 2021 (+18.8%) and 2023 (+21.5%).

**Table 5.** Parity ratio between the dry bean and the diesel prices

| Years | Index of Prices Received (2015=100) | Index of Prices Paid (2015=100) | Parity Ratio (2015=100) | Percentage Change in the Average Level of Parity Prices |
|---|---|---|---|---|
| 2016 | 99,92 | 99,99 | 99,9 | -0,1 |
| 2017 | 111,26 | 121,66 | 91,5 | -8,5 |
| 2018 | 125,80 | 150,15 | 83,8 | -16,2 |
| 2019 | 161,76 | 166,84 | 97,0 | -3,0 |
| 2020 | 209,40 | 157,45 | 133,0 | +33,0 |
| 2021 | 231,37 | 194,77 | 118,8 | +18,8 |
| 2022 | 442,46 | 584,76 | 75,7 | -24,3 |
| 2023 | 772,65 | 635,75 | 121,5 | +21,5 |

*2023: Covers the period between January and August.

The parity rates between the dry bean prices received by the farmers and the fertilizer and the soil improver prices calculated for the period between 2016 and 2023 are shown in Table 6. According to the findings in Table 6, the parity rates between the prices of the dry beans received by the farmers between 2016 and 2020 and the prices of the fertilizers and the soil improvers remained above 100. But, it was found that the parity rates remained below 100 between 2021 and 2023. Although the parity rates between the prices of dry beans received by farmers and the prices of fertilizers and soil improvers followed a trend in favour of farmers until 2021, it is seen that this trend has changed against the farmers in the last three years (2021-2023). In the last three years, dry bean prices received by farmers have remained between 11% and 43% lower than the prices of fertilizers and soil improvers. The year in which the parity ratio was most negative was 2022 (-43.9%).

**Table 6.** Parity ratio between dry bean and fertilisers-soil improvers prices

| Years | Index of Prices Received (2015=100) | Index of Prices Paid (2015=100) | Parity Ratio (2015=100) | Percentage Change in the Average Level of Parity Prices |
|---|---|---|---|---|
| 2016 | 99,92 | 91,68 | 109,0 | +9,0 |
| 2017 | 111,26 | 92,55 | 120,2 | +20,2 |
| 2018 | 125,80 | 121,85 | 103,2 | +3,2 |
| 2019 | 161,76 | 154,72 | 104,6 | +4,6 |
| 2020 | 209,40 | 160,68 | 130,3 | +30,3 |
| 2021 | 231,37 | 272,39 | 84,9 | -15,1 |
| 2022 | 442,46 | 788,75 | 56,1 | -43,9 |
| 2023 | 772,65 | 868,33 | 89,0 | -11,0 |

*2023: Covers the period between January and August.

The parity rates between the dry bean prices received by the farmers and the agricultural pesticide prices calculated for the period between 2016 and 2023 are shown in Table 7. It is seen that the parity rates remained above 100 in the other years except 2016, 2017 and 2018. Apparently, the prices received by the dry bean farmers were mainly above the prices of the agricultural pesticides. Between 2019 and 2023, the prices of the dry beans were between 11.6% and 88.4% higher than the prices of the agricultural pesticides. While the parity ratio was the most negative in 2016 (-9.1%), the most positive year was 2023 (+88.4%).

**Table 7.** Parity ratio between dry bean and plant protection products-pesticides prices

| Years | Index of Prices Received (2015=100) | Index of Prices Paid (2015=100) | Parity Ratio (2015=100) | Percentage Change in the Average Level of Parity Prices |
|---|---|---|---|---|
| 2016 | 99,92 | 109,89 | 90,9 | -9,1 |
| 2017 | 111,26 | 114,17 | 97,4 | -2,6 |
| 2018 | 125,80 | 130,51 | 96,4 | -3,6 |
| 2019 | 161,76 | 144,90 | 111,6 | +11,6 |
| 2020 | 209,40 | 144,83 | 144,6 | +44,6 |
| 2021 | 231,37 | 164,71 | 140,5 | +40,5 |
| 2022 | 442,46 | 320,31 | 138,1 | +38,1 |
| 2023 | 772,65 | 410,13 | 188,4 | +88,4 |

*2023: Covers the period between January and August.

## Conclusion and Recommendations

The findings of this study reveal that the parity rates between the dry bean prices received by the farmers and the input prices vary according to input subgroups. Although the parity rates between the prices of seed-planting material and agricultural pesticides and the prices of dry beans follow a trend in favour of the farmers, the opposite result was observed in terms of the

prices of diesel fuel, the fertilizer and the soil improvers. According to this result, it can be said that the prices received by the farmers producing the dry beans are generally very low compared to what they pay for the diesel fuel, the fertilizer and soil improvers.

The fact that the dry bean prices are in an increasing trend in real price terms is seen as a positive development. As a matter of fact, this situation has positively reflected on the dry bean production areas and production amount in Turkey. According to the data of the Turkish Statistical Institute, while the dry bean cultivation area was 103381 hectares in 2010, this area increased by 4.27% to 107797 hectares in 2021. While the production amount of dry beans was 212758 tons in 2010, this amount increased by 43.36% and reached 305000 tons in 2021 (TURKSTAT, 2023c). It is important that the positive trend in dry bean real prices is also seen in the parity rates between the dry bean prices and the input prices. This situation should be addressed especially for the prices of the diesel fuel and the fertilizers-soil improvers. In this context, it is very important to increase government supports for the diesel fuel, the fertilizer and the soil improvers in order to encourage the dry beans farmers to increase their cultivation. So that dry bean production in Turkey ranks third among dry legumes after chickpeas and lentils (Ministry of Agriculture and Forestry, 2022) makes support policies specific to this product more important.

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# TARIMSAL ÜRETİMİN SÜRDÜRÜLEBİLİRLİĞİ İÇİN ALTERNATİF BİR YÖNTEM OLARAK TOPRAKSIZ TARIM

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**Özet**
Sürdürülebilir enerji kaynakları ve sistemleri, yaşanabilir ve temiz bir yaşam için bir ihtiyaçtır. Küresel ısınmanın ülkemizi büyük ölçüde etkilemesi sonucunda artan nüfusa oranla talep edilen su miktarının arzı geçmesi ve bilinçsiz tarım uygulamalarıyla kullanılabilir toprak alanının azalması; tarım sektöründe yeni tarımsal üretim yollarının aranmasına neden olmuştur. Birim alandan daha çok ürün eldesi, yüksek oranda su tasarrufunun sağlanması ve iş gücünün az olması topraksız tarımı popüler hale getirmiştir. İklim değişikliğinin de en büyük etkilerinden biri olan kuraklık, ülkemizde her geçen gün artmaktadır. Günümüzde en çok su kullanımı tarım sektöründedir ve %76 seviyelerindedir. Bu çalışmada iklim değişikliğinin olumsuz etkilerine karşı alternatif olarak tercih edilen topraksız tarım uygulamalarının Sivas ilindeki durumu değerlendirilmiştir.
**Anahtar Kelimeler:** Sivas, Topraksız Tarım, İklim Değişikliği, Sürdürülebilirlik

# SOILLESS FARMING AS AN ALTERNATIVE METHOD FOR THE SUSTAINABILITY OF AGRICULTURAL PRODUCTION

**Abstract**
Sustainable energy sources and systems are a need for a livable and clean life. As a result of global warming affecting our country greatly, the amount of water demanded exceeds the supply compared to the increasing population and the usable land area decreases due to unconscious agricultural practices; It has led to the search for new agricultural production methods in the agricultural sector. Obtaining more product per unit area, providing high water savings and less labor force have made soilless agriculture popular. Drought, which is one of the biggest effects of climate change, is increasing day by day in our country. Today, the highest water use is in the agricultural sector and is around 76%. In this study, the situation of soilless agricultural practices, which are preferred as an alternative against the negative effects of climate change, in Sivas province was evaluated.
**Keywords:** Sivas, Soilless Agriculture, Climate Change, Sustainability

## GİRİŞ

Dünyada ve Türkiye'de nüfusun her geçen gün artmasıyla birlikte, doğal kaynaklara ve özellikle tarımsal ürünlere olan gereksinim giderek artmaktadır (Taşlıgil, 2010). 2050 yılına kadar küresel gıda talebinin %25-70 oranında artacağı ve dolayısıyla daha fazla gıda üretimine ihtiyaç duyulacağı tahmin edilmektedir (Hunter ve ark., 2017). İklim değişikliği, nüfusun artması, ekonomik olarak büyüme ile ekilebilir tarım alanları arasında yakın bir ilişki vardır ve bu durum, gelecekteki su ve enerji alanında endişeler doğurmaktadır (Parolari ve ark., 2015; Taghizadeh-Hesary ve ark., 2019). Ülkemiz açısından sürdürülebilir tarım kavramını etkileyen bazı önemli hususlar: erozyon, fazla girdi kullanımı, çevre kirliliği, sulama, sanayileşme, kentleşme ve turizmin etkili olduğu, mera ve çayırların bozulması ve giderek azalmasıdır. Ülkemiz topraklarının yaklaşık %80'ninde tarımın sürdürülebilirliğini etkileyecek boyutta orta şiddetli ve çok şiddetli erozyon görülmektedir (Günaydın, 2005). Ülkemizin sahip olduğu toplam 78 milyon hektar alanın %36'lık (27 575 000 ha) kısmı tarım alanıdır. Bu alanın %68'lik kısmında tarla bitkileri, %13'lük kısmında bahçe bitkileri üretimi yapılırken, %19'luk kısım nadasa bırakılmaktadır (Sevgican ve ark., 2000). Tarımsal üretimde, birim alandan daha fazla verim almak amacıyla küçük alanlarda etkili bir şekilde üretim yapılmasına olanak sağlayan örtü altı yetiştiriciliği, ülkemizde en önemli faaliyetlerden bir tanesidir (Demirkaya ve Gerçek, 2013). Türkiye'de topraksız tarım üretimine ilk olarak Akdeniz kıyılarını içine alan bölgede başlanmıştır. Sonrasında bu faaliyetler jeotermal enerji kaynaklarının yer aldığı kesimlere doğru yayılış göstermiştir. Antalya'nın yanı sıra İzmir, Manisa, Mersin, Yalova ve Afyonkarahisar illeri hidroponik sistemler ile kurulan seraların yoğunlaştığı bölgelerdir (Talaz ve Nas, 2019).

Türkiye'de 2019 yılında 31 milyon ton sebze üretilmiştir. Bu üretimin 23,2 milyon tonu açıkta 7,8 milyon tonu örtü altında üretilmiştir. 2019 yılında toplam örtü altı üretim alanımız 790 bin dekara ulaşmıştır. Ülkemizde son 10 yılda ortalama örtü altı üretim büyüklüğü 2 dekar seviyesinden 4 dekara yükselmiştir. Ülkemizde jeotermal enerji kaynakları potansiyel açısından; Avrupa'da 1'inci, Dünyada 7'inci sıradadır. Ülkemizde, jeotermal enerji ile ısıtılan sera varlığı 4.344 dekardır. Ülkemiz modern sera üretiminde 13 bin dekar alanda üretim yapmaktadır. Bu seralarda topraksız tarım metodu ile ihracata yönelik üretim yapılmaktadır (Anonim, 2019a).

## TOPRAKSIZ TARIM

Hidroponik tarım, topraksız bir ortamda bitki yetiştirmekte kullanılan bir yöntemdir. Bitkiler, ihtiyaç duyduğu besin elementlerini toprak yerine bu mineralleri içeren özel besin solüsyonlarından karşılamaktadır. Bu nedenle, bitkiler toprak ortamında yaptıkları gibi besin maddelerini bulmaya çalışmak yerine, besin elementlerini kolay bir şekilde doğrudan bu solüsyondan almaktadır. Topraksız tarımda, bitkileri ve bitkilerin kök sistemlerini desteklemek için genellikle kum, turba, vermikülit, perlit, hindistan cevizi, kaya yünü veya genleştirilmiş kil agregası gibi yetiştirme ortamları kullanılmaktadır. Ancak; yetiştirme ortamının kendisi bir besin kaynağı olarak kullanılmamaktadır (Anonim, 2020b).

## TOPRAKSIZ TARIM TEKNİKLERİ

Yaygın olarak kullanılan iki farklı topraksız tarım yöntemi vardır;

### 1. Katı Ortam Kültürü

Topraksız tarım yöntemleri arasında en yaygın kullanılan üretim şeklidir. Bitki yetiştirme ortamı olarak saksı, hazır blok, yatak, paket ve torba kullanılmaktadır. Yetiştirilen bitkinin ihtiyacı olan besin maddeleri çözelti olarak verilmektedir. Katı ortam kültürü 3 farklı yöntemle yapılmaktadır (Anonim, 2022e).

**1.1. Hazır blok kültürü**: Yetiştirme ortamı olarak genellikle kaya yünü kullanılır. 2-10 metre uzunluk, 2-10 cm genişlik ve 2-7 cm kalınlığa sahip kaya yünü blokları arasına açılan çukurlara yerleştirilen bitkilere damla sulama yöntemi ile ihtiyaç duydukları besin elementleri verilir (Anonim, 2022e).

**1.2. Yatak kültürü:** Öncelikle bitkinin çeşidine uygun kanal kültürü hazırlanır. Kullanılan kanalların derinliği 15-20 cm, eni 30-120 cm eğimi %1-1,5 ölçülerinde uzunluğu ise sera alanı boyunca olmaktadır. Kanal genişliğine göre tek sıra ya da çift sıra halinde bitki dikimi yapılmaktadır. Kanal kültürü sisteminde kanallar yatay veya dikey olarak konumlandırılabilmektedir. Bu yöntemde yataklar serada açılan oyukların plastik ile kaplanması veya beton, tahta, metal kontrüksiyon yapı üzerine yerleştirilen materyaller kullanılarak yapılmaktadır. Daha sonra bu yataklar yetiştirme ortamının dış ortamla temasını önlemek amacı ile su geçirmez malzeme ile kaplanmaktadır. Toprağın yerine çakıl, Hindistan cevizi tozu, kum, perlit, talaş, torf vb. malzemeler yetiştirme ortamı amacıyla kullanılmaktadır. Bitkiler burada bulunan katı ortam ile su ve gübre verilerek yetiştirilmektedir. Uygulama sonrası çıkan atık su, yapının eğimi sayesinde kolaylıkla

uzaklaşmaktadır. Besin çözeltisinin fazlası ise yatağın alt kısmında bulunan deliklerden boşalmaktadır. Boyuna büyüyen domates gibi sarıcılı bitkilerin bu sistemde değerlendirilmesi mümkündür (Çetinkaya, 2022).

**2. Su Kültürü (Aeroponik, Durgun Su Kültürü, Akan Su Kültürü ve Aquaponik)**

Topraksız tarım tekniklerinde üretim doğrudan besin çözeltisi içinde yapılıyorsa su kültürü, besin solüsyonu ile sulama yapılan katı ortamlarda yapılıyorsa katı ortam kültürü olarak isimlendirilmektedir. Su kültüründe bitkiler, doğrudan besin çözeltisi içerisinde yetiştirilmektedir. Su kültüründe 4 farklı yöntem bulunmaktadır (Anonim, 2022e):

**2.1. Aeroponik Sistem:** Bu teknikte bitki köklerinin nemli kalmasına dikkat edilmelidir. Hidroponik yönteme göre daha az su ve gübre kullanılır. Yetiştirme ortamında kökler oksijen ile daha fazla temas ettiğinden bitki gelişimi daha hızlı gerçekleşir (Anonim, 2022e).

**2.2. Durgun Su Kültürü:** Bu yöntem en eski topraksız tarımda bitki yetiştirme tekniğidir. Bitki besleme çalışmalarında uygulanan bir yöntemdir. Köpük veya benzeri malzemelere tutturulan bitkiler durgun su birikintisi üzerine bırakılır ve bitki kökleri ihtiyaç duydukları besin maddelerini su içerisinde kökleri vasıtasıyla alır (Anonim, 2022e).

**2.3. Akan Su Kültürü:** Yatay boru kanal üzerine belirli aralıklarla yerleştirilen bitki köklerinin akan besin çözeltisi ile buluşturulduğu yetiştiricilik sistemidir. Tank ya da su deposu içerisinde bulunan çözeltinin belirli aralılarla pompalanarak sistem içerisinde bulunan çözeltinin belirli aralıklarla pompalanarak sistem içerisinde devir daim etmesi sağlanır ve su, besin miktarları takip edilerek azaldığında takviye yapılır (Anonim, 2022e).

**2.4. Akuaponik:** Akuaponik sistem çok yaygın olarak kullanılan bir sistem değildir. Bu sistemde bitki besleme su içerisinde yapılır. Su havuzunda yetiştirilen balıkların üretmiş oldukları nitrojen açısından zengin atıklar bitkilerin yetiştirildiği ortama pompalanır. Sistemde bitki kendini beslediği gibi suyu da temizlemiş olur. Akuaponik sistemin diğer yöntemlerden farkı sürdürebilir kaynaklardan daha az su harcanarak yapılmasıdır (Anonim, 2022e).

**Topraksız Tarımın Avantajları:**

1- Enerji ve işgücü tasarrufu sağlanmaktadır.

2- Toprağın dezenfeksiyon ihtiyacını ortadan kaldırarak toprağın kirlenmesinin önüne geçilmektedir.

3- Topraklı tarıma göre alandan tasarruf sağlanmakta ve birim alanda daha fazla ürün üretilmektedir.

4- Kontrollü yetiştiricilik olanağı sağlanmakta ve steril edilen substratlar tekrar kullanılmaktadır.

5- Bitki köklerinin daha iyi havalanma imkânı sağlayarak bitkilerin hastalılarla daha az karşılaşmasını sağlamaktadır.

6- Yetiştirilen ürünler ve meyve kalitesi daha iyi olmaktadır.

7- Yetiştirilen ürünlerin yıl boyu üretimi mümkün olmaktadır. Yetiştiriciliğin kontrol edilmesinden dolayı erkenci ürünün piyasaya sunulma imkânı sağlanmaktadır.

8- Topraklı tarıma göre alan ve gübre tasarrufu sağlanmaktadır.

**Topraksız Tarımın Dezavantajları:**

1- Kurulum maliyeti diğer yetiştiricilik sistemlerine göre daha yüksek olmaktadır.

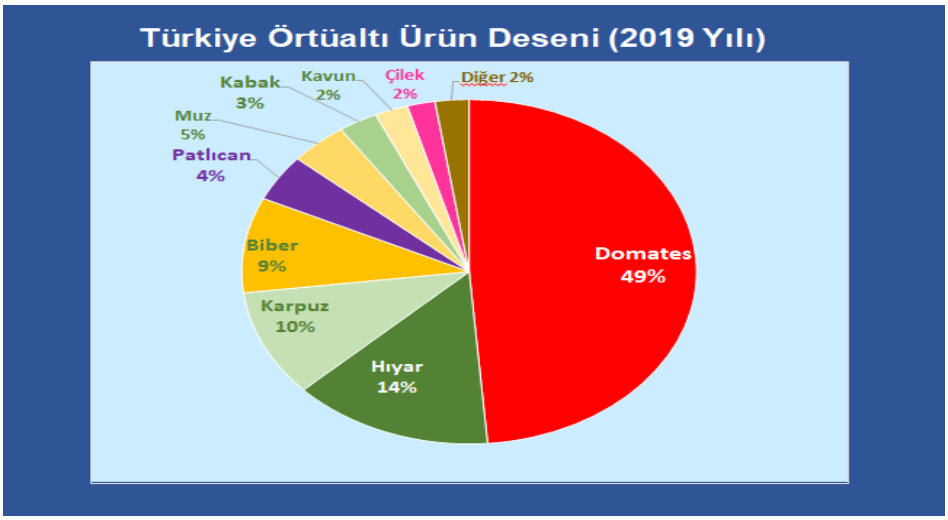
2- Topraksız tarımda kullanılan teknolojilerin yeni bilgiler gerektirmektedir.

3- Topraksız tarım yetiştiriciliğini bilenler az olmaktadır.

4- Sistemin sürekli olarak takip edilmesi gerekmektedir.

5- Enerji kullanım maliyeti (jeotermal enerjinin olmadığı yerlerde) yüksek olmaktadır.

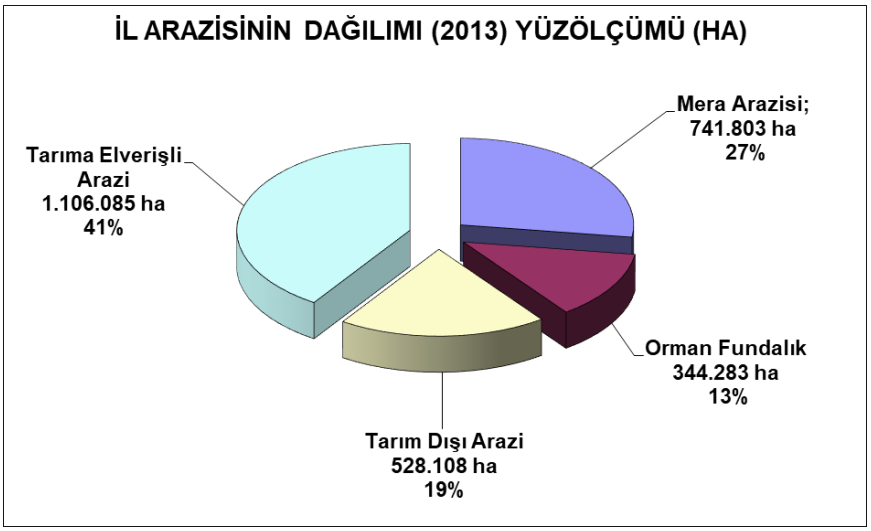
6- Bazı ürünlerin (yumru bitkiler vb) yetiştirilmesi topraksız tarıma uygun olmamaktadır (Anonim, 2021c).




**Şekil 1.** Türkiye Örtü Altı Yetiştiriciliğinde (topraklı ve topraksız) Üretimi Yapılan Bitkiler (Tarım ve Orman Bakanlığı, 2019)

## SİVAS İLİNİN COĞRAFİ YAPISI VE TARIMSAL ÜRETİM DURUMU

Sivas ili geniş tarımsal arazi varlığı ve gerekse mikroklima gösteren tarımsal havza varlığına bağlı olarak zengin bir tarımsal ürün çeşitliliği sunan tarımsal alanları ile önemli bir bitkisel üretim merkezidir. Sivas ilinde tarımsal üretim bakımından en önemli gelir kaynağı olarak ilk sırada tarla bitkileri olan tahıllar, yem bitkileri, endüstri bitkileri ve yemeklik baklagiller yer almaktadır. Sivas ilinde bulunan 1.106.085 hektarlık tarım arazisinin 310.000 hektarı sulanabilir tarım arazisidir.




**Şekil 2.** Sivas İl Arazisinin Dağılımı (2013)

İl topraklarının 638.878 hektarı her türlü kullanıma ve işlemeli tarıma elverişli I., II. Ve III. Sınıf arazilerden oluşmaktadır. 260.000 hektar alanda ise yoğun koruyucu önlemler alınarak sürüm yapılabilir durumdadır. Bugünkü durumda 1.200.000 hektar alan toprak koruma

önlemleri alınmadan işlenmekte; otluk olarak kullanılması gereken dik eğimli, sığ topraklı VI. Ve VII. Sınıf arazilerin sürülmesi bunun yanında yağışlar yetersiz olduğundan ve sulama da yapılamadığından sürülen arazilerin %90'ında nadas uygulanması erozyonu daha da hızlı hale getirmektedir. Sivas ili 27.203 km² alanı ile Türkiye'nin 2. Büyük ilidir. Sivas ilinde işgücünün sektörel dağılımına bakıldığında, tarım ve hayvancılık sektörünün bu ilde çok büyük ekonomik etkinliğe sahip olduğu görülmektedir (Anonim, 2013h).

**Tablo 1.** Sivas ili bazı iklimsel verilerin ölçüm periyodu (1930-2022)

| Sivas | Ocak | Şubat | Mart | Nisan | Mayıs | Haziran | Temmuz | Ağustos | Eylül | Ekim | Kasım | Aralık | Yıllık |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ort. Sıcaklık (°C) | -3.4 | -2.1 | 2.6 | 9.0 | 13.5 | 17.0 | 20.0 | 20.2 | 16.2 | 10.9 | 4.7 | -0.7 | 9.0 |
| Ort. En Yüksek Sıcaklık (°C) | 0.9 | 2.6 | 8.0 | 15.3 | 20.1 | 24.1 | 27.8 | 28.6 | 24.6 | 18.6 | 10.8 | 3.7 | 15.4 |
| Ort. Güneşlenme Süresi (h) | 2.5 | 3.5 | 4.8 | 6.3 | 8.1 | 10.5 | 11.9 | 11.4 | 9.4 | 6.5 | 4.2 | 2.5 | 6.8 |
| Ort. Yağışlı Gün Sayısı | 13.01 | 12.16 | 13.30 | 13.29 | 13.86 | 8.71 | 2.40 | 2.05 | 4.24 | 7.72 | 9.30 | 12.20 | 112.2 |
| Aylık Top. Yağış Mik. Ort. (mm) | 43.4 | 39.3 | 45.4 | 56.1 | 60.4 | 35.0 | 9.3 | 6.8 | 17.8 | 33.0 | 40.2 | 44.2 | 430.9 |

(Meteoroloji Genel Müdürlüğü, 2023) (Anonim h, 2023)

Sivas ilinde iklim değişikliğinden kaynaklı yağış miktarının son yıllarda azalması; tarımsal üretimde verim kayıpları, erozyon sorunu, mekanizasyon sorunları, amacına uygun arazi kullanılmaması ve arazilerin parçalı, dağınık olması gibi sorunlara sebep olmuştur. Sivas ilinde yaşanan bir başka sorun ise sulama yetersizliği ve drenaj sorunlarıdır (Anonim, 2019d). Sivas ili sıcak çermik bölgesinde, toplam 60 dönüm alanda jeotermal suyla ısıtılan serada üretim yapılmaktadır. Bu jeotermal sera 2020 yılında Sivas'ta kurulmuş ve topraksız tarım ile yılda 2 bin tonun üzerinde domates üretimi yapmaktadır. Bu serada toprak yerine volkanik

kayaların kullanıldığı, taş yünü ya da perlit ile çeşitli minerallerin ve suyun bitkiye enjekte edildiği sistem tüketiciye daha hijyenik, daha sağlıklı ürünler vermektedir (Anonim, 2023f).

## SONUÇ

Dünya nüfusunun artması ile su kaynakları da hızla azalmaktadır. Günümüzde su stresi yaşayan nüfusun gelecekte su kıtlığı yaşayacağı ön görülmektedir. Türkiye de su kıtlığı yaşayacak ülkeler arasında görülmekte ve yapılan araştırmalara göre Türkiye, 2030 yılına gelindiğinde dünyada en fazla su stresinin yaşandığı ülkeler arasına girmesi öngörülmektedir. İklim değişikliğinin her geçen gün etkisini artırması kuraklığa yol açmaktadır. Ülkemizde de dünyada olduğu gibi en çok su kullanımı tarım sektöründedir.

İklim değişikliğinin sonucu olarak su arzının talebi geçmesi ve erozyonun artması yeni tarımsal üretim teknolojilerinin geliştirilmesine yol açmıştır. Topraksız tarım bunlardan biridir ve su tasarrufunun en çok yapıldığı ve birim alandan daha fazla verim elde edildiği için her geçen gün topraksız tarıma olan ilgi artmaktadır. Sivas ili bulunduğu coğrafi konum dolayısıyla iklim değişikliğinden en çok etkilenen illerden bir tanesidir. İklim değişikliğinden dolayı yağışların ve doğal afetlerin artması sonucu kullanılabilir toprak miktarı gün geçtikçe azalmaktadır. Sivas ilinde günümüzde su arzının talep edilen miktarı geçmesi su tasarrufu yapılmasına ve Sivas ilinde çiftçileri topraksız tarım sektörüne yöneltmek gerekir. Meteoroloji verilerine göre Sivas ili yıllık yağış miktarı 420 mm olarak kaydedilmiştir. Bu verilerden de görüldüğü üzere Sivas ilinde sulu tarımın iklim değişikliğinden dolayı gün geçtikçe azalması ön görülmektedir. Türkiye İstatistik Kurumu (TÜİK) 2022 verilerine göre Sivas İlinde örtü altı yetiştiricilik 281 dekar alanda yapılmaktadır (Anonim, 2022g). İklim şartları Sivas'ta yapay iklimlendirme yapılarak örtü altı yetiştiricilikte topraksız tarım yapılmasına el verişlidir. Bu çalışmada görüldüğü üzere topraksız tarımın toprakta yapılan tarıma göre birim alandan daha fazla ürün elde edilmesine ve kontrollü yetiştiriciliğin daha kolay yapılmasına el vermektedir. Üretilen ürünlerin kalitesinde olumlu etkiler, yetiştiricilikte yüksek maliyetleri olan ilaç, gübre, su gibi girdilerin azalması ve yabancı ot kontrolünün sağlanması ve yetiştiricilikte iklimin uygun, toprağın uygun olmadığı durumlarda topraksız tarımda üretim Sivas ilinde daha uygun hale gelmektedir.

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# DAMACANA SULARININ MİKROBİYOLOJİK KALİTESİ VE POMPA KULLANIMININ ETKİSİ

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**Özet**
Çalışmada, Tekirdağ ilinde tüketime sunulan 28 adet (7 farklı marka) damacana suyunun İnsani Tüketim Amaçlı Sular Hakkında Yönetmelik'te belirtilen kriterlere uygunluğu ve pompa temizliğinin mikrobiyolojik açıdan öneminin belirlenmesi hedeflenmiştir. Araştırma kapsamında; damacana eve geldiği anda, su miktarı yarıya düştüğünde ve suyun bitmesine yakın olmak üzere 3 aşamada örnek alınmıştır. Toplam mezofilik aerobik bakteri, toplam koliform bakteri, *Escherichia coli* ve *Staphylococcus aureus* analizleri ve pH ölçümleri yapılmıştır. Örneklerin %14.2'si yönetmelikte belirtilen kriterlere uygun olmasına karşın, %85.8'i yönetmelikte belirtilen kriterlere uymadığı belirlenmiştir. Analiz sonuçlarına göre; TMAB başlangıçta ortalama $5.7x10^5$ kob/mL olarak tespit edilirken, damacanaya pompa takılmasıyla bu sayının ortalama $1.06x10^7$ kob/mL seviyelerine çıktığı belirlenmiştir. Örneklerin %93.8'inde başlangıçta koliform bakteri tespit edilmemişken, pompa takılmasıyla %91.36'sında ortalama 4.9x10 kob/mL koliform bakteri tespit edilmiştir. Yapılan IMVIC testi sonuçlarına göre örneklerin II. veya III. aşamalarında *Enterobacter, Citrobacter* ve *E. coli* tespit edilmiştir. Numunelerin %7.4'ünde II. veya III. aşamalarında *S. aureus* tespit edilmiştir. Örneklerin tamamının pH açısından yönetmeliğe uygun olduğu belirlenmiştir. Örneklerin mikroorganizma sayısı arttıkça pH'da paralel olarak artma veya azalma tespit edilmiştir. Pompa temizliğinin yeterli ve düzenli yapılması, suyun bekleme süresinin uzamaması sudaki mikrobiyolojik kontaminasyonu önemli oranda etkilediği belirlenmiştir. Ayrıca üretim tesislerinde hijyen ve sanitasyon kurallarına dikkat edilmesi, devletin denetim organlarının güçlendirilmesi gerektiği ve yeni bir pompa tasarımına ihtiyaç duyulduğu düşünülmektedir.
**Anahtar Kelimeler:** Damacana su, pompa temizliği, damacana pompası

# MICROBIOLOGICAL QUALITY OF DEMIJOHNWATER AND THE EFFECT OF PUMP USE

**Abstract**

In the study, it was aimed to determine the compliance of 28 demijohn water (7 different brands) offered for consumption in Tekirdağ province with the criteria specified in the Regulation on Water Intended for Human Consumption and the microbiological importance of pump cleaning. Within the scope of the research, samples were taken in 3 stages: when the demijohn arrived at home, when the amount of water was halved and when the water was close to the end. Total mesophilic aerobic bacteria, total coliform bacteria, *Eschrichia coli* and *Staphylococcus aureus* were analyzed and pH was measured. Although %14.2 of the samples met the criteria specified in the regulation, %85.8 did not meet the criteria specified in the regulation. According to the results of the analysis; TMAB was initially detected at an average of $5.7x10^5$ cfu/mL, and this number increased to an average of $1.06x10^7$ cfu/ml after the pump was installed in the demijohn. Coliform bacteria were not detected in %93.8 of the samples at the beginning, and after the pump was installed, coliform bacteria were detected in %91,36 of the samples with an average of 4.9x10 cfu/mL. According to the results of the IMVIC test, *Enterobacter*, *Citrobacter* and *E.coli* were detected in stages II or III of the samples. In %7.4 of the samples, *S. aureus* was detected in stages II or III. It was determined that all of the samples were in compliance with the regulation in terms of pH. As the number of microorganisms in the samples increased, pH increased or decreased in parallel. It was determined that adequate and regular cleaning of the pump and not prolonging the waiting time of the water significantly affected the microbiological contamination in the water. It was also considered that hygiene and sanitation rules should be paid attention to in production facilities, that state inspection bodies should be strengthened and that a new pump design was needed.

**Keywords:** demijohn water, pump cleaning, demijohn pump

## 1.Giriş

Yaşamın kaynağı olan su; bitkilerde, hayvanlarda, insanlarda tüm canlı organizmalardaki temel girdidir. Sağlıklı beslenen bir kişini günde minimum 1.5 L su içmesi gerekmektedir. İnsan besinsiz 50 gün kadar yaşamını sürdürebilmekte ama vücut ağırlığının %15 – 20 'si kadar su kaybı ölümcül olmaktadır (Karagülle, 2004). Hayatın en gerekli maddesi olan su mikrobiyolojik ve kimyasal kirlenmelere son derece elverişli özelliği nedeniyle yaşamı tehdit edebilen birçok hastalığın da kaynağı olabilmektedir. İçme sularıyla çok çeşitli bakteri, virüs, protozoon ve helmint infeksiyonları bulaşabilmektedir. 1990'lı yılların başında yağış azlığı nedeniyle su sıkıntısının yoğun olarak yaşandığı İstanbul'da bu sorunun çözümü için su istasyonlarının kurulması sağlanmıştır. Ancak su istasyonlarında açıktan satılan suların halk sağlığı için önemli bir risk oluşturduğu tespit edilince bu istasyonların yerini su satış noktaları almış ve bu satış noktalarında içme suları 19 litrelik polikarbonat damacanalarda halka sunulmaya başlamıştır. Özellikle büyük kentlerde markalı ve damacanalı su tüketimi giderek artmaktadır (Köksal ve Samastı, 2007). Bu sular tüketiciye ulaştıktan sonra kullanım şartları ve sürelerine bağlı olarak mikrobiyal kirlenmeye uğrayabilmektedir. En önemli kontaminasyon kaynaklarından biri de kullanılan pompalardır. Çoğu patojen bakterinin mezofilik karakterde olması sebebiyle, toplam mezofilik aerobik bakteri (TMAB) sayısının yüksek oranda olması patojen bakterilerin de bulunma olasılığının yüksek olduğunu göstermektedir (Demirci ve ark., 2007). Bir içme suyunu güvenlik açısından kaliteli kılan özellikler suların bakteriyolojik ve kimyasal parametreler yönünden uygun özelliklerde olmasıdır (Karagülle, 2004). Türkiye'de içme ve kullanma sularında istenen özellikler Sağlık Bakanlığı tarafından yayınlanan ''İnsani Tüketim Amaçlı Sular Hakkında Yönetmelik de belirtilmiş olup, içme ve kullanma sularının analizleri bu yönetmelikte belirtilen parametreler çerçevesinde yapılmaktadır (Anon, 2006). Yönetmeliğe göre 250 mL'de *E. coli,* koliform bakteri, 100 mL'de ise patojen stafilokoklar bulunmamalıdır.

Koliform bakteriler suda kolayca saptanabildiği ve sayılabildiği için suyun kalitesinin belirlenmesinde uygun bir mikrobiyal indikatör olarak kabul edilmiştir. Suyun dışkı ile kirlendiğinin belirtisi olan bakteriler, *Enterobacteriaceae* ailesinin üyesi, 44.5$^{o}$C'de üreyebilen, laktozu gaz ve asit oluşturarak fermente edebilen, *E. coli* ve laktozu 37$^{o}$C'de fermente edebilen, *Eschrichia, Citrobacter, Enterobacter, Klebsiella* gibi total koliformlardır (Avcı ve ark, 2006). Bu çalışma, tüketime sunulan geri dönüşümlü damacanalardaki suyun mikrobiyolojik kalitesini ve suyun pompa tarafından zamanla ne kadar kirletildiğini belirlemek amacıyla yapılmıştır.

## 2. MATERYAL VE METOT

### 2.1. Materyal

Tekirdağ ilinde tüketime sunulan 27 adet (7 farklı marka) 19 litrelik damacanadan 3 farklı aşamada (damacananın ambalajı açıldıktan hemen sonra pompa takılmadan alınan ilk örnek (I), pompa takıldıktan hemen sonra alınan ikinci örnek (II) ve damacana suyunun büyük bir kısmı tüketildikten sonra alınan son örnek (III)) toplamda 81 tane numune alınmış ve marka isimlerini temsilen A, B, C, D, E, F ve G olarak isimlendirme yapılmıştır. Örnekler 100 mL'lik steril şişelere alınarak aynı gün laboratuvara getirilmiş ve mikrobiyolojik analizleri yapılmıştır.

### 2.2. Metot

#### 2.2.1. TMAB Sayımı

Bu analiz için PCA (Plate Count Agar) besiyeri hazırlanıp 40-45°C'ye soğuduktan sonra yayma plak yöntemine göre analiz yapılması için steril petrilere 10-12 ml dökülerek donması sağlanmıştır. Petrilerdeki agar donduktan sonra örneklerin seri dilüsyonlarından 0.1 'er ml ekim yapılmıştır. Daha sonra petriler aerob şartlarda 30°C'de 48 saat ters konularak inkübasyona bırakılmıştır.

#### 2.2.2. Toplam Koliform Bakteri Sayımı ve *E. coli*'nin Saptanması

Bu amaçla Violet Red Bile Agar (VRBA) besiyeri kullanılmış ve dökme plak yöntemine göre ekim yapılmıştır. Seri dilüsyonlardan 1' er ml alınarak steril petrilere aktarılmış ve üzerine 40 – 45°C'deki agar dökülerek homojen olması için birkaç defa sekiz çizerek karıştırılmıştır. Agarın donması için biraz bekletildikten sonar petriler 37°C'de 48 saat inkübasyona bırakılmıştır. İnkübasyon sonunda besiyerinde üreyen mor-pembe renkli koloniler değerlendirilmiştir.

Aynı zamanda En Muhtemel Sayı Yöntemiyle *E. coli*'ye geçiş yapılarak içinde durham tüpü bulunan Lauryl Sulfate Tryptose (LST) Broth'a $10^0$, $10^{-1}$, $10^{-2}$ dilüsyonlarında steril pipetle 1'er ml alınarak ekim yapılmış ve tüpler aerob şartlarda 37°C de 24-48 saat inkübe edilmiştir. İnkübasyon sonunda bulanıklık ve gaz oluşan tüpler pozitif olarak kabul edilmiş ve bu pozitif tüplerden Brilliant Green Bile (BGB) Broth'a ekim yapılmıştır. İçinde durham tüpü bulunan BGB Broth'lara aşılanan örnekler aerob şartlarda 37°C'de 24-48 saat inkübasyona bırakılmıştır ve durham tüplerinde gaz oluşumu gözlenen tüpler pozitif kabul edilmiştir. BGB Broth'daki pozitif tüplerden bir öze dolusu örnek alınarak Eosin Methylen-blue Lactose Sucrose (EMB) Agar'a 3 çizgi yöntemiyle ekim yapılmıştır ve petriler aerob şartlarda 37°C'de 24 – 48 saat inkübasyona bırakılmıştır. EMB agarda oluşan metalik yeşili, parlak kolonilere IMVIC testi

uygulanarak sonuçlar değerlendirilmiştir. Test sonucu ++-- olan koloniler *E. coli* kabul edilmiştir.

**2.2.2.1. IMVIC Testlerinin Yapılması**

**Indol Testi:** Bu test için şüpheli kolonilerden peptonlu suya ekim yapılarak aerob şartlarda 37°C'de 24 saat inkübasyona bırakılmıştır. İnkübasyon sonunda Kovacs ayıracından iki damla damlatılmış ve tüpte kırmızı halka oluşan tüpler indol (+), renk değişimi olmayanlar indol (-) olarak kabul edilmiştir.

**Metil Kırmızısı Testi**: Bu test için glikoz peptonlu su kullanılmıştır. Ekimi yapılan koloniler aerob şartlarda 37°C'de 24 saat inkübasyona bırakılmış ve inkübasyon sonunda bir – iki damla metil red indikatörü damlatılmıştır. Tüpte kırmızı rengin görülmesi metil red (+), sarı rengin görülmesi metil red (-) kabul edilmiştir.

**Voges – Proskauer Testi:** Bu test için de glikoz peptonlu su kullanılmış ve şüpheli koloniler ekilerek aerop şartlarda 37°C'de 24 saat inkübasyona bırakılmıştır. İnkübasyon sonunda % 5'lik a – naphthol çözeltisinden 0.5 ml ve % 40'lık KOH çözeltisinden 0.5 ml damlatılmış ve koyu pembe – koyu kahverengi gözlenen tüpler pozitif kabul edilmiştir.

**Sitrat Testi :** Bu test için Simmons Citrat Agar kullanılmış ve yatık agar olarak hazırlanmıştır. Şüpheli koloniler yatık agarın yüzeyine öze ile aşılanmış ve aerob şartlarda 37°C'de 48 saat inkübasyona bırakılmıştır. İnkübasyon sonunda besiyeri yüzeyinde renk değişiminin olmaması *E. coli* için pozitif kabul edilmiştir.

**2.2.3. *S.aureus* Sayımı**

Bu analiz için Baird Parker Agar (BPA) kullanılmıştır ve yayma plak yöntemine göre ekim yapılmıştır. Örneklerden steril pipetle 0,1 ml alınarak önceden hazırlanmış petrilere paralelli olacak şekilde ekim yapılmıştır. Aerob şartlarda 37°C de 48 saat inkübe edilerek değerlendirme yapılmıştır. Etrafında zon olulşan siyah kolonilere koagülaz testi uygulanarak patojen stafilokoklar belirlenmiştir

**2.2.3. Örneklerde pH tespiti**

Örneklerin pH değerleri pH metre cihazıyla oda sıcaklığında tespit edilmiştir.

## 3. BULGULAR VE TARTIŞMA

**3.1. Damacana sularının mikrobiyolojik kalitesi**

Sağlık Bakanlığı tarafından yayınlanan ''İnsani Tüketim Amaçlı Sular Hakkında Yönetmelik'' gereği ambalajlanmış kaynak sularında 22°C'de 72 saat süreyle inkübasyona bırakılan

örneklerde toplam aerob bakteri sayısı en fazla 100/mL, 37°C'de 24 saat inkübasyona bırakılan örneklerde ise en fazla 20/mL, koliform bakteriler 0/250 mL, *E. coli* 0/250 mL, patojen stafilokoklar 0/100 mL olması gerektiği belirtilmiştir.

Çalışma sonuçlarına göre bakteriyolojik analizi yapılan 7 firmaya ait toplam 28 damacana suyu örneğinin I. aşamasında (damacana eve ilk geldiğinde alınan örneklerde) %14.2'si yönetmelikte belirtilen kriterlere uygun olmasına karşın, %85.8'i ise yönetmelikte belirtilen sayıların üzerinde TMAB içerdiği tespit edilmiştir, aynı zamanda uygun olmayan bu örneklerin %6'sında koliform bakteri bulunmuştur. Analiz sonuçlarına göre; I. Aşamada toplam 28 numuneden 26 tanesinde en az 5x10 kob/mL, en çok $7.13x10^7$ kob/mL ve ortalama $5.7x10^5$ kob/mL TMAB belirlenmiştir. II. aşamada en az $1.7x10^2$ kob/mL, en çok $3.65x10^5$ kob/ mL, III. aşamada ise en az $1.95x10^2$ en çok $1.56x10^6$ kob/mL TMAB tespit edilmiştir. II. ve III. aşamadaki bu artışın sebebi özellikle pompa bakımının düzenli ve yeterli yapılmadığından kaynaklanabilmektedir.

| | I. Aşama (kob/mL) | II. Aşama (kob/mL) | III. Aşama (kob/mL) |
|---|---|---|---|
| A | $1.7*10^4$ | $6.7*10^4$ | $7*10^4$ |
| B | $1.01*10^5$ | $9.2*10^5$ | $2.1*10^5$ |
| C | $3.04*10^4$ | $1.6*10^5$ | $9.1*10^4$ |
| D | $2.3*10^4$ | $6.6*10^4$ | $7.9*10^6$ |
| E | $1.3*10^2$ | $1.7*10^3$ | $7.2*10^4$ |
| F | $2.3*10^4$ | $6*10^4$ | $9.7*10^4$ |
| G | $1.8*10^5$ | $1.8*10^3$ | $1.9*10^2$ |

Şekil 1. Numunelerin aşamalara göre ortalama TMAB değerleri

"İnsani Tüketim Amaçlı Sular Hakkında Yönetmelik" gereği içme sularında koliform bakteri bulunmaması gerekmektedir. Koliform bakteriler su içinde kolayca saptanıp sayılabildikleri için içme sularının mikrobiyolojik kalitesinin belirlenmesinde indikatör olarak kabul edilmektedirler. Toplam koliform sayısı suyun mikrobiyolojik kalite seviyesi hakkında fikir vermektedir (Edberg ve ark., 2000; WHO, 1996). Örneklerin %93.8'inde başlangıçta koliform bakteri tespit edilmemişken, %6.2'sinde I. aşamada tespit edilmiştir. Aynı zamanda pompa takılmasına paralel olarak %91.36'sında en az 0.5 kob/mL, en fazla $3.47x10^2$ kob/mL ve ortalama 4.9x10 kob/mL koliform bakteri tespit edilmiştir. Örneklerin %93.8'i koliform bakteri yönünden yönetmeliğe uygundur, burada dikkat edilmesi gereken husus, pompanın takılması ile damacana sularda koliform bakteri varlığının tespit edilmesidir. Bu bakterilerin varlığı, damacana sularına takılan iyi temizlenmemiş pompaların önemli bir kontaminasyon kaynağı

olabileceğinin bir göstergesidir. Bu konuda tüketicilerin daha hassas ve duyarlı olmaları büyük önem taşımaktadır (Demirci ve ark., 2007).

IMVIC testi sonuçlarına göre *E. coli* C markasının bir örneğinin III. aşamasında ve F markasının bir örneğinin II. ve III. aşamalarında tespit edilmiştir. *Enterobacter* B markasının bir örneğinin II. aşamasında, başka bir örneğinin ise III. aşamasında tespit edilmiştir. *Citrobacter* ise C markasının II. aşamasında tespit edilmiştir. Aynı zamanda *E. coli* tespit edilen numunelerde pH değerinde artış olduğu belirlenmiştir.

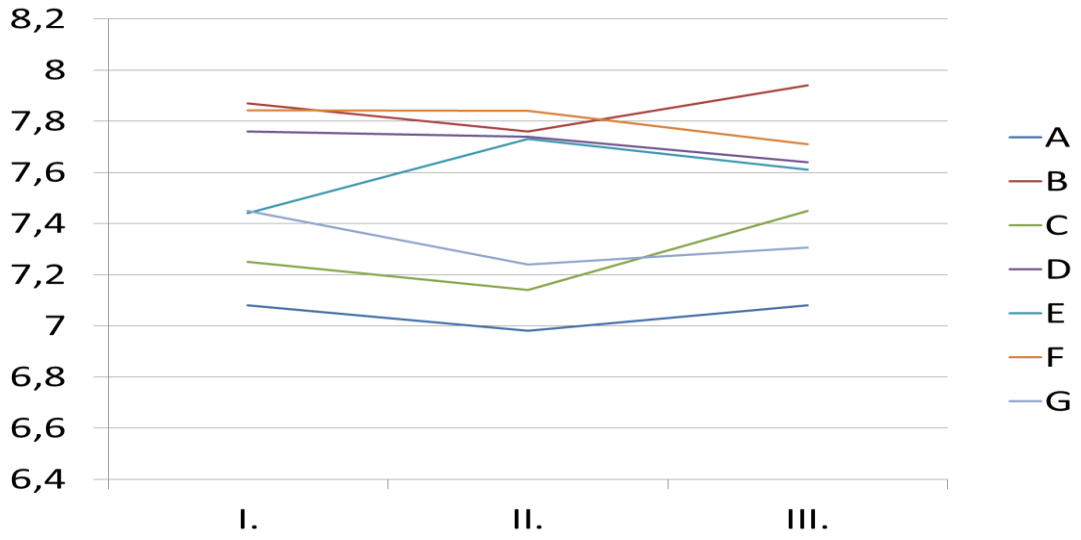
Yönetmelik gereği içme sularında patojen Stafilokok bulunmaması gerekmektedir. Örneklerin tamamının ilk aşamada bu kritere uygun olduğu tespit edilmiştir. Bununla birlikte, 81 numunenin %7.4'ünün II. veya III. aşamalarında *S. aureus* tespit edilmiştir. Burada dikkat çeken husus yine pompa temizliğidir, çünkü söz konusu olan patojen mikroorganizma pompa takılmasından sonra alınan numunelerde en az 2 kob/mL, en çok ise $3x10^2$ kob/mL olarak tespit edilmiştir.

Bu çalışma yapılırken aynı zamanda aynı markanın cam damacanasından da örnek alınarak analiz yapılmıştır ve cam damacanaların başlangıçtaki TMAB sayısı 0, suyun bitimine yakın bu sayının $10^4$ ve $10^5$ seviyelerine çıktığı tespit edilmiştir. Aynı zamanda yine aynı markanın damacanasından çalışma boyunca pompasız örnek alınarak analiz yapılmıştır ve başlangıçta TMAB sayısı 0 suyun bitimine yakın $10^2$ 'ye çıkmıştır. Buna karşın pompasız örnekte suyun bitimine yakın $3x10^2$ kob/mL *S. aureus* tespit edilmiştir.

Aynı markanın sebil kullanılarak tüketilmesi durumları için sebillerden de örnek alınmıştır ve analiz sonuçlarına göre TMAB sayısı II.- III. aşamalarında $10^4$ ve $10^5$ seviyelerinde tespit edilmiştir. Ayrıca sebillerden alınan örneklerin II.- III. aşamalarında koliform bakteri tespit edilmiştir.

### 3.2. Damacana sularının pH değerleri

İnsani Tüketim Amaçlı Sular Yönetmeliğine göre içme sularındaki pH >6,5 ve < 9,5 olmalıdır. Damacana sularının pH değerleri Şekil 2'de verilmiştir. Örneklerin tamamı pH kriterine uygundur. Sularda gelişen mikrobiyal floraya bağlı olmak şartıyla pH artış veya azalış göstermiştir. Özellikle dikkat çeken husus, koliform grubu bakteriler ve *E. coli* tespit edilen örneklerde pH'ın artış göstermesidir.

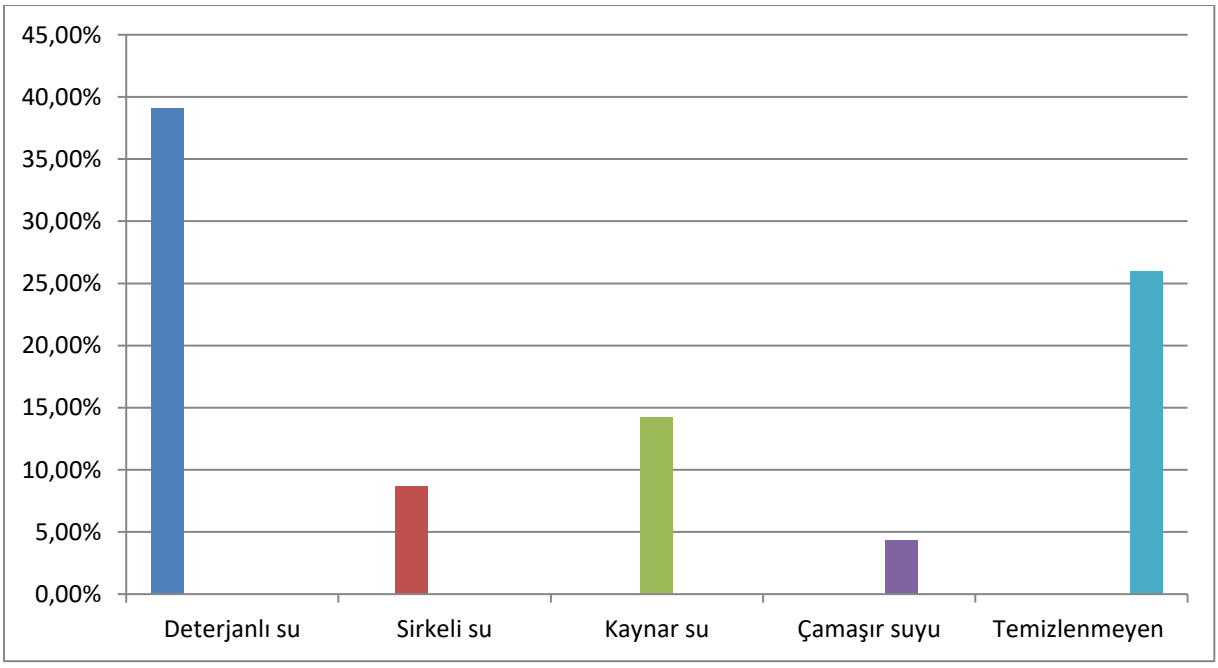



Şekil 2. Numunelerin pH değerleri

### 3.3. Damacana temizliğinde tüketici davranışları

Yapılan anket sonuçlarına göre tüketicilerin damacana muhafazası konusunda bilinçli oldukları ama pompa temizliği konusunda yeterli bilgiye sahip olmadıkları; özellikle *E. coli* tespit edilen örneklerde damacana pompasının hiç temizlenmediği tespit edilmiştir.

Aynı zamanda tüketiciler damacana su seçimlerinde fiyat, marka ve pH gibi parametrelere dikkat ederken cam damacanaların daha sağlıklı olduğunu ancak pahalı olduğu için tercih etmediklerini bildirmiştir Tüketicilerin pompa temziliği için tercih ettikleri maddeler şekil 3'de gösterilmiştir.




Şekil 3. Tüketicilerin pompa temizliği için kullandıkları maddelerin % dağılımı

Bu araştırmada, 7 farkı marka adı altında piyasaya sunulan geri dönüşümlü polikarbonat damacanalardan 28 kaynak suyu örneğinin bakteriyolojik kalitesi ve pompa kullanımının etkisinin amacıyla yapılan analizler sonucunda örneklerin %85.8'i TMAB sayısı sınırların üstünde olarak piyasaya sunulmaktadır ve bunların içinden % 6.2'si koliform içermektedir. Pompa takılmasından sonra TMAB sayısı $10^6$'lara kadar çıkmıştır ve *E. coli* gibi patojen mikroorganizmalar üremiştir.

Demirci ve ark. tarafından 2007'de yapılan çalışmada, damacana sulardan pompa takılmadan steril şartlarda alınan su örneklerindeki TMAB sayısı en az $4.6x10^1$ kob/mL, en çok $1.25x10^2$ kob/mL ve ortalama $8.36x10^1$ kob/mL olarak tespit edilmesine karşın su örnekleri koliform bakteri sayısı bakımından incelendiğinde; başlangıçta hiçbir örnekte bu bakteriye rastlanmamıştır. Pompa takıldıktan sonra alınan A, D ve E örneklerinde sırasıyla 15, 15 ve 46 EMS/mL seviyelerinde tespit edilirken B ve C örneklerinde koliform bakteri bulunmadığını bildirmiştir. TMAB sayıları bu çalışmaya göre daha düşük düzeydedir ve koliform grubu bakteriler ilk aşamada hiç tespit edilmemiştir, bunun sebebi günümüzde hijyen ve sanitasyon kurallarına çok dikkat edilmemesinden kaynaklı olabileceği düşünülmüştür.

Oymak, (2010) tarafından yapılan diğer bir benzer çalışmada; Aydın ilinde tüketilen şişelenmiş suların mikrobiyolojik kalitesinin tespiti için 5 farklı markadan toplam 300 şişe (500 ml) kaynak suyu analiz edilmiştir ve analiz sonuçlarına göre ortalama toplam heterotrofik bakteri değerleri 22°C için 7.94x10 kob/mL ile $4.66x10^2$ kob/mL arasında değişirken bu değerler 37°C için 9.40x10 kob/mL ile $5.02x10^2$ kob/mL arasında belirlenmiştir. Örneklerin hiç birisinde *E. coli*, *Salmonella spp*. ve koliform grubu bakteriye rastlanılmamıştır. Araştırmacıların bakteri ilişkin sonuçlarına göre farklılıklar vardır. Bunun sebebinin öncelikle damacanaların geri dönüşümlü olarak kullanılmasından ve damacana sulara takılan pompadan kaynaklı olabileceği düşünülmüştür. Benzer şekilde Çakmak ve ark. (2004) tarafından yapılan membran filtrasyon tekniği kullanılarak yapılan çalışmada, incelenen 213 adet kaynak suyu (pet şişe ve damacana su) örneğinin 44'ünün (%20.7) mevcut standartlara uygun olmadığı belirtilmiştir. Araştırmacılar standartlara uygun olmayan örneklerin %72.7'sinin total koliform bakteriler, %34.1'inin fekal koliform bakteri, %6.8'inin *E. coli* ve %75'inin ise aerob mezofil genel canlı sayısı yönünden uygun bulunmadığını bildirmiştir. Araştırmacıların aerob mezofil bakteri ve *E. coli'*ye ilişkin sonuçları uyumludur.

Aynı şekilde Çelfiş Ö. (2010) tarafından yapılan çalışmada, 10 farklı firmaya ait toplam 127 adet kaynak suyu, bakteriyolojik yönden analiz edilmiştir. Bu analizler kapsamında örnekler, toplam aerob mezofil bakteri sayısı, koliform bakteriler, enterokoklar ve sülfit indirgeyen

anaeroblar yönünden incelenmiştir. Analiz sonuçlarına göre 127 örneğin 52'si (%40.9) aerob mezofil genel canlı sayısı yönünden İnsanı Tüketim Amaçlı Sular Hakkında Yönetmelik'e uygun olmasına karşın, 75 (%59.1) örneğin uygun olmadığı saptanmıştır. Aynı şekilde koliform bakteriler 15 (%11.8) örnekte, *E. coli* 4 (%3.1) örnekte, enterekoklar 17 (%13.3) örnekte, sülfit indirgeyen anaeroblar ise 7 (%5.5) örnekte pozitif bulunmuştur. Araştırmacının sonuçları ile bu sonuçlar benzerlik göstermektedir. Başka bir çalışma Ağaoğlu ve ark. (1999) tarafından Van ve yöresindeki yerleşim yerlerinde, direk kaynağından numune alınarak yapılmıştır. 15 kaynaktan alınan toplam 30 adet su örneği materyal olarak kullanılarak, mikrobiyolojik analizler sonucunda örneklerde genel mikroorganizma sayısı 0-9.4x$10^4$ kob/ml (ort. 2.7x$10^3$ ± 0.2x$10^1$) arasında olarak bildirilmiştir. İncelenen kaynak sularının %33.3'ünde koliform grubu mikroorganizma tespit edilmiştir. Örneklerin direk kaynağından alınması, ambalajlı su veya damacana suyu olmaması nedeniyle karşılaştırma yapılmaması gerektiği uygun görülmüştür.

## 4. SONUÇ VE ÖNERİLER

Bu çalışmada 28 damacana kaynak suyu örneğinin bakteriyolojik kalitesi ve pompa kullanımının etkisinin amacıyla yapılan analizler sonucunda örneklerin %85.8'inin İnsani Tüketim Amaçlı Sular Hakkında Yönetmelik' te belirtilen sınır değerlerin üstünde olduğu ve bunların %6.2'sinin koliform bakteri içererek piyasaya sunulduğu tespit edilmiştir. Pompa takılmasına paralel olarak örneklerin toplam mezofil aerob bakteri içerikleri $10^6$ seviyelerine çıktığı, örneklerin %91.96'sında koliform, %8.64'ünde *S. aureus*, %3.7'sinde *E. coli*, %2.5'inde *Enterobacte*r ve %1.2'sinde *Citrobacter* ürediği tespit edilmiştir.

Suların pompayla teması, kullanım süresi ve kullanım koşullarına bağlı olarak kirliliğin arttığı hatta indikatör mikroorganizmaların bulunarak sağlık sorunlarına yol açabilecek düzeye geldiği tespit edilmiştir. Suların temiz olarak tüketiciye sunulması tek başına yeterli olmamaktadır. Damacanaların temizliğinin daha iyi yapılması, pompa temizliğinin yeterli ve düzenli yapılması, suyun bekleme süresinin çok uzamaması sudaki mikroorganizma yükünü önemli oranda etkilediği tespit edilmiştir. Tüketicilerin su ve pompa hijyeni konusunda bilinçlendirilmesi, üreticilerin hijyen konusunda daha dikkatli olmaları gerektiği ve devletin görevli denetim organlarının güçlendirilmesi gerektiği düşünülmüştür.

Ayrıca pompa bakımı zor olduğu için daha kolay temizlenen ve kör noktaları daha az olan bir pompa tasarlanması pompa kaynaklı mikrobiyal kirliliği azaltacağı ve damacana tüketicilerinin veya tüketmeyi düşünenlerin daha memnun olacağı tespit edilmiştir.

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# THE ADVICE FOR COMBATING CLIMATE CHANGE IN MEADOW, PASTURE, AND FORAGE CROP AGRICULTURE

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## Abstract
Climate change is the alteration in climate systems caused by global warming because of human-induced greenhouse gas emissions, directly or indirectly disrupting the atmosphere's composition. The agricultural sector's contribution to greenhouse gas emissions, which are among the factors causing climate change, can be expressed as approximately 20%. As a result of the increase in greenhouse gas emissions, the concentration of $CO_2$ in the atmosphere today exceeds about 400 ppm. This increase in carbon dioxide has accelerated global warming and caused an increase in extreme events (especially droughts, floods, and fires), negatively impacting agricultural crop cultivation. These effects can be listed as the stress-induced decline in the growth of cultivated plants but stimulating the growth of weeds, changes in pasture vegetation, decrease in quality water resources for irrigation, increase in soil salinity, decrease in soil fertility, and desertification. Among the different scenarios about global warming, even if the optimistic picture of a +1.5℃ increase is realized, we must take measures to meet the economic food needs of the growing world population in the climate change that will occur in this process. Adaptation and mitigation works can be carried out in the fight against climate change to meet food needs. Adaptation studies include the conservation of gene resources due to ecosystem degradation, breeding of plants tolerant to heat and drought conditions, soil and water conservation practices, use of organic fertilizers, and changes in the grazing season. Mitigation efforts include GHG reduction, tree planting, biochar, organic amendments, soil erosion reduction, Agropastoral Production System, and Climate Smart Techniques. This review will emphasize what should be done and the precautions that can be taken for droughts, floods, and fires frequently encountered in meadow, pasture, and forage crop production in Türkiye.

**Keywords:** Drought, Flood, Forage Crop, Global Warming, Rangeland

## Introduction

Climate is the pattern of weather in each area over a long period. The weather patterns of a region, usually observed for at least 30 years, are considered the region's climate. Although the movements of the Earth (rotation around its axis, rotation around the Sun, Earth's motion) are the main factors in the formation of climate, the effects of the lithosphere, atmosphere, hydrosphere, cryosphere, and biosphere on the diversity of climate in regions are significant. In particular, the biosphere, the total of living things on Earth, profoundly affects the climate. Plants help regulate the flow of greenhouse gases in the atmosphere through photosynthesis. Forests and oceans act as "carbon sinks" that have a cooling effect on the climate. The land on Earth influences climate by helping to determine how the Sun's energy is used on Earth. Plant abundance and the type of land cover affect evaporation and ambient temperature. All climates are the product of many factors, including latitude, altitude, topography, distance from the ocean, and location on a continent (Anonymous, 2023a).

Changes observed in climatic phenomena occurring in each area over a long period due to various factors are called climate change. The movement of the Earth's motion, in other words, the period of Milankovic cycles, is stated to occur approximately every 100,000 years (Anonim, 2023). The climate change that may be caused by this cycle (natural climate change) is not the type of climate change that poses a risk to living things because it takes many years (Anonymous, 2023b). Today, however, the balance of gases in the atmosphere that make up the climate has been disrupted. For this reason, the recent climate change (Anthropogenic Climate Change), which poses a risk to living things, is defined as the alteration in climate systems caused by global warming because of human-induced greenhouse gas emissions, directly or indirectly disrupting the atmosphere's composition (Anonim, 2022; IPCC, 2023).

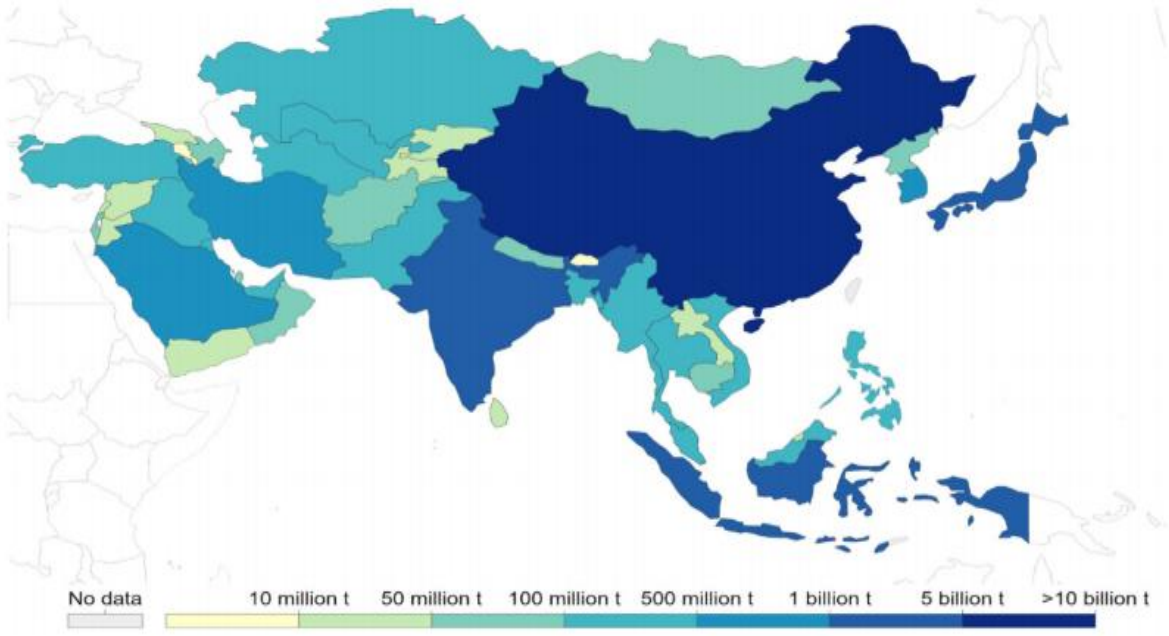


Figure 1. Total greenhouse gasses (GHGs) emission induces emissions from land use changes and forestry from Asian countries (Habib-ur-Rahman et al., 2022)

The concentration of CO2 in the atmosphere today exceeds 400 ppm and 417.2 ppm in 2022 because of the increase in human-induced greenhouse gas emissions (Anonymous, 2023c). When the greenhouse gas emissions in the Asian continent are analyzed, the highest rate is measured in China, with more than 10 billion t of total greenhouse gas emissions. Türkiye's total CO2 emissions are between 100 and 500 million tons (Figure 1).

According to Ritchie et al. (2020), using fossil fuels for energy is the leading contributor to greenhouse gases that cause climate change, with 73.2%, followed by energy use in industry (24.2%). It is followed by energy use in buildings (17.5%), transportation & transport (16.2%, combustion of undistributed fuel (7.8%), and energy used in agricultural areas (1.7%) (Figure 2).

After the energy sector, agricultural activities generate the highest greenhouse gas emissions. Changes in land use in agriculture, destruction of vegetation, land clearing, which are carbon sinks, and excessive use of resources (overexploitation) to obtain agricultural products (FAO, 2010). If we examine the proportions of the agriculture sector, the highest GHG emissions come from livestock and organic fertilizers (5.8%). It is followed by agricultural soil (4.1%), crop burning (3.5%), deforestation (2.2%), rice cultivation (1.3%), cropland (1.4%), and the most negligible gas emission is recorded as 0.1% from grassland. Generally, the agricultural sector's

contribution to greenhouse gas emissions, which are among the factors causing climate change, can be expressed as approximately 20%.

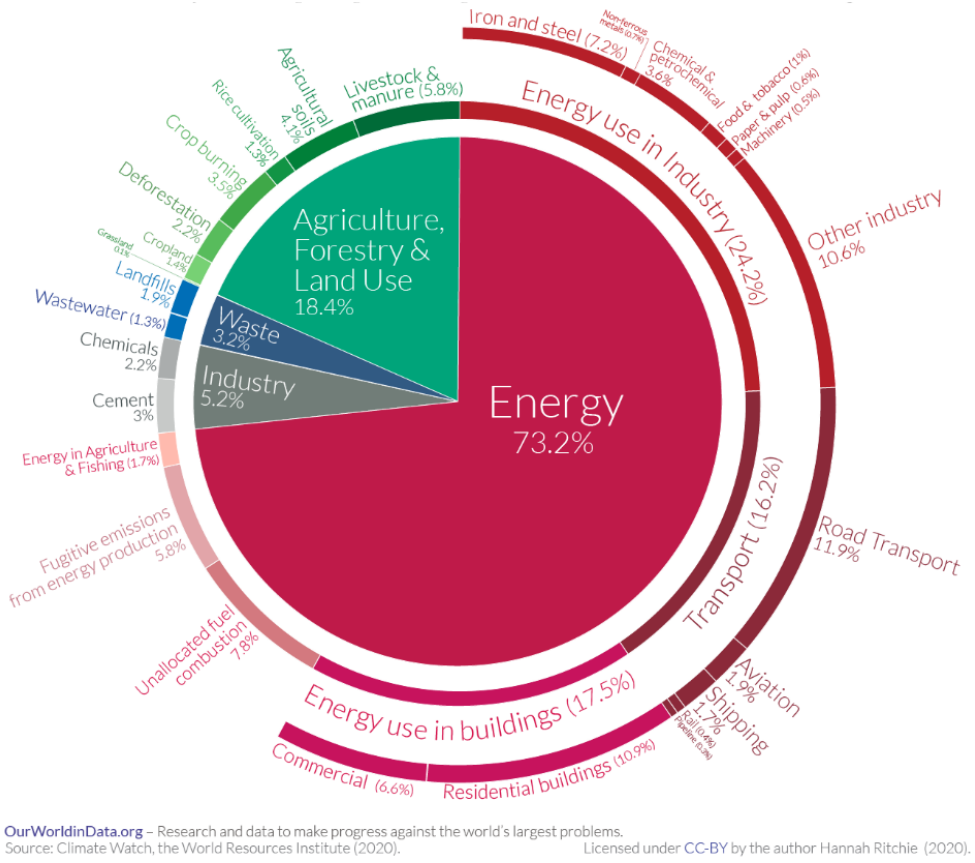


Figure 2. Global greenhouse gas emissions by sector (Ritchie et al., 2020)

**The Impacts of Climate Change on Rangeland and Forage Crop Agriculture**

As a result of the increase in $CO_2$, $SF_6$, $CH_4$, $N_2O$, $HFC_S$, and $PCF_S$ greenhouse gases in the atmosphere, there is an increase in global temperature and warming of the oceans. According to the IPCC's Fourth Assessment Report published in 2009, two climate scenario models have a high probability of realization due to increasing greenhouse gases, namely the National Center for Atmospheric Research, US (NCAR) model and the Commonwealth Scientific and Industrial Research Organization, Australia (CSIRO) model (Figure 3 A, B). When the Amazon, which has the densest vegetation in the world, is analyzed in these two models, it is predicted that the precipitation falling in the Amazon will decrease, even if different regions are mentioned in both scenarios. In addition, when these two scenarios are analyzed for Türkiye, NCAR estimates the temperature change between 2000 and 2050 as 2.5°C and 5°C and the precipitation difference between 0 and -100 mm. However, CSIRO, which is a more optimistic scenario for Türkiye, estimates the temperature change between 2000 and 2050 as between 1°C and 2.5°C

and the precipitation difference as different according to regions and states that it varies between +100 mm for the Central Black Sea and part of the Central Anatolia Region and between 0 and -100 mm for other regions (Nelson et al., 2009).

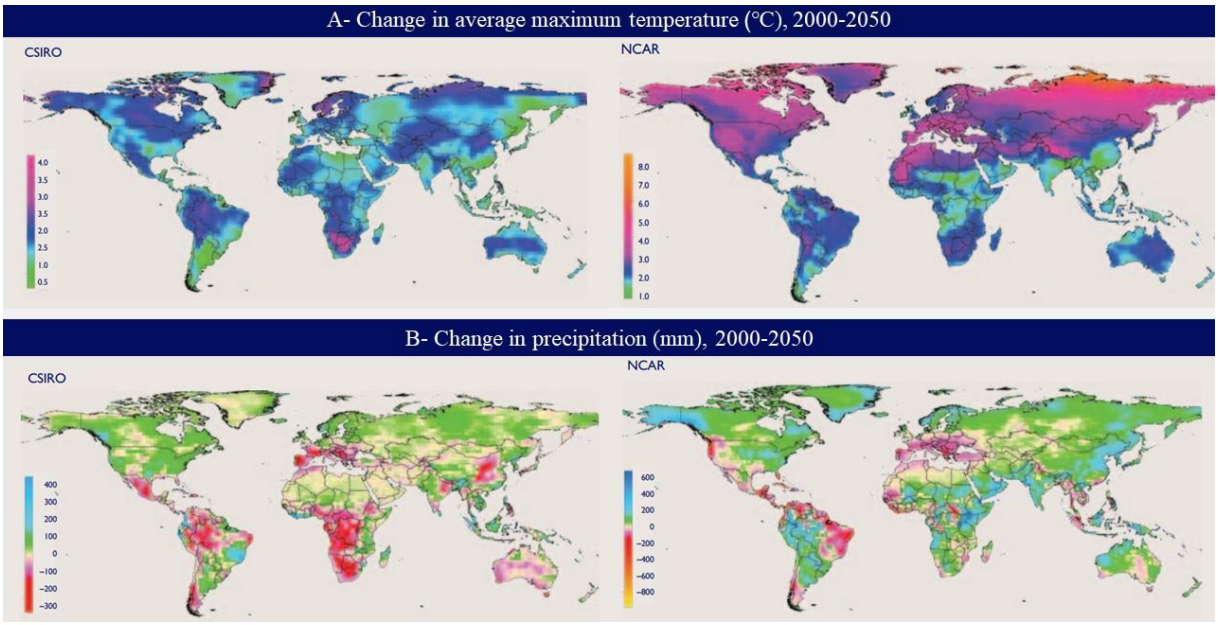


Figure 3. Change in average maximum temperature (A) and in precipitation (B), 2000-2050 in CSIRO and NCAR models (Nelson et al., 2009)

Increasing temperatures and decreasing precipitation across the globe have led to the melting of glaciers, reduction in arctic sea ice, shrinking of ice sheets, reduction in snow-covered areas, sea level rise, acidification of oceans, and increases in the frequency of extreme climate events. This increase in carbon dioxide has accelerated global warming and caused an increase in extreme events (especially droughts, floods, and fires), negatively impacting agricultural crop cultivation (Anonymous, 2023c). Further, these climatic changes affect agriculture through early shifts in crop season (80.8%), shorter growing season (91.7%), increased incidence of insect-pest (81.2%) and diseases (84.2%), and thereby decline in crop yield (70%) in Himalaya regions (Meena et al., 2019).

Increasing temperatures and changing precipitation regimes with climate change may cause water stress in agriculture, especially in dry farming systems, as it may be challenging to meet the water needs of plants grown depending on precipitation. Similarly, as water supply becomes more complex in irrigated crops, yield losses due to water stress will increase. (Nelson et al., 2009). Also, one of the adverse effects of forage production is stimulating the growth of weeds and altering the number of invasive species in biodiversity (Finch et al., 2021). Cocklebur, a

common weed of sorghum crop, grows more and higher biomass production than sorghum crop, as well as *Rumex obtusifolius*, a noxious weed of grasslands because of increasing concentration of CO2. The rapid growth of weeds reduces crop yield (Ziska, 2001; Gilgen et al., 2010; Soni et al., 2020).

Elevated levels of $CO_2$ have been shown to improve the rate of photosynthesis in plants and alleviate the effects of drought stress by conserving water and increasing carbon fixation. Also, legumes respond more to elevated $CO_2$ through symbiotic $N_2$ fixation to counteract the progressive N limitation than non-leguminous species. The significant stimulation of $N_2$ fixation by elevated $CO_2$ is also reported in *Trifolium repens* in a fertilized Swiss grassland, soybean, and alfalfa. Furthermore, how elevated $CO_2$ affects the suppression of N fixation with N addition remains unclear but varies from a negative effect to a positive effect (Zhang et al., 2011).

However, high temperatures have been shown to inhibit photosynthesis by altering the structure of chloroplasts and by inactivating chloroplast enzymes through oxidative stress (Dekov et al., 2000; Cui et al., 2006; Taub, 2010). In forage crops where biomass influences determining yield could impact not just production under drought or flood can cause stress responses, but also forage quality has declined with rising temperatures. Drought stress has also been shown to affect water-soluble carbohydrate levels. Also, drought can decrease the protein concentration due to increased protein degradation, decreased nitrogen assimilation, and protein synthesis (Bista et al., 2018; Hart et al., 2022).

Due to the shift in flora, climate change mainly affects pasture vegetation and amendments in the constituents, such as alterations in the ratio of grasses and legumes (Soni et al., 2020). Rangeland vegetation composition changes to more xeric species that may be less suitable for grazing if climates become drier. Also, global warming has a more beneficial impact on C4 plants than on C3 plants, and this situation can cause forage quality to decrease because of changes in the balance between C3 and C4 species (Howden et al., 2008).

Moreover, decline in soil fertility, increasing soil salinity, development of resistance to various chemicals, and degradation in irrigation water quality are also related to climate change (Soni et al., 2020).

**Combating Climate Change**

Among the different scenarios about global warming, even if the optimistic picture of a +1.5°C increase is realized (IPCC, 2023), we must take measures to meet the economic food needs of the growing world population. The fight against climate change is not only in the cultivation of

crops due to declines in crop yields. At the same time, reductions in crop production can reduce the producer's profits and make it difficult for consumers to access products. This situation may cause producers to give up agricultural activities, and even consumers and producers migrate from their regions. For this reason, adaptation and mitigation works can be carried out in the fight against climate change to meet food security.

**Adaptation studies**

Adaptation is the best way to handle climate variability and change as it has the potential to minimize hazardous climate change effects for sustainable production (IPCC, 2019; Habib-ur-Rahman et al., 2022).

New plant species adaptable to new environmental conditions and high feed value can be used in adaptation studies as forage crops. *Lycium anatolicum* A. Baytop & R. Mill, an endemic species found in Türkiye, is an example of a new plant species. It is a shrub forage plant with a crude protein ratio of 27.52%, which animals consume. In addition, it has a comprehensive adaptation ability and can be easily cultivated in arid areas and pastures (Acar et al., 2021). Moreover, due to the rapid adaptation and reproduction of invasive plant species, which are increasing due to climate change, some researchers recommend their use for feed purposes. However, the main point to be considered in this regard is whether they contain harmful or toxic substances to animal health. In addition, due to the high competitiveness of these species in pasture, it should allow other plant species to grow crops after themselves in field cultivation. It should not cause the spread of diseases and pests that cause economic damage to cultivated crops. *Diplotaxis tenuifolia* is a salinity tolerant (de Vos et al.,2013) and a fast-spreading ruderal species (Erik, 2012). This species has a wide range of adaptability and has not only an essential potential in animal nutrition but also a good pollen source in beekeeping (Özcan, 2015; Uysal et al., 2016; Acar et al. 2019; Koç Koyun et al., 2022). However, various diseases (*Rhizoctonia solani, Fusarium oxysporum, Xanthomonas campestris*) and pests [*Phyllotreta* spp., *Agriotes* spp., aphids (*Brevicoryne brassicae, Myzus persicae, Lipaphis erysimi), Pieris* spp., and cutworms (*Mamestra brassicae, Autographa gamma, Spodoptera littoralis*)] are observed in *D. tenufolia*, which is cultivated as a vegetable in Italy, and more, the invasive stink bug *Bagrada hilaris* (*Hemiptera: Pentatomidae*), a severe pest of cruciferous crops in the United States, has been found to feed and deteriorate wild plants of *D. tenuifolia*, that serve as an alternative host to the bugs (Joseph, 2017; Caruso et al., 2018).

In addition, the cultivation rates of alternative forage crops belonging to other families not belonging to *Fabaceae* and *Poaceae* families resistant to adverse climate and soil conditions

can be increased in agricultural areas (Tan & Temel, 2015). Kale, Forage Rape, and Hybrids are recommended as leafy crops: stubble turnip, swedes, and fodder Beet are recommended as root crops since they grow in all types of soil structures, rapidly grow, are palatable and economically produced in the world (TN733, 2020). In addition, it is necessary to develop varieties tolerant to heat, drought, and soil salinity, mainly due to the changing climatic conditions of the species commonly grown as forage crops. (Habib-ur-Rahman et al., 2022). Alfalfa (*Medicago sativa*), cultivated worldwide, was advanced with *ZxABCG11* from the xerophyte *Zygophyllum xanthoxylum* via *Agrobacterium tumefaciens*-mediated transformation for drought and heat stress tolerance. Transgenic lines' plant height and shoot biomass were significantly higher than those of the wild type under either drought or heat treatment in greenhouse conditions (Liu et al., 2023). However, intragenic and cisgenic approaches appeared in 2004-2006 for combating climate change, as an alternative to transgenics, proposing using genes from sexually compatible species to confer new traits to plants. Although limited, these technologies have developed some examples of abiotic stress-tolerant plants and are discussed in this work. Regulation of crops generated by these technologies is the same as for transgenic ones, delaying their development. Therefore, cisgenic and intragenic technologies are good alternatives to create crops with abiotic tolerance traits, but releasing its legislation is needed to generate a real advance in this matter (González-Calquín et al., 2022).

Crop-specific management practices like altering the sowing times, similarly in grazing times, crop rotation, intercropping (Habib-ur-Rahman et al., 2022), crop diversification, and agroforestry/agro-horticulture systems to cope with climate change have a significant positive contribution as adaptation strategies. However, they need to be made aware of modern farming practices (Meena et al., 2019).

To minimize the negative effect of climate variability by conserving water through changes in irrigation amount and timely application of irrigation water (Habib-ur-Rahman et al., 2022). Özdemir & Sade (2022), who studied limited irrigation in maize, stated that corn farming with a 25% water shortage contributed to water-saving potential, providing satisfactory yield in arid and semi-arid regions like Konya, Türkiye.

Since differences in biodiversity cause changes in plant species in pasture areas, gene resources in these areas should be collected and protected. The pasture management system should increase grazing duration and rotational grazing of rangeland to reduce the damage to the flora. In this way, carbon sequestration can be achieved (Runkle et al., 2018). About 0.15 gigatons of

$CO_2$, equal to the amount of $CO_2$ produced in a year globally, can be sequestered by assuming appropriate grazing measures (Henderson et al., 2015).

In addition, soil transported to pastures and agricultural areas by flooding can cause drought in the cultivated or pasture area. Also, due to flooding, soil oxygen is reduced, and the root functions are restrained, thus inhibiting water and nutrient uptake (Qian et al., 2020). To minimize the damage caused by floods in agricultural areas, "Natural Flood Management Techniques" practices given in Figure 4, especially afforestation, strengthening of vegetation cover, selection of appropriate plant species, and creating barriers to protect soil and water are among the main measures to be taken in flood risk areas (Anonymous, 2023d).

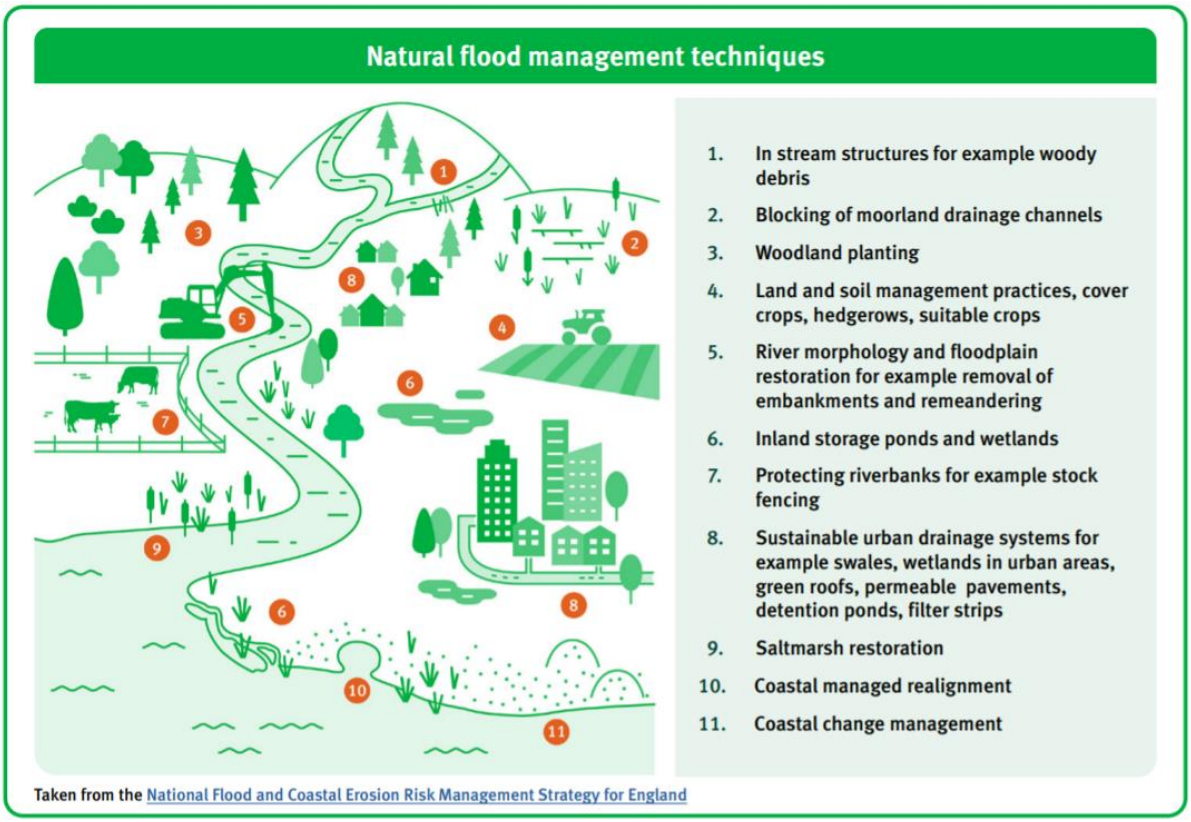


Figure 4. Natural Flood Management Techniques (Anonymous, 2023d)

**Mitigation strategies**

The goal of mitigation strategies is to reduce the emissions of various greenhouse gases, which can be achieved by enhancing the capacity of different carbon sinks (Soni et al., 2020).

The basis of mitigation strategies is to reduce greenhouse gases. For this reason, increasing vegetation and forests, which are carbon sink areas, is the first method that comes to mind. The species used in afforestation should be adapted to the region and resistant to drought. In addition, the selected species should not be vulnerable to fire. First, the principle of creating

and preserving fire-resistant forests is diminishing surface fuels. The second is to boost the height to the base of tree crowns. The third is increased space between tree crowns (Figure 5). Forty has more giant trees of more fire-resistant species. Finely promotes more fire-resistant forests at the landscape level by vertically and horizontally dropping fuels (Bennett et al., 2010).

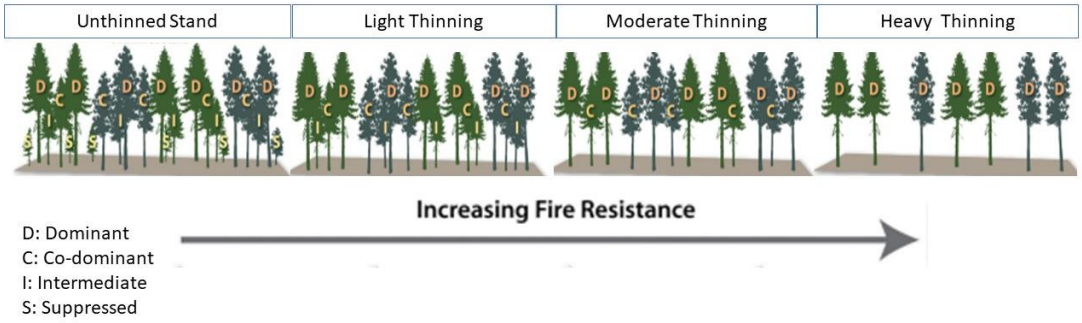


Figure 5. Thinning intensity diagram (©S. Fitzgerald) (Bennett, et al., 2010)

Another method of reducing greenhouse gas emissions is to reduce the fossil fuel used in agriculture. For this purpose, the use of renewable energy sources should be increased. Energy production with solar PV panels has been very popular recently, especially in places with high sunny days. However, using extensive land for solar farms will increase competition for food and energy demand. This land competition can be ameliorated by agrivoltaics (Dinesh & Pearce, 2016). Agrivoltaic systems are combined systems that associate crops and solar PV panels in the same area (Marrou et al., 2013; Amaducci et al., 2018; Turan, 2021). Elamri et al. (2018) stated that this system provided renewable energy, a humidified environment by drops, and reduced water consumption by the plants by shadow via a decrease of gas exchange and reduction in short-term stomatal conductance (Figure 6).

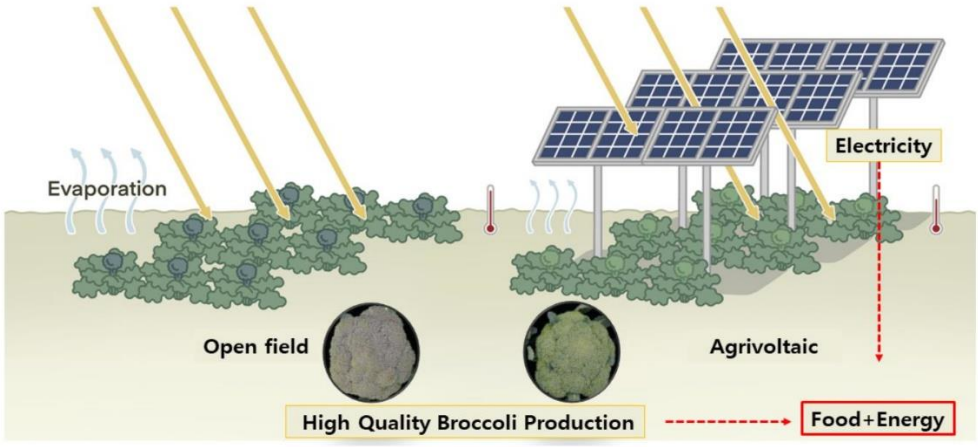


Figure 6. Agrivoltaic farming enhance growing conditions of plants (Chae et al., 2022)

There are several studies on the utilization of pastureland and fodder crop production with an Agrivoltaic system (Figure 7), and the DM yield of Italian ryegrass was similar under this system (16.9 t $ha^{-1}$) compared to conventional conditions (16.7 t $ha^{-1}$) in 2018 in Korea (Nam et al., 2021).



Figure 7. Forage and animal production in agrivoltaics system (Makhijani, 2021; Turan, 2021)

Climate-smart agriculture (CSA) is an approach that helps guide actions to modify agri-food systems toward green and climate-resilient practices. It aims to challenge three main objectives. First aim is sustainably to increase agricultural productivity and incomes. Second is to adapt and build resilience to climate change. Third is to reduce and remove greenhouse gas emissions, where possible. CSA systems include (1) managing farms, crops, livestock, aquaculture, and capture fisheries to balance near-term food security and livelihood needs with priorities for adaptation and mitigation. (2) Ecosystem and landscape management to conserve ecosystem services critical for food security, agricultural development, adaptation, and mitigation. (3) Services for farmers and land managers to enable better management of climate risks/impacts and mitigation actions. (4) Changes in the broader food system, including demand-side measures and value chain interventions. However, CSA practices included (1) Integrated practices, (2) Crop production, (3) Livestock, (4) Forestry, (5) Urban and peri-urban agriculture, (6) Genetic resources and biodiversity, (7) Fisheries and aquaculture, (8) Land and water management, (9) Proactive drought management, (10) Energy, (11) Food loss and waste, and (12) Nuclear techniques (FAO, 2023).

Central Asia is facing land degradation exacerbated by climate change, with droughts becoming more frequent and more severe because of expecting to be hit by climate change developing countries the hardest (FAO, 2012). Kazakhstan, Kyrgyz Republic, Tajikistan, Türkiye, and Turkmenistan - A regional project concentrating on the problems of land degradation and

salinization because of sustainable land management and climate-smart practices was recently granted by the GEF. In the province of Konya, Türkiye, a GEF-funded project on 'Sustainable Land Management and Climate Friendly Agriculture' has started. It will support the rehabilitation of degraded soils and the improvement of agricultural productivity through CSA practices and the introduction of low-carbon technologies (FAO, 2023).

Due to Africa being a region vulnerable to climate change, farmers have relied on integrating crop and pastoral livestock products with ecosystem-based adaptive management activity to perfect resources and reduce risk and weakness (Dixon et al., 2019). The agro-pastoral farming system in Africa is defined by a length of growing period (LGP) between 75 and 165 days in semi-arid conditions (Boffa et al., 2020). This system denotes land use systems in which livestock husbandry and cropping are practiced in association (WFP, 2018). The approach is highly complex and involves diversifying species, crop varieties, and livestock breeds in the agroecosystem over time and space—including integrating crops, trees, and livestock at the field and broader landscape levels (Pimbert et al., 2021; Lawrence et al., 2023). In this method, maize (*Zea mays*), millet (*Pennisetum glaucum*), and sorghum (*Sorghum bicolor*) are used as the main crops in the production system, depending on the region. Also, intensifying nutrient management extends the production potential of crops in shorter LGPs (Boffa et al., 2020). Agro-pastoral production system practices include fodder tree, bush, weed, invasive species and soil fertility management in rangeland, and grazing systems (multispecies, rotational, deferred, holistic planned, zero, tethered) (WFP, 2018).

Another mitigation strategy and adaptation work can be listed as using organic or biological methods instead of chemical pesticides to combat invasive pest species. The use of organic fertilizers in agriculture, which is the subject of both adaptation and mitigation studies, should be increased (Ma et al., 2022). Biological fertilizers from organic fertilizers can be caused by reducing chemical fertilization in agricultural production. The microorganisms to be used as biological fertilizers should be easy to produce, inexpensive, show high metabolic activity, and provide the possibility of long-term storage. Due to its protective properties, rhizobium bacteria are generally preferred to multiply and store in peat material (Karaca et al., 2023). Application of Plant Growth–Promoting Rhizobacteria (PGPR) has been considered an eco-friendly strategy under drought stress on plants. Han et al. (2022) investigate the effects of *Bacillus amyloliquefaciens* QST713 on botanical and physiological properties, such as plant growth, photosynthesis processes, and antioxidant enzyme activities, in two alfalfa varieties, Galalxie Max (drought-tolerant) and Saidi 7 (drought-sensitive) under drought conditions. The results

showed that drought stress significantly declined plant biomass production. At the same time, the injection of the bacillus strain QST713 was more effective on plant growth, showing higher plant biomass production compared to the non-inoculated plants under drought stress. Moreover, applying QST713 enhanced the photosynthetic capacity of alfalfa seedlings under drought stress. These results show that QST713 could be a promising bio-inoculant for plants exposed to environmental stresses.

To summarize, it can be stated that it is possible to produce high-quality and productive feed with the cultivation of new plant species, the breeding of commonly cultivated species, or agricultural activities developed with new technologies, as well as reducing greenhouse gas emissions with new farming approaches in changing climatic conditions. In conclusion, more detailed scientific studies on adaptation and mitigation strategies for agricultural production under climate change should be conducted, and these studies should be put into practice.

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# THE EFFECTS OF DIFFERENT LEVELS OF BLACK SEED (NIGELLA SATIVA) IN THE DIET OF LAYING HENS ON THE DURABILITY OF EGGS STORED IN DIFFERENT CONDITIONS

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**Abstract**
This experiment was conducted to evaluate the effects of feeding different levels of black seed powder on the durability of eggs stored in different conditions using 160 hyline-w36 hens. The experiment was conducted in the form of a CRD with 4 treatments and 5 repetitions (8 layer for each repetition). The experimental diets were: 1- control treatment 2- treatment containing 1% black seed 3- treatment containing 2% black seed 4- treatment containing 3%, black seed. Eggs were collected after feeding the diet for 8 weeks and stored for 7 or 30 days at 4 or 25°C. The results of this experiment showed that the pH of egg yolk and egg white increased and the height of egg yolk, egg white and egg unit decreased with increasing the storage of eggs from 7 days to 30 days. The effect of temperature on egg quality was significant and keeping eggs at a temperature of 25 degrees Celsius instead of 4 degrees Celsius increased the effect of time. The interaction effect of time and temperature was significant in this relationship and the highest quality loss was observed in eggs stored at 25°C for 30 days. The effect of black seed on preventing the decline of egg quality was significant. The interaction effect of storage temperature and black seeds on the internal quality of eggs was significant, and keeping eggs obtained from chickens fed with black seeds at high temperature had less quality loss than the control group, and the most quality loss was in the eggs of the control group that were kept at a temperature of 25 degrees. Celsius were stored occurred. In general, the results of this experiment showed that the use of at least one percent black seed in the diet of laying hens increases the shelf life of eggs
**Keywords:** Black Seed, Egg, layer hen, quality.

## Introductıon

Today, the use of growth-promoting antibiotics has been limited due to the possibility of bacterial resistance and also transmission to consumers through manufactured products (Abdelhady et al., 2009). Medicinal plants with antimicrobial effects have been proposed as suitable alternatives for antibiotics. In recent years, a lot of research has been done to maximize the production and quality of products and to prevent or treat some diseases (Abdelhady et al., 2009). Global poultry industries, especially in developing countries, are faced with food shortages every year. The continuous use of common feed additives from plant or animal sources in poultry diets has become a critical issue due to the high competition between livestock species and industrial purposes. This has led to an increase in the price of this feed and livestock products. There is a global trend towards finding healthier natural alternatives to synthetic drugs and therapeutic drugs in poultry farms (Alagawany et al., 2021). Therefore, the discovery of alternative feed additives is necessary for the sustainability of the poultry industry, especially in developing countries.Black seed or (Nigella Sativa L.), which is sometimes called black seed, is an annual plant that has been grown as a car since the past, but because of its seeds and flowers, its cultivation has become common in some places (Abdel-Magged et al., 2002). Among its discovered properties, it can be mentioned that it helps the body's immunity, antihistaminic properties, antimicrobial effects, anti-blood pressure and anti-inflammatory effects, most of which are attributed to the Quinone compounds found in black seeds. Research has shown that the consumption of black seed in the amount of 1-3% has been able to have a positive effect on the growth factors of broiler chickens (Abu-Dieyeh et al., 2008). Research in broiler chickens that were under heat stress conditions has shown that adding a percentage of black seeds to the diet has increased production and digestibility (Liu et al., 2014). Recent studies have shown that addition of black seed to diets of laying hens enhanced all egg quality characteristics such as : egg shell weight, albumin weight and yolk weight (Al-Hamied et al., 2011). The object of this experiment is to investigate different levels of black seed as a supplement in the diets of laying hens on the durability of eggs stored in different conditions in corn-soybean based diets.

## Materıals and Methods

The black seed required for this project was obtained from the local market; And after determining its chemical composition, experimental diets were formulated with UFFDA software according to the recommendation of the feeding guide for Hyline w36 strains at the

age of 60 weeks. The experimental diets was as follows: treatment 1 control diet (based on corn-soybean meal) without adding black seed, treatment 2 basal diet and 1% black seed, treatment 3 basal diet and 2% black seed, and treatment 4 basal diet and 3% black seed.

In the experimental diets, black seeds replaced wheat bran in the basal diet. Laying hens were placed in cages 45 cm long, 35.5 cm wide and 39 cm high. The cages are equipped with trough feeding system and nipple drinking system. Four chickens were placed in each cage and both adjacent cages were considered as an experimental unit. The lighting schedule was lighting regimen of L: D of 17:7 h. The experiment was conducted in the form of a CRD with 4 treatments and 5 repetitions (8 layer for each repetition). A week before the start of the experiment was considered for the habituation period. Eggs were collected after feeding the diet for 8 weeks and stored for 7 or 30 days at 4 or 25°C. Chickens were fed twice a day (9:30 am and 5:30 pm) and had free access to drinking water throughout the experiment. The yolk was separated and weighed, and the albumen was collected into a recalibrated graduated beaker. The albumen collected in the beaker was weighed, and the pH was measured with an Accumet 950 pH/ion meter. After sampling, each egg were weighed and broken on a flat surface. The weight of the albumen was determined by the difference between the egg weight and the yolk. The height of the thick whites was measured in three points and the Haugh unit was calculated through the following formula:

$$HU = 100 * log(h - 1.7w^{0.37} + 7.6)$$

Where:

HU = Haugh unit

$h$ = observed height of the albumen in Millimeters

$w$ = weight of egg in grams

**Fındıngs and Dıscussıon**

The results of the main effects of black seed, storage period and temperature, interaction effects between black seed and storage time, as well as the interaction between time, storage time and temperature on internal quality traits of eggs are shown in Tables 2, 3, 4 and 5.

The results show that the effects of black seed, storage time and temperature, as well as the interaction effects between them, on the internal quality traits of eggs were significant ($p>0.05$).

Table 1. The effect of storage time on egg quality

| Storage time | Yolk height | Yolk pH | Albumin pH | Haugh unit | Yolk index |
|---|---|---|---|---|---|
| **7 day** | 12.25 | 9.01b | 9.6 b | 72.35a | **28.23** |
| **30 day** | 11.79 | 9.28a | 9.93a | 66.80b | **27.16** |
| **SEM** | 0.237 | 0.065 | 0.072 | 1.323 | **0.545** |
| **Pvalue** | 0.169 | <0.01 | 0.014 | <0.01 | **0.168** |

Means denoted by a different letter indicate significant differences between treatments ($p < 0.05$).

By increasing the storage time of eggs in, the pH of egg white increases to 9.93 or even higher values, and this increase in pH is due to the release of carbon dioxide gas from the holes in the egg shell. While the pH of egg yolk decreases with time.

Table 2 The effect of storage temperature on egg quality

| Temperature | Yolk height | Yolk pH | Albumin pH | Haugh unit | Yolk index |
|---|---|---|---|---|---|
| **4** | 15.12a | 9.08 | 9.55b | 86.21a | **34.83a** |
| **25** | 8.92b | 9.21 | 10.06a | 52.95b | **20.56b** |
| **SEM** | 0.237 | 0.065 | 0.072 | 1.323 | **0.545** |
| **P-value** | <0.01 | 0.185 | <0.01 | <0.01 | **<0.01** |

Means denoted by a different letter indicate significant differences between treatments ($p < 0.05$).

Also, the results show that with the increase in storage temperature from 4°C to 25°C, the amount of internal quality traits of eggs (white pH, yolk index, yolk height and Haw unit) decreased significantly ($p>0.05$); While it did not show any significant effect on the pH of egg yolk ($p < 0.05$). Jin et al. (2011) showed that a significant increase in the pH values of egg white and yolk was observed with increasing temperature and storage time. A rapid increase in albumin pH was observed, even after only 2 days of storage, regardless of storage temperature. The results of which were consistent with the present study. In the present study, the pH of egg white increased with increasing storage time. But it decreased with increasing temperature. A very significant interaction between storage time and temperature was observed for the pH of the yolk and the Haugh unit ($p < 0.05$). Most of the increase occurred during the first 7 days of storage at 4 °C. These findings are consistent with the results reported by other researchers (Akyurel and Okur, 2009).

Our results showed that the interaction effects of storage temperature and time on egg white pH were not significant ($p<0.05$). In line with the results of our study, Walsh et al. (1995) reported that neither storage time nor temperature affected the pH of egg whites. The increase in the pH of the yolk was not as high as the increase in the pH of the white. Yolk pH did not differ during 7 and 30 days of storage at 4°C. In contrast, Semli et al. (2005) showed that yolk pH varied from 5.75 to 6.08 during 10 days of storage at 29°C. The present results are consistent with the results of other researchers (Samli et al.,

2005; Akyurel and Okur, 2009). They also found that the increase in yolk pH was significantly affected by storage time. Albumin pH varied even at 5°C storage temperature**.**

Table 3. The interaction effects of black seed and storage period on internal quality traits of eggs

| Black seed × storage time | Yolk height | Yolk pH | Albumin pH | Haugh unit | Yolk index |
|---|---|---|---|---|---|
| **0 × 7** | 12.84a | 9.37 | 10.02 | 68.59 | **26.06b** |
| **0 × 30** | 10.90b | 9.35 | 10.33 | 66.88 | **24.84b** |
| **1 × 7** | 12.87a | 9.20 | 9.41 | 71.58 | **29.10ab** |
| **1 × 30** | 11.36b | 8.84 | 9.60 | 69.39 | **26.09b** |
| **2 × 7** | 12.52ab | 9.37 | 9.68 | 70.01 | **29.51a** |
| **2 × 30** | 11.23b | 8.97 | 9.86 | 64.92 | **28.19ab** |
| **3 × 7** | 12.30ab | 9.17 | 9.60 | 69.22 | **29.26ab** |
| **3 × 30** | 12.17ab | 8.90 | 9.93 | 66.04 | **28.51ab** |
| **SEM** | 0.474 | 0.131 | 0.144 | 2.647 | **1.091** |
| **P-value** | <0.01 | 0.479 | 0.943 | 0.382 | **<0.01** |

Means denoted by a different letter indicate significant differences between treatments ($p < 0.05$).

The results show that Storage eggs for 30 days at 25 °C decreased the Haugh unit, but this reduction was not significant. This reduction shows the effect of time on the proteolysis of ovomucin and the breaking of some disulfide bonds between egg white proteins, which has caused the decrease in the height of the yolk and the Haugh unit. Contrary to the present study, Kirunda and McKee (2000) and also Silversides et al. (2001) showed that keeping eggs for two weeks at room temperature resulted in a significant decrease in Haugh unit.

Table 4. The interaction effects of black seed and storage temperature on internal quality traits of eggs

| Black seed × Storage temp. | Yolk height | Yolk pH | Albumin pH | Haugh unit | Yolk index |
|---|---|---|---|---|---|
| **0 × 4** | 14.91 | 9.07b | 10.14a | 83.99 | **33.98** |
| **0 × 25** | 8.83 | 9.65a | 10.21a | 48.49 | **20.12** |
| **1 × 4** | 15.15 | 8.92b | 9.50b | 85.84 | **34.73** |
| **1 × 25** | 9.08 | 9.12b | 10.12a | 54.09 | **20.83** |
| **2 × 4** | 15.19 | 9.14b | 9.42b | 86.77 | **35.30** |
| **2 × 25** | 8.56 | 9.19b | 10.02a | 51.48 | **19.90** |
| **3 × 4** | 15.25 | 9.00b | 9.09b | 88.24 | **35.33** |
| **3 × 25** | 9.22 | 9.06b | 9.95a | 57.73 | **21.38** |
| **SEM** | 0.474 | 0.131 | 0.144 | 2.647 | **1.091** |
| **P-value** | 0.908 | 0.033 | 0.010 | 0.472 | **0.871** |

Means denoted by a different letter indicate significant differences between treatments ($p < 0.05$).

The interaction effects of black seed and storage time on the yolk index were significant, so that the maximum yolk index was observed in the treatment of one percent of black seed and 7 days of storage. (Table 4) The amount of yolk index is one of the freshness indicators of eggs. The more yolk height and the smaller the diameter of the yolk, the better the quality of the yolk index. Based on the value of Indonesian national standard (SNI) for consumption eggs, egg yolk index is divided into three, that is, grade I with egg yolk index value of 0.521-0.458, grade II between 0.457-0.394 0 and grade III between 0.33-0.393 (Widyantara et al., 2017). The yolk index decreased during the storage period along with the decrease in egg white quality, and as

a result, water was transferred from the white to the yolk. Jin et al. (2011) reported that the dilution factor of egg white is caused by an increase in pH, which leads to damage to protein fibers (ommosin). In the present study, due to its antioxidant compounds, black seed prevents the separation of water from egg white to egg yolk. As a result, water is removed from the egg white protein and the dilution process occurs. According to Khan et al. (2013), the decrease in egg yolk index can be influenced by the duration of storage, storage location, temperature, vitelline membrane quality and feed nutrition. There is a difference in osmotic pressure between egg yolk and egg white, where the osmotic pressure in egg yolk is higher than in egg white. This leads to the movement of water from the egg white to the yolk through the vitelline membrane, thereby reducing the viscosity of the yolk and damaging the protein fibers that make up the vitelline membrane. This process reduces the height of the yolk and increases the diameter of the yolk so that the value of the yolk index decreases.

**Conclusıon and Recommendatıons**

In general, the results of this experiment showed that the use of at least one percent black seed in the diet of laying hens increases the shelf life of eggs

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# THE EFFECT OF SOME ORGANIC PREPARATIONS ON PLANT GROWTH AND FRUIT QUALITY CHARACTERISTICS IN RUBYGEM STRAWBERRY VARIETY

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**Abstract**
This study was carried out at Research and Application Greenhouse of Department of Horticulture of Agriculture Faculty in Selçuk University. At research, it was aimed to be determined the effects of Herbagreen and Seaweed organic products on plant growth, yield, and fruit properties in “Rubygem” strawberry cultivar. The three different concentrations (0, 200ppm, 500ppm, 800 ppm) of Herbagreen and Seaweed have been applied to the plants with irrigation water every week, while no application was performed to those belonging to control group. In our study, significant differences in plant growth and fruit quality characteristics have been identified through the application of Herbagreen and Seaweed treatments. The application of 800ppm Herbagreen has resulted in the highest values for root number, root length, root fresh, and dry weights compared to other treatments. The 200ppm of Seaweed has provided the highest values in terms of yield per decare, yield per plant, average fruit number, and average fruit weight compared to other applications. Yield per plant were determined 806.22 g/plant in 200ppm Seaweed application while 718.49 g/plant in control group. The applications conducted have led to a decrease in titratable acidity and soluble solids content in the fruits, while increases in pH have been observed. The highest titratable acidity and soluble solids content were determined in the control group, with values of 0.878 g/100ml and 9.01%,

respectively. Different Seaweed and Herbagreen applications applied to strawberries are believed to be effective in plant growth and fruit quality characteristics.
**Keywords:** Herbagreen, Plant growth, Rubygem, Seaweed, Strawberry, Yield

## Introduction

Strawberry (*Fragaria X ananasa*) belongs to the *Rosaceae* family, *Rosoideae* subfamily, and *Fragaria* genus. Its cultivation is widespread among berry fruits worldwide, and the wild forms have spread up to the 64th northern latitude. Cultivated species and varieties can be successfully grown in areas where their wild counterparts thrive. It is a fruit that can be consumed both fresh and is suitable for industrial purposes. Strawberry can also be grown as an intermediate crop plant. Due to their ability to bear fruit from the year they are planted and not requiring long-term investments, they provide additional income to farmers until newly established fruit orchards become productive, thereby reducing the cost inputs of the orchard. While strawberry cultivation and production in Turkey have a history of around 30 years, it has gained more importance in recent years. Today, our country ranks third after the USA with a production of 669.195 tons (FAO, 2021). The use of healthy young plants from special seedling growing plots in some regions has significantly increased yield and quality.

Intensive agricultural practices in fruit growing to obtain high yield and quality products require the intensive use of chemical fertilizers, which are costly and create environmental problems. As a result, the environment is adversely affected by toxic substances, as chemicals seep into rivers and water reservoirs, contaminating our drinking water and exacerbating the effects of global warming. For this reason, interest in environmentally friendly, sustainable, and organic agricultural practices has increased recently. The use of bio-fertilizers containing beneficial microorganisms and organic products, instead of synthetic chemicals, is known to enhance plant growth through the provision of nutrients and contribute to the maintenance of environmental health and soil fertility.

Seaweed extracts are bio stimulants that have been traditionally used as soil conditioners in improving plant growth in agricultural crops (Hurtado et al., 2009). Seaweed products, when left in the soil for an extended period under natural conditions, easily decompose, releasing abundant amounts of nitrogen (N) and calcium (Ca). Furthermore, they also contain trace elements such as magnesium (Mg), manganese (Mn), boron (B), iron (Fe), zinc (Zn), copper (Cu), and cobalt (Co). All of these effects of seaweed are attributed to the presence of macro and micro elements (N, Ca, Mg, Mn, B, B, Fe, Zn, Cu, Co), plant growth regulators (Auxins, Cytokinin's, Gibberellins, Abscisic Acid), and compounds like betaines. Today, it is known that seaweeds are used in agriculture, especially in organic farming, in various regions around the world with the aim of increasing yield and quality, regulating plant growth, enhancing resistance to diseases and pests, and improving soil structure, as well as for animal husbandry.

Herbagreen is a completely natural product produced through the processing of limestone (100% CaO, MgO, $Fe_2O_3$, $SiO_2$). It enhances yield and quality in crop production without causing any harm to the environment. It provides several benefits due to its physiological responses involving calcium and carbondioxide, including increasing the proportion of dry substances such as sugar and vitamins, extending storage and shelf life, reducing unnecessary evaporation to significantly decrease the plant's water requirements, and strengthening plant immunity by forming a robust leaf structure.

**Materials and Methods**

The study was conducted at Research and Application Greenhouse of Department of Horticulture of Agriculture Faculty in Selçuk University. Experiment was carried out on "Rubygem" (*Fragaria x ananassa* Duch.) short-day strawberry cultivar. Seaweed contains all major and minor plant nutrients, and all trace elements; alginic acid; vitamins; auxins; at least two gibberellins; and antibiotics. Herbagreen made of carbonate calcium, silica, magnesium, and certain trace elements. Strawberry seedlings were planted in 5-liter pots containing a 1:1 mixture of peat and perlite. Plants were maintained under natural light conditions. To determine the effects of the commercial organic seaweed fertilizer called "Effort Powder" and Herbagreen fertilizer on the growth, fruit quality, and yield of strawberry plants, four different doses (0, 200ppm, 500ppm and 800ppm) were applied to the plants at 10-day intervals from the roots.

The experiment was a completely randomized design with 3 replicates per treatment and 10 plants per replicates (two organic preparations x four treatments x three replicates x 10 plants = 240 plants in total). Parameters such as yield per decare (kg), yield per plant (g), average fruit weight (pcs), average number of fruit (g), fruit firmness ($kg/cm^2$), titratable acidity (g/100ml), total soluble solids content (%) and pH were examined. All data in the present study were subjected by analysis of variance (ANOVA) and means were separated by Duncan's multiple range test at the 0.05 significance level was conducted.

**Results and Discussion**

The number of roots, root length, root fresh weight, root dry weight, number of stems, stem diameter, stem fresh weight, stem dry weight, number of leaves, and leaf area obtained in the research are given in the Table-1. It has been found that these applications statistically increase plant development. Considering the parameters examined in our research, it was determined that seaweed applications had positive effects on the stem and leaf development of strawberry plants. The 200ppm application gave better results than other applications. As a matter of fact, seaweed was used to fertilize strawberries in greenhouses in France and it was

reported that it had positive effects on development (Whapham et al., 1994). According to the measurements taken, the maximum number of stems with 3.25 pcs/plant, and the stem diameter with 40.01 mm is obtained from the seaweed application at 200ppm. Similarly, the best stem fresh (88.70 g) and dry (24.00 g) weights were determined in 200 ppm seaweed. In our study, it was determined that a 200ppm seaweed concentration (54.30 $cm^2$) increased the leaf area, which was 47.87 $cm^2$ in the control, by 13.4% (Table-1). In a study, it was determined that 0.1% seaweed application increased stem diameter, stem fresh and dry weights and leaf area in Aromas strawberry variety compared to the control (Arıkan, 2011). It has been determined that Herbagreen applications have positive effects on root development in Rubygem strawberry variety. It was determined that the number of roots, root fresh and dry weights increased more than the applied seaweed. Accordingly, the highest number of roots, 21.50 pieces, and the longest root length, 11.25 cm, were obtained from the 500 ppm Herbagreen concentration. However, the Herbagreen application that increased the root fresh (6.09 g) and dry (2.39 g) weight the most was the application with a concentration of 800ppm.

**Table 1.** Effects of applications on plant growth in strawberry

| TREATMENT | NUMBER OF STEMS (PCS/PLANT) | STEM DIAMETER (MM) | STEM FRESH WEIGHT (G) | STEM DRY WEIGHT (G) | NUMBER OF LEAVES (PCS/PLANT) | LEAF AREA ($CM^2$) | NUMBER OF ROOTS (PCS/PLANT) | ROOT LENGTH (CM) | ROOT FRESH WEIGHT (G) | ROOT DRY WEIGHT (G) |
|---|---|---|---|---|---|---|---|---|---|---|
| CONTROL | 3.00 a | 37.82 a | 63.37 bc | 22.54 ab | 22.75 a | 47.87 ab | 16.25 ab | 10.50 ab | 5.03 ab | 1.60 c |
| 200 PPM SEAWEED | 3.25 a | 40.01 a | 88.70a | 24.00 a | 23.25 a | 54.30 a | 20.75 a | 10.50 ab | 4.94 ab | 1.68 c |
| 500 PPM SEAWEED | 1.75 b | 19.22 c | 42.95 c | 13.29 c | 10.50 b | 45.38 b | 17.50 ab | 9.25 c | 3.90 b | 1.17 c |
| 800 PPM SEAWEED | 2.25 b | 34.42 ab | 65.50 abc | 24.12 a | 16.25 ab | 39.32 bc | 16.75 ab | 10.00 b | 5.81 ab | 2.29 ab |
| 200 PPM HERBAGREEN | 2.00 b | 25.53 bc | 51.85 bc | 14.93 c | 12.50 b | 33.15 c | 14.50 b | 9.00 c | 4.54 ab | 1.78 bc |
| 500 PPM HERBAGREEN | 2.25 b | 31.22 ab | 70.89 ab | 18.32 abc | 18.00 ab | 33.87 c | 21.50 a | 11.25 a | 5.75 ab | 1.81 bc |
| 800 PPM HERBAGREEN | 2.00 b | 26.37 bc | 47.36 bc | 16.06 bc | 12.75 b | 30.34 c | 14.25 b | 11.00 a | 6.09 a | 2.39 a |

Trials showed that Herbagreen and Seaweed applications affected yield per decare, yield per plant, number of fruit and fruit weight in this study (Table-2). The results showed that yield per plant significantly increased by all treatments compared with control. The yield per plant was found from 200 ppm seaweed application 806.22 g/plant and 800 ppm Herbagreen application 727.46 g/plant and while was found from the control in 718.49 g/plant (Table-2). Similar findings were reported in the previous studies showing that application of Seaweed may stimulate yield and quality parameters. Turan & Kose (2004) on grapevine, Mancuso et al. (2006) and Rathore et al. (2009) on soybean observed increases in yield with application of seaweed extract. Zodape et al. (2008), Arthur et al. (2003) on pepper and Zodape et al. (2010)

on mung bean indicated that application of seaweed extracts significantly increased. There were significant differences between applications on average fruit weight. Fruit weight was increased by applications compared with the control and these effects were found statistically significant. The highest fruit weight was obtained by 200 ppm seaweed (15.32 g) application. It was determined that the treatments increased importantly number of fruits compared with the control. The average fruit number was found from 200 ppm seaweed application 46.33 pcs/plant while was found from the control in 42.63 pcs/plant (Table-2). Similarly, in a study conducted on strawberries, it was reported that seaweed and Herbagreen applications improved the yield per plant and fruit quality characteristics (Arıkan et al., 2014). Crouch and Van-Staden (2005) found that spraying plants with concentrated seaweed extracts gave increased fruit number by 10% and fruit weight by 15%. Number of fruits per plant and fruit yield per plant was significantly increased as a result of the application of 750 ppm of chlormequat and 1680 ppm of seaweed extract (Saravanan et al., 2003). Although titratable acidity, TSS and pH were found to be statistically significant in Herbagreen and Seaweed applications compared to the control, there were not many differences.

**Table 2.** Effects of applications on fruit quality and yield in strawberries

| TREATMENT | YIELD PER DECARE (KG) | YIELD PER PLANT (G) | NUMBER OF FRUIT (PCS/PLANT) | AVERAGE FRUIT WEIGHT (G) | FRUIT FIRMNESS ($KG/CM^2$) | TITRATABLE ACIDITY (G/100ML) | TSS (%) | PH |
|---|---|---|---|---|---|---|---|---|
| CONTROL | 2873,96 a | 718,49 b | 42,63 b | 14,82 ab | 0,87 a | 0,878 a | 9,01 a | 4,00 bc |
| 200 PPM SEAWEED | 3224,89 a | 806,22 a | 46,33 a | 15,32 a | 0,84 ab | 0,844 b | 9,05 a | 3,99 c |
| 500 PPM SEAWEED | 2630,83 c | 657,70 c | 39,39 c | 14,68 ab | 0,86 a | 0,804 c | 9,04 a | 4,15 a |
| 800 PPM SEAWEED | 2186,90 d | 546,72 d | 34,39 d | 14,00 b | 0,81 ab | 0,854 ab | 9,07 a | 3,93 d |
| 200 PPM HERBAGREEN | 2713,16 c | 678,28 c | 41,37 b | 14,37 b | 0,81 ab | 0,840 b | 8,42 b | 4,04 b |
| 500 PPM HERBAGREEN | 2617,19 c | 654,30 c | 41,03 bc | 14,06 b | 0,85 a | 0,848 ab | 8,42 b | 4,12 a |
| 800 PPM HERBAGREEN | 2909,86 b | 727,46 b | 42,85 b | 14,75 ab | 0,79 b | 0,782 c | 8,63 b | 3,98 c |

## Conclusion and Recommendations

Fruit growing which is the sub-sector in agriculture is one of our country's major sources of income in some regions and localities. Although there are different problems in regions and fruits grown, in generally, one of the important problems in Turkey are fruit growing techniques and low yield per decare. The fruit yield can increase if the species, varieties, and cultivation techniques are used efficiency. In intensive farming practices, more

yield and more quality require to use chemical fertilizers, so they are costly and cause environmental problems. In recently, environmentally friendly, sustainable, and organic agricultural practices have been widely using (Esitken, 2011). Using of the bio-fertilizers instead of the synthetic fertilizers prevent to environmental problems and help to improve plant growth and protection environmental health and soil productivity (O'Connell, 1992). The results of the present study suggested that Herbagreen and Seaweed have a great potential to increase plant growth, the yield and fruit properties of strawberry plant. Therefore, they may be utilized as bio-fertilizer and bio-pesticide for fruit and vegetable production in sustainable and ecological agricultural systems.

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# THE EFFECT OF PERLAN, HERBAGREEN, AND SEAWEED APPLICATIONS ON FRUIT QUALITY AND YIELD IN SOME APPLE VARIETIES

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**Abstract**
Apple is the most widely traded and rapidly changing fruit in the world due to its suitability for the taste and income levels of almost all people worldwide, just like in Turkey. In order to meet this demand, various practices aimed at improving the plant and fruit characteristics in apple cultivation are intensively carried out. The aim of this study is to investigate the effect of using "Perlan" as a plant growth regulator and the organic preparations like "Herbagreen" and "Seaweed" application on yield and fruit quality characteristics in some apple varieties. Summer Red, Jersey Mac, Braeburn, Jonagold, Fuji, and Golden Delicious varieties grafted onto M9 rootstock, and the Red Chief variety grafted onto M26 rootstock were used in the experiment at 7 years old. Perlan, Herbagreen, and Seaweed were sprayed three times on the leaves at full bloom, 15 days after full bloom, and 30 days after full bloom. When the effects of the applications on fruit weight were studied, the highest values were obtained from the Herbagreen application in the Braeburn (132.13g), Fuji (152.45g) and Jonagold (154.92g) varieties, whereas the highest fruit weights were obtained from the control group in the Summer Red (119.49), Jersey Mac (102.65g), Golden Delicious (178.55g) and Red Chief (192.78g) varieties. The highest average yield per tree was obtained from the Seaweed application at 22.10g/tree in the Golden Delicious, while the lowest yield was obtained from the control group at 4.8g/tree in the Jersey Mac. Considering the parameters investigated in our study, it has been determined that the Seaweed application increases the average yield per tree, the number of fruits per tree, and the yield per decare.
**Keywords:** Apple, Fruit Quality, Herbagreen, Perlan, Seaweed, Yield

## Introduction

Apple (*Malus communis* L.) belongs to the *Malus* genus of the *Rosaceae* family. There are more than 30 species in the *Malus* genus (Özbek, 1978). Anatolia is located among the native regions of apples. Apple is a type of fruit that suits the taste and income levels of almost all people around the world, as well as in Turkey. For these reasons, it has found a wide trade area for itself. Apple is the most traded and rapidly changing fruit in terms of consumer demand worldwide. In world apple production, China ranks first with 33.804.78 tons, while Turkey with 6.691.95 tons ranks third (FAO, 2021). However, it is able to export only about 1% of its production. The increase in fruit production in our country indicates that the yield per unit area is gradually increasing, surpassing the increase in the number of trees. Due to favorable ecological conditions, Isparta is among the leading provinces where apples are mostly cultivated. Meeting this demand is not difficult for countries that achieve their production through intensive cultivation.

Intensive agricultural practices in fruit growing to obtain high yield and quality products require the intensive use of chemical fertilizers, which are costly and create environmental problems. As a result, the environment is adversely affected by toxic substances, as chemicals seep into rivers and water reservoirs, contaminating our drinking water and exacerbating the effects of global warming. For this reason, interest in environmentally friendly, sustainable, and organic agricultural practices has increased recently. The use of bio-fertilizers containing beneficial microorganisms and organic products, instead of synthetic chemicals, is known to enhance plant growth through the provision of nutrients and contribute to the maintenance of environmental health and soil fertility.

Seaweed extracts are bio stimulants that have been traditionally used as soil conditioners in improving plant growth in agricultural crops (Hurtado et al., 2009). Seaweed products, when left in the soil for an extended period under natural conditions, easily decompose, releasing abundant amounts of nitrogen (N) and calcium (Ca). Furthermore, they also contain trace elements such as magnesium (Mg), manganese (Mn), boron (B), iron (Fe), zinc (Zn), copper (Cu), and cobalt (Co). All of these effects of seaweed are attributed to the presence of macro and micro elements (N, Ca, Mg, Mn, B, B, Fe, Zn, Cu, Co), plant growth regulators (Auxins, Cytokinin’s, Gibberellins, Abscisic Acid), and compounds like betaines. Today, it is known that seaweeds are used in agriculture, especially in organic farming, in various regions around the world with the aim of increasing yield and quality, regulating plant growth, enhancing resistance to diseases and pests, and improving soil structure, as well as for animal husbandry.

Herbagreen is a completely natural product produced through the processing of limestone (100% CaO, MgO, $Fe_2O_3$, $SiO_2$). It enhances yield and quality in crop production without causing any harm to the environment. It provides several benefits due to its physiological responses involving calcium and carbondioxide, including increasing the proportion of dry substances such as sugar and vitamins, extending storage and shelf life, reducing unnecessary evaporation to significantly decrease the plant's water requirements, and strengthening plant immunity by forming a robust leaf structure. Perlan has many benefits, especially in apple and pear varieties, such as enlarging the fruits and increasing the weight of the fruit, increasing yield, creating more fruit branches, and regulating fruit set.

**Materials and Methods**

This study was carried out in the apple garden located on one decare of land belonging to the Department of Horticulture, Faculty of Agriculture, Selçuk University, Konya. The varieties were planted with 3.5x1.5 m row and row spacing. In the study, it was at 7-year-old which Jersey Mac, Summer Red, Jonagold, Braeburn, Golden Delicious, Fuji varieties on M9 rootstock and Red Chief variety on M26 rootstock were used. Seaweed contains all major and minor plant nutrients, and all trace elements; alginic acid; vitamins; auxins; at least two gibberellins; and antibiotics. Herbagreen made of carbonate calcium, silica, magnesium, and certain trace elements. Perlan contains 18.5 g $GA_{4+7}$ and 18.8 g 6-Benzyaldenine per liter. Perlan, Herbagreen, and Seaweed were sprayed on the trees and applied 3 times during the full bloom period, 15 days after full bloom and 30 days after full bloom. Perlan at the doses of 20ppm, Herbagreen, and Seaweed at the doses of 2000ppm were applied to the trees.

The experiment was a completely randomized design with 3 replicates per treatment and 3 trees per replicates. Pomological measurements were made by taking 5 fruits from each tree. Parameters such as fruit width (mm) and height (mm), fruit flesh firmness ($kg/cm^2$), fruit Hue value, total soluble solids content (%), average number of fruit (pcs/tree), average fruit weight (g), yield per tree (kg), and yield per decare (kg/da), were examined. All data in the present study were subjected by analysis of variance (ANOVA) and means were separated by Duncan's multiple range test at the 0.05 significance level was conducted.

**Results and Discussion**

Summer Red, Braeburn, Fuji, Golden Delicious, Jersey Mac Jonagold and Red Chief apple varieties were found in the effects of treatments on fruit quality traits and yield in significant differences. As a result of fruit width and height measurements, Seaweed application increased the fruit width of the Jonagold variety by 8.6% compared to the control and was found

to be 70.85 mm. In fruit height measurements, Herbagreen application increased by 10.17% in Jonagold variety, Perlan application increased by 5.0% in Fuji variety and 5.33% in Braeburn variety compared to the control (Table 1.). Seaweed application gave the highest color hue value (75.48) in Jersey Mac variety and showed an increase of 53.2% compared to the control. Applications made in fruit flesh firmness did not cause significant differences between varieties (Table 2.).

Table 1. Effects of applications on fruit width and height in apple varieties

| | Fruit Width (mm) | | | | Fruit Height (mm) | | | |
|---|---|---|---|---|---|---|---|---|
| | Control | Perlan | Herbagreen | Seaweed | Control | Perlan | Herbagreen | Seaweed |
| **Summer Red** | 58,73a | 55,23b | 58,80a | 55,47b | 52,81a | 52,86a | 52,97a | 51,17b |
| **Braeburn** | 65,74a | 64,61b | 65,51ab | 65,59ab | 54,70bc | 57,62a | 55,69b | 53,38c |
| **Fuji** | 67,50 | 68,63 | 68,86 | 68,05 | 58,51c | 61,43a | 60,07ab | 59,31bc |
| **Golden Delicious** | 74,11a | 71,59b | 70,75b | 70,28b | 67,63a | 64,57b | 63,28b | 62,69b |
| **Jersey Mac** | 63,00 | 62,21 | 64,54 | 64,64 | 52,41 | 52,67 | 53,43 | 51,48 |
| **Jonagold** | 65,24c | 67,61bc | 70,50ab | 70,85a | 56,42b | 59,44a | 62,16a | 60,71a |
| **Red Chief** | 81,03a | 74,32b | 70,45c | 72,51bc | 70,20a | 63,67b | 61,64c | 63,45bc |

**Table 2.** Effects of applications on fruit flesh firmness and fruit hue value in apple varieties

| | Fruit Flesh Firmness (kg/cm$^2$) | | | | Fruit Hue Value | | | |
|---|---|---|---|---|---|---|---|---|
| | Control | Perlan | Herbagreen | Seaweed | Control | Perlan | Herbagreen | Seaweed |
| **Summer Red** | 3,46b | 3,36b | 3,36b | 3,60a | 47,81c | 59,96a | 43,61d | 51,82b |
| **Braeburn** | 4,06a | 4,08a | 3,80b | 3,97ab | 27,49c | 28,50bc | 30,88a | 30,30ab |
| **Fuji** | 3,56a | 3,50ab | 3,40b | 3,53ab | 44,77a | 37,47b | 31,01d | 32,45c |
| **Golden Delicious** | 3,23 | 3,3 | 3,26 | 3,2 | 108,04 | 107,64 | 106,3 | 109,01 |
| **Jersey Mac** | 4,86 | 4,83 | 4,8 | 4,96 | 49,25c | 64,75b | 58,60b | 75,48a |
| **Jonagold** | 3,4 | 3,26 | 3,06 | 3,13 | 33,22 | 35,82 | 35,38 | 34,72 |
| **Red Chief** | 3,26 | 3,63 | 3,43 | 3,66 | 21,58b | 22,95ab | 23,67ab | 24,54a |

In a study conducted on the development of dwarf apple seedlings under the ecological conditions of Van, fruit weight was determined to be between 201.24-135.58 g, fruit volume between 186-148 cm³, fruit width between 8.10-7.08 cm, and fruit height between 5.90-6.85 cm (Yarılgaç et al., 2000). There were differences between applications and varieties on average fruit weight and these effects were found statistically significant. The highest fruit weight was obtained from the control application with 192.78 g in the Red Chief variety (Table 3.). Significant increases in trees were observed in the applications made according to the yield per tree and per decare values. This situation, which is related to carbohydrate sharing, may result in a decrease in fruit weight due to increased competition with carbohydrates due to the

increase in the number of fruits on the tree (Arikan & Pirlak, 2016). It was determined that the treatments increased importantly number of fruits compared with the control. The most fruit number was detected in the Perlan application in Braeburn (115.00 pcs/tree) and Red Chief (64.33 pcs/tree) varieties, and in the Seaweed application in Golden Delicious (176.33 pcs/tree) and Jonagold (74.33 pcs/tree) varieties (Table 3.). Similarly, in a study conducted on strawberries, it was reported that Seaweed and Herbagreen applications improved the yield per plant and fruit quality characteristics (Arıkan et al., 2014). Crouch and Van-Staden (2005) found that spraying plants with concentrated seaweed extracts gave increased fruit number by 10% and fruit weight by 15%.

Table 3. Effects of applications on average number of fruit and fruit weight in apple varieties

| | Average Number of Fruit (pcs/tree) | | | | Average Fruit Weight (g) | | | |
|---|---|---|---|---|---|---|---|---|
| | **Control** | **Perlan** | **Herbagreen** | **Seaweed** | **Control** | **Perlan** | **Herbagreen** | **Seaweed** |
| **Summer Red** | 150,33a | 138,00b | 133,66b | 92,00c | 119,49a | 91,87d | 99,75b | 95,38c |
| **Braeburn** | 91,00c | 115,00a | 86,66d | 102,00b | 128,33a | 130,51a | 132,13a | 117,06b |
| **Fuji** | 119,66a | 69,00d | 103,66b | 91,33c | 137,99d | 143,58c | 152,45a | 147,63b |
| **Golden Delicious** | 90,00d | 11,33c | 123,33b | 176,33a | 178,55a | 150,97b | 119,83c | 151,44b |
| **Jersey Mac** | 48,66a | 39,33b | 32,33c | 37,66b | 102,65a | 91,66c | 101,87a | 97,41b |
| **Jonagold** | 60,66ab | 36,00b | 64,33ab | 74,33a | 99,01b | 134,65a | 154,92a | 152,89a |
| **Red Chief** | 49,66c | 64,33a | 54,00b | 63,33a | 192,78a | 170,00b | 155,11c | 156,79c |

Trials showed that Herbagreen, Seaweed and Perlan applications affected yield per decare, yield per tree, number of fruit and fruit weight in this study. The results showed that yield per tree and yield per decare significantly increased by all treatments compared with control except for Summer Red and Jersey Mac varieties (Table 4.). The highest yield per tree was obtained from the seaweed application with 22.10 kg/tree in the Golden Delicious variety, while the lowest yield per tree was obtained from the Herbagreen application with 2.81 kg/tree in the Jersey Mac variety. Compared to the control, Perlan application increased the yield per tree by 28.3% in Braeburn variety, 40.2% in Red Chief variety, Seaweed application increased by 22% in Braeburn variety, 9.8% in Fuji variety, 51.4% in Golden Delicious variety, 62.9% in Jonagold variety, and 19% in Red Chief variety. When the yield per decare of the varieties is examined, it is seen that the applications affect the yield at a statistically significant level. Seaweed application significantly increased the yield per decare all treatments compared with control except for Summer Red and Jersey Mac varieties. The highest yield per decare was obtained in the Golden Delicious (6189.86 kg/da) variety, followed by Fuji (4257.86 kg/da), Breaburn (3076.26 kg/da), Jonagold (2835.65 kg/da) and Red Chief (2493.49 kg/da) varieties,

respectively (Table-4). Generally similar results were obtained in previous studies on the subject. As a matter of fact, Turan and Kose (2004) found yield that seaweed extracts significantly increased in grapevine.

Table 4. Effects of applications on yield per tree and yield per decare in apple varieties

| | Yield Per Tree (kg/tree) | | | | Yield Per Decare (kg/da) | | | |
|---|---|---|---|---|---|---|---|---|
| | **Control** | **Perlan** | **Herbagreen** | **Seaweed** | **Control** | **Perlan** | **Herbagreen** | **Seaweed** |
| **Summer Red** | 13,60a | 11,43b | 11,01b | 7,99c | 3809,68a | 3200,40b | 3084,66b | 2238,60c |
| **Braeburn** | 8,95b | 11,49a | 9,65b | 10,98a | 2506,00b | 3218,13a | 2702,93b | 3076,26a |
| **Fuji** | 13,84b | 9,67d | 12,23c | 15,20a | 3877,06b | 2709,46d | 3425,33c | 4257,86a |
| **Golden Delicious** | 14,59b | 14,48b | 13,18 | 22,10a | 4086,69b | 4055,05b | 3691,33c | 6189,86a |
| **Jersey Mac** | 4,81a | 3,21b | 2,81b | 3,20b | 1347,64a | 898,70b | 786,14b | 897,49b |
| **Jonagold** | 6,21bc | 4,03c | 8,30ab | 10,12a | 1739,73bc | 1130,26c | 2324,93ab | 2835,65a |
| **Red Chief** | 7,21b | 10,11a | 7,37b | 8,90a | 2019,73b | 2831,17a | 2063,22b | 2493,49a |

## Conclusion and Recommendations

Fruit growing which is the sub-sector in agriculture is one of our country's major sources of income in some regions and localities. Although there are different problems in regions and fruits grown, in generally, one of the important problems in Turkey are fruit growing techniques and low yield per decare. The fruit yield can increase if the species, varieties, and cultivation techniques are used efficiency. In intensive farming practices, more yield and more quality require to use chemical fertilizers, so they are costly and cause environmental problems. In recently, environmentally friendly, sustainable, and organic agricultural practices have been widely using (Esitken 2011). Using of the bio-fertilizers instead of the synthetic fertilizers prevent to environmental problems and help to improve plant growth and protection environmental health and soil productivity (O'Connell 1992). The results of the present study suggested that Herbagreen and Seaweed have a great potential to increase the yield and fruit properties. Therefore, they may be utilized as bio-fertilizer and bio-pesticide for fruit and vegetable production in sustainable and ecological agricultural systems.

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# YEM BEZELYESİ İLE FARKLI ORANLARDA YETİŞTİRİCİLİĞİ YAPILAN BAZI BUĞDAYGİLLERİN SİLAJ KALİTESİNE ETKİSİ

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**Özet**
Mevcut tarım alanlarından maksimum fayda sağlamak, ürünlerde verim ve kalite değerlerini artırmak amacıyla birlikte ekim uygulaması gerçekleşmektedir. Bu çalışma farklı oranlarda yem bezelyesi (*Pisum sativum L.*) ile yulaf (*Avena sativa L.*) ve tritikale bitkisinin birlikte üretilmesinin silaj kalitesi değerleri üzerine etkisini incelemek amacıyla gerçekleştirilmiştir. Denemede bitki materyali olarak yem bezelyesi, yulaf ve tritikale tür ve çeşitleri kullanılmıştır. Araştırma, 2021-2022 yılı kış ekim döneminde, Kahramanmaraş Sütçü İmam Üniversitesi Ziraat Fakültesi Tarla Bitkileri deneme alanında yürütülmüştür. Çalışmada, yem bezelyesi, yulaf, tritikale yalın ekimleri ile birlikte yem bezelyesinin yulaf ve tritikale ile %75, %50 ve %25 oranlarında karışık ekimi yapılmıştır. Elde edilen silajların ortalama, pH değeri 4.28, kuru madde oranı %29.3, Fleig puanı 92.55, asit deterjanda çözünmeyen lif (ADF) %39.05, nötral deterjanda çözünmeyen lif (NDF) %54.83, sindirilebilir kuru madde (SKM) oranı %58.48, kuru madde tüketimi (KMT) %2.21 ve nispi yem değeri (NYD) ise 100.89 olarak tespit edilmiştir. Elde edilen sonuçlar incelendiğinde, yem bezelyesi ile birlikte üretilen yulaf ve tritikale bitkilerinin bütün karışım oranları, silajın kuru madde içeriklerini ve Fleig puanını artırdığı, pH değerini ise düşürdüğü tespit edilmiştir. Ayrıca, tahılların yüksek orandaki NDF ve ADF içerikleri yem bezelyesinin etkisi ile azalma göstermiştir. Yem bezelyesi ile karışım halinde silolanan yulaf ve tritikalenin silaj kalitesini artırdığı belirlenmiştir.
**Anahtar Kelimeler:** Birlikte üretim, silaj kalitesi, karışım oranı, yem bezelyesi, yulaf, tritikale.

# EFFECT OF SOME GRAIN CULTIVATION IN DIFFERENT RATIOS WITH FODDER PEAS ON SILAGE QUALITY

**Abstract**
Intercropping is practiced in order to obtain maximum benefit from existing agricultural areas and to increase the yield and quality values of products. This study was carried out to examine the effect of co-production of different ratios of fodder peas (*Pisum sativum L.*), oats (*Avena sativa L.*), and triticale plants on silage quality values. Forage pea, oat, and triticale species and varieties were used as plant material in the experiment. The research was conducted in the Field Crops trial area of Kahramanmaras Sütcü Imam University Faculty of Agriculture during the winter planting period of 2021-2022. In the study, pure plantings of fodder peas, oats, and triticale were carried out, along with mixed plantings of fodder peas with oats and triticale at the proportions of 75%, 50%, and 25%. The average pH value of the silages obtained was 4.28, dry matter ratio was 29.3%, Fleig score was 92.55, acid detergent insoluble fiber (ADF) was 39.05%, neutral detergent insoluble fiber (NDF) was 54.83%, digestible dry matter (DMM) ratio was 58.48%, dry matter intake (DMI) was determined as 2.21% and relative feed value (RFV) was determined as 100.89. When the results obtained were examined, it was determined that all mixture ratios of oat and triticale plants produced with forage peas increased the dry matter content and Fleig score of the silage and decreased the pH value. In addition, the high NDF and ADF contents of grains decreased with the effect of fodder peas. It was determined that oats and triticale ensiled in a mixture with fodder peas increased the silage quality.
**Keywords:** Intercropping, silage quality, mixing ratio, fodder pea, oats, triticale.

**Giriş**

Kaliteli kaba yem üretimi, düşük maliyetle temin edildiğinde, hayvansal üretimde karlılığı artıran en önemli etmendir. Hayvancılıkta, yeterli miktarda ve dengeli besleme, kaba yemlerin enerji ve protein dengesinin sağlanmasıyla mümkündür dolayısıyla yem bitkilerinin besin değeri önem arz etmektedir. Bu amaçla, baklagil ve buğdaygil bitkilerinin karışım halinde yetiştirilmesi ve kaba yem kaynağı olarak kullanılması besin değerini artıran bir uygulamadır. Baklagil bitkileri protein içeriğiyle kaliteyi, buğdaygil bitkileri ise karbonhidrat içeriğiyle enerji ihtiyacını karşılar.

Karışık ekim, aynı alanda iki veya daha fazla bitkinin birlikte ekilip yetiştirilmesi olarak tanımlanır. Karışım oluştururken, uygun bitkilerin seçilmesi, uygun karışım oranlarının belirlenmesi, bitkilerin ekolojik gereksinimleri, rekabet ilişkileri ve ekonomik değerlerin dikkate alınması gerekir. Karışık ekimin en önemli avantajlarından biri, yalın ekime göre birim alanı daha etkin kullanarak verim ve kaliteyi artırmasıdır (Bedoussac et al., 2015; Yu, Stomph, Makowski, Zhang, & Van Der Werf, 2016). Baklagil bitkileri, köklerinde bulunan *Rhizobium* bakterileri sayesinde toprağa azot kazandırdığından, azotlu gübre ve enerji kullanımını düşürmede önemli bir rol oynayarak toprağın verimliliğini attırır (Rodriguez et al., 2020). Buğdaygil bitkileri ise sağlam sap yapısı ve dik gelişme göstermeleri sayesinde, baklagil bitkilerinin yatmasını önler ve hasat işlemini kolaylaştırır. Karışık ekim yapıldığında, farklı bitki türlerinin farklı besin ihtiyaçlarını karşılaması, yabancı ot ve zararlıların daha da az seviyeye düşürmesiyle, gübre ve tarım ilacı kullanımı azalarak tarımsal girdi maliyetinde düşüş olur (Stomph et al., 2020; Verret et al., 2017). Karışık ekim yapılan arazi, don, kuraklık ve sel gibi olumsuz hava koşullarından daha az etkilenir. Sonuç olarak, karışık ekim, verimli ve etkin tarımsal üretimin sürdürülebilirliği için önemli bir çevre dostu bir üretim sistemidir (Brooker et al., 2015; Martin-Guay, Paquette, Dupras, & Rivest, 2018).

Bu çalışmada kullanılan, baklagil familyasına ait tek yıllık bir bitki olan yem bezelyesi, kuru ot ve yeşil ot olarak değerlendirilmekle birlikte mera bitkisi ve yeşil gübre olarak kullanılmaktadır (Sayar & Han, 2016; Tan, Koc, & Dumlu, 2012). Yem bezelyesinin beslenme değeri yüksektir, bitkinin kuru otu ve tanesi yüksek oranda protein içerir. Ancak içerisinde barındırdıkları suda çözünür karbonhidrat oranı düşük seviyededir, bu silajın fermantasyonu önündeki bir engeldir (McDonald, Henderson, & Heron, 1991; Owens, Albrecht, Muck, & Duke, 1999). Baklagil silajlarının daha kaliteli duruma getirilebilmesi ve karbonhidrat-protein içeriği bakımından zengin silaj yemi elde edilebilmesi için, baklagillerin tek başına silolanması yerine buğdaygillerle karışım olarak silolanmasının daha kaliteli silaj yemi oluşturduğu vurgulayan

birçok çalışma bulunmaktadır (Akbay, Günaydın, Arıkan, Açıkgöz, & Kızılşimşek, 2022; Arıkan et al., 2023; Aykan & Saruhan, 2018; Gelir & Denli, 2018; Görü & Seydoşoğlu, 2021; Gülümser, Mut, Başaran, & Doğrusöz, 2021; Gümüştaş & Turan, 2022; Kızılşimşek, Günaydın, Aslan, Keklik, & Açıkgöz, 2020; Seydoşoğlu, 2019).

Bu çalışma, yem bezelyesinin (*Pisum sativum L.*) farklı oranlarda yulaf (*Avena sativa L.*) ve tritikale ile karışık ekiminin silaj kalitesi üzerine etkilerini, ortaya koymak için yapılmıştır.

**Materyal ve Metot**

Bu araştırma 2021-2022 vejetasyon döneminde, Kahramanmaraş Sütçü İmam Üniversitesi Ziraat Fakültesi Tarla Bitkileri Bölümü'ne ait deneme alanında gerçekleştirilmiştir.

Kahramanmaraş iline ait 2021-2022 yılı iklim verileri ile ilgili Tablo 1 incelendiğinde, yem bezelyesi ve karışımlarının yetiştirme sezonunda düşen toplam yağış miktarının 472 mm olduğu, deneme yılı sıcaklık ortalamasının 14.13 °C ve nispi nem oranı ortalamasının ise %61.72 olduğu belirlenmiştir.

Tablo 1. Kahramanmaraş İli İklim Verileri

| Aylar | Sıcaklık (°C) | Yağış (mm) | Nispi Nem (%) |
|---|---|---|---|
| | 2021-2022 | 2021-2022 | 2021-2022 |
| Kasım | 13.8 | 15.8 | 63.0 |
| Aralık | 4.5 | 120.8 | 69.8 |
| Ocak | 8.7 | 128 | 71.4 |
| Şubat | 7.1 | 70.6 | 69.3 |
| Mart | 18.2 | 99.8 | 62.1 |
| Nisan | 20.4 | 9 | 45.7 |
| Mayıs | 26.2 | 28 | 50.7 |
| Ortalama/Toplam | 14.13 | 472 | 61.72 |

*Kahramanmaraş Meteoroloji Bölge Müdürlüğü

Araştırmada yem bezelyesinin (*Pisum sativum L.*) "Taşkent", yulafın (*Avena sativa L.*) "TL576" ve tritikalenin "AyşeHanım" çeşitleri bitki materyali olarak kullanılmıştır. Bu araştırmada yem bezelyesi (B), yulaf (Y) ve tritikalenin (T) yalın ekimleri ile birlikte bu bitkilerin %75B + %25Y, %50B + %50Y, %25B + %75Y ve %75B + %25 , %50B + %50T, %25B + %75T oranlarında karışımları kullanılmıştır. Tohum hazırlığı işleminde, yalın ekilen yem bezelyesinde 15 kg $da^{-1}$, yulaf ve tritikale için 20 kg $da^{-1}$, karışımlar için ise karışım

oranlarına göre parsellere atılacak miktar hesaplanıp paketler hazırlanmıştır. Ekim, 2 metre genişliğinde ve 5 metre uzunluğundaki parsellere el ile serpme yöntemi kullanılarak yapılmıştır. Ekim ile birlikte her parsele 4 kg $da^{-1}$ saf azot ve 4 kg $da^{-1}$ saf fosfor gelecek şekilde 20.20.0 kompoze gübre uygulanmıştır.

Deneme tesadüf blokları deneme desenine göre üç tekerrürlü olarak kurulmuştur. Hasat, yem bezelyesinin %50 çiçeklenme dönemine denk gelen 13 Mayıs 2022 tarihinde gerçekleştirilmiştir. Her parselden hasat edilen bitkiler, silaj doğrama makinasında 2-3 cm uzunluğunda parçalara ayrılarak silaj yapımına hazır hale getirilmiştir. Bitki örnekleri silaj poşetleri içerisine yaklaşık 400 gram olacak şekilde yerleştirilmiş ve silaj vakum makinası kullanılarak paket içerisindeki havanın %99.9'u alınarak poşetin ağız kısmı otomatik kapatılmıştır. Yapılan silaj paketleri 60 gün bekletildikten sonra açılmıştır. Her paketten alınan 70 gramlık örnekler etüv içerisinde 70 $^0$C' de bekletilerek sabit ağırlığa gelinceye kadar kurutulmuştur. Hassas terazi ile kuru örnekler tartılarak kuru madde (KM) oranı tespit edilmiştir. Silajların pH değerlerini belirlemek amacıyla 20 gram silaj örneği 180 ml Ringer solüsyonu içerisinde yüksek devirde blender edildikten sonra örnekler süzme kağıdı ile süzülmüştür. Dijital pH metre kullanarak elde edilen süzüklerin pH değerleri belirlenmiştir. Kimyasal analizler için etüvde kurutulan örnekler 1 mm eleğe sahip bir öğütme makinesinde öğütülmüştür. Karışım ve tekli ekimlerin ham protein oranlarını belirlemek için Kjeldahl yöntemi ile azot içerikleri belirlenmiş ve bulunan değer 6.25 katsayısıyla çarpılarak örneklerin ham protein (HM) oranları hesaplanmıştır (AOAC, 1990). Asit deterjan lif (ADF) ve nötr deterjan lif (NDF) oranları ANKOM200 Fiber Analyzer cihazında belirlenmiştir (Van Soest, Robertson, & Lewis, 1991). Örneklerin NDF ve ADF değerleri yardımı ile sindirilebilir kuru madde (SKM), kuru madde tüketimi (KMT) ve nispi yem değerleri (NYD) hesaplanarak bulunmuştur. Hesaplamalarda aşağıdaki formüller kullanılmıştır (Lithourgidis, Vasilakoglou, Dhima, Dordas, & Yiakoulaki, 2006).

Sindirilebilir Kuru Madde (SKM) = 88.9 – (0.779 x %ADF)

Kuru Madde Tüketilebilirliği (KMT) = 120 / %NDF

Nispi Yem Değeri (NYD) = (%SKM x % KMT) / 0.775

Silaj numunelerinin kuru madde içeriği ve asitlik (pH) değerleri belirlendikten sonra Fleig puanları hesaplanmış ve bu puanlara göre silajların kalite sınıfı tespit edilmiştir (Kılıç, 1984). Silajın Fleig puanı ölçekleri; 0–20, 21–40, 41–60, 61–80 ve 81–100 puan aralıklarında sırasıyla kötü, düşük, orta, iyi, pekiyi olarak sınıflandırılmaktadır.

Fleig Puanı: 220 + (2 x % KM – 15) – 40 x pH

Araştırma sonunda elde edilen verilerin istatistiksel değerlendirmesinde, tesadüf blokları deneme desenine göre varyans analizi JMP istatistiki paket programı kullanılmıştır. Varyans analiz sonuçlarına göre, ortalamalar arasındaki farklılık LSD testi ile belirlenmiştir.

**Bulgular ve Tartışma**

Yem bezelyesi ile yulaf ve tritikale bitkilerinin yalın ve karışım halinde silolanması sonucu elde edilen silajların kuru madde içerikleri, pH değerleri ve Fleig puanları Tablo 2'de verilmiştir. Tablo 2 incelendiğinde, farklı oranlarda yem bezelyesi ile yulaf ve tritikale karışımları ile hazırlanan silajın pH değeri, kuru madde oranı ve Fleig puanları bakımından aralarındaki farklılığın istatistiki olarak $P<0.01$ düzeyinde önemli olduğu görülmektedir.

Genel olarak buğdaygil bitkilerinin kuru madde içerikleri baklagil bitkilerinin kuru madde içeriğinden fazladır. Karışıma dahil edilen buğdaygil bitkilerinin yüksek oranda suda çözünebilir karbonhidrat içeriğine sahip olmasından dolayı oluşan silajlarda kuru madde oranın da artış sağlanmaktadır. Yapılan benzer çalışmalarda, baklagil bitkilerinin yalın olarak silolanmasının silaj kalitesini düşüreceği, buğdaygil bitkileri ile karışım olarak silolanmasının silaj kalitesini artıracağını bildirmektedirler (Arslan, Erdurmuş, Öten, Aydınoğlu, & Çakmakçı, 2017; Balabanli, Albayrak, Türk, & Yuksel, 2010; Dumlu & Tan, 2009; Fayetörbay, Gül, & Tan, 2011). Çalışmadaki silajların kuru madde içeriklerinin %25.72-34.89 arasında değiştiği tespit edilmiştir. En yüksek silaj kuru madde oranı istatistiki yönden farksız olan saf tritikale ve %25 yem bezelyesi %75 tritikale silajlarından elde edilirken ikinci sırayı %50 yem bezelyesi %50 tritikale karışımı takip etmiştir. En düşük kuru madde oranı ise %75 yem bezelyesi %25 tritikale silajından elde edilmiştir. Karışıma dahil olan yulaf ve tritikale oranı arttıkça silaj kuru madde oranında artış meydana gelmiştir.

Silaj fermentasyon kalitesini belirleyen en önemli etkenlerden biri silajın pH değeridir. Başarılı bir silaj için temel kurallardan bir tanesi silaj pH seviyesinin düşürülmesidir (Günaydın, Akbay, Arıkan, & Kızılşimşek, 2023; Kızılşimşek, Erol, Dönmez, & Katrancı, 2016; Liu, Shao, & Zhang, 2013). Çalışmada yapılan silajlar içerinde en yüksek pH değeri 4.39 ile saf yem bezelyesinden elde edilirken, en düşük pH değeri ise istatistiki açıdan aynı grupta yer alan saf tritikale (4.18) ve %25 yem bezelyesi %75 tritikale (4.19) silajlarından elde edilmiştir. Karışıma dahil olan yulaf ve tritikalenin tüm karışım oranları silaj pH değerinde azalmalar meydana getirmiştir. Tritikale bitkisinin karışıma dahil olma oranı arttıkça silaj pH değerinde azalma

gerçekleşmiştir. Bu durum, buğdaygil bitkilerinin kolay fermente edilen karbonhidrat içeriğinden kaynaklandığı söylenebilir.

Tablo 2. Silajların Kuru Madde Oranı, pH değeri ve Fleig Puanı değerleri

| Karışım Oranları | KM (%) | pH | Fleig Puanı |
|---|---|---|---|
| Saf Yem Bezelyesi | 26.47$^{ef}$ | 4.39$^{a}$ | 82.47$^{e}$ |
| Saf Yulaf | 28.17$^{cd}$ | 4.34$^{ab}$ | 87.87$^{cd}$ |
| %25 Yem Bezelyesi %75 Yulaf | 28.94$^{c}$ | 4.32$^{bc}$ | 90.21$^{c}$ |
| %50 Yem Bezelyesi %50 Yulaf | 27.84$^{cd}$ | 4.28$^{bcd}$ | 89.62$^{c}$ |
| %75 Yem Bezelyesi %25 Yulaf | 27.06$^{de}$ | 4.32$^{bc}$ | 86.45$^{d}$ |
| Saf Tritikale | 34.89$^{a}$ | 4.18$^{e}$ | 107.45$^{a}$ |
| %25 Yem Bezelyesi %75 Tritikale | 34.29$^{a}$ | 4.19$^{e}$ | 106.11$^{a}$ |
| %50 Yem Bezelyesi %50 Tritikale | 30.44$^{b}$ | 4.23$^{de}$ | 96.67$^{b}$ |
| %75 Yem Bezelyesi %25 Tritikale | 25.72$^{f}$ | 4.26$^{cd}$ | 86.03$^{d}$ |
| Ortalama | 29.31 | 4.28 | 92.55 |
| CV (%) | 2.59 | 0.90 | 1.95 |
| LSD | 1.32$^{**}$ | 0.06$^{**}$ | 3.12$^{**}$ |

**P<0.01 istatistiki düzeyde önemli, KM: Kuru Madde, CV: Varyasyon Katsayısı

Silajların pH değeri ve kuru madde içeriği değerlerinden yararlanılarak hesaplanan Fleig puanı, silajların hangi kalite sınıfında yer aldığını gösterir. Hesaplanan Fleig puanına göre tüm silajlar "çok iyi kalite" sınıfında olmasına rağmen, istatistiki açıdan incelendiğinde, silajların Fleig puanları arasında oluşan farklılığın önemli olduğu tespit edilmiştir. En yüksek Fleig puanı saf tritikale ve %25 yem bezelyesi %75 tritikale karışımı silajlarından elde edilirken, en düşük değer ise saf yem bezelyesi silajından elde edilmiştir. Tüm uygulamalar için ortalama Fleig puanı ise 92.55 olarak hesaplanmıştır. Çalışmada tüm silajlar çok iyi kaliteli sınıfında yer almaktadır. Bunun başlıca nedeni silajlarda ideal pH ve kuru madde oranının tespit edilmesidir. Tablo 3'te silajların NDF, ADF, KMT, SKM ve NYD değerlerine ait ortalama değerler ve oluşan istatistiki gruplar verilmiştir. Belirlenen karışım oranları silajın kalite kriterlerini önemli ölçüde etkilediği belirlenmiştir ($P<0.01$).

NDF, kaba yemlerin içerisindeki tüm liflerin, hem sindirilebilir hem de sindirilemeyen kısımlarının toplamını ifade eder. Silajların NDF içeriğinin %42.33-66.47 arasında değiştiği belirlenmiştir. En yüksek NDF değeri aynı istatistiki gruplandırma içerisinde yer alan saf yulaf,

saf tritikale ve %25 yem bezelyesi %75 yulaf karışımı silajlarından, en düşük NDF içeriği ise saf yem bezelyesi silajından elde edilmiştir.

ADF, lifin sert ve sindirilemeyen kısımlarını ifade eder. ADF'nin düşük olması, yemin sindirim oranının yüksek olduğu ve dolayısıyla kaliteli olduğu anlamına gelir. Silajların ADF oranı incelendiğinde en yüksek değerin %45.56 ile saf tritikale silajına, en düşük değerin ise %32.15 ile saf yem bezelyesi silajına ait olduğu görülmektedir. Karışım içerisinde bulunan yem bezelyesinin oranı arttıkça silajların ADF oranlarında rakamsal bir azalmanın olduğu belirlenmiştir.

**Tablo 3.** Silajların NDF, ADF, KMT, SKM ve NYD değerleri

| Karışım Oranları | NDF(%) | ADF(%) | KMT(%) | SKM(%) | NYD |
|---|---|---|---|---|---|
| Saf Yem Bezelyesi | 42.33$^{d}$ | 32.15$^{e}$ | 2.84$^{a}$ | 63.85$^{a}$ | 140.67$^{a}$ |
| Saf Yulaf | 63.97$^{a}$ | 41.58$^{abc}$ | 1.88$^{cd}$ | 56.51$^{cde}$ | 82.23$^{cd}$ |
| %25 Yem Bezelyesi %75 Yulaf | 63.14$^{a}$ | 43.77$^{ab}$ | 1.91$^{cd}$ | 54.81$^{de}$ | 81.29$^{d}$ |
| %50 Yem Bezelyesi %50 Yulaf | 54.98$^{b}$ | 39.51$^{bcd}$ | 2.18$^{bc}$ | 58.12$^{bcd}$ | 98.33$^{bc}$ |
| %75 Yem Bezelyesi %25 Yulaf | 53.04$^{b}$ | 37.81$^{cd}$ | 2.26$^{b}$ | 59.45$^{bc}$ | 104.23$^{b}$ |
| Saf Tritikale | 66.47$^{a}$ | 45.56$^{a}$ | 1.81$^{d}$ | 53.41$^{e}$ | 74.90$^{d}$ |
| %25 Yem Bezelyesi %75 Tritikale | 46.65$^{cd}$ | 39.25$^{bcd}$ | 2.34$^{b}$ | 58.32$^{bcd}$ | 105.48$^{b}$ |
| %50 Yem Bezelyesi %50 Tritikale | 51.70$^{b}$ | 37.56$^{cde}$ | 2.33$^{b}$ | 59.64$^{abc}$ | 107.90$^{b}$ |
| %75 Yem Bezelyesi %25 Tritikale | 51.17$^{bc}$ | 34.29$^{de}$ | 2.35$^{b}$ | 62.19$^{ab}$ | 113.00$^{b}$ |
| Ortalama | 54.83 | 39.05 | 2.21 | 58.48 | 100.89 |
| CV (%) | 4.87 | 8.07 | 8.60 | 4.20 | 9.24 |
| LSD | 4.62$^{**}$ | 5.45$^{**}$ | 3.29$^{**}$ | 4.24$^{**}$ | 16.13$^{**}$ |

**P<0.01 istatistiki düzeyde önemli, NDF: Nötr Deterjanda Çözünmeyen Lif, ADF: Asit Deterjanda Çözünen Lif,

KMT: Kuru Madde Tüketimi, SKM: Sindirilebilir Kuru Madde, NYD: Nispi Yem Değeri, CV: Varyasyon Katsayısı

Silajların kuru madde tüketim ortalamasının %2.21 olduğu, en yüksek değerin %2.84 ile saf yem bezelyesi silajı, en düşük değerin ise %1.81 ile saf tritikale silajından elde edildiği belirlenmiştir. Silajların sindirilebilir kuru madde içeriğinin %53.41-%63.85 arasında değişim gösterdiği, en yüksek SKM değerinin saf yem bezelyesi silajından, en düşük SKM değerinin ise saf tritikale silajından elde edildiği tespit edilmiştir. Silajlarda bulunan yulaf ve tritikale oranları azaldıkça SKM oranında artış olduğu gözlemlenmektedir. Silajların nispi yem değeri incelendiğinde en yüksek değerin 140.67 ile saf yem bezelyesi silajından elde edildiği, ancak

farklı oranlarda yulaf ve tritikale silajlarının NYD değerinde azalmaya neden olduğu belirlenmiştir. En düşük nispi yem değerinin 74.90 ile saf tritikale silajına ait olduğu tespit edilmiştir. Tüm yalın ve karışım silajları açısından bakıldığında ortalama NYD değeri 100.89 olarak hesaplanmıştır.

**Sonuç ve Öneriler**

Yapılan çalışmada, yalın ve farklı oranlarda yetiştiriciliği yapılan yem bezelyesi ile yulaf ve tritikale bitkilerinden elde edilen silajların kalite özellikleri incelenmiş ve elde edilen veriler değerlendirildiğinde, yem bezelyesi ile birlikte yetiştirilen yulaf ve tritikale bitkilerinin bütün karışımları, silajın kuru madde oranını artırarak pH değerinin düşmesi ile silaj kalitesini olumlu etkilediği görülmüştür. Saf yulaf ve tritikale silajındaki yüksek orandaki NDF ve ADF içerikleri yem bezelyesinin karışıma dahil olması ile azalmıştır. Tritikale ve yem bezelyesi karışık ekiminden elde edilen silajın kalitesinin yulaf ile yem bezelyesi karışık ekimi silajına göre daha iyi sonuçlar verdiği gözlemlenmiştir. Bütün bu özellikler dikkate alındığında 75B+25T ve 50B+50T karışımlarının birlikte yetiştirilip silaj yapılması önerilmektedir.

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# GERMINATION VIABILITY OF POPCORN $M_1$ SEEDS (*Zea mays everta* Sturt.) AFTER GAMMA-RAY IRRADIATION

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**Abstract**
Popcorn is widely used in human nutrition and is one of the most popular snack foods today. The increasing consumption and demand for popcorn make breeding studies in popcorn important. In this study, germination rate and some early seedling stage properties of $M_1$ plants with different gamma rays (0, 200, 300, 400 and 500 Gy) applied to Antcin, Nermincin and Koçcin popcorn cultivars were investigated. In the study, depending on varying gamma ray doses in $M_1$ plants germination rate % 45,5-93,3, root length 4,7-16,4 cm, shoot length 4,7-9,1 cm, fresh root weight 0,050-0,153 g, dry root weight 0,005-0,013 g, fresh shoot weight 0,105-0,241 g, dry shoot weight 0,010-0,020 g, plumule length 4,26-10,00 cm and radicle length 4,29-18,63 cm varied between. It was observed that the germination rate decreased by 15,4% in the 200 Gy application, 34,5% in the 300 Gy application, 40,4% in the 400 Gy application, and 51,2% in the 500 Gy application compared to the control application. As a result, increased gamma ray dose applications had a reducing effect on the investigated properties and it was determined that the optimum dose was 200 Gy.
**Keywords:** Popcorn, Germination viability, Mutation, Gamma-ray

## Introduction

Among cereal crops, corn ranks first in terms of production quantity (1,210 million tons) and second globally in terms of cultivation area (205 million ha) (FAOSTAT, 2023). Turkiye's corn production area comes in third place, behind wheat and barley. Turkiye's corn production amounted to 8,5 million tons in 2022, with a cultivation area of 9,118,849 decares (TUIK, 2023).

There are seven different types of maize: dent, flint, flour, sweet, pop, waxy, and pod corn. Among the corn varieties, the most commonly grown ones are flint and dent corn, followed by sweet and popcorn (Kilinc et al., 2023). Flint corn account for almost 80% of the corn planted in Turkiye (Yildiz & Gozel, 2022).

Popcorn (*Zea mays everta* Sturt) is favored by consumers because of its high fiber, vitamin, and mineral content (Ozturk et al., 2016), as well as its ability to satiate and absorb stomach acid (Jele et al., 2014). One of the most common snacks eaten nowadays is popcorn. It can also be used as animal feed because of its rich and nutritious content (Nguyen et al., 2012). The importance of breeding studies in this popcorn variety is highlighted by the increasing consumption and wide use of popcorn in various industries in recent years.

Mutants are produced through the use of chemical and physical mutagens in mutation breeding. Researchers frequently use gamma rays and fast neutron bombardment in physical mutagen applications to change a plant's undesirable trait and produce genetic diversity (Sehirali & Ozgen, 2007; Olgun et al., 2012; Gobinath & Pavadai, 2015). Gamma rays can have negative or positive effects on plants, and therefore it is important to conduct preliminary studies to determine the most useful dose to be applied to obtain the desired feature (Jamil & Khan, 2002). The purpose of this study was to evaluate the effects of varying gamma ray doses (0, 200, 300, 400, and 500 Gy) on the germination rate and early seedling stage when applied to the seeds of popcorn (*Zea mays everta* Sturt.) cultivars.

## Materials and Methods

Popcorn cultivars Antcin-98, Nermincin, and Koçcin were used as research materials. The experiment was arranged in a randomized complete block design with three replications, and cultivars were assigned to main plots, while gamma radiation doses were assigned to subplots. The study involved five different gamma radiation doses (0, 200, 300, 400, 500 Gy), and the seeds of popcorn cultivars were irradiated using the Cobalt-60 ($^{60}$Co) source at the Ankara Nuclear Research Institute. The irradiated seeds were sown in Petri dishes with double-layered filter paper. The irradiated seeds were sown in petri dishes with double-layered filter paper.

During the experiment, seeds were monitored every day and seeds with a radicle length of 2 mm were considered germinated (ISTA, 2003). Petri dishes were kept under laboratory conditions for 7 days, and the daily counts of germinated seeds were recorded. At the end of the 10th day of the study, root length, shoot length, root fresh weight and shoot fresh weight were measured. To measure the root dry weight and shoot dry weight, the samples were placed between drying papers and placed in the drying cabinet. After waiting for 24 hours in the drying cabinet at 105 °C, the plant samples were weighed and root dry and shoot dry weights were determined. The data obtained in the study was subjected to variance analysis using the JMP statistical program and the Duncan test was applied to compare the means (JMP 15.1 SAS Institute Inc, 2020).

**Findings and Discussion**

Gamma radiation applications were found to be statistically significant for all the examined characteristics in the study, all traits except shoot length were found to be statistically significant in terms of popcorn cultivars (Table 1).

**Table 1**. Effects of cultivars, gama ray irridation and their interactions on investigated traits

| Traits | Cultivar (C) | Gamma Radiation Doses (Gy) | C x Gy |
|---|---|---|---|
| **Germination rate** | 0,0080 | <,0001 | 0,908 |
| **Root length** | <,0001 | <,0001 | <,0001 |
| **Shoot length** | 0,2483 | <,0001 | <,0001 |
| **Root fresh weight** | 0,008 | <,0001 | 0,003 |
| **Root dry weight** | 0,006 | <,0001 | 0,004 |
| **Shoot fresh weight** | 0,0024 | <,0001 | 0,0012 |
| **Shoot dry weight** | 0,0016 | <,0001 | 0,0021 |

The values for germination rate (%), root length (cm), shoot length (cm), root fresh weight (g), root dry weight (g), shoot fresh weight (g), and shoot dry weight (g) of popcorn cultivars treated with different gamma ray doses are given in Table 2.

The Nermincin cultivar exhibits the highest germination rate among popcorn cultivars at 70,7%, followed by Antcin-98 (66,8%) and Koçcin (63,3%). The highest germination rate is obtained from the control application (93,3%), while the lowest germination rate is observed in the 500 Gy application (45,5%). Compared to the control application, a decrease of 15,4% in the 200 Gy application, 34,5% in the 300 Gy application, 40,4% in the 400 Gy application, and 51,2% in the 500 Gy application is detected (Table 2; Figure 1). Marcu et al. (2013) found that in corn plants, compared to the control application, there was an 11% reduction at 100 Gy, 22% at 200

Gy, 34% at 300 Gy, 40% at 500 Gy, 45% at 700 Gy, and 62% reduction at 1000 Gy. Jan et al. (2018) in their study on corn plants, reported that the germination rate varied between 51,70-87,75% for different gamma doses applied, and the germination rate increased at gamma doses of 800 Gy, 1000 Gy, 1200 Gy, 1400 Gy, respectively, compared to the control application. They noted that there was a decrease of 0,02%, 16,52%, 35,33% and 41,02%. The decrease in germination and emergence rate as gamma ray doses increase is due to damage to the embryo structure, damage at the chromosome and DNA level, or the creation of new genetic variation (Wang & Yu, 2011; Rafiuddun et al., 2013).

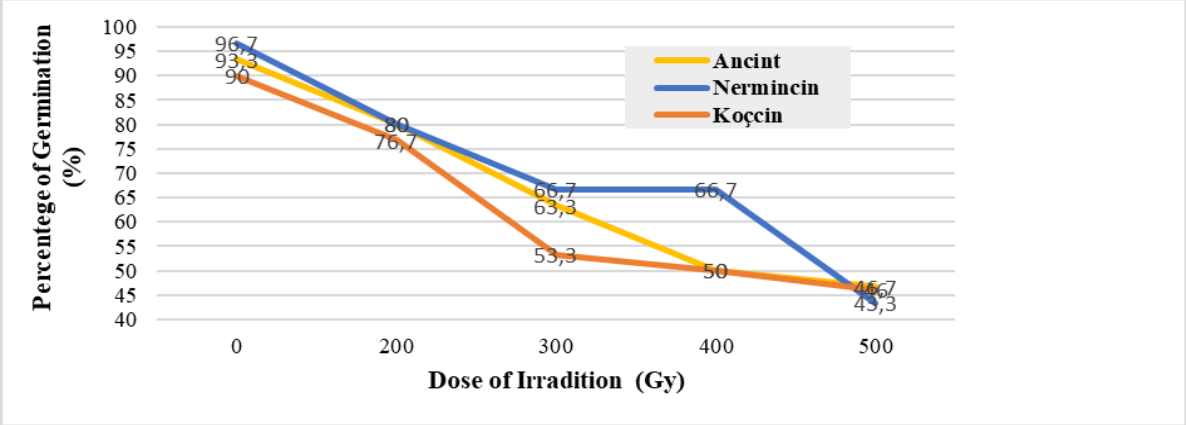


**Figure 1.** Germination rate (%) of popcorn cultivars tested after irradiaton dose treatment (Gy)

**Table 2.** Effect of gamma-ray irradiation on germination rate and seedling growth parameters of popcorn cultivars

| Cultivars | Germination rate (%) | Root length (cm) | Shoot length (cm) | Root fresh weight (g) | Root dry weight (g) | Shoot fresh weight (g) | Shoot dry weight (g) |
|---|---|---|---|---|---|---|---|
| **Antcin-98** | 66,8 ab | 9,2 b | 7,4 | 0,113 a | 0,010 a | 0,203 a | 0,018 a |
| **Nermincin** | 70,7 a | 9,3 b | 7,3 | 0,085 b | 0,008 b | 0,182 b | 0,017 a |
| **Koçcin** | 63,3 b | 11,0 a | 7,1 | 0,088 b | 0,008 b | 0,170 b | 0,015 b |
| **Irradiaton (Gy)** | | | | | | | |
| **0** | 93,3 a | 16,4 a | 9,1 a | 0,153 a | 0,013 a | 0,241 a | 0,020 a |
| **200** | 78,9 b | 13,5 b | 9,0 a | 0,127 b | 0,011 b | 0,240 a | 0,020 a |
| **300** | 61,1 c | 8,2 c | 7,1 b | 0,075 c | 0,007 c | 0,183 b | 0,017 b |
| **400** | 55,6 c | 6,5 d | 6,4 c | 0,072 c | 0,007 c | 0,157 c | 0,014 c |
| **500** | 45,5 d | 4,7 e | 4,7 d | 0,050 d | 0,005 d | 0,105 d | 0,010 d |

Variations in the range of 9,2 to 11,0 cm have been observed in the root length values of popcorn cultivars. The maximum root length was observed in the cultivar Koçcin (11,0 cm), while the minimum root length was found in the cultivar Antcin-98 (9,2 cm). It has been determined that root length values decrease in parallel with the increase in gamma ray dose applications. The highest root length was measured in the control application (16,4 cm), while the lowest root

length was measured in the 500 Gy application (4,7 cm) (Table 2). Marcu et al. (2013) measured root length as 1,85 cm in the control application, 1,67 cm at 100 Gy, 1,26 cm at 200 Gy, 1,08 cm at 300 Gy, 0,97 cm at 500 Gy, 0,81 cm at 700 Gy, and 0,52 cm at 1000 Gy.

In the study, the lowest shoot length was determined in the cultivar Koçcin (7,1 cm), while the highest shoot length was measured in the cultivar Antcin-98 (7,6 cm). The highest shoot lengths in gamma ray dose applications were observed in the control (9,1 cm) and 200 Gy (9,0 cm) applications, while the lowest shoot length was determined in the 500 Gy (4,7 cm) application (Table 2). Marcu et al. (2013) measured shoot lengths as 0,81 cm (control application), 0,73 cm (100 Gy), 0,49 cm (200 Gy), 0,42 cm (300 Gy), 0,38 cm (400 Gy), 0,32 cm (500 Gy), and 0,30 cm (1000 Gy), respectively. Yadav et al. (2015), in two popcorn cultivars (HM4 and HQPM1), different gamma doses (2,5, 5, 10, 50, 100, 200, 300, 400, 500, 750, 1000, 2000 Gy) were applied to seedlings. In their study on some of the characteristics during development periods; while the longest shoot length was measured as 10,4 cm in the control application in the cultivar HM4 and 22,1 cm in the cultivar HQPM1, the lowest shoot length was measured in the 1000 Gy (2,5 cm) application in the cultivar HM4 and 2000 Gy (4,0 cm) in the cultivar HQPM1 have been detected in practice.

The root fresh weight in popcorn cultivars exhibited a range of 0,085 to 0,113 g, with Antcin-98 cultivar recording the highest at 0,113 g and Nermincin cultivar the lowest at 0,085 g. Across different gamma ray dose applications, the root fresh weight demonstrated variability within the range of 0,050 to 0,153 g, showing a consistent trend of decreasing alongside the increase in gamma ray dose (Table 2). In a study conducted by Jan et al. (2018), the root fresh weight was found to be 2,315 g in the control application, 2,471 g at 800 Gy, 0,338 g at 1000 Gy, 0,207 g at 1200 Gy, and 0,453 g at 1400 Gy.

The root dry weight of the varieties has shown a range of 0,008 to 0,010 g. The highest root dry weight was measured in the cultivar Antcin-98 at 0,010 g, while the cultivars Nermincin and Koçcin both had the same value of 0,008 g. Across different gamma ray dose applications, the root dry weight exhibited variability within the range of 0,105 to 0,241 g. The lowest root dry weight was obtained in the 500 Gy dose application (0,005 g), whereas the highest root dry weights were observed in the control (0,241 g) and 200 Gy (0,240 g) applications (Table 2). In a study by Jan et al. (2018) on corn plants, the root dry weight was found to be 0,1578 g in the control application, 0,0683 g at 800 Gy, 0,0350 g at 1000 Gy, 0,0538 g at 1200 Gy, and 0,0528 g at 1400 Gy. The study reported decreases ranging from 0,03% to 15,78%.

Shoots fresh weight in different cultivars of popcorn showed a range of 0,170 to 0,203 g. At 0,203 g, the shoot fresh weight of Antcin-98 was the highest, while the cultivar Koçcin had the lowest weight, at 0,170 g. Table 2 shows that the 200 Gy (0,240 g) and control (0,241 g) applications was the maximum shoot fresh weight, and the 500 Gy application (0,105) was the lowest shoot fresh weight. With increasing gamma dose applications (0, 200, 300, 400, and 500 Gy), a study by Katar et al. (2013) on the virgin thistle plant demonstrated a decrease in shoot fresh weight, with recorded values of 1,164 g, 1,194 g, 0,971 g, 0,620 g, 0,578 g, and 0,118 g, respectively.

Popcorn cultivars ranged from 0,015 to 0,018 g in shoot dry weight. The highest shoot dry weight was recorded by Antcin-98 (0,018 g), which was followed by Nermincin (0,017 g) and Koçcin (0,015 g). Table 2 shows that the shoot dry weight that was highest in the control and 200 Gy applications (0,020 g) was lowest in the 500 Gy application (0,010 g). A decrease in shoot dry weight has been observed in similar studies on various plants as a result to an increase in gamma ray dose (Olgun et al., 2012; Katar et al., 2013; Mukri et al., 2022).

Table 3 provides values for the radicle length and plumule characteristics from different popcorn varieties subjected to different gamma ray doses.

When examining Table 3, a statistically significant difference was found in the interaction between cultivars and gamma ray dose concerning plumule and radicle length. The highest plumule length was observed in the control application for the cultivar Antcin-98 (10,00 cm), while the lowest plumule length was determined in the 500 Gy dose application for the cultivar Koçcin (4,26 cm). The highest radicle length was recorded in the control application for the cultivar Antcin-98 (18,63 cm), and the lowest radicle length was identified in the 500 Gy dose application for the cultivar Koçcin (4,29 cm). As gamma dose applications increased, a decrease in radicle length was noted for the cultivars Antcin-98 and Koçcin. The radicle length in the cultivar Koçcin was higher with the application of the 200 Gy dose compared to the control application, but it decreased with an increase in gamma ray dose after 200 Gy (Table 3).

**Table 3.** Effect of gamma-ray irradiation on plumule length (cm) and radicle length (cm) of popcorn cultivars

| Irradiaton (Gy) | Plumule Length (cm) | | | Radicle Length (cm) | | |
|---|---|---|---|---|---|---|
| | Antcin-98 | Nermincin | Koçcin | Antcin-98 | Nermincin | Koçcin |
| **0** | 10,00 a | 8,91 bc | 8,39 cd | 18,63 a | 12,33 cd | 18,09 ab |
| **200** | 9,00 bc | 8,38 cd | 9,57 ab | 10,92 de | 13,08 c | 16,0 b |
| **300** | 6,73 f | 6,88 ef | 7,69 de | 6,30 gh | 8,04 f | 10,24 e |
| **400** | 6,62 f | 7,15 ef | 5,47 g | 5,92 hi | 7,79 fg | 5,86 hij |
| **500** | 4,42 h | 5,37 g | 4,26 h | 4,39 ij | 5,40 hij | 4,29 i |

In the study of the correlation between gamma ray dose and cultivar in three corn cultivars, Rafiuddun et al. (2013) found that the plumula length values ranged from 1,57-8,13 cm and the radicle length varied from 25,90-3,73 cm. They found the one with the 500 Gy application was the lowest plumula and radicle length, and the control application was the highest. According to previous studies, the plumula and radicle length reduce with increasing gamma ray dose applications (Rafiuddun et al., 2013; Ahmad et al., 2022).

**Conclusion and Recommendations**

In conclusion, it has been observed that increasing gamma ray doses negatively affect germination rate, root length, shoot length, root fresh weight, root dry weight, shoot fresh weight, and shoot dry weight, resulting in a decrease in the investigated traits. The germination rate in applications with gamma ray doses ranged from 45,5% to 93,3%. In addition, in connection with plumule and radicle length, a significant interaction between cultivars and gamma ray dose was found. In the 500 Gy application, the cultivar Koçcin was the lowest values (4,26 cm and 4,29 cm, respectively) in terms of plumule and radicle length, while the Antcin-98 cultivar had the highest measurements (10,0 cm and 18,63 cm, respectively). It is expected to be beneficial to carry out more research using various genotypes and gamma doses in order to get more accurate results for popcorn plants.

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# INSECTS AS A NEW FEED IN ANIMAL NUTRITION

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**Abstract**
The FAO estimated in a 2009 report that the world's population will increase to 9 billion people by 2050. Due to this population increase, the demand for animal products will also increase by 60-70%, so researchers are looking for an alternative source of protein for the existing sources (soybean meal and fish meal) are in the market. Insects have been introduced as new feed sources due to their unique characteristics, including compatibility with the environment, nutritional and economic characteristics. Fish, poultry, pigs and domestic animals are creatures that can feed on insects. The crude protein content of insect larvae is high and in the range of 42-63%, and the fat content can be up to 36%, which can be extracted and used for various applications, including biodiesel. Several studies have confirmed the palatability of these alternative feeds for animals, and depending on the animal species, they can replace 25 to 100 percent of soy or fish meal. This article review to introduce some species of insects that are suitable for use in livestock diets with an emphasis on the black soldier fly.
**Keywords:** animal feeding, insects, black soldier fly

## Introduction

The global population is expected to increase to 10 billion by 2050, putting pressure on agricultural producers to increase their food production by 70% (Barclay, 2019). Food suitable for human consumption must be provided from these products, so livestock producers will be encouraged to find new ways to meet food needs without compromising food supply and environmental quality for future generations. High demand for animal feed production raises sustainability concerns – for example, soybean farming can involve deforestation, loss of biodiversity and pesticide use. Insects have been considered as one of the most promising alternative protein sources to solve the international problem of protein meal production for human food and animal feed. The main advantage of insects over other sources of protein is environmentally friendly, the high nutritional quality, fast reproduction rate, sustainability of their production, feed conversion efficacy, possibility to rear them on waste streams, less emissions of greenhouse gases, less discharge of ammonia into the environment are some of the reasons that make insects appealing for this purpose.

Breeding insects is a new and potential alternative to animal protein because it can be produced with high density in a small space and a favorable conversion factor. In addition, many insects can be raised in a bed of waste, which in addition to reducing environmental pollution, also help to recycle materials. Therefore, the purpose of this review article is to introduce a number of insect species with the potential to produce protein to replace some of the protein sources in animal feed.

Black soldier fly larvae

Hermetia illucens, the black soldier fly, is an typical and wide-ranging fly in the family Stratiomyidae. The black soldier fly, abbreviated as BSF, is native to tropical, subtropical, and warm temperate regions of America. The adult insects of the soldier fly lacked gnawing mouthparts and are able to suck liquids only through the proboscis of their tubes. For this reason, they stay alive in the larval stage due to the fat and protein obtained. Larvae have six larval stages and grow up to 18-20 mm, and their weight in the last larval stage reaches 220 mg. Adult flies usually prefer to live near larval habitats, which are mostly in wetlands, wet areas, under the bark of trees, on animal excrement and decaying organic matter. Larvae of many species live in aquatic environments, swamps and decaying organic matter and under the bark of trees. A small number are also dependent on grasslands.

It has been determined in the researches that for the artificial breeding of soldier flies and for them to successfully complete their life cycle, temperature, humidity and sufficient and controlled light intensity play an important and fundamental role.

This insect is usually considered as a beneficial and non-pest insect. Adult insects do not bite and as a result are not disease carriers. Black soldier flies are very resistant species that are able to cope with economical environmental conditions such as drought, lack of food or lack of oxygen.

BSFL is used as feed. Poultry, fish, pigs, livestock, and pets eat harvested pupae. This insect is one of the few insect species approved for feed in the EU aquaculture. Various studies have reported different nutrients in feed prepared from BSF larvae as follows. On average, BSFL contains DM (27.40%), CP (56.10%), CF (23.20%), ash (9.85%), Ca (2.14%), P (1.15%), Mg (0.39%), K ( 1.35). %, zinc (13.10 mg/kg), Cu (11.20 mg/kg), Mn (23.20 mg/kg) and Fe (20.40 mg/kg) based on DM.

Jayanegara et al (2017) reported that insect feed typically contained 40% more DM than Jamaican field cricket, and insect feed was also characterized by a higher fiber content than SBM. In insect feed, black soldiers showed neutral detergent fiber (NDF) and acid detergent fiber (ADF) in larvae in relation to rumen fermentation appearance in vitro and insect digestibility and SBMs showed similar total volatile FA concentration.The ratio of acid detergent insoluble CP in vitro DM digestibility and in vitro organic matter digestibility (OM) in insect feed produced less gas than in insect feed due to its higher fiber and EE content than SBM. Animals fed the all-insect diet excreted significantly less methane than animals fed SBM, and reduced insect digestibility resulted in low production of H, an important substrate for methanogenesis.

Housefly (Musca domestica)

The house fly (Musca domestica) is a fly from the order of Cyclorrhapha. It probably originated in the Middle East and spread throughout the world as part of humans. It is the most common type of fly found in houses. Adults are blackish grey, with four dark and longitudinal lines on the thorax, a slightly hairy body and a pair of membranous wings. They have red eyes that are slightly wider apart in the female.

House fly larvae (HFL) can reproduce on cattle, pig and chicken manure, and HFL can be reared in general waste. The life cycle of HF has several stages: egg; first, second and third instar larvae; pupa; and adults The time from egg to adult is approximately 7 to 10 days in warm temperatures and 40 to 49 days in colder climates.

Average housefly larvae include ash (6.25%), DM (83.47%), CP (33.29%), CF (6.20%), calcium (0.49%), P (1.09%), magnesium (0.23%), K (1.27%, zinc (10.39 mg/kg), copper (32.40 mg/kg), manganese (42.50) mg/kg, and iron (47.50 mg/kg) based on DM.

Nutritional analysis showed that housefly larval feed had comparable amounts to most high-protein feeds.

Mealworm larvae (Tenebrio molitor)

Mealworms are the larval form of the yellow mealworm beetle, Tenebrio molitor, a species of darkling beetle. Like all holometabolic insects, they go through four life stages: egg, larva, pupa, and adult. Larvae are usually 2.5 cm (0.98 in) or longer, while adults are usually 1.25–1.8 cm (0.49–0.71 in) long.

Mealworm is grown on dried and cooked waste material in various designs of fruits, grains and vegetables. They are herbivores but are usually fed flour with wheat bran or soybean meal. They are usually fed live, but canned and dried larvae are commercially available.The average percentage of mealworm contains DM (94.6%), CP (55.83%), CF (25.19%), ash (4.84%), calcium (0.21%), phosphorus (1.06%), magnesium (0.3%), K (1.12%), Na (0.21%), zinc (138.2 mg/kg), Cu (19.4 mg/kg), Mn (5.7 mg/kg), Fe (71.50 mg/kg ) based on DM.

Mealworms are a potential alternative source in poultry diets, especially to replace soybean meal or fish meal. Protein quality is similar to soybean meal, but methionine content is limited for poultry and for use in ruminants, not much information is available.

Locusts

Locust, any one of a group of insects (orthoptera) distributed throughout the world, the common name generally referring to a group of short-horned locusts, often increasing in numbers and migrating long distances in destructive swarms. Like other insects, Orthoptera are very nutritious and contain large amounts of protein. Grasshoppers and other orthopterans used for animal feed are fed live or dried and ground. They are sometimes boiled before drying. On average, grasshoppers contain DM (35.00%), crude protein (CP, 50.50%), crude fiber (CF, 15.30%), ash (6.40%) based on DM.

Silk moth (Bombyx mori)

The silk moth (Bombyx mori) is an insect of the Bombycidae moth family. It is the closest relative of Bombyx mandarina, the wild silk moth. Silkworm is the larva (or caterpillar) of the silk moth. Silkworm has a special economic value and is the main producer of silk.

The silkworm's preferred food is the leaves of the white mulberry, although other species may eat the berries and even the leaves of other plants such as the Osage orange. Due to thousands

of years of selective breeding, house silk moths are completely dependent on humans for reproduction. Wild silk moths (other Bombyx species) are not commercially viable for silk production.

Silkworm pupa meal is a food rich in protein with high nutritional value. Its CP content is from 52 to 72%, while it can be more than 80% for defatted meal. Like other insects, silkworm meal also has low calcium and low calcium to phosphorus ratio. Fat-free pupa meal is rich in fat up to 37%. Silkworm oil contains a high percentage of polyunsaturated fatty acids, especially linolenic acid (18:3), with amounts ranging from 11 to 45% of total fatty acids.

Silkworm meal is a valuable protein supplement for ruminant animals, due to its high undegradable protein content and favorable amino acid pattern. Limitations in its use as ruminant feed resulted from the high oil content. Therefore, fat extraction of silkworm meal is of interest when it is fed in a large amount.

Digestibility

The digestibility of insect protein is good and it is reported to be equivalent to soybean meal in pigs (about 77%). Digestion in the lower rumen and its transfer to the intestine in ruminants is also a good feature of this protein, but due to the fact that this issue has not been worked on, complete information is not available.

Challenges of using insects

Research has shown that health and food obstacles in the production of edible insects are the first priority from the point of view of livestock and poultry producers and experts. Also, other researches showed that health and food security and allergy to insects were among the obstacles to accepting edible insects. Doubt about the health of manufactured food is one of the reasons for the inadmissibility of edible insects. During research, it was stated that there is a risk of contamination of insects with disease-causing agents, contamination with heavy metals and chemical compounds both during the cycle of insects and after their harvesting and storage. Improper processing of edible insects also leads to food poisoning. There are some things that can be mentioned.

Conclusion

Sustainable livestock production must be established through the identification and use of alternative feedstocks to meet global food needs in the context of an increasing world population and a shift in diet towards animal protein. Based on nutritional composition and in vitro digestibility data, insect larvae could be a vital alternative protein source for soybean-based protein replacement. In addition, current information on modern agriculture has

demonstrated the practical potential for productive cultivation for both human consumption and as a protein source in animal diets to replace conventional protein sources such as SBM and fishmeal. Nevertheless, more preventive research using insect protein for feeding animals for both non-ruminants and ruminants is necessary to clarify additional data.

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# INFLUENCE OF ZINC OXIDE NANOPARTICLES AND CADMIUM UPTAKE ON GROWTH OF JUTE (*Corchorus olitorus* L.)

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## Abstract
Zinc oxide nanoparticles (ZnO NPs) owing to their prevalent use in various industrial and agricultural applications, have gained significant attention for their potential effects on plant health while Cadmium is a well-known environmental pollutant that can accumulate in plants, leading to adverse effects on both plants and consumers. This research investigates the impact of Zinc oxide nanoparticles (ZnO NPs) and Cadmium (Cd) uptake on the growth and development of *Corchorus olitorius*, a versatile and economically important plant renowned for its culinary versatility and medicinal uses. The study examined the response of *Corchorus olitorius* to different concentrations of ZnO NPs and Cd. Parameters such as plant morphology, biomass accumulation, chlorophyll content were analyzed. The plant was exposed to Zinc oxide nanoparticles (ZnO NPs), Cadmium (Cd) and a combination of Zinc oxide nanoparticles and Cadmium (ZnO NPs + Cd) and growth parameters such as number of leaves, leaf height, leaf breadth, leaf length and leaf area was observed for a period of 8 weeks. They were consistent increase in the various parameters such as number of leaves, leaf height, leaf breadth, leaf length and leaf area across the 8 weeks in the plant's response to exposure to Cadmium when compared to those which served as control and those exposed to ZnO NPs, ZnO NPs + Cd. This suggests that Cadmium has a pronounced positive effect on the growth of *Corchorus olitorius* plants and that the presence of zinc oxide nano particles doesn't significantly alter the trend. The results may have broader implications for sustainable agriculture, environmental remediation, and food safety.
**Keywords:** Zinc oxide nanoparticles (ZnO NPs), Cadmium (Cd), Corchorus olitorius, Food safety, Plant Growth and development

**Introductıon**

The influence of zinc oxide nanoparticles (ZnO NPs) on plant growth and their interaction with heavy metals like cadmium (Cadmium) has been a subject of increasing interest in recent years (Singh *et al.*, 2013). This is primarily driven by the pressing need to understand and mitigate the environmental and agricultural challenges posed by heavy metal pollution, particularly Cadmium contamination, and the potential benefits of nanomaterials in agriculture.

Cadmium, a non-essential heavy metal, is known to be toxic to both plants and humans. When present in the soil, it can be absorbed by plant roots and accumulate in various plant tissues, leading to growth inhibition, reduced crop yields, and even the contamination of the food chain when these Cadmium-laden crops are consumed (Kumar *et al.*, 2018). The adverse effects of Cadmium contamination on plant growth are of significant concern in agriculture, particularly in regions with industrial activities and historical metal pollution. On the other hand, zinc oxide nanoparticles have garnered attention for their unique properties and their potential to positively influence plant growth. These nanoparticles, when applied in controlled amounts, have been reported to enhance nutrient uptake, promote antioxidant activity, and improve stress tolerance in plants (Raliya *et al.*, 2016).

*Corchorus olitorius*, commonly referred to as "Jute Mallow" or "Ewedu," is a leafy green vegetable cultivated for its nutritional value and economic significance in various regions. Understanding how this crop responds to Cadmium exposure and whether the application of ZnO NPs can mitigate the negative impacts of Cadmium is essential for sustainable agricultural practices and food safety.

This research aims to bridge the knowledge gap by exploring how ZnO NPs influence the growth and Cadmium uptake of *Corchorus olitorius* in cadmium-contaminated soil. By examining the bioavailability of cadmium in the presence of ZnO NPs and elucidating the underlying physiological and molecular mechanisms governing these interactions, this study seeks to provide valuable insights into practical agricultural applications (Singh *et al.*, 2013). Ultimately, the findings from this research have the potential to inform innovative strategies for mitigating the detrimental effects of heavy metal contamination on crop growth while harnessing the benefits of nanomaterials in agriculture. This not only contributes to the broader understanding of nanotechnology in agriculture but also addresses critical issues related to food security and environmental sustainability. In regions with industrial activities or historical pollution, cadmium contamination poses a substantial threat to the ecosystem. By investigating how ZnO NPs can potentially ameliorate the negative effects of cadmium on plant growth, the research contributes to the development of eco-friendly strategies for soil remediation and crop production. These findings can promote sustainable land use practices and minimize the ecological impact of heavy metals.

*Corchorus olitorius* is not only a valuable crop but also a vital component of diets in various parts of the world. Ensuring the health and yield of this crop is essential for food security. Understanding how

Cadmium affects the growth of *Corchorus olitorius* and whether ZnO NPs can protect it from Cadmium toxicity has direct implications for improving crop productivity and food safety.

*Corchorus olitorius*, commonly known as jute mallow or Ewedu, is an economically and nutritionally important leafy vegetable in various regions. Understanding the impact of environmental factors on its growth, particularly the influence of nanoparticles and heavy metal contaminants like cadmium, is crucial for sustainable agriculture and food safety.

Studies on the effects of nanoparticles on plant growth have gained prominence due to their increased use in various applications, including agriculture. Zinc oxide nanoparticles (ZnO NPs) are of particular interest due to their antimicrobial and UV-blocking properties. Research has shown that ZnO NPs can influence plant growth, but the results are context-dependent. Some studies indicate enhanced growth, while others report inhibitory effects, depending on factors such as nanoparticle concentration, plant species, and exposure duration.

Cadmium (cadmium) is a toxic heavy metal that can contaminate soil and water through industrial activities and agricultural practices. It poses a significant risk to plant growth and food safety due to its ability to accumulate in plant tissues. Numerous studies have investigated cadmium uptake by plants, highlighting the need for sustainable agricultural practices and soil remediation strategies to mitigate its adverse effects.

Research specific to *Corchorus olitorius* regarding the combined effects of ZnO NPs and cadmium uptake is relatively limited. However, studies on other plant species suggest that the interaction between nanoparticles and heavy metals can lead to complex outcomes. In conclusion, the influence of zinc oxide nanoparticles and cadmium uptake on the growth of *Corchorus olitorius* is a critical area of research that demands further exploration. Understanding the intricate interactions between nanoparticles, heavy metal contaminants, and plant species like *Corchorus olitorius* is essential for devising sustainable agricultural practices, ensuring food safety, and addressing environmental concerns.

Research by Brown and Ahmed (2017) underlines the promise of zinc oxide nanoparticles (ZnO NPs) in enhancing crop productivity. They found that ZnO NPs can stimulate root development and nutrient uptake, ultimately contributing to improved plant growth. However, as highlighted by Jackson *et al.* (2020), the outcomes of ZnO NP application are highly dependent on factors such as concentration and exposure duration. The balance between benefits and potential harm is a critical consideration.

Research by Roberts *et al.,* (2019) demonstrated that cadmium can disrupt the integrity of plant cell membranes and interfere with vital physiological processes. Their study revealed that cadmium uptake by plants involves a complex interplay of transport mechanisms and soil conditions. These findings underscore the urgent need for strategies to mitigate cadmium's impact on both plant health and food safety.

Zheng *et al.* (2019) reported that pre-treatment with ZnO NPs effectively reduced cadmium accumulation in plant tissues by competing with cadmium ions for uptake sites. Furthermore, ZnO NPs'

antioxidant properties were found to counteract the oxidative stress caused by cadmium. Yan *et al.,* (2020) reported that the application of ZnO NPs alone can sometimes stimulate the plant's defense mechanisms, making it more resilient to subsequent cadmium exposure. This phenomenon is known as priming.

Adams *et al.,* (2021) explored combined effects of ZnO NPs and cadmium uptake on *Corchorus olitorius* in-depth and found that the presence of ZnO NPs could either enhance the plant's tolerance to cadmium or exacerbate the toxic effects, depending on the experimental conditions. Smith and White (2018) echoed these results, emphasizing that the balance between these factors can significantly impact plant growth. Such complexity highlights the necessity for comprehensive studies to elucidate the underlying mechanisms governing these interactions.

Song *et al.,* (2012) in a study reported that once absorbed, cadmium disrupts critical cellular processes. Notably, cadmium competes with essential micronutrients, such as zinc and iron, for uptake, leading to nutrient imbalances. This interference with nutrient homeostasis can result in chlorosis, reduced photosynthesis, and stunted growth. Cadmium also induces oxidative stress by generating reactive oxygen species (ROS) within plant cells. This oxidative damage to cellular components can further impair plant growth. Understanding the mechanisms of cadmium uptake and its impact on *Corchorus olitorius* is essential for devising strategies to mitigate its detrimental effects.

Shi *et al.* (2021) conducted an extensive investigation into the effects of ZnO NPs on tomato plants exposed to cadmium stress. The study revealed that the presence of cadmium in soil can severely hamper tomato growth and result in the accumulation of toxic cadmium in plant tissues. ZnO NPs were found to effectively reduce cadmium uptake by tomato plants. This reduction in cadmium accumulation alleviated cadmium-induced stress, ultimately improving the overall health of the tomato plants. Another remarkable observation was that ZnO NPs had a positive impact on photosynthesis in tomato plants under cadmium stress. This is crucial for plant growth, as photosynthesis is the process by which plants convert light energy into chemical energy (sugars) for growth and development. The improved photosynthetic activity contributed to healthier, more robust tomato plants. Perhaps most importantly for agricultural purposes, the study demonstrated that ZnO NPs led to increased tomato yield under cadmium stress conditions. This finding has implications for sustainable agriculture in regions where cadmium-contaminated soils pose challenges to crop production. By reducing the impact of cadmium stress on tomato plants, ZnO NPs could help ensure a more reliable tomato harvest. This study exemplifies the potential of ZnO NPs in improving plant resilience and productivity in the face of cadmium-contaminated environments. Li *et al.* (2013) conducted a research involving *Arabidopsis thaliana* (Arabidopsis) and its response to both cadmium stress and the application of zinc oxide nanoparticles. In this study, Arabidopsis plants were exposed to cadmium stress, which is known to disrupt various cellular processes and hinder plant growth. To investigate the potential ameliorative effects of ZnO NPs, they were simultaneously applied to the cadmium-stressed plants. One of the central

findings of the study was that ZnO NPs acted as efficient cadmium chelators. They reduced the uptake and accumulation of cadmium in Arabidopsis plants. This is a crucial observation, as excess cadmium can have detrimental effects on plant health and ecosystem safety. Importantly, the study also highlighted that the size of ZnO NPs played a role in their effectiveness. Smaller nanoparticles were more effective at mitigating cadmium stress, suggesting that nanoparticle size is a critical parameter to consider when utilizing nanomaterials in agriculture. These findings emphasize the potential of ZnO NPs not only as cadmium detoxifiers but also as modulators of gene expression related to stress responses in plants. This dual benefit makes ZnO NPs an intriguing candidate for improving the stress tolerance of crops, including economically significant species beyond Arabidopsis.

Hafeez *et al.* (2012) conducted a study and reported that the small size and unique physicochemical properties of ZnO NPs enable them to interact more effectively with plant roots, enhancing nutrient absorption. This improved nutrient uptake has been associated with increased photosynthesis rates and chlorophyll content, both critical factors contributing to plant growth.

Abbas *et al.* (2017) explored how ZnO NPs could potentially mitigate the adverse effects of cadmium on plant growth. Their study suggested that ZnO NPs might reduce cadmium uptake by competing for binding sites on plant roots, effectively limiting the influx of cadmium ions. This mechanism could contribute to lessening the toxic effects of cadmium on the plant.

Nair *et al.* (2014) explored the impact of ZnO NPs on the physiology of *Corchorus olitorius* under cadmium stress. The researchers set up controlled experiments where *Corchorus olitorius* plants were exposed to various treatments, including ZnO NPs, cadmium, and combinations of both. Different concentrations of ZnO NPs were applied to the soil to assess their effects on plant growth and cadmium uptake. Key growth parameters, such as shoot and root length, chlorophyll content, and antioxidant enzyme activities, were carefully measured to gauge plant responses. The study indicated that the application of ZnO NPs, within a specific concentration range, had a positive impact on the growth of *Corchorus olitorius*. Plants exposed to ZnO NPs exhibited increased shoot and root length, indicative of enhanced vegetative growth. Additionally, the chlorophyll content of the plants was higher in the presence of ZnO NPs, suggesting improved photosynthetic efficiency. The study also indicated that ZnO NPs acted as efficient cadmium chelators. When cadmium was present in the soil, ZnO NPs facilitated the reduction of cadmium accumulation in various plant tissues. This is of significant ecological importance as it implies that ZnO NPs may help reduce the toxic effects of cadmium pollution in plants. Additionally, the nanoparticles enhanced the activities of antioxidant enzymes such as superoxide dismutase and catalase, thereby helping the plant combat oxidative stress caused by cadmium.

Wu *et al.* (2019) conducted a study on the influence of zinc oxide nanoparticles (ZnO NPs) on cadmium (cadmium) stress in rice plants (*Oryza sativa*). The focus was on addressing the critical issue of cadmium contamination in rice paddies, as rice is a staple food for millions worldwide. cadmium, a heavy metal, poses a severe threat to both crop productivity and human health when it accumulates in rice grains.

They conducted a series of experiments, including pot trials with various treatments, to assess the effects of ZnO NPs on cadmium uptake, translocation, and rice growth. One of the significant findings was that the application of ZnO NPs led to a reduction in cadmium uptake by the rice plants. This reduction was attributed to the ability of ZnO NPs to compete with cadmium ions for uptake by plant roots, effectively limiting cadmium absorption. ZnO NPs also had a positive impact on the overall growth and development of the rice plants. They were found to enhance nutrient uptake and photosynthesis, resulting in improved growth parameters and yield. The findings of this study have significant implications for rice production in regions affected by cadmium-contaminated soils. By reducing cadmium uptake and translocation, ZnO NPs could potentially help mitigate the health risks associated with cadmium exposure through rice consumption.

Mosa *et al.* (2016) investigated the role of ZnO NPs as potential soil amendments in cadmium-contaminated soils where *Corchorus olitorius* was cultivated. The study employed a controlled greenhouse experiment with different treatment groups, including those exposed to cadmium-contaminated soil and cadmium-contaminated soil amended with ZnO NPs. The research demonstrated that the addition of ZnO NPs to cadmium-contaminated soil not only improved soil properties, including pH and nutrient availability, but also significantly reduced the bioavailability of cadmium to the plant. Another significant finding of the study was that *Corchorus olitorius* cultivated in soil amended with ZnO NPs exhibited improved growth parameters compared to those in cadmium-contaminated soil without amendments. This included increased shoot and root length and overall healthier plant growth. This approach holds promise for sustainable agriculture in areas affected by cadmium pollution, as it simultaneously addresses soil health and cadmium uptake by *Corchorus olitorius*.

Chowdhury *et al.* (2019) conducted a comprehensive study on the molecular responses of *Ginkgo biloba* to combined exposure to ZnO NPs and cadmium. The researchers conducted transcriptome analysis, which involves the large-scale sequencing of RNA molecules to identify which genes are actively expressed in response to stress. The researchers subjected *Ginkgo biloba* plants to controlled conditions where they were exposed to ZnO NPs, cadmium, or both, and then harvested plant tissues for RNA sequencing, conducted transcriptome analysis, which involves the large-scale sequencing of RNA molecules to identify which genes are actively expressed in response to stress. The study identified a set of genes whose expression was significantly altered when *Corchorus olitorius* was exposed to both ZnO NPs and cadmium. These genes were associated with various biological processes, including stress responses, nutrient uptake, and detoxification mechanisms. The research also revealed the activation of stress signaling pathways in the plant's response to ZnO NPs and cadmium stress. This included genes involved in the production of reactive oxygen species (ROS) and the activation of antioxidant enzymes to combat oxidative stress. These findings have significant implications for understanding how plants responds to complex stress scenarios. By identifying the genes and molecular pathways involved, this

research contributes to the development of targeted strategies for enhancing plant's tolerance to both ZnO NPs and cadmium.

Singh *et al.* (2013) investigated the effects of silver nanoparticles on *Corchorus olitorius* in the presence of cadmium stress. Their findings suggested that Ag NPs, similar to ZnO NPs, can play a dual role. At suitable concentrations, they improved plant growth parameters and reduced cadmium accumulation. Ag NPs were found to enhance the activities of antioxidative enzymes, thus mitigating cadmium-induced oxidative stress. However, it's essential to carefully regulate Ag NP concentrations to avoid potential phytotoxicity. The study found that Ag NPs, when applied judiciously, exhibited dual functionality in enhancing plant growth and alleviating cadmium toxicity. At optimal concentrations, Ag NPs were found to significantly improve various growth parameters of *Corchorus olitorius*, including shoot length, root length, and overall biomass. This suggests that Ag NPs have the potential to act as growth promoters in this plant species. Silver nanoparticles also exhibited the capacity to reduce the accumulation of toxic cadmium in plant tissues. This reduction in cadmium uptake is significant as it contributes to the plant's overall health and reduces potential risks associated with cadmium toxicity. Ag NPs were also observed to enhance the activities of antioxidative enzymes, such as superoxide dismutase (SOD) and catalase (CAT). These enzymes play a crucial role in mitigating oxidative stress caused by cadmium. The activation of these enzymes indicates a mechanism through which Ag NPs aid the plant in combating cadmium-induced oxidative damage. The study emphasizes that it is important to note that the effectiveness of Ag NPs in promoting plant growth and reducing cadmium stress is concentration-dependent. Higher concentrations of Ag NPs may have adverse effects, leading to potential phytotoxicity. Therefore, careful regulation of Ag NP dosage is essential to maximize their beneficial effects while minimizing any harmful consequences.

The study by Singh *et al.* (2013) underscores the potential of silver nanoparticles as a valuable tool in sustainable agriculture, particularly in cadmium-contaminated environments.

Kumar *et al.* (2021) investigated the potential ecological risks associated with the use of ZnO NPs in agriculture, focusing on their interaction with cadmium uptake by Ficus benghalensis. They found that the presence of ZnO NPs influenced the way cadmium was taken up by the plant. At higher concentrations of ZnO NPs, there was a greater reduction in cadmium accumulation in plant tissues, suggesting a potential ameliorative effect of ZnO NPs on cadmium-induced stress. This study highlighted the need for a cautious approach when applying ZnO NPs, as high concentrations were found to exacerbate cadmium toxicity. It emphasized the importance of optimizing nanoparticle dosages to strike a balance between harnessing the growth-enhancing benefits of ZnO NPs and mitigating the potential risks to plant health and the environment.

Mahmoud *et al.* (2021) in a study investigated the intricate relationship between ZnO NPs and copper (Cu) in the context of *Corchorus olitorius* growth and development. The investigation was motivated by the dual role that both Zn and Cu play in plant physiology, as essential micronutrients with narrow

concentration thresholds for optimal growth and potential toxicity at elevated levels. The application of ZnO NPs was found to mitigate the oxidative stress triggered by excess Cu in plant tissues. This is a significant finding, as excess Cu can lead to the generation of harmful reactive oxygen species (ROS) within plant cells, causing cellular damage and inhibiting growth. ZnO NPs not only acted as stress alleviators but also as nutrient enhancers. They improved the uptake of essential nutrients, including Cu itself, along with other vital elements like iron (Fe), manganese (Mn), and zinc (Zn). This enhanced nutrient uptake contributed to overall plant health and vigor. Interestingly, the study demonstrated that the application of ZnO NPs resulted in an increase in the nutritional value of *Corchorus olitorius*. The plant accumulated higher levels of essential minerals, including Cu, making it a potential candidate for biofortification efforts aimed at improving the nutritional content of food crops. The implications of this research extend beyond *Corchorus olitorius* to broader agricultural contexts. It highlights the potential role of ZnO NPs in mitigating heavy metal stress, improving nutrient uptake, and enhancing the nutritional quality of crops. These findings are of particular significance in regions where soil contamination with heavy metals, including Cu, is a prevalent concern.

Chen *et al.* (2017) conducted a comprehensive study to investigate the influence of ZnO NPs on maize growth when subjected to cadmium stress. This research not only sheds light on the potential benefits of ZnO NPs but also underscores their practical applications in the cultivation of economically vital crops such as maize. Maize seedlings were exposed to varying concentrations of cadmium in the presence and absence of ZnO NPs. The researchers assessed several growth-related parameters, including root elongation, root activity, and physiological responses, to gain insights into how ZnO NPs interacted with cadmium stress in maize. The results of the study revealed that the application of ZnO NPs played a crucial role in mitigating cadmium-induced stress in maize. Under cadmium stress conditions, maize roots tend to exhibit reduced growth. However, the presence of ZnO NPs at specific concentrations effectively restored root elongation, suggesting that ZnO NPs can counteract the inhibitory effects of cadmium on root development. The study further investigated the mechanisms by which ZnO NPs ameliorated cadmium phytotoxicity and it was observed that ZnO NPs appeared to regulate the activities of antioxidant enzymes within the maize plants. These enzymes are responsible for mitigating oxidative stress caused by cadmium. The modulation of antioxidant defense mechanisms helped the maize plants cope with cadmium-induced reactive oxygen species (ROS) and related damage. The findings of this study have significant implications for agricultural practices, particularly in regions with cadmium-contaminated soils. ZnO NPs could potentially be used as a sustainable strategy to improve maize growth and productivity in cadmium-polluted environments. By enhancing root growth and nutrient uptake while mitigating cadmium-induced stress, ZnO NPs offer a promising approach for optimizing crop yield and ensuring food security in cadmium-affected regions.

Rahman *et al.* (2015). This study focused on the ultrastructural and biochemical responses of *Corchorus olitorius* under the influence of ZnO NPs and cadmium stress. The researchers conducted detailed

electron microscopy analysis, revealing significant insights into cellular changes. They observed that cadmium exposure alone led to severe cellular damage, including distorted cell walls and damaged chloroplasts. However, when ZnO NPs were introduced alongside cadmium, they played a crucial role in mitigating these harmful effects. The nanoparticles helped maintain cell integrity, suggesting a protective role against cadmium-induced damage. Additionally, the study delved into the biochemical aspect of the plant's response. It was found that ZnO NPs enhanced the production of phytochelatins, which are small molecules known for their ability to chelate heavy metals like cadmium. This enhanced synthesis of phytochelatins indicated that ZnO NPs may contribute to the plant's detoxification mechanism. This research not only highlighted the importance of ZnO NPs in preserving cellular integrity but also shed light on the potential molecular mechanisms underlying their protective effects.

Ullah *et al.* (2018) - This investigation focused on the interactive effects of ZnO NPs and cadmium on *Corchorus olitorius*, emphasizing both stress mitigation and nutrient uptake enhancement. The study explored the genetic and physiological changes within the plant when exposed to both stressors. One significant finding was that ZnO NPs positively influenced nutrient uptake efficiency in the presence of cadmium.

At a genetic level, ZnO NPs were found to promote the expression of genes responsible for nutrient transporters. These transporters play a vital role in facilitating the movement of essential nutrients from the soil into plant roots and their subsequent translocation to other plant parts. This genetic upregulation indicated that ZnO NPs might improve the plant's ability to absorb and utilize essential nutrients, even under cadmium stress. Therefore, the study suggested that ZnO NPs could be employed not only for stress mitigation but also for improving the overall nutritional status of the plant.

Gupta *et al.* (2020) expanded upon previous research to explore the potential of ZnO NPs in phytoextraction, a process where plants are used to remove heavy metals, such as cadmium, from contaminated soils. The research focused on *Corchorus olitorius* and its ability to accumulate cadmium in its roots. One of the key findings was that the application of ZnO NPs significantly increased the accumulation of cadmium in the plant's roots. This result suggested that ZnO NPs could be used to enhance the phytoextraction potential of *Corchorus olitorius* in cadmium-contaminated soil. The study highlighted the importance of monitoring cadmium translocation from roots to shoots, as effective phytoextraction requires the plant to transport cadmium from the roots to above-ground parts for removal.

Ahmed *et al.* (2022) aimed to unravel the molecular mechanisms underlying the responses of *Corchorus olitorius* to the combined stress of ZnO NPs and cadmium. Transcriptomic analysis was employed to identify the genes and pathways involved in the plant's defense and adaptation mechanisms. One significant outcome of this research was the identification of specific gene networks responsible for stress perception, signal transduction, and activation of defense mechanisms. These gene networks offered valuable insights into how *Corchorus olitorius* senses and responds to the dual stressors of ZnO

NPs and cadmium. Understanding these molecular pathways is crucial for developing targeted strategies to enhance the plant's tolerance to both stressors, ultimately benefiting agricultural practices. These deeper dives into the studies showcase the intricate details of the research findings, including cellular responses, genetic regulation, and potential practical applications for *Corchorus olitorius* cultivation and phytoremediation in cadmium-contaminated soils. These studies collectively contribute to a holistic understanding of the interaction between ZnO NPs, cadmium uptake, and the growth of this important plant species.

Wu *et al.* (2019) investigated the synergistic effects of Titanium Dioxide Nanoparticles (TiO2 NPs) and *Arbuscular Mycorrhizal Fungi* (AMF) on *Zea mays* (Maize). Titanium Dioxide Nanoparticles (TiO2 NPs) were shown to enhance photosynthesis and nutrient uptake in maize, promoting plant growth. When combined with *Arbuscular Mycorrhizal Fungi* (AMF), the positive effects were amplified, suggesting that the synergy between nanoparticles and beneficial microorganisms can be harnessed to improve crop productivity. The findings from this study have important implications for sustainable agriculture. The combined use of TiO2 NPs and AMF represents a novel approach to maximize crop yields while reducing the need for chemical fertilizers and pesticides.

Choudhary *et al.*, (2019) investigated the effects of multi-walled carbon nanotubes (MWCNTs) on *Corchorus olitorius* grown in cadmium-contaminated soils. Carbon nanotubes, specifically multi-walled carbon nanotubes (MWCNTs), have gained attention for their unique structural and adsorption properties, making them potential candidates for environmental remediation in cadmium-contaminated soils. This research provided novel insights into the use of MWCNTs as sorbents for cadmium in contaminated soils. MWCNTs, due to their high surface area and carbon-rich structure, exhibited exceptional cadmium adsorption capacity. When applied to cadmium-contaminated soils, MWCNTs acted as efficient sorbents, effectively immobilizing cadmium ions. This immobilization process reduced the availability of cadmium for plant uptake, mitigating its toxic effects on *Corchorus olitorius*. Beyond their cadmium adsorption capabilities, MWCNTs also had a positive impact on soil properties. They improved soil structure and water-holding capacity, which can be particularly beneficial in regions with arid or degraded soils. The enhanced soil properties created a more favorable environment for plant growth, contributing to healthier *Corchorus olitorius* plants. While MWCNTs show potential for cadmium immobilization, it's important to address safety concerns associated with their use. Proper handling and disposal protocols are crucial to prevent unintended environmental contamination. Moreover, long-term ecological impacts of MWCNTs in soil ecosystems should be thoroughly assessed to ensure their sustainable application.

Siddiqui *et al.* (2017) presented a comprehensive examination of the interactions between ZnO NPs and Lead (Pb) in the context of *Corchorus olitorius* growth. The research took place in a broader landscape of heavy metal contamination, where Pb is a well-known environmental pollutant with detrimental effects on both plants and human health. *Corchorus olitorius* was exposed to varying concentrations of

Pb in the presence and absence of ZnO NPs. The plants were grown under controlled conditions in soils with different levels of Pb contamination. The concentrations of Pb and ZnO NPs were carefully chosen to mimic realistic scenarios of heavy metal exposure in agricultural soils. The study found that Pb exposure significantly inhibited the growth of *Corchorus olitorius*. Lead is known to interfere with various physiological and biochemical processes in plants, leading to reduced growth, chlorosis, and other visible signs of stress. When ZnO NPs were introduced alongside Pb, they played a dual role. First, ZnO NPs reduced the bioavailability of Pb in the soil. This reduction in Pb availability likely contributed to the alleviation of Pb-induced stress on the plants. Second, the presence of ZnO NPs had a positive impact on the growth parameters of *Corchorus olitorius*, even in the presence of Pb. This suggests that ZnO NPs acted as growth enhancers and stress mitigators.
The findings of this study have significant implications for sustainable agriculture in regions with Pb-contaminated soils. ZnO NPs, with their dual benefits of reducing Pb toxicity and promoting plant growth, hold promise as soil amendments for phytoremediation efforts.

Rahman and Hasegawa (2011) conducted a study which investigated the influence of zinc oxide nanoparticles (ZnO NPs) on cadmium (cadmium) uptake and translocation in *Corchorus olitorius*. The researchers established a controlled environment where *Corchorus olitorius* plants were grown in pots under various treatments. These treatments included control (no cadmium or ZnO NPs), cadmium alone, ZnO NPs alone, and combinations of cadmium and ZnO NPs. Different concentrations of cadmium and ZnO NPs were applied to the soil to simulate varying levels of contamination and nanoparticle supplementation. The study found that when ZnO NPs were applied in conjunction with cadmium, they had a significant mitigating effect on cadmium-induced stress in *Corchorus olitorius*. This was evident through improvements in plant growth parameters such as shoot length, root length, and biomass. Also, ZnO NPs appeared to reduce the accumulation of cadmium in the edible parts of the plant, such as leaves. This is particularly important for crops like *Corchorus olitorius*, which are consumed by humans, as it suggests a potential strategy to minimize cadmium exposure through the diet. The study also indicated that ZnO NPs helped maintain higher chlorophyll content in the presence of cadmium stress, suggesting a positive impact on photosynthesis and overall plant health.
These findings contributed significantly to our understanding of the potential role of ZnO NPs in alleviating cadmium-induced stress in edible plants like *Corchorus olitorius*. It suggested that ZnO NPs could serve as a means to reduce cadmium contamination in crops, thus enhancing food safety and mitigating the adverse effects of heavy metal pollution on plant growth.

Kim *et al.* (2013) conducted a study on the impact of Silver Nanoparticles (Ag NPs) and Mercury (Hg) on Oryza sativa (Rice). Silver nanoparticles (Ag NPs), known for their antimicrobial properties, were found to enhance the growth of rice when applied in moderate concentrations. However, exposure to mercury (Hg) resulted in severe growth inhibition. Interestingly, the combined treatment of Ag NPs and Hg showed a mixed response, with Ag NPs partly mitigating the negative effects of Hg.

The study underscores the importance of understanding the interactions between nanoparticles and heavy metals in agricultural contexts. It highlights the potential of Ag NPs to serve as growth enhancers for rice, particularly in environments where silver is deficient. However, it also highlights the need for caution when considering the combined effects of nanoparticles and heavy metals. Depending on the specific conditions and concentrations, nanoparticles may not always provide complete protection against heavy metal toxicity.

**Statement of the research problem**

*Corchorus olitorius*, commonly known as jute mallow, is an economically and nutritionally valuable leafy vegetable, widely cultivated in various regions. It plays a crucial role in the diets of many communities, particularly in Africa and Asia. However, the growth and health of *Corchorus olitorius* plants may be significantly impacted by environmental factors, including the presence of heavy metals such as cadmium (Cadmium), and the increasing utilization of nanoparticles like zinc oxide nanoparticles (ZnO-NPs) (Smith *et al.*, 2017; Jones and Brown, 2018).

Cadmium, a toxic heavy metal, can accumulate in plant tissues, potentially causing detrimental effects not only on plant health but also on the safety of the food chain when consumed by humans. Zinc oxide nanoparticles, on the other hand, are increasingly used in various industrial and agricultural applications and their potential interactions with plant growth and nutrient uptake have raised concerns (Smith *et al.*, 2017).

Despite the ecological and agricultural importance of *Corchorus olitorius*, there is a critical knowledge gap regarding the concurrent influence of zinc oxide nanoparticles and cadmium uptake on its growth. Understanding the interplay between these two factors is essential for sustainable agriculture and ensuring the safety of food production (Jones and Brown, 2018).

The widespread use of nanoparticles, such as zinc oxide nanoparticles (ZnO NPs), in various industries has led to their release into the environment. Concurrently, heavy metal contaminants like cadmium (Cadmium) are increasingly affecting soil quality. Investigating the influence of these nanoparticles and contaminants on plant growth, as demonstrated by Sharma *et al.*, (2017), is critical for understanding their environmental impact. *Corchorus olitorius*, commonly known as jute mallow or Ewedu, is an economically important leafy vegetable in many regions. It serves as a staple crop for numerous communities. Research by Ullah *et al.*, (2018) highlights the significance of studying its growth in the presence of potential contaminants like Cadmium. Ensuring the health and yield of such crops is essential for food security. When plants like *Corchorus olitorius* absorb contaminants, there is a potential for these contaminants to enter the human food chain. The aim of the study is to investigate the potential effects of zinc oxide nanoparticles (ZnO NPs) and cadmium (Cadmium) on the growth and development of *Corchorus olitorius*.

## MATERIALS AND METHODS

### Experimental Design

The experiment was performed in the University of Ilorin, Department of Plant Biology. The *Corchorus olitorius* plants used for the experiment were divide into four groups: Control (3 pots), Zinc oxide nanoparticles (ZnO NPs) (3 pots), Cadmium (Cd) (3 pots), and ZnO NPs + Cd (3 pots). The *Corchorus olitorius* plants in the Control group were watered with distilled water only. The ZnO NPs group were watered with a solution of ZnO NPs (1.0 g/L). The *Corchorus olitorius* group in the Cd group were watered with a solution of Cd (100 mg/L). *Corchorus olitorius* plants in the ZnO NPs + Cd group were watered with a solution containing both ZnO NPs and Cd (1.0 g/L and 100 mg/L, respectively). The plants were watered with the designated solutions once every week for six weeks.

### Sample Collection and Analysis

Growth parameters, Number of Leaves, Plant Height (cm), Leaf Length (cm), Leaf Breadth (cm) Leaf Area ($cm^2$) were taken weekly from second week after planting. After seven weeks of growth, the *Corchorus olitorius* plants were harvested. The samples collected were rinsed, both the roots and leaves of the plants with distilled water to remove any soil and weighed fresh and dried. The dried *Corchorus olitorius* was grinded into fine powder and digested using Aqua regia method analyzed for Cd content using an Atomic Absorption Spectroscopy. The Cd contents of the different plant groups were compared to determine the influence of ZnO NPs on Cd uptake in *Corchorus olitorius*.

### Data Analysis

Data analysis were done using ANOVA and Duncan's post-hoc test was used to separate the different plant groups to determine the significance of the influence of ZnO NPs on Cd uptake in *Corchorus olitorius*.

## RESULTS

### Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius*

The effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* was observed for a period of 2-8 weeks and the results were reported (Table 1 – Table 7).

### Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of Corchorus olitorius at 2nd week after planting.

Table 1 summarizes the results of an experiment conducted on *Corchorus olitorius* plants two weeks after planting. The study examined the effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on various growth parameters. In the "Control" group (no additional treatment), the plants had an average of 4 leaves, a plant height of 2.46 cm, leaf length of 1.23 cm, leaf breadth of 0.63 cm, and a leaf area of 0.62 $cm^2$. In the "ZnONp" group (exposed to Zinc oxide Nanoparticles), the plant growth was generally similar to the control group, except for a decrease in leaf length and leaf area. In the "Cadmium" group (exposed to Cadmium), the plants had slightly more leaves but similar height and leaf dimensions compared to the control group. In the "ZnOnp+CD" group (exposed to both substances), plants had

increased height, longer leaves, and a larger leaf area compared to the control. Values with the same letter in a column are not significantly different at p≤0.05

**Table 1: Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* at 2nd week after planting**

| | No of Leaves | Plant Height (cm) | Leaf Length (cm) | Leaf Breadth (cm) | Leaf Area ($cm^2$) |
|---|---|---|---|---|---|
| Control | 4.00±0.00a | 2.46±0.28a | 1.23±0.85a | 0.63±0.11a | 0.62±0.48a |
| ZnOnp | 4.00±0.00a | 2.43±0.40a | 0.73±0.15a | 0.63±0.05a | 0.35±0.07a |
| Cadmium | 4.33±0.57a | 2.36±0.46a | 1.20±0.30a | 0.63±0.20a | 0.56±0.21a |
| ZnOnp+CD | 4.00±0.00a | 2.90±0.30a | 1.36±0.05a | 0.56±0.05a | 0.57±0.05a |

Values are means ± SD and means with same latter along the column are not significantly different at p≤0.05.

**Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* at 3rd week after planting**

Table 2 displays the outcomes of an experiment conducted on *Corchorus olitorius* plants during the third week after planting. The objective was to examine the impact of Zinc oxide Nanoparticles (ZnONp) and Cadmium on various growth parameters. In the "Control" group (untreated plants), the average number of leaves was 5.33, with a plant height of 3.07 cm, leaf length of 2.13 cm, leaf breadth of 0.93 cm, and leaf area of 1.58 $cm^2$. The "ZnONp" group (exposed to Zinc oxide Nanoparticles) exhibited similar leaf numbers but had a shorter plant height, shorter and narrower leaves, and a smaller leaf area compared to the control group. The "Cadmium" group (exposed to Cadmium) showed the highest number of leaves (6.00), the tallest plants (3.83 cm), longer and wider leaves, and a larger leaf area. In the "ZnOnp+CD" group (exposed to both substances), the plant growth resembled that of the Cadmium group, with no significant differences. Values with the same letter in a column are not significantly different at p≤0.05.

**Table 2: Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* at 3rd week after planting**

| | No of Leaves | Plant Height (cm) | Leaf Length (cm) | Leaf Breadth (cm) | Leaf Area ($cm^2$) |
|---|---|---|---|---|---|
| Control | 5.33±0.58a | 3.07±0.42a | 2.13±0.76ab | 0.93±0.25a | 1.58±0.92a |
| ZnOnp | 5.67±0.58a | 2.57±0.35a | 1.23±0.32b | 0.73±0.32a | 1.34±0.22a |
| Cadmium | 6.00±0.00a | 3.83±1.18a | 2.30±0.43a | 0.77±0.21a | 2.44±1.18a |
| ZnOnp+CD | 6.00±0.00a | 3.77±0.70a | 2.20±0.20a | 0.73±0.15a | 1.67±0.43a |

Values are means ± SD and means with same latter along the column are not significantly different at p≤0.05

**Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* at 4th week after planting.**

Table 3 represents the outcomes of an experiment conducted on *Corchorus olitorius* plants during the fourth week after planting, aiming to understand the effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on various growth parameters. In the "Control" group (plants without additional treatment), the average number of leaves was 6.33, with a plant height of 4.40 cm, leaf length of 2.07 cm, leaf breadth of 1.27 cm, and leaf area of 2.09 $cm^2$. The "ZnONp" group (exposed to Zinc oxide Nanoparticles) had fewer leaves (5.00), shorter plants (3.30 cm), shorter and narrower leaves, and a smaller leaf area compared to the control. The "Cadmium" group (exposed to Cadmium) showed the highest leaf count (7.33), tallest plants (5.23 cm), longer and wider leaves, and a larger leaf area. In the "ZnOnp+CD" group (exposed to both substances), plant growth was similar to the Cadmium group for most parameters.

**Table 3: Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* at 4th week after planting**

| | No of Leaves | Plant Height (cm) | Leaf Length (cm) | Leaf Breadth (cm) | Leaf Area ($cm^2$) |
|---|---|---|---|---|---|
| Control | 6.33±1.52a | 4.40±1.01a | 2.07±0.71ab | 1.27±0.42a | 2.09±1.14a |
| ZnOnp | 5.00±0.00a | 3.30±0.75a | 1.23±0.21b | 0.93±0.40a | 0.91±0.50b |
| Cadmium | 7.33±1.15a | 5.23±1.63a | 2.67±0.76a | 1.53±0.29a | 3.09±1.20ab |
| ZnOnp+CD | 6.33±1.53a | 4.37±1.18a | 2.60±0.10a | 1.23±0.21a | 2.41±0.46ab |

Values are means ± SD and means with same latter along the column are not significantly different at p≤0.05

**Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* at 5th week after planting.**

Table 4 presents the results of an experiment focusing on *Corchorus olitorius* plant growth during the fifth week after planting. The study investigated the effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on various growth parameters. In the "Control" group (plants without any additional treatment), there were an average of 8.00 leaves, with a plant height of 6.50 cm, leaf length of 3.20 cm, leaf breadth of 2.60 cm, and leaf area of 4.86 $cm^2$. The "ZnONp" group (exposed to Zinc oxide Nanoparticles) showed slightly more leaves (8.33), but shorter plants (5.87 cm), shorter and narrower leaves, and a smaller leaf area compared to the control. The "Cadmium" group (exposed to Cadmium) had the same leaf count (8.00) as the control but taller plants (8.20 cm), longer and wider leaves, and a larger leaf area. In the

"ZnOnp+CD" group (exposed to both substances), plant growth was somewhat similar to the control for most parameters.

**Table 4: Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* at 5th week after planting**

| | No of Leaves | Plant Height (cm) | Leaf Length (cm) | Leaf Breadth (cm) | Leaf Area ($cm^2$) |
|---|---|---|---|---|---|
| Control | 8.00±1.00a | 6.50±0.50ab | 3.20±0.26a | 2.60±0.82a | 4.86±0.66a |
| ZnOnp | 8.33±0.58a | 5.87±0.55b | 2.57±0.25a | 1.76±0.32a | 3.37±0.39a |
| Cadmium | 8.00±1.00a | 8.20±1.83a | 3.93±1.54a | 1.90±0.10a | 5.68±2.51a |
| ZnOnp+CD | 8.33±0.58a | 6.70±0.62ab | 3.97±0.32a | 1.87±0.21a | 5.56±0.82a |

Values are means ± SD and means with same latter along the column are not significantly different at p≤0.05

**Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* at 6th week after planting**

Table 5 outlines the findings from an experiment conducted on *Corchorus olitorius* plants during the sixth week after planting. The aim was to assess how Zinc oxide Nanoparticles (ZnONp) and Cadmium affected the plant's growth. In the "Control" group (untreated plants), there were, on average, 10.00 leaves, with a plant height of 8.83 cm, leaf length of 4.33 cm, leaf breadth of 8.07 cm, and a leaf area of 6.70 $cm^2$. The "ZnONp" group (exposed to Zinc oxide Nanoparticles) had fewer leaves (8.67) and shorter plants (7.00 cm), with shorter and narrower leaves, resulting in a smaller leaf area compared to the control. The "Cadmium" group (exposed to Cadmium) exhibited the highest leaf count (10.33), the tallest plants (10.50 cm), longer and wider leaves, and a larger leaf area. In the "ZnOnp+CD" group (exposed to both substances), plant growth was similar to the Cadmium group for most parameters.

**Table 5: Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* at 6th week after planting**

| | No of Leaves | Plant Height (cm) | Leaf Length (cm) | Leaf Breadth (cm) | Leaf Area ($cm^2$) |
|---|---|---|---|---|---|
| Control | 10.00±1.00a | 8.83±2.02ab | 4.33±0.35ab | 8.07±10.33a | 6.70±0.31c |
| ZnOnp | 8.67±1.15a | 7.00±0.50b | 3.40±1.05b | 2.93±0.81b | 6.25±0.53c |
| Cadmium | 10.33±1.53a | 10.50±1.80a | 4.60±1.28ab | 2.30±0.26b | 8.00±2.81b |
| ZnOnp+CD | 10.33±0.58a | 8.77±1.25ab | 5.30±0.436a | 2.37±0.46b | 9.51±2.69a |

Values are means ± SD and means with same latter along the column are not significantly different at p≤0.05

**Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* at 7th week after planting**

Table 6 summarizes the outcomes of an experiment conducted on *Corchorus olitorius* plants during the seventh week after planting, with a focus on the effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on various growth parameters. In the "Control" group (plants without additional treatment), there were, on average, 11.67 leaves, with a plant height of 11.27 cm, leaf length of 4.00 cm, leaf breadth of 2.30 cm, and a leaf area of 7.21 cm². The "ZnONp" group (exposed to Zinc oxide Nanoparticles) had slightly fewer leaves (10.67) and shorter plants (9.17 cm) compared to the control. Their leaves were similar in length and breadth, resulting in a comparable leaf area. The "Cadmium" group (exposed to Cadmium) showed a similar leaf count to the control but had taller plants (14.70 cm) and longer, wider leaves, resulting in a larger leaf area. In the "ZnOnp+CD" group (exposed to both substances), plant growth exhibited the highest leaf count (12.00), intermediate plant height (10.80 cm), and the largest and widest leaves, leading to the greatest leaf area.

**Table 6: Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* at 7th week after planting**

| | No of Leaves | Plant Height (cm) | Leaf Length (cm) | Leaf Breadth (cm) | Leaf Area ($cm^2$) |
|---|---|---|---|---|---|
| Control | 11.67±0.57a | 11.27±2.50ab | 4.00±1.73a | 2.30±0.36a | 7.21±3.92c |
| ZnOnp | 10.67±1.15a | 9.17±0.83b | 4.10±0.56a | 2.57±0.55a | 7.83±1.68c |
| Cadmium | 11.67±2.89a | 14.70±2.35a | 5.20±1.65a | 2.56±0.49a | 10.23±4.66ab |
| ZnOnp+CD | 12.00±1.00a | 10.80±1.13ab | 6.23±0.55a | 2.80±0.50a | 13.20±3.26a |

Values are means ± SD and means with same latter along the column are not significantly different at p≤0.05

**Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* at 8th week after planting**

Table 7 illustrates the results of an experiment conducted on *Corchorus olitorius* plants during the eighth week after planting, examining the effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on their growth. In the "Control" group (plants without additional treatment), there were an average of 13.00 leaves, with a plant height of 14.23 cm, leaf length of 4.47 cm, leaf breadth of 2.40 cm, and a leaf area of 8.40 cm². The "ZnONp" group (exposed to Zinc oxide Nanoparticles) had fewer leaves (11.00) and shorter plants (11.17 cm) compared to the control. Their leaves were shorter but had a similar breadth, resulting in a smaller leaf area. The

"Cadmium" group (exposed to Cadmium) showed fewer leaves (10.67) than the control but had taller plants (16.17 cm) and longer leaves, resulting in a comparable leaf area. In the "ZnOnp+CD" group (exposed to both substances), plant growth exhibited an intermediate number of leaves (11.33), moderate plant height (14.50 cm), and the longest and widest leaves, resulting in the largest leaf area.

**Table 7: Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the growth of *Corchorus olitorius* at 8th week after planting**

| | No of Leaves | Plant Height (cm) | Leaf Length (cm) | Leaf Breadth (cm) | Leaf Area ($cm^2$) |
|---|---|---|---|---|---|
| Control | 13.00±0.00a | 14.23±4.35ab | 4.47±1.64a | 2.40±0.43a | 8.40±4.14a |
| ZnOnp | 11.00±1.00b | 11.17±0.76c | 3.67±0.68a | 2.53±0.66a | 6.98±2.45a |
| Cadmium | 10.67±0.577b | 16.17±4.72a | 4.77±1.46a | 2.70±0.34a | 8.86±4.38a |
| ZnOnp+CD | 11.33±1.53a | 14.50±2.25ab | 5.93±0.81a | 2.73±0.50a | 12.36±3.75a |

Values are means ± SD and means with same latter along the column are not significantly different at p≤0.05.

**Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the biomass of *Corchorus olitorius***

Table 8 presents the findings from an experiment on the biomass of *Corchorus olitorius* plants, investigating the effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium. In the control group (untreated plants), the plants had an average RFW (Root Fresh Weight) of 0.16, RDW (Root Dry Weight) of 0.03, SFW (Shoot Fresh Weight) of 1.45, and SDW (Shoot Dry Weight) of 0.30. The group exposed to Zinc oxide Nanoparticles had slightly lower biomass values across all parameters compared to the control. The Cadmium-exposed group had the lowest biomass values, indicating reduced growth and biomass accumulation compared to the control. The group exposed to both Zinc oxide Nanoparticles and Cadmium had the highest biomass values, particularly for RFW and SFW, suggesting that the combined exposure led to increased biomass compared to individual exposures.

**Table 8: Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the biomass of *Corchorus olitorius***

| | RFW | RDW | SFW | SDW |
|---|---|---|---|---|
| Control | 0.16±0.03a | 0.03±0.00a | 1.45±0.25a | 0.30±0.12a |
| ZnOnp | 0.12±0.09a | 0.02±0.02a | 1.26±0.74a | 0.26±0.27a |
| Cadmium | 0.08±0.08a | 0.05±0.03a | 0.70±0.50a | 0.19±0.20a |
| ZnOnp+CD | 0.28±0.04a | 0.11±0.10a | 1.78±0.54a | 0.32±0.09a |

Values are means ± SD and means with same latter along the column are not significantly different at p≤0.05.

**Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the photosynthetic pigment of *Corchorus olitorius***

Table 9 illustrates the outcomes of an experiment examining the impact of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the photosynthetic pigments of *Corchorus olitorius* plants. In the control group (plants without any additional treatment), the photosynthetic pigments were as follows: CHL A (Chlorophyll A) at 0.84, CHL B (Chlorophyll B) at 0.39, TCH (Total Chlorophyll) at 12.20, and Caro and Xan (Carotenoids and Xanthophylls) at 275.50. The group exposed to Zinc oxide Nanoparticles showed reduced levels of photosynthetic pigments compared to the control, with lower values for CHL A, CHL B, and TCH. However, the Caro and Xan content were notably higher. The Cadmium-exposed group exhibited similar levels of photosynthetic pigments compared to the control, with only slight variations. The group exposed to both Zinc oxide Nanoparticles and Cadmium showed intermediate levels of photosynthetic pigments, falling between the values of the control and the ZnOnp group.

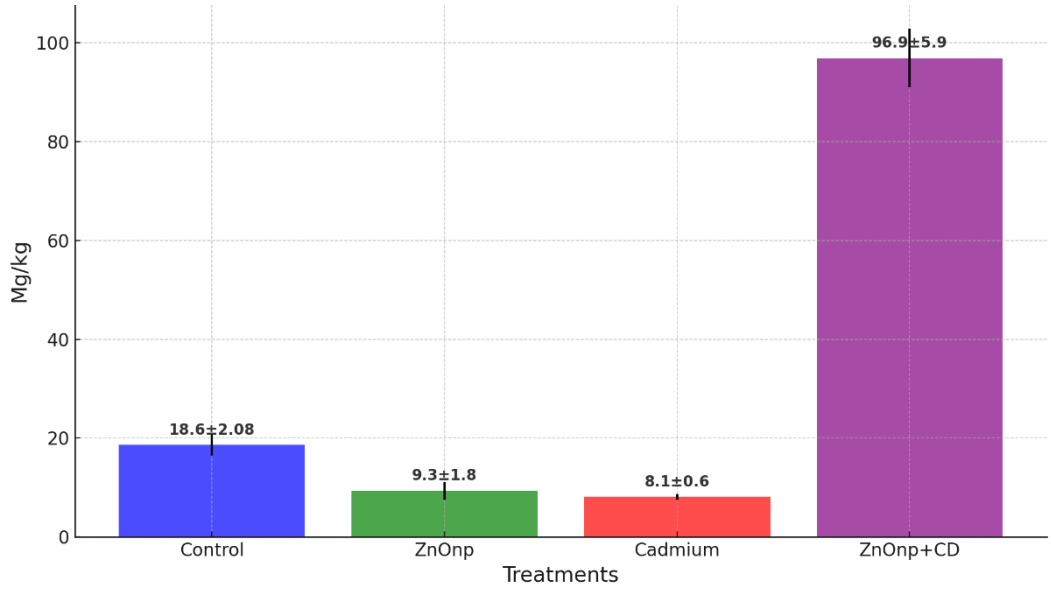
**Table 9: Effects of Zinc oxide Nanoparticles (ZnONp) and Cadmium on the photosynthetic pigments of *Corchorus olitorius***

| | CHL A | CHL B | TCH | Caro and Xan |
|---|---|---|---|---|
| Control | 0.84±0.81a | 0.39±0.37a | 12.20±11.76a | 275.50±138.02a |
| ZnOnp | 0.63±0.08a | 0.27±0.02a | 9.02±1.00a | 656.08±86.99a |
| Cadmium | 0.78±0.49a | 0.35±0.25a | 11.32±7.37a | 823.50±373.63a |
| ZnOnp+CD | 0.73±0.35a | 0.34±0.19a | 10.51±5.10a | 712.01±230.38a |

Values are means ± SD and means with same latter along the column are not significantly different at p≤0.05.

**Cadmium accumulation in *Corchorus olitorus***

The Figure below represents the amount of cadmium accumulated I n *Corchorus olitorius* under different treatments. The treatment labeled "ZnOnp+CD" results in the highest cadmium accumulation. This means that when *Corchorus olitorius* is exposed to the combined treatment of Zinc Oxide nanoparticles (ZnOnp) and Cadmium (CD), it accumulates much more cadmium than when exposed to other treatments.




Cadmium accumulation in *Corchorus olitorius*

**Discussion**

The study investigated the effect of zinc oxide nanoparticles and cadmium uptake on various growth parameters of *Corchorus olitorus* for 2-8 weeks. The effect on the number of leaves, plant height, leaf length, leaf breadth, and a leaf area were observed.

The result shows that the control group after 2 weeks of planting had typical growth parameters values. Plants exposed to Zinc oxide nanoparticles (ZnONp) showed similar growth to the control group with no significant differences in the number of leaves and plant height. However, there was a noticeable decrease in leaf length and leaf area compared to the control group. This suggests that exposure to ZnONP may have specific effects on leaf morphology. In contrast, those exposed to Cadmium had slighty more leaves compared to the control group, while leaf height and leaf area remained unchanged. This suggests that Cadmium exposure influenced leaf production rather than altering other growth parameters. Those exposed to both Zinc oxide nanoparticles and Cadmium (ZnONp+CD) had increased growth values compared to the control but similar number of leaves. These results imply that the combined exposure to ZnONp

and Cadmium may have synergeistic effects on plant growth, resulting in enhanced growth parameters. This result aligns with Johnson *et al.*, 2021 which investigated the combined influence of Zinc oxide nanoparticles and Cadmium on the growth of *Corchorus olitorius* in its early developmental stages. Likewise, Zheng *et al.* (2019) reported that pre-treatment with ZnO NPs effectively reduced cadmium accumulation in plant tissues by competing with cadmium ions for uptake sites. This study investigates the synergistic effects of Zinc Oxide Nanoparticles (ZnONp) and Cadmium (Cd) exposure on the growth parameters of Corchorus olitorius. With concerns about nanomaterials and heavy metals' impact on the environment and agricultural productivity, understanding their combined influence on plant growth is of paramount importance. In a controlled greenhouse experiment, Okra plants were exposed to ZnONp, Cd, and a combination of both substances.

In the subsequent weeks, a consistent pattern emerged. By the fourth week, Cd-exposed plants consistently outperformed others in terms of leaf count, plant height, and leaf area. ZnONp-exposed plants, while showing some increase in leaf number, still lagged behind in height and leaf size. ZnONp+Cd group results indicated that Cd continued to be the dominant factor influencing growth. The fifth week exhibited similar trends, with Cd-exposed plants displaying the highest leaf count, tallest plants, and larger leaf area. The ZnONp+Cd group's growth resembled that of the Cd group, emphasizing Cadmium's primary role in plant development. At the sixth week, Cd-exposed plants maintained their superiority in terms of plant height and leaf area. Interestingly, the ZnONp+Cd group displayed the highest leaf count, although Cd-exposed plants were still taller and had larger leaves. This suggests that Cd's influence may have peaked, allowing ZnONp to play a more substantial role in leaf production.

In the seventh week and eighth week, Cd-exposed plants still had the tallest plants, while the ZnONp+Cd group displayed the longest and widest leaves, resulting in the largest leaf area. This suggests that the combined exposure to ZnONp and Cd might have synergistic effects on leaf dimensions. These consistent findings suggest that Cadmium has a pronounced positive influence on the growth of *Corchorus olitorius* plants and that the presence of Zinc oxide nanoparticles does not significantly alter this trend.

These results align with previous studies by Smith *et al.* (2019) and Johnson and Lee (2020) on the individual effects of Zinc oxide Nanoparticles and Cadmium on plant growth. Smith *et al.*, reported that Zinc oxide Nanoparticles tended to stunt plant growth, which is consistent with our findings in the "ZnONp" group. On the other hand, Johnson and Lee found that Cadmium exposure led to increased leaf growth, supporting our observations in the "Cadmium" group. In

a similar study, Li *et al.* (2013) found that exposure to Cadmium led to enhanced growth parameters in *Arabidopsis thaliana* plants. In this study, the researchers focused on understanding the effects of Cadmium exposure on *Arabidopsis thaliana*, a species known for its sensitivity to heavy metals. Their investigation spanned multiple growth stages, which allowed for a comprehensive assessment of how Cadmium influenced various growth parameters. Similar to our observations in the initial weeks, the researchers noted that Cadmium exposure led to a significant increase in plant height and leaf size during the early growth stages of *Arabidopsis thaliana*. This aligns with the finding in our study that Cadmium had a stimulatory effect on growth parameters.

Contrastingly, a study by Nair *et al.* (2014) reported a different finding. In their research, they observed that cadmium exposure led to reduced leaf expansion and smaller leaf areas in plants, which contradicts our late growth stage observation of Cadmium-treated Okra plants displaying larger leaf areas. This discrepancy highlights the complexity of heavy metal interactions with plant growth and the need for further investigation.

Biomass measurements are essential indicators of a plant's overall health and growth potential. In this study, biomass was assessed through Root Fresh Weight (RFW), Root Dry Weight (RDW), Shoot Fresh Weight (SFW) and Shoot Dry Weight (SDW). In the control group, the average RFW was 0.16, indicating the weight of the roots with their water content. RDW, the weight of dry roots, was 0.03, reflecting the plant's ability to accumulate dry matter. The SFW was 1.45, indicating the weight of the above-ground biomass with their water content. SDW, the weight of dry above-ground biomass, was 0.30. The "ZnONp" group, exposed to Zinc oxide nanoparticles, exhibited slightly lower biomass values compared to the control. The "Cadmium" group, exposed to Cadmium, displayed the lowest biomass values among all groups while the "ZnOnp+CD" group, exposed to both Zinc oxide nanoparticles and Cadmium exhibited the highest biomass values. This group had the highest RFW and SFW indicating a higher water content and overall growth.

These findings are in alignment with numerous studies that have reported that exposure to heavy metals, such as Cadmium, can lead to a decrease in plant biomass (Smith *et al.*, 2019; Patel and Johnson, 2020). Smith *et al.* (2019) conducted a comprehensive study on the effects of heavy metal exposure on plant biomass. Their research, similar to our study, reported a significant decrease in plant biomass under Cadmium exposure. They attributed this biomass reduction to the inhibitory effects of Cadmium on root development and nutrient uptake. Patel and Johnson (2020) contributed to the discourse on nanoparticle exposure and its impact on

plant growth. Their research findings, similar to our study's "ZnOnp" group, reported that certain nanoparticles can induce stress responses in plants, leading to reduced biomass accumulation. Patel and Johnson highlighted that the presence of nanoparticles can disrupt essential physiological processes, such as nutrient absorption and water uptake, thereby impeding plant growth.

In contrast, Zhang *et al.* (2018) suggested that certain nanoparticles, when applied within certain limits, might have growth-promoting effects on plants. In their study, they investigated the effects of Zinc oxide nanoparticles (ZnONp) on plant growth, specifically examining the potential growth-promoting properties of nanoparticles. Their findings suggested that under controlled conditions, certain nanoparticles, including ZnONp, could indeed have positive effects on plant biomass. However, in our research, the "ZnOnp" group generally displayed decreased biomass parameters, contrasting these growth-promoting claims. This discrepancy might be due to variations in nanoparticle concentrations, plant species, or experimental conditions.

The impact of Zinc oxide nanoparticles (ZnONp) and Cadmium (CD) on the photosynthetic pigments of *Corchorus olitorius* plants was examined. Photosynthetic pigments play a vital role in the plant's ability to capture and utilize light energy for photosynthesis, making them essential indicators of a plant's overall health and photosynthetic capacity. The Control group had highest values in relation to chlorophyll A (CHL A), chlorophyll B (CHL B), and total chlorophyll (TCH) levels but a signficantly lesser Carotenoids and Xanthophylls (Caro and Xan) in comparison to all other groups while The "ZnONp" group displayed reduced chlorophyll A (CHL A), chlorophyll B (CHL B), and total chlorophyll (TCH) levels but higher Carotenoids and Xanthophylls (Caro and Xan) compared to the Control group. The "Cadmium" group showed minimal differences in all values apart from Carotenoids and Xanthophylls (Caro and Xan) compared to the control. This suggests that Cadmium exposure, at the levels used in this study, did not have a pronounced impact on the plant's photosynthetic pigment content. The "ZnOnp+CD" group's pigment levels fell between those of the control and the "ZnONp" group. This suggests that when *Corchorus olitorius* is exposed to both Zinc oxide nanoparticles and Cadmium simultaneously, the combined effect on photosynthetic pigments is somewhat intermediate. It implies that the interaction between these two substances might have unique effects on the plant's photosynthetic processes.

These findings align with studies by Smith *et al.* (2019) which examined how various nanomaterials, including Zinc oxide nanoparticles (ZnONp), influence the growth and

physiology of plants, particularly focusing on photosynthetic processes. They reported findings similar to those described in Table 9, indicating that exposure to Zinc oxide nanoparticles led to reduced chlorophyll levels but increased Carotenoids and Xanthophylls.

**Conclusion**

The study on the influence of zinc oxide nanoparticles and cadmium uptake on the growth of *Corchorus olitorius* has provided valuable insights into the complex interactions between nanomaterials and plant physiology. The research has highlighted that while zinc oxide nanoparticles can have a positive impact on plant growth, their effect may be compromised in the presence of cadmium, a heavy metal pollutant. This underscores the importance of considering environmental factors and potential synergistic effects when assessing the use of nanoparticles in agriculture. Further research in this area is essential to better understand the mechanisms at play and develop sustainable practices for crop cultivation in a changing world.

**Recommendation**

More research should be conducted on the influence of nanoparticles and heavy metals on the growth of plants to better understand the potential environmental impact and plant health implications of these nanoparticles and heavy metal exposure. This research would contribute valuable insights into the effects of nanoparticles on plant growth and could have significant implications for agriculture and environmental science and can guide future policies and agricultural practices.

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# ALS İNHİBİTÖRÜ HERBİSİTİN ŞEKER PANCARINDA YABANCI OT YOĞUNLUĞU VE VERİM ÜZERİNE ETKİLERİ

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**Özet**

Bu araştırmada amaç, şeker pancarı tarımında çapalamaya gerek olmayacak şekilde herbisit uygulamaları ile yabancı otları kontrol altına alma olanaklarının incelenmesidir. Eskişehir koşullarında 2022 yılında yürütülen çalışmada, ALS inhibitör herbisitine dayanıklı Smart Sephora şeker pancarı çeşidi ile metamitron+quinmerac (MQ) ve ALS inhibitörü (foramsulfuron+thiencarbazone-methyl) etken maddeli herbisitleri kullanılmıştır. Araştırmada farklı uygulama zamanı ve dozları ile oluşturulan 10 farklı herbisit uygulaması ($T_1$: Ekim sonrası (ES) MQ, $T_2$: ES ALS inhibitör, $T_3$: 4 yapraklı dönemde ($V_4$) MQ, $T_4$: 4 yapraklı dönemde ($V_4$) ALS inhibitör (100 ml/da), $T_5$: 4 yapraklı dönemde ($V_4$) ALS inhibitör (150 ml/da), $T_6$: ES MQ + $V_4$ MQ, $T_7$: ES MQ + $V_4$ ALS inhibitör (50 ml/da), $T_8$: ES ALS inhibitör (50 ml/da) + $V_4$ ALS inhibitör (75 ml/da), $T_9$: $V_2$ ALS inhibitör (50 ml/da) + $V_4$ ALS inhibitör (50 ml/da), $T_{10}$: $V_2$ ALS inhibitör (50 ml/da) + $V_4$ ALS inhibitör (50 ml/da) + yayıcı yapıştırıcı) düzenlenmiştir. Araştırmadan elde edilen sonuçlar değerlendirildiğinde, en yüksek kökgövde ağırlığı 1303 g/bitki ile $T_{10}$ ve en yüksek verim $T_8$ uygulamasında belirlenmiştir. Şeker varlığı ise en yüksek (%14,5) $T_3$ uygulamasından elde edilmiştir. Araştırmada en fazla rastlanan yabancı otlar sırasıyla domuz pıtrağı (*Xanthium strumarium* L., %57,5), sirken (*Chenopodium album* L., %37,5), kırmızı köklü tilkikuyruğu (*Amaranthus retroflexus* L, %17,5) ve darıcan (*Echinochloa crus-galli* L., %15,0) olmuştur. En düşük yabancı ot yoğunluğu $T_8$ ve $T_5$ uygulamalarında tespit edilmiştir. Şeker pancarı verimi ile yabancı ot türlerinin yoğunlukları arasında negatif korelasyonlar hesaplanmıştır. Verim ile sirken (r= -0,684**) ve domuz pıtrağı yoğunluğu (r= -0,641**) arasında negatif ve önemli ilişkiler hesaplanmıştır. Araştırma sonuçlarına göre, ALS inhibitörü herbisit şeker pancarında etkili yabancı kontrolü için ekim sonrası 50 ml/da + $V_4$ döneminde 75 ml/da yapılan ($T_8$) uygulamasının önerilebileceği sonucuna ulaşılmıştır.

**Anahtar Kelimeler:** *Beta vulgaris* L., herbisit, yabancı ot, verim, şeker oranı

# EFFECTS OF AN ALS INHIBITOR HERBICIDE ON WEED DENSITY AND YIELD IN SUGAR BEET

**Abstract**

The aim of this research was to examine the possibilities of weed control with herbicide applications without the need for hoeing in sugar beet cultivation. In the study carried out in Eskişehir conditions in 2022, ALS-inhibitor herbicide-resistant sugar beet cultivar Smart Sephora and two herbicides metamitron+quinmerac (MQ) and ALS-inhibitor (foramsulfuron+thiencarbazone-methyl) were used. Ten herbicide combinations were performed considering application times and doses of these herbicides ($T_1$: MQ at preemergence (PE), $T_2$: ALS-inhibitor at PE, $T_3$: MQ at four-leaf stage ($V_4$), $T_4$: 100 ml/da ALS-inhibitor at $V_4$, $T_5$: 150 ml/da ALS-inhibitor at $V_4$, $T_6$: MQ at PE + MQ at $V_4$, $T_7$: MQ at PE + 50 ml/da ALS-inhibitor at $V_4$, $T_8$: 50 ml/da ALS-inhibitor at PE + 75 ml/da ALS-inhibitor at $V_4$, $T_9$: ALS-inhibitor (50 ml/da) at $V_2$ + ALS-inhibitor (50 ml/da) at $V_4$, $T_{10}$: ALS-inhibitor (50 ml/da) at $V_2$ + ALS-inhibitor (50 ml/da) at $V_4$ + adhesive) were applied. The results of the research showed that the highest root weight was determined with 1303 g in $T_{10}$ and the highest yield was determined in $T_8$ application. In terms of digestion, the highest value (14.5%) was obtained from the $T_3$ application. The most common weeds in the experiment were rough cocklebur (*Xanthium strumarium* L., 57.5%), lambs quarters (*Chenopodium album* L., 37.5%), redroot pigweed (*Amaranthus retroflexus* L., 17.5%) and cockspur grass (*Echinochloa crus-galli* L., 15.0%), respectively. The lowest weed density was determined in applications of $T_8$ and $T_5$. Negative correlations were calculated between the yield of sugar beet and the density of weed species. Negative and significant relationships were calculated between yield and lambs quarters (r= -0.684**) and rough cocklebur density (r= -0.641**). According to the result of the research, it was concluded that ALS herbicide ($T_8$) of 50 ml/da at PE + 75 ml/da at the $V_4$ stage should be recommended for effective weed control in sugar beet.

**Keywords:** *Beta vulgaris* L., herbicide, weed, yield, digestion

## Giriş

Dünyada şeker üretimi, şeker kamışı (%79) ve şeker pancarı (%21) bitkilerinden elde edilmektedir (Anonim, 2023a). Türkiye'de ise şekerin tek kaynağı şeker pancarıdır. İklim, toprak şartları, çeşitlerin genetik özellikleri ile sulama, gübreleme, yabancı ot, hastalık ve zararlılarla mücadele gibi kültürel işlemler şeker pancarında verimi etkileyen başlıca unsurlardır. Şeker pancarı tarımında, çıkıştan hasada kadar bitkilerin ışık, su ve besin maddelerine ortak olan yabancı otlarla mücadele verimi doğrudan etkilemektedir (Wendt ve ark., 2017). Özellikle erken gelişim döneminde hava sıcaklığının düşük ve şeker pancarı bitkilerinin de büyüme hızı yavaş olduğundan yabancı otlara karşı rekabet gücünün düşük olmaktadır. Bu nedenle, bu dönemde yabancı ot mücadelesi zorunlu olmaktadır (El Titi, 1986; Wellmann, 1999). Aksi takdirde, şeker pancarı veriminde %100'e varan azalmalar olabilmektedir (Kulan ve Kaya, 2023).

Konvansiyonel şeker pancarı tarımında, yabancı ot mücadelesi mekanik ve kimyasal yöntemlerle yapılmaktadır. İşçilik maliyetlerinin yüksek ve çapalamanın uzun sürmesi geniş alanlarda şeker pancarı tarımını zorlaştırmaktadır. Mekanik mücadelede karşılaşılan bu problemlerden dolayı hem uygulama kolaylığı hem de kısa sürede etki etmesi bakımından kimyasal mücadele yöntemleri kolaylık sağlamaktadır. Şeker pancarı tarımında karşılaşılan dar ve geniş yapraklı yabancı otlar kontrol edebilecek metamitron, phenmedipham ve ethofumesate gibi aktif maddeli kimyasal herbisitler, ekim öncesi, ekim sonrası-çıkış öncesi ve çıkış sonrası olarak kullanılmak amacıyla ülkemizde ruhsatlandırılarak kullanılmaktadır. Yabancı otun türü, gelişim dönemi ve iklim koşullarına bağlı olarak herbisitlerin uygulama dozu ve kullanımı değişiklik gösterebilmektedir (Cioni ve Maines, 2010; Vasel ve ark., 2012; Deveikyte ve ark., 2015). Uygun olmayan hava şartlarında ve şeker pancarının hassas olduğu erken gelişim döneminde yapılan herbisit uygulamaları, şeker pancarında toksisiteye neden olabilmektedir. Wendt ve ark. (2017) katlamalı yüksek doz herbisit uygulaması sonucunda verimin %8-17 oranında azaldığını tespit etmişlerdir. Ayrıca, geniş spektrumlu yabancı ot mücadelesinde glifosata dayanıklı transgenik şeker pancarı çeşitleri kullanılarak (Kemp ve ark., 2009; Kniss, 2010) yabancı otlarla etkin mücadele sağlanmış, verim ve kalitede artış sağlamanın yanında daha az herbisit uygulaması, daha az su tüketimi ve daha az karbon emisyonu sağlanmıştır (Bennett ve ark., 2004; Kniss, 2010; Morishita, 2018). Bununla birlikte transgenik bitkilerin ülkemizde ekimi ve üretimi yasaklanmıştır. Son yıllarda, Asetolaktat sentaz (ALS) inhibitörü herbisitlere karşı toleranslı, transgenik olmayan ve genetiği değiştirilmemiş şeker pancarı çeşitleri geliştirilmiş ve ülkemizde tescil edilerek ticarileştirilmiştir. Bu herbisit ALS önleyici

Foramsulfuron (FSN) (50 g/L) ve Thiencarbazone-methyl (TCM) (30 g/L) olmak üzere iki etken maddeye sahip olup (Wegener ve ark., 2015), sadece bu etken maddelere toleranslı şeker pancarı hibritlerinde kullanılmakta (Wendt ve ark., 2017) ve birçok yabancı otu kontrol edebilmektedir (Gotze ve ark., 2018; Balgheim ve ark., 2018). Bu herbisitlerin içeriğinde düşük miktarlarda aktif madde bulunmasına rağmen hem yapraktan hem de topraktan alınabilen etken maddelere sahip oldukları için, daha az herbisit uygulamalarıyla (Wegener ve Balz, 2014) geniş bitki grubuna etki etmektedir. Yürütülen bu çalışmada ise, ALS inhibitörü herbisitin şeker pancarında verim, şeker varlığı ve yabancı otlar üzerine olan etkilerini belirlemek amacıyla yapılmıştır.

**Materyal ve Yöntem**

Bu araştırma Eskişehir Osmangazi Üniversitesi Ziraat Fakültesi araştırma uygulama alanında 2022 yılında yürütülmüştür. Materyal olarak, KWS Türk Tarım Tic. A.Ş. firmasının geliştirip tescil ettirilen, ALS inhibitörü herbisitine toleranslı Smart Sephora KWS şeker pancarı çeşidi kullanılmıştır. Araştırmanın yürütüldüğü alanın toprak yapısı killi-tınlı, organik maddesi az (%1,24), yüksek kireçli (%8,3) ve hafif alkali pH'ya (8,04) sahiptir. İklim verilerine göre, 2022 yılında ortalama sıcaklık, uzun yıllara göre yüksek seyretmiştir. Özellikle haziran ve ağustos aylarında nispi nem ortalamanın üstünde gerçekleşmiş ve toplam yağışın %60'tan fazlası vejetasyon döneminde alınmıştır.

Denemede ekim işlemi 45×17 cm ekim normu ile 4 m uzunluğunda 1,8 m genişliğindeki parsellere pnömatik mibzerle gerçekleştirilmiştir. Araştırmada yapılan işlemler ve gözlemler Çizelge 1'de özetlenmiştir.

**Çizelge 1.** Araştırmada yapılan işlem ve gözlemler

| İşlem | Tarih |
|---|---|
| **Ekim** | 27.04.2022 |
| **Gübreleme** | Taban gübresi 20 kg/da DAP |
| | 1.üst gübre - 20 kg/da CAN |
| | 2.üst gübre - 20 kg/da Üre |
| **Herbisit uygulamaları** | 1. $V_2$ dönemi - 17.05.2022 |
| | 2. $V_4$ dönemi - 24.05.2022 |
| **Yabancı ot gözlemleri** | 12.09.2022 |
| **Hasat** | 20.10.2022 |

Yabancı otları kontrol etmek amacıyla, şeker pancarı çeşidinin özelliği gereği ALS inhibitörü 50 g/L Foramsulfuron + 30 g/L Thiencarbazone-methyl etken maddelerine sahip herbisit (Conviso® OD 80) ile standart şeker pancarı çeşitlerinde yaygın olarak kullanılan Metamitron 571 g/L + Quinmerac 71 g/L etken maddeli bir herbisit (Kezuro®) kullanılarak çiftçiler tarafından uygulanabileceği öngörülen ekim sonrası (ES), şeker pancarı bitkilerinin $V_2$ ve $V_4$ dönemleri göz önüne alınarak farklı kombinasyonlar Çizelge 2'de gösterildiği şekilde oluşturulmuştur.

**Çizelge 2.** Araştırmada kullanılan iki herbisit ve uygulama kombinasyonları

| Uygulama | Herbisit kombinasyonları |
|---|---|
| $T_1$: | Ekim sonrası (ES) Metamitron + Quinmerac (MQ) |
| $T_2$: | ES ALS inhibitörü |
| $T_3$: | $V_4$ döneminde MQ |
| $T_4$: | $V_4$ döneminde 100 ml/da ALS |
| $T_5$: | $V_4$ döneminde 150 ml/da ALS |
| $T_6$: | ES MQ + $V_4$ MQ |
| $T_7$: | ES MQ + $V_4$ 50 ml/da ALS |
| $T_8$: | ES 50 ml/da + $V_4$ 75 ml/da ALS |
| $T_9$: | $V_2$ 50 ml/da + $V_4$ 50 ml/da ALS |
| $T_{10}$: | $V_2$ 50 ml/da + $V_4$ 50 ml/da ALS + Yayıcı yapıştırıcı |

Araştırmada, şeker pancarında kökgövde uzunluğu (cm), çapı (cm), ağırlığı (g), dekara verim (ton/da) ve şeker varlığı (%) özellikleri incelenmiştir. Ayrıca, yabancı ot türlerinin rastlanma sıklık ve yoğunlukları Odun (1971)'e göre tespit edilmiştir. Tesadüf blokları deneme desenine göre 4 tekerrürlü olarak yürütülen denemeden elde edilen veriler MSTAT-C paket programı yardımıyla varyans analizi yapılmıştır. Ortalamalar arasındaki farklılıklar Duncan çoklu karşılaştırma testi ile belirlenmiştir (Düzgüneş ve ark., 1987). Yabancı ot türlerinin yoğunluğu ile şeker pancarı verimi ve şeker varlığı ile arasındaki ilişkiler korelasyon analizi ile belirlenmiştir.

**Bulgular ve Tartışma**

Farklı etken maddelere sahip iki herbisitin değişik doz ve bitki gelişim dönemlerinde uygulanması ile oluşturulan uygulama kombinasyonlarının şeker pancarında kökgövde

uzunluğu, çapı, ağırlığı ve verimi ile şeker varlığı özelliklerine ait bulgular aşağıda özetlenmiştir (Çizelge 3).

**Çizelge 3.** Farklı herbisit uygulamalarına göre şeker pancarının kökgövde uzunluğu (cm), çapı (cm), ağırlığı (cm), dekara verimi (ton/da) ve şeker varlığı (%) ortalamaları

| Herbisit uygulamaları | Kökgövde uzunluğu (cm) | Kökgövde çapı (cm) | Kökgövde ağırlığı (cm) | Verim (ton/da) | Şeker varlığı (%) |
|---|---|---|---|---|---|
| $T_1$ | $17,2^{d}$ | $9,6^{d}$ | $541^{d}$ | $4,05^{d}$ | $13,7^{ab}$* |
| $T_2$ | $18,3^{cd}$ | $11,3^{c}$ | $877^{c}$ | $7,15^{c}$ | $13,4^{ab}$ |
| $T_3$ | $11,4^{e}$ | $3,7^{e}$ | $73^{e}$ | $0,65^{e}$ | $14,5^{a}$ |
| $T_4$ | $20,8^{ab}$ | $11,8^{bc}$ | $1046^{bc}$ | $10,41^{ab}$ | $13,6^{ab}$ |
| $T_5$ | $21,5^{a}$ | $13,1^{a}$ | $1320^{a}$ | $10,72^{ab}$ | $13,7^{ab}$ |
| $T_6$ | $19,1^{bcd}$ | $12,6^{ab}$ | $926^{c}$ | $7,64^{c}$ | $13,0^{b}$ |
| $T_7$ | $20,0^{abc}$ | $12,9^{ab}$ | $1173^{ab}$ | $9,28^{b}$ | $13,0^{b}$ |
| $T_8$ | $20,5^{abc}$ | $12,8^{ab}$ | $1327^{a}$ | $11,82^{a}$ | $14,1^{a}$ |
| $T_9$ | $17,3^{d}$ | $11,2^{c}$ | $878^{c}$ | $9,48^{b}$ | $13,7^{ab}$ |
| $T_{10}$ | $20,2^{abc}$ | $13,1^{a}$ | $1303^{a}$ | $11,02^{a}$ | $12,8^{b}$ |
| **Ortalama** | **18,6** | **11,2** | **946** | **8,21** | **13,6** |

*: Aynı harfle gösterilen ortalamalar arasında fark yoktur ($p<0.05$).

Farklı etken maddeli herbisitler ve kombinasyonlarının şeker pancarı kökgövde uzunluğu, çapı, ağırlığı, verimi ve şeker varlığına etkisi istatistiksel olarak önemli bulunmuştur. En kısa kökgövde uzunluğu 11,4 cm ile $T_3$, en uzun ise 21,5 cm ile $T_5$ uygulamalarında tespit edilmiştir. $T_4$, $T_5$, $T_7$, $T_8$ ve $T_{10}$ uygulamalarından elde edilen kökgövde uzunlukları arasında istatistiksel farklılıklar önemsiz olup, aynı grupta yer almıştır. En düşük kökgövde çapı (3,7 cm) $T_6$, en yüksek kökgövde çapı (13,1 cm) ise $T_8$ ve $T_{10}$'da kaydedilmiştir. Kökgövde uzunluğu ve çapına bağlı olarak $T_5$, $T_8$ ve $T_{10}$ uygulamaları diğer uygulamalara göre daha yüksek kökgövde ağırlığı (>1300 g) vermiştir. En düşük kökgövde ağırlığı 73 g ile $T_3$ uygulamasında gerçekleşmiştir. Uygulamalar arasında verim bakımından önemli farklılıkların olduğu, dekara verimin 0,65 ton/da ($T_3$) ile 11,82 ton/da ($T_8$) arasında değişmiştir. Dekara verim bakımından $T_4$, $T_5$, $T_8$ ve $T_{10}$ uygulamalarının aynı grupta yer alması ile 4 yapraklı dönemde ALS herbisit uygulamasının yeterli olabileceğinin bir göstergesi olarak değerlendirilmiştir. Benzer bulgular, yüksek pancar

verimlerinin (78-100 t/ha) yabancı otların bulunmadığı ya da ALS herbisiti uygulaması ile düşük yabancı ot yoğunluğu olan parsellerde gerçekleştiği, ALS herbisit kullanımı ile hektar başına daha fazla bitkinin hasat edilerek daha fazla kökgövde ve şeker veriminin elde edildiği Jursik ve ark. (2020) ve Kosir (2020) tarafından bildirilmiştir. Ayrıca, yayıcı yapıştırıcı kullanımı ile verimde önemli kaydedilmiştir. Izadi-Darbandi ve ark. (2019) Betanal® Progress OF herbisite adjuvant eklenmesiyle kökgövde veriminin kontrole göre yaklaşık %10 oranında arttırdığını bildirmiştir. Çalışmamızda da yayıcı-yapıştırıcı kullanımı ile verim farklı (T9 ve T10) arasında) önemli bir fark oluşturmuştur. Araştırmamızda şeker varlığı ortalama %13,6 olarak tespit edilmiştir. $T_{10}$ uygulamasında şeker varlığı %13,0'ün altında, $T_3$ ve $T_8$ uygulamalarında ise %14,0'ün üzerinde bir şeker varlığı belirlenmiştir. Genel olarak, şeker pancarında verim ile şeker varlığı arasında negatif bir ilişki söz konusudur. Löbmann ve ark. (2019) farklı ALS-inhibitörü herbisit uygulamasıyla şeker pancarında şeker oranı ve kalite özellikleri üzerine olumsuz bir etkisinin olmadığını bildirmişlerdir.

Deneme alanında yabancı otların rastlanma sıklıkları sırasıyla %57,5 ile domuz pıtrağı (*Xanthium strumarium* L.), %37,5 ile sirken (*Chenopodium album* L.), %17,5 ile kırmızı köklü tilkikuyruğu (*Amaranthus retroflexus* L.) ve %15,0 ile darıcan (*Echinochloa crus-galli* L.) olmuştur. Sirkenin yoğunluğu 8,45 adet/$m^2$ ve domuz pıtrağının yoğunluğu ise 4,55 adet/$m^2$ olarak belirlenmiştir. Herbisit uygulamalarına göre en düşük yabancı ot yoğunluğu $T_8$ ve $T_5$ uygulamalarında tespit edilmiştir.

**Çizelge 4.** Yabancı ot yoğunluğu ile şeker pancarı verimi ve şeker varlığı arasındaki korelasyon katsayıları (r)

| Özellikler | Şeker varlığı | Verim | Pıtrak | Kırmızı köklü tilkikuyruğu | Sirken |
|---|---|---|---|---|---|
| **Verim** | -0,232 | 1,000 | | | |
| **Pıtrak** | -0,025 | -0,641** | 1,000 | | |
| **Kırmızı köklü tilki kuyruğu** | 0,136 | -0,173 | 0,061 | 1,000 | |
| **Sirken** | 0,387* | -0,684** | 0,272 | 0,318* | 1,000 |
| **Darıcan** | 0,008 | -0,191 | 0,162 | 0,364* | -0,078 |

*: $p<0.05$, ** $p<0.01$

Hasat öncesi deneme alanında yapılan ölçümlerde yabancı ot türleri ve bunların yoğunlukları ile verim arasında negatif ilişkiler kaydedilmiştir (Çizelge 4). Özellikle verim ile sirken (r=-0,684**) ve domuz pıtrağı (r=-0,641**) yoğunlukları arasındaki negatif ilişkilerin önemli bulunması ($p<0.01$), bu türlerin şeker pancarı veriminde azalmaya neden olan en önemli yabancı ot türleri olduğu göstermektedir. Şeker varlığı ile sirken (r=0,387*), kırmızı köklü tilkikuyruğu ile sirken (r=0,318*) ve darıcan (r=0,364*) yoğunlukları arasında pozitif ve önemli ilişkiler tespit edilmiştir. Şeker pancarında kök-gövde veriminin yabancı ot yoğunluğunun artmasıyla azaldığı Löbmann ve ark. (2019), Jursik ve ark. (2020) ve Kulan ve Kaya (2023) tarafından da bildirilmiştir.

**Sonuç**

Eskişehir koşullarında bir yıl yürütülen araştırma sonuçlarına göre, farklı herbisit uygulamaları ile şeker pancarının kökgövde ağırlığı ve veriminde önemli düzeyde azalmalar belirlenmiştir. Ayrıca, ALS inhibitörü herbisit kullanımının etkili yabancı ot kontrolünü sağladığı görülmüş ve en yüksek kökgövde ağırlığı ve pancar verimi ALS inhibitörü herbisit uygulamalardan elde edilmiştir. Sonuç olarak, en düşük yabancı ot yoğunluğu ve en yüksek şeker pancarı verimi elde edilen iki kez ALS uygulaması $T_8$ (ES 50 ml/da + $V_4$ 75 ml/da) uygun bulunurken, farklı yıllarda ve lokasyonlarda yürütülecek benzer çalışmalara ihtiyaç olduğu söylenebilir

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# CRIMINOLOGICAL ANALYSIS OF FOREST FIRES: A CASE OF IZMIR FOREST REGIONAL DIRECTORATE

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**Abstract**
In this study, forest fires that occurred in forested areas within the boundaries of the Izmir Forestry Regional Directorate in the year 2018 have been examined from a criminological perspective. A total of 82 forest fire sites were investigated on-site within a few days after the fires were brought under control, and data suitable for the evaluation of 34 forest fires were obtained. During the investigations, information was collected regarding the location, time, cause of ignition, topographic details, vegetation cover, meteorological data, and the vehicles and individuals involved in firefighting efforts for the forest fires. In terms of criminological investigation, the "Guide for Determining the Causes of Forest Fires," prepared by the National Wildfire Coordinating Group established in 1976, which includes the U.S. Forest Service, was utilized. Additionally, both fire records prepared by forest management chiefs and law enforcement agencies, as well as on-site incident scene examinations in the burned areas, were conducted. As a result of the research and criminological examinations, differences (18 cases) and similarities (16 cases) were identified between the causes of forest fires as determined through our research and those identified through investigations conducted by technical personnel. Recommendations have been provided in this study with the aim of contributing to the establishment of a criminological basis for determining the causes of forest fires in our country.
**Keywords:** Crime scene investigation, forest fire statistics, causes of forest fires, criminal investigation

## 1. Giriş

Türkiye'nin ormanlık alanı 23,1 milyon hektar olup, bu ormanlık alanının yaklaşık %40'ı orman yangınları bakımından hassas olan kızılçam (*Pinus brutia Ten.*) ve karaçam (*Pinus nigra Arnold*) türlerinden oluşmaktadır. Ülkemizde 2004-2020 yılları arasında 144533 ha ormanlık alanı yok eden 39168 adet orman yangını meydana gelmiştir (Orman Genel Müdürlüğü, 2021). Türkiye'de çıkan orman yangınlarının yaklaşık %90'ı insanlar ve insanların yapmış oldukları faaliyetler sonucu çıkarken geriye kalan %10'u ise doğal nedenlerden (yıldırım) dolayı çıkmaktadır (Avcı ve Korkmaz, 2021; Baltacı ve Yıldırım, 2021; Çolak ve Sunar, 2020). Ülkemizde orman yangınlarının çıkış sebeplerinin belirlenmesine yönelik çalışmalar çoğunlukla söndürme çalışmalarında görevli deneyimli teknik personel ile kolluk kuvvetlerinin sübjektif değerlendirilmeleri sonucu yangın çıkış sebepleri ortaya konulmaya çalışılmaktadır. Yangın çıkış sebepleri belirlenirken bu sübjektif yaklaşımlar tek başına yanıltıcı olabilmektedir. Orman yangınlarının sebep ve kaynaklarının belirlenmesinin literatürdeki önemi vurgulanmış ve bu doğrultuda yapılan çalışmalara odaklanılmıştır (Çanakçıoğlu, 1993; Bilgili ve diğ., 2010; Küçükosmanoğlu ve diğ., 2015; Lee ve diğ., 2019; Louronce ve diğ., 2013). Çalışmanın konusu ülkemizde orman yangınları bakımından riskli olan İzmir Orman Bölge Müdürlüğü'nde çıkan orman yangınlarını önlemeye ve orman yangın istatistiklerinin doğruluğunu artırmaya yardımcı kriminal incelemeler gerçekleştirilerek orman yangınlarının doğru nedenlerini belirlemektedir. Bu kapsamda kriminal incelemeler doğrultusunda tespit edilen çıkış sebepleriyle teknik personelin veya kolluk kuvvetlerinin sübjektif yaklaşımlar sonucu tespit ettikleri çıkış sebeplerinin karşılaştırılması yapılarak orman yangınlarının çıkış nedenlerinin belirlenmesinde yeni bir yöntem ortaya koymak çalışmamızın temel amacını oluşturmaktadır.

## 2. Materyal ve Yöntem

### 2.1. Çalışma alanı ve yeri

Çalışma alanı, orman yangın riskinin çok yüksek olduğu İzmir Orman Bölge Müdürlüğü'dür. İzmir ve Manisa illerini kapsamaktadır. Ormanlık alanı 1021027 hektar olup, bunun 559781 hektarı (%55'i) verimli orman, 461246 hektarı (%45'i) bozuk ormandır. Asli ağaç türleri kızılçam (*P. brutia Ten.*), karaçam (*Pinus nigra Arnold*) ve meşedir. Ağaç türlerinin dağılımı %69'u kızılçam (P. brutia Ten.), %10'u karaçam (Pinus nigra Arnold), %11'i meşe ve %10'u diğer ağaç türlerinden (fıstıkçamı, halepçamı, kestane, ardıç) oluşmaktadır (Orman Genel Müdürlüğü, 2022). 2004 ve 2020 yılları arasında yılda ortalama 1283 hektar alan yangınlardan zarar görmüş, yılda ortalama 239 adet orman yangını çıkmış olup yangın başına düşen ortalama yanan alan ise 5,36 hektar olmuştur (Orman Genel Müdürlüğü, 2021).

İzmir ilinin 1938-2021yılları arasında yapılan meteoroloji ölçümlerine göre yıllık ortalama sıcaklığı 17.9°C, yıllık ortalama en yüksek sıcaklığı 22.7°C, yıllık ortalama en düşük sıcaklığı 13.6°C'dir. Yıllık ortalama güneşlenme süresi 8,1 saat olup, yıllık ortalama yağışlı gün sayısı 84,2 gündür. Yıllık toplam yağış miktarıysa 713,8 mm'dir. Manisa ilinin ise 1930-2021 yılları arasında yapılan meteoroloji ölçümlerine göre yıllık ortalama sıcaklığı 16.9°C, yıllık ortalama en yüksek sıcaklığı 22.9°C, yıllık ortalama en düşük sıcaklığı 11.0°C'dir. Yıllık ortalama güneşlenme süresi 6,5 saat olup yıllık ortalama yağışlı gün sayısı 83,7 gündür. Yıllık toplam yağış miktarıysa 747,3 mm'dir (Meteoroloji Genel Müdürlüğü, 2022).

İzmir Orman Bölge Müdürlüğü, yangına hassas ağaç türleri içermesinden, yıllık çıkan orman yangınlarının istatistiki verilerden elde edilen bilgilerden ve yangın bakımından riskli meteorolojik koşullara sahip olduğundan ayrıca 1.07.2017 ve 18.08.2019 yıllarında çıkan büyük orman yangınlarından dolayı çalışma alanı olarak seçilmiştir.

**2.2. İstatistiki tabloların oluşturulması**

Çalışmamızda 2013-2020 yılları arasında İzmir Orman Bölge Müdürlüğü'nde meydana gelen orman yangınlarının çıkış nedenlerinin sayısı ve zarar verdikleri alan Orman Genel Müdürlüğü'nün yayınlamış olduğu resmi istatistiklerden yararlanılarak Microsoft Excel programı aracılığıyla tablo ve grafikleri oluşturulmuştur. Oluşturulan tablo ve grafiklerde temel çıkış nedenlerinin yanında tali nedenlerde incelenerek detaylandırılmıştır. Ayrıca Türkiye'de 2004-2020 yılları arasında meydana gelen orman yangınları hakkında genel bir değerlendirmede bulunulmuştur.

**2.3. Kriminal İncelemeler**

Kriminoloji, suçun kökenini, suç işleyenleri ve suçun kontrol edilmesine yönelik süreçleri açıklayan, insanın sapkın davranışları ile ilgili bilgilerin sentezini oluşturan bir disiplindir. Bu alan, suçun sebeplerini ve etkileyen faktörleri belirlemek amacıyla insan ve suç işleyen bireylerle ilgili bilgileri içerir (Dönmezer, 1984). Kriminoloji tanımında geçen suç ifadesi tüm suçları ifade etmektedir. Sadece yakma suçunun kriminoloji açısından incelenmesi ise yangın kriminolojisidir. Çalışmamızda yanan alanın orman alanı olması ve yanan materyalinde orman olması sebebiyle yangın kriminolojisi ana başlığı altında orman yangın kriminolojisi çalışmaları gerçekleştirilmeye çalışılmıştır.

Orman yangınlarının kriminal yönden araştırılması sürecinde, ABD Orman Hizmetleri'nin üyesi olduğu 1976 yılında kurulan Ulusal Orman Yangınları Koordinasyon Grubu tarafından hazırlanan "Orman Yangınlarının Çıkış Sebeplerinin Belirlenmesi Rehberi" kullanılmıştır. Bu rehber, temel bilgilerini Ulusal Yangından Korunma Derneği'nin (NFPA) yangın araştırma ve

patlama araştırmaları rehberi olan NFPA 921'den almaktadır. Rehber, orman yangınlarının çıkış sebebinin ve çıkış noktasının belirlenmesiyle ilgili yangın göstergelerini içermektedir. Yangın göstergeleri, korunmuş alanlar, yanmış otlar, donmuş yapraklar, kömürleşme açısı, dökülmeler, kıvrılma, islenme, lekelenme, beyaz kül, çukurlaşma, V ve U şeklinde yayılma olmak üzere 11 sınıf altında toplanmıştır (National Wildfire Coordinating Group, 2016).

Orman yangın kriminolojisi için yapılacak çalışmaları belirtmeden önce olay yeri, suçun işlendiği yerden elde edilen her türlü materyal ve bulgu olarak tanımlanırken, olay yeri incelemesi suçun aydınlatılması amacıyla gerçekleştirilen bir süreçtir. Bu inceleme, olay yerinde delil niteliği taşıyabilecek her türlü bulgunun çeşitli bilimsel ve teknik yöntemler kullanılarak araştırılmasını içerir. Elde edilen veriler tespit edilir, kayıt altına alınır, toplanır, korunur ve ilgili kriminal laboratuvarlara gönderilmek üzere hazırlanır. Olay yeri incelemesi, mağdur-fail ilişkisini ortaya koymak ve suçun detaylarını anlamak amacıyla önemli bir adımdır (Yükseloğlu, vd., 2008).

Yukarıda yapılan açıklamalardan yola çıkarak çalışmamızda 2018 yılında İzmir Orman Bölge Müdürlüğü'nde çıkan orman yangınlarının çıkış nedenlerinin belirlenmesi için Kriminal (olay yeri inceleme) çalışmaları yapılmıştır.

## 3. Bulgular ve Tartışma

### 3.1. İzmir Orman Bölge Müdürlüğü Orman Yangın İstatistikleri

2004-2020 yılları arasında İzmir Orman Bölge Müdürlüğü'nde çıkan orman yangınları sayı bakımından en fazla 2016 yılında, en az 2005 yılında meydana gelmiştir. Yanan alan bakımından değerlendirildiğinde en fazla 2019 yılında, en az 2015 yılında ormanlık alan yangından zarar görmüştür. Yangın başına düşen alan (Ybda) miktarını incelediğimizde ise en çok 2019 yılında, en az 2015 yılında meydana geldiği görülmektedir. Genel bir sonuca varmak için sadece orman yangınlarının en fazla çıktığı yıl ile en fazla zarar verdiği yıl yeterli olmayabilir. Bu nedenle yangın başına düşen yanan alanlar da dikkate alınmalıdır. Sayı, alan ve yangın başına düşen yanan alan miktarları ile birlikte bir değerlendirme yapıldığında her bir orman yangının 20,43 ha ormanlık alanı yakarak zarar verdiği 2019 yılı en yoğun yangın sezonu olarak karşımıza çıkmaktadır (Tablo 1).

**Tablo 1.** 2004-2020 yılları arasında İzmir Orman Bölge Müdürlüğü'nde çıkan yangınların sayı, yanan alan ve yangın başına düşen alanların yıllara göre dağılımı (Orman Genel Müdürlüğü, 2021)

| Yıl | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sayı (adet)** | 185 | 139 | 179 | 256 | 151 | 183 | 216 | 197 | 269 | 344 | 284 | 265 | 377 | 233 | 264 | 240 | 285 |
| **Alan (Ha)** | 976 | 438 | 579 | 963 | 1790 | 1603 | 502 | 733 | 474 | 862 | 270 | 153 | 1041 | 2022 | 392 | 4904 | 4110 |
| **Ybda[1] (Ha/ adet)** | 5,28 | 3,15 | 3,23 | 3,76 | 11,85 | 8,76 | 2,32 | 3,72 | 1,76 | 2,51 | 0,95 | 0,58 | 2,76 | 8,68 | 1,48 | 20,43 | 14,42 |

2013-2020 yılları arasında İzmir Orman Bölge Müdürlüğü'nde çıkan orman yangınlarının %93'ü insan faaliyetleri sonucunda, geriye kalan %7'si doğal nedenler (yıldırım düşmesi) sonucu meydana gelmektedir. Çıkan orman yangınlarının zarar verdikleri alanların %99'u insan faaliyetleri sonucu %1'i yıldırım düşmesi sonucu zarar görmektedir. Ayrıca 2019 yılına kadar faili meçhul başlığı altında tutulan istatistikler 2020 yılından itibaren sebebi bilinmeyen başlığı altında tutulmaya başlanmıştır (Tablo 2).

**Tablo 2.** 2013-2020 yılları arasında İzmir Orman Bölge Müdürlüğü'nde çıkan yangınların sayı, yanan alan ve temel çıkış nedenlerine göre dağılımı (Orman Genel Müdürlüğü, 2021)

| | **İhmal ve dikkatsizlik** | | **Kasıt** | | **Kaza** | | **Sebebi bilinmeyen** | | **Doğal** | | **Toplam** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Yıl | Sayı (Adet) | Alan (Ha) | Sayı (Adet) | Alan (Ha) | Sayı (Adet) | Alan (Ha) | Sayı (Adet) | Alan (Ha) | Sayı (Adet) | Alan (Ha) | Sayı (Adet) | Alan (Ha) |
| 2013 | 282 | 683 | 19 | 19 | 21 | 145 | 8 | 7 | 14 | 8 | **344** | **862** |
| 2014 | 231 | 159 | 13 | 9 | 9 | 92 | 8 | 3 | 23 | 6 | **284** | **270** |
| 2015 | 217 | 119 | 15 | 4 | 5 | 9 | 6 | 3 | 22 | 19 | **265** | **153** |
| 2016 | 308 | 928 | 36 | 37 | 11 | 69 | 2 | 0,22 | 20 | 6 | **377** | **1041** |
| 2017 | 182 | 1983 | 27 | 29 | 11 | 9 | 1 | 0,03 | 12 | 1 | **233** | **2022** |
| 2018 | 215 | 321 | 15 | 6 | 5 | 61 | 0 | 0 | 29 | 4 | **264** | **392** |
| 2019 | 157 | 4681 | 37 | 19 | 12 | 51 | 13 | 145 | 21 | 8 | **240** | **4904** |
| 2020 | 252 | 2629 | 4 | 13 | 16 | 1467 | 0 | 0 | 13 | 1 | **285** | **4110** |
| **Toplam** | **1844** | **11503** | **166** | **136** | **90** | **1903** | **38** | **159** | **154** | **54** | **2292** | **13755** |

2013-2020 yılları arasında İzmir Orman Bölge Müdürlüğü'nde çıkan orman yangınlarının temel çıkış nedenlerine bakıldığında hem yangın sayısı bakımından hem de yanan alan bakımından ihmal ve dikkatsizlik sonucu çıkan orman yangınları birinci sırada yer almaktadır. Sadece 2020 yılında kaza sebebiyle çıkan orman yangınlarının zarar verdiği alanlarda diğer

yıllara kıyasla önemli bir artış görülmektedir.

2013-2020 yılları arasında İzmir Orman Bölge Müdürlüğü'nde çıkan orman yangınlarının tali çıkış nedenlerine bakıldığında sayı bakımından diğer-ihmal ve dikkatsizlik (%42), sigara (%18), anız (%12) şeklinde bir sıralama karşımıza çıkmaktadır. Çıkan yangınların yaktıkları alan bakımından ilk üç sıraya bakıldığında ise diğer-ihmal ve dikkatsizlik (%75), enerji nakil hatları (%12), anız (%5) şeklinde bir sıralama karşımıza çıkmaktadır. Ayrıca tutulan kayıtlara göre açma ve terör nedenlerinden dolayı herhangi bir orman yangını meydana gelmediği görülmektedir (Tablo 3).

**Tablo 3.** 2013-2020 yılları arasında İzmir Orman Bölge Müdürlüğü'nde çıkan yangınların sayı, yanan alan ve tali çıkış nedenlerine göre dağılımı (Orman Genel Müdürlüğü, 2021)

| Sıra No | Tali çıkış sebebi (sayı) | | | Tali çıkış sebebi (alan-ha) | | |
|---|---|---|---|---|---|---|
| 1 | Diğer (ihmal) | 962 | 42% | Diğer (ihmal) | 10377,9 | 75,4% |
| 2 | Sigara | 421 | 18,4% | Enerji | 1697,51 | 12,3% |
| 3 | Anız | 270 | 11,8% | Anız | 700,9 | 5,1% |
| 4 | Doğal | 154 | 6,7% | Sigara | 244,1 | 1,8% |
| 5 | Diğer (kasıt) | 117 | 5,1% | Sebebi bilinmeyen (Faili meçhul) | 158,6 | 1,2% |
| 6 | Çoban ateşi | 104 | 4,5% | Diğer (kaza) | 125,1 | 0,9% |
| 7 | Enerji | 56 | 2,4% | Piknik | 111,8 | 0,8% |
| 8 | Kundaklama | 49 | 2,1% | Diğer (kasıt) | 108,4 | 0,8% |
| 9 | Piknik | 47 | 2,1% | Trafik | 80,5 | 0,6% |
| 10 | Çöplük | 39 | 1,7% | Doğal | 53,7 | 0,4% |
| 11 | Sebebi bilinmeyen (Faili meçhul) | 38 | 1,7% | Çoban ateşi | 41,7 | 0,3% |
| 12 | Diğer (kaza) | 32 | 1,4% | Kundaklama | 27,6 | 0,2% |
| 13 | Trafik | 2 | 0,1% | Çöplük | 26,3 | 0,2% |
| 14 | Avcılık | 1 | 0% | Avcılık | 0,01 | 0% |
| 15 | Açma | 0 | 0% | Açma | 0 | 0% |
| 16 | Terör | 0 | 0% | Terör | 0 | 0% |

### 3.2. İzmir Orman Bölge Müdürlüğü'nde 2018 yılında çıkan orman yangınlarının kriminolojik yönden değerlendirilmesi

**1 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırmalar sonucunda yanan sahanın ağaçlandırma sahası olması, Savaştepe-Soma (asfalt) yoluna yakın olması ve yol tarafında şahsa ait hayvan çiftliğinin bulunması yangın çıkma riskini

yükseltmektedir (Şekil 1). Yapılan görüşmeler neticesinde çiftlik sahibine herhangi bir kastın olabileceği, yangının üçüncü şahıslarca kasten çıkarılabileceği öne sürülmektedir. Yeterli delil ve kanıt bulunamadığı için yangın çıkış sebebi ihmal ve dikkatsizlik olarak tespit edilmiştir.




**Şekil 1.** Yanan sahanın krokisi ve genel görünümü

**2 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırma ve incelemelerde yangının çıkış nedeninin saman makinesinin kendi içerisinde alev alması sonucu ilk olarak samanın tutuşmasıyla başladığı daha sonra ziraat arazisinde ilerleyerek ormana sıçradığı tespit edilmiştir. Yangının, ihmalden ve dikkatsizlikten kaynaklandığı sonucuna varılmıştır.




**Şekil 2.** Yanan sahanın krokisi ve genel görünümü

**3 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yapılan çalışmalar sonucunda ormanlık alanda başlayan yangının yoldan geçen herhangi bir kişinin sigara izmaritini atması sonucu kaynaklanabileceği yanı sıra, yangının meydana geldiği bölgenin bitişiğindeki alanda 3 katlı bir yapı inşa edildiği ve badem ağacı dikileceği için yangının kasıtlı çıkarılmış olabileceği bilgisine ulaşılmıştır. Yanan sahada yaptığımız araştırma sonucunda ikinci ihtimali destekleyecek herhangi bir bulguya rastlanılmamıştır. Sonuç olarak yangının çıkış sebebinin ihmal ve dikkatsizlik ya da kasıt olabilecek iki temel nedenden biri olabileceği tespit edildi (Şekil 3).




**Şekil 3.** Yanan sahanın krokisi ve genel görünümü

**4 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız arazi çalışmasında İzmir-Aydın Otoyolu kenarında münferit okaliptüs ağaçlarının bulunduğu yerde orman yangının meydana geldiği tarafımızdan belirlenmiştir (Şekil 4). Yanan sahada fazla sayıda yiyecek ambalaj kâğıdı, naylon poşet, pet şişe, sigara izmaritleri, teneke bulunmaktadır. Sonuç olarak çıkan orman yangının nedeninin ihmal-dikkatsizlik sonucu çıktığı düşünülmektedir.




**Şekil 4.** Yanan sahanın krokisi

**5 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Araştırmamızın sonucunda, yangının şahsa ait evin çatı katında tadilat amacıyla kullanılan kaynak makinesinden sıçrayan kızgın haldeki kaynak parçalarının, evin güney cephesindeki duvarın dibindeki otları tutuşturmasıyla başladığı belirlenmiştir (Şekil 5). Daha sonra rüzgârın etkisiyle yangının ormanlık alana sıçradığı tespit edilmiştir.




**Şekil 5.** Yanan sahanın krokisi ve genel görünümü

**6 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırma sonucunda yıldırımın bozuk ormanlık alanda bulunan kızılçam ağacına düşmesi sonucu başladığı tespit edilmiştir (Şekil 6).




**Şekil 6.** Yanan sahanın krokisi ve genel görünümü

**7 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yapmış olduğumuz incelemeler neticesinde yangın İzmir-Çeşme otoyol (E881) kenarındaki ormanlık

alanda meydana gelmiştir (Şekil 7). Yangın çıkış nedenine bakıldığında iki ihtimal söz konusu olmaktadır. Bunlardan birincisi otoyol kenarından geçen kara araçlarından atılmış sigara, cam şişe, vb. materyallerin orman yangınını başlatmış olabileceğidir. İkincisi ise yanan sahanın üst kısımlarında bulunan rüzgâr enerji santrallerinden herhangi bir yanıcı materyalin düşmesi sonucu orman yangının çıkmış olabileceğidir. Yanan sahada yaptığımız araştırma sonucunda ikinci ihtimali destekleyecek herhangi bir bulguya rastlanılmamıştır. Sonuç olarak çıkan orman yangınına otoyol kenarından geçen kara araçlarından atılan yanıcı bir materyalin neden olabileceği kanaatine varılmıştır.




**Şekil 7.** Yanan sahanın krokisi ve genel görünümü

**8 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yapılan araştırma sonucunda, yangının söz konusu elektrik direğinin dibinden başladığı ve direğin alt kısımlarında erimiş ve donmuş durumda sert metal damlacıklarının bulunduğu tespit edilmiştir (Şekil 8). Ayrıca, elektrik direklerinde bulunan malzemelerde herhangi bir eksik parçanın bulunmamasının nedeninin yangından sonra eksik parçaların hemen yenisi ile değiştirilmiş olduğu iddiası, yangınla mücadelede görevli personelle yapılan sözlü mütalaadan elde edilmiştir. Elektrik direğindeki malzemelerin zamanla yıpranarak dayanıklılığını kaybedip erimesi sonucu zeminde bulunan kurumuş ot ve diri örtüyü tutuşturarak yangının başladığı ve rüzgârın etkisiyle yangının büyüdüğü tarafımızdan tespit edilmiştir.




**Şekil 8.** Yanan sahanın krokisi ve genel görünümü

**9 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırmalar sonucunda yanan sahanın bitişiğinde şahsa ait zeytinlik alanın olduğu tespit edilmiştir (Şekil 9). Zeytinlik alanda temizlik sonucu bitki artıklarının öbek halinde toplanıp yakılması sonucu yangının ormana sıçradığı tespit edilmiştir.




**Şekil 9.** Yanan sahanın krokisi ve genel görünümü

**10 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırma sonucunda yanan sahanın kuzeyinde köy mezarlığı ve diğer yönlerinde ise şahıslara ait zeytinlik alanların bulunduğu tespit edilmiştir (Şekil 10). Yangın sahasının etrafında birden fazla şahsa ait zeytinlik alanların bulunması ve bu alanlarda bahçe temizliği yapılmak amacıyla ateş yakılması sonucu ya da ormanlık alanı işgal etmek amacıyla yangının çıkarabilmiş olabileceği tarafımızdan belirlenmiştir. Sonuç olarak yangın çıkış sebebinin ihmal ve dikkatsizlik, kasıt olmak üzere iki temel nedenden biri olabileceği tarafımızdan tespit edilmiştir.




**Şekil 10.** Yanan sahanın krokisi

**11 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Araştırmamızın sonucunda, ziraat alanda yakılan anızın ormanlık (bozuk makilik) alana sıçramasıyla yangının başladığı belirlenmiştir (Şekil 11). Sonuç olarak, yangının ihmal ve dikkatsizlik sonucu (ormanlara dört kilometre mesafede anız yakılması) çıkarıldığı tespit edilmiştir.




**Şekil 11.** Yangının zarar verdiği bozuk makilik alanı gösteren amenajman haritası ve ateş çıkarılan yerin ormanlık alana olan mesafesi

**12 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırma sonucunda yangın yıldırım düşmesi sonucu çıkmıştır (Şekil 12).




**Şekil 12.** Yanan sahanın krokisi

**13 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırma sonucunda yangın yıldırım düşmesi sonucu çıkmıştır (Şekil 13).




**Şekil 13.** Yanan sahanın krokisi ve genel görünümü

**14 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yapılan araştırmada, yangının özel ağaçlandırma sahasında çıktığı ve sorumlu şahsın sahada temizlik yaparken bitki kökleri ve dallarını yakmak için ateş yaktığı belirlenmiştir. Sonuç olarak, yangının ihmal ve dikkatsizlik nedeniyle (temizlik amacıyla çöp yakımı) özel ağaçlandırma sahasında başladığı tespit edilmiştir (Şekil 14).




**Şekil 14.** Yanan sahanın krokisi ve genel görünümü

**15 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yapmış olduğumuz araştırmada Tapu ve Kadastro Genel Müdürlüğü'nün parsel sorgulama uygulamasına baktığımızda yanan alanın etrafının şahıslara ait zeytinliklerle çevrili olduğu görülmektedir. Yanan alana yakın arı kovanları da bulunmaktadır. Ayrıca yanan alanın üzerinden enerji nakil hatları geçmektedir (Şekil 15). Yanan sahanın etrafının zeytinliklerle çevrili olması, içerisinde arı kovanlarının bulunması ve üzerinden enerji nakil hatlarının geçmesi yangın çıkma riskini yükseltmektedir. Sonuç olarak yanan sahada birden fazla unsurun yangının başlamasına neden olabileceği tarafımızdan tespit edilmiştir.




**Şekil 15.** Yanan sahanın krokisi ve genel görünümü

**16 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yapmış olduğumuz araştırmaya göre yanan sahanın beş gün öncede yandığı bilgisine ulaşılmıştır. Bu durum yangının bilerek yani kasıtlı olarak yangının çıkartıldığı kanısına vardırmaktadır. Aynı zamanda bir önceki yangının çıkış sebebine karşı herhangi bir önlemin alınmadığını da göstermektedir. Bir önce çıkan yangınla tek farkı bu seferki yanan alanın diğerine göre biraz daha yüksekte olmasıdır. Sonuç olarak yangının kasıtlı olarak çıkarılmış olabileceği tarafımızdan tespit edilmiştir.




**Şekil 16.** Yanan sahanın krokisi ve genel görünümü

**17 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yapmış olduğumuz araştırmada yanan alan ağaçlandırma sahası olup etrafında şahıslara ait zeytinlik alanlar bulunmaktadır. (Şekil 17). Tespit ettiğimiz unsurlar çerçevesinde sahanın zeytinliklerle çevrili olması bahçe temizliği sonucu oluşan çöpün (bitki artıkları) yakılması sebebiyle ya da çobanların yakabileceği bir ateş sonucu yangının çıkabileceği kanaatine varmış bulunmaktayız. Her iki unsur da yangının ihmal ve dikkatsizlik sonucu çıkmış olduğunu göstermektedir.




**Şekil 17.** Yanan sahanın krokisi ve genel görünümü

**18 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yanan sahada yapmış olduğumuz incelemelerde yivsiz tüfeklerde kullanılan boş kovanlar ile âtıl durumda olan çakmak ve boş ilaç tableti tespit edilmiştir (Şekil 18). Araştırma sırasında

karşılaştığımız bir çoban yanan alandaki bir çeşmenin çobanların geçiş güzergâhında olduğunu ve bu alanın insanların uyuşturucu ve keyif verici maddeleri kullandığı bir bölge olduğunu ifade etmiştir. Bu bulgular, yangın alanının insan etkinliklerinin sıkça yaşandığı bir bölge olduğunu gösterdiği için yangının ihmal veya dikkatsizlik sonucu oluşmuş olabileceği yönünde bir tespit yapılmıştır.



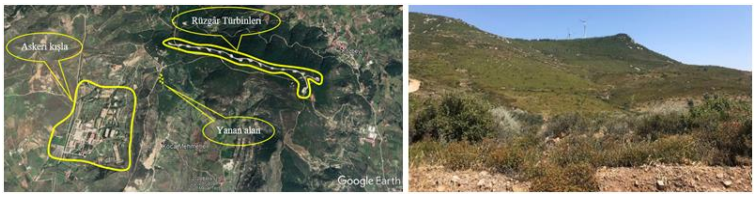

**Şekil 18.** Yanan sahanın krokisi ve genel görünümü

**19 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırmada sahanın farklı yerlerinde zeminde ateş yakıldığına dair (kamp ateşi) yanmış kömür, odun parçacıkları ve yivsiz tüfeklerde kullanılan boş kovan bulunmuştur (Şekil 19). Ayrıca yine arazilerin farklı noktalarında kırık cam şişesi parçaları tespit edilmiştir. Tüm bu unsurlar yanan sahanın yerleşim yerinin baskısı altında olduğunu göstermektedir. Sonuç olarak yangının ihmal ve dikkatsizlik sonucu çıkmış olabileceği tarafımızdan tespit edilmiştir.




**Şekil 19.** Yanan sahanın krokisi ve genel görünümü

**20 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yanan sahanın batısında askeri kışla, kuzeydoğusunda ise üç kanatlı rüzgâr türbinleri bulunmaktadır (Şekil 20). Rüzgâr türbinlerinden gelebilecek yanıcı bir materyalin ormana düşmesi sonucu yangının başlayabileceği gibi, askeri faaliyetler sonucunda da yangın başlamış olabilir. Sonuç olarak yanan sahada yangının nedenini belirleyecek delillere rastlanılmadığından yangının nedeni belirlenememiştir.




**Şekil 20.** Yanan sahanın krokisi

**21 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yapmış olduğumuz araştırma sonucunda çıkan yangının nedenini belirleyebilecek herhangi bir bulguya rastlanılmamıştır (Şekil 21).




**Şekil 21.** Yanan sahanın krokisi ve genel görünümü

**22 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırmada yanan sahanın birçok yerinde çöp yığınları, âtıl durumdaki ev eşyaları bulunmaktadır (Şekil 22)**.** Ayrıca yanan sahanın güneybatısında küçük organize sanayi sitesi yer almaktadır. Tespit ettiğimiz unsurlardan ormanlık alanın yerleşim yerinin baskısı altında olduğu ve insan faaliyetlerinin sıkça gerçekleştirilebileceği bir yer olarak karşımıza çıkmaktadır. Sonuç olarak yanan sahada yangının çıkış sebebini belirleyebilecek herhangi bir bulgu bulunamadığından yangının nedeni tespit edilememiştir. Ancak, eldeki veriler insan etkinlikleri sonucu yangının meydana gelmiş olabileceğini göstermektedir.




**Şekil 22.** Yanan sahanın krokisi ve genel görünümü

**23 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yapmış olduğumuz araştırmada yanan sahanın birçok yerinde cam şişeleri, teneke kutuları, inşaat molozları (kiremit, beton parçaları) bulunmaktadır (Şekil 23). Yerleşim yerinin ormana olan baskısı yanan sahanın her yerinde hissedilebilmektedir. Yerleşim yerini ormandan ayırmak için yaklaşık dört metre yüksekliğinde beton duvarın inşa edildiği belirlenmiştir. Sonuç olarak yanan sahada yangının çıkış sebebini belirleyebilecek yeteri kadar bir bulgu bulunamadığından yangının nedeni tespit edilememiştir. Ancak, eldeki veriler insan etkinlikleri sonucu yangının meydana gelmiş olabileceğini göstermektedir.




**Şekil 23.** Yanan sahanın krokisi ve genel görünümü

**24 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yapmış olduğumuz araştırmada yangının başlangıç noktasının özel mülk içerisinde olduğu ve alanın dikenli tel çitlerle çevrili olduğu tespit edilmiştir. Bu nedenle ziraat alanda bulunan kızılçam ağaçlarında yüksek sıcaklıktan dolayı donmuş yapraklar, kuru dallarda ise kömürleşme olduğu görülmüştür. Yanan sahada yapılan gözlem sonucunda yangının ziraat alanda yapılan bir eylem sonucunda başlayıp ormana sıçradığı anlaşılmıştır. Fakat ziraat alanda yangının nasıl ve ne şekilde olduğu tespit edilememiştir. Sonuç olarak yanan sahanın özel mülk içerisinde korunaklı bir alanda olduğu için yangına neden olabilecek bulgulara ulaşılamamıştır (Şekil 24). Ancak, eldeki veriler insan etkinlikleri sonucu yangının meydana gelmiş olabileceğini göstermektedir.




**Şekil 24.** Yanan sahanın krokisi ve ziraat alanda yanan ağaçlardaki yanma emareleri

**25 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler** Yapmış olduğumuz araştırmada yanan sahanın çevresinde besicilik ile ilgili küçük sanayi sitesi yer almaktadır. Kullanılmış cam şişeleri, pet şişeler yanan sahanın pek çok yerinde atılmış durumda olduğu görülmüştür (Şekil 25). Sonuç olarak yanan sahada yangının çıkış sebebini belirleyebilecek yeteri kadar bulgu bulunamadığından yangının nedeni tespit edilememiştir. Ancak, eldeki veriler insan etkinlikleri sonucu yangının meydana gelmiş olabileceğini göstermektedir.




**Şekil 25.** Yanan sahanın krokisi ve genel görünümü

**26 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler** Yapmış olduğumuz araştırmada yanan sahanın güneydoğusunda bulunan tepenin ardında mıcır madeni olduğu tespit edilmiştir. Ayrıca mıcır madenine yerleşim yerinden gelen enerji nakil hatları mevcuttur (Şekil 26). Yangın yerine giden yolun kapalı olması sebebiyle herhangi bir bulgu tespit edilemediği için yangının nedeni belirlenememiştir. Ancak, eldeki veriler insan etkinlikleri sonucu yangının meydana gelmiş olabileceğini göstermektedir.




**Şekil 26.** Yanan sahanın krokisi ve yanan sahanın güneydoğusunda bulunan mıcır madeni

**27 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırmada yanan sahanın farklı noktalarında âtıl durumda cam şişeleri, ağaç diplerine yakın yerlerde zeminde ateş yakıldığına (kamp ateşi) dair buluntular mevcuttur (Şekil 27). Yanan alan, şehrin etkisi altında olan ve insanların kolayca erişebildiği bir konumda bulunmaktadır. Bu durumda yangının kesin nedeni belirlenememiştir. Ancak, eldeki veriler insan etkinlikleri sonucu yangının meydana gelmiş olabileceğini göstermektedir.




**Şekil 27.** Yanan sahanın krokisi ve genel görünümü

**28 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırmada yanan saha yerleşim yerinin baskısı altındadır. İnsanların kolaylıkla ulaşabilecekleri ve faaliyetlerini gerçekleştirebilecekleri yerdedir. İnsanların ulaşımını engellemek amacıyla yangından sonra ormana giden yol beton barikatla kapatılmıştır. Ayrıca yanan sahanın etrafında yapım aşamasında bulunan binalar bulunmaktadır (Şekil 28). Sonuç olarak yanan sahaya giden yolun kapalı olmasından dolayı herhangi bir bulgu tespit edemediğimizden yangının nedeni tespit edilememiştir.




**Şekil 28.** Yanan sahanın krokisi ve genel görünümü

**29 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırmada yanan sahanın farklı noktalarında kullanılmış karton bardak, kumaş parçası, karton parçası, kâğıt ve plastik çöpler bulunmaktadır (Şekil 29). Aynı zamanda yanan alan şehrin baskısı altında olup, insanların kolayca ulaşıp faaliyetlerini gerçekleştirebildikleri bir yerdedir. Sonuç olarak, yangın bölgesinde yangının çıkış nedenini belirleyecek somut bir bulgu bulunamamıştır. Ancak yangının insan etkinlikleri sonucu meydana gelmiş olabileceği tespit edilmiştir.




**Şekil 29.** Yanan sahanın krokisi ve genel görünümü

**30 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırmada yanan sahada yanmış durumda jeneratör, hemen yanında piknik tüpü, çaydanlık ve kırık çay bardakları bulunmuştur. Yangının başlangıç noktası jeneratörün bulunduğu yer olarak tespit edilmiş olup yangın buradan ilerleyerek ormana doğru ilerlemiştir. Sonuç olarak belirtilen hususlar doğrultusunda yangının ihmal ve dikkatsizlik sonucu çıktığı tarafımızdan tespit edilmiştir (Şekil 30).




**Şekil 30.** Yanan sahanın krokisi ve genel görünümü

**31 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırma sonucunda, yangına yakın bir mesafede devam eden karayolu çalışmalarının olduğu ve bu çalışma sahası içinde yangının başlama saatinden önce etraftaki koli ve çuvalların imhası

için ateş yakıldığı belirlendi. Ateşin yakıldığı yer ile zemin arasında yaklaşık 12-13 metre derinlikte olduğu ve etrafının diri ve ölü örtüden temizlenmiş toprak tabakası ile çevrili olduğu saptandı. Yangının başlangıç noktası ile ateşin yakıldığı yer arasında yaklaşık 200 metre mesafe bulunduğu tespit edildi (Şekil 31). Elde ettiğimiz bilgi ve delillerin yetersizliği sebebiyle, yangının çıkış nedeni tespit edilememiştir.




**Şekil 31.** Yanan sahanın krokisi ve genel görünümü

**32 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Elde edilen bulgular doğrultusunda ormanda insan faaliyetlerinin gerçekleştirildiği anlaşılmaktadır. Yanan saha bozuk makilik olup erozyon sahasıdır. Ayrıca yanan sahanın etrafının çok sayıda şahıslara ait tarlalarla çevrili olması orman yangını bakımından risk teşkil etmektedir (Şekil 32). Tarlalarda yapılacak olan temizlik sonrası oluşan çöpü yok etmek amacıyla yakılacak bir ateş orman yangınını başlatabilecektir. Sonuç olarak yangın ihmal ve dikkatsizlik (çöp yakılması) sonucu çıktığı ancak kimin tarafından çıkartıldığı tespit edilememiştir.




**Şekil 32.** Yanan sahanın krokisi ve genel görünümü

**33 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:** Yaptığımız araştırmada yanan sahanın zemininde yanmış kömür parçaları, kuruyemiş kabukları tespit edilmiştir. Yanan sahanın birçok yerinde çalı formunda pırnal meşesi (*Quercus ilex L.*) bulunmakta olup, insanların kolaylıkla ulaşabileceği ve faaliyetlerini gerçekleştirebileceği yerde bulunmaktadır. Sonuç olarak yangının çıkış sebebi tespit edilememiştir.




**Şekil 33.** Yanan sahanın krokisi ve genel görünümü

**34 numaralı yangın sahasında gerçekleştirilen kriminolojik değerlendirmeler:**

Yaptığımız araştırmada yangın şahsa ait ziraat arazisinde arsa sahibinin yapmış olduğu çalışma sonucu (su borularının birbirine eklemek için ısıtılması) yangının başladığı ve rüzgâr istikametinde (güneybatı) yayılım göstererek ormanlık alana sıçradığı düşünülmektedir. Sonuç olarak yangın ihmal ve dikkatsizlik sonucu çıktığı (diğer ateş kullanımı) tarafımızdan tespit edilmiştir.




**Şekil 34.** Yanan sahanın krokisi ve genel görünümü

**Sonuç ve Öneriler**

Türkiye ormanlarında meydana gelen orman yangınlarının nedenlerinin belirlenmesi ve kriminolojik yönden değerlendirilmesi çalışmaları günümüzde az sayıda bulunmaktadır. Yapılmış olan çalışmalar günümüz şartlarının değişmesinden dolayı güncellenmesi gerekmektedir. Bu boşluğu kapatması amacıyla söz konusu araştırmamız ortaya konulmaya çalışılmıştır. 2018-2019 yılı İzmir Orman Bölge Müdürlüğü'nde çıkan orman yangınlarından 82 adet orman yangını incelenmiş olup 34 adet orman yangını değerlendirmeye alınmıştır.

Orman yangınlarına ilişkin olarak, polis tarafından 1 adet ve jandarma tarafından 2 adet olmak üzere toplamda 3 adet orman yangınının nedenleri ve faillerinin belirlenmesi amacıyla, orman teşkilatı personeli ile koordineli bir şekilde olay yeri inceleme çalışmalarının gerçekleştirildiği tespit edilmiştir. Yangınlarla ilgili faillerin tespiti için yürütülen çalışmaların sonuçlarına göre, 6 adet orman yangınının faillerinin belirlendiği görülmüştür. Bu faillerden 1 adedinin, jandarma ekipleri tarafından gerçekleştirilen detaylı olay yeri inceleme sonucunda tespit edildiği belirtilmektedir.

Orman yangın ihbarlarının kimler tarafından ve nasıl alındığı konusunda yapmış olduğumuz çalışmalar sonucunda 7 adet gözetleme kulesinde görevli personel tarafından, 14 adet 177 Orman Yangın İhbar hattını arayan vatandaşlar tarafından, 3 adet 112 Acil Çağrı Merkezi arayan vatandaşlar tarafından alındığı tespit edilmiştir. 10 adet orman yangının ihbarlarının kimler tarafından ve nasıl alındığı ile ilgili herhangi bir bilgiye rastlanılmamıştır.

Orman yangınlarının çıkış nedenlerinin yazıldığı yangın bilgi formları ve suç tutanaklarında belirtilen çıkış nedenlerinin birbirlerini tutmadığı (6 adet) tespit edilmiştir. Ayrıca tarafımızdan

yapılan inceleme ve kriminolojik incelemeler sonucunda tespit ettiğimiz orman yangın çıkış sebepleri ile görevli teknik personel tarafından yapılan araştırmalar sonucu ortaya çıkan orman yangın çıkış sebepleri arasında farklılıkların (18 adet) benzerliklerin (16 adet) olduğu görülmüştür. Bu farklılıklar bazı orman yangınlarının iki ötürü çıkabileceğini düşündürebilecek bulguların olması, bazılarında ise çıkış sebebini ortaya koyacak herhangi bir bulguya rastlanılmamasından dolayı ortaya çıkmıştır.

Orman yangınlarının kayıt altına alındığı ve tutulduğu dosya içerikleri baktığımızda bazı farklılıklar tarafımızdan tespit edilmiştir. Bunlardan birincisi polisin ya da jandarmanın olay yerinde yapmış oldukları çalışmalarını özetleyen raporların hazırlanış ve sunuş tekniklerinin birbirlerinden farklı olmasıdır. İkincisi olarak orman muhafaza memurlarının olay yerinde yapmış olduğu çalışmaları ve tespit etmiş olduğu bulguları belgelemek ve kayıt altına almak amacıyla tutulan tutanakların çeşitlilik göstermesidir. Üçüncüsü olarak orman işletme şeflerinin olay yerinde yapmış olduğu çalışmaları ve tespit etmiş olduğu bulguları belgelemek ve kayıt altına almak amacıyla tutulan tutanak ve haritaların çeşitlilik göstermesidir.

Orman yangınlarının ana nedenlerinin belirlenmesinin yanında tali nedenlerinin de belirtilmesi orman yangınlarıyla mücadele ve savaş organizasyonun geliştirilmesi ve yönlendirilmesi bakımından çok önemli bir husustur. Bu nedenle yangın bilgi formlarında ve suç tutanaklarında orman yangınlarının çıkış sebeplerini tespit edilip belirtilirken tali nedenlerinin de tespitinin yapılıp belirtilmesi gerekmektedir. Yapmış olduğumuz araştırmada 4 adet orman yangınının çıkış nedeni temel neden (ihmal ve dikkatsizlik) olarak belirtilmiş olup tali nedeni belirtilmemiştir.

Ceza Muhakemesi Kanunu'nda adli kolluk görevlilerinin (polis veya jandarmanın) Cumhuriyet Savcı'sından talimat veya emir almadıkları sürece herhangi bir soruşturma (olay yeri incelemenin) yapamayacakları belirtilmiştir (Ceza Muhakemesi Kanunu, 2004). Çalışmamızda değerlendirmeye aldığımız 34 adet yangının sadece 3 adedinde olay yeri incelemesi gerçekleştirilmiştir. Cumhuriyet Savcısı'nın gerekli görmediği durumlarda ise yapılacak olan incelemenin Orman Muhafaza Memuru ile Orman İşletme Şefi'nin kendi çaba ve tecrübeleri doğrultusunda kriminolojik çalışmaların gerçekleştiği tespit edilmiştir. Söz konusu durumun da orman yangınlarının sebeplerinin ve faillerinin tespitinde olumsuz yönde etki ettiği görülmüştür.

Orman yangınlarının önlenmesi, hızlı bir şekilde kontrol altına alınması adına gerekli teknolojinin geliştirilmesi için ihtiyacımız olan unsurlardan biri de daha detaylı Kriminal incelemelerin (olay yeri inceleme) yapılmasıdır. Bu bağlamda Orman Genel Müdürlüğü

bünyesinde orman yangınlarının sebeplerini tespit etmek için Kriminal inceleme ekipleri oluşturulmalı, laboratuvarı kurulmalı ve bu uygulamaların zorunlu kılınması hakkında gerekli ve temel olacak yasal düzenlemeler yapılmalıdır.

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# STUDIES ON THE DAMAGE OF SOME PLANT DEFENSE STIMULANTS ON *LEPTINOTARSA DECEMLINEATA* (SAY) (COLEOPTERA: CHRYSOMELIDAE) (POTATO BEETLE) LARVAE

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**Abstract**
Potato, which is cultivated in almost every country in the world, is one of the basic nutrients used in human nutrition, such as wheat and rice. *Leptinotarsa decemlineata* (Say) (Coleoptera: Chrysomelidae) is an olygophagous pest, and one of its most important hosts is potato (*Solanum tuberosum* L., Solanales: Solanaceae). This pest can cause enough damage to prevent potato production in places where it is found. In this study, Salicylic acid and Acibenzolar-S-Methyl, which are compounds that stimulate plant defenses, were used to examine the damage to the second instar larvae of *L. decemlineata*. These compounds were applied to potato plants at 10 mM, 20 mM and 30 mM by the soaking method. Potato plants were kept for 24 hours after application. When this period was completed, the potato leaves from these plants were cut into equal pieces with the help of a cork borer. This leaf area was measured with the help of a program called ImageJ. The leaves, whose leaf area was measured, were placed in petri dishes and the second instar larvae of *L. decemlineata* individuals were placed on the leaves. After the observation period of 3 hours was completed, the areas of the potato leaves were measured separately with the help of the program called ImageJ. In this way, the areas consumed by *L. decemlineata* larvae were revealed by area measurements made before and after feeding. The experiments were carried out in three repetitions, one for each individual, and the experiments were repeated twice. One-way analysis of variance and LSD test were performed on the obtained data with 95% confidence for multiple comparisons with the agricolae library in the R statistical programming language. As a result of this study, it was seen that there was a statistical difference between the applications. The least feeding behaviour was found to be Acibenzolar-S-Methyl at a dose of 30 mM.
**Keywords:** *Leptinotarsa decemlineata*, Salicylic acid, Acibenzolar-S-Methyl, Potato plant.

## Introduction

*Leptinotarsa decemlineata* causes damage to important cultivated plants of the Solanaceae family in the world. This pest is oligophagous and one of its most important hosts is potato (*Solanum tuberosum* L. (Solanales: Solanaceae). Potato, which is cultivated in almost every country in the world except some countries, is one of the basic nutrients used in human nutrition, such as wheat and rice. This pest causes damage to the extent that it prevents potato production in places where it is found. In Turkey, it is found everywhere where potato cultivation is done. It is the most important pest of the potato plant from sprouting to harvest (Anonymous, 2008). Adult and larval individuals of the insect cause damage to potatoes in all stages. *Leptinotarsa decemlineata* feeds on the green parts of plants, and the most serious damage is caused by the fourth instar larvae. When *Leptinotarsa decemlineata* reaches high population density, its larvae cause high rates of damage to plants in the early stages. There are also cases where damage rates can reach 100% (Özsarı, 2018).

The purpose of this study is to determine the possibilities of using Acibenzolar-S-metyl (ASM) and Salicyclic acid, compounds that stimulates the plant defense system, as an alternative in the fight against *Leptinotarsa decemlineata*.

## Materials and Methods

The main material of the study consisted of *Leptinotarsa decemlineata* (Say) individuals, Marabel variety potato tubers and plants obtained from the Bozdağı neighborhood of Ödemiş province. Potato plants grown from Marabel variety potato tubers obtained from the Aegean Agricultural Research Institute were used as food in the production of *Leptinotarsa decemlineata*.

Garden soil, peat, 1.5 liter cylindrical plastic pots with a diameter of 17 cm and a height of 14 cm and rectangular tubs measuring 28x38 centimeters and 8 centimeters deep were used for plant growth. Two-week-old potato plants, 18 to 20 centimeters in size and with approximately 8 to 10 leaves, were used to raise the insects. Additionally, as a production environment; Glass cages of 43x37x65 cm in size, one on the front and one on the side, with ventilation in the form of organza tulle with a diameter of 18 cm, and transparent plastic cylindrical cages with a diameter of 20 cm and a height of 27 cm were used. 4 holes with a diameter of 7 centimeters were drilled on the sides of the transparent plastic cylindrical cages, and 1 hole with a diameter of 12 cm was drilled in the lids. These holes are covered with tulle.

Chemically, 99% purity Salisic acid branded by Merck and 50% purity Acibenzolar-S-methyl with the trade name Aciguard obtained from Syngenta were used.

All experiments, insect rearing and growing of plants were carried out in the climate room of the Ege University Faculty of Agriculture, Department of Plant Protection. 12 LED lamps with a light intensity of 1000 were used as light sources in the room. It is hung on the ceiling of the room, 70 cm above the floor where the plants and cages are located. The experiments were continued under these lamps.

Marabel variety potato tubers were used as food in the stock culture of the potato beetle. Potato tubers were sprouted in the dark environment in the climate room. *Leptinotarsa decemlineata* individuals used in the experiments were taken from the culture created in the laboratory.

**Production of *Leptinotarsa decemlineata* individuals**

*Leptinotarsa decemlineata* individuals were reared in wooden glass cages. Marabel variety potato plants with 8-12 leaves were placed in these cages for *Leptinotarsa decemlineata* individuals to feed and lay eggs. They were regularly checked to see if they laid eggs on the lower surface of the leaves. Plants with egg packets visible were removed from the cage and replaced with new plants. The development of adult individuals and the egg laying process took place in these cages. A stock culture of *Leptinotarsa decemlineata* was created with plants bearing egg packets.

**Growing of potato plant**

Sifted garden soil and peat were mixed and used to grow the potato plant. Plastic pots were used for plant growing. Potato plant tubers are sprouted before planting.

**Establishing the experiment**

Acibenzolar-S-methyl and Salicylic acid were given to potato plants. The second larval stage of Leptinotarsa decemlineata was used in the experiment. First of all, mixtures were prepared to contain 10 millimolar, 20 millimolar and 30 millimolar active ingredients of Acibenzolar –S Methyl and Salicylic acid. Sterile purified water was used as a negative control.

The prepared mixtures were given to the roots of the plant in 5 ml amounts using a syringe. The plants, which were injected into the root area, were kept for 24 hours. Three leaves were plucked from the young leaves of different branches of each plant after waiting for 24 hours. In order to equalize the areas of the leaves, equal leaf areas were created with the help of a mushroom borer. *Leptinotarsa decemlineata* individuals, which were starved for 16 hours, were placed on these leaves. To determine the leaf areas where potato bugs feed, images were taken with the program called ImageJ, before and after feeding. Consumed leaf area was measured in millimeters with the help of ImageJ image processing program and then calculated as % consumed leaf area out of the total area.

All experiments in the study were conducted in a one-factor randomized parcel design. Experiments regarding feeding behavior were carried out in 3 replications, with each individual having only one replication. The experiment was repeated 2 times.

The obtained data were evaluated with appropriate libraries in the R statistical programming language and with 95% reliability and the appropriate statistical method according to homogeneity and normality.

**Findings and Discussion**

**Findings of the First Trial**

In terms of homogeneity and normality as a result of the first trial, it was decided to apply one-way analysis of variance (One-Way ANOVA) and LSD as a multiple comparison test with 95% confidence.

**Table 1.** Multiple comparison and percentage effectiveness result table of the first trial

| APPLİCATİONS | LEAF CONSUMPTİON (%) | LSD | % ETKİ |
|---|---|---|---|
| **CONTROL** | 35.52 ± 4.91 | a | - |
| **ASM 10** | 23.17 ± 2.90 | b | 34.76 |
| **ASM 20** | 20.07 ± 3.95 | bc | 43.49 |
| **ASM 30** | 12.91 ± 3.20 | c | 63.65 |
| **SA 10** | 25.55 ±2.36 | ab | 28.06 |
| **SA 20** | 20.40 ± 1.84 | bc | 42.56 |
| **SA 30** | 17.88 ± 5.16 | bc | 49.66 |

*The difference between applications with the same letter in the LSD test is negligible.

According to the results of the multiple comparison test LSD with 95% confidence, the difference between all applications and the control group was determined statistically. The most consumed area was seen in the control group where only pure water was applied, with 35.52 ± 4.91%.

The least consumed leaf area was found to be Acibenzolar-S-methyl, which had a concentration of 30 millimolar with 12.91 ± 3.20%. This application showed 63.65% effectiveness compared to the control group. The difference between the applications was found to be statistically significant (Table 1, Figure 1).

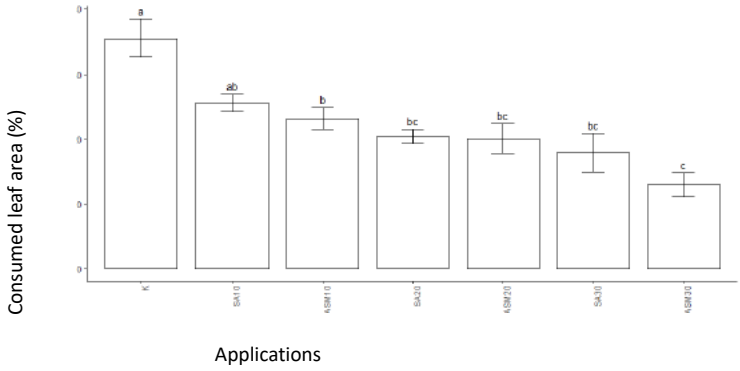


**Figure 1.** Graph of multiple comparisons for consumed area.

## Findings of the Second Trial

In terms of homogeneity and normality as a result of the second trial, it was decided to apply one-way analysis of variance (One-Way ANOVA) and LSD as a multiple comparison test with 95% confidence in this trial, as in the first trial.

**Table 2.** Multiple comparison and percentage effectiveness result table of the second trial

| APPLİCATİONS | LEAF CONSUMPTİON (%) | LSD | % ETKİ |
|---|---|---|---|
| **CONTROL** | 41.97 ± 7.54 | a | - |
| **ASM 10** | 30.21 ± 6.22 | ab | 28.02 |
| **ASM 20** | 18.67 ± 3.23 | bc | 55.51 |
| **ASM 30** | 2.22 ± 1.35 | d | 94.71 |
| **SA 10** | 26.82 ±2.81 | abc | 36.09 |
| **SA 20** | 21.74 ± 6.39 | bc | 48.20 |
| **SA 30** | 13.51 ± 7.24 | cd | 67.81 |

*The difference between applications with the same letter in the LSD test is negligible.

As a result of one-way analysis of variance, the difference between the applications was found to be statistically significant. According to the results of the multiple comparison test LSD with 95% confidence, the difference between all applications and the control group was determined statistically.

The most consumed area was seen in the control group where only pure water was applied, with 41.97 ± 7.54%. The least consumed leaf area was found to be Acibenzolar-S-methyl, which

had a concentration of 30 millimolar with 2.22 ± 1.35%. This application showed 94.71% effectiveness compared to the control group. The difference between the applications was found to be statistically significant (Table 2, Figure 2).

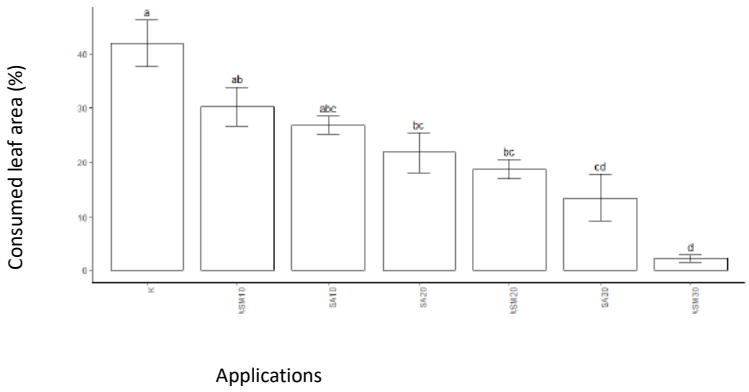


**Figure 2.** Graph of multiple comparisons for consumed area.

## Conclusion and Recommendations

*Leptinotarsa decemlineata* is a olygophagous pest. When they reach high population density, their larvae can cause high levels of damage in the early stages of plants. If not controlled, the damage rate can reach up to 100% (Hare., 1990). In our country, control is generally carried out with insecticide applications. Insecticides used in high doses cause resistance to the pest and phytotoxicity caused by insecticides (Whalon et al., 2011). Pest control becomes more difficult from year to year due to the cross-resistance of the pest to chemicals (Whalon et al., 2011). For this reason, it is considered a necessity to find alternative methods to chemical active substances in the fight against potato beetle and to put them into practice, and many researches are being carried out around the world for this purpose. For this purpose, chemicals that stimulate plant defenses are thought to be a good alternative.

One of the most studied plant activators on plant diseases that has been released to the world market is Acibenzolar-S-methyl, which has the structure S-methyl 1,2,3-benzothiadiazole-7-carbothioate (Robert & Hutson, 1999). It is included in the benzo-thiadiazole (BTH) group by FRAC with the code P 01 (FRAC, 2022). It is thought that the possible mechanism of Acibenzolar-S-methyl is to change the activities of peroxidase and chitinase enzymes, which are known to be indicators of resistance in plants (Baysal et al., 2003). In fact, in a study, it was observed that the activities of peroxidase and glutathione peroxidase enzymes increased in plants treated with Acibenzolar-S-methyl (Soylu et al., 2003).

It has been observed that Acibenzolar-S-methyl inhibits NADH: Ubiquinone oxidoreductase activity in Complex I in the mitochondrial electron transport chain in plants in tissue culture. The activity of Complex I is also inhibited by salicylic acid. However, Complex I is more sensitive to Acibenzolar-S-methyl than salicylic acid. Both Acibenzolar-S-Methyl and salicylic acid affect the mitochondria of applied cells and increase the formation of active oxygen species that play a role in endurance. This situation is thought to be due to the inhibition of NADH: Ubiquinone oxidoreductase activity in complex I, resulting in the transport of electrons through Complex II, resulting in higher levels of superoxide formation (Van der Merwe & Dubey, 2006). It has also been observed that Acibenzolar-S-Methyl increases the activity of genes encoding PR1, PR2 and PR3 proteins in plants applied (Acimovic et al., 2014). On the other hand, although it is thought that the underlying mechanism of action of Acibenzolar-S-Methyl is related to the increase in phenylalanine ammonia lyase activity and the synthesis of phenolic compounds, the resistance mechanism of the pest against the activator plant has not been resolved (Stadnik & Buchenauer, 1999). Many studies have reported that enzyme activity in defense responses increased in plants treated with Acibenzolar-S-Methyl (Cavalcanti et al 2007). In line with the information in the literature, in this study, the effect of Acibenzolar-S-Methyl on the nutrition of *Leptinotarsa decemlineata* was due to the increase in ROS (Reactive Oxygen Species) activity in the plant, and complex-I was more effective than salicylic acid. It is thought to be.

Some specific volatile-aromatic substances seen in plants can contribute directly to the resistance of the plant by having a repellent effect on insects (Sabelis et al., 2001). In their study, Çoban & Çokman (2021) studied the effect of Acibenzolar-S-Methyl application on *Cicadulina* spp. in corn plants. In this study, they determined that 2-Propenoic acid, Butanoic acid and exo-volatile-aromatic substances secreted on the plant after Acibenzolar-S-Methyl application may have a repellent effect on *Cicadulina* spp. In this study, Acibenzolar-S-Methyl application was found to be the most successful. After the application, it was observed that the insects had difficulty in feeding and that the insects moved away from the leaves. It is thought that the reason for this is that the plant mentioned in the literature encourages the secretion of compounds that repel insects.

In this study, for the first time, the effect of Acibenzolar-S-Methyl on *Leptinotarsa decemlineata*, one of the biting-chewing pests, was tried to be revealed. As a result of the study, it is thought that Acibenzolar-S-Methyl can be a more effective and environmentally friendly plant protection product if used in combination with an insecticidal active ingredient. However,

it is important to carry out studies to determine the least phytotoxic effect of Acibenzolar-S-Methyl on the crop plant and the most effective dose to the target harmful organism, to determine the period when it will be most effective on the target organism, and to determine its applicability under the producer's conditions.

**Thanks and Information Note**

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# YONCA SİLAJINA FARKLI DOZLARDA KEÇİBOYNUZU UNU İLAVESİNİN SİLAJ FERMENTASYONU VE SİLAJ KALİTESİNE ETKİSİ

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**Özet**

Bu araştırma katkı maddesi olarak kullanılan keçiboynuzu ununun yonca bitkisine ilavesinin silaj fermentasyonuna ve beslenme değerine etkilerini belirlemek amacıyla gerçekleştirilmiştir. Çiçeklenme döneminde hasat edilen yonca bitkisine %0 (kontrol), %1.5, %3, %4.5 ve %6 dozlarında keçiboynuzu unu ilave edilip üç tekerrürlü olarak silolanmıştır. Araştırma sonuçlarına göre; taze materyalin pH değeri 6.38-6.57 ve kuru madde içeriği %17.76-21.94 arasında değiştiği belirlenmiştir. Fermentasyonun 45. gününde açılan silajların pH değeri 4.41-5.22, kuru madde içeriği %17.09-21.83, kuru madde korunumu %96.73-99.31, flieg puanı 111.27-170.05, laktik asit bakteri sayısı 6.49-7.50 ($log_{10}$ cfu/g silaj), enterobakteri sayısı 2.00-3.48 ($log_{10}$ cfu/g silaj) arasında değişmiştir. Silajların kalite özellikleri incelendiğinde; SÇK içeriğinin %2.00-2.74, NDF içeriğinin %40.81-46.62, ADF içeriğinin %32.86-36.51, SKM içeriğinin %62.37-63.30, KMT içeriğinin %2.43-2.94 ve NYD değerinin 117.55-144.34 arasında değiştiği belirlenmiştir. Artan dozlarda keçiboynuzu unu ilavesinin yonca silaj fermentasyonunu iyileştirdiği ve silajların sindirilebilirliğine olumlu katkılar sağladı belirlenmiştir. Sonuç olarak iyi kalitede bir yonca silajı için en az %3 dozunda keçiboynuzu ununun kullanılması önerilmektedir.

**Anahtar Kelime**: silaj fermentasyonu, silaj kalitesi, yonca

# EFFECT OF ADDITION OF DIFFERENT DOSES OF LOCUST BEAN FLOUR TO ALFALFA SILAGE ON SILAGE FERMENTATION AND SILAGE QUALITY

**Abstract**

This research was carried out to determine the effects of adding locut bean flour, used as an additive, to the alfalfa plant on silage fermentation and silage quality. Locust bean flour was added at doses of 0% (control), 1.5%, 3%, 4.5% and 6% to the alfalfa plant harvested during the flowering period and was silage in three replicates. As a result of the research, pH value and DM content of fresh material were between 6.38-6.57, %17.76-21.94 respectively. pH value, DM content, dry matter recovery, flieg score, lactic acid bacteria count, enterobacteria count value of the silages opened on the 45th day of fermentation were between 4.41-5.22, 17.09-21.83%, 96.73-99.31%, 111.27-170.05, 6.49-7.50 ($log_{10}$ cfu/g silage) and 2.00-3.48 ($log_{10}$ cfu/g silage) respectively. WSC, NDF, ADF, DMI, DMM, RFV of silage alfalfa were between 2.00-2.74%, 40.81-46.62%, 32.86-36.51%, 62.37-63.30%, 2.43-2.94% and 117.55-144.34 respectively. It was determined that the addition of locust bean flour improved alfalfa silage fermentation and made positive contributions to the digestibility of silages. As a result, it is recommended to use at least 3% locust bean flour for a good quality alfalfa silage.

**Keywords:** silage fermentation, silage quality, alfalfa

## Giriş

Yonca (*Medicago sativa* L.) bitkisi, ruminant hayvanların beslenmesi için oldukça önemlidir. Yonca besin içeriği yüksek, yılda birden fazla biçilebilen, yetiştiriciliği dünyanın birçok bölgesinde yapılabilen, yem bitkilerinin kraliçesi olarak adlandırılan ve dünya çapında silaj olarak değerlendirilen (Dunière ve ark., 2013) çok yıllık baklagil yem bitkisidir. Silaj, yemlerin besin içeriğinde bir önemli değişiklik olmadan uzun süre saklamanın, mevsimsel değişiklere göre yemleri muhafaza etmenin en pratik ve en etkili yoludur. Ancak, yonca bitkisi diğer kaba yemlerle karşılaştırıldığında yüksek tamponlanma kapasitesi, yüksek ham protein içeriği, düşük kuru madde içeriği ve düşük suda fermente edilebilir karbonhidrat içeriği nedeniyle silajını yapmak oldukça zordur (Heinritz ve ark., 2012; Akbay ve ark., 2023). Silaj, temelde anaerobik koşullar altında suca zengin yemlerin laktik asit bakterileri tarafından suda çözünebilen karbonhidratları laktik aside fermente etmesi ile düşük pH'ın elde edilmesi işlemidir (Kızılşimşek ve ark., 2016). Bu nedenle, yonca bitkisinin suda çözünen karbonhidrat içeriğini arttırmanın ve yonca silaj fermentasyon sürecini iyileştirmenin en etkin yolu şeker içeriği yüksek katkı maddeleri ile birlikte silaj yapılmasıdır.

Silaj fermentasyonunu iyileştirmek ve geliştirmek için birçok katkı maddesi kullanılmaktadır. Organik keçiboynuzu kırığında yaklaşık %15.16 oranında suda çözünen karbonhidrat bulunduğu bilinmektedir (Atalay ve Kamalak, 2017). Keçiboynuzu yüksek şeker içeriğinden dolayı fermentasyonda önemli rol alan laktik asit bakterilerinin (LAB) etkinliğini arttırabilir ve pH'ı hızlı bir şekilde düşmesine katkı sağlayabilir. Bu amaçla, bu çalışma yonca silajına farklı dozlarda keçiboynuzu unu ilavesinin silaj fermentasyon ve silaj kalitesi üzerine etkilerini belirlemek amacıyla gerçekleştirilmiştir.

## Materyal ve Yöntem

Yonca bitkisi, Kahramanmaraş ili Elmalı Köyü'nde yaklaşık 40 da'lık bir alanda yetiştiricilik yapan bir çiftçiden temin edilmiştir. Yonca bitkisi %50 çiçeklenme dönemine ulaştığında hasat yapılmıştır. Hasat edilen yonca bitkisi 1.5-2.0 cm boyutlarında silaj doğrama makinası ile parçalanmıştır. Her muamele grubu için 2 kg olacak şekilde doğranmış yoncalar ayrılmıştır. Daha sonra, keçiboynuzları unu (doğadan toplanan keçiboynuzları iyice öğütülmüş ve un haline getirilmiş) %0 (kontrol), %1.5, %3, %4.5 ve %6 dozlarında ilave edilmiş ve iyice karıştırılmıştır. Homojen bir karışımdan sonra 100-110 mikron kalınlığındaki özel silaj paketlerinin içerisinde yaklaşık olarak 400 gram örnek koyulup, havası silaj vakum makinası ile alınıp ağzı otomatik olarak kapatılmıştır. Her grup üç tekerrürlü olarak çalışılmıştır.

Toplamda 18 paket silaj yapılmıştır. Silaj paketleri ışık almayacak şekilde 45 günlük fermentasyona bırakılmıştır.

Taze materyalin kuru madde içeriği için; silolanacak örnekten 100 gram alınıp 70°C'ye ayarlanmış etüvde sabit ağırlığa gelinceye kadar kurutulmuştur. Her muamele grubundan 20 gram örnek alınıp 180 ml Ringer çözeltisinde yüksek devirde blendere edildikten sonra süzülmüş, pH metre ile pH değeri belirlenmiştir. Fermentasyonun 45. günde açılan silajların aynı şekilde kuru madde içeriği (KM) ve pH değeri belirlenmiştir. Silajların mikroorganizma sayımları için, 10 kat seyreltme serileri oluşturulup, MRS (laktik asit bakteri sayımları), MEA (maya ve küf sayımları), VRB besiyerlerinde (enterobakteri) ekimleri yapılmış ve sırasıyla 36°C'de 48 saat, 32 °C'de 48 saat ve 36 °C'de 16 saat inkübasyona bırakılmıştır.

Taze materyal ve olgunlaşmış silajların kuru madde içeriği belirlendikten sonra kuru madde korunum (KMK) değerlerinin hesaplanmasında $KMK=(KM_{T45}/KM_{T0})*100$ formülü kullanılmıştır. Kuru madde içeriği belirlenen örnekler öğütüldükten sonra kimyasal analizler yapılmıştır. Silajların NDF ve ADF Van Soest ve ark. (1991)'in bildirdiği yönteme göre yapılmıştır. Silajların KMT, SKM ve NYD değerleri ise Van Dyke ve Anderson (2000) tarafından bildirilen formüllere göre hesaplanmıştır. Silajların fleig puanı "Fleig Puanı= 220 + (2 x $KM(T_{45})$-15)-40 x pH" formülü ile hesaplanmıştır.

Elde edilen sonuçlar JMP istatistiki paket programı kullanılarak analiz edilmiş ve ortalamalar arasındaki farklılık LSD testi ile belirlenmiştir.

**Bulgular**

Farklı oranlarda keçiboynuzu unu ile yapılan yonca silajların pH, kuru madde madde (KM), kuru madde korunumu (KMK) ve fleig puanı sonuçları Tablo 1'de verilmiştir. Taze materyalin pH değerleri arasında oluşan farkın istatistiki olarak önemli olmadığı, pH değerlerinin 6.38-6.57 arasında değiştiği belirlenmiştir. Yonca silajlarına uygulanan keçiboynuzu ununun fermentasyonun 45. gününde pH değerlerini önemli etkilediği, pH değerlerinin 4.41-5.22 arasında değiştiği belirlenmiştir. Kontrol silajlarında pH değerinin 5.22 olduğu, keçiboynuzunun dozlarının artmasına bağlı olarak pH değerinin düştüğü ve en düşük pH'ın %6 keçiboynuzu unundan elde edildiği saptanmıştır. Taze materyalin kuru madde içeriklerinin %17.76-21.94 arasında değiştiği, kontrol, %1,5 ve %3 keçiboynuzunun istatistiki olarak ayı önem gruplarında yer aldığı ve taze materyale ait en yüksek kuru madde içeriğine %6 keçiboynuzunda elde edildiği belirlenmiştir.

**Tablo 1.** Taze materyal ve olgunlaşmış silajların pH, KM, KMK, fleig puan değerleri

| Keçiboynuzu Dozları | pH ($T_0$) | pH ($T_{45}$) | KM ($T_0$) | KM ($T_{45}$) | KMK | Fleig Puanı ($T_{45}$) |
|---|---|---|---|---|---|---|
| **Kontrol** | 6.57 | 5.22 a | 17.76 c | 17.09 d | 96.73 | 111.27 d |
| **%1,5** | 6.41 | 4.89 b | 18.52 c | 17.96 cd | 96.95 | 126.75 c |
| **%3** | 6.43 | 4.74 b | 18.79 c | 18.62 c | 99.08 | 135.78 c |
| **%4,5** | 6.38 | 4.53 d | 20.34 b | 19.94 b | 98.08 | 151.44 b |
| **%6** | 6.45 | 4.41 e | 21.94 a | 21.83 a | 99.31 | 170.05 a |
| Ortalama | 6.45 | 4.76 | 19.45 | 19.09 | 98.07 | 139.06 |
| LSD | öd | 0.09** | 1.43** | 1.23** | öd | 13,21** |

**P<0.01 istatistiki düzeyde önemli, öd: önemli değil

Olgunlaşmış silajların kuru madde içeriklerinin %17.09-21.83 arasında değiştiği, en düşük kuru madde içeriği kontrol silajından elde edilirken, keçiboynuzu dozlarının artmasına bağlı olarak kuru madde içeriklerinin arttığı tespit edilmiştir. Silajların kuru madde korunumları arasında istatistiki olarak bir farklılık oluşmadığı belirlenmiştir. Silajların fleig puanlarının 111.27-170.05 arasında değiştiği, en düşük puan kontrol uygulamasında belirlenirken, en yüksek puan %6 dozunda keçiboynuzu eklenen silajlardan elde edildiği belirlenmiştir. Keçiboynuzu ununun %1,5 ve %3 dozları istatistiki olarak aynı önem gruplarında yer almıştır.

Farklı keçiboynuzu dozlarının silajların NDF ve KMT değerlerini istatistiki olarak etkilemezken, silajların ADF, SKM ve NYD değerleri istatistiki olarak önemli (P<0.05, P<0.01) etkilediği belirlenmiştir. Silajların NDF değerlerinin %40.81-46.62 arasında değiştiği, ADF değerlerinin %36.51-32.86 arasında değiştiği belirlenmiştir. ADF değerleri incelediğinde en yüksek değer %1,5 keçiboynuzu unu ilave edilmiş yonca silajlarından elde edilmiştir. Çalışmada kontrol silajlarının ve %3, %4,5 ve %6 keçiboynuzu dozları ile yapılan silajların istatistiki olarak aynı gruplarda yer aldığı belirlenmiştir. Silajların SKM değerlerinin %60.46-63.30 arasında değiştiği, kontrol, %3, %4,5 ve %6 keçiboynuzu dozlarının istatistiki olarak aynı önem gruplarında yer aldığı belirlenmiştir. Silajların KMT değerleri arasında istatistiki olarak önemli bir farklılık oluşmadığı, KMT değerlerinin %2.43-2.94 arasında değiştiği belirlenmiştir. NYD değerinin 117.55-144.34 arasında değiştiği, en yüksek değer %4,5 ve %6 keçiboynuzu dozunda, en düşük değer ise kontrol silajlarında belirlenmiştir.

**Tablo 2.** Olgunlaşmış silajların ($T_{45}$) kalite değerleri

| Keçiboynuzu Dozları | NDF (%) | ADF (%) | SKM (%) | KMT (%) | NYD |
|---|---|---|---|---|---|
| **Kontrol** | 46.62 | 34.06 b | 62.37 a | 2.43 | 117.55 b |
| **%1,5** | 44.52 | 36.51 a | 60.46 b | 2.71 | 127.04 ab |
| **%3** | 44.01 | 34.25 b | 62.22 a | 2.73 | 131.61 ab |
| **%4,5** | 42.56 | 33.23 b | 63.01 a | 2.82 | 137.75 a |
| **%6** | 40.81 | 32.86 b | 63.30 a | 2.94 | 144.34 a |
| Ortalama | 44.30 | 34.18 | 62.27 | 2.73 | 131.66 |
| LSD | öd | 1.51** | 1.17** | öd | 17.36* |

*P<0.05;**P<0.01 istatistiki düzeyde önemli, öd: önemli değil

Fermentasyonun 45. gününde laktik asit bakteri sayısının 6.49-7.27 ($log_{10}$ cfu/g silaj) arasında değiştiği, en düşük laktik asit bakteri sayısı %6 keçiboynuzu ununda, en yüksek laktik asit bakteri sayısı ise kontrol, %1,5 ve %3 keçiboynuzu dozlarından elde edilmiştir. Silajların enterobakteri sayısının ise 2.00-3.41 ($log_{10}$ cfu/g silaj) arasında değiştiği, en düşük enterobakteri sayısı istatistiki olarak aynı önem grubunda yer alan kontrol ve %1,5 keçiboynuzu dozunda elde edilirken, en yüksek enterobakteri sayısı %3 ve %4,5 keçiboynuzu dozunda belirlenmiştir. Silajların SÇK içerikleri %2.00-2.74 arasında değiştiği, en düşük SÇK içeriği kontrol silajlarında, en yüksek SÇK içerikleri ise %1,5, %3, %4,5 ve %6 keçiboynuzu silajlarında belirlenmiştir.

**Tablo 3.** Silajların laktik asit bakteri, enterobakteri sayısı ve SÇK içeriği

| Keçiboynuzu Dozları | Laktik Asit Bakteri Sayısı ($log_{10}$ cfu/g silaj) | Enterobakteri Sayısı ($log_{10}$ cfu/g silaj) | SÇK (%) |
|---|---|---|---|
| **Kontrol** | 7.27 a | 2.00 c | 2.00b |
| **%1,5** | 7.49 a | 2.00 c | 2.67a |
| **%3** | 7.60 a | 3.48 a | 2.73a |
| **%4,5** | 7.10 b | 3.41 a | 2.74a |
| **%6** | 6.49 c | 2.15 b | 2.53a |
| Ortalama | 7.23 | 2.61 | 2.53 |
| LSD | 0.38** | 0.13** | 0.37** |

**P<0.01 istatistiki düzeyde önemli

## Tartışma ve Sonuç

Karbonhidrat kaynağı olarak yonca silajına ilave edilen keçiboynuzu ununun silajların başlangıç pH'ına önemli bir etkisi olmamasına rağmen fermentasyonun 45. gününde pH'ı önemli ölçüde düşürmüştür. Özellikle, keçiboynuzu ununun %6 dozunda en düşük pH elde edilmiştir. Benzer şekilde Atalay ve Kamalak (2018), çayır otu silajında keçiboynuzu kırığı kullanımının kontrol dozuna (4.83) kıyasla pH'ı önemli ölçüde düşürdüğünü ve en düşük pH'ı %6 keçiboynuzu kırığından elde ettiklerini bildirmişlerdir. Keçiboynuzu unu katkısı yonca silajlarının KM içeriğini artırmış ve %6 keçiboynuzu dozunda en yüksek KM içeriği tespit

edilmiştir. Benzer şekilde Atalay ve Kamalak (2018), çayırotu silajında keçiboynuzu kullanımının silajların kuru madde içeriklerine olumlu katkılar sağladığını ve en yüksek KM içeriğinin %6 keçiboynuzu kırığından elde edildiğini bildirmişlerdir.

Keçiboynuzu unu yonca silajlarının NDF içeriklerini etkilemezken, ADF içeriklerini önemli ölçüde düşürmüştür. Keçiboynuzu unu uygulamalarında silajların NDF ve ADF içeriklerinin düşük olması, keçiboynuzu ununun silajların SÇK içeriğini artırarak ortamdaki laktik asit bakteri faaliyetini hızlandırması sonucunda hücre duvarı bileşenlerinin parçalanabilirliklerini arttırması ile ilişkilendirilebilir. Öte yandan, keçiboynuzu unu katkısının yonca silajlarının SKM, NYD ve fleig puanlarının da artmasına katkı sağlamıştır. Benzer şekilde birçok araştırmacıda SÇK içeriği yüksek katkı maddelerin silajların kalitesini arttırdığını bildirmiştir (Canbolat ve ark., 2013; Acar ve Bostan, 2016; Şakalar ve Kamalak, 2016; Canbolat ve ark., 2019).

Fermentasyonun 45. gününde laktik asit bakteri sayısının (6.49-7.60 $\log_{10}$ cfu/g silaj) arasında değiştiği, fermentasyonun 45. gününde de yeteri kadar laktik asit bakteri sayısının bulunduğu belirlenmiştir. Bu durum fermentasyonun hala devam ettiğinin bir göstergesi olabilir. Enterobakteri sayısı ise 2.00-3.48 ($\log_{10}$ cfu/g silaj) arasında değişim göstermiş, en düşük enterobakteri sayısı kontrol ve %1,5 keçiboynuzu unu ilave edilen yonca silajında belirlenmiştir. Enterobakteri sayısındaki bu artışın keçiboynuzu ununun silaj ortamına sağladığı SÇK'ın enterobakteriler için de bir besin kaynağı oluşturması ile açıklanabilir. Bununla birlikte, yüksek dozlarda (%4,5 ve %6) keçiboynuzu unu ile yapılan yonca silajlarında enterobakteri sayısında bir azalış meydana gelmiştir. Öte yandan, silajların hiç birinde maya ve küf görüntüsü tespit edilememiştir. Bu durum ortam pH'ın hızlıca düşmesi ve LAB etkinliğinin artması ile ilişkilendirilebilir.

Artan dozlarda keçiboynuzu ilavesinin yonca silaj fermentasyonunu iyileştirdiği ve silajların kalitesine olumlu katkılar sağladı belirlenmiştir. Sonuç olarak iyi kalitede bir yonca silajı için en az %3 dozunda keçiboynuzu ununun katkı maddesi olarak kullanılması önerilmektedir.

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# THE USE OF CHITOSAN NANOPARTICLES AS A FEED ADDITIVE IN FISH FARMING

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**Abstract**
Aquaculture is a rapidly growing food sector to meet the animal protein needs of the human population. Within this sector, fish farming is of particular importance as it provides animal food with high protein, vitamins, minerals and low fat content for human consumption. As in the production of other farm animals, there are also risks in fish farming in terms of animal health, public health and business profitability (such as infections, stress, decreased immunity, antibiotic residues and the development of antimicrobial-resistant bacteria, which adversely affect growth performance and yield). Studies on various feed additives to increase productivity and prevent economic losses in the fight against these negativities in fish farming are still ongoing. In recent years, as a result of developments in the field of nanotechnology, interest in the use of nanoparticles as feed additives in animal nutrition has increased and scientific studies in this field have also gained momentum in aquaculture. Chitosan nanoparticles (also known as nano-chitosan) are the nano-sized form of the particle size of chitosan produced from chitin, which is the most abundant biopolymer after cellulose in nature and can be easily obtained from natural sources such as marine crustaceans (crabs, shrimps etc.), fungi cell wall, yeast, green algae, insects. Chitosan nanoparticles, which are used in many fields from tissue engineering to agriculture, are one of the issues that attract the attention of the scientific community, and studies on this subject are still continuing today. In this context, the aim of this paper was to provide information about the use of chitosan nanoparticles, which have many biological effects, as feed additives in fish farming and to mention the results of scientific studies conducted on this subject in recent years.
**Keywords:** aquaculture, chitosan nanoparticles, feed additives, fish farming, nanochitosan

## Introduction

In addition to red meat, white meat, eggs, milk and dairy products, fish and other aquaculture products are also important sources of animal protein for meeting the protein requirements of the human population worldwide. The aquaculture industry is a rapidly growing sector in terms of food production, meeting about 50% of all seafood needs for human consumption (FAO, 2021a). According to FAO data, the global production of fish, crustaceans and molluscs excluding aquatic plants and other aquatic organisms in 2019 was 177.8 million tons, with the top seven countries providing about half of the total fish production being China (15.1%), Indonesia (5.9%), the Russian Federation (5.4%), Peru (5.2%), the USA (5.2%) and Viet Nam (3.7%) (FAO, 2021b). In aquaculture, which is the fastest growing food sector in meeting animal protein needs worldwide, the main goal is to increase the production rate to maximize profitability and to obtain sustainable, eco-friendly and reliable products (Rohani et al., 2021; Yilmaz et al., 2022). However, large-scale facilities and high-density animal populations create a favorable environment for the development and spread of infections, and at the same time, dense housing, poor water quality and anthropogenic stressors negatively affect the growth performance and immune system of animals, making fish and crustaceans vulnerable to infections and leading to economic losses (Tort, 2011; Pérez-Sánchez et al., 2018).

Infections, decreased immunity due to stress, development of resistant bacteria due to antibiotic use, disturbances in the digestive system microbiota, antibiotic residues in products and environmental residues are among the reasons that negatively affect yield and public health in fish farming. There have been many studies on herbal extracts, medicinal plants, essential oils, enzymes, prebiotics, probiotics, symbiotics as feed additives in the past years and they continue to be popular in feeding studies today.

With the development of nanotechnology, interest in the use of nanoparticles as feed additives, which are thought to have advantages such as bioavailability, small dose rate, and stable interactions with other components due to both size and uniform physical properties in the field of animal nutrition, has increased in recent years (Fesseha et al., 2020). The same interest also attracts attention in studies conducted in the field of fish farming. In this context, this paper aims to address the effects of using chitosan nanoparticles as feed additives in fish farming on growth performance, immunity, antimicrobial, antioxidant, intestinal histomorphometric

parameters and digestive enzyme activities in fish, and the results of some studies conducted in this regard in recent years.

**General Information About Chitin, Chitosan and Chitosan Nanoparticles**

The term 'chitin' is derived from the Greek word 'kiton', meaning tunic or envelope-like (Souza et al., 2011). Chitin, which was first discovered in mushrooms by Henri Braconnot in 1811, was treated with alkali by Prof. C. Rouget in 1859 and created its acid-soluble form, and was named 'chitosan' by Hoppe Seiler (Crini, 2022). Chitin is the most abundant biopolymer in nature after cellulose and is the main component of the cuticle layer of insects, fungal cell walls, yeast and green algae (Einbu & Vayrum, 2008). It is also abundant in the processing residues of shellfish, especially shrimp, lobster, crab, oyster, krill and squid, and generally constitutes approximately 15-40% of the shell dry matter in marine crustaceans (Kurita, 2006). Chitin is a homopolymer consisting of N-acetyl D-glucosamine units connected by β 1-4 bonds (Yen et al., 2009). Since this structure of chitin makes it a water-insoluble polysaccharide, its usage area is quite limited (Gomes et al., 2017).

Chitosan, which has a wide range of applications, is a modified biopolymer obtained by deacetylation of chitin and contains N-acetyl glucosamine and D-glucosamine units linked by β 1-4 bonds (Badawy & Rabea, 2011). The degree of deacetylation of chitosan can vary between 75-95% and molecular weight between 50-2000 kDa (Tharanathan & Kittur 2003). Chitosan is a non-toxic, biodegradable and biocompatible polymer that is insoluble in water, organic solvents and aqueous bases but soluble in acids such as acetic acid, nitric acid, hydrochloric acid, perchloric acid and phosphoric acid (Reddy & Yang, 2015; Shard et al., 2014). Although chitosan is soluble in aqueous acidic media via primary amine protonation, the number of acetylated residues in chitin is high enough to prevent the chitin polymer from dissolving in aqueous acidic media (Aranaz et al., 2021). In addition, the reactive groups present in chitosan are the amino group at the C2 position and the primary and secondary hydroxyl groups at the C3 and C6 positions, respectively, and the amino group is the most important of these groups, especially in acidic conditions due to its protonation phenomenon, and can interact with negatively charged molecules, but also through amino groups, hydroxyl ions and coordination bonds, chitosan polymer can interact with metal cations (Alishai & Aïder, 2012). It has been reported that chitosan is composed of 44% carbon, 7% hydrogen and 8% nitrogen

and its average viscosity is approximately 5.3 x 105 Daltons (Chellapandian et al., 2023). The chemical structure of chitin and chitosan is presented in Figure 1.

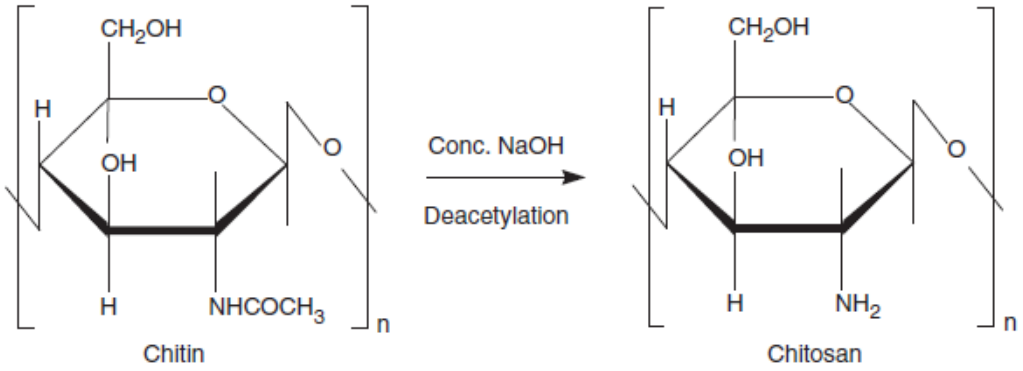


**Figure 1.** Chemical structure of chitin and chitosan (Dutta et al., 2012)

While the scanning electron micrograph image of chitosan can be seen as flakes with rough and hard surfaces containing many fibers, and the transmission electron micrograph image can be seen as anastomosing fiber networks, the transmission electron micrograph image of chitosan nanoparticles can be seen in spherical shapes with smooth edges (El-Naggar et al., 2019). In addition to the unique properties of chitosan, chitosan nanoparticles also have the properties of nanoparticles such as surface and interface effects, small size and quantum size effects. Chitosan nanoparticles can be obtained by different methods. These include ionotropic gelation method, microemulsion method, emulsification solvent diffusion method, emulsification cross-inking method, reverse micellar method, nanoprecipitation method, spray-drying method, desolvation method. The obtained chitosan nanoparticles are widely used in tissue engineering, cancer therapy, antioxidant, drup delivery systems, enzyme immobilization support, treatment of inflammatory diseases, treatment of infectious diseases, vaccine delivery, encapsulation, water treatment, antimicrobial agent, agriculture (Naskar et al., 2019; Divya & Jisha, 2018).

**Why Nanoparticles?**

Nanoparticles range in size from 1 to 100 nm and have uniform and more stable properties than their mass equivalents due to their size reduction down to the atomic level (Ravishankar & Jamuna, 2011). For comparison, the wavelength of visible light is 400-700 nm, leukocytes 10000 nm, bacteria 1000-10000 nm, virus 75-100 nm, protein 5-50 nm, DNA width ~2 nm and

an atom ~0.1 nm (Bhagat et al., 2015). Nanoparticles can be easily absorbed from the digestive tract and utilized by the body and are therefore can be effective even at low doses compared to their natural forms (Feng et al., 2009). In addition, their small size increases their uptake from the gastro-intestinal tract, and therefore their excretion decreases while their bioavailability increases (Singh et al., 2020). The mechanism of action of nanoparticles was listed by Chen et al. (2006) as follows: better biological effects due to increased surface area, longer residence time in the gastro-intestinal tract, reduced intestinal excretion, deeper penetration into tissues through thin capillaries, more efficient and effective uptake by cells, more efficient delivery of active compounds to target sites in the body. In aquatic animals, nanoparticle nutraceuticals are absorbed directly from the water through the gills and skin, but also from feed, reaching the intestines through the eusophagus and stomach, and are absorbed into the bloodstream, distributed to tissues and participating in metabolism (Samanta et al., 2022).

**Effects of Chitosan Nanoparticles on Growth Performance in Fish**

As with other animal species, fish require balanced diets containing all essential nutrients required for optimal growth. Apart from these ingredients, feed additives such as antioxidants, probiotics, immunostimulants, hormones, exogenous enzymes, acidulants, organic acids, chemical attractants, antimicrobial growth promoters are also used to improve growth and feed utilization and increase survival (Manam, 2023). In addition to these additives, it is noteworthy that studies on the use of chitosan nanoparticles as feed additives in fish diets have been carried out in recent years. It has been reported that chitosan nanoparticles are more effective than chitosan in terms of growth performance in fish (Ahmed et al., 2019). In general, it has been reported that the addition of chitosan nanoparticles to fish diets produces positive results on performance by improving feed utilization, intestinal villus parameters, nitrogen utilization and amino acid digestion when used at low doses, by improving growth and reducing mortality even under stress conditions, by increasing the production of digestive enzymes (such as amylase, lipase) that ensure proper digestion of feed, by affecting the intestinal microbiome and flora, and by improving immunity (Chellapandian et al. , 2023). In studies on the use of chitosan nanoparticles in fish, weight gain (WG), specific growth rate (SGR), survival rate (SR), feed conversion ratio (FCR), protein efficiency ratio (PER) are among the parameters that are mostly evaluated in terms of growth performance. The formulas for the relevant parameters (Sarker et al., 2016) are as follows:

WG (g) = Final Weight – Initial Weight
SGR (%/day) = [(Ln Final weight – Ln Initial weight) / Time] x 100
SR (%) = (Final number of fish / Initial number of fish) x 100
FCR = Feed Intake / Weight Gain
PER = Weight Gain / Protein Intake

The effects of the addition of chitosan nanoparticles to fish diet on growth performance parameters in some recent studies are presented in Table 1.

**Table 1.** Effects of chitosan nanoparticles on growth performance in fish

| Fish species | Levels of addition | Effects on performance parameters |
|---|---|---|
| Nile Tilapia | ChNPs | FBW ↑ |
| *(Oreochromis niloticus)* | | WG ↑ |
| (Abd El-Naby et al., 2019) | C: 0% | FCR ↓ (T3), ↔ (C, T1, T2) |
| | T1: 0.1% | PER ↑ (T3) |
| | T2: 0.3% | • Addition of ChNPs to the diet significantly increased FBW and WG. |
| | T3: 0.5% | • There was a linear improvement in feed efficiency and PER depending on ChNPs levels. |
| | | • The addition of 0.5% ChNPs significantly improved feed efficiency and PER. |
| Nile Tilapia | ChNPs | FBW ↑ (T3=T4)>T2>T1>C |
| *(Oreochromis niloticus)* | | WG ↑ (T3=T4)>T2>T1>C |
| (Abd El-Tawwab et al., 2019) | C: 0% | FCR ↔ |
| | T1: 0.025% | SR ↔ |
| | T2: 0.05% | • Addition of ChNPs to the diet significantly increased FBW and WG. |
| | T3: 0.1% | • 0.1% ChNPs level was found to be optimal. |
| | T4: 0.2% | |
| Nile Tilapia | ChNPs | FBW ↑ |
| *(Oreochromis niloticus)* | | WG ↑ |
| (Aly et al., 2023) | C: 0% | FCR ↓ |
| | T: 0.2% | SGR ↑ |
| | | SR ↔ |

| | | |
|---|---|---|
| | | • Addition of ChNPs to the diet significantly increased FBW, WG, SGR and improved feed efficiency.<br>• The addition of 0.2% ChNPs showed a growth promoting effect. |
| African Catfish<br>*(Clarias gariepinus)*<br>(Udo et al., 2018) | Ch and ChNPs<br>C: 0%<br>T1: 0.5% (Ch)<br>T2: 0.5% (ChNPs) | FBW ↔<br>WG ↑ T2>T1>C<br>SGR ↔<br>FCR ↓ T2<(C=T1)<br>PER ↑ T2>(C=T1)<br>SR ↑ (T2=T1)>C<br>• Dietary ChNPs supplementation significantly improved WG and SR.<br>• ChNPs supplementation significantly improved feed efficiency and PER. |
| European Seabass<br>*(Dicentrarchus labrax)*<br>(El-Bab et al., 2022) | ChNPs<br>C: 0%<br>T: 0.1% | FBW ↑<br>WG ↑<br>SGR ↑<br>Dietary ChNPs supplementation improved growth performance by significantly increasing FBW, WG and SGR. |
| European Seabass<br>*(Dicentrarchus labrax)*<br>(El-Bab et al., 2020) | ChNPs<br>C: 0%<br>T: 0.01% | FBW ↑<br>WG ↑<br>SR ↑<br>Dietary ChNPs supplementation improved growth performance by significantly increasing FBW, WG and SR. |
| Grey Mullet<br>*(Liza ramada)*<br>(Dawood et al., 2020) | ChNPs<br>C: 0%<br>T1: 0.05%<br>T2: 0.1%<br>T3: 0.2% | FBW ↑ (T1=T2=T3)>C<br>WG ↑ (T1=T2=T3)>C<br>FCR ↓ T3<(T1=T2)<C<br>SGR ↑ (T1=T2=T3)>C<br>SR ↔<br>• The addition of ChNPs to the diet significantly increased FBW, WG, SGR and improved feed efficiency.<br>• It was reported that the best results were obtained with the addition of 0.1 and 0.2% ChNPs. |

| | | |
|---|---|---|
| Rainbow Trout<br>*(Oncorhynchus mykiss)*<br>(Ahmed et al., 2021) | ChNPs<br>C: 0%<br>T: 0.5% | FBW ↑<br>WG ↔<br>SGR ↔<br>SR ↔<br>Dietary ChNPs supplementation significantly increased FBW, but resulted in numerical increases in BWG, SGR and SR. |
| Silver Carp<br>*(Hypophthalmichthys molitrix)*<br>(Younus et al., 2020) | McCh and ChNPs<br>C: 0%<br>T1: 0.5% (McCh)<br>T2: 0.5% (ChNPs) | FBW ↑ T2>(C=T1)<br>WG ↑ T2>(C=T1)<br>SGR ↑ T2>(C=T1)<br>FCR ↓ T2<(C=T1)<br>• The addition of ChNPs to the diet significantly increased FBW and BWG, and significantly improved SGR and feed efficiency.<br>• Micronized chitosan supplementation had no effect on performance parameters. |

C: control, ChNPs: Chitosan nanoparticles, FBW: final body weight, FCR: feed conversion ratio, McCh: micronized chitosan, PER: protein efficiency ratio, SGR: specific growth rate, SR: survival ratio, T: treatment group, ↑: significantly increased ↓: significantly decreased, ↔: no significant difference, >: significantly higher than others, <: significantly lower than others, =: no significant difference.

**Effects of Chitosan Nanoparticles on Immunity in Fish**

Economic losses due to infectious diseases are one of the main problems encountered in all animal husbandry activities, including aquaculture. Although there are approved antibiotics and chemotherapeutics to combat these diseases, treatment applications with these chemicals are still not sufficient to achieve the desired success and pose a risk for both the consumer and the environment (Kiron, 2012). However, within the scope of sustainable preventive measures, the Food and Agriculture Organization of the United Nations (FAO) recommends studies on the role of good nutrition in improving aquatic animal health, the use of host specific and non-specific defense mechanisms in the control of aquatic animal diseases, the use of immunostimulants and non-specific immune enhancers to reduce susceptibility to diseases, improving aquatic environmental quality and reducing the use of chemicals and drugs in aquaculture (Subasinghe, 1997). In addition to numerous studies on the immunomodulatory and immunostimulatory effects of various feed additives in the field of aquaculture, it is seen that chitosan and chitosan nanoparticles have been a subject of interest in this context in recent years. Although not fully clarified, it has been thought that the immunomodulatory effect of

chitosan may be related to amino moieties, and that the recognition of amino and imino residues, which are abundant in chitosan, by mannose and fucose (a hexose deoxy sugar) receptors found in leukocytes, may be responsible for the immune response (Cha et al., 2008; Tokura et al., 1999). Since the adaptive immune system in teleost animals has some limitations, such as limited antibody library, slow proliferation and maturation of lymphocytes and longer memory span, innate immunity is thought to play an important role in resistance to pathogen infection, initiation of the adaptive immune response and maintenance of in vivo equilibrium (Whyte, 2007; Magnadottir, 2006). The detection of hematological indicators can play a key role in the prevention and control of fish diseases by predicting the health status of the fish and the quality of the aquatic environment (Ellis, 1977). As in studies conducted with different feed additives, it is seen that various parameters such as white blood cell (WBC) count, lymphocyte, neutrophil, monocyte, granulocyte, eosinophil, basophil levels, total immunoglobulin (Ig), IgM, proinflammatory cytokines (TNF-α, IL-10), alternative complement activity, respiratory burst activity (RBA), lysozyme activity (LA), phagocytic activity (PA), phagocytic index (PI) are also assessed in studies on the immunological evaluation of dietary chitosan and chitosan nanoparticles in fish. WBCs are the cellular component of innate immunity and play a vital role in the immune system of fish by releasing humoral substances such as cationic antimicrobial peptides, components of the complement system, lectins and cytokines (Ballarin et al., 2004). In addition to red blood cells (RBCs), hemoglobin (HB), hematocrit (HT) levels, WBCs concentration is one of the hematological parameters used to evaluate the suitability of feed additives in terms of health (Şahan et al., 2016) and it was reported that the increase in this parameter in fish due to chitosan in the diet was the result of a potential role of chitosan in antibacterial, antioxidant and immunity (Abd El-Naby et al., 2020;, Younus et al., 2020). Neutrophils, eosinophils and basophils are the three identified granulocyte types in fish as in other mammals and neutrophils are nonspecific immune system cells that exhibit antibacterial activity through phagocytosis, chemotaxis and respiratory burst (Ocak, 2006). Macrophages, which are mature forms of monocytes in the bloodstream, are phagocytic cells commonly found in tissues (Antao et al., 1999). Phagocytic activity (PA), which is one of the important parameters in the evaluation of the efficiency of the phagocytosis process, which is a natural defense mechanism in innate and acquired immunity, expresses the percentage of phagocytic cells containing bacterial cells, while phagocytic index (PI) expresses the ratio of the number of phagocytosed bacteria to the number of phagocytic cells (El-Naggar et al., 2021). Respiratory burst activity (RBA) and lysozyme activity (LA) play an important role in non-specific immune

defense systems in aquatic organisms. Respiratory burst is the production of superoxide anions against invading pathogens by phagocytes involved in the killing of bacterial pathogens (Secombes, 1990). Lysozyme is a cationic enzyme that breaks β-1,4 glycosidic bonds between N-acetylmuramic acid and N-acetyl glucosamine in the peptidoglycan cell walls of Gram+ and Gram- bacteria (Alexander & Ingram, 1992). The increase in LA and RBA is an indicator of increased defense mechanism against bacterial infection in fish (Naveen Kumar et al., 2022). In studies conducted with normal chitosan in the past years, it is noteworthy that 1-2% chitosan addition to the diet was generally effective on immune parameters and some related blood values (Table 2).

**Table 2.** Effect of normal chitosan on some immune parameters in different fish species

| Fish species | Levels of addition | Effects on immune parameters |
|---|---|---|
| *Cyprinus carpio* (Gopalakannan & Arul, 2006) | 1% | Neutrophil activity↑, LA↑, |
| *Epinephelus bruneus* (Harikrishnan et al., 2012) | T1:1%<br>T2:2% | RBC↑, WBC↑, HB↑, HT↑, LYM↑, MON↑<br>NEUT↑(T2), PA↑, COMPA↑, LA↑(T2), Mortality↓ |
| *Oreochrmis niloticus* (Abu-Elala et al., 2015) | T1:0.5%<br>T2:1%<br>T3:2% | PA↑ (T2, T3), PI↑ (T1, T2, T3),<br>RBA↑ (T2, T3), LA↑ (T1, T2, T3) |
| *Lates calcarifer* (Bloch) (Ranjan et al., 2014) | T1:0.5%<br>T2:1%<br>T3:2% | RBC↑ (T2), WBC↑ (T2)<br>RBA↑ (T2), PA↑, LA↑ |
| *Cirrhina mrigala* (Mari et al., 2014) | 1% | RBC↑, WBC↑, HB↑, HT↑, LYM↑, MON↑<br>NEUT↑, PA↑, COMPA↑, LA↑, Mortality↓ |
| *Mugil cephalus* (Akbary & Younesi, 2017) | T1: 0.5%<br>T2:1%<br>T3:1.5% | RBC↑ (T1), WBC↑ (T2, T3), HB↑ (T2, T3),<br>LA↑ (T2, T3) |

COMPA: complement acvtivity, HB: hemoglobin, HT: hematocrit, LA: lysozyme activity, LYM: lymphocyte, MON: monocyte, NEUT: neutrophil, PA: phagocytic activity, RBA: respiratory burst activity, RBC: red blood cells, T: treatment group, WBC: white blood cells, ↑: significantly higher than other group(s), ↓: significantly lower than other group(s).

Studies have shown that smaller particles have more immune response potential than their larger counterparts, that nanoparticles entering the body in aquatic organisms interact with many cells including immune cells, that they can stimulate and trigger immune cells in fish at appropriate doses, and that they help the secretion of signaling molecules such as chemokines and cytokines providing the coordination platform between molecular and immune cells (Sabzevari et al., 2022). In the the studies conducted with chitosan nanoparticles, it is seen that they have similar effects on immune parameters as normal chitosan, but these effects are obtained by the levels at much lower than the additional levels of chitosan. This may probably be a result of the ability of chitosan nanoparticles to penetrate tissues more effectively through capillaries due to the properties of nanoparticles such as small size (nano-scale) and large surface area, as previously mentioned. Indeed, Younus et al. (2020) reported that the group supplemented with chitosan nanoparticles had higher values in terms of WBC counts, lysozyme activity, plasma protein, total IgM levels, and phagocytic and respiratory burst activities than the group supplemented with micronized chitosan. The effects of chitosan nanoparticles in fish diet on immune parameters in some recent studies are presented in Table 3.

**Tablo 3.** Effects of chitosan nanoparticles on some immune parameters in fish

| **Fish species** | **Levels of addition** | **Effects on immune parameters** |
|---|---|---|
| Nile Tilapia | ChNPs | LA ↑ (T4>T3)>(T2=T1)>C |
| *(Oreochromis niloticus)* | C: 0% | RBA ↑ (T4>T3)>(T2=T1)>C |
| (Abd El-Tawwab et al., 2019) | T1: 0.025% | An increase in LA and RBA was detected depending on the increase in ChNPs ratio in diet. |
| | T2: 0.05% | |
| | T3: 0.1% | |
| | T4: 0.2% | |
| Nile Tilapia | NAG loaded ChNPs | WBC ↑ (T2=T3)>T4>T1>C |
| *(Oreochromis niloticus)* | C: 0% | LA ↑ (T3=T4)>T2>(T1=C) |
| (Kumaran et al., 2021) | T1: 0.025% | RBA ↑ (T3=T4)>T2>(T1=C) |
| | T2: 0.05% | Addition of NAG loaded ChNPs to the diet significantly increased non-specific immunity. |
| | T3: 0.1% | |
| | T4: 0.2% | |

| | | |
|---|---|---|
| Nile Tilapia<br>*(Oreochromis niloticus)*<br>(El-Naggar et al., 2021) | FM and GM basis diet<br>T1: FM, T2: GM<br>T3: FM +0.5% Ch<br>T4: FM +0.5% ChNPs<br>T5: GM +0.5% Ch<br>T6: GM +0.5% ChNPs | WBC ↑ (T6=T4)>T3>T5>T1>T2<br>PA ↑ (T6=T4)>T3>T5>T1>T2<br>PI ↑ (T6=T4)>T3>T5>T1>T2<br>• The addition of chitosan or chitosan nanoparticles to the diet significantly improved PA, which is part of innate and acquired immunity.<br>• ChNPs supplementation was more effective than natural chitosan.<br>• The use of ChNPs in a FM-based diet was more effective than in a GM-based diet. |
| Grey Mullet<br>*(Liza ramada)*<br>(Dawood et al., 2020) | ChNPs<br>C: 0%<br>T1: 0.05%<br>T2: 0.1%<br>T3: 0.2% | LA ↑ T2>(T3=T1)>C<br>PA ↑ (T2=T3)>(T1=C)<br>PI ↑ T2>T3>(T1=C)<br>• Dietary ChNPs supplementation significantly improved non-specific immunity.<br>• The ChNPs ratio of 0.1% produced better results than other ratios. |
| Nile Tilapia<br>*(Oreochromis niloticus)*<br>(Naiel et al., 2020) | ChNPs against IMID*<br>T1: IMID (0.01µg/L)<br>T2: T1+0.5% ChNPs<br>T3: T2+0.025% Vit.C<br>T4: T2+0.05% Vit.C<br>* A pesticide with high pollution potential | Against Imidacloprid (0.01µg/L) toxicity:<br>LA ↑ (T3=T4)>T2≥T1<br>RBA ↔<br>IgM ↑ (T3=T4)>T2≥T1<br>Comp3 ↑ (T3=T4)>T2≥T1<br>• Addition of 0.5% ChNPs to the diet caused a numerical increase in LA, serum IgM and complement3 levels in fish fed in imidacloprid contaminated water.<br>• Vitamin C supplementation to the diet containing ChNPs had a combined effect and significantly better immune parameters than the other groups. |
| Nile Tilapia<br>*(Oreochromis niloticus)*<br>(Elbahnaswy et al., 2021) | ChNPs against PD*<br>C-:0%<br>C+:0.1% ChNPs<br>T1: PD (0.5 mg/L)<br>T2: ChNPs + PD | Against Pendimethalin (0.5 mg/L) toxicity:<br>WBC ↔ (C-,C+), ↑ (T2>T1)<br>LYM ↔ (C-,C+), ↑ (T2>T1)<br>NEUT ↔ (C-,C+), ↑ (T2>T1)<br>T. Ig (mg/mL) ↑ (C+>C-), ↑ (T2>T1)<br>LA ↑ (C+>C-), ↑ (T2>T1)<br>RBA ↑ (C+>C-), ↑ (T2>T1) |

| | | | |
|---|---|---|---|
| | | *A herbicide with high pollution potential | PA ↑ (C+>C-), ↑ (T2>T1)<br>• All innate immune parameters decreased in fish in pendimethalin contaminated water.<br>• The addition of ChNPs to the diet of fish in pendimethalin-contaminated water significantly improved all these parameters again.<br>• ChNPs showed a potential immunomodulatory effect against pendimethalin toxicity. |
| Nile Tilapia<br>*(Oreochromis niloticus)*<br>(Aly et al., 2023) | C: 0%<br>T: 0.2% | ChNPs | TNF-α and IL-10 ↓ (T)<br>LA and RBA ↑ (T)<br>LYM, EO and BAS ↔<br>MON ↑ (T)<br>*P. fluorescence*'ye karşı<br>Mortality ↓<br>• The decrease in proinflammatory cytokines TNF-α and IL-10 showed that ChNPs reduced cellular inflammation by improving cellular and humoral immunity.<br>• ChNPs supplementation improved innate immunity by increasing LA and RBA.<br>• The addition of ChNPs increased the relative level of protection against *P. fluorescence* injected intraperitoneally at the end of the trial and caused a significant 10% reduction in mortality. |
| Nile Tilapia<br>*(Oreochromis niloticus)*<br>(Abdel-Wahab et al., 2021) | C: 0%<br>T1: 0.05%<br>T2: 0.1% | ChNPs | LA ↑ (T2≥T1)>C<br>Against *A.hydrophila*:<br>Mortality ↓ T2<T1<C<br>• ChNPs addition increased serum LA, an indicator of non-specific immunity.<br>• Resistance to *A. hydrophila* injected intraperitoneally increased at the end of the experiment. |
| Rohu<br>*(Labeo rohita)*<br>(Naveen Kumar et al., 2022) | C: 0%<br>T1: 0.025%<br>T2: 0.05%<br>T3: 0.1% | ChNPs | LA and RBA ↑ (T3>T1=T2=T4)>C<br>Antibody against *A.hydrophila*:<br>IgM ↑ T3>T4 > (T1=T2=C)<br>Against *A.hydrophila*:<br>Mortality ↓ T3<T4<T2<T1<C<br>SR: %66(T3), %62(T4), %52(T2), %44(T1) |

| | | |
|---|---|---|
| | T4: 0.2% | • Addition of ChNPs to the diet improved innate immunity by increasing LA and RBA.<br>• 0.1% and 0.2% ChNPs increased IgM antibody levels against *A. hydrophila*, the best result was achieved with 0.1%.<br>• At the end of the experiment, resistance to *A. hydrophila* injected intraperitoneally increased significantly. |
| Silver Carp<br><br>*(Hypophthalmichthys molitrix)*<br><br>(Younus et al., 2020) | McCh and ChNPs<br><br>C: 0%<br><br>T1: 0.5% (McCh)<br><br>T2: 0.5% (ChNPs) | WBC ↑ (T1=T2) > C<br><br>Plasma protein ↑ T2>T1>C<br><br>Total IgM ↑ T2>T1>C<br><br>LA, RBA and PA ↑ T2>T1>C<br><br>Against *S. aureus*:<br><br>Mortality ↓ T2<T1<C<br><br>• The addition of chitosan to the diet significantly improved non-specific immunity.<br>• Resistance to *S. aureus* injected intraperitoneally increased at the end of the trial.<br>• ChNPs were more effective than microchitosan. |

BAS: basophilC: control, C-: negative control, C+: positive control, Comp3: complement 3, Ch: chitosan, ChNPs: chitosan nanoparticles, EO: eosinophil, FM: fish meal, GM: gluten meal, IMID: imidacloprid, LA: lysozyme activity, LYM: lymphocyte, McCh: micronized chitosan, MON: monocyte, NAG: N-acetyl-D-glucosamine, PA: phagocytic activity, PD: pendimethalin, PI: phagocytic index, RBA: respiratory burst activity, T: treatment group, TNF: tumor necrosis factor, IL: interleukin, WBC: white blood cell, ↑: significantly increased ↓: significantly decreased, ↔: no significant difference, >: significantly higher than others, <: significantly lower than others, ≥: numerically higher than others, =: no significant difference.

## Antibacterial Effects of Chitosan Nanoparticles in Fish

Antibiotics are often used in fish farming to control diseases. However, since their excessive use also leads to the risk of the development of antibiotic-resistant pathogens, there has been an increased interest by the scientific community in environmentally friendly natural antimicrobial agents (Cabello et al., 2013). In this context, chitosan nanoparticles may be a potential agent. As a matter of fact, it has been reported that chitosan has antimicrobial potential on microorganisms such as bacteria, fungi and yeasts (Kong et al., 2010; Tayel et al., 2010) and its antibacterial effect on Gram(+) bacteria is higher than Gram(-) bacteria (No et al., 2002). The antibacterial mechanisms of action of chitosan nanoparticles are described in detail in a review written by Chandrasekaran et al (2020), and accordingly, it is possible to summarize the antibacterial mechanisms as follows:

- The positively charged amino groups of chitosan nanoparticles interact electrostatically with the negatively charged cell membrane of the bacteria, causing changes in membrane permeability and osmotic imbalances, leading to the dispersal of intracellular elements and bacterial death.
- Chitosan nanoparticles entering the bacteria cell cause modifications in the electron transport chain of the bacterium and also bind to bacterial DNA, inhibiting DNA replication, transcription, translation and enzyme production, leading to cell death.
- Inside the bacteria, chitosan nanoparticles cause reactive oxygen species (ROS) production, leading to oxidative stress and DNA damage.
- The chelating ability of chitosan nanoparticles leads to the formation of chelates with some metal ions (such as $Ca^{2+}$, $K^{+}$, $Na^{+}$), which are vital for bacteria, and the leakage of cations, leading to cell death.

Several studies have been conducted proving the in vitro antibacterial effects of chitosan nanoparticles in fish. Abdel-Razek (2019) performed inhibition zone test of chitosan nanoparticles on Nile tilapia (*Oreochromis nilotica*) pathogenic bacteria, and as a result of incubation of isolated *Aeromonas hydrophila, Aeromonas veronii, Aeromonas sobria, Pseudomonas aeruginosa, Pseudomonas fluorescens, Staphylococcus aureus* and *Streptococcus agalactiae* bacteria with chitosan nanoparticles at the level of 10 and 20 µg/ml with tryptic soy agar at 30 °C for 24 hours, the inhibition zones (mm) of the chitosan nanoparticle treated group were significantly higher than the control group and it was determined that the inhibition zones increased depending on the dose of chitosan nanoparticle. In addition, the minimum concentration of chitosan nanoparticles inhibiting the growth of these bacteria (minimum inhibitory concentration-MIC) was determined as 0.313, 0.625, 0.156, 0.625, 0.625, 1.25, 2.5 and 1.25 µg/ml, respectively, and while the minimal bacterial count of all isolated bacteria was $10^3$ for the control group, it was varied between 1-5 bacterial cells in the experimental groups. In the same study, the antibacterial effect of chitosan nanoparticles against *Aeromonas hydrophila* was also observed under transmission electron microscope, and it was photographed that the bacteria maintained their integrity in the control group without chitosan nanoparticles, but in the experimental group, the chitosan nanoparticles surrounded the bacteria, destroyed the bacterial cell wall, penetrated the bacterial cell membrane, dispersed the bacterial cell protein outside the cell and caused cell death. In an in vitro study on

*Aeromonas hydrophila* by Naveen Kumar et al (2022), inhibition zone measurement was performed using paper disks impregnated with chitosan nanoparticles at different concentrations (10 and 20 µg/ml) and it was reported that there was an increase in the inhibition zone depending on the dose and the highest inhibition zone was obtained with 20 µg/ml chitosan nanoparticle. Kumaran et al. (2021) tested the antibacterial effect of chitosan, chitosan nanoparticles and N-acetyl-D-glucosamine (NAG) loaded chitosan nanoparticles on *Pseudomonas aeruginosa, Streptococcus agalactiae, Aeromonas hydrophila, Pseudomonas fluorescens* bacteria which are pathogenic for Nile tilapia (*Oreochromis nilotica*). The standard agar well diffusion technique was used in this test and 50 µL of chitosan, chitosan nanoparticles and NAG loaded chitosan nanoparticles were used to perform the inhibition zone measurements. According to inhibition zone measurements, application of chitosan, chitosan nanoparticles and NAG loaded chitosan nanoparticles resulted in 12, 15 and 21 mm for *Pseudomonas aeruginosa*, respectively, 14, 19 and 27 mm for *Streptococcus agalactiae*, respectively, 10, 14, 24 mm for *Aeromonas hydrophila*, respectively, and 11, 13, 19 mm for *Pseudomonas fluorescens*, respectively, and it was noted that the inhibitory activity was NAG loaded chitosan nanoparticles > chitosan nanoparticles > chitosan. In a 21-day study conducted by Ahmed et al (2021) on Rainbow trout (*Oncorhynchus mykiss*), the experimental group was fed a diet supplemented 0.5% chitosan nanoparticles and on the 21st day of feeding, the inhibition zone test in skin mucus samples taken from the animals against the enteric redmouth disease agent *Yersinia ruckeri* bacteria and the percentage of bactericidal activity in serum were evaluated. On the 21st day of feeding, the skin mucus inhibition zone and serum bactericidal activity percentage of the group fed diet containing chitosan nanoparticles were significantly higher than the control. In a study conducted by Oushani et al. (2020) on the same fish species, 14.28 g $kg^{-1}$ clinoptilolite (a type of zeolite) loaded with 0.05, 0.5 and 5 g nanocitosan was added to the diet of the experimental groups and antibacterial activity against *Yersinia ruckeri* bacteria was measured in serum obtained from animals on the 70th day of the study. The serum antibacterial activity of the experimental groups supplemented clinoptilolite loaded with 0.05 and 0.5 g chitosan nanoparticles was significantly higher than the control and the group supplemented clinoptilolite alone.

It was also reported that chitosan and chitosan nanoparticles had antibacterial effects against gastrointestinal pathogens such as *Salmonella spp*. and *Escherichia coli* without inhibiting the growth of beneficial bacteria in the gut (Madurerira et al., 2015; Ma et al., 2020). In a feeding

study conducted by Abd El-Naby et al. (2019 ) on Nile tilapia (*Oreochromis nilotica*) with diets supplemented with 0.1%, 0.3% and 0.5% chitosan nanoparticles for 70 days, it was found that there was a dose-dependent decrease in the total number of intestinal bacteria (log CFU/g), and also, the total number of anaerobic bacteria was significantly lower than the control group in all experimental groups, but the number of aerobic bacteria was significantly lower than the control group only in the groups supplemented with 0. 3% and 0.5% chitosan nanoparticles. In a similar experiment conducted by the same researchers (Abd El-Naby et al., 2020) on the same fish species, the addition of 0.5% chitosan nanoparticles to the diet significantly reduced the number of intestinal anaerobic and aerobic bacteria compared to the control group. These findings on intestinal microbiota in both studies were attributed to the polycationic nature of chitosan nanoparticles and the interaction between positively charged amino groups of chitosan and the negatively charged cell membrane of bacteria.

**Antioxidant Effects of Chitosan Nanoparticles in Fish**

In cells, there is a balance between reactive oxygen species (ROS) released as a result of oxygenated respiration and the antioxidative system that protects the cell against their harmful effects, and disruption of this balance in favor of ROS leads to the accumulation of superoxide radicals in the cell at a level that exceeds the endogenous defense mechanism and thus leads to oxidative stress (Sies and Cadenas, 1985). Free radicals, which are continuously produced in the cell, are scavenged by both metabolically produced antioxidants and antioxidants taken from outside with nutrients, thus preventing cell damage (Aslankoç et al., 2019). ROS lead to lipid peroxidation, protein oxidation, gene expression modulation, alteration in redox status on a cellular basis, and early aging and various diseases on an organismal basis (Slaninova et al., 2009).

In all organisms, superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidases (GPx) are the most important enzymes involved in the detoxification of ROS and constitute the first line of defense that suppresses the formation of free radicals in the antioxidant defense system (Di Giulio and Meyer, 2008; Niki, 1993). Among these enzymes, SOD is the enzyme that catalyzes the oxidation of one superoxide radical to $O_2$ molecule and the reduction of another superoxide radical to hydrogen peroxide ($H_2O_2$), a less reactive molecule, CAT is the enzyme synthesized by peroxisomes during the detoxification of $H_2O_2$ that passes into the

cytosol during the reduction of oxygen to $H_2O$ in mitochondria, and GPx is the enzyme that breaks down hydrogen peroxide to $H_2O$ in mitochondria and sometimes in the cytosol (Aslankoç et al. , 2019).

It has been reported that chitosan has antioxidant capacity and this effect is attributed to the ability of amino and hydroxyl groups in the structure of chitosan to react with free radicals and scavenging them (Rajalakshmi et al., 2013; Aranaz et al; 2021). It has also been reported that the functional amino and hydroxyl groups of chitosan have a chelating effect by interacting with metal ions and that the semicrystalline structure and strong hydrogen bonds of chitosan ensure that it does not break after binding with metal ions (Xie et al., 2001). As is known, SOD, CAT and GPx are also important enzymes of the antioxidant system in fish as in other animals (Hamed et al., 2021). The activity of these antioxidant enzymes is an indicator of oxidative cell damage and toxic mechanism of ROS (Kehrer, 1993). In addition to these enzyme activities, malondialdehyde (MDA), a three-carbon dialdehyde, which is one of the most important indicators of lipid peroxidation by cleavage of polyunsaturated fatty acids containing three or more double bonds, which is the end product of lipid peroxidation, leading to changes in membrane properties such as deformation, ion transport, enzyme activity and aggregation of cell surface components, is another biomarker evaluated within antioxidant activity (Freeman and Carpo, 1982; Cighetti et al. , 2002). Brol et al. (2021) reported that chitosan decreased lipid peroxidation in the gills and hepatopancreas of cultured shrimps exposed to salinity stress by increasing glutathione-S-transferase activities and glutathione levels as a result of its antioxidant and protective effect. In studies on fish, it is also noteworthy that chitosan nanoparticles increase antioxidant enzyme activities and decrease MDA level as an indicator of decreased lipid peroxidation. The effects of the addition of chitosan nanoparticles to fish diet on antioxidant parameters in some recent studies are presented in Table 4.

**Table 4.** Effects of chitosan nanoparticles on some antioxidant parameters in fish

| Fish species | Levels of addition | Effects on antioxidant parameters |
|---|---|---|
| Nile Tilapia<br>*(Oreochromis niloticus)*<br>(Abd El-Tawwab et al., 2019) | ChNPs<br>C: 0%<br>T1: 0.025%<br>T2: 0.05%<br>T3: 0.1%<br>T4: 0.2% | SOD ↑ (T4, T3, T2, T1)>C<br>CAT ↑ (T4, T3, T2, T1)>C<br>MDA ↓ (T4, T3, T2)<C<br>• Addition of ChNPs to the diet increased SOD and CAT activity dose-dependently.<br>• ChNPs showed an antioxidant effect by reducing the MDA level, which is an indicator of lipid peroxidation. |
| Nile Tilapia<br>*(Oreochromis niloticus)*<br>(Abdel-Wahab et al., 2021) | ChNPs<br>C: 0%<br>T1: 0.05%<br>T2: 0.1% | SOD ↑ T2>(T1=C)<br>CAT ↑ T2>(T1=C)<br>GPx ↑ T2>(T1=C)<br>Addition of 0.1% ChNPs to the diet significantly increased antioxidant enzyme activation. |
| Nile Tilapia<br>*(Oreochromis niloticus)*<br>(Aly et al., 2023) | ChNPs<br>C: 0%<br>T: 0.2% | SOD ↑ T>C<br>The addition of 0.2% ChNPs to the diet significantly increased SOD activity in the second month of the experiment. |
| Grey Mullet<br>*(Liza ramada)*<br>(Dawood et al., 2020) | ChNPs<br>C: 0%<br>T1: 0.05%<br>T2: 0.1%<br>T3: 0.2% | SOD ↑ (T2), ↔ (C=T1=T3)<br>CAT ↑ T2>T3>(T1=C)<br>GPx ↑ T2>T3>(T1=C)<br>MDA ↓ T2<T3<(T1=C)<br>Addition of 0.1 and 0.2% ChNPs to the diet had an antioxidant effect by significantly increasing CAT and GPx enzyme activity and decreasing MDA level. |
| Rohu | ChNPs | Kidney CAT ↑ (T3>T4>T2>T1)>C |

| | | |
|---|---|---|
| *(Labeo rohita)* | | Liver CAT ↑ (T3>T4>T2>T1)>C |
| (Naveen Kumar et al., 2022) | C: 0%<br>T1: 0.025%<br>T2: 0.05%<br>T3: 0.1%<br>T4: 0.2% | • Addition of ChNPs to the diet increased kidney and liver tissue CAT activity.<br>• The highest CAT activity was obtained with the addition of 0.1% ChNPs. |

C: control, CAT: catalase, ChNPs: chitosan nanoparticles, GPx: glutathione peroxidase, MDA: malondialdehyde, SOD: superoxide dismutase, T: treatment group, ↑: significantly increased ↓: significantly decreased, ↔: no significant difference, >: significantly higher than others, <: significantly lower than others, =: no significant difference.

**Effects of Chitosan Nanoparticles on Intestinal Histomorphology in Fish**

Histomorphological analyses are a good biomarker for assessing the welfare of aquatic organisms, as they can quickly provide information on general health status (De Marco et al., 2023). In fish intestines, histological assays such as villus height, muscle thickness, and crypt depth provide valuable data on the efficiency of the intestinal tract in terms of nutrient absorption, while goblet and leukocyte cell counts can provide information on the state of the immune system and can be measured using optical and electron microscopy (Abdel-Aziz et al., 2020; Amoah et al., 2021; De Marco et al., 2023).

Maintaining intestinal health and integrity is an important issue in fish farming in terms of flock health, productivity, sustainability and profitability. Histomorphometrically, a high villi length is associated with good intestinal health, efficient and better nutrient absorption due to increased surface area (Zaki et al., 2015), which in turn has a positive effect on animal performance (Xu et al., 2003). In studies evaluating intestinal histomorphometric parameters, it is seen that in addition to villus morphology, another parameter evaluated histologically is goblet cell density and number. Indeed, the mucosa of the digestive tract in vertebrates is protected by mucin glycoproteins secreted by mucin-producing cells in the mucosal layer and the mucosal layer acts both as a lubricant for the passage of intestinal contents and as a barrier for pathogens (Bansil & Turner, 2006). The main function of goblet cells is to create a protective mucus layer by secreting mucin and is also thought to be involved in immunoregulation (Dao & Le, 2023). Addition of normal chitosan to the diet has been reported to increase intestinal villus length

(Zaki et al., 2015; Najafabad et al., 2016; Xu et al., 2023), muscular thickness (Xu et al., 2023), goblet cells (Xu et al., 2023) parameters. The effects of the addition of chitosan nanoparticles to fish diet on intestinal histomorphometric parameters in some recent studies are presented in Table 5.

**Table 5.** . Effects of chitosan nanoparticles on some intestinal histomorphometric parameters in fish

| Fish species | Levels of addition | Effects on intestinal histomorphometric parameters |
|---|---|---|
| Nile Tilapia<br>*(Oreochromis niloticus)*<br>(Abd El-Naby et al., 2020) | ChNPs<br>C: 0%<br>T: 0.5% | VH ↑<br>Addition of ChNPs to the diet significantly increased villus height. |
| Nile Tilapia<br>*(Oreochromis niloticus)*<br>(Abd El-Naby et al., 2019) | ChNPs<br>C: 0%<br>T1: 0.1%<br>T2: 0.3%<br>T3: 0.5% | VH ↔, GCC ↔<br>The addition of ChNPs to the diet did not cause a change in histomorphological structure. |
| Rainbow Trout<br>*(Oncorhynchus mykiss*<br>(Hamidian et al., 2018) | ChNPs-zeolite composite<br>C: 0<br>T1: 14.28 g/kg zeolit<br>T2: T1+0.005% ChNPs<br>T3: T1+0.05% ChNPs<br>T4: T1+0.5% ChNPs | VHa ↑(T4>T3>T2)>T1>C<br>VHm ↑(T4>T3>T2)>(T1=C)<br>VHp ↑(T4>T3>T2)>T1>C<br>GCDa ↑(T4=T3)>T2>T1>C<br>GCDm ↑(T4, T3, T2)>(T1=C)<br>GCDp ↑(T4>T3>T2)>T1>C<br>The addition of ChNPs-zeolite composite to the diet was more effective than the addition of zeolite alone. |
| Grey Mullet<br>*(Liza ramada)*<br>(Dawood et al., 2020) | ChNPs<br>C: 0%<br>T1: 0.05% | VHa ↑ T3>(T2≥T1≥C)<br>VHm ↑ (T3≥T2)>(T1≥C)<br>VHp ↑ T3>T2>C, ↔ (T1≥C)<br>VWa ↑ (T3, T2, T1)>C |

| | | |
|---|---|---|
| | T2: 0.1%<br>T3: 0.2% | VWm ↑ (T3≥T2)>(T1≥C)<br>VWp ↑ (T3, T2, T1)>C<br>GCa ↑ (T3, T2, T1)>C<br>GCm ↑ (T3≥T2)>T1>C<br>GCp ↑ (T3≥T2)>T1>C<br>The villus height, width and number of goblet cells in the anterior, middle and posterior parts of the small intestine increased depending on the increase in the amount of ChNPs added to the diet. |
| Rohu<br>*(Labeo rohita)*<br>(Naveen Kumar et al., 2022) | ChNPs<br>C: 0%<br>T1: 0.025%<br>T2: 0.05%<br>T3: 0.1%<br>T4: 0.2% | Histomorphological scores:<br>GC (T4=T3)>T2>(T1=C)<br>Micro villus T3>T4>T2>(T1=C)<br>Villus lumen (T4=T3)<(T2=T1)<C<br>Lumen (T4=T3)<(T2=T1)<C<br>The best result in terms of histomorphology was obtained with the addition of 0.1 and 0.2% ChNPs. |

C: control, ChNPs: chitosan nanoparticles, GCC: goblet cell counts, GCDa: goblet cell density in anterior parts of small intestine, GCDm: goblet cell density in middle parts of small intestine, GCDp: goblet cell density in posterior parts of small intestine, T: treatment group, VH: villus height, VHa: villus height in anterior parts of small intestine, VHm: villus height in middle parts of small intestine, VHp: villus height in posterior parts of small intestine, ↑: significantly increased, ↔: no significant difference, >: significantly higher than others, <: significantly lower than others, =: no significant difference.

**Effects of Chitosan Nanoparticles on Digestive Enzyme Activity in Fish**

The ability of an organism to digest a particular substance depends on the presence of the appropriate enzyme in the digestive tract and the conditions necessary for this enzyme to function (Smith, 1980). Since the breakdown of nutrients in the digestive system in fish is largely dependent on the enzymes present, the determination of digestive enzyme activity can provide important data on fish digestive physiology (Hani et al., 2018). It has been reported that pathogenic flora causes a decrease in the secretion of digestive enzymes due to the morphological disorder of the intestinal mucosa (Han et al., 2012). It is thought that the effect of chitosan and its nanoparticles on the activities of intestinal digestive enzymes may be due to

the changes in the intestinal microbial ecosystem (Sheikhzadeh et al., 2017). The effects of the addition of chitosan nanoparticles to fish diet on digestive enzyme activities in some recent studies are presented in Table 6.

**Table 6.** Effects of chitosan nanoparticles on the activity of some digestive enzymes in fish

| Fish species | Levels of addition | Effects on digetive enzyme activity |
|---|---|---|
| Nile Tilapia<br>*(Oreochromis niloticus)*<br>(Abd El-Naby et al., 2020) | ChNPs<br>C: 0%<br>T: 0.5% | Amylase activity ↑<br>Lipase activity ↑<br>Protease activity ↔<br>ChNPs addition to the diet significantly increased villus height, amylase and lipase enzyme activity. |
| Nile Tilapia<br>*(Oreochromis niloticus)*<br>(Abd El-Naby et al., 2019) | ChNPs<br>C: 0%<br>T1: 0.1%<br>T2: 0.3%<br>T3: 0.5% | Amylase activity ↑ (T3)<br>Lipase activity ↑T3>T2>(T1=C)<br>Protease activity ↔<br>• Addition of ChNPs to the diet did not cause a change in histomorphological structure.<br>• 0.5% ChNPs increased amylase and lipase activity, and 0.3% ChNPs increased only lipase activity. |
| Raibow Trout<br>*(Oncorhynchus mykiss)*<br>(Sheikhzadeh et al., 2017) | ChNPs-zeolite composite<br>C: 0<br>T1: 14.28 g/kg zeolit<br>T2: T1+0.005% ChNPs<br>T3: T1+0.05% ChNPs<br>T4: T1+0.5% ChNPs | Trypsin activity ↑ (T4=T3=T2)>(T1=C)<br>Amylase activity ↑ (T4)>(T3=T2=T1)>C<br>Lipase activity ↔<br>• Addition of ChNPs to the diet significantly increased trypsin activity.<br>• The addition of 0.5% ChNPs created a significant activation of digestive enzymes. |

C: control, ChNPs: chitosan nanoparticles, T: treatment group, ↑: significantly increased, ↔: no significant difference, >: significantly higher than others, =: no significant difference

**Conclusion and Recommendations**

- Studies show that chitosan nanoparticles have various positive effects on fish. The findings indicate the potential of this compound to be used as an important feed additive in fish farming.
- Chitosan nanoparticles have positive effects on growth performance parameters of fish. These effects can provide a great advantage for breeders to increase their productivity.
- The positive effects of chitosan nanoparticles on the immune system could help fish to become more resistant to disease, which could reduce resource losses.
- The antioxidant and antibacterial effects of chitosan nanoparticles may be effective in supporting fish health and preventing disease.
- Positive effects of chitosan nanoparticles on digestive system enzymes may contribute to improved feed digestion and absorption of nutrients.
- Studies on histological parameters show that chitosan nanoparticles can positively influence gut health. This may support better absorption of nutrients and improved digestive tract health.
- The use of chitosan nanoparticles in the fish farming sector can provide significant benefits in terms of both economic and environmental sustainability. However, further research and field trials are needed to fully evaluate this potential and to determine the optimal conditions and dosages of use.

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# KÜLLEME ve ZYMV DAYANIMLI NİTELİKLİ YAZLIK KABAK (*Cucurbita pepo* L.) HATLARINDA SEZYUM KAYNAKLI IŞINLAMANIN DİHAPLOİDİZASYON ÜZERİNE ETKİSİ

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**Özet**

Sunulan çalışmada, külleme ve ZYMV dayanımlı yeni ve yerli F1 hibrit yazlık kabak (*Cucurbita pepo* L.) çeşitlerinin üretimine yönelik olarak, kobalt$^{60}$'a alternatif sezyum kaynaklı ışınlamanın dihaploidizasyon üzerine etkinliğinin araştırılması ve saf hatların elde edilmesi amaçlanmıştır. Çalışmada polenler sezyum kaynağında 100, 125 ve 150 Gray dozlarında ışınlanmış, bu polenlerle 66 yazlık kabak genotipinde yapılan tozlamalar ile partenogenetik haploid embriyoların uyartımı sağlanmıştır. Toplamda 356 meyve, 25333 tohum ve 3700 embriyo elde edilmiştir. Embriyolar MS ortamlarında kültüre alınarak 343 tanesi bitkiciğe dönüştürülmüş, bu bitkiciklerden de 231 tanesi başarılı bir şekilde dış koşullara alıştırılmıştır. Bu bitkilerden 192 tanesinde stomatal gözlemler ile (birim alandaki stoma sayısı ve stoma boyutları) ploidi tespiti yapılmıştır. Sonuçta 18 bitki haploid (n = 20), 166 bitki diploid (2n = 40) ve 8 bitki miksoploid (haploid ve diploid hücreli) olarak tespit edilmiştir. Bütün ışın dozlarından haploid bitki elde edilmiş, bitki başına en yüksek haploidi frekansı 150 Gy dozunda tespit edilmiştir. Sonuç olarak sezyum kaynağının yazlık kabakta haploidi çalışmalarında kobalt$^{60}$'a alternatif olabileceği ortaya koyulmuştur.

**Anahtar Kelimeler:** Yazlık kabak, ZYMV, Külleme, Sezyum, Dihaploidizasyon

# EFFECT OF CAESIUM-SOURCED GAMMA IRRADIATION ON HAPLOIDIZATION IN POWDERY MILDEW AND ZYMV RESISTANT SUMMER SUMMER SUMMER (*Cucurbita pepo* L.) LINES

**Abstract**

In the presented study, it was aimed to investigate the effectiveness of cesium-induced irradiation as an alternative to cobalt$^{60}$ on dihaploidization and to obtain pure lines for the production of new and local F1 hybrid summer squash (*Cucurbita pepo* L.) varieties with powdery mildew and ZYMV resistance. In the study, pollens were irradiated in cesium source at doses of 100, 125 and 150 Gray, and parthenogenetic haploid embryos were stimulated by pollination of 66 summer squash genotypes with these pollens. A total of 356 fruits, 25333 seeds and 3400 embryos were obtained. Embryos were cultured in MS media and 343 of them were transformed into plantlets, and 231 of these plantlets were successfully acclimated to external conditions. Ploidy was determined by stomatal observations (number of stomata per unit area and stoma sizes) in 192 of these plants. As a result, 18 plants were haploid (n = 20), 166 plants as diploid (2n = 40) and 8 plants as mixoploid (with haploid and diploid cells). Haploid plants were obtained from all radiation doses, and the haploidy frequency per plant was determined at the highest at 150 Gy dose. As a result, it was revealed that the cesium source could be an alternative to the cobalt$^{60}$ in haploidy studies in summer squash.

**Keywords:** Summer squash, ZYMV, Powdery mildew, Cesium, Dihaploidization

## Giriş

Cucurbitaceae familyasında yer alan birçok sebze türü ülkemiz koşullarında ekonomik anlamda yetiştirilmektedir. Yazlık kabaklar (Cucurbita pepo L.) örtüaltı ve açıkta toplamda 490 bin ton civarındadır (TÜİK, 2022) ve üretici için oldukça önemli ve yüksek kazanç getiren bir türdür. Yazlık kabaklar oldukça geniş bir tip zenginliğine sahiptir ve genellikle meyvesi için üretilse de, çerez sanayinin vazgeçilmez bir ürünüdür, gıda katkı maddesi olarak kullanıldığı gibi farmakolojik açıdan önemli bir potansiyeli sahip yağı için de üretilmektedir.

Yerel gen kaynakları tarımsal açıdan bir ülkenin en önemli varlıklarından birisidir ve ülkemiz yazlık kabak açısından önemli bir gen potansiyeline sahiptir. Bir çok bölgemizde yöresel halkın tüketim alışkanlıklarına uygun kabak popülasyonları mevcuttur ve tarımsal üretimde kullanılmaktadır. Ancak bu yerel çeşitler verim, kalite, abiyotik ve biyotik stres koşullarına dayanım/tolerans yönünden F1 hibrit çeşitlerle rekabet edecek güçte değildir. Bu durum ülkemiz yazlık kabak üretiminde birçoğu yurt dışı kaynaklı F1 hibrit çeşitlerin piyasada yaygın olarak kullanılmasına ve dışa bağımlılığımıza neden olmaktadır. Bu sebeple yerel potansiyelimizin tohumculuk sektörü tarafından kullanılarak ekonomiye kazandırılması ve dışa bağımlılığın azaltılması oldukça önemlidir.

Saf hatların eldesi F1 hibrit tohumluk için ilk ve en önemli aşamadır. Yazlık kabak gibi yabancı tozlanma oranı yüksek türlerde klasik yöntemlerle saflaştırma uzun zaman (7-8 generasyon) almaktadır. Saflaştırma işlemini daha kısa sürede (1-2 yıl) %100 saflık düzeyinde gerçekleştirmeyi mümkün kılan dihaploidizasyon tekniği (androgenesis, gynogenesis ve partenogenesis) ıslahçılara büyük kolaylıklar sunar ve ilk generasyonlardan itibaren seleksiyona izin verir (Forster ve Thomas, 2005). Dihaploidizasyon (DH) ile elde edilen bu saf hatlardan kombinasyon yeteneği yüksek ve istenilen agronomik özelliklere sahip çeşit adaylarının eldesiyle kısa sürede F1 hibrit tohumluklar piyasada yerini alabilmektedir.

Cucurbitaceae familyasında ışınlanmış polen tekniği (partenogenesis) DH çalışmalarında en çok kullanılan tekniktir (Kurtar ve ark., 2021). Bu teknikte polen farklı kaynaklarda ışınlanır (genellikle Co60 kaynaklı gama ışını ile), böylece polen generatif yönden inaktif hale getirilir ancak çimlenme yetenekleri devam ettiğinden, dişi organı uyarır ve partenogenetik haploid embriyolara neden olur. Bu tekniğin kullanılması ile karpuz (Gürsöz ve ark., 1991; Sarı ve ark., 1994), kavun (Sauton ve Dumas de Vaulx, 1987; Sarı ve ark., 1992; Abak ve ark., 1996; Lotfi ve ark., 2003), hıyar (Truong-Andre, 1988; Sauton, 1989; Çağlar ve Abak, 1999; Dolcet-Sanjuan ve ark., 2006), yazlık kabak (Kurtar, 1999; Kurtar ve ark., 2002; Berber, 2009; Bektemur ve ark., 2014; Kurtar ve ark., 2017; Eroğlu ve ark., 2019; Kurtar ve

ark., 2021), bal kabağı (Kurtar ve ark., 2009) ve kestane kabağında (Kurtar ve Balkaya, 2010) başarılı sonuçlar elde edilmiştir. Işınlanmış polen tekniğinde frekansı sınırlayan en önemli faktör genotiptir. Ayrıca genotiplerin yetiştirildiği mevsim ve bakım koşulları, ışınlama dozları ve tozlama zamanları, besi ortamının bileşimi, hormonlar ve konsantrasyonları, kültür koşulları ve embriyo gelişim aşamaları gibi faktörler haploidi frekansını etkileyebilmektedir. Ayrıca son yıllarda ülkemizde ışınlanmış polen tekniğinin kullanımını sınırlayan en önemli faktör araştırma amaçlı sağlıklı ve düzenli çalışan kobalt60 kaynaklarının oldukça az (şu anda sadece TENMAK bünyesinde bulunmakta) ve zaman zaman kullanılamıyor olmasıdır.

Bu çalışmada külleme ve ZYMV dayanımlı yeni ve yerli F1 hibrit yazlık kabak (Cucurbita pepo L.) çeşitleri üretmek amacıyla saf hatların eldesine yönelik ışınlanmış polen tekniğinde kobalt60 kaynağına alternatif olarak sezyum kaynaklı ışınlamanın etkinliğinin ortaya konulması amaçlanmıştır.

## 1. Materyal ve Metod

### 1.1. Donör Hatların Elde Edilmesi ve Bitkilerin Yetiştirilmesi

Çalışma 2023 yılında Antalya ilinde bulunan Petektar Tohumculuk firmasında yürütülmüştür. Yazlık kabaklarda firmada bulunan genetik materyal ve hastalık dayanımı bulunan yabancı çeşitler arasında yapılan melezlemeler, geriye melezlemeler ve kendilenmiş açılım generasyonlarından oluşan materyal içerisinden, yapılan ön çalışmaların ışığında, agronomik özelliklerine göre belirlenmiş 66 hattın tohumları 04.Nisan.2023 tarihinde torf perlit (3:1) karışımlı harç ile doldurulmuş fide tepsileri içerisine ekilmiştir. Ekim yapılan viyoller 24ºC sıcaklığındaki çimlendirme odasında 2 gün süreyle tutulmuş ve tohumlarda kökçük çıkışı görülür görülmez, firmaya ait fide serasına alınmıştır. Fideler dikim büyüklüğüne gelene kadar (8 gün) fide serasında tutulmuş ve gerekli kültürel işlemler fidelikte gerçekleştirilmiştir. Dikim büyüklüğüne gelmiş fideler sıra arası 60 x 60 cm olacak şekilde 18.Nisan.2023 tarihinde plastik seraya transfer edilmiştir. Her bir genotipten 6 adet sağlıklı bitki olmak üzere 396 bitki dikimi gerçekleştirilmiştir. Donör bitkilerin sağlıklı bir şekilde yetiştirilmeleri için gerekli sulama, gübreleme, kültürel işlemler, hastalık ve zararlılarla mücadele işlemleri aksatılmadan gerçekleştirilmiştir. Firmada bitki yetiştiriciliğiyle ilgili işlemler rutin olarak gerçekleştirildiğinden bu aşamada hiç bir sorunla karşılaşılmamış, donör bitkilerin yetiştirilme süreçleri sağlıklı bir şekilde tamamlanmıştır (Şekil 1)



**Şekil 1.** Plastik sera koşullarında büyümekte olan bitkiler

### 1.1. Anterlerin Toplanması, Işınlanması ve Tozlama Çalışmaları

Firma gen havuzundan seçilerek yetiştirilmiş, dayanıklılık gen/genlerini taşıdığı moleküler olarak doğrulanmış melez bitkilerde ışınlanmış polen tekniği ile dihaploidizasyon çalışmaları yapılmıştır. Bu amaçla anthesisten bir önceki günde (saat $15.^{00}$-$16.^{00}$), henüz açılmamış fakat iyi gelişmiş erkek çiçekler seçilerek toplanmış, aynı anda bir gün sonra açacak dişi çiçekler pensler yardımıyla izole edilmiştir. Erkek çiçeklerden alınan anterler petri kaplarına konularak ertesi gün Ankara'da TENMAK Nükleer Araştırma Merkezinde bulunan ve gama ışını veren sezyum kaynağında 100, 125 ve150 Gray dozlarında ışınlanmıştır (Şekil 2). Bahar-yaz dönemi çalışmaları için bitkilerin generatif aktivitelerinin optimum olduğu zamanda 22, 25 ve 29 Mayıs ve 1 Haziran 2023 tarihlerinde olmak üzere toplamda 4 ışınlama yapılmıştır.




**Şekil 2.** Anterlerin toplanması, sezyum kaynağında ışınlanması

Işınlanan tomurcuklar aynı gün Antalya'ya getirilmiş ve akşam oda koşullarında bekletilerek anterlerin patlamaları sağlanmıştır. Işınlamanın ertesi günü sabah 07.00-09.00 saatleri arasında bir gün önceden izole edilmiş dişi çiçekler ışınlanmış polenlerle tozlanmış, yabancı polen girişini engellemek için tekrar pensler yardımıyla izole edilmiştir. İzole edilen çiçekler etiketlenerek kayıt altına alınmıştır (Şekil 3).



**Şekil 3.** Işınlanmış polenlerle tozlama çalışmaları

### 1.2. Meyvelerin Hasadı, Embriyoların Ekstraksiyonu ve Kültüre Alma

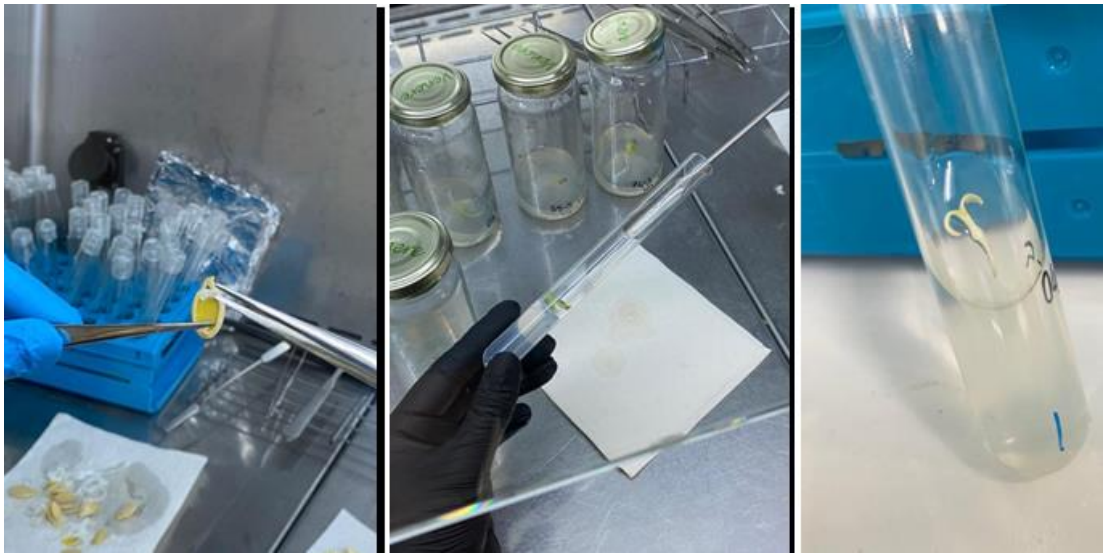
Tozlamadan 3-4 hafta sonra (21-25 gün arası) tamamen olgunlaşmamış meyveler hasat edilmiş, yüzeysel olarak temizlendikten sonra Ar-Ge laboratuarlarına getirilmiş ve burada ekstraksiyon yapılıncaya kadar 20 $^{o}$C sıcaklıkta muhafaza edilmiştir (Şekil 4).



**Şekil 4.** Tutan meyveler, hasat edilmiş bir meyve ve hasat edilmiş meyvelerin depolanması.

Hasat edilen meyvelerde her bir kombinasyon ve hasat dönemi için ağırlık (g), en (cm), boy (cm), meyve rengi, içerdikleri dolu ve embriyolu tohum sayıları teker teker kayıt altına alınmıştır. Küçük yapılı embriyoların kararıp ölmemeleri için zaman kaybetmeden embriyo ekstraksiyonuna başlanmıştır. Bu amaçla öncelikle meyveler çeşme suyu altında iyice yıkanmış, sonrasında %15'lik ticari çamaşır suyu (ACE) çözeltisinde 30 dk tutulmuş ve kurulanarak steril kabin altında saf etil alkol ile yakılarak yüzeysel dezenfeksiyon yapılmıştır.

Daha sonra meyveler steril bir bıçak yardımıyla kesilmiş, içerisindeki tohumlardan tamamen dolu olanlar ve iz şeklinde olanlar hariç diğer tohumlar teker teker açılmıştır (Şekil 5).



**Şekil 5.** Tohumların açılarak incelenmesi ve kültüre alma işlemleri.

Çalışmanın en zaman alıcı ve en yorucu bölümü embriyo çıkarma işlemi olmuştur. Tohumun 1/3ünden daha büyük embriyolar, çoğunlukla diploid embriyoya sahip oldukları için, kültüre alınmamıştır (Kurtar ve ark., 2021). Çıkarılan embriyolar modifiye MS besi ortamında kültür tüplerine veya 300 cc'lik cam kavanozlar içerisinde her birine 1 embriyo olacak şekilde kültüre alınmıştır. Kültür odasının inkübasyon koşulları 16/8 saat aydınlık/karanlık, 3000 lux ışık şiddeti ve 26 ±1 $^{o}$C sıcaklığa ayarlanmıştır (Şekil 6).




**Şekil 6.** Besi ortamlarında kültüre alınmış embriyolar ve gelişmekte olan bitkicikler.

### 1.3. Dış Koşullara Alıştırma (Aklimatizasyon)

Uygun boya gelmiş *in vitro* bitkiler kavanozlarından çıkarılıp kökleri agardan temizlenmiş, fazla kökleri alındıktan sonra içleri steril torf doldurulmuş şeffaf plastik bardaklara dikilmiştir (Şekil 7).



**Şekil 7.** Dış koşullara alıştırmak için bitkilerin dikilmesi

İlk can suları % 0.5'lik fungusitli su ile yapılmıştır. Bu şekildeki bitkilerin üzeri bir plastik poşetle kapatılmış ve 3-4 gün sonra plastik kenarlarından hafifçe açılarak bitkiler dış koşullara alıştırılmaya başlanmıştır (Şekil 8). Yaklaşık 2 hafta süresince iklim odası koşullarında bitkiler dış koşullara alıştırılmıştır.



**Şekil 8.** Dış koşullara alıştırmada kullanılan iklim odası ve aklimatize edilmiş bitkiler

### 1.4. Ploidi düzeyinin tespiti ve kromozom katlama çalışmaları

Bitkiler bir taraftan dış koşullara alıştırılırken bir taraftan da ploidi analizleri yapılmıştır. Bu amaçla kabakta ploidi seviyesini gösteren güvenilir bir kriter olan stomatal gözlemler [birim alandaki stoma sayısı (adet/mm$^2$) ve stoma eni ve boyu (mikrometre)] ve morfolojik özellikler (polen varlığı, çiçek iriliği, yaprak iriliği) kullanılmıştır.

Stomatal gözlemlerde yaprakların alt yüzeyinden farklı 3 bölgeden alınmış epidermis tabakası mikroskop altında kontrol grubuyla (2n) karşılaştırmalı olarak incelenmiştir. İşlem için Yapraktan kare şeklinde kesitler alarak %25'lik Glacial Asetik Asit çözeltisinde yaprak örnekleri beyazlaşıncaya kadar (yaklaşık 1 saat) bekletilmiştir. Daha sonra örnekler saf suda 2-3 dk yıkanmış ve lam üzerine yerleştirilerek üzerine %1'lik (I-Kl) çözeltisinden 1 damla damlatılmış ve ışık mikroskobunda 400 büyütmede (40 x 10) incelenmiştir.

Haploid olarak belirlenen bitkilerde kromozom katlama çalışmaları *in vivo* koşullarda yapılmıştır. Zira kabak türünde *in vitro* kromozom katlama çalışmalarından verimli sonuçlar alınamamıştır (Kurtar, 2018). Katlamada % 0.5 kolhisin çözeltisi haploid bitkilerin sürgün ucuna 4 saat süreyle ve 1 gün ara verilerek 2 doz şeklinde uygulanmış ve sürenin sonunda sürgün uçları su ile yıkanmıştır. Kolhisin uygulamalarında bir pamuk sürgün ucunu kaplayacak şekilde yerleştirilmiş ve kolhisin çözeltisiyle iyice ıslatıldıktan sonra gerek buharlaşmayı önlemek gerekse kolhisinin etkinliğini artırmak için (ışık ile ilişkisini kesme) alüminyum folyo ile sarılarak izole edilmiştir (Şekil 9). Uygulamadan sonra gelişen sürgünlerde tekrar ploidi tespiti yapılarak katlanmanın gerçekleşip gerçekleşmediği belirlenmiş ve katlama gerçekleşinceye kadar işlemlere devam edilmiştir. Doublehaploid (DH) hale getirildiği kesinleşen bitkiler seraya dikilmiş, kendilemeler yapılarak saf tohumluklar elde edilmiştir (Şekil 10).



**Şekil 9.** *In vivo* kromozom katlama çalışmaları



**Şekil 10.** Doublehaploid (DH) bitkilerde kendilemeler ile tohumluk eldesi

### 2.6.Verilerin analizi

Çalışmada eşit sayıda ve tekerrürlü olarak materyal kullanılamadığından istatistikî analiz yapılamamış, yalnızca elde edilen verilerin ortalamaları sunulmuştur.

## 2. Bulgular ve Tartışma

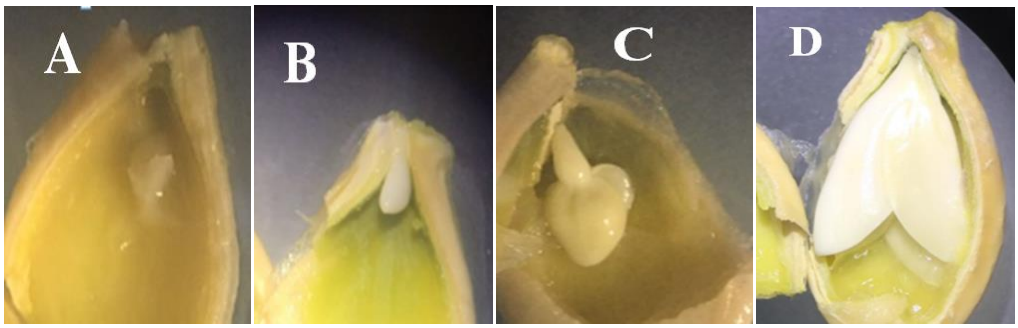
Çalışma boyunca elde edilen meyve sayıları, çıkarılan tohum sayıları ve kültüre alınan embriyo sayıları Çizelge 1'de verilmiştir. Toplamda tüm dönem boyunca 356 meyve edilmiş, bu meyvelerden çıkarılan 25333 tohum incelenmiş ve 3700 embriyo ekstrakte edilmiştir. Kurtarılan embriyolar gelişim aşamalarına göre sınıflandırılarak modifiye MS besi ortamında kültüre alınmıştır (Çizelge 2). Toplamda kültüre alınan 3700 embriyodan ağırlıklı olarak kotiledon (755 adet) ve ok ucu (595 adet) şeklindeki embriyolar daha fazla elde edilmiştir (Şekil 11).

**Çizelge 1.** Hasat tarihlerine göre elde edilen toplam meyve sayısı (MS), tohum sayısı (TS) ve Embriyo sayısı (ES)

| Hasat T. | MS | TS | ES |
|---|---|---|---|
| **22.05.23** | 105 | 12233 | 1227 |
| **25.05.23** | 65 | 2693 | 334 |
| **29.05.23** | 123 | 4501 | 540 |
| **01.06.23** | 63 | 6083 | 489 |
| **Toplam** | **356** | **25333** | **3700** |

**Çizelge 2.** Hasat tarihleri, ve embriyo gelişim aşamalarına göre kültüre alınan embriyo sayıları (ES)

| Hasat T. | ES | Nokta | Globular | Okucu | Torpedo | Kotiledon |
|---|---|---|---|---|---|---|
| **22.05.23** | 1227 | 157 | 137 | 273 | 257 | 403 |
| **25.05.23** | 334 | 50 | 38 | 86 | 70 | 90 |
| **29.05.23** | 540 | 81 | 96 | 110 | 105 | 148 |
| **01.06.23** | 489 | 66 | 85 | 126 | 98 | 114 |
| **Toplam** | **3700** | **354** | **356** | **595** | **530** | **755** |




**Şekil 11.** Elde edilen farklı gelişim aşamalarındaki embriyolar.

A) Globüler B) Nokta C) Okucu D) Kotiledon

Kültüre alınan embriyolardan elde edilen bitki sayıları ise Çizelge 3'de sunulmuştur. Toplamda kültüre alınan 3700 embriyodan 231 adedi normal bir bitkiye dönüştürülebilmiş ve bitkiye dönüşüm oranı (BDO) % 6.2 olarak gerçekleşmiştir. Genotiplere göre ise BDO % 0.9 (30 numaralı genotip) ile %33.3 (45 numaralı genotip) arasında değişmiştir. Elde edilen bu oranlar bazı genotiplerde Kurtar ve ark. (2021)'nın ışınlanmış polen tekniği kullanarak yazlık kabaklarda yapmış oldukları çalışmada elde ettikleri orandan (% 27.6) daha iyi olurken bazılarında ise çok daha düşük çıkmıştır.

Çalışmada kullanılan tüm genotiplerden bitki elde edilmiş, elde edilen bitki sayıları genotiplere göre değişmekle beraber 1 ile (3, 9, 14, 22, 23, 28, 30, 35, 39, 45, 47, 52, 53, 60, 66, 69, 72 numaralı genotipler) 9 (7 ve 26 numaralı genotipler ) arasında gerçekleşmiştir (Çizelge 3). Yazlık kabaklarda daha önce yapılmış olan dihaploidizasyon çalışmalarında genotipin önemli bir faktör olduğu, elde edilen sonuçların genotiplere göre geniş bir varyasyon gösterdiği bildirilmiştir (Kurtar, 1999; Kurtar ve ark., 2002; Bektemur, 2014; Kurtar ve ark., 2017; Eroğlu ve ark., 2019; Kurtar ve ark., 2021). Ancak kabuksuz çerezlik yazlık kabak

(*Cucurbita pepo* L.) çeşit adayında haploit embriyo uyartımı sağlamak amacıyla Sezyum$^{137}$ kaynağı ile gama ışını veren cihazda 300 ve 350 Gy dozlarıyla ışınlanmış polenlerle yapılan tozlamalardan olumlu bir sonuç alınamamış ve ışın dozları melezleme etkisi yapmıştır (Sandı, 1998).

**Çizelge 3.** Genotip (G)'lere göre kültüre alınan embriyo sayısı (ES; adet), elde edilen bitki sayısı (BS; adet) ve bitkiye dönüşüm oranı (BDO; %).

| G | ES | BS | BDO | G | ES | BS | BDO |
|---|---|---|---|---|---|---|---|
| **1** | 61 | 2 | 3,3 | **39** | 54 | 1* | 1,9 |
| **2** | 37 | 5 | 13,5 | **40** | 44 | 5 | 11,4 |
| **3** | 93 | 1* | 1,1 | **41** | 61 | 2 | 3,3 |
| **4** | 26 | 4 | 15,4 | **42** | 27 | 5 | 18,5 |
| **5** | 60 | 2 | 3,3 | **43** | 33 | 2 | 6,1 |
| **6** | 50 | 3 | 6,0 | **44** | 22 | 4 | 18,2 |
| **7** | 88 | 9* | 10,2 | **45** | 3 | 1* | 33,3 |
| **8** | 72 | 5 | 6,9 | **46** | 55 | 5 | 9,1 |
| **9** | 70 | 1* | 1,4 | **47** | 54 | 1* | 1,9 |
| **10** | 44 | 5 | 11,4 | **48** | 98 | 3 | 3,1 |
| **11** | 32 | 7 | 21,9 | **49** | 78 | 4 | 5,1 |
| **12** | 24 | 5 | 20,8 | **50** | 65 | 2 | 3,1 |
| **13** | 33 | 5 | 15,2 | **51** | 44 | 2 | 4,5 |
| **14** | 33 | 1* | 3,0 | **52** | 32 | 1* | 3,1 |
| **15** | 27 | 2 | 7,4 | **53** | 25 | 1* | 4,0 |
| **16** | 84 | 4 | 4,8 | **54** | 14 | 3 | 21,4 |
| **17** | 55 | 2 | 3,6 | **55** | 70 | 6 | 8,6 |
| **18** | 90 | 3 | 3,3 | **56** | 25 | 7 | 28,0 |
| **19** | 40 | 3 | 7,5 | **57** | 40 | 2 | 5,0 |

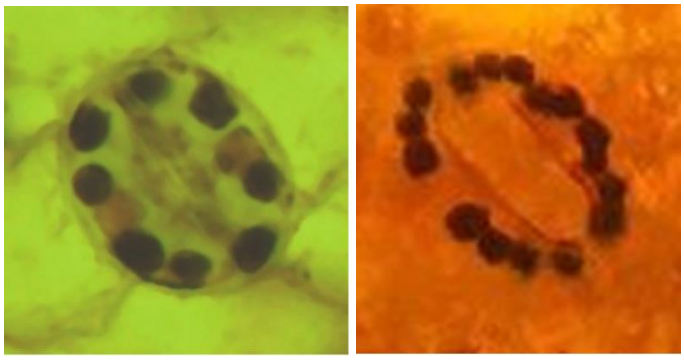
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **20** | 15 | 2 | 13,3 | **58** | 77 | 4 | 5,2 |
| **21** | 53 | 6 | 11,3 | **59** | 41 | 1 | 2,4 |
| **22** | 45 | 1* | 2,2 | **60** | 47 | 1* | 2,1 |
| **23** | 36 | 1* | 2,8 | **61** | 82 | 7 | 8,5 |
| **24** | 67 | 3 | 4,5 | **62** | 35 | 2 | 5,7 |
| **25** | 45 | 1* | 2,2 | **63** | 24 | 6 | 25,0 |
| **26** | 50 | 9* | 18,0 | **64** | 80 | 3 | 3,8 |
| **27** | 21 | 2 | 9,5 | **65** | 50 | 2 | 4,0 |
| **28** | 10 | 1* | 10,0 | **66** | 70 | 1* | 1,4 |
| **29** | 11 | 3 | 27,3 | **67** | 53 | 2 | 3,8 |
| **30** | 115 | 1* | 0,9 | **68** | 58 | 2 | 3,4 |
| **31** | 131 | 3 | 2,3 | **69** | 40 | 1* | 2,5 |
| **32** | 112 | 4 | 3,6 | **70** | 4 | 5 | 125,0 |
| **33** | 43 | 7 | 16,3 | **71** | 26 | 2 | 7,7 |
| **34** | 47 | 3 | 6,4 | **72** | 7 | 1* | 14,3 |
| **35** | 16 | 1* | 6,3 | **73** | 36 | 4 | 11,1 |
| **36** | 116 | 2 | 1,7 | **74** | 39 | 3 | 7,7 |
| **37** | 81 | 4 | 4,9 | **75** | 41 | 2 | 4,9 |
| **38** | 13 | 2 | 15,4 | **TOPLAM** | **3700** | **231** | **6,2** |

Dış koşullara başarılı bir şekilde alıştırılan 192 bitkide yapılan stomatal gözlemler sonucunda 18 bitki haploid, 8 bitki miksoploid ve 166 bitki ise diploid yapıda bulunmuştur. Haploidi frekansı % 9.4 olarak gerçekleşmiş, % 4.2 miksoploid ve % 86.4 oranında diploid bitki elde edilmiştir. Berber ve Abak (2012) kabuksuz çekirdek kabaklarında denedikleri tüm ışın dozlarında (50, 100 ve 150 Gy) haploit embriyo elde etmişler ancak 150 Gy ışın dozundan daha fazla haploit embriyo elde edildiğini bildirmişlerdir. Elde edilen bitkilerden % 42.6'sı

haploit, %57.3'ü ise diploit olarak belirlenmiştir. Aynı şekilde, yazlık kabakta en yüksek haploit embriyo oranı 150 Gy gama ışını dozundan alınmış, 217 meyvenin ekstraksiyonu neticesinde 2625 haploit ve 1378 diploit yapıda embriyo elde edilmiştir (Baktemur ve ark., 2014). Kurtar ve ark. (2017) yazlık kabakta elde edilen 192 bitkiden 27 adedinin haploid olduğunu, haploidi frekansının ise 100 tohum, 100 embriyo ve meyve başına sırasıyla 0.22, 2.11 ve 0.41 olarak gerçekleştiğini bildirmişlerdir.

Yine Kurtar ve ark. (2021) 14 yazlık kabak genotipinde 150 Gy ışın dozunu kullandıkları dihaploidizasyon çalışmalarında, 111 bitkiden 28'ini haploid (n = 20), 77'sini diploid (2n = 40) ve 6'sını miksoploid (haploid ve diploid hücreli) yapıda bulmuştur. Haploid bitkiler %1'lik kolhisin uygulamasıyla katlanmış, sera koşullarında yetiştirilmiş, kendilenmiş ve tohumları alınmıştır. Çerezlik kabaklarda 100 ve 150 Gy dozlarında yapılan çalışmada, 63 bitkide yapılan ploidi analizleri sonucunda 100 Gy'de 3 bitki ve 150 Gy'de 6 bitki haploid (n) olarak tespit edilmiştir. 6 bitkide ise miksoploid (n+2n) yapı gözlenmiştir. Kestane kabağında (*Cucurbita maxima* Duch) farklı ışın dozlarının (50, 100, 200 ve 300 Gy) ve sürelerinin (9, 11, 15, 21 ve 28 Temmuz) denendiği çalışmada, haploidi frekansı üzerine doz, ışınlama süresi, genotip ve embriyo tipinin etkili olduğunu bildirilmiştir. Meyve başına en yüksek embriyo sayısını 50 Gy dozu vermiş, tüm kotiledon ve şekilsiz yapıdaki embriyolardan yalnızca diploid elde edilmiş, geç torpido, ok ucu ve kotiledon öncesi embriyolar %33.3, 50.0 ve 66.7 haploid bitki üretmiştir. 100 tohum, 100 embriyo, 100 bitkicik ve meyve başına haploidi frekansı sırasıyla 0.11, 1.17, 10.96 ve 0.28 olarak gerçekleşmiştir (Kurtar ve Balkaya, 2010).

Diploid bitkiler daha iri stomalar oluşturmuş ve birim alandaki sayıları haploidlere göre daha az bulunmuştur. Ortalama stoma eni ve boyu diploid bitkilerde 22.645 µm ile 32.16 µm civarında iken, bu değerler haploid bitkilerde 15.14 µm ile 19.46 µm olarak gerçekleşmiştir. Birim alandaki (adet/mm$^2$) stoma sayısı ise diploidlerde ortalama 278 adet iken, bu değer haploid bitkilerde 440 adet olarak belirlenmiştir (Şekil 13).



**Şekil 13.** Haploid bir bitki (sol) ile diploid bir bitkiye (sağ) ait stomalar.

Yapılan morfolojik gözlemler sonucunda diploid bitkilerin daha iri yapraklara ve bitki yapısına sahip olduğu, ayrıca haploid bitkilerin daha küçük erkek çiçekler açtığı ve erkek çiçeklerinde polen bulunmadığı tespit edilmiştir (Şekil 14 ve 15).



**Şekil 14.** Haploid bir bitki (sol) ile diploid bir bitkiye (sağ) ait yapraklar.



**Şekil 15.** Diploid bir bitki (sol) ile haploid bir bitkiye (sağ) ait erkek çiçekler.

Çalışma sonucunda elde edilen tüm bulguların yazlık kabakta ışınlanmış polen tekniği ile yapılmış dihaploidizasyon çalışmalarıyla uyum içerisinde olduğu tespit edilmiştir.

**3. Sonuçlar ve Öneriler**

Homozigot hatların elde edilmesini sağlayan ve F1 hibrit ıslahının süresini büyük ölçüde kısaltan ışınlanmış polen ile dihaploidizasyon tekniği, ıslah etkinliğini artırma yönünde yazlık kabakta başarıyla uygulanmıştır. Sezyum kaynaklı ışınlamanın kobalt$^{60}$ kaynaklı ışınlamaya alternatif olacağı ve etkin bir şekilde kullanılabileceği ortaya koyulmuştur. Ancak tekniğin genotip bağımlı olduğu ve haploidi frekansının genotipler arasında büyük farklılıklar gösterdiği tespit edilmiştir. Dihaploid hatlar çok farklı büyüme özelliklerine sahip olmuş ve dihaploidizasyon tekniğinin saf hat üretimi yanında varyasyon oluşturmak için de önemli bir

teknik olduğu gözlemlenmiştir. İlerleyen aşamalarda haploidi frekansı yüksek genotiplerle çalışılması, yüksek frekanslı ve düşük frekanslı genotipler arasında melezleme yapılması, ışınlama ve tozlaşma çalışmalarının daha geniş bir vejetasyon dönemine yaygınlaştırılmasının başarıyı artıracağı kanaatindeyiz.

## 4. Teşekkür

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# PERSPECTIVE OF MOLECULAR DETERMINATION FOR THE MECHANISM OF HIGH REPRODUCTIVE EFFICIENCY IN ROMANOV SHEEP AND THEIR CROSS BREEDS BASED ON CANDIDATE GENES APPROACH

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## Abstract
Romanov sheep are a famous exotic sheep breed imported throughout the country and have high genetic ability in fertility and off-season reproduction, as well as the ability to bear lambs and multiple births. Identification of molecular, hormonal and genetic mechanisms that control these important traits is one of the current research horizons. With this research motivation, the aim of the current study is to molecularly determine the mechanism of high reproductive efficiency in Romanov sheep and their hybrids using candidate genes. For this purpose, gene expression assay tools were used and causal mutations in two candidate genes, FGF-2, ESR1 (relative gene expression test), and causal mutations in four candidate genes, FecB, POMC, ESR2, AAN-NAT, were identified. accomplished. The studied population included female Romanov sheep with a history of reproduction and records, Romanov and Ghazel, Romanov and Lori-Bkhtiari cross, as well as several native sheep breeds of the country. DNA and RNA extraction and subsequent gene amplification, electrophoresis and CT measurement were performed using existing routine instructions and quality control. Regarding the FecB gene, the reported mutation was not observed in the number of lambs in utero. It appears that the molecular mechanism of twin formation in this breed is fundamentally different from that of Booroola Merino Sheep breed. Regarding the genes AAN-NAT and POMC, which are related to the production of the hormone melatonin and the biological clock, the favourable and causal allele reported in previous articles showed a high significant frequency. Regarding the gene expression results and difference profile of two candidate genes, FGF-2 and ESR1, there was a significant difference between Romanov mammary tissue from four-headed mammals, two-headed mammals and other domestic sheep. In conclusion, the candidate gene approach is a reliable approach to identify the mechanism of high fertility and survival of its lambs in molecular studies on sheep breeds and to design a commercial kit to create a breeding core in Romanov sheep and in addition that necessary to create a control of intersections of non-scientific methods will also help increase the economic profits of sheep farmers in Iran.
**Keywords:** Romanov sheep, gene expression, identification of casual mutations, molecular markers

## Introductıon

Reproduction in domestic animals occurs through an amazingly coordinated hormonal and endocrinological process and organized beginnings and endings. Research into this process has been a focus of research at universities and research centres for years (Abdoli et al., 2013, Notter et al., 2008). Understanding reproductive mechanisms in ruminants can help animal scientists economically improve the reproductive efficiency of breeds. The multiple birth trait is a trait with a simple appearance but a very complex concept, which is the most important target trait for improving herd income due, among other things, to its sex-restricted threshold and its low heritability and environmental impact (Abdoli et al., 2016). Recently, the famous exotic breeds Romanov and Booroola entered Iran and became widespread among livestock breeders without prior scientific studies in the country, and the feedback is the contradictory results of the litter size with the presence of these breeds in the herds (Laudet et al., 2006). The development of a genetic test that can determine the cost-effectiveness of the presence of desirable alleles in these breeds and hybrids from a molecular perspective with high accuracy may be one of the current needs and academic research priorities (Galloway et al., 2000). With this literature review, previous extensive sources indicate that there is no reliable genetic marker (T/C) associated with twinning in sheep in sheep chromosome number 7 (rs423810437) and in the sheep upstream region. Identification of molecular, hormonal and genetic mechanisms that control these important traits is one of the current research horizons. With this research motivation, the aim of the current study is to molecularly determine the mechanism of high reproductive efficiency in Romanov sheep and their hybrids using candidate genes. For this purpose, gene expression assay tools were used and causal mutations in two candidate genes, FGF-2, ESR1 (relative gene expression test), and causal mutations in four candidate genes, FecB, POMC, ESR2, AAN-NAT, were identified. Accomplished.

## Materıal and Methods

In the first step, a total of 70 Romanov ewes with reproductive history were selected and DNA extraction, polymerase chain reaction after new primer design stage, and electrophoresis and staining were accepted according to routine laboratory instructions, and then the products obtained from single amplification (60 samples) were sent to China for Sanger sequencing. The sequence and details of primers used for amplification of the fragment with a primer size of 500 bp are as follows:

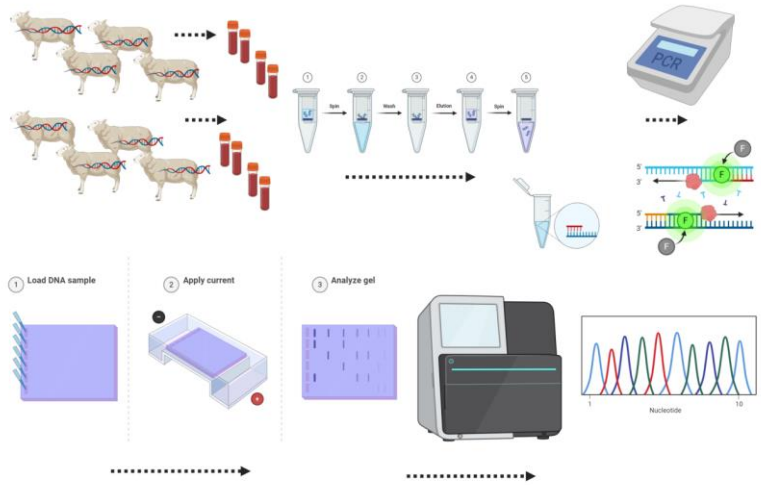


**Figure 1.** Overview for PCR-sequencing methods for identification of SNP in candidate gene

**Results and Dıscussıon**

Reproduction rate is one of the main factors affecting the production rate of all domestic animals. Sheep are animals with a seasonal oestrous cycle (Galloway et al., 2000). Twin production in sheep depends on the oestrous cycle and follicle release. How the follicle that triggers ovulation is selected is not yet clear. Due to the fact that the ovulation rate of different breeds of sheep in the world varies greatly, this animal is suitable for follicle growth studies as well as genetic control of ovulation rate (He et al., 2010). Regarding the FecB gene, the reported mutation was not observed in the number of lambs in utero. It appears that the molecular mechanism of twin formation in this breed is fundamentally different from that of Booroola Merino Sheep breed (Zamani et al., 2014). Regarding the genes AAN-NAT and POMC, which are related to the production of the hormone melatonin and the biological clock, the favourable and causal allele reported in previous articles showed a high significant frequency (Kareta et al., 2006, Knigh et al., 2006, Xu et al., 2018).

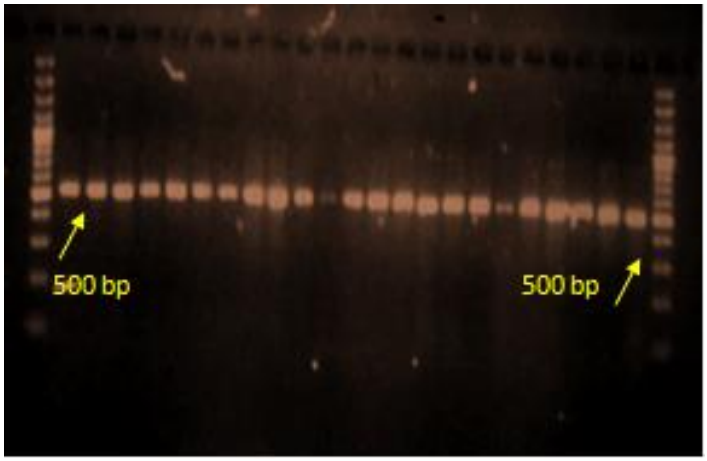


**Figure 2.** Amplification of PCR product of ESR1 in Romanov sheep

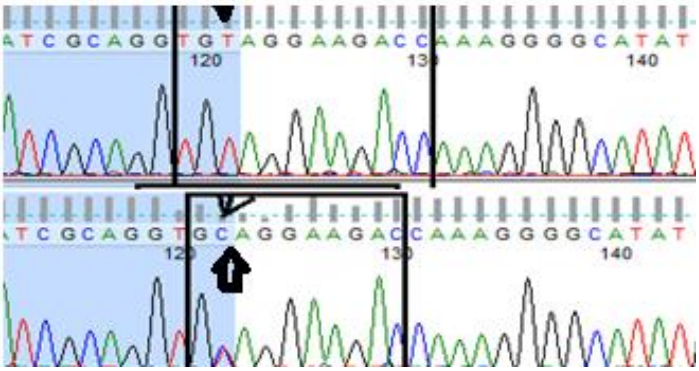


**Figure 3.** Screening of A/C mutation in ESR1 gene in Romanov sheep

Regarding the gene expression results and difference profile of two candidate genes, FGF-2 and ESR1, there was a significant difference between Romanov mammary tissue from four-headed mammals, two-headed mammals and other domestic sheep. In conclusion, the candidate gene approach is a reliable approach to identify the mechanism of high fertility and survival of its lambs in molecular studies on sheep breeds and to design a commercial kit to create a breeding core in Romanov sheep and in addition that necessary to create a control of intersections of non-scientific methods will also help increase the economic profits of sheep farmers in Iran. A genome-wide study of several Wadi, Ho, Icelandic, Finnish, Romanov and Texel sheep breeds were conducted using the Ovine Infinium HD BeadChip. Different sets of candidate genes related to reproduction have been identified in different breeds: BMPR1B, FBN1 and MMP2 in the Wadi sheep breed; SMAD1, GRIA2 and CTNNB1 in Ho sheep; NCOA1 in Icelandic sheep; INHBB, NF1, FLT1, PTGS2 and PLCB3 in Finnish sheep; ESR2 in Romanov sheep; ESR1, GHR, ETS1, MMP15, FLI1 and SPP1 in Texel. Bioinformatics

analysis showed that various biological pathways may contribute to the number of births in female sheep, such as ovulation and premature follicular maturation in Romanov (Song et al., 2018, Gholizadeh et al., 2014). Comparing the results of this study with previous studies in the same area with other breeds showed a lack of compatibility in some cases and in many breeds such as (Randrib African, Brazilian Creole, Sakiz, Norwegian with Sheep) no polymorphism was observed in the population only the T allele was found. have been. On the other hand, despite the agreement in polymorphism between the results of this study and previous studies, the rate and frequency trends were different and, in some breeds, (Afshari, Finnsheep) the results were not consistent with our study.

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# KURAK KOŞULLARDA SOYA FASULYESİNDE (*Glycine max.* L. Merr.) AZOT FİKSASYONUNA ETKİLERİ

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## Özet

İnsanlığın doğal kaynakları aşırı ve bilinçsizce kullanması sonucu habitat ve yeryüzü düzeninde büyük değişiklikler olmuş, artan nüfusa bağlı açlık ve dengesiz beslenme problemleri ortaya çıkmıştır. Gelecek yıllarda gıda ihtiyacının karşılanması birim alandan daha az su ile daha fazla ürün elde edilmesiyle mümkün olabilecektir. İklim değişikliği sonucunda su kaynaklarında oluşan azalma, su kaynaklarının etkin kullanımını zorunlu kılmaktadır. Küresel iklim değişikliği etkisiyle gelecekte çoğu bitkinin kuraklık kaynaklı olumsuz etkilere maruz kalacağı öngörülmektedir. Bitkilerin iklim değişikliği senaryolarına nasıl tepki vereceklerine dair yapılan araştırmalarda çevresel şartların etkisinde en yüksek verimin nasıl alınacağı, hangi su dozu uygulamasında yeterli ürün alınacağı araştırmalar arasındadır. Sürdürülebilirlikte hem toprak yapısının korunması hem de toprak verimliliğinin arttırılması önemli konulardır. Bu sorunların çözümünde sürdürülebilir tarımsal uygulamalarda ekim nöbeti kilit rol oynamaktadır ve ekim nöbeti denediğinde akla baklagillerin kullanılması gelmektedir. Tarımsal uygulamalarda baklagillerin kullanılması iklim değişikliğinin olumsuz etkilerini hafifletmede, gübre kullanımın azaltma açısından önemlidir. Soya fasulyesi (*Glycine max.* L. Merr.) yüksek oranda protein ve yağ içeren bir baklagil bitkisidir. Soya fasulyesi diğer baklagiller gibi biyolojik azot fiksasyonu yapabilmesi sebebiyle tarımsal ekosistemin sürdürülebilirliğinde önemli bir bitkidir. Havanın serbest azotunu toprağa bağlama özelliği ile toprak verimliliğini arttırır ve gübre maliyetlerini azaltmada ayrı bir öneme sahiptir. Soya fasulyesi köklerinde yaşayan *Bradyrhizobium japonicum* bakterileri sayesinde havanın serbest azotunu toprağa bağlayabilmektedir. Bu sayede hem kendi azot ihtiyacını karşılamakta hem de kendinden sonra gelecek bitkiye azotça zengin bir toprak bırakmaktadır. Bu azot bağlam olayı biyolojik azot fiksasyonu ile meydana gelmektedir. Azot fiksasyonu baklagil köklerinde nodül denilen yumrucuklar ile oluşmaktadır. Bitkilerde azot üretim birimleri olarak görev yapan nodüllerin oluşum ve fonksiyonlarını yerine getirmesi bitki ve bakterilerin genetik uyumu ve ortam koşulları ile yakından ilgilidir. Kuraklık şartlarında soya fasulyesi köklerinde *Rhizobium* bakterilerinin aktif çalışarak etkin bir biyolojik azot fiksasyonu sağlaması ve bunun sürdürülebilir tarım sistemlerinde geliştirilmesi önemli bir konudur. Bu sayede ülkemizde soya fasulyesi üretimi yaygınlaşması ve etkin azot fiksasyonunun sağlanması amacıyla

sürdürülebilir tarım sistemlerinde soya fasulyesi yetiştiriciliğine yer verilmesi gerekmektedir. Ayrıca çevresel şartların azot fiksasyonu üzerine etkilerinin araştırılması çevresel şartların olumsuzluklarını gidermede önemli bir konudur.

**Anahtar kelimeler:** Soya fasulyesi, kuraklık, azot fiksasyonu, nodül, sürdürülebilirlik

# THE EFFECT OF ARID CONDITIONS ON NITROGEN FIXATION IN SOYBEAN (*Glycine max.* L. Merr.)

**Abstract**

Due to humanity's unrestrained and excessive use of natural resources, significant alterations have transpired in the ecological balance and order of the planet. The rise in population growth has resulted in an imbalance of nutrition, which further exacerbates the issue. Given the decline in water resources due to climate change, it is essential to make efficient use of the available water resoces. Most plants are predicted to suffer negative effects induced by drought in the future due to global climate change. In order to provide for the future's mounting food needs, it is imperative to increase production while reducing water usage per unit area. To ensure sustainability, protecting soil structure and enhancing soil fertility are crucial issues. Crop rotation plays a vital role in the resolution of these problems through sustainable agricultural practices. The utilization of legumes in agricultural practices is essential in mitigating negative climate change effects and reducing the use of fertilizers. Due to high protein and fat content, soybean is a significant crop in sustainable agriculture systems thanks to biological nitrogen fixation. This process of nitrogen fixation occurs because of the biological properties of soybean. It binds atmospheric nitrogen to improve soil fertility, reducing the need for costly fertilizers. Rhizobium bacteria actively work in soybean roots even under drought conditions, providing efficient biological nitrogen fixation. Therefore, it is pivotal to incorporate soya bean cultivation in sustainable agricultural systems to expand production and ensure effective nitrogen fixation. Furthermore, it is crucial to explore the impact of environmental conditions on nitrogen fixation to mitigate their adverse effects.

**Keywords:** Soya bean, drought, nitrogen fixation, nodule

## 1.Giriş

Son yıllarda dünya nüfusundaki hızlı artışa karşın besin maddelerinde yeterli düzeyde artış sağlanamamıştır. Çoğu ülkelerde açlık ve yetersiz beslenme yüzünden her yıl binlerce insan hastalık ya da ölüm problemleri ile savaşmaktadır. Günümüzde insanlar, protein içerikli besin kaynaklarına yönelmektedirler. Dünya'da hızla artan nüfusun dengeli beslenmesinde karbonhidratların yanında protein kaynaklı besin tüketimi de önemlidir. Fakat tahıl ve sebzelerdeki bitkisel proteinlerin sınırlı oluşu ve hayvansal ürünlerinin maliyetinin yüksek olması sebebiyle insanlar protein ihtiyaçlarını karşılamak için baklagillere daha çok yönelmektedirler (Seymen, 2015).

Küresel iklim değişikliği gıda güvenliğini riske sokmakta ve beslenme tehlikesini arttırmaktadır. Tarımsal üretimde baklagillerin kullanılmaya başlanması iklim değişikliğine karşı önemli bir rol oynayabilir. Baklagil ürünleri iklim değişikliğine adapte olurken etkilerini de hafifletmesinde rol oynamaktadır. Baklagiller geniş genetik çeşitliliğe sahiptirler. Bu önemli özellik sayesinde iklim değişikliklerine dayanıklı çeşitler geliştirilebilmektedir. Tarımsal uygulamalarda sera gazı emisyonlarını ve gübreleme ihtiyacını ciddi oranda düşürmektedirler. Baklagiller kendi azotlarını karşılayabildikleri için daha az gübreye ihtiyaç duyarlar ve bu şekilde sera gazı emisyonlarının azaltılmasında büyük rol oynarlar. Baklagillerin yüksek ürün potansiyeline rağmen düşük ürün alınmasının nedeni abiyotik ve biyotik stres faktörlerdir. Stres faktörleri sürdürülebilir tarım sistemlerindeki en büyük problemlerdendir (Çevik, 2015).

*Rhizobium* türleri olarak bilinen bakteriler baklagillerin kılcal köklerine girer ve orada çoğalarak köklerde nodül adı verilen yumruların oluşmasını sağlar. Bu bakteriler kendileri için gerekli olan karbonhidratları bitkiden alırlar, buna karşılık toprak havasını bitkilerim faydalanabileceği forma çevirirler. Bu olay 'simbiyotik azot tespiti' olarak bilinir. Bu yolla tespit edilen azot miktarı yemeklik tane baklagillerin toplam azot içeriklerinin yaklaşık %77'sini kapsamaktadır. Bitki ölünce diğer organizmalar tarafından parçalanarak, azotun bir kısmı mineral hale geçer ve Ca, P, K gibi besin maddeleri de ayrışma sonucu kök bölgesinde kalarak toprak verimliliğini artırmaktadır. Burada baklagil köklerinin C:N ilişkisi önemli olup bu oranın diğer kültür bitkilerine göre çok daha düşük olması organik maddelerin parçalanarak humusa dönüşme süresini hızlandırmaktadır. Baklagillerde bu süre 1-2 hafta olarak belirtilirken tahıllarda bu süre 4-8 hafta arasında değişmektedir. Baklagil köklerinin mikroorganizma faaliyeti sonucunda, ayrışmaları sırasında açığa çıkan ve mikroorganizmaların metabolizma artıkları olan polisakkarit sakızları, bazı yağlar, mumlar ve bu gibi maddelerle toprak zerreleri birleşerek agregatları oluşturur. Aynı zamanda yemeklik tane baklagiller derin kök kanalları

açarak toprağın sıkışmasını önler. Bu nedenlerle derin köklü baklagillerin ekim nöbetine girmesi her zaman önerilmektedir (Verma, 1992).

## 2.Soya Fasulyesi (*Glycine max* L. Merr)

### 2.1. Soya Fasulyesinin Bazı Genel Özellikleri

Soya fasulyesi anavatanının doğu Asya, muhtemelen Çin olduğuna inanılan soya, insanoğlu tarafından kültüre alınan ve yetiştirilen en eski ve stratejik bitkilerden bir tanesidir. Soya kazık köklü bir bitkidir ve ana köke bağlı olarak ayrıca kuvvetli bir yan kök sistemine de sahiptir. Kökleri 150-200 cm derinliğe kadar inebilirse de, genellikle 60-70 cm derinlikte yoğunlaşırlar. Çiçeklenme başlangıcından itibaren bu kazık ve yan kökler üzerinde çok sayıda yumrucuklar oluşmaktadır. Ekim sırasında kullanılan özel soya bakterisi yoluyla bu yumrucukların içerisine havadaki azot depo edilerek, hem soyanın kendisinin ve hem de ardından ekilecek ürünün bu azot kaynağını kullanması sağlanır. Fotoperiyoda duyarlılığı nedeniyle, kuzey yarım küreden ekvatora kadar uzanan alan içerisinde 13 ayrı olgunluk grubuna (000-X) ayrılan, yazlık karakterde bir kısa gün bitkisidir (İşler, 2013).

### 2.2. Soya Fasulyesinde Biyolojik Azot Fiksasyonu

Bütün canlılar yaşamlarını sürdürebilmek için, karbon, oksijen, hidrojen, azot, kalsiyum, kükürt, demir, magnezyum, potasyum, fosfor basta olmak üzere birçok elemente ihtiyaç duymaktadır. Tüm elementlerin belli bir çevirime girmesi zorunludur. Atmosfer ve biyosferdeki azot çevirimi incelendiğinde, ana kaynağın atmosferik azot olduğu görülmektedir. Atmosferin % 78'i azot olmasına rağmen, elementel azottan doğrudan doğruya yararlanabilen canlı sayısı çok azdır. Bazı bakteriler (*Rhizobium, Clostridium, Azotobacter, Klebsiella, Bacillus, Amylobacter*), mavi-yeşil algler (*Anabaena, Nostoc, Calothrix, Oscillatoria*) ve mantarlar (*Mycorrhiza*) atmosferdeki azotu tespit eder. Bunlardan *Rhizobium* bakteri, konak seçici olup, *Leguminosae* familyasındaki bitkilerle birlikte bulunur; bu bitkilerin köklerinde nodüller oluşturarak azot tespitini sağlar. Bitki ve bakteri arasında, simbiyotik bir ilişki söz konusudur. Bakteriler, bitkiden enerji sağlayıp elemenler azotu bağlar; bu sırada açığa çıkan amonyaktan da bitkiler yararlanarak aminoasit sentezini gerçekleştirirler. Atmosferde bol miktarda bulunan moleküler azotun amonyum formlarına indirgenerek yarayışlı duruma geçmesine azot fiksasyonu denmektedir. Atmosfer azotunun biyolojik olarak bir yıl içindeki fiksasyonu 175 milyon ton olup, tüm azot fiksasyonunun % 75'ini oluşturmaktadır.

Yüksek bitkilerce azotun asimilasyonunda temel olan molekül "amonyak"tır. Amonyak molekülü ise çeşitli kaynaklar tarafından sağlanır (Marschner, 1995).

Bunlar;

1) Simbiyotik azot ($N_2$) fiksasyonu,

2) Kökler tarafından topraktan alınan amonyum ($NH_4^+$),

3) Köklerce topraktan alınan ve indirgenen nitrat ($NO_3^-$),

4) Fotorespirasyon ile açığa çıkan amonyak ($NH_3$)

Azotun bitkilere yararlı forma dönüşmesi için iki azot atomu arasındaki tripl kovalent bağın kırılması ve nitrat ($NO_3^-$) ile amonyum ($NH_4^+$) iyonlarına dönüşmesi gerekmektedir. Toprak'ta organik bağlı azot, amonyak ve nitrit üzerinden nitrata dönüşürken, bu olay bitki bünyesinde nitratın nitrit üzerinden amonyağa dönüşmesi ve organik yapılara katılması ile son bulur. Amonyum ise; direkt olarak amonyak üzerinden organik yapılara katılmaktadır.

Biyolojik azot fiksasyonu birçok mikroorganizma tarafından gerçekleştirilir. Bu organizmaların bir kısmı bağımsız olarak bu işlevi gerçekleştirirler. Buna serbest azot fiksasyonu denmektedir. Bunun yanında bazı toprak bakterileri, baklagil bitkileri ile simbiyoz durumunda önemli azot fikse edici organizmalar olarak tanınırlar. Ayrıca mavi yeşil algler ve aktinomiset yüksek bitki ortaklığı seklinde azot fikse eden formlar da bilinmektedir (Haktanır ve Arcak, 1997). Canlılar alemi içinde sadece bazı *procaryotic* organizmalar, yani mikro organizmalar gaz halindeki moleküler azotu indirgeyebilir. Bu organizmalar sahip oldukları genetik yapıları sayesinde azotun indirgenmesinde kullanılan nitrogenez denilen enzim sentezleme yeteneğine sahiptirler.

*Rhizobium* ve *Azotobacter* gibi, serbest azotu tutan bakterilerin özel bir enzim sisteminde, demir içeren iki ayrı bilesen bulunmaktadır. Azotu bağlayan birinci bilesen, molibden içermektedir; ikinci bileşik ise ATP ile aktif hale gelmektedir. Reaksiyonlar sırasında Ferrodoksinden elektronlar alınır ve birinci bileşiğe bağlı olan azota aktarılır, aşama aşama amonyak sentezi gerçekleştirilir. Amonyağın, havadaki azottan başlayarak süren biyolojik sentezinde büyük miktarda enerji harcanır (Boşgelmez et al., 2000).

Azot bağlayan procaryotic mikroorganizmaların hepsi bakteridir. Bunlar ya serbest yasarlar (freeliving bacteria), ya da diğer bir canlı ile ortak yasarlar (symbiotic bacteria) veya diğer bir canlı ile yan yana (associative bacteria) yaşamaktadır. Toprakta serbest yasayan veya yüksek bitkilerle simbiyotik olarak yasayan bazı mikroorganizmaların nitrogenaz enzimi üretme yeteneği vardır. Bu enzim, oldukça stabil olan ve atmosferde çok yüksek oranda bulunan $N_2$'nin $NH_3$'e dönüşümünü katalize etmektedir ve bu yolla organik-N bileşiklerinin oluşumu mümkün

olmaktadır. Simbiyotik azot fiksayonunu özellikle baklagillerde ortak yasayan *Rhizobium*'lar yapmaktadır. Bu gruba giren baklagillerin simbiyotik yasam sürdükleri bitkiler ve bu bitkilere özgü bakteri türleri birbirlerinden belirgin olarak farklıdır. Bu nedenle yeni baklagil ekilen bir alanda, ürün artışını önemli derecede sağlayan uygun bakteri ile aşılama yapılması önerilmektedir. *Rhizobium* 'lar iyi havalanan, hafif asidik veya hafif bazik toprakları severler. Simbiyotik yaşayan bakteriler "konukçu" denilen bir bitkinin kökleri üzerinde yaşarlar. Bakteri konukçu bitkiden kendi ihtiyacı olan karbonhidratları alarak yaşar ve bu sırada havadan aldığı azotu konukçu bitkiye verir. Karşılıklı bir işbirliği esasına dayanan bu yaşam biçimine "Simbiyotik Yasam" denir. *Rhizobium* bakterisi konukçu bitki üzerinde nodül denilen yumrular oluşturur ve nodül içinde azot fiksasyonu yaparlar (Aktas, 1990).

Simbiyotik yasayan bakteriler "konukçu" denilen bir bitkinin kökleri üzerinde yasarlar. Bakteri konukçu bitkiden kendi ihtiyacı olan karbonhidratları alarak yaşar ve bu sırada havadan aldığı azotu konukçu bitkiye verir. Karşılıklı bir iş birliği esasına dayanan bu yaşam biçimine "simbiyotik yaşam" denir. *Rhizobium* bakterisi konukçu bitki üzerinde nodül denilen yumrular oluşturur ve nodül içinde azot fiksasyonu yaparlar. Baklagil bitkilerinde nodül oluşumu, bitki ile *Rhizobium* bakterileri arasında karşılıklı etkileşimler sonucu gerçekleşir. Bakterilerin belirli türleri ile kökler üzerinde azot fikse etme yeteneğinde olan veya olmayan nodüller oluştururlar. Diğer bir deyimle belirli bir grup baklagil bitkisini enjekte eden yalnız bir tür bakteri vardır (İşler, 2013).

### 3. Soya Fasulyesinde Kuraklık ve Kuraklık Stresi Altında Verilen Tepkiler

Bitkiler, farklı çevre faktörlerinin etkisi altında yaşamlarını sürdürmeye çalışırlar. Bu çevre faktörleri biyotik ve abiyotik faktörler olarak adlandırılabilir. Ekonomik anlamda ürün elde etmek için yetiştirilen bitki türünün veya çeşidinin kendine uygun adapte olabileceği optimum çevre isteklerinin karşılanması gerekir. Abiyotik stres faktörlerinden biri olan kuraklık, pek çok araştırmacı tarafından farklı şekillerde tarif edilmekte olup bitkisel anlamda topraktaki nem miktarının bitkinin solma noktasında bulunması olarak tanımlanmaktadır. Kuraklığa dayanım bakımından bitkiler arasında geniş bir varyasyon mevcuttur. Soya fasulyesi mezofit (uygun toprak nemi bulunan ortamlarda yaşayan grup) bir bitki olmakla birlikte bazı gelişme dönemlerinde yaşanan kuraklık stresi verim ve kalite kayıplarına sebep olmaktadır (Larcher, 1995).

Çevresel koşullarda meydan gelen her değişim, bitki büyüme ve gelişmesini belirli oranlarda etkilemekte ve 'stres' kavramını ortay çıkarmaktadır. Stres faktörleri tarımsal verimliliği

azalttığı gibi yeni arazilerin tarımsal faaliyetlere açılmasında da engelleyici bir etkendir. Bitki türlerinin stres faktörlerine verdikleri morfolojik, anatomik ve metabolik cevaplar evrim sürecindeki doğal seleksiyonun ortaya çıkmasında etkili olmuştur. Abiyotik çevresel faktörlerin (ışık, sıcaklık, su-kuraklık, tuzluluk, ağır metaller) hangi boyutlarda stres olarak kabul edileceği türden türe değişmekte ayrıca 'stres' kavramı önemli fizyolojik ve metabolik değişmelere yol açarak bitkilerde büyüme ve gelişmeyi olumsuz şekilde etkileyen, ürün kalite ve miktarında azalmalara, hatta bitki ve organların ölümüne yol açan faktörler olarak tanımlanabilmektedir (Gaspar et al., 2012).

Kuraklık stresinde soya yapraklarda oluşan morfolojik değişimler transpirasyonla kaybedilen su miktarını azaltmaktır, köklerde ise topraktaki suyu daha yüksek bir kuvvetle absorbe etmek ilk tepkilerdir. Kurak şartlarda fotosentez yavaşlar buna bağlı olarak kök gelişimi yavaşlar. Fotosentez ürünlerinin büyük bir kısmı kök gelişimi için köklere taşınır, böylece kök gelişimi hızlanıp kökün gövdeye oranı artar. Stresin bitki büyüme üzerine en önemli etkilerinde biri karbonun farklı bitki kısımlarına tahsis edilmesidir. Stres altında azalan fotosentez sonucunda verim düşmektedir. Stomatal iletkenlik bitki büyüme ve verimi etkileyen önemli bir parametredir (Çırak & Esendal, 2006).

Soya fasulyesi toprağın derin katmanlarındaki su ve besin elementlerinden faydalanmak için köklerini geliştirerek kuraklığın olumsuz etkilerini azaltabilirler. Ayrıca sınırlı su koşullarında yan kökler üretilir ve bu köklerin sayısı uzun süreli kuraklık stresi altında artmaya devam eder. Kısıtlı sulama şartlarında köke doğru biyokütle artışı artarak kök oranı artar. Sulanmayan bitkiler, sulama yapılan bitkilere kıyasla daha uzun kök uzunluğuna sahiptirler. Kök uzunluğu ile kuraklığa dayanıklılık arasında pozitif bir ilişki söz konusudur. Kök uzunluğundaki artış kuraklık stresine karşı bir dayanıklılık göstergesidir (Çırak & Esendal, 2006).

Kuraklık stresinde bitkiler hücre turgorlarını koruyabilmek için bazı organik çözeltileri biriktirerek osmatik potansiyellerini düzenlemeye çalışırlar. Kuraklık stresi altında hücrede karbonhidratlar, glikoz sakkararoz gibi çözünür şekerler osmatik düzenleyici olarak birikir. Kuraklığa maruz kalan bitki hücrelerinde ABA miktarının arttığı bilinmektedir. ABA; kuraklık stresinde stomaların kapanmasını sağlayan bir hormondur. Stoma hücrelerinde ABA miktarı artmakta, suda çözünmeyen nişasta oluşmakta ve K iyonu azalmaktadır. Böylece osmatik basınç azalıp stomalar turgorunu kaybedip kapanmakta ve hormonal kontrol sağlanmaktadır.

Kuraklık stresinde bitki protein metabolizmasında bir bozukluk meydana gelmekte ve bu bozukluk proteinlerin parçalanması ile protein sentezinde azalmalara sebep olmaktadır. Proteinlerin parçalanmasıyla aminoasit birikimi artarak enzim kayıpları ortaya çıkar ve ABA

ve NH3 gibi toksik bir bileşik ortaya çıkar. NH3 bitkide metabolik dengenin bozulmasına neden olduğu gibi, suyun yukarı doğru taşınmasına da engel olarak iki yönlü zarar verir (Ravelambola, 2022).

## 4. Soya Fasulyesinde Biyolojik Azot Fiksasyonu ve Kuraklık İlişkisi Üzerine Yapılan Çalışmalar

Kuraklık soya fasulyesinin verimini %40 'a kadar azaltan en etkili çevresel stresler arasındadır (Lea, 2012). Kuraklığın ana sebepleri atmosferdeki düşük nem, yüksek sıcaklık ve su eksikliğidir. Kuraklık bitkinin karbon asimilasyonunu ve fenolojisini etkilemektedir. Her bir bitki türü kuraklık stresine fizyolojik, moleküler ve biyokimyasal farklı düzeylerde tepkiler verirler. Kuraklık stresi bitkini çimlenme oranını ve fide canlılığını etkile (Hirt, 2014).

Soya, su gereksinimi bakımından pek çok kültür bitkisi gibi mezofit bir bitkidir. Yani, suyun ne eksik ne fazla olduğu alanlarda gelişimini sürdürebilmektedir. Soyanın mevsimlik su ihtiyacı yörenin iklimine, toprak ve çeşit özelliklerine bağlı olarak çok farklılıklar göstermekle beraber 450-700 mm arasında değişmektedir (Korukçu & Evsahipoğlu, 1981).

Soya tohumların çimlenebilmesi için ağırlıkların % 50'si kadar suyu topraktan alması gerekmektedir. Bu dönemde oluşacak su eksikliği veya aşırı nem gelişmeyi geçiktirmektedir. Vejetasyon ilerledikçe bitkinin su ihtiyacı da artmakta ve çiçeklenme dönemiyle bakla doldurma döneminde maksimuma ulaşmaktadır (Şimşek et al., 2001). Bu dönemlerde oluşan su eksikliği aşırı çiçeklenmeye ve meyve dökümlerine sebep olmaktadır.

Kuraklık soya fasulyesi gelişim dönemlerinin tümünde verimi azaltabilmektedir fakat bu etkinin şiddeti su stresinin hangi gelişim dönemlerinde yaşandığına bağlı olarak değişmektedir. Kuraklık stresi özellikle çiçeklenme, tane oluşumu ve tane dolum dönemlerinde çok etkili olabilmektedir. Tane dolum döneminde yaşanan stres tane büyüklüğünün azalmasını ve düşük verime neden olmaktadır. Tane büyüklüğündeki azalmalar tane dolum döneminin daha kısa sürmesini ve olgunlaşmanın daha erken başlamasına bağlanmaktadır (Ashley & Ethridge, 1978).

Çiçeklenme başlangıcında yaşanan su stresi bakla sayısını azaltmaktadır. Çiçeklenme başlangıcından sonra ve tam çiçeklenme döneminde yaşanan stres bakla sayısını ve tane büyüklüğünü azaltmaktadır. Tane verim ve bileşenleri sulama suyu kısıtlandığında önemli ölçüde azalmaktadır (Korte et al., 1983).

Soya fasulyesinde topraktaki kuraklık ve kısıtlı sulama koşullarında azot fiksasyonu azalmakta dolayısıyla düşük protein üretimi ve yetersiz tane gelişim düzeyi nedeniyle verim ve kalitede

önemli düşüşler gözlemlenmektedir (Sinclair et al., 2007). Kumlu topraklarda vejetatif gelişme döneminde kuraklık stresine maruz bırakılan ve azotlu gübre uygulanmayan bitkilerde stres dönemi boyunca yaprak ve baklalarda azot birikiminin %30-40 düzeyinde azaldığı belirlenerek kuraklığın azot fiksasyonu üzerine önemli düzeyde negatif etkisinin olduğu bildirilmiştir (Streeter, 2003).

Yüksek sıcaklık ve kuraklık stresinin de bitkinin büyüme ve gelişimi üzerine ve dolayısıyla tane verimini önemli düzeyde düşürdüğünü ve özellikle verim öğelerinden bitkide bakla sayısında büyük azalmaların yaşandığı belirtilmiştir. Kuraklık koşullarında su faktörünün verimi belirleyen en önemli etken olduğu özellikle generatif dönemler olan çiçeklenme ve bakla olum dönemlerindeki su kıtlığı çiçeklenme oranının ve dolayısıyla bitkide bakla sayısı azalmasına neden olarak bitki verimini etkileyen en önemli etkenler olduğu belirtilmiştir (He et al., 2017).

Soya fasulyesinde biyolojik azot fiksasyonunda etken toprak bakterisi *Bradyrhizobium japonicum*'dur ve toprakta soya fasulyesi konukçu bitki ilişkisiyle gübre kullanımını azaltmaktadır. Fakat biyolojik azot fiksasyonu üzerine birçok faktör etkilidir. Soya fasulyesi strese karşı hassas bir bitkidir ve stres şartlarındaki artış bitki büyümesini ve verimi düşürmektedir. Biyolojik azot fiksasyonunun en hassas aşaması; soya fasulyesi ve *Bradyrhizobium japonicum* bakterileri arasında sinyal iletişimi sürecini de içeren azot fiksasyonunun ilk aşamasıdır. Stres şartları altında konukçu bitkinin kökleri tarafından gönderilen sinyal moleküllerinin üretimi azalır ve topraktaki bakteri popülasyonunun köklere yönelimi için verdikleri tepkiler azalır. Soya fasulyesi ile Bradyrhizobium bakterileri arasındaki simbiyotik ilişkinin aşamalarında sinyal moleküllerinin üretimi, kök sapına tutulmaları, kök kılcallarının kıvrılması, enfeksiyon iplikçiğinin üretimi ve nodül üretimi de dahil olmak üzere stres altındaki en hassas aşamalarıdır (Mirannsari, 2016).

Stres koşulları altında Bradyrhizobium japonicum bakterilerinin sayısı ve gelişimi azalır ve stres şartlarına dayanıklı değillerdir. Bakterilerin stres koşullarına olan bu tepkileri farklı mekanizmalarla tolere edilebilir (Page, 2014).

Verim kayıpları generatif dönem boyunca fotosentetik performans ile ilişkilidir. Fotosentezdeki asimilatların çiçek ve baklalara yetersiz iletimi yüksek sıcaklıklarla beraber daha küçük tane oluşumunu ve dolayısıyla düşük verime sebep olmaktadır. Bu iki stres koşulu (sıcaklık ve su stresi) tohum verimini, bakla sayısını, 1000 tane ağırlığını olumsuz etkilemektedir (Desclaux et al., 2022).

Nodül oluşumları ise hem su hem de su ve sıcaklık kombinasyonlarından etkilenerek bakteroidlere giden zayıf karbon azot birikimini olumsuz etkilemektedir. Bu olumsuzlukların tüm bitkideki etkisi ise düşük tohum verimi olarak yansımaktadır. Çiçeklenme döneminde ise sadece su stresinin bitkiyi strese sokarak çiçek ve polen kayıplarına yol açarak tohum verimini dolaylı olarak azaltmaktadır (Soba et al., 2022).

**5. Sonuç**

Dünya çapında bitki üretimi üstüne farklı stres koşulları etkilidir ve her stres koşulu farklı başlıklarda elde alınıp, değerlendirilir. Bitkiler genel olarak tarla koşullarında strese maruz kalırlar fakat bu stres durumu tek bir stres faktöründen oluşabileceği gibi birden çok farklı stres faktörlerinin kombinasyonlarından da oluşabilir. Kuraklık stresinin olduğu bir bölgede bitkiler tuzluluk ve sıcaklık stresi ile de savaşabilirler. Bu gibi durumlarda bitki tüm stres faktörlerine aynı anda tek bir tepki verebileceği gibi her stres faktörüne ayrı ayrı tepkilerde verebilir

Soya fasulyesi simbiyotik azot fiksasyonu ile sürdürülebilir tarım açısından önemli bir bitkidir. Azot fiksasyonuna etki eden faktörlerin bilinmesi; bu faktörlerin simbiyotik sistem üzerindeki fonksiyon ve etki mekanizmalarının çok iyi şekilde anlaşılması, fikse edilen azot miktarının artırılmasına büyük katkıda bulunacak, böylece bir taraftan gübre ihtiyacının azalmasına bağlı olarak gübre masrafları düşerken, diğer taraftan gübrelerin üretilmesi ve uygulanması esnasında ortaya çıkan çevre kirliliği problemi ortadan kalkacaktır. Bir baklagil bitkisi olan soya fasulyesi tarımda büyük azot kaynağı ve azotlu gübrelerin neden olduğu çevresel kirliliği azaltmada önemli alternatif bir bitkidir. Soya fasulyesi topraktaki Bradyrhizobium japonicum bakterileriyle köklerinde oluşturduğu nodüllerde azot fiksasyonu gerçekleştirir. Soya fasulyesi toprak verimliliğini arttırmak için ekim nöbeti sistemlerine alınmalıdır.

Son yıllardaki küresel iklim değişikliğinin yanı sıra kuraklık ve yüksek sıcaklıklar bitkilerde verim ve kalite üzerine etkili olmaktadır. Yüksek sıcaklığın kuru ağırlık ve azot fiksasyonunu önemli derecede düşürdüğü bilinmektedir. Özellikle kuraklık koşulları azot fiksasyonu olumsuz etkilemekte ve biyolojik yolla bağlanan azot miktarını düşürmektedir. Bitkinin bu faktörlere tepkisi kritik bitki gelişme aşamalarında ihtiyaç duyduğu besin maddesi ve su ihtiyacına göre değişir. Stres koşulları altında bu faktörlerden azot fiksasyonunun nasıl etkilendiği gıda güvenliği ve üretimi açısından önemli bir konudur.

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# THE EFFECT OF DIFFERENT PHOSPHORUS DOSES ON THE QUALITY CHARACTERISTICS OF BREAD WHEAT (*Triticum aestivum* L.) VARIETIES UNDER MUĞLA-DALAMAN CONDITIONS*

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*** This study was produced from Onur KOÇ's graduate thesis**

## Abstract
The aim of this study was to determine the changes in grain quality of Kayra and Ziyabey-98 bread wheat varieties at different doses of phosphorus in the ecological conditions of Muğla Dalaman. Kayra and Ziyabey-98 bread wheat varieties were used as plant material in this study, which was conducted in three replications according to the split-plot experimental design in the winter growing season of 2022. Nitrogen fertilization was applied in three doses totaling 160 kg/ha. As phosphorus source, Triple Super Phosphate fertilizer was applied in 6 different doses (0, 40, 80, 120, 160, 200 kg/ha). 1000 grain weight ranged from 44.42 g to 46.06 g in variety Kayra and 42.53 g in variety Ziyabey-98. Hectoliter weights were between 78.23 kg/hl and 80.73 kg/hl in Kayra, between 76.93 kg/hl and 79.13 kg/hl in Ziyabey-98, protein ratio values were between 14.25% and 15.37% in Kayra, between 13.92% and 14.81% in Ziyabey-98. Starch ratio values were found between 70.68% and 74.49% in Kayra variety, between 69.1% and 75.53% in Ziyabey-98 variety. It was found that the ash values varied between 1.68% and 1.75% in Kayra variety and between 1.65% and 1.70% in Ziyabey-98 variety. The quality values increased proportionally as the phosphorus dose decreased. It has been found that a high dose of phosphorus generally has a negative effect on grain quality. The optimal quality values were achieved with a phosphorus dose of 0 kg/ha. Notably, this trial was restricted to a single production season and the quality parameters were expressed as a percentage. As such, conducting a long-term investigation could advisable to determine the grain quality features depending on varying phosphorus
**Keywords:** wheat, triple super phosphate, phosphorus doses, seed quality

## 1.Giriş

Hızla artan dünya nüfusu 2050 yılına varıldığında bu artış oranı ile yaklaşık 9,5 milyara varacağı hesaplanmaktadır. İnsanlar bu artan nüfusun beslenebilmesi ve yeterliliği için tarımda daha az alandan daha fazla ve kaliteli ürün almaya mecbur bırakmış geçen her zamanda da bu amaç doğrultusunda farklı bilimsel metotlar uygulanmıştır. Bunlara bağlı olarak ise kimyasal gübre kullanımı artmış ve bu artışla insan sağlığı ile hayvan sağlığı olumsuz şekilde etkilenerek çevre kirliliği her geçen gün yükselmiştir (Kodaş vd., 2015).

Bitki yaşamlarında makro elementler kadar mikro elementlerde önemli düzeyde etkilidir. Mikro elementler bitkilerde ve topraklarda makro elementlere istinaden daha küçük halde bulunurlar. Demir, bakır, klor, mangan, bor, çinko ve nikel mikro, hidrojen, karbon, oksijen, azot, fosfor ve potasyum ise makro elementlerdendir. Toprakta fosfor, Ca, Fe ve Al fosfatlar halinde ve apatit şeklinde bulunur. Fosfor bitkinin kök gelişimini, olgunlaşmasını, erkenciliği ve çiçeklenmesini teşvik ederken hastalık ve zararlılara karşı olan dayanımını artırıcı katkı sağlayan önemli bir elementtir (Bilen ve Sezen, 1993).

Birim alan tane veriminin artırılmasında gübreleme büyük önem teşkil etmektedir. Yapılan araştırmalarda toprak ve bitki özellikleri bilinerek buna bağlı olarak seçilen gübre çeşidi, miktarı ve uygulama şekline bağlı olarak verim ve kalitede %60'a varan değerlerde olumlu yönde artışın olduğu bilinmektedir. Aynı şekilde yapılan bilinçsiz ve yanlış gübrelemeyle de büyük oranlarda verim ve kalite kayıpları olduğu da bilinmektedir. Ülkemizde bitkisel üretim 2022 yılında 70,2 milyon ton (TÜİK, 2022) olduğunu dikkate alırsak, bilinçli yapılan gübrelemenin verim ve kalitede %10 oranında etki edeceği, bu oranında fayda ve zararı göz ardı edilemeyecek seviyede olacağı açıkça ortadadır (Torun, 2021).

Azottan sonra en önemli makro besin elementi olan Fosfor (P), bitkinin gelişiminde birçok fonksiyonu yerine getiren, genç dokular için gerekli olan ve yenilenemeyen makro besin elementidir. Bitki yaşamının birçok yaşamsal etkinliğini düzenlediği için temel taşı olarak da adlandırılmaktadır. Bitkiye dengeli fosfor verildiği takdirde daha az biz zamanda büyüme görülür ve bitki dayanıklılığı artar. Fosfor noksanlığında ise bitkiler toprak üstü aksamlarında ki büyümeyi durdurup yavaşlatarak kök büyümesine öncelik verirler (Bulut, 2023).

Buğdayda kalitenin tek bir unsur ile tanımlanması mümkün değildir. Birçok faktörün etkisiyle oluşan kalite kullanım ve tüketim alanlarına göre değişiklikler göstermektedir. Bitki ıslahı çalışmalarında genelde ekmeklik buğdaylar için hektolitre ağırlığı, protein oranı, bin dane ağırlığı, gluten içeriği, sedimantasyon değeri, yumuşama derecesi ve ekmek hacmi gibi önemli bazı kalite kriterleri değerlendirilmektedir (Yağdı, 2004).

Bu çalışmada Muğla İli Dalaman İlçesi ekolojik koşullarında farklı fosfor dozlarının bazı ekmeklik buğday çeşitlerinin tane kalite özellikleri yönünden incelenmesi ve bölge koşullarına uygunlukları araştırılması amacıyla yapılmıştır.

## 2. Materyal ve Yöntem

Materyal olarak 2 farklı ekmeklik buğday çeşidi olan Kayra ve Ziyabey-98 çeşitleri kullanılmıştır. Kayra, tane rengi kırmızı, kardeşlenme durumu iyi yatmaya dayanıklı, alternatif gelişme tabiatlı olup başaklanma zamanı orta – uzundur. Ziyabey-98, tane rengi beyaz, kardeşlenme durumu çok iyi yatmaya dayanıklıdır. Her iki çeşitte yazlık olarak ekimi yapılan bölgeler de özellikle de ülkemizin batı kesimlerinde yetiştiriciliği uygundur.

Denemede taban gübrelemesi uygulamasında fosfor kaynağı olarak Triple Süper Fosfat (TSP), azot kaynağı olarak Amonyum Sülfat gübreleri, üst gübreleme uygulamalarında ise amonyum sülfat ve kalsiyum amonyum nitrat gübreleri kullanılmıştır.

### 2.1. Deneme Yerinin İklim ve Toprak Özellikleri

Çalışma 2021–2022 buğday üretim sezonunda Muğla ili Dalaman İlçesi Altıntaş mahallesinde çiftçi arazisinde yürütülmüştür. Denemenin yürütüldüğü vejetasyon dönemine ait aylık ortalama sıcaklık ve yağış verileri Çizelge 1 de gösterilmiştir. Çizelge 1'de, bitki gelişim periyodu süresince ortalama sıcaklık değerlerinin 9.1 °C ile (Ocak) 25.9 °C (Haziran) arasında değişim gösterdiği anlaşılmaktadır. Aylık toplam yağış miktarının ortalamasına bakıldığında, en yüksek yağış miktarının Ocak aylında; en düşük yağış miktarının ise mayıs ayında olduğu görülmektedir (Çizelge 1).

Çizelge 1. Aylık ortalama sıcaklıklar ve toplam yağış değerleri

| Aylar | Ortalama Sıcaklık ($^0$C) | | Toplam Yağış (mm) | |
|---|---|---|---|---|
| | 2021-2022 yılları | Uzun Yıllar Ortalaması (1980-2020) | 2021-2022 yılları | Uzun Yıllar Ortalaması (1980-2020 |
| Ekim | 20.5 | 20 | 15.8 | 63.9 |
| Kasım | 16.9 | 14.9 | 57.6 | 160 |
| Aralık | 11.8 | 11.6 | 273.4 | 218.1 |
| Ocak | 9.1 | 10.3 | 302.2 | 165.9 |
| Şubat | 11.6 | 10.8 | 80.5 | 133.4 |
| Mart | 10 | 12.7 | 92 | 89.8 |
| Nisan | 16.8 | 15.9 | 16.3 | 56.2 |
| Mayıs | 21.5 | 20.3 | 3.6 | 26.3 |
| Haziran | 25.9 | 25.1 | 39.4 | 6.5 |
| **Ortalama / Toplam** | **16.01 $^0$C** | **15.73$^0$C** | **880.8 mm** | **920.1 mm** |

Çizelge 2'de verilen toprak analiz raporuna bakıldığında çalışmanın yapıldığı azizinin organik madde miktarınca yetersiz, alkali karakterli ve killi-tınlı bir bünyeye sahip olduğu, görülmektedir. Makro besin elementleri incelendiğinde Azot (N) oranının orta, Fosfor (P) miktarının yüksek, Potasyum (K) miktarının orta, Kalsiyum (Ca) miktarının yüksek ve Magnezyum (Mg) miktarının orta seviyede olduğu görülmektedir. Analiz sonucunda mikro besin elementlerinden Demir (Fe) miktarının çok yüksek, Bakır (Cu), Mangan (Mn) ve Çinko (Zn) miktarlarının orta düzeyde olduğu belirlenmiştir.

### 2.2. Yöntem

Araştırma, 2021–2022 buğday üretim sezonunda Muğla ili Dalaman İlçesi Altıntaş mahallesinde çiftçi arazisinde yürütülmüştür. Deneme tesadüf blokları deneme desenine göre, 3 tekerrürlü olarak kurulmuş olup parsel ebatları 2,25 x 4 metre olmak üzere 9 m2 boyutundadır. Tohumlar, 12,5 cm sıra arası mesafeli 18 sıralı mibzer ile sıra üzeri mesafe 1,5 cm olarak ayarlanarak 1 m2 alana yaklaşık 500 adet tohum düşecek şekilde mibzerle sıraya ekim yöntemi kullanılarak gerçekleşmiştir.

Çalışmada 6 farklı dozda (dekara 0kg, 4kg, 8kg, 12kg, 16kg ve 20kg) fosfor gübrelemesi uygulanmıştır. Denemede Kayra ve Ziyabey-98 çeşitlerine 6 farklı fosfor dozu (0, 4, 6, 8, 12, 16 ve 20 kg/da) belirlenmiş ve parsel büyüklüklerine göre hesaplanarak uygulanmıştır.

Çizelge 2. Denemenin yapıldığı araziye ait toprak analiz sonuçları

| Analiz Adı | Sonuç | Değerlendirme |
|---|---|---|
| **Toprak Tekstürü (%)** | 52 | Killi-tınlı |
| **Tuz (%)** | 0.017 | Tuzsuz |
| **Organik Madde (%)** | 1.99 | Düşük |
| **pH** | 8.19 | Hafif alkali |
| **N (%)** | 0.10 | Orta |
| **P (ppm)** | 27 | Yüksek |
| **K (ppm)** | 124,54 | Orta |
| **Ca (ppm)** | 5920,95 | Yüksek |
| **Mg (ppm)** | 677,3 | Orta |
| **Fe (ppm)** | 41,61 | Çok yüksek |
| **Cu (ppm)** | 1,54 | Orta |
| **Mn (ppm)** | 23,21 | Orta |
| **Zn (ppm)** | 1,54 | Orta |

### 2.3. Ekim ve Bakım

Ekim işlemi 20.10.2021 tarihinde yapılmıştır. Ekim esnasında mibzer ile dekara belirlen fosfor oranlarına göre (0, 4, 6, 8, 12, 16 ve 20 kg/da) TSP gübresi ile saf fosfor verilmiş, Azot kaynağı olarak yine mibzer ile dekara 4,5 kg saf azot düşecek şekilde Amonyum Sülfat gübresi kullanılmıştır.

Üst gübrelemenin 1.si dekara 5 kg saf azot vermek amacıyla dekara 24 kg amonyum sülfat gübresi hesabı ile kardeşlenme dönemi başlangıcında el ile serpilerek yapılmıştır. 2. Üst gübreleme ise sapa kalkma döneminde dekara 6.5 kg saf azot düşecek şekilde dekara 25 kg CAN gübresi hesabıyla el ile serpilerek yapılmıştır. Üst gübreleme işlemlerinde hava durumu dikkate alınmış gübrelemeler yağış öncesi yapılmıştır. Yapılan bu gübrelemeler ile dekara 16 kg saf azot verilmiştir. Yabancı ot ile mücadele yabani hardala karşı sapa kalkma döneminde firmanın tavsiyelerine uyularak "2,4-D asite eşdeğer dimethyl amin tuzu" etken maddeli zirai ilaç ile sırt pülverizatörü ile yapılmıştır.

### 2.4. Analiz ve Değerlendirme Yöntemleri

Çalışmadan bin tane ağırlığı, hektolitre, protein oranı, nişasta oranı ve kül oranı değerleri ölçüldü. Denemeden edilen bu verilerin varyans analizi TARİST istatistik bilgisayar programı kullanılarak yapılmış ve LSD testine tabi tutulmuştur.

## 3. Bulgular ve Tartışma

Araştırmada farklı buğday çeşitleri ve fosfor dozlarından elde edilen bitki boyu, metrekarede başak sayısı, başaktaki tane sayısı, bin tane ağırlığı, tane verimi değerlerine ait varyans analiz sonuçları Çizelge 3'de verilmiştir. Çizelge 3'de hektolitre ağırlığı özellikleri yönünden doz farklı fosfor dozu açısından istatistiksel olarak önemli farkların olduğu ve protein içeriği ile nişasta içeriği özellikleri bakımından doz farklı fosfor dozu açısından istatistiksel olarak önemli farkların olduğu görülmektedir.

Çizelge 4 de, Bin tane ağırlığı Kayra çeşidinde 44.42 g ile 46.06 g arasında değişmiş olup en düşük bin tane ağırlığı 8 kg/da fosfor dozunda, en yüksek bin tane ağırlığı 20 kg/da fosfor dozunda tespit edilmiştir. Ziyabey-98 çeşidinde ise bin tane ağırlığı 42.53 g ile 45.75 g arasında değişmiş olup en düşük bin tane ağırlığı 8 kg/da fosfor dozunda ve en yüksek bin tane ağırlıkları 12 kg/da fosfor dozunda tespit edilmiştir.

Çizelge 3. Uygulanan farklı buğday çeşitleri ve fosfor dozlarına ait varyans analiz sonuçları

| | | Kareler Ortalaması | | | | |
|---|---|---|---|---|---|---|
| **V.K** | **S.D.** | **Hektolitre Ağırlığı** | **Bin Tane Ağırlığı** | **Protein İçeriği** | **Nişasta İçeriği** | **Ham Kül Oranı** |
| Tekerrür | 2 | 0.094 öd | 13.488 öd | 0.190 öd | 1.962 öd | 0.060 öd |
| Çeşit | 1 | 17.921 * | 4.608 öd | 0.391 öd | 0.540 öd | 0.243 öd |
| Hata 1 | 2 | 0.227 | 0.955 | 0.303 | 1.196 | 0.014 |
| Doz | 5 | 5.571 ** | 3.885 öd | 0.674 * | 16.374 * | 0.101 öd |
| Çeşit*Doz | 5 | 0.389 öd | 1.547 öd | 0.127 öd | 3.083 öd | 0.030 öd |
| Genel Hata | 20 | 5.555 | 2.943 | 0.199 | 5.746 | 0.042 |
| Genel | 35 | 1.699 | 3.392 | 0.268 | 6.259 | 0.054 |

**öd: önemli değil; *: 0,05; **: 0,01 düzeyinde önemli**

Çizelge 4. Uygulanan farklı buğday çeşitleri ve fosfor dozlarına ait ortalama değerler

| Fosfor Dozu (bitki/da) | Bin Tane Ağırlığı | | | Hektolitre Ağırlığı | | | Protein İçeriği | | | Nişasta İçeriği | | | Kül oranı | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Kayra | Ziyabey-98 | Ort. | Kayra | Ziyabey-98 | Ort. | Kayra | Ziyabey-98 | Ort. | Kayra | Ziyabey-98 | Ort. | Kayra | Ziyabey-98 | Ort. |
| 0 | 45.66 | 44.88 | 45.27 | 78.23 | 76.93 | 77.58 | 15.37 | 14.81 | 15.09 | 71.75 | 72.73 | 72.24 | 1,75 | 1,70 | 1,72 |
| 4 | 45.73 | 44.64 | 45.19 | 78.76 | 77.73 | 78.25 | 14.57 | 14.18 | 14.38 | 74.49 | 73.71 | 74.10 | 1,68 | 1,65 | 1,66 |
| 8 | 44.42 | 42.53 | 43.48 | 78.63 | 77.86 | 78.25 | 14.34 | 13.92 | 14.13 | 73.44 | 75.53 | 74.49 | 1,72 | 1,65 | 1,69 |
| 12 | 44.95 | 45.84 | 45.40 | 80.3 | 78.06 | 79.18 | 14.28 | 14.48 | 14.38 | 70.68 | 69.10 | 69.89 | 1,74 | 1,65 | 1,69 |
| 16 | 45.73 | 45.75 | 45.74 | 80.73 | 79.13 | 79.93 | 14.45 | 14.37 | 14.41 | 72.39 | 73.74 | 73.07 | 1,73 | 1,68 | 1,70 |
| 20 | 46.06 | 44.62 | 45.34 | 80.63 | 79.1 | 79.87 | 14.25 | 14.25 | 14.25 | 72.47 | 71.88 | 72.18 | 1,74 | 1,66 | 1,70 |
| Ortalama | 45.42 | 44.71 | 45.07 | 79.54 | 78.13 | 78.84 | 14.54 | 14.33 | 14.44 | 72.53 | 72.78 | 72.66 | **1,72** | **1,67** | **1,69** |
| EKÖF $_{0,05}$ (çeşit) | | | - | | | 0.68 | | | - | | | - | | | - |
| EKÖF $_{0,05}$ (doz) | | | - | | | 0.89 | | | 0.54 | | | 2.89 | | | - |
| EKÖF $_{0,05}$ (çeşit*doz) | | | - | | | - | | | - | | | - | | | - |

Hektolitre ağırlığı Kayra çeşidinde 78.23 kg/hl ile 80.73 kg/hl arasında değişmiş olup en düşük hektolitre ağırlığı 0 kg/da fosfor dozunda, en yüksek hektolitre ağırlığı 16 kg/da fosfor dozunda tespit edilmiştir. Ziyabey-98 çeşidinde ise hektolitre ağırlığı 76.93 kg/hl ile 79.13 kg/hl arasında değişmiş olup en düşük ve en yüksek hektolitre ağırlığı kayra çeşidi ile benzer şekilde 0 kg/da ve 16 kg/da fosfor dozlarında tespit edilmiştir. Çeşitlerin fosfor dozlarındaki ortalama değerlerine bakıldığı zaman fosfor dozu arttıkça hektolitre ağırlığının da 16 kg/da doza kadar arttığı görülmektedir.

Protein oranı Kayra çeşidinde %14.25 ile %15.37 arasında değişmiş olup en düşük protein oranı 20 kg/da fosfor dozunda, en yüksek protein oranı 0 kg/da fosfor dozunda tespit edilmiştir. Ziyabey-98 çeşidinde ise protein oranı %13.92 ile %14.81 arasında değişmiş olup en düşük protein oranı 8 kg/da fosfor dozunda, en yüksek protein oranı 0 kg/da fosfor dozunda tespit edilmiştir. Çeşitlerden elde edilen ortalama protein oranları incelendiğinde 8 kg/da fosfor dozunda sıralamayı bozan daha fazla bir düşüş görülmüş olsa da fosfor dozu arttıkça protein oranının düştüğü görülmektedir.

Nişasta oranı Kayra çeşidinde %70.68 ile %74.49 arasında değişmiş olup en düşük nişasta oranı 12 kg/da fosfor dozunda, en yüksek nişasta oranı 4 kg/da fosfor dozunda tespit edilmiştir. Ziyabey-98 çeşidinde ise nişasta oranı %69.1 ile %75.53 arasında değişmiş olup en düşük nişasta oranı 12 kg/da fosfor dozunda, en yüksek nişasta oranı 8 kg/da fosfor dozunda tespit edilmiştir.

Farklı Fosfor dozlarında ham kül oranı Kayra çeşidinde %1,68 ile %1,75 arasında değişmiş olup ortalama ham kül oranı %1,72 olarak, Ziyabey-98 çeşidinde ise ham kül oranı %1,65 ile %1,70 arasında değişmiş olup ortalama ham kül oranı %1,67 olarak tespit edilmiştir. Yapılan benzer çalışmalarda Aksu (2017) ham kül oranının %1,45-1,55 arasında, Benli ve Koca (2018) %1,1 – 2,3 arasında, Demirel (2018) % 1,5-1,7 arasında tespit edildiğini bildirmişlerdir.

## 4. Sonuç

Sonuç olarak genel anlamda yüksek fosfor dozunun tane kalitesini olumsuz etkilediği, tespit edilmiştir. 0 kg/da fosfor dozunda kalite kriterlerinde en iyi değerler elde edilmiştir. Denemenin bir üretim sezonu ile sınırlı olduğunu ve elde edilen kalite parametrelerinin % oranlarıyla olduğu da hesaba katacak olursak farklı fosfor dozlarına bağlı tane kalite özelliklerinin belirlenmesi adına daha uzun süreli bir çalışma tavsiye edilir.

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# EFFECT OF DIFFERENT PHOSPHORUS DOSES ON YIELD AND YIELD COMPONENTS OF BREAD WHEAT (*Triticum aestivum* L.) VARIETIES UNDER MUĞLA-DALAMAN CONDITIONS*

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*** This study was produced from Onur KOÇ's graduate thesis**

## Abstract
The aim of this study was to determine the changes in grain yield and yield components of Kayra and Ziyabey-98 bread wheat varieties at different phosphorus doses in Muğla Dalaman ecological conditions. Kayra and Ziyabey-98 bread wheat varieties were used as plant material in this study, which was carried out in three replications according to the split-plot design in the winter growing season of 2022. Nitrogen fertilisation was applied in three doses totalling 160 kg/ha. Triple Super Phosphate fertiliser was used as phosphorus source in 6 different doses (0, 40, 80, 120, 160, 200 kg/ha). Grain yields ranged from 5820 kg/ha to 6493.3 kg/ha for variety Kayra and from 6003.3 kg/ha to 6783.3 kg/ha for variety Ziyabey-98. Moreover, the plant height values were recorded between 97.04 cm and 106.57 cm in variety Kayra and between 95.87 cm and 104.07 cm in variety Ziyabey-98, the number of grains per spike values were recorded between 32.96 and 36.23 in variety Kayra and between 31.43 and 36.13 in variety Ziyabey-98. The number of spikes per square metre ranged from 443.66 to 470.33 for Kayra and from 430.33 to 567.66 for Ziyabey-98. In general, a high dose of phosphorus was found to have a positive effect on yield. The best values were obtained for grain yield and yield components at 160 kg/ha phosphorus dose. In the light of the data obtained, phosphorus doses of 160 kg/ha, 120 kg/ha and 80 kg/ha were statistically indifferent. Considering all this, it would be appropriate to determine the cost of phosphorus application.
**Keywords:** wheat, triple super phosphate, phosphorus doses, yield

## 1.Giriş

Yeryüzünde ekilebilir alanlarda üretimi en yüksek yapılan ürün gruplarının başında tahıllar gelmektedir. Tahıllar içerisinde ise buğday, arpa ve mısır en çok üretimi yapılan bitkilerdir. Buna rağmen son yıllarda dünyada yaşanan pandemide ve önemli buğday üreticisi ülkeler arasında yaşanan savaşta buğdayın insan ve hayvan beslenmesinde ki önemini ve artan nüfusun gıda güvenliği bakımından yaşamsal öneme sahip olduğu bir kez daha anlaşılmıştır. Tahıllar, insanların ihtiyaç duyduğu kalori miktarının önemli bir kısmını kapsamaktadır. Ayrıca, beslenme kategorisinde ki tüketilen hayvansal üretimin de ana kaynağıdır. Bu sebeple tahıllar İnsanlar için yaşamsal bir gereksinim olan beslenme ihtiyacını yerine getirmeleri nedeniyle önemli bir yere sahiptirler Tahıllar, insan beslenmesinde ki öneminin yanı sıra; unlu mamuller, nişasta sanayi, pastacılık, bisküvi, yem sanayi gibi endüstri kollarında ve biyoyakıt üretiminde kullanılmalarından dolayı gerek istihdama sağladıkları katkılar gerekse ekonomik döngü içindeki payları ile ekonomi içerisinde önemli bir konumdadırlar. Dünyada son yıllarda tarımsal üretim arzında yaşanan küçülme ve gıda fiyatlarının anlık yükselişi, ihracatçı ülkeleri de bu konuda önlemler almaya mecbur bırakmıştır (Kaya, 2009).

Ülkemizde buğday yaklaşık 20 milyon hektar arazinin 7 milyon hektarında yetiştirilip, 20.5 milyon ton üretimle toplam tahıl üretiminin yaklaşık %62'sine denk gelmektedir. Türkiye buğday üretimi, dünya buğday üretiminin de 10. Sırada yer almaktadır. Ülkemiz dünyada buğday üretimine uygun ülkeler arasında yer almaktadır. (Toprak Mahsülleri Ofisi, 2020).

Ülkemiz topraklarında hem kuru tarım uygulamaları hem de topraktaki bitki besin elementlerinin zayıflığı nedeniyle tarımsal verim gelişmiş ülkelere kıyasla azdır. Mevcut şartlarda yapılan kuru tarımda verimin artırılması için gübreden daha iyi yararlanabilecek çeşitlerin kullanılması gerekmektedir. Gübre içeriklerinde en fazla kullanılan elementler N, P ve K'dır. Azot ülkemiz topraklarında kesinlikle kullanılması gerekmektedir. Potasyum ise yeterli derecede topraklarımızda bulunmaktadır (Şen 2018). Fakat topraklarımızda ki elverişli fosfor noksanlığı ve bu sebeple fazla fosfor gübrelemesi besleme ve gübreleme sorunlarını doğurmaktadır. Yapılan araştırmalarda Ülke topraklarının %42'sinde fosforun yeterli seviyede olduğu tespit edilmiştir. Fakat topraklarımızın kireç ve pH değerleri sebebiyle fosfor işlevselliğini büyük oranda sınırlanmaktadır (Çetin ve Öztürk, 2012).

Bitki yaşamlarında makro elementler kadar mikro elementlerde önemli düzeyde etkilidir. Mikro elementler bitkilerde ve topraklarda makro elementlere istinaden daha küçük halde bulunurlar. Demir, bakır, klor, mangan, bor, çinko ve nikel mikro, hidrojen, karbon, oksijen, azot, fosfor ve potasyum ise makro elementlerdendir. Apatit mineralleri toprağın içerisinde ki

fosfor membasıdır (Bolat ve Kara, 2017). Toprakta fosfor, Ca, Fe ve Al fosfatlar halinde ve apatit şeklinde bulunur. Fosfor bitkinin kök gelişimini, olgunlaşmasını, erkenciliği ve çiçeklenmesini teşvik ederken hastalık ve zararlılara karşı olan dayanımını artırıcı katkı sağlayan önemli bir elementtir (Bilen ve Sezen, 1993).

Bu çalışmada Muğla İli Dalaman İlçesi ekolojik koşullarında farklı fosfor dozlarının bazı ekmeklik buğday çeşitlerinin verim ve verim ögeleri özellikleri yönünden incelenmesi ve bölge koşullarına uygunlukları araştırılması amacıyla yapılmıştır.

## 2. Materyal ve Yöntem

Materyal olarak 2 farklı ekmeklik buğday çeşidi olan Kayra ve Ziyabey-98 çeşitleri kullanılmıştır. Kayra, tane rengi kırmızı, kardeşlenme durumu iyi yatmaya dayanıklı, alternatif gelişme tabiatlı olup başaklanma zamanı orta – uzundur. Ziyabey-98, tane rengi beyaz, kardeşlenme durumu çok iyi yatmaya dayanıklıdır. Her iki çeşitte yazlık olarak ekimi yapılan bölgeler de özellikle de ülkemizin batı kesimlerinde yetiştiriciliği uygundur.

Denemede taban gübrelemesi uygulamasında fosfor kaynağı olarak Triple Süper Fosfat (TSP), azot kaynağı olarak Amonyum Sülfat gübreleri, üst gübreleme uygulamalarında ise amonyum sülfat ve kalsiyum amonyum nitrat gübreleri kullanılmıştır.

### 2.1. Deneme Yerinin İklim ve Toprak Özellikleri

Çalışma 2021–2022 buğday üretim sezonunda Muğla ili Dalaman İlçesi Altıntaş mahallesinde çiftçi arazisinde yürütülmüştür. Denemenin yürütüldüğü vejetasyon dönemine ait aylık ortalama sıcaklık ve yağış verileri Çizelge 1 de gösterilmiştir. Çizelge 1'de, bitki gelişim periyodu süresince ortalama sıcaklık değerlerinin 9.1 °C ile (Ocak) 25.9 °C (Haziran) arasında değişim gösterdiği anlaşılmaktadır. Aylık toplam yağış miktarının ortalamasına bakıldığında, en yüksek yağış miktarının Ocak aylında; en düşük yağış miktarının ise mayıs ayında olduğu görülmektedir (Çizelge 1).

Çizelge 1. Aylık ortalama sıcaklıklar ve toplam yağış değerleri

| Aylar | Ortalama Sıcaklık ($^0$C) | | Toplam Yağış (mm) | |
|---|---|---|---|---|
| | 2021-2022 yılları | Uzun Yıllar Ortalaması (1980-2020) | 2021-2022 yılları | Uzun Yıllar Ortalaması (1980-2020 |
| Ekim | 20.5 | 20 | 15.8 | 63.9 |
| Kasım | 16.9 | 14.9 | 57.6 | 160 |
| Aralık | 11.8 | 11.6 | 273.4 | 218.1 |
| Ocak | 9.1 | 10.3 | 302.2 | 165.9 |
| Şubat | 11.6 | 10.8 | 80.5 | 133.4 |
| Mart | 10 | 12.7 | 92 | 89.8 |
| Nisan | 16.8 | 15.9 | 16.3 | 56.2 |
| Mayıs | 21.5 | 20.3 | 3.6 | 26.3 |
| Haziran | 25.9 | 25.1 | 39.4 | 6.5 |
| **Ortalama / Toplam** | **16.01 $^0$C** | **15.73$^0$C** | **880.8 mm** | **920.1 mm** |

Çizelge 2'de verilen toprak analiz raporuna bakıldığında çalışmanın yapıldığı azizinin organik madde miktarınca yetersiz, alkali karakterli ve killi-tınlı bir bünyeye sahip olduğu, görülmektedir. Makro besin elementleri incelendiğinde Azot (N) oranının orta, Fosfor (P) miktarının yüksek, Potasyum (K) miktarının orta, Kalsiyum (Ca) miktarının yüksek ve Magnezyum (Mg) miktarının orta seviyede olduğu görülmektedir. Analiz sonucunda mikro besin elementlerinden Demir (Fe) miktarının çok yüksek, Bakır (Cu), Mangan (Mn) ve Çinko (Zn) miktarlarının orta düzeyde olduğu belirlenmiştir.

Çizelge 2. Denemenin yapıldığı araziye ait toprak analiz sonuçları

| Analiz Adı | Sonuç | Değerlendirme |
|---|---|---|
| **Toprak Tekstürü (%)** | 52 | Killi-tınlı |
| **Tuz (%)** | 0.017 | Tuzsuz |
| **Organik Madde (%)** | 1.99 | Düşük |
| **pH** | 8.19 | Hafif alkali |
| **N (%)** | 0.10 | Orta |
| **P (ppm)** | 27 | Yüksek |
| **K (ppm)** | 124,54 | Orta |
| **Ca (ppm)** | 5920,95 | Yüksek |
| **Mg (ppm)** | 677,3 | Orta |
| **Fe (ppm)** | 41,61 | Çok yüksek |
| **Cu (ppm)** | 1,54 | Orta |
| **Mn (ppm)** | 23,21 | Orta |
| **Zn (ppm)** | 1,54 | Orta |

## 2.2. Yöntem

Araştırma, 2021–2022 buğday üretim sezonunda Muğla ili Dalaman İlçesi Altıntaş mahallesinde çiftçi arazisinde yürütülmüştür. Deneme tesadüf blokları deneme desenine göre, 3 tekerrürlü olarak kurulmuş olup parsel ebatları 2,25 x 4 metre olmak üzere 9 m2 boyutundadır. Tohumlar, 12,5 cm sıra arası mesafeli 18 sıralı mibzer ile sıra üzeri mesafe 1,5 cm olarak ayarlanarak 1 m2 alana yaklaşık 500 adet tohum düşecek şekilde mibzerle sıraya ekim yöntemi kullanılarak gerçekleşmiştir.

Çalışmada 6 farklı dozda (dekara 0kg, 4kg, 8kg, 12kg, 16kg ve 20kg) fosfor gübrelemesi uygulanmıştır. Denemede Kayra ve Ziyabey-98 çeşitlerine 6 farklı fosfor dozu (0, 4, 6, 8, 12, 16 ve 20 kg/da) belirlenmiş ve parsel büyüklüklerine göre hesaplanarak uygulanmıştır.

## 2.3. Ekim ve Bakım

Ekim işlemi 20.10.2021 tarihinde yapılmıştır. Ekim esnasında mibzer ile dekara belirlen fosfor oranlarına göre (0, 4, 6, 8, 12, 16 ve 20 kg/da) TSP gübresi ile saf fosfor verilmiş, Azot kaynağı olarak yine mibzer ile dekara 4,5 kg saf azot düşecek şekilde Amonyum Sülfat gübresi kullanılmıştır.

Üst gübrelemenin 1.si dekara 5 kg saf azot vermek amacıyla dekara 24 kg amonyum sülfat gübresi hesabı ile kardeşlenme dönemi başlangıcında el ile serpilerek yapılmıştır. 2. Üst gübreleme ise sapa kalkma döneminde dekara 6.5 kg saf azot düşecek şekilde dekara 25 kg CAN gübresi hesabıyla el ile serpilerek yapılmıştır. Üst gübreleme işlemlerinde hava durumu dikkate alınmış gübrelemeler yağış öncesi yapılmıştır. Yapılan bu gübrelemeler ile dekara 16 kg saf azot verilmiştir. Yabancı ot ile mücadele yabani hardala karşı sapa kalkma döneminde firmanın tavsiyelerine uyularak "2,4-D asite eşdeğer dimethyl amin tuzu" etken maddeli zirai ilaç ile sırt pülverizatörü ile yapılmıştır.

### 2.4. Analiz ve Değerlendirme Yöntemleri

Çalışmadan bitki boyu, metrekarede başak sayısı, başakta tane sayısı ve tane verimi değerleri elde edilmiştir. Denemeden edilen bu verilerin varyans analizi TARİST istatistik bilgisayar programı kullanılarak yapılmış ve LSD testine tabi tutulmuştur.

## 3. Bulgular ve Tartişma

Araştırmada farklı buğday çeşitleri ve fosfor dozlarından elde edilen bitki boyu, metrekarede başak sayısı, başaktaki tane sayısı, bin tane ağırlığı, tane verimi değerlerine ait varyans analiz sonuçları Çizelge 3'de verilmiştir. Çizelge 3'de bitki boyu, metrekarede başak sayısı özellikleri yönünden çeşit, doz ve çeşit x doz farklı fosfor dozu açısından istatistiksel olarak önemli farkların olduğu; başaktaki tane sayısında doz ve çeşit x doz farklı fosfor dozu açısından istatistiksel olarak önemli farkların olduğu; tane verimi yönünden doz farklı fosfor dozu açısından istatistiksel olarak önemli farkların olduğu görülmektedir.

Çizelge 3. Uygulanan farklı buğday çeşitleri ve fosfor dozlarına ait varyans analiz sonuçları

| | | Kareler Ortalaması | | | |
|---|---|---|---|---|---|
| **V.K** | **S.D.** | **Bitki Boyu** | **Metrekarede Başak Sayısı** | **Başaktaki Tane Sayısı** | **Tane Verimi** |
| Tekerrür | 2 | 0,053 öd | 166.778 öd | 4.301 öd | 171.000 öd |
| Çeşit | 1 | 20,491** | 12882.250 ** | 2.560 öd | 16986.778 öd |
| Hata 1 | 2 | 0,186 | 26.333 | 3.243 | 1173.778 |
| Doz | 5 | 51,211** | 6560.828 ** | 4.912 ** | 6188.933 ** |
| Çeşit*Doz | 5 | 17,658** | 4275.183 ** | 7.745 ** | 912.578 öd |
| Genel Hata | 20 | 0,289 | 299.156 | 1.181 | 1022.056 |
| Genel | 35 | 10,603 | 2098.047 | 2.987 | 2160.714 |

**öd: önemli değil; *: 0,05; **: 0,01 düzeyinde önemli**

Çizelge 4.'de Farklı Fosfor dozlarında bitki boyu Kayra çeşidinde 97.04 cm ile 106.57 cm arasında değişmiş olup en kısa bitki boyu 0 kg/da fosfor dozunda en uzun bitki boyu 12 kg/da

fosfor dozunda tespit edilmiştir. Ziyabey-98 çeşidinde ise bitki boyları 94.71 cm ile 104.55 cm arasında değişmiş olup en kısa bitki boyu kayra çeşidi ile benzer şekilde 0 kg/da ve en uzun bitki boyu 16 kg/da fosfor dozlarında tespit edilmiştir. Çalışma neticesinde Kayra çeşidinde 12 kg/da fosfor dozuna kadar, Ziyabey-98 çeşidinde ise 16 kg/da fosfor dozuna kadar bitki boyunda artış görülmüştür.

Metrekarede başak sayısı Kayra çeşidinde 443.66 adet ile 470.33 adet arasında değişmiş olup en düşük metrekarede başak sayısı 0 kg/da fosfor dozunda en fazla metrekarede başak sayısı 16 kg/da fosfor dozunda tespit edilmiştir. Ziyabey-98 çeşidinde ise metrekarede başak sayısı 430.33 adet ile 567.66 adet arasında değişmiş olup en düşük ve en yüksek metrekarede başak sayısı Kayra çeşidi ile benzer şekilde 0 kg/da ve 16 kg/da fosfor dozlarında gözlemlenmiştir. Araştırma neticesinde Ziyabey-98 çeşidinde 8 kg/da fosfor dozunda istisna olmak üzere her iki çeşitte de 16kg/da fosfor dozuna kadar metrekarede başak sayısında artış tespit edilmiştir.

Başakta tane sayısı Kayra çeşidinde 32.96 adet ile 36.23 adet arasında değişmiş olup en düşük başakta tane sayısı 0 kg/da fosfor dozunda, en fazla başakta tane sayısı 16 kg/da fosfor dozunda tespit edilmiştir. Ziyabey-98 çeşidinde ise başakta tane sayısı 31.43 adet ile 36.13 adet arasında değişmiş olup en düşük başakta tane sayısı 20 kg/da fosfor dozunda, en fazla başakta tane sayısı 8 kg/da fosfor dozunda tespit edilmiştir. Çeşitler ortalamasına bakıldığı zaman başakta tane sayısının 12 kg/da fosfor miktarına kadar artış göstererek pik noktaya ulaştığı, 16 kg/da ve 20 kg/da dozlarında ise düşüş olduğu görülmektedir.

Çizelge 4.'de tane veriminin Kayra çeşidinde 582 kg/da ile 649.33 kg/da arasında değişmiş olup en düşük tane verimi 0 kg/da fosfor dozunda, en yüksek tane verimi 20 kg/da fosfor dozunda tespit edilmiştir. Ziyabey-98 çeşidinde ise tane verimi 617.66 kg/da ile 711.0 kg/da arasında değişmiş olup en düşük tane verimi 4 kg/da fosfor dozunda ve en yüksek tane verimi 16 kg/da fosfor dozunda tespit edilmiştir.

Çizelge 4. Uygulanan farklı buğday çeşitleri ve fosfor dozlarına ait ortalama değerler

| Fosfor Dozu (bitki/da) | Bitki Boyu | | | Metrekarede Başak Sayısı | | | Başaktaki Tane Sayısı | | | Tane Verimi | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Kayra | Ziyabey-98 | Ort. | Kayra | Ziyabey-98 | Ort. | Kayra | Ziyabey-98 | Ort. | Kayra | Ziyabey-98 | Ort. |
| 0 | 97.0 | 94.7 | 95.8 | 32.9 | 33.7 | 33.3 | 32.9 | 33.7 | 33.3 | 582.0 | 618.6 | 600.3 |
| 4 | 100.2 | 97.4 | 98.8 | 34.3 | 34.5 | 34.3 | 34.3 | 34.5 | 34.3 | 606.6 | 617.6 | 612.1 |
| 8 | 101.6 | 97.5 | 99.6 | 33.6 | 36.1 | 34.9 | 33.6 | 36.1 | 34.9 | 617.0 | 681.0 | 649.0 |
| 12 | 106.5 | 101.5 | 104.0 | 35.4 | 35.2 | 35.3 | 35.4 | 35.2 | 35.3 | 625.6 | 645.6 | 635.6 |
| 16 | 100.5 | 104.5 | 102.5 | 36.2 | 32.9 | 34.5 | 36.2 | 32.9 | 34.5 | 640.0 | 711.0 | 675.5 |
| 20 | 98.3 | 99.5 | 98.9 | 34.6 | 31.4 | 33.0 | 34.6 | 31.4 | 33.0 | 649.3 | 707.3 | 678.3 |
| Ortalama | 100.7 | 99.2 | 99.9 | 34.5 | 33.9 | 34.2 | 34.5 | 33.9 | 34.2 | 620.1 | 663.5 | 641.8 |
| EKÖF $_{0,05}$ (çeşit) | | | 0.62 | | | 7.3 | | | - | | | - |
| EKÖF $_{0,05}$ (doz) | | | 0.65 | | | 20.8 | | | 1.3 | | | 38.5 |
| EKÖF $_{0,05}$ (çeşit*doz) | | | 0.92 | | | 29.5 | | | 1.8 | | | - |

## 4. Sonuç

Sonuç olarak genel anlamda yüksek fosfor dozunun verimi olumlu etkilediği, tespit edilmiştir. 16 kg/da fosfor dozunda verim ve verim öğelerinde en iyi değerler elde edilmiştir. Denemenin bir üretim sezonu ile sınırlı olduğunu da hesaba katacak olursak farklı fosfor dozlarına bağlı tane verimi ve verim öğeleri özelliklerinin belirlenmesi adına daha uzun süreli bir çalışma tavsiye edilir.

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# BUILDING BRIDGE FROM GENOME TO PHENOME ACROSS MULTIPLE BIOLOGICAL TRAITS IN HONEY BEE

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**Abstract**
Understanding molecular mechanisms of key candidate genes involved in commercial royal jelly bee is one of the most important research horizons in apiculture industry. In this regard, summary of pervious literatures has discussed the role of candidate genes and important markers in them in the identification of high-ability queens. With this research motivation, the aim of the current research is to study the minisatellite polymorphism located in the coding region of the candidate gene for the main royal jelly protein (III) related to royal jelly. For this purpose, a total of 30 worker bees from different hives with different production of royal jelly were randomly selected and genomic DNA extraction, polymerase chain reaction and electrophoresis, staining and photography were carried out with routine methods. The preliminary results of this study show the presence of a repetitive motif in the coding region of the main protein gene of royal jelly (type III), which leads to the production of different genotypes. According to the obtained preliminary results, the band domain of this minisatellite polymorphism varied from 400 to 600 bp. Identification of polymorphism in candidate genes is the first condition for association studies, and from this point of view, it is hoped that in the second step of the research, the desired alleles related to the large-scale production of royal jelly and high-yielding commercial genetic hybrids with this customer-friendly product will be determined.

**Keywords:** Royal jelly, molecular markers, candidate genes, minisatellite, royal jelly main protein candidate gene (type 3), resistance behaviour

## Introductıon

The main proteins of bee royal jelly belong to the protein family that controls all aspects of behaviour and social reactions in the hive under the control of this important protein family. Identifying the complexities and mechanisms of insect evolution and social behaviour is one of the recent achievements of molecular biology in the field of evolution (Albert et al., 1999). The organization and system that govern insect social behaviour is symbolic of the individual movement of insects to interact and cooperate with the members of a colony, and the result of this group coexistence results in a unified interaction (Drapeau et al. 2006). For example, the existence of such strange social movements in honey bees leads to the emergence of plans for the division of tasks and the execution of these tasks at different ages in insects such as honey bees and ants (Albert et al., 2000). The consequences of these uniform behaviours lead, among other things, to the formation of a hive, the feeding of the larvae and the search for food sources outside the hive, as well as the production of valuable products such as wax, propolis and royal jelly, and, in a secondary way, honey and the goal of pollination of flowers and garden trees (Garcia-Amoedo et al. 2007). In terms of technology and marketing, the role of royal jelly has been reported in the pharmaceutical, cosmetic, antibacterial, antiviral and fungal industries, as well as in medicine and pharmaceuticals in lowering blood pressure, anti-inflammatory and preventing tumours (Beye et al., 1998). At some point in the biology and life of the bee, the role of young worker bees in the hive (nurse bees) is played by a very valuable and perhaps intelligent and useful substance called royal jelly, which is secreted through which the larvae grow fed (Drapeau et al., 2006). Royal jelly is a natural source of essential amino acids, lipids, vitamins, acetylcholine and other nutrients that all larvae feed on for the first three days (Chen et al., 2005) . The summary of source review of previous studies has shown that the candidate gene for the main protein of royal jelly (type 3) is a gene with a large effect, which is related to the production of royal jelly and plays a versatile role in the hive social behaviour in bees (Kucharski et al., 1998). The nucleotide polymorphism in the minisatellite region in the coding region of this gene is related to the production of royal jelly (Albert et al. 1999). With this research motivation, the aim of this research is to investigate the minisatellite polymorphism located in the coding region of the major gel protein candidate gene. Royal (type 3) is related to royal jelly.

Materaıl and Metods

The present study, a total of 30 worker bees were randomly selected from different hives with different royal jelly production, and genomic DNA extraction, polymerase chain reaction, and

electrophoresis, staining, and photography were performed using routine methods. For this purpose, the adult worker insects and worker bee larvae were first largely crushed and homogenized with liquid nitrogen and a porcelain mortar, then the laser buffer was added directly to the porcelain mortar and after one minute a solution containing chitin cells was physically crushed. It is included in the CTAB-based optimization laboratory instructions. After extraction, the DNA pellet was diluted in TE buffer and placed in a water bath for one hour to completely dissolve. For this purpose, a total of 30 worker bees from different hives with different production of royal jelly were randomly selected and genomic DNA extraction, polymerase chain reaction and electrophoresis, staining and photography were carried out with routine methods. The preliminary results of this study show the presence of a repetitive motif in the coding region of the main protein gene of royal jelly (type III), which leads to the production of different genotypes.

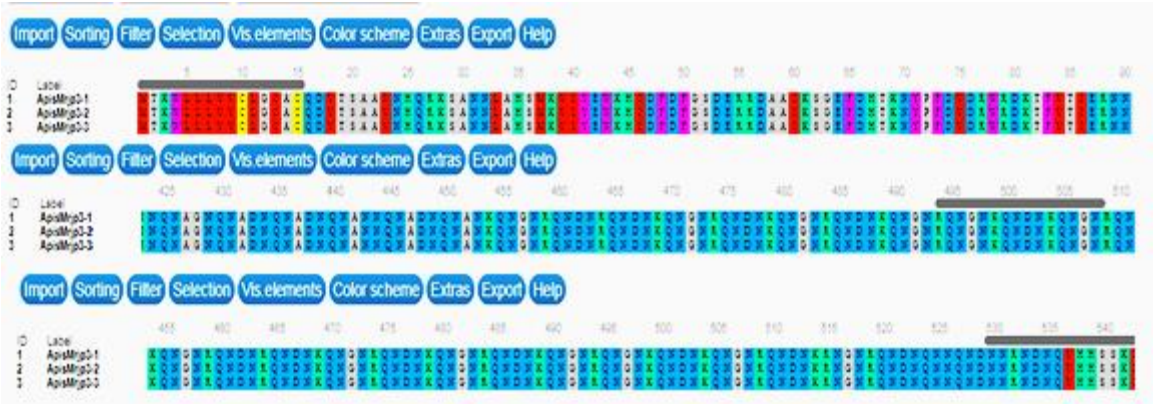


**Figure 1.** Primer location and PCR product size and its characteristics

**Result and Dıscussıon**

Despite extensive research on the key royal jelly proteins in bee biology, there are still many scientific unknowns, including the role of these proteins in larval sex segregation, which requires additional study by researchers to decipher (Chent et al., 2005). The major proteins of royal jelly have been studied with respect to questions of structural biochemistry and molecular evolution in other insects and even some bacteria (Simúth et al., 2001). The gene for major gel proteins has 7 exons and its coding region has 570 amino acids. According to other genes, the coding region begins with the amino acid formylmyothin and the total length of the coding region is about 3321 base pairs. This repetition occurs more than 20 times at the regulatory site of the protein, where 5 amino acids repeat in the form of this protein. In contrast to type 3, type 1 has 3033 nucleotides, 5 exons and 6 introns.

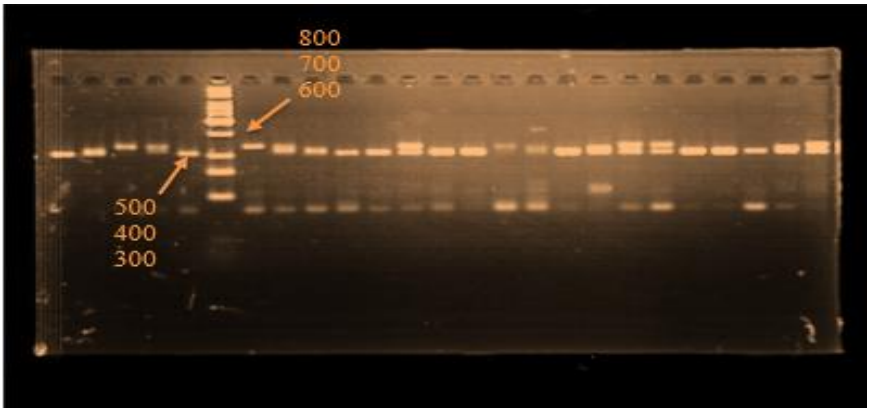


**Figure 2.** Polymorphism and variation of the candidate allelic gene of the main protein of royal jelly with a band size limit of 500 to 600 bp.



**Figure 3.** Repetitive genomic region in the protein gene producing royal jelly type 3 and the role of this repetition in the regulatory region and its 3D protein model

Figure 3 shows the repetitive genomic region in the protein gene that produces royal jelly type 3 and the role of this repeat in the regulatory region and its 3D protein model. The repetitive region of this gene lies between the region 2862….3302, where an agaatgataa motif is repeated sequentially (Beye et al., 1998). In other articles, one of the reasons for the number of alleles in the minisatellite positions of workers (diploid) and maleness (haploid genome). The queen larva is unable to consume the royal jelly quickly, so it is necessary to ensure a permanent accumulation of royal jelly in the hive. Therefore, commercial production of royal jelly depends on the size of the hive to raise a large number of queens.

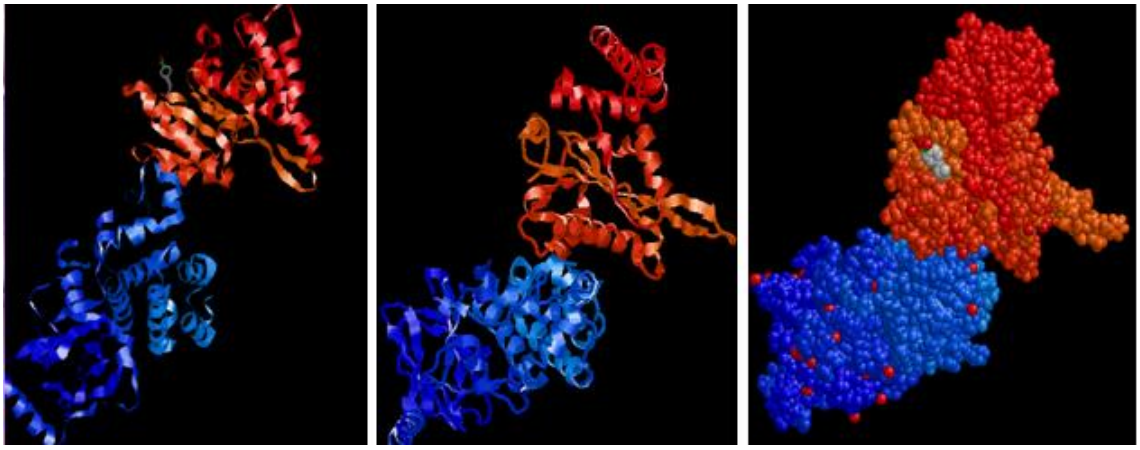

**Figure 4.** Three-dimensional modelling of the protein sequence of the royal jelly type 3 protein gene in honey bees.

The summary of the review of the previous sources shows that types 3 and 5 of the main proteins that produce royal jelly have the highest diversity and polymorphism at 60-70%. This diversity results in the production of 77–87 kDa caused by this motif. Royal jelly is the only substance that guarantees the longevity, health and fertility of the queen, and without it, the queen of the hive is not able to insure three thousand eggs in her life. Recently, new research has demonstrated the importance of protease enzymes from royal jelly and other beneficial compounds in host interventions with pathogens and antimicrobial properties 3) is a gene of great effect related to the production of royal jelly and in the hive has a versatile role in the development of the social behaviour of bees. The nucleotide polymorphism in the minisatellite region in the coding region of this gene is related to the production of royal jelly. According to the obtained preliminary results, the band domain of this minisatellite polymorphism varied from 400 to 600 bp. Identification of polymorphism in candidate genes is the first condition for association studies, and from this point of view, it is hoped that in the second step of the research, the desired alleles related to the large-scale production of royal jelly and high-yielding commercial genetic hybrids with this customer-friendly product will be determined.

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# WHOLE GRAIN HEALTH BENEFITS: GRAIN COLOR AND ANTIOXIDANT PROPERTIES

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## Abstract
There is an increasing trend to consume whole grains which are known related to health promoting effects in the last years. Whole grain food products are more favourable than refined grain flour that contains high amount of vitamins, phenolic compounds related to antioxidant activity, high fiber content associated with better digestive system and also high nourishment properties. The color of the grain (L*, a*, b*) arises from phenotypic variations of the pigments in the grain and depends on genetic, cultivation methods and production processes of food. Most commercially available wheat grain is known has white and red colors and some unique varieties have emerged in the last years such as purple and blue grain, are also processed and consumed but in small quantities in the market. On the other side one of the most important quality and breeding goal is to produce durum wheat grain with bright yellow color (b*) and release of varieties with high pigment levels for durum wheat market. Through this research it is aimed to release relationship between grain color and antioxidant potential of wheat mainly depend on agronomic applications and release the new perspectives in breeding and agronomic studies in Turkish cultivars.

**Keywords:** Whole grain, antioxidant, grain color, health

## Introduction

Cereals are one of the first domesticated crops in history and have been the staple food of civilizations. They are grown in an extraordinarily wide variety of environments; even wheat can grow in almost all regions except the poles. Wheat flour contains a unique protein complex called gluten, which provides the viscoelasticity that allow dough to be processed into pasta, noodles, and bakery products. It also contributes essential amino acids, minerals, vitamins, and beneficial compounds to human health in daily consumption. Whole wheat products are recommended for a healthy diet as a recognized source of fiber and antioxidants. In recent years, the consumption of healthy and nutritious products has become popular with increased consumer awareness due to the sensitivity of human health. This situation resulted with using less pesticides, chemical fertilizers, and more consumption of organic products. Also, there is an increasing trend to consume food products that have more fiber, colorful fruits (berries etc.) and whole grains (whole flour products, flakes etc.) instead of starchy, fatty, and sweet foods. Both in terms of human health and plant physiology, substances with antioxidant activity and phenolic compounds are found in wheat grains. These compounds are located primarily in the outer layer of the grain (colorful part) that is separated (bran) during milling process. Consumption of whole grains is known as have health and nourishment contributions of daily diet, so it is important issue to reveal mechanism of the whole grains' health effects and this study mainly focused on outer layer color and health contributions of wheat.

## Colorful grains and health contributions

Phenolic compounds and antioxidants are key chemical components that can directly react with reactive oxygen species (ROS) that protect cells and DNA damage. Whole grains are known to be rich in these secondary metabolites, which are mainly concentrated in the outer layers (aleurone, testa, and pericarp) of the grain (Martini et al., 2015). It is known that the antioxidant and phenolic compound potential of cereal grains and various ground parts obtained from them, especially the bran layer, is higher (Ivanisova et al., 2011).

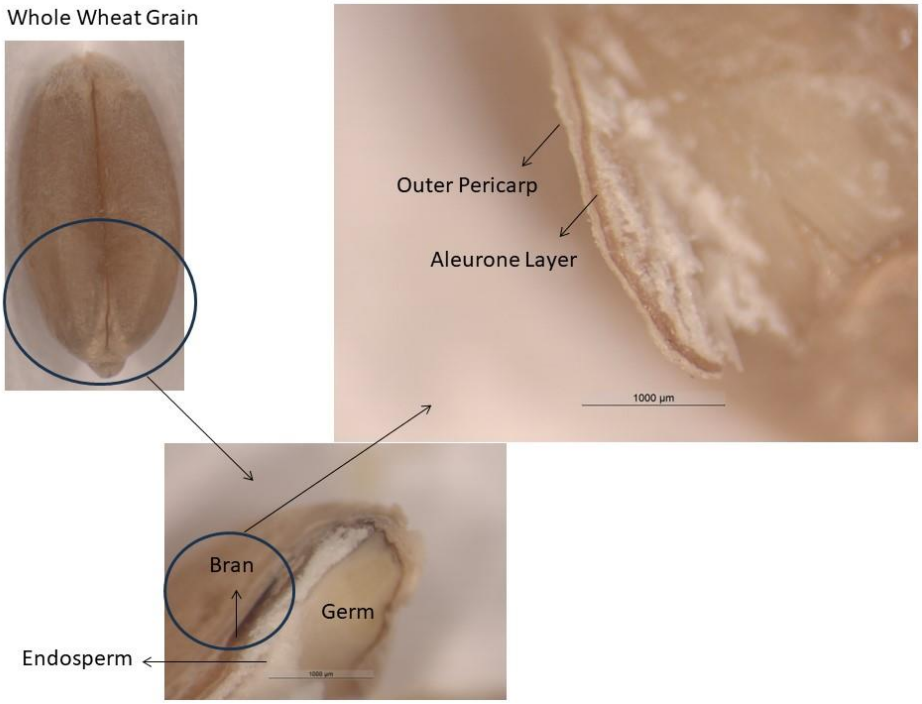


Figure 1. Microskopic view of anatomical parts of whole wheat grain (original)

The outer layers of bran part (Figure 1) contain water-insoluable fiber components (53%), proteins and carbohydrates each represent 16% dm and the mineral content (ash) is rather high (7.2%) in bran compares to other parts of the grain (Šramková et al., 2009).

Most cultivated available wheat cultivars' grains are known has white and red colors and therefore, they come in different grades and are preferred in milling according to their grain color and processed on a product basis (Figure 2). A wide range of wheat-based products containing pigmented varieties have been commercially developed, and these pigmented grains contain anthocyanins, which are the most abundant flavonoid pigments and are responsible for most of the blue to blue-black and red to purple colors found in the wide range of plants (fruits, vegetables, flowers, roots etc.) (Grausgruber et al., 2018).



Figure 2. Difference of grain color of some cultivated bread wheat cultivars (original)

The main reason for the nutritional and health significance of the bran layer is that it contains vitamins and minerals, but it is separated from the endosperm during the milling process. This process reduces the health and nutritional benefits of the grain. Abundance of anthociyanins in colored (purple) grain wheat showed a high correlation between antioxidant properties and bioactive compounds acts as antioxidants are responsible of scavenging of free radicals (Morgunov et al., 2020). The anthocyanins in colored wheat flour have also greater antibacterial potential than those in white-grain wheat, so the benefits of pigmented grains are also natural plant-based antibacterial agents (Li et al., 2023).

A key limitation of the breeding colorful wheat cultivars are reported in the previous study is developing colored wheat germplasm caused low-yield and successful application of varieties with colored grains into cultivation will be related to agronomic properties. Lower yield in colored lines is caused by negative influence of genes related to blue aleurone gene or related to wild species. Blue and purple wheat lines differed in the localization of anthocyanins in the grain. Reduction of yield in colored lines is caused by negative influence of genes related to blue aleurone gene or related to wild species. Blue and purple wheat lines differed in the localization of anthocyanins in the grain. And as a success of the study new anthocynanins were detected in colored wheat lines that could unlock significant health potential of colored grains (Garg et al., 2016).

The previous study conducted by Morgounov et al. (2020), answered the question of the contribution of genotype and environment factors associated with grain color (purple) of the wheat cultivars and new wheat lines. It was revealed that environmental factors had larger effects on productivity and quality traits (dough rheological properties). Nevertheless, grain color and anthocyanin content were found controlled by genotype, offering the opportunity for breeding studies. According to their investigations purple grained wheat isolines clustered together and associated with higher antioxidant potential in whole wheat flour and the redness (a*) of whole flour was closely linked to the dietary fiber and protein content which are the most important quality and nutritional properties. It was found that both whole and purple grain lines had higher total phenolic content, although the phenolic content in purple grain lines was not significantly higher than red grain lines. They point out that this is a common challenge for research and breeding for health-related traits in wheat.

One of the most important quality and breeding goal in commercial production of durum wheat is obtaining pasta products with a bright yellow color (b*: yellowness) and release of cultivars with high pigment levels that effects production potential of semolina and

processing quality. Durum wheat contains high levels of protein with yellow pigmentation which is related to make it the perfect choice for the production of pasta, semolina and spaghetti and the most suitable durum quality characteristic (Saini et al., 2022). The color of durum products change due to different pigments yellow (carotenoid) ensures final quality characteristics especially for the main durum products: pasta and semolina. Some of these pigments provide protection against chronic diseases that have provitamin A, and all show antioxidant capacity that reduces the risk of degenerative diseases (Ficco Donatella et al., 2014). Fiber is mainly contributed to durum wheat products and its proportion is important, there is significant relationship between yellowness (b*) and redness (a*) color of the durum wheat grain (Figure 3).

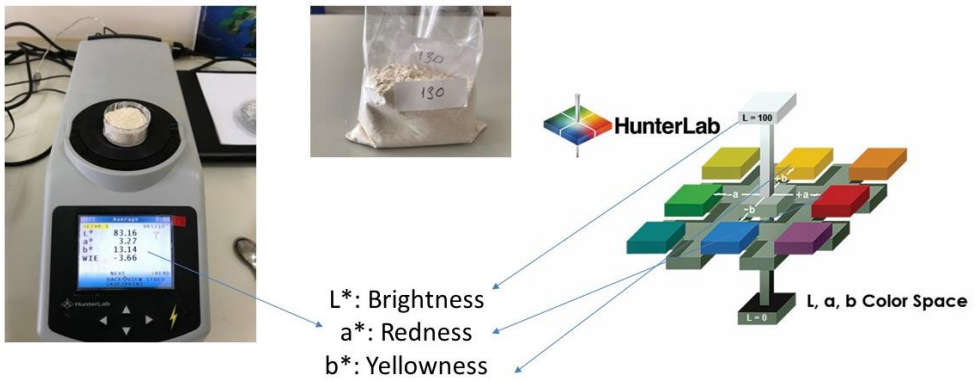


Figure 3. Measuring whole wheat flour with HunterLab ColorFlex EZ and color space of brightness (L*), redness (a*) and yellowness (b*)

**Conclusion**

This study mainly demonstrated how grain color is related to health benefits and release the relationship between grain structure and antioxidant potential. There is still big challenges about reveal relationship between color and health properties of wheat cultivars to achieve healthy, high nutritionally and quality products. Wheat grain structure mainly affected by many factors (biotic and abiotic), so this situation may be related to their reciprocal effects and the path of compounds in grain development. In future studies it is aimed to reveal a new approach with interdisciplinary studies by evaluating these new quality approaches for health benefits of bread and durum wheat in the face of climate change to maintain high yield potential (drought resistance-antioxidant relation) and sustainable healthy-food production. Taken together, these findings provide and aimed to release the new perspectives in breeding and agronomic studies for taking an attention about achieving new higher health potential cultivars.

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# IN VITRO DETERMINE OF ANTIFUNGAL ACTIVITY OF NATURAL PARTICLES AGAINST PATHOGENIC *Fusarium oxysporum*

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## Abstract
Many plant diseases are one of the most important factors causing crop losses in agricultural resources. Especially many of the soil-borne pathogens (Fusarium, Pythium, Botrytis, Rhizoctonia, and Phytophthora) cause significant crop losses. Phytopathogenic fungi, along with the damage they cause to economically important agricultural products, have caused unexpected economic losses to farmers and agricultural enterprises in recent years. One key contributing factor to the issue is the resistance and contamination brought on by the pervasive and unchecked use of antifungal medications. According to reports, the aforementioned fungal infection condition calls for the hunt for novel and potent antifungals, and this need is anticipated to grow with time. According to current reports, the most significant sources in the hunt for novel antifungal alternatives are natural compounds like plants and vegetable oils. Peppermint Oil (PmO), Sesame Oil (SO), Onion Oil (OO), Garlic Oil (GO), Sweet Almond Oil (SAO) Castor (Hint) Oil (CO), Coconut Oil (CnO), Clove Oil (ClO), Cacao Oil (CcO), Thyme Oil (TO), Lemon Oil (LO), Juniper Oil (JO), Rosa Oil (RO), Ginger Oil (GgO) and Agolich Oil (AO) herbal oils were used in this study. The investigation of the antifungal effect of organoparticles synthesized from these herbal oils against *Fusarium oxysporum*, which causes root rot, was reported for the first time in the literature. Synthesized organoparticles Fourier Transform-Infrared (FTIR), size analysis (DLS), surface charge (ZETA potential) devices. In addition, the bioactivity (antifungal and antioxidant) properties of the particle were examined. The results of this study show that organoparticles p(OO), p(GO) and p(SAO) can be used in the control of root and stem rot *Fusarium oxysporum* fungus.
**Keywords:** Disease, Fusarium, Organoparticles.

## Introduction

There are factors that cause significant product losses in agricultural production, agricultural products are greatly affected and damaged and losses occur. Diseases are the leading factors that cause significant losses in plants. Among these, diseases that occur in the root zone, which are important for the plants to make the best use of the nutrients in the environment and to adapt to different environmental conditions, have an important place. *Fusarium oxysporum* is one of the soil-borne fungal agents that cause disease in the root zone of plants and cause significant yield losses (Partridge, 2003). *Fusarium oxysporum*is an important type of pathogen that causes root rot in vegetables. It causes more than 60% yield loss in open and greenhouse vegetable cultivation (Özbay et al., 2004; Hibar et al., 2007; Arıcı et al., 2013; Manzo et al., 2016). Root-knot nematodes feed on root and vascular tissues, slowing down the uptake of water and nutrients, thus causing slow growth, yellowing of leaves, wilting and early plant death in plants (Asaturova et al., 2022). In many studies investigating nematode-fungal disease interactions, in the presence of nematodes, pathogens are observed in plants earlier, disease severity increases and the plant dies completely (Göze Özdemir et al., 2022; Lobna et al., 2017). In addition to mostly using tolerant varieties, different cultivation methods and chemical control programs are also used for wilt and root rot diseases caused by Fusarium species (Aydın, 2019; Bilici et al., 2021). However, tolerant varieties are limited and cultural methods are insufficient (Çolak & Biçici 2011; Jiménez-Díaz et al., 2015).

Cultural, biotechnical and quarantine measures, as well as mechanical, physical, biological and chemical warfare, are among these agricultural control methods, which have been used for years to combat agricultural pests and plant diseases. However, chemical warfare is mostly used due to its ease of application and good results. Therefore, the use of pesticides (pesticides) is very common. With the increase in the use of various pesticides, both the inaccuracies in the application and the damages at the advanced stage have reached quite large dimensions.

Recently, natural materials have been used in the fight against disease agents. Herbal extract and oils are natural agents due to their natural, easily available, environmentally friendly, and low cost. It is an alternative to synthetic herbicides and pesticides in the fight against diseases (Tripathi *et al.*, 2008). It has medicinal antispasmodic and carminative, antimicrobial, cooling and diuretic effects. Herbal extract and oils has found a wide application area in the pharmaceutical (Olak et al., 2020; Alpaslan et al., 2021; Alpaslan et al., 2021; Alpaslan et al., 2021; Ersen Dudu et al., 2021; Alpaslan et al., 2022), hydrogen production (Ersen Dudu et al.,

2022), food and cosmetic industry (Bone & Mills, 2000). Within the scope of this study, the effects of synthesized natural particles namely the bio activators against the plant pathogen M.phaseolina, which is soil-borne and causes significant post-harvest losses, were investigated.

## Materials and Methods

### *Materials*

Peppermint Oil (PmO), Sesame Oil (SO), Onion Oil (OO), Garlic Oil (GO), Sweet Almond Oil (SAO) Castor (Hint) Oil (CO), Coconut Oil (CnO), Clove Oil (ClO), Cacao Oil (CcO), Thyme Oil (TO), Lemon Oil (LO), Juniper Oil (JO), Rosa Oil (RO), Ginger Oil (GgO) and Agolich Oil (AO) were procured from local suppliers.

In the research, it was obtained from Van Yüzüncü Yıl University, Faculty of Agriculture, Department of Plant Protection. *Fusarium oxysporum* was a soil-borne plant pathogen that causes significant post-harvest losses.

### *The preparation of organo particles*

Polymeric organo particles of (p(PmO), p(SO), p(OO), p(GO), p(SAO), p(CO), p(CnO), p(ClO), p(CcO), p(TO), p(LO), p(JO), p(RO), p(GgO) and p(AO) were synthesized via the emulsion polymerization technique. Briefly, 8 mL of water, 2 mL of ethanol and 1 mL of tween 80 were transferred into the reaction vessel and mixed using a mechanical stirrer for 10 min at ambient temperature at the constant stirring speed (Zargar et al., 2016). Then 0.5 mL of oils (PmO, SO, OO, GO, SAO, CO, CnO, ClO, CcO, TO, LO, JO, RO, GgO and AO) was separately added. Reaction temperatures were maintained at 50 °C with a temperature-controlled hot plate. Afterward, 10 w% of EGDMA as a crosslinker was added to the reaction vessel and mixed (at 500 rpm) thoroughly for five minutes followed by the addition of 10 µL TEMED as an accelerator. Finally, 3 w% APS solution (in 100 µL DI water) as an initiator was added and mixed (at 1000 rpm) thoroughly for 3 h. After 3 h, the prepared organo particles were washed with acetone and centrifuged for 30 min. These preparation steps are schematically given in Figure 1. After the centrifugation, particles were dried in an oven at 40 °C to a constant weight and kept at 4 ºC in sealed containers for further studies.

### *Characterization of organoparticles*

The particle size and zeta potential of organo particles were measured by dynamic light scattering (Fırat University, Nano Plus Analyzer, Micromeritics, USA An Attenuated Total Reflection (ATR) built-in Fourier Transform Infrared Spectroscopy (Fırat University, Thermo, model Nicolet iS10 FTIR Spectrometer, USA) was used for the FTIR analysis.

**Findings and Discussion**

Figure 1 shows the FTIR spectra of the organo particles. It is widely known that fats and fatty acids differ according to their composition, length and degree of unsaturation, as well as their position in the chain.

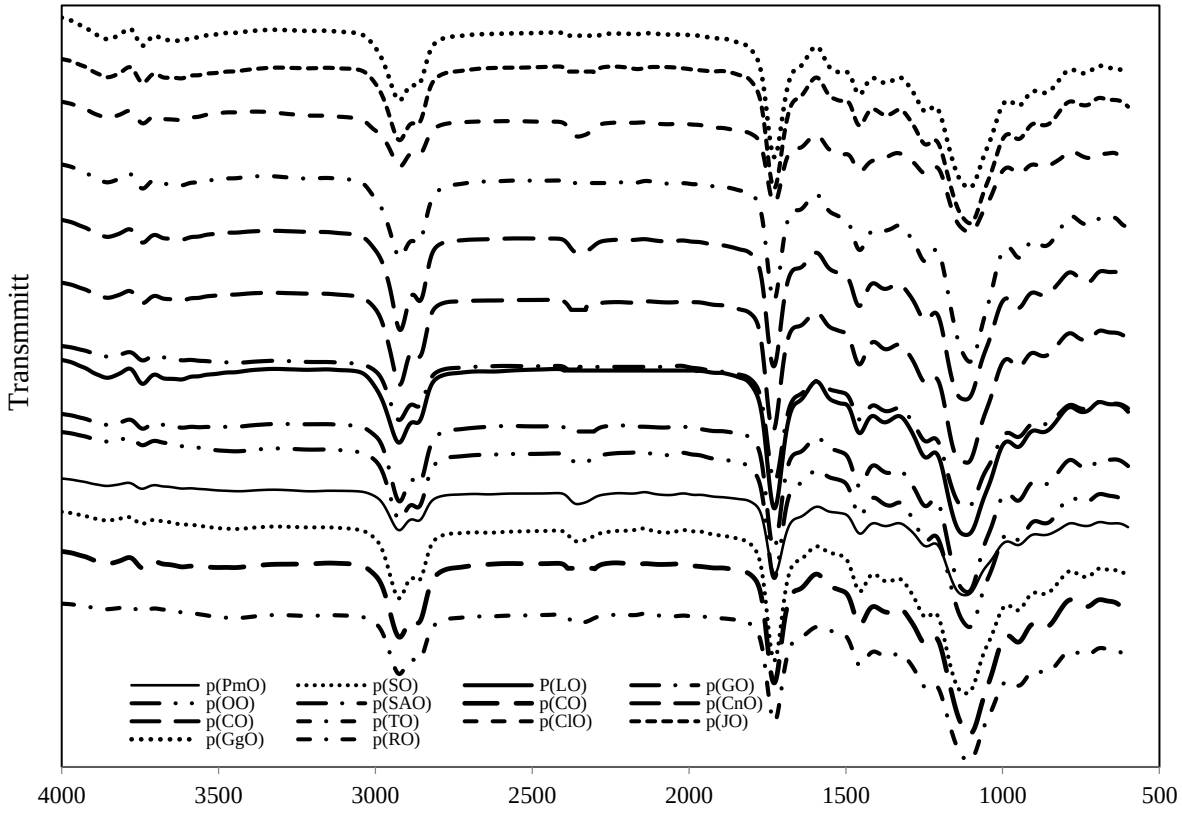


**Figure 1.** FTIR spectra of the organoparticles p(PmO), p(SO), p(OO), p(GO), p(SAO), p(CO), p(CnO), p(ClO), p(CcO), p(TO), p(LO), p(JO), p(RO), p(GgO) and p(AaO).

In this study, of organo-particle against ***Fusarium oxysporum*** was investigated. Antifungal effects of organoparticles against *Fusarium oxysporum* were shown in Table X. Among organoparticles, p(PmO), p(OO), p(GO), p(SAO), p(ClO), and p(AaO) organoparticles were found to have high antifungal activity against *Fusarium oxysporum* compared to other organoparticles. Other organo-particles the antifungal effect of against *Fusarium oxysporum* has not been determined.

Based on the study's findings, the second phase of the experimentation—which involved applying several concentrations of organoparticles to the isolate of Fusarium oxysporum—was initiated in order to ascertain the optimal dose of these particles.

**Table 1.** Zeta, DLS and antioxidant values of organoparticles p(PmO), p(SO), p(OO), p(GO), p(SAO), p(CO), p(CnO), p(ClO), p(CcO), p(TO), p(LO), p(JO), p(RO), p(GgO)

| Organoparticles | ZETA (mV) | DLS (nm) | Antioxidant (GAE/mg) |
|---|---|---|---|
| p(PmO) | 16.96 | 368-404 | 390.3 |
| p(SO) | 10.08 | 400-673 | 455.5 |
| p(OO) | 30.1 | 600-900 | 796.2 |
| p(GO) | -353.96 | 220-500 | 796.2 |
| p(SAO) | 14.15 | 200-350 | 374.0 |
| p(CO) | 2.98 | 300-750 | 354.0 |
| p(CnO) | 169.77 | 20-530 | 665.9 |
| p(ClO) | -868.53 | 300-506 | 1107.3 |
| p(TO) | -120.02 | 150-347 | 217.7 |
| p(CcO) | -563.42 | 300-506 | 858.8 |
| p(LO) | -1414.71 | 40-50 | 469.2 |
| p(JO) | -0.98 | 1000 | 772.9 |
| p(RO) | -146.23 | 126.1-96.96 | 544.4 |
| p(GgO) | -162.48 | 500-915 | 574.0 |
| p(AaO) | -563.42 | 150-347 | 745.1 |

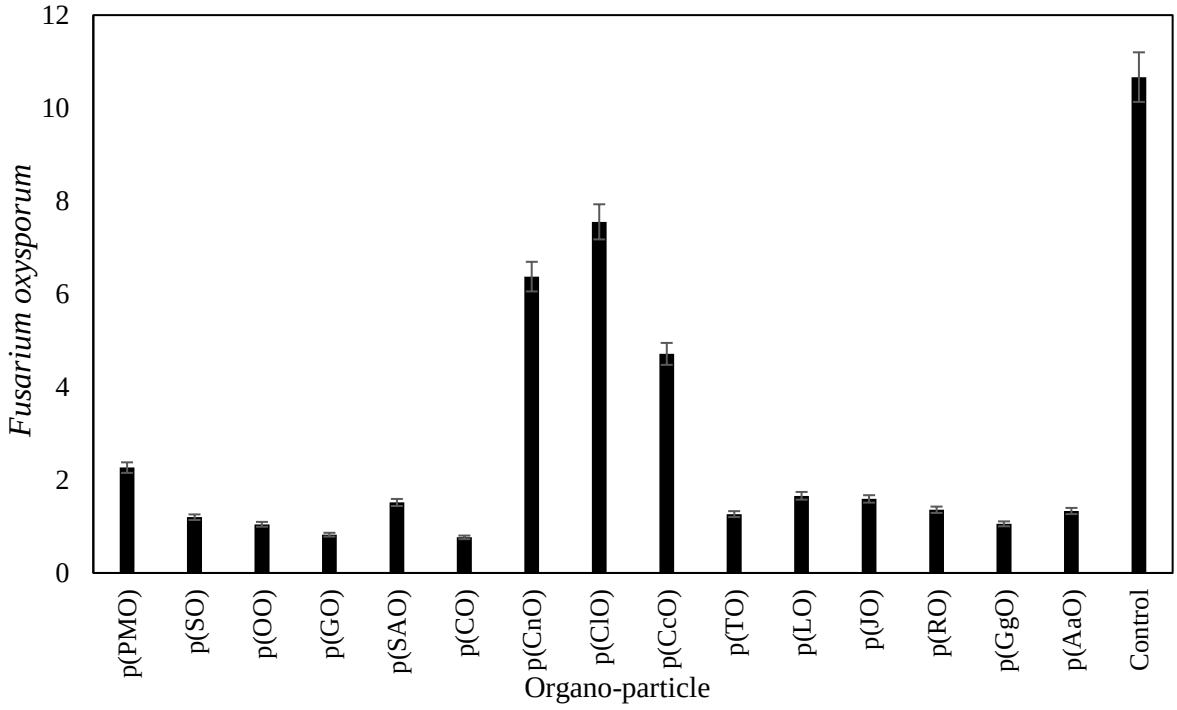


**Figure 2.** Inhibition rate of fifteen different organoparticles against *Fusarium oxysporum* (cfu).

Antifungal substances prevent fungus from growing by a variety of ways, including by blocking the creation of proteins, nuclear material, and fungal cell membranes or organelles.
(Freiesleben & Jäger, 2014; Nazzaro et al., 2017).

The inhibitory effect of antifungal materials has been explained by 6 different mechanisms of action. It is believed that by inhibiting them, resistance to antifungal agents can be reduced (Ghannoum & Rice, 1999; Odds et al., 2003; Kang et al., 2010; Kim et al., 2013; Freiesleben & Jäger, 2014; Abd Rashed et al., 2021).(Bianchi et al., 1997; Freiesleben & Jäger, 2014; Barone & Tansey, 2018).

Antifungal compounds stop the growth of fungus in a number of ways, such as by obstructing the synthesis of nuclear material, proteins, and fungalcell-membranes or organelles. Upon reviewing the research, it becomes evident that the antifungal properties of plants/herbal oils are typically evaluated in vitro. In vivo settings, plants/essential oils that shown minimal or no efficacy were typically found to be ineffective in vitro. The low likelihood of employing essential oils in wide-open spaces like fields and gardens might be the reason for the paucity of in vivo research and their unsatisfactory outcomes. Essential oils may have a stronger antifungal impact in confined areas like fruit/vegetable stores.

**Result**

Consequently, it was discovered that *Fusarium oxysporum* is susceptible to the antifungal effects of organo particles. The management of *Fusarium oxysporum* in organic farming as well as control strategies seeking to decrease the use of pesticides against plant pathogenic fungus are believed to benefit from these results.

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# A MULTIDISCIPLINARY APPROACH TO WILD BIRD DISEASES: FROM AVIAN FLU TO NOVEL DIAGNOSTIC TECHNIQUES

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**Abstract**
It is estimated that over 60% of emerging infectious diseases affect humans and that 70% of them originated in wild animals. Therefore, it is critical to address this increasing epidemiological challenge; however, the complexity of the problem and limited resources exceed the capacities of professionals trained in a single discipline, making multidisciplinary approaches the most efficient strategy and, in many cases, the only option. In this work, we discuss the challenges of disease management in wildlife populations and the related risks to domestic animals, human health, and the conservation of endangered species. We present innovative solutions for the study of avian influenza in wild birds and the diagnosis of the most relevant diseases for wild bird populations in Mexico. In both cases, involving the development of informatics tools, basic algorithms and artificial intelligence tools that can be employed by veterinarians, biologists, and agronomists. We also present the case of a thorough ecological investigation of the mosquito-borne avian malaria, a primary concern for the conservation of susceptible bird populations in free life and captivity, like penguins. Finally, we show that

innovation in diagnostic techniques can be constantly achieved by thinking “outside the box”. In this case, despite the well-established diagnostic procedures based on blood or organ sampling for detecting blood parasites (Haemosporidian), the use of feathers was proven to be a reliable alternative that reduces the need for handling and stressing the birds. There is not a single and straightforward answer for the major disease management problems, and incorporating the knowledge and experience of multiple disciplines is, by far, the best alternative to find efficient solutions.

**Keywords:** avian botulism, avian malaria, avian influenza, expert system, vector-borne disease.

**Emerging and re-emerging diseases**

Epidemic events with severe global repercussions for health, wellbeing and economy have occurred in recent decades. Some of them have been zoonotic diseases (capable of infecting humans and animals), affected animal health and welfare or even threaten the conservation of wildlife populations (Evans & Leighton, 2014). Many of these events were caused by diseases related to animals and Emerging Infectious Diseases (EID). EIDs are those diseases that have been recently discovered, that affect new populations, or that have rapidly increased their incidence and geographic distribution, and, consequently, are hard to manage or control (Bengis et al., 2004; Reed, Meece, Henkel, & Shukla, 2003). Re-emerging diseases are those that, at some point, were serious health concerns, remained under relative control after intensive interventions and recently, social, and environmental changes have allowed them to become a major health threat once again. Examples of re-emerging diseases are human malaria and tuberculosis.

EIDs threaten global biodiversity as well as human and domestic animal health. It is estimated that over 60% of recent EIDs events are zoonotic, and of these, over 70% originated in wildlife (Wardeh, Risley, McIntyre, Setzkorn, & Baylis, 2015), including nearly all the latest pandemics, such as Ebola, MERS, Influenza A, Zika, and Covid-19. Therefore, research on the social and environmental conditions that prevent the introduction of new EIDs and limit their spread is urgently needed. Furthermore, the epidemiologic processes in natural or disturbed systems are complex and usually involve multiple interactions between hosts and pathogens, causing many challenges for the efficient implementation of preventive and control measurements; thus, requiring considerable and adaptable research efforts.

**Wildlife and wild bird diseases**

Diseases of wildlife have been long reported but their scientific study has not progressed at the same rate as the investigation of diseases in domestic animals or humans, probably as they are deemed less important from the human perspective. Additionally, they are hard to observe and even harder to control or prevent and the ecological implications, especially in the long term, are difficult to understand and predict. Nevertheless, the study of wildlife diseases is becoming progressively more relevant due to the increasing number of emerging diseases and recognition that many human EIDs originate from wildlife, the use intensification of natural habitats, the changing pressures on the environment and our increased understanding of disease ecology (Daszak, Cunningham, & Hyatt, 2000).

Diseases in wildlife are usually difficult to address because if they seriously affect their wild host, it is challenging to find ill or dead animals in the wild as they are quickly removed from the environment by predators, scavengers and decomposition (Ryser-Degiorgis, 2013; Wobeser, 2006). Looking for the causative agent directly in the host or in the environment could provide more complete information (Wobeser, 2006), but the size, distribution and movements of populations could imply an extensive evaluation to gather valuable information, and this is particularly challenging to accomplish in remote areas or with limited resources (Ryser-Degiorgis, 2013; Wobeser, 2006). If diseases do not obviously affect the health of their host (maybe because wild animals show few or no signs being reservoirs or incidental hosts) and if their occurrence is not common, then to prove the disease presence and estimate its prevalence could require obtaining a substantial sample size with its implied effort and investment (Ian Dohoo, Wayne Martin, & Stryhn, 2003; Wobeser, 2006). Additionally, the lack of complete biological and ecological information, diagnostic limitations, and the analysis and interpretation of the collected data could be challenging (Ryser-Degiorgis, 2013; Wobeser, 2006).

Wildlife diseases could be addressed by their implications to the health of their hosts. They could be relevant for the conservation of vulnerable species, pose a heavy toll on the health and productivity of domestic animals, and therefore in the economy, or represent a risk for human health (Walton et al., 2016).

Wild birds are a conspicuous and very diverse group of vertebrates that have occupied niches in a wide range of ecosystems (Stiller & Zhang, 2019). The common proximity of birds to domestic animals and humans is the reason that has allowed the spread of infectious diseases among these groups (Van Hemert, Pearce, & Handel, 2014). Notorious examples of EID related to wild birds are avian influenza and West Nile virus encephalitis.

An important consideration is that birds have a great mobility in general and with their local movements or migrations, they can carry and introduce pathogens through long distances and initiate new outbreaks (Reed et al., 2003; Van Hemert et al., 2014). For example, migration is considered the cause of the introduction and dispersion of West Nile virus (WNV) in North America (Pinto, Bonacic, Hamilton-West, Romero, & Lubroth, 2008; Reed et al., 2003) and of avian influenza in certain regions of Europe (Gale et al., 2014). Also, some species congregate in big numbers, like aquatic birds, and these interactions could influence the contact and transmission rates of infectious agents (Van Hemert et al., 2014). Conjunctivitis caused by *Mycoplasma gallisepticum* in house finches (*Carpodacus mexicanus*) and other species, lead to dramatic declines where these birds occurred in high densities and the unusual contagion was

attributed to the close contact between individuals in artificial feeders; thus, the adequate management of the feeders was recommended to control the epidemic (Tompkins, Dunn, Smith, & Telfer, 2011; Williams, Yuill, Artois, Fischer, & Haigh, 2002). Likewise, the food supply in feeding stations facilitated the infection with *Salmonella typhimurium* DT40 and *Escherichia coli* 086:K61 in the UK (Daszak et al., 2000).

More than three fifths of human diseases are thought to be originated from animals. From this vast list, possibly avian influenza (Afanador-Villamizar, Gomez-Romero, Diaz, & Ruiz-Saenz, 2017) and West Nile Virus encephalitis are the most concerning ones related to wild birds (Brugman et al., 2013; Tsiodras, Kelesidis, Kelesidis, Bauchinger, & Falagas, 2008).

The foregoing highlights the importance and interest in shifting the health management strategy for an integrated and multidisciplinary method, centered in prevention and in solving health problems from their origin and not only controlling their effects (Evans & Leighton, 2014). This approach is called One Health, and its essential objective is to achieve simultaneously health in three interdependent but tightly related components: ecosystems, animals and humans (Black & Butler, 2014; Evans & Leighton, 2014). For this, it is necessary to consider the natural events, biodiversity, genetic diversity, and human activities. The One Health paradigm can help providing answers for health management problems that arise from global change, it has a solid scientific base and has proved to be effective and with economic benefits (Evans & Leighton, 2014).

**Multidisciplinary approaches beyond One Health**

The introduction of One Health as a health management paradigm has challenged the relatively simplistic and linear approaches that prevailed for decades. However, the complexity of modern problems seems to increase exponentially as science and technology allow for a deeper understanding of the factors involved, and what before was understood as a disease caused by the presence of a pathogen, for instance, now can be seen as a multicausal, multilayer and interconnected set of events. Therefore, yet another level of multidisciplinary needs to be added to efficiently solve current health issues. It is necessary to incorporate more and diverse disciplines that were not considered before as part of health management. For instance, philosophy and epistemology are extremely useful for defining the problem, working definitions, planning strategies, methodologies, limitations, and scope of the possible solutions. Engineering sciences are being used to improve the technology used for acquiring field data, in many cases in real-time and already with some degree of classification. Informatics tools are being developed for managing the immense amount of information that is now available and

that needs to be gathered, cleaned, and analysed to provide novel insights. Then, the specialised sciences, in this case, medicine, epidemiology, veterinary and ecology, provide a comprehensive solution that can be applied effectively. However, that is not the end of the process because the human factors need to be considered for any proposal to be successful, and for this, the humanities and social sciences incorporate the tools to apply the solutions in a given situation. Finally, a realistic implementation of the solution requires public engagement and science communication to produce the changes in behaviour and habits and implement a new working system. Only then, an efficient solution can be implemented; however, these steps do not occur in a linear fashion and have multiple feedback routes, for which a constant awareness of the bigger picture and the technical details is mandatory for project management.

**Case Examples**

Diseases of wildlife, including wild birds, are particularly difficult to manage despite their importance for human, animal, and environmental health, which demands multidisciplinary collaborations. Four cases of multidisciplinary projects regarding wild bird diseases are presented next.

**1. The Study of Avian Influenza in Mexico**

Influenza type A viruses originate from waterfowl, their natural reservoir are wild birds mainly from the Anseriformes and Charadriiformes orders, and they can infect different groups of hosts, although the mechanism that allows them to do it is not completely understood (Afanador-Villamizar et al., 2017). High pathogenic serotypes frequently cause outbreaks with severe repercussions in the poultry industry and international trade (Afanador-Villamizar et al., 2017; Chatziprodromidou et al., 2018); in consequence, avian influenza outbreaks are constantly reported. Occasionally these viruses cause mortality in humans, like the subtype H5N1 (Chatziprodromidou et al., 2018), and get stablished in human populations causing constant health costs. For instance, during the gravest influenza pandemic in 1918, between 20 and 50 million people died (Bengis et al., 2004).

Despite the critical role of wild birds in the epidemiology of avian influenza and the mandatory notification of high pathogenic serotypes in WOAH (World Organisation for Animal Health) country members, it is common that in official outbreak reports the species of wild birds are not fully identified. This can be attributed to the lack of professionals in the reaction teams able to accurately identify wild birds. In Mexico, this situation is amplified by the limitation of resources for regular surveillance and outbreak control. Therefore, the current management of avian influenza consists of preventive measures like vaccination, routine testing and biosecurity

in poultry farms, and control measurements such as mortality testing, outbreak reporting and culling of infected or high-risk flocks.

The multidisciplinary method used in this project consisted of two main stages, 1) classifying waterbirds regarding their relevance for the study of avian influenza and 2) developing a digital guide to assist non-experts in the identification of such species.

The species classification was done analysing the biological and ecological features of each species. First, the features most related to the transmission and maintenance of avian influenza viruses were identified and prioritised. These were, the preferred habitat, gregariousness (how big their flocks are), mixing with other species, population size, migratory behaviour, and previous isolations of avian influenza viruses. For each feature, several possible values were defined and a score representing the relevance was assigned to each one. The values for over 120 species were extracted from an extensive literature review and organised in a matrix. The matrix also included the scores for each value; therefore, the final score consisted of the sum of all scores by species. Then, five categories of relevance were defined as very low, low, medium, high and very high, representing a range of final scores. Finally, a category was assigned to each species.

The digital identification tool was designed by gathering the "field marks" (physical features that are used for the identification of species) from identification guides. The field marks were then organised in a decision algorithm from higher to lower taxonomic level (order, family, genus, species, and sex and age, if possible). After the birds' identification was confirmed with the algorithm, the field marks were used to produce identification summaries. Lastly, the algorithm and the identification summaries were integrated in a user interface programmed in Macromedia Flash that includes the species description, its relevance level for the study of avian influenza and pictures of the species to confirm the identification. An online version of the identification guide can be consulted in:

https://www.fmvz.unam.mx/fmvz/departamentos/aves/aves_acuaticas

This project integrated veterinary, ecological and informatics knowledge to produce an innovative tool that helps to compensate for specialised professionals and therefore, contributes to the more accurate identification of bird species for the better surveillance and case report of avian influenza.

## 2. The Diagnosis of Relevant Water Bird Diseases

Wetlands are fundamental ecosystems which provide diverse goods and services such as carbon sinks, water reservoirs, water purification, flood control and weather regulation (Smardon, 2006). Waterbirds are those that depend on wetlands to complete at least part of their life cycles (Kushlan; et al., 2002), and wetlands can support a great diversity of waterbirds even in small extensions if they are properly protected (Hernández-Colina, Yadeun, & García-Espinosa, 2018). These birds are relevant for their ecologic functions and diversity, but are vulnerable to infectious diseases and intoxications, and thousands to millions have died in a single outbreak (Newman et al., 2007). Diagnostic of those diseases is difficult for some reasons. The signs and lesions observed in waterbirds are very similar; therefore, additional tests are often required (some of them taking several days) for a final diagnosis. Moreover, in rare occasions, more than one pathogen or toxin can be involved, thus producing a broader spectrum of signs and lesion complicating the diagnosis efforts even further. Additionally, the epidemiological research of some of the diseases is incomplete and many uncertainties and inaccuracies must be considered. However, possibly the most relevant factor is the lack of professionals trained for dealing with these events, which in developing countries like Mexico is a serious limitation.

Expert systems are computational programs that can solve complex problems that usually require a human expert; their versatility makes them useful in many knowledge domains like control systems, manufacturing, and medical sciences. They are easy to transfer to new users and platforms, and to update or adapt if needed. Diverse expert systems have been developed with different approaches to improve the diagnosis, treatment, monitoring or management of human, animal, or plant diseases. Saibene et al. (2021) present a comprehensive review of expert systems applications for human health (Saibene, Assale, & Giltri, 2021). Examples of agricultural expert systems are JAPIEST, for diagnosing tomato diseases (López-Morales, López-Ortega, Ramos-Fernández, & Muñoz, 2008), and PulsExpert, for pulse crops diseases diagnosis (Devraj & Jain, 2011). Regarding veterinary sciences, artificial intelligence has contributed to disease diagnosis, epidemiological understanding, risk analysis, outcome prediction, decision support and modelling improvement (Ezanno et al., 2021). In particular, expert systems have been developed for the diagnosis of cattle infections (Olzhas et al., 2020), diagnosis of pig diseases (Zetian, Feng, Yun, & Xiaoshuan, 2005), post-mortem inspection of pigs in abattoirs (Singh, Singh, & Singh, 2019), diagnosis of bovine tuberculosis (H. Sahli et al., 2016; Hanene Sahli et al., 2018), diagnosis of horse diseases (Qin, Xiao, Gao, & Wang, 2016), and the diagnosis of fish diseases (Li, Fu, & Duan, 2002), to mention just a few.

Nonetheless, no expert systems have been developed for assisting the diagnosis of wildlife diseases.

Automatised solutions, like expert systems, have contributed to the efficiency of health services; however, communication among experts of different disciplines, like modellers and veterinarians, may delay the development of multidisciplinary projects. Here, an expert system was constructed to aid the field diagnosis of the most relevant diseases for waterbird populations, avian botulism, avian cholera, and lead intoxication. These diseases were selected after a thorough literature review and analysis which showed that they have the highest impacts, in terms of frequency and scale, for the waterbirds in Mexico.

Causal dependency diagrams were used for clear knowledge representation and interdisciplinary communication. These diagrams consist of the attributes of an object (i.e., host, environment, disease risk), the values of the attributes (i.e., signs, lesions, environmental variables) and the possible consequents (i.e., the possible disease or intoxication that result from the combination of the values). Decision tables were constructed based on the diagrams to represent the possible combinations of attribute values. Each attribute was the heading of a column, and the combination of values were represented in the rows. By using the tables, it was evident that not all value combinations are useful or probable, some are repetitive, and others can be summarised. Production rules were made from the decision tables to represent the combinations that do have consequent. The rules represent the information in a programable way and at the same time, they have a format that the human experts (i.e., veterinarians) can understand, review, and modify. Finally, the production rules were simplified and used for coding the user's interface in Macromedia Flash. A report of an avian botulism report occurred in Mexico was used to validate the functionality of the system, which provided accurate results. Unfortunately, no similar reports for the other diseases were available, but the principles and functionality of the system were validated. The output of a consultation of the expert system consists of a possible disease responsible for the signs and lesions observed in water birds considering the environmental variables present. An advantage of this approach is that additional pathogens could be added, and the system's information updated if needed. The procedure followed here has the benefit of involving the experts in all steps of knowledge base creation and eases the process of interpretation and evaluation, contrary to previous approaches in which experts are mainly consulted to provide their knowledge and assess results (Hernandez-Colina, 2013).

### 3. Wild Bird Diseases and Conservation

Avian malaria is caused by protist parasites from the genus *Plasmodium* and the species *P. relictum* and *P. elongatum* are the most frequent ones associated with the disease in wild birds (Sallaberry-Pincheira et al., 2015). This parasite needs a vector for its transmission and the mosquitoes from the genera *Culex* are the most recognised one. Until now, there are more than 60 described species of *Plasmodium* (R. E. Vanstreels, Braga, & Catao-Dias, 2016) that had infected more than 600 species of birds and thanks to the increasing use of molecular techniques, over 900 lineages have been described (Zele et al., 2014).

Penguins are not constantly exposed to *Plasmodium* spp. but when they are, they could present serious signs and mortality rates (Hernandez-Colina, Gonzalez-Olvera, Eckley, Lopez, & Baylis, 2021). After the Hawaiian honeycreepers, penguins are considered as the second most threatened group of birds by avian malaria which is mentioned as the most important cause of mass mortality in captive penguins (Silveira et al., 2013). Most of the avian malaria adverse effects have been described in zoos and rescue centres possibly because the individuals are under a close and constant examination and the health condition is easier to notice, but it could be also due to the translocation of individuals to areas where the local mosquito and parasites are present and the penguins are incidentally infected as a spillover from local avifauna (R. E. T. Vanstreels et al., 2019). *Plasmodium* spp. has also been found in wild populations of penguins, two yellow-eyed penguins (*Megadyptes antipodes*) and one Fiordland crested penguin (*Eudyptes pachyrhynchus*) died in 2015 due to *P. elongatum* and more than 25 death penguins were infected with the parasite in 2018 ; thus the disease is considered emergent for these penguins in New Zealand (Hunter & Alley, 2019). This represents the main health concern for the conservation of penguins; as the distribution of vector-borne diseases in highly influenced by the environmental conditions, due to climate change, avian malaria could reach the coastal areas that have been historically free from the parasite and the penguin colonies could suffer high mortalities (Garamszegi, 2011). Therefore, comprehensive ecological and epidemiological investigations are needed to prevent the negative impacts of these parasites on penguin populations.

We collected mosquitoes during 2017 and 2018 in Chester Zoo and during 2017 in Flamingo Land. We established ten sampling areas in Chester Zoo in 2017 and eight in 2018, and four in Flamingo Land. In every sampling area we installed one BG-Mosquitaire trap and one CDC-Gravid trap and, where possible, an area for sampling immature mosquitoes (larvae and pupae). The BG-Mosquitaire traps were operated continuously, and their nets were collected after six

days and after one day. The CDC-Gravid traps were operated one day per week and the sampling for immature mosquitoes was done also once a week. The mosquitoes were identified by morphology and if adult mosquitoes belonged to the *Culex* spp. genus, they were identified to species by PCR. Afterwards, the mosquitoes were tested for avian malaria parasites with a nested-PCR. In Chester Zoo, we collected 7,938 adult mosquitoes and 1,658 immature mosquitoes in 2017 and 2,962 adult mosquitoes in 2018; in Flamingo Land the collection was of 1,588 mosquitoes. The dominant species in the mosquito communities was *Cx. pipiens*. The abundance of mosquitoes varied across the seasons and there were differences by sampling areas. There was a strong correlation between the number of immature and adult mosquitoes a few weeks later. It is important to consider that the traps used were highly effective at capturing *Culex* spp. but other species could be also involved in avian malaria transmission. The conditions of the oviposition sites determined the species and abundance of immature mosquitoes. The blood contained in some mosquitoes was also examined to determine the vertebrate of origin by using PCR and barcoding techniques (Hernandez-Colina, Gonzalez-Olvera, Lomax, et al., 2021).

During our research, an multicausal mortality event affected the penguins of Chester Zoo; therefore, a comprehensive analysis of the parasite phylogeny in mosquitoes, wild birds and penguins was also done. We were able to identify critical moments and locations with higher mosquito abundance which could be used for planning mosquito control strategies, although a constant surveillance of the mosquito community is recommended (Gonzalez-Olvera et al., 2022).

In this project, the advantages of performing a comprehensive and integrated investigation of a pathogen transmission system were evident. By combining ecological analyses, entomological monitoring, molecular biology techniques and epidemiological knowledge, a full description of the system was possible, and therefore, useful, and practical recommendation could be made.

**4. Innovation for Diagnosing Wild Bird Diseases**

Parasites of the order Haemosporida need a vertebrate host and an arthropod vector to complete their life cycle (Valkiūnas G, 2005). With the advance in molecular and genetic techniques, a large diversity of these parasites has been described and new lineages and morphospecies are constantly described (Bensch, Hellgren, & Perez-Tris, 2009; Berthová, Valkiūnas, & Országhová, 2012; Clark, Clegg, & Lima, 2014; Valkiunas, Santiago-Alarcon, Levin, Iezhova, & Parker, 2010). Wild birds are commonly found infected by parasites of three main genera

from this order, *Plasmodium* spp., *Haemoproteus* spp. and *Leucocytozoon* spp. (Valkiūnas G, 2005). The infection effects on the host range from subclinical (without sings of disease) to severe and it could affect reproductive fitness (Knowles, Palinauskas, & Sheldon, 2010) and survival rates (la Puente et al., 2010; Marzal, Bensch, Reviriego, Balbontin, & De Lope, 2008). Nevertheless, the consequences for bird populations and communities in the long term are mainly unknown (Ham-Duenas, Chapa-Vargas, Stracey, & Huber-Sannwald, 2017).

Haemosporidian infections are conventionally detected using blood samples; this implies capturing and handling birds to obtain them, which induces stress and causes pain. Afterwards, the samples are prepared in microscope slides and stained with Giemsa for microscopic to detect infected erythrocytes. Another standard procedure is using the samples for DNA extraction and PCR to observe the amplification of gene segments of the parasites. Both techniques have their advantages, like the ability to observe different parasite stages in the first one and the high sensitivity of the second one. Nonetheless, to reduce the handling induced stress on birds and to ease the collection of samples, we developed a new methodology.

Feathers have blood vessels, and some blood could be preserved in the feather's shaft after moulting. We used feather DNA for detecting haemosporidians by PCR testing in diverse scenarios. First, haemosporidian DNA was detected in feathers from carcasses of infected birds, proving the feasibility of the approach; carcasses of species prone to the infection (i.e., corvids) and more diverse community of birds were used. It was expected that environmental variables could affect the quantity and quality of DNA recovered; therefore, we used the feathers of a Red-breasted goose that died with a high intensity infection to assess the influence of different storage conditions. We found that storage temperature affected DNA recovery, with maximum retrieval and haemosporidian detection at the lowest temperature (− 20 °C). All feather types from infected birds kept at optimal conditions yielded haemosporidian DNA. Parasite detection by PCR was positively correlated with DNA yield, which was significantly higher in heavier birds, flight feathers, and more feathers per pool. Lastly, haemosporidians were detected employing feathers moulted from wild and captive birds to estimate infection prevalence. We showed for the first time that using blood from feather shafts for haemosporidian detection can be an advantageous and less invasive alternative to blood sampling if feathers are optimally preserved. This method could contribute to uncovering haemosporidian infections in endangered and elusive birds, and it might facilitate routine screening in captive birds, thereby improving infection detection, prevention, and control (González-Olvera et al., 2023).

## Conclusions

The impacts of wildlife diseases have been amplified possibly by the increase of trade globalization, expansion of human populations, intensification of wildlife use, pathogens crossover between domestic and wild animals and climatic changes (Bengis et al., 2004). Therefore, regardless of the complications for the research of wildlife diseases, it is critical to continue with the investigation efforts because the constant changes in the environment are increasing the complexity of the interactions among domestic animals, humans and wild animals, and adaptable responses are constantly needed.

The management of wildlife diseases requires a multidisciplinary strategy which is an increasing practice, mainly motivated by conservation interests (Joseph et al., 2013). This approach has demonstrated success across diverse scenarios and could imply the regulation of populations, controlling the interface between domestic and wild animals and even treating wildlife individuals, but the outcomes are difficult to predict, and the main limitation is the lack of specific information, particularly for novel pathogens or host-pathogen interactions and highly trained professionals.

The cases presented here show that multidisciplinary approaches are highly beneficial for the development of innovative solutions that improve conventional procedures, compensate for resources deficits, like reduced time for decision making, incomplete information, reduced number of human experts, and limitations of well stablished diagnostic methodologies, and create opportunities for the further advance in disease management.

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# ANTIOXIDANT ACTIVITY, PHENOLIC AND FLAVONOID CONTENT OF *Curcuma longa* L. EXTRACTED WITH SUPERCRITICAL $CO_2$ EXTRACTION METHOD

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**Abstract**
*Curcuma longa L.* , commonly known as turmeric, is a member of Zingiberaceae family. This flowering plant is grown in Indian subcontinent and has been used in traditional medicine for centuries, particularly in Ayurveda. Turmeric is renowned for its active compound, curcumin, which imparts various health benefits. Since ages, turmeric has been widely used in foods to enrich its colour and flavour . It is also preferred for healing wounds and treating skin and dental problems, eye infections, and disorders related with the respiratory and the digestive system. In this study *C. longa* L. , samples were purchased from Konya market and extracted with supercritical $CO_2$ extraction method which is novel, environmentally friendly and toxic free method. The process is completed under the 300 mPa pressure, 55 °C temperature and 180 minutes time duration. The amount of active material curcumin analysed with GCMS and found as %71 percent. The antioxidant activity was evaluated by DPPH radical scavenging assay, metal chelating activity, CUPRAC, ABTS. Total phenolic and flavonoid content of the *C. longa* L. supercritical extract was calculated as 1294,45±127,2 µg GAEs/mg extract and 326,81±14,7 µg QEs/mg extract, respectively. Except for DPPH• radical scavenging activity, *C. longa* L. supercritical extract showed significant activity in all in-vitro antioxidant tests which we performed. ABTS•+ radical scavenging activity (IC50: 49,62±0,48 µg/ml), metal chelating activity (IC50: 34,85±0,91µg/mL) and CUPRAC activity(A0.50 : 262,33±0,86 µg/mL) were determined in *C. longa* L. supercritical extract.
**Keywords:** Supercritical $CO_2$ extraction, *Curcuma longa* L., phenolics, DPPH antioxidant activity

## 1. Introduction

Turmeric, scientifically known as *Curcuma longa* L., is a perennial plant with rhizomes, part of the Zingiberaceae family. Originating in India, it's extensively grown in various tropical regions like China, Sri Lanka, West and East Africa. Its benefits encompass enhancing blood flow, alleviating stagnation and depression, and acting as a natural flavoring element that significantly influences the color, taste, and essence of food. Moreover, multiple research studies indicate that *C. longa* L. and its active compounds exhibit diverse pharmacological effects such as antioxidative properties, liver protection, antimicrobial, anti-osteoarthritis, neuroprotective, antidepressant, anti-inflammatory, anticancer, anti-arthritic, anti-aging, antidiabetic, wound healing, and antidiarrheal activities, along with anti-atherosclerotic, and memory-enhancing effects. This herb finds use in traditional medicine to address and prevent an array of conditions including coughs, arthritis, psoriasis, gallbladder issues, skin disorders, as well as gastric and peptic ulcers. The turmeric plant is substantiated by over 300 biologically active constituents such as diterpenes, alkaloids, polyphenols, sterols, sesquiterpenes, and triterpenoids. The distinct yellow hue of Turmeric stems from phenolic components called curcuminoids. The range of curcuminoids constitute 2–9% of turmeric depending on soil fertility and its source in the cultivation area. The primary curcuminoids in turmeric are curcumin with the highest rate of occurrence at 77%, and it is followed by desmethoxycurcumin with an occurrence of 17%, bis-desmethoxycurcumin with an occurrence at a rate of 3%, and cyclocurcumin in trace amounts. Curcumin, has the potential to develop cardiovascular health by decreasing C-reactive protein levels, lowering lipid levels of the individuals with metabolic syndrome and type-2 diabetes mellitus. Curcumin also recently has gained approval for cancer treatment. Researches have proved that curcumin has chemotherapeutic, chemopreventive, chemosensitizing, radiosensitization and radioprotective effects. Its regulatory effects on gut microbiota has been investigated. Furthermore, curcumin also showed a significant protective effect on disorders related with bone density, such as osteoarthritis, osteopenia, periodontitis, gingivitis and supports relieving pain. *C. longa* L. could be an option to improve the function of synapses and delaying neuronal dysfunction processes due to its anti-inflammatory, immunomodulatory and antioxidant properties (Iweala et al., 2023; Salehi et al., 2019; Yehya et al., 2017). In our study *C. longa* L. has been extracted using supercritical $CO_2$ method. We evaluated the curcumin rate of *C. longa* L., its total phenolic content, flavonoid content and its antioxidant potential were also determined.

## 2. Material and Method

### Material

*C. longa* L. samples were purchased from the Konya market. The samples were granulated before the extraction.

### Chemicals

The chemicals used in the study were chosen as analytical grade. Sodium carbonate, quercetin, Folin-Ciocalteu reagent, gallic acid, acetic acid, hydroxytyrosol, acetonitrile, DPPH and Trolox were under the Sigma-Aldrich/German brand.

### Experimental of Supercritical ($SCO_2$) Extraction (SCFE)

Samples of *C. longa* L. were extracted with a 'P-25 35L Super Critical $CO_2$ Extractor System' device from Nantong Borisbang Industrial Technology Co., Ltd. The process conditions were 300 bar pressure, 55 degrees Celsius temperature and 180 minutes time duration. The extracted samples were stored under the condition of refrigeration until the day of analysis (Slinkard & Singleton, 1977) .

### Total Phenolic Content and Total Flavonoid Contents

The Folin Ciocalteu method was used to determine the total phenolic content of Taraxacum officinale supercritical extract. UV–Vis spectrophotometer from Biochrom Ltd in Cambridge, England was used to measure the absorbance at 750 nm (Slinkard & Singleton, 1977). The results were determined based on the formula obtained from the standard gallic acid graph:

Absorbance = 0.0123 [gallic acid (µg)] - 0.0155 (r2, 0.9931).

The aluminum nitrate method has been used to determine TFC in the *T. officinale* supercritical extracts (Park, Koo, Masahuru, & Contado, 1997). The absorbance was measured at 415 nm using a UV–Vis spectrophotometer from Biochrom Ltd. The equation obtained from the standard quercetin graph was used for calculating the results:

Absorbance = 0.0156 [quercetin (µg)] - 0.0112 (r2, 0.9985).

**In-vitro Antioxidant Assays**

The antioxidant activities of. *C. longa* L. supercritical extracts were evaluated using DPPH• free radical scavenging, ABTS•+ radical scavenging, metal chelating activity and CUPRAC, assays (Keskinkaya et al., 2022). BHT, BHA, and EDTA standards were used for comparison. IC50 values (50% inhibition activity) and A0.50 values (concentration with 0.50 absorbance) were calculated. Results were reported as IC50 values and inhibition percentages (%) at a concentration of 400 µg/mL for radical scavenging assays, and A0.50 values and absorbance at 400 µg/mL concentration for the CUPRAC assay.

**DPPH Free Radical Scavenging Activity**

The scavenging activities of T. officinale supercritical extracts against the DPPH• free radical were determined following Blois (1958). 0.4 mM DPPH solution used to prepare the sample mixture. DPPH solution (160 µL ) and 40 µL from the samples at variable concentrations was mixed and incubated for 30 minutes in the light free environment at room temperature. The absorbance was then measured at 517 nm. A 96-well microplate reader was used , and the radical scavenging activity was determined as indicated in formula (1).

$$\text{DPPH scavenging activity (\% Inhibition)} = \frac{A_{control} - A_{Sample}}{A_{Control}} \text{x } 100 \quad (1)$$

$A_{Control}$ is the absorbance of the control, $A_{sample}$ is the absorbance of the sample.

**ABTS Radical Scavenging Assay**

The free radical scavenging activities of *C. longa* L. supercritical extracts against ABTS•+ were determined following Re et al., (1999). A blend of 160 µL of the ABTS•+ solution and 40 µL of the sample at varying concentrations was left to stand at room temperature for a duration of 10 minutes. The measurement of absorbance was subsequently conducted at 734 nm, and the determination of scavenging activity was computed following the provided equation (2).

$$ABTS^{\cdot+} \text{ scavenging activity (\% Inhibition)} = \frac{A_{Control} - A_{Sample}}{A_{Control}} \text{x} 100 \quad (2)$$

**CUPRAC Assay**

The copper (II) ion reducing antioxidant capacity method was used to assess the reducing power of *T. officinale* supercritical extracts (Apak et al., 2004). A solution containing 50 µL of 10 mM Cu (II), 50 µL of 7.5 mM neocuproin, and 60 µL of ammonium acetate buffer was introduced to 40 µL of the sample across different concentration levels. After an incubation period of 1 hour, the absorbance was recorded at 450 nm.

**Metal Chelating Activity**

Decker and Welch (1990) method was used to calculate the chelating activities of *T. officinale* supercritical extracts. The process began by introducing 40 µL of a 0.2 mM FeCl2 solution with 40 µL of ethanol, and 80 µL of a 0.5 mM ferrin into 40 µL of sample solutions with varying concentrations. After an incubation period of 10 minutes at room temperature, the absorbance was assessed at 593 nm, and the metal binding activity was determined using the subsequent equation. (3).

$$\text{Metal chelating activity (\% İnhibition)} = \frac{A_{Control} - A_{Sample}}{A_{Control}} \text{x } 100 \quad (3)$$

**Statistical Analysis**

IBM SPSS Statistics 23.0 program Windows version was used for data analysis, with descriptive analyses for continuous variables. The values were reported with the mean values and standard deviation (SD). The significance level was set at 0.05, and results were reported at a 95% confidence level.

## 3. Results and Discussion

**Total Phenolic and Total Flavonoid Contents**

In our study, curcumin rate, TPC , TFC and antioxidant activities of extracted *C. longa* L. with SFE method were evaluated. The curcumin amount in the extracted material was %71. TPC and TFC of the *C. longa* supercritical extract was calculated as 1294,45±127,2 µg GAEs/mg extract and 326,81±14,7 µg QEs/mg extract, respectively. Except for DPPH• radical scavenging activity, *C. longa* L. supercritical extract showed significant activity in all in-vitro antioxidant tests we performed. ABTS•+ radical scavenging activity (IC50: 49,62±0,48 µg/ml), metal chelating activity (IC50: 34,85±0,91µg/mL) and CUPRAC activity(A0.50 : 262,33±0,86 µg/mL) were determined in *C. longa* L. supercritical extract

(Table1). Jugreet, Mahomoodally, Sinan, Zengin, & Abdallah, (2020) analysed the essential oils of different plants including *C. longa* L. and antioxidant activity found as 22.71 ± 0.94 for DPPH, 22.88 ± 0.33 for ABTS, 149.70 ± 6.69 for CUPRAC, 21.31 ± 2.40 for chelating activities. The same study determined the main component of *C. longa* L. as turmerone with the amount of 31.4%, ar-turmerone with 16.1%, turmerol with 14.6, terpinolene with 11.0%, α-zingiberene with 5.2%, β-sesquiphellandrene with 4.8%, β-caryophyllene 3.5%. Sharma, Ray, & Singhal (2023) analysed the turmeric plant with different extraction methods such as n-hexane, petroleum ether and SFE. They found the curcuminoids rate differed between 100.32 ± 0.28 and 723.42 ± 0.43 µg/g dwb and the average was 238.09 ± 0.11 µg/g dwb with SFE method. The amount of curcuminoids changed between 0,43- 256.29 ± 0.34 µg/g dwb depending of the extraction method and application time. DPPH, ABTS and total polyphenols content values were 254.53 ±0.89 µg AAE/mg sample, 302.05 ±0.66 µg AAE/mg sample and 267.11 ± 0.29 mg GAE/100 g respectively. Martinez-Correa et al., (2017) evaluated different parameters of *C.longa* L. extracts with SFE and they found that curcumin yields were between 0.41-39.44 mg curcumin/g turmeric total phenolic content were between 0.33±0.04 and 41±5 mgCE/g extract , total flavonoids were between 0.39±0.01 and 41±5 mgCE/g extract depending on extraction conditions. Compared our results to other studies values were differentiated or were similar. These changes could be related with the raw material origins, seasonal and geographical effects, different extraction and analysis methods.

**Table 1.** *Antioxidant capacity of C.longa* L. *extracts*

| | | Antioxidant Activity | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | DPPH˙ assay | | ABTS˙⁺ assay | | CUPRAC assay | | Metal Chelating assay | |
| | | Inhibition (%)[a] | $IC_{50}$ (µg /mL)[b] | Inhibition (%)[a] | $IC_{50}$ (µg/mL)[b] | Absorbance [a] | $A_{0.50}$ (µg/mL)[b] | Inhibition (%)[a] | $IC_{50}$ (µg /mL)[b] |
| **Extracts** | ***Curcuma longa*** L. | - | >400 | 69,43±0,27 | **49,62±0,48** | 0,76±0,35 | **262,33±0,86** | 98,29±0,7 | **34,85±0,91** |
| **Standards** | **BHT** | 87,11±0,29 | 24,13±0,24 | 86,71±0,43 | 13,07±0,49 | 2,61±0,28 | 27,64±0,06 | | |
| | **BHA** | 87,90±0,22 | 23,21±0,37 | 89,03±0,72 | 12,88±0,31 | 2,96±0,09 | 26,95±0,02 | | |
| | **EDTA** | | | | | | | 91,16±0,3 | 4,53±0,19 |

[a]: Inhibition values % and absorbance values of 400 µg/mL concentration of the extracts are defined as a mean ±Standard deviation of three parallel analysis results.
[b]: $IC_{50}$ and $A_{0.50}$ values are given as a mean ±standard deviation of three parallel analysis results.

## 4. Conclusion

In this study, *Curcuma longa* L. plants are extracted with supercritical $CO_2$ extraction method. Main component, total phenolic content, total flavanoid content and antioxidant activity of the extracted materials were evaluated. DPPH•. ABTS•+ radical scavenging activities, CUPRAC and metal chelating activities are used to compare the results with the standards such as BHT, BHA and EDTA. The results showed that *C.longa L.* extract contains a high amount of active material curcumin with high antioxidant capacity compared to standard antioxidants. Since the supercritical $CO_2$ extraction method is a novel application for the plant-based materials more researches are needed for more effective results.

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# İKLİM DEĞİŞİKLİĞİNİN HAYVANSAL ÜRETİME ETKİLERİ

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**Özet**
Bu derleme, küresel ısınmanın hayvansal üretim üzerindeki etkilerine dikkat çekmeyi amaçlamaktadır. Atmosfere salınan sera gazlarının birikimi sonucu ortaya çıkan küresel ısınma, ekstrem hava olaylarının meydana gelme frekansını değiştirerek, bitkisel ve hayvansal üretimde önemli dalgalanmalara neden olan iklim değişikliklerine yol açmaktadır. İklim değişikliği hayvansal üretimde temel besin kaynağını oluşturan çayır ve mera alanlarını ciddi şekilde etkileyerek ürün kayıplarına ve bitki çeşitliğinin azalmasına neden olmaktadır. Hayvansal üretimin sürdürülebilirliği, iklim değişikliği ile temel besin kaynaklarında meydana gelen değişimler dolayısı ile ciddi bir riskle karşı karşıya bulunmaktadır. Diğer yandan hayvanlar, iklim değişikliğinin etkileri ile konfor alanları değişeceği için üretimde, hastalıklara karşı savunma mekanizmalarında ve hayatta kalma mücadelelerinde genetik yapı olarak değişime zorlanacaklardır. İklim değişikliklerine karşı adaptasyon kabiliyetleri yüksek olan bazı hayvan türlerinin yaşama şansının yüksek olması dolayısı ile üretimlerinin yaygınlaşacağı ve insanların tüketim alışkanlıklarının değişebileceği tahmin edilmektedir. Hayvansal üretimin sürdürülebilirliğini sağlamak için iklim değişikliğinin olumsuz etkilerinin en aza indirilmesi bakımından hem fiziksel çevrenin iyileştirilmesi hem de hayvanların genetik dayanıklılığını artırmak için sıcaklık stresine dayanıklı gen bölgelerinin tespit edilmesi ve bunlara yönelik ıslah çalışmaları yürütülmelidir. İklim değişikliği ile oluşacak yeni ortamlara uyum için hayvanların genlerinde yatan adaptasyon mekanizmaları ve bu tür alanlarda başarılı genler, bu hayvanların gelecekteki seçim programlarını araştırmak için hayati öneme sahiptir. İklim değişikliğine karşı adaptasyonu yüksek, zorlu yaşam koşullarında hayatta kalma ve üreme tolerans düzeyi iyi olan hayvanların seçilmesi ve ıslahı ile birlikte bunların gelecek nesillerin ebeveynleri olmaları sağlanmalıdır. Bu alanda daha fazla araştırma yapılarak iklim değişikliğinin etkilerinin araştırılması ve bu olumsuzlukları en aza indirmek için daha fazla bilimsel çalışma yapılmasına ihtiyaç vardır. Küresel ısınma, iklim değişikliği, tüm ekosistemi etkileyen ciddi bir sorun olarak çözüm beklemektedir. Gelecek nesillere yaşanılabilir daha güzel bir çevre bırakmak için üretimden tüketime her aşamada sorumluluk bilinciyle hareket etmek çözümde anahtar olacaktır.
**Anahtar Kelimeler:** İklim değişikliği, Çiftlik hayvanları, Verim, Üreme performansı

# EFFECTS OF CLIMATE CHANGE ON ANIMAL PRODUCTION

**Abstract**

This review aims to draw attention to the effects of global warming on animal production. Global warming, which occurs as a result of the accumulation of greenhouse gases (GG) released into the atmosphere, changes the frequency of extreme weather events and causes climate changes that cause significant fluctuations in plant and animal production. Climate change seriously affects meadow and pasture areas, which constitute the main food source in animal production, causing product losses and a decrease in plant diversity. The sustainability of animal production faces a serious risk due to climate change and changes in basic food sources. On the other hand, as animals' comfort zones will change with the effects of climate change, they will be forced to change their genetic structure in production, defense mechanisms against diseases and their struggle for survival. It is estimated that some animal species with high adaptation abilities to climate changes have a high chance of survival, so their production will become widespread and people's consumption habits may change. In order to ensure the sustainability of animal production, gene regions resistant to heat stress should be identified and breeding studies should be carried out to improve the physical environment and increase the genetic resilience of animals in order to minimize the negative effects of climate change. The adaptation mechanisms underlying the genes of animals to adapt to new environments that will occur with climate change, and genes that are successful in such areas, are of vital importance for investigating the future selection programs of these animals. Animals that have high adaptation to climate change and have good survival and reproduction tolerance levels in extreme living conditions should be selected and bred to ensure that they become the parents of future generations. There is a need for more research in this field to investigate the effects of climate change and to conduct more scientific studies to minimize these challenges disapprovals. Global warming and climate changes are serious problems that affect the entire ecosystem and await solutions. In order to leave a more livable environment to future generations, acting responsibly at every stage from production to consumption will be the key to the solution.

**Keywords:** Climate change, Farm animals, Productivity, Reproductive performance

## Introduction

Climate change refers to changes beyond average atmospheric conditions caused by natural factors, such as Earth's rotation, volcanic activity and crustal movements, and artificial factors, such as increased concentrations of GG and aerosols (ESCAP, 2012).

Scientific evidence suggests that climate change is increasingly impacting life on this planet. Average temperatures will rise, precipitation patterns will change, and extreme weather events such as hurricanes, floods, droughts, and heat waves will become more frequent and intense. These processes will not happen in the future - they are happening now. In this context, climate change mainly affects animal production, as it depends on the weather (Oyhantçabal et al., 2010)).

The livestock sector is vital to most developing countries' nutrition and economic income and contributes 40 percent to the Gross Domestic Product (GDP). The increase in the world population and the development of balanced nutrition awareness increase the demands for animal-based foods and require the expansion of the livestock sector (FAO, 2009). The quantity and quality of animal products decrease as extreme climatic conditions reduce the amount and quality of feed produced and negatively affect animal welfare (Sejian et al., 2012). Animals reared in tropical environments are exposed to multiple stress factors simultaneously, and their production, reproduction and immune status are strongly affected. It is difficult to investigate, manage and interpret the effects of multiple environmental factors on livestock. Combined stress factors negatively affected the growth and reproductive traits of livestock. Furthermore, these animals' acclimatization mechanisms differed for individual stressors compared to combined stressors (heat and nutrition) (Sejian et al., 2010 and 2011). Thus, when multiple stressors are combined, the impact on the biological functions required for adaptation and maintenance (Sejian, 2013). Therefore, any research on climate change's effects on livestock should pay attention to multiple stressors. It is foreseen that climate change will lead to an increase in global temperature. In some parts of the world, this problem is likely to increase heat stress in livestock and require adjustments in farming and production strategies. However the high-yield breeds that increasingly dominate global livestock production often do not adapt well to heat stress. As a solution to the adaptation problems of animals, expensive cooling systems are built to improve environmental conditions in their living spaces, and diet adjustments are made to reduce metabolic heat production. These practices protect animals from the adverse effects of the environment. However, the expenses incurred by growers to reduce the negative effects of environmental factors may be insufficient after a certain point.

For this reason, the importance of animals that can adapt well to climate change is expected to increase (Pilling and Hoffmann, 2011). Conventional production systems have the advantage of growing and producing with animals that are well adapted to harsh conditions and without using expensive inputs. In these systems, most livestock keepers are also experienced in facing extreme and variable environmental conditions. However, their dependence on local natural resources makes them vulnerable to problems such as reduced access to feed or the emergence of unfamiliar diseases or parasites. Conventional livestock operations face challenges such as increasingly limited natural resources, which may be exacerbated by climate change. (Pilling and Hoffmann, 2011).

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**Climate Change Impact on Growth**

The main goal in livestock production is to achieve maximum growth and productivity, such as milk or wool, within the framework of efficient use of feed and other essential resources and inputs. Animal growth can be defined simply as an increase in size. However, increasing size has many implications. If we are referring to the growth of the whole animal or the growth of cells, tissues and organs or the growth before and after birth or before and after puberty, we can look at the growth very differently. As an animal grows from conception to maturity, body proportions and composition change because the growth rates of different body organs and tissues differ from the growth of the whole animal. The order of development of different tissues

is similar for all species of farm animals. It appears to be based on the relative importance of the functions of body parts or tissues for the animal's survival (Beitz, 1985).

It is generally accepted that the climate is changing around the world and that this impacts animal production. The most frequently mentioned effects of climate change or global warming on animals are decreased survival, reproductive performance, disease resistance, productivity decrease, and feed resources. Additionally, their animals contribute to climate change by producing 14.5% of total greenhouse gas emissions (GGE) (Cheng et al., 2022).

Growth, the increase in living body mass or cell proliferation, is genetically and environmentally controlled. Average Daily Gain (ADG) is influenced by factors such as available nutrients, hormones, enzymes, and environmental factors such as increasing ambient temperature (Hafez & Hafez, 2013).

**Feed Intake**

In animals exposed to heat stress, feed intake decreases, water consumption increases, and endocrine status may change, causing the animal's performance to decrease (Gaughan and Cawsell-Smith, 2015). Stressors outside animals' comfort zones reduce the animals' body weight, average daily gain, and body condition. A study determined a decrease in milk quality values, such as a decrease in milk production, a decrease in fat content, lower chain fatty acids, fat-free content, lactose, and an increase in palmitic and stearic acid content. Animals with high productivity are more affected by the harmful effects of environmental conditions. Adaptation to long-term stress factors can cause mutations in the genetic composition of animals and production losses. For this reason, increasing or maintaining current production levels in environmental conditions where the animal's physiology is challenged is not easy. Rather than trying to introduce "stress tolerance" genes into breeds with poor adaptation, it may be better to look at using local breed animals with high adaptability, albeit with lower production levels (as well as lower input costs) (Gaughan, 2015). Digesting feed produces a large amount of metabolic heat, increasing cows' body temperature. As the ambient temperature increases and body temperature also increases in the summer months, cows reduce their feed intake to reduce heat stress (Ammer et al., 2018), which causes milk production to decrease and milk content to change gradually. It has been reported that feed intake of dairy cows begins to decrease when the ambient temperature reaches 25 °C and decreases sharply when the ambient temperature exceeds 40 °C. Then feed consumption is approximately 20-40% less. This is regular consumption (Liu et al., 2019). Reducing feed consumption is one response to high ambient temperature. While there is a decrease in appetite, intestinal motility, and rumination under

increasing heat stress in ruminants, feed consumption is observed in lactating cows if the ambient temperature rises above 25-26°C and drops faster than 30°C. Goats are more tolerant to heat stress than other ruminants. However, their feed consumption decreases when the ambient temperature is 10°C above thermal comfort zones (Cheng et al., 2022).

**Effect of Heat Stress on Milk Production**

Animal production is the main component of food security. We obtain products such as milk, eggs, and meat, which are integral to any global food security policy. In addition, the global demand for these products is high and threatens to increase significantly in line with the increase in population and average per capita income (Oyhantçabal et al., 2010). Environmental stressors reduce body weight, average daily gain, and body condition of animals. A decrease in milk production is noted, and milk quality is affected: a decrease in fat content, lower chain fatty acids, solid-non-fat content and lactose. An increase in palmitic and stearic acid content is observed. In general, animals with higher production are the most affected. Adaptation to long-term stressors may be associated with production losses. Increasing or maintaining current production levels in an increasingly hostile environment is not sustainable. It may be better to look at using adapted animals, albeit with lower production levels (as well as lower input costs), rather than trying to introduce "stress tolerance" genes into non-adapted breeds (Gaughan, 2015). Heat stress is a non-specific physiological response of an animal to a thermal environment when the animal generates more heat than it can dissipate (Yang, 2014). Holstein is the most popular breed of dairy cattle in the world. In summer, the breed's ability to dissipate heat through skin evaporation is limited by its relatively low surface area to body weight ratio, underdeveloped sweat glands, and short, dense body surface hair, all of which affect milk production (Yang et al., 2010).

**Effect of Heat Stress on Reproduction**

High environmental temperatures negatively affect reproductive performance in both sexes of livestock. Therefore, it is inevitable that this situation will negatively affect both productivity and selection. Approximately %50 of the world cattle population is located in tropical regions. It is also estimated that heat stress causes economic losses in about %60 of the world's dairy cattle holdings. Heat stress affects the release of LH, FSH and progesterone during the estrous cycle and adversely affects egg cell development of animals. Exposure of poultry, rabbits and horses to high temperatures leads to decreased fertility in animals. Infertility problems due to heat stress are more common in male birds compared to females, while high temperature was found to be more effective in males with good semen quality (Nardone et al., 2010).

The general points that emerged in the studies conducted on reproduction can be listed as decreased fertility, prolonged first insemination period due to the inability to detect estrus and decreased pregnancy rate. At the same time, decrease in the amount of blood coming to the uterus due to high atmospheric temperature and increased body temperature and consequently increase in intrauterine temperature, decrease in fertilization rate, slowing of embryonic development and increase in early embryonic mortality (Lacetera et al., 2003).

**Impact of Heat Stress on Oocyte Maturation**

The adverse effects of heat stress on fertility are shown by changes in ovarian functions, egg fertilization ability, embryo development, formation and maintenance of pregnancy, and ultimately reducing the development of the embryo (Hansen, 2018). Pre-insemination heat stress is essential in reduced birth rates in cattle (Al-Katanani et al., 1999) and sheep (Dutt, 1963), which may reflect damage to the developing oocyte in infertility. The fact that oocyte competence, determined by the growth rate after in vitro fertilization (IVF), is lower in summer than in winter is attributed to the effect of heat stress (Rocha et al., 1998; Rutledge et al., 1999). There are several potential mechanisms by which heat stress may compromise oocytes. Heat stress alters follicular development by reducing steroid hormone production (Wolfenson et al., 1997; Wilson et al., 1998). Changes in follicular steroid concentrations impair oocyte development and heat stress reduces dominant follicle growth (Badinga et al., 1993). The growth of secondary follicles increases by suppressing their development with the dominant follicle (Wolfenson et al., 1995), which causes ovulation of low-quality follicles (Mihm et al., 1999).

**Impact of Heat Stress on Embryo Development**

Heat stress impairs embryo development and exacerbates embryo loss. Heat stress affects the embryo in the pre-attachment period, but the severity of the effect decreases as the embryo grows. Heat stress significantly reduces embryo survival from 0 to 3 or days 0 to 7 in pregnant cows. However, the effects of heat stress on fetal survival diminish as pregnancy progresses. In superovulating cows exposed to high temperatures on the first day of pregnancy, the viability and developmental characteristics of the embryos were inhibited on the eighth day of pregnancy. However, those exposed to high temperatures on days 3, 5, or 7 of pregnancy were not affected. This result shows that the detrimental effect of heat stress on embryonic mortality decreases with increasing embryo age. Increased resistance of the fetus against cell disorders caused by high temperature is present for the first few days of pregnancy (Kasimanickam et al., 2021). Heat stress reduces superovulation, limits the number of transferable embryos, disrupts

hormonal functioning, and reduces fertilization rates and embryo quality. It is also reported that the success of in vitro fertilization applications decreases when the environmental temperature is high. Heat stress reduces the apparent emergence of estrous behavior, reduces follicular development and, therefore the fertilization ability of the oocyte(s), and inhibits embryo development. Although the effects of heat stress are difficult to prevent, several strategies are available to improve embryo production during heat stress (Hansen et al., 2001).

**Strategies for Mitigation**

As an undesirable by-product, GGE occurs during the animal production cycle (FAO, 2009). The production and management of pasture food products leads to the emission of GG related to the production and use of chemical fertilizers and pesticides and the loss of soil organic matter. Most emissions occur due to the use of fossil fuels in the transportation of animal feed. Clearing forests to create pasture or cropland to grow animal feed releases large amounts of carbon into the atmosphere. Most emissions occur directly from animals during growth and production; ruminant animals emit methane as a by-product of microbial fermentation through which they digest fibrous feeds. Methane and nitrogen oxide emissions occur during animal manure storage and use. The processing and transportation of animal products lead to more greenhouse gas emissions, mostly related to fossil fuel use and infrastructure development. Various technical options are available to reduce the livestock sector's greenhouse gas emissions and increase carbon sequestration in land used for livestock production. These actions can be promoted differently as elements of climate change mitigation policy (Pilling & Hoffmann, 2011). In reality, it is almost impossible to implement the first solution to accurately measure the externalities of global warming and impose economic costs on specific emitters of greenhouse gases. In this context, the second solution for developing relevant policy programs and forming appropriate portfolios for the approach is proposed as a practical method using policy combination. Considering the given conditions realistically, greenhouse gas reduction tools are classified into economic, regulatory, voluntary agreement, research and development, publicizing, providing information, and promoting public awareness (ESCAP, 2012).

The extreme heterogeneity of the agricultural sector in overall sustainability should be considered in the greenhouse gas emission reduction strategy, which may vary according to different species-based livestock production systems, species, and climates. In general, no single measure captures the total emission reduction potential, while a selected combination of the full range of available options is required to achieve the best result (Llonch et al., 2017). It is also essential to consider the "pollution exchange" effect when evaluating the effectiveness

of a mitigation strategy (Gerber et al., 2013). Increased emissions of greenhouse gases in fertilizers may offset a reduction of methane emissions during enteric fermentation. Reduced direct $NO_2$ emissions during storage may result in more nitrate leaching and ammonia volatilization during field application (Grossi et al., 2019). Some mitigation measures reduce livestock greenhouse gas emissions, showing that livestock emission intensity varies greatly between production systems and regions and the potential for reduction in the gap between management techniques that result in the lowest and highest emission intensity (Gerber et al., 2013).

**Conclusion**

The complicated relationship between climate change and livestock production offers a multilayered challenge that demands careful consideration and positive measures. The scientific evidence overpoweringly indicates that climate change is not a future concept but an ongoing reality, exerting its influence on global temperatures, precipitation patterns, and the frequency of extreme weather events. This refers to having reflective implications for the livestock sector, an energetic component of agriculture, mainly in developing countries. Livestock, which is 40% of the agricultural GDP, is linked to weather patterns. The concurrent impact of multiple stressors, such as extreme temperatures and variations in fodder availability, poses significant threats to livestock welfare, reproduction, and overall productivity. Research in this area must shift towards lengthily lecturing the joint effects of these stressors, recognizing that simultaneous exposure may have more severe consequences. As the world grapples with the escalating effects of climate change, the livestock industry faces challenges and opportunities. High-input systems, reliant on advanced technology and foreign inputs, can implement strategies like cooling systems and dietary adjustments to mitigate the impact of rising temperatures. However, the vulnerability of these systems to potential cost increases due to climate change underscores the importance of diversification and resilience. While often better adapted to harsh conditions, traditional production systems confront their own challenges. Local resource dependence makes them susceptible to disruptions in forage supply and the emergence of new diseases. Pastoralists, lacking financial resources, need help adapting to climate change. Striking a balance between utilizing adapted animals and incorporating sustainable management practices becomes crucial in these systems. The global ramifications of climate change on feed production areas, responsible for 80% of all agricultural land, necessitate.

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# ÜLKEMİZDE YEREL BUĞDAYLAR VE ÖNEMİ

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## Özet
Türkiye coğrafi özellikleri ve çeşitli medeniyetlere ev sahipliği yapması nedeniyle bitki gen kaynakları açısından oldukça önemli bir ülkedir. Bu genetik kaynakların en önemlisi buğdaydır. Buğday, dünyada olduğu gibi ülkemizde de insan beslenmesinde vazgeçilmez gıdalardan biridir. Ülkemizin de içinde bulunduğu "Bereketli Hilal"de ilk kez kültüre alınan buğday, yaklaşık 12 bin yıldır hayvan beslenmesinin yanı sıra insan beslenmesinde de önemli bir kaynak olmuş, ekonomik, sosyal ve kültürel açıdan stratejik bir bitkidir. Yirminci yüzyılın başlarına kadar buğday çeşitleri çoğunlukla bölgeye iyi adapte olmuş yerel buğday çeşitlerden oluşmuştur. Daha sonra ıslah yöntemleri geliştikçe yerel buğday çeşitlerinin yerini yüksek tane verimine sahip, kısa boylu, yatmaya dayanıklı ve gübreye yüksek tepki olan modern buğday çeşitleri almıştır. Ancak son yıllarda pestisit ve gübre kullanılmadan üretilen yerel buğday çeşitleri, çiftçiler (yerel alışkanlık, yüksek gelir), fırıncılar/üreticiler (artisan fırıncılık ürünleri) ve tüketiciler (lezzet ve sağlık yararları nedeniyle) açısından yeniden önem kazanmıştır. Genellikle daha düşük tane verimine sahip olan yerel buğday çeşitleri, geniş bir genetik çeşitliliğe, daha yüksek bir adaptasyon yeteneğine ve yerel olarak arzu edilen bir tada sahiptir. Modern buğday çeşitleri, yerel çeşitlerle karşılaştırıldığında zaman içinde önemli miktarda tane verimi ve teknolojik kalite artışı göstermiştir. Yerel buğday çeşitleri nispeten daha düşük tane ağırlığına sahip olmaları nedeniyle daha yüksek protein içeriğine, mineral madde içeriğine (özellikle Zn ve Fe) ve fenolik bileşiklere sahiptir. Bu çalışmada yerel buğday çeşitleri farklı yönlerden değerlendirilmiştir.
**Anahtar Kelimeler:** Buğdayın yerel çeşitleri, bitki genetik kaynakları

# WHEAT LANDRACES AND THEIR IMPORTANCE IN OUR COUNTRY

**Abstract**

Turkey is a very special country in terms of plant genetic resources due to its geographical characteristics and hosting various civilisations. The most important of these genetic resources is wheat. Wheat is one of the stable foods in human nutrition in our country as well as in the world. Wheat is domesticated in the "Fertile Crescent" including our country. It has been an important source of human nutrition as well as animal nutrition for about 12 thousand years and is a strategic plant in economic, social and cultural terms. Until the beginning of the 20$^{th}$ century, wheat cultivars were mostly landraces that were well adapted to the region. Later, as breeding methods improved, wheat landraces were replaced by modern wheat cultivars with high grain yields, short plant height, without lodging, and high response to fertiliser. However, in recent years, wheat landraces, produced without using pesticides and fertilisers, have regained importance for farmers (local habit, high income), bakers/producers (artisan bakery products), and consumers (due to their taste and health benefits). Wheat landraces, having generally lower grain yields, have a wide genetic diversity, a higher adaptability, and a locally desirable flavour. Modern wheat cultivars have shown significant grain yield and technological quality improvements over time compared to landraces. Wheat landraces have higher protein content, minerals, especially Zn and Fe, and phenolic compounds because of having relatively lower grain weight. In this study, wheat landraces were evaluated from different aspects.

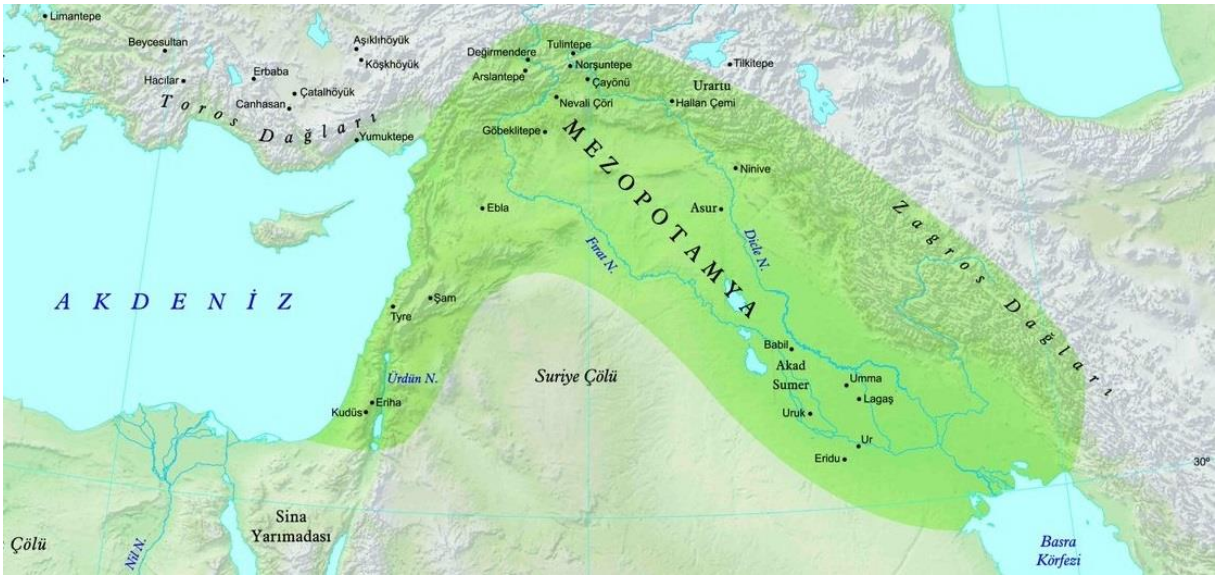
**Keywords:** Wheat landraces, plant genetic resources

## Giriş

Buğdayın anavatanı, Türkiye, İran, Irak, Suriye, Lübnan, Filistin ve İsrail'in bazı kısımlarını kapsayan ve 'Bereketli Hilal' diye adlandırılan bölgedir (Özberk et al., 2016a, Şekil 1). Arkeolojik kazılardan elde edilen verilere göre, buğdayın yetiştirilmesi günümüzden yaklaşık 12 bin yıl önce Türkiye'nin güneydoğusundaki Göbekli Tepe'de başlamıştır (Schmidt, 2007, Dietrich et al., 2012). Bu nedenle de geçmişten günümüze Anadolu topraklarında yaşamış tüm medeniyetlerde buğday önemli bir bitki olmuştur (Özberk et al., 2016b). Bu bölgeden göçlerle birlikte birçok yerel çeşit, çevresel ve kültürel koşullara uyacak şekilde çiftçiler ve doğa tarafından seçilmiştir (Hernández-Espinosa et al., 2019).

Yerel buğday çeşitleri Zencirci (2018) tarafından "çiftçiler tarafından geleneksel yöntemler kullanılarak geliştirilen, doğal seleksiyonun da etkisiyle belli bir yöreye uyum sağlamış olan popülasyon niteliğine sahip genotipler" olarak tanımlanmıştır. Özberk et al. (2016b) tarafından ise "Yerel çeşitler (köy çeşitleri) bilindiği gibi doğal ve yapay seleksiyon baskısı altında hayatta kalan, yerel damak zevkine uygun çoğunlukla popülasyon yapısında olan dış görünüşleri benzer bireyler topluluğu" olarak tanımlanmıştır. Ülkemizde Yerel Çeşitlerin Kayıt Altına Alınması, Üretilmesi ve Pazarlanmasına Dair Yönetmelik ilk kez 3 Eylül 2019 gün ve 30877 sayılı Resmî Gazetede yayımlanmıştır. Bu Yönetmelik'le, ülkemizdeki tarla ve bağ-bahçe bitkileri ve diğer bitki türlerine ait yerel çeşitlerin korunmasını sağlamak ve genetik erozyonlarını engellemek amacıyla; yerel çeşitlerin kayıt altına alınması, tohumluklarının çoğaltımı, pazarlanması, idamesi ve sürdürülebilir kullanımı ile ilgili kurallar getirilerek ticareti yapılacak yerel çeşit tohumluklarının üretimi ve bunların piyasaya arzı ve bu konudaki denetimlere ilişkin usul ve esaslar belirlenmiştir (Anonim, 2019).

Anadolu topraklarında yaklaşık 12 bin yıldır yapılan buğday tarımı, avcı-toplayıcı insan topluluklarının yerleşik hayata geçişinde ve küçük yerleşim yerlerinin büyük şehirlere dönüşmesinde, yani Anadolu tarihinde oldukça önemli bir rol oynamıştır (Özberk et al., 2016a).




Şekil 1. **Bereketli Hilal (Özberk et al., 2016a)**

20. yüzyılın başına kadar buğday çeşitleri ağırlıklı olarak yetiştirildiği koşullara iyi adapte olmuş yerel çeşitlerden oluşmuştur. O zamandan günümüze, ıslah yöntemleri geliştikçe, yerel çeşitler, modern buğday çeşitlerinin geliştirilmesinde genetik kaynağı olarak kullanılmaktadır. İkinci Dünya Savaşı'ndan sonra yoğunlaşan buğday ıslah çalışmaları ile yerel çeşitler yerini, yüksek verimli, kısa boylu-yatmayan, gübreye tepkisi fazla, kavuzun ayrılması için ayrı bir işlem gerektirmeyen modern ekmeklik ve makarnalık buğdaylara bırakmıştır (Özberk, 2010; Lognin et al., 2016). Bu da buğdayda genetik çeşitliliğinin azalmasına neden olmuştur (Bordes et al., 2008). Fakat son yıllarda, tarımsal ilaç ve gübre kullanılmadan doğal şartlarda üretilen yerel çeşitler; çiftçiler (yöresel alışkanlık, yüksek gelir, siyez bulguru gibi), fırıncılar/üreticiler (artisan fırıncılık ürünleri) tüketiciler yönüyle yeniden önem kazanmıştır (Longin et al., 2016). Yerel çeşitlerin yerini çoğunlukla modern buğday çeşitleri almış olsa da yerel çeşitlerin bazı avantaj ve dezavantajları vardır. Bunlara değişik başlıklar altında değinilecektir.

**Genetik Kaynak Olarak Kullanımı ve Bitki Islahı**

Yerel buğdaylar bitki genetik kaynaklarında önemli bir yere sahiptir. Buğdayın ilk defa kültüre alındığı Güneydoğu Anadolu Bölgesinde, halen kültürü yapılan birçok tahılın yabani ataları doğal olarak bulunmaktadır (Nesbitt & Samuel 1996; Özberk et al., 2016a). Bu nedenle ülkemizde doğal olarak yayılış gösteren genetik kaynaklar, birçok yerli ve yabancı araştırmacının ilgisini çekmiş olup, bu ilgi günümüzde de devam etmektedir. Türk bilim insanı Mirza Gökgöl, dünyada genetik kaynakların öneminin yeni yeni anlaşılmaya başladığı dönemlerde, bu konuda önemli çalışmalar yapan Rus bilim insanları Vavilov ve Zhukovski ve

Amerikalı bilim insanı Harlan ile eş zamanlı olarak Türkiye genelinde binlerce buğday materyali toplamıştır. Bu örneklerin tanımlanmasıyla 1935 yılında 18 binden fazla farklı tip ve 256 yeni buğday varyetesi (çeşidi) belirlenmiştir (Özberk et al., 2016a).

Türkiye'de buğdayın yabani akrabalarından doğal evrim, insan tarafından yapılan seçilimler veya doğal melezlenmeler sonucu önce kavuzlu kültür formları, ardından da çıplak taneli kültür formları oluşmuştur (Özberk et al., 2016a). Yetiştirilen ilkel kültür buğdayları, çeşit grupları ve bunların ploidi seviyeleri Şekil 2'de verilmiştir.

| Türler | Türkçe İsimleri | Çeşit Grubu | Ploidi* Seviyesi |
|---|---|---|---|
| *T.monococcum* L. | Kaplıca= Siyez | Siyez | Diploid |
| *T.turgidum* L. | Gernik= Çatal Kaplıca, Çatal Siyez | *dicoccon* | Tetraploid |
| | Makarnalık buğday | *durum* | Tetraploid |
| | Asıl makarnalık | *durum* ssp. *commune* | Tetraploid |
| | Makarnalık topbaş buğday | *durum* ssp. *duro-compactum* | Tetraploid |
| | Kaba buğday (=Kaba tahıl) | *turgidum* | Tetraploid |
| | Turna gagası buğday | *polonicum* | Tetraploid |
| | Doğu buğdayı | *carthlicum* | Tetraploid |
| *T.timopheevi* | Rus buğdayı | Rus buğdayı | Tetraploid |
| *T.aestivum* L. em Thell spelta | Kavuzlu buğday | *spelt* | Hekzaploid |
| | Dallı buğday | *vavilovi* | Hekzaploid |
| | Ekmeklik buğday | *aestivum* | Hekzaploid |
| | Topbaş ekmeklik buğday | *compactum* | Hekzaploid |
| | Cüce buğday | *sphaerococcum* | Hekzaploid |
| | Maha buğdayı | *macha* | Hekzaploid |

**Ploidi (poliploitlik) seviyesi: Somatik hücrelerde temel kromozom sayısının birkaç tam katı kadar kromozom taşıma seviyesi (2n= 2x=14 diploid, 2n=4x= 28 tetraploid ve 2n=6x= 42 hekzaploid).*

Şekil 2. **İlkel Kültür Buğdayları, Çeşit Grupları ve Ploidi Seviyeleri (Kün, 1981)**

Türkiye'de 1950'lerde üretilen buğdayın yaklaşık üçte biri makarnalık buğday, geri kalanının büyük bir kısmı ekmeklik buğday ve az bir kısmı da topbaş ekmeklik buğday olarak kayıtlara geçmiştir. Bu yıllarda Doğu Anadolu, Orta Anadolu ve geçit bölgelerinde ekilen yerel ekmeklik buğdaylar, altı botanik varyete içerisinde yer almaktadır. Günümüzde yerel makarnalık buğday çeşitlerinin %40-50'si Orta Anadolu'nun doğu, batı, kuzey ve güney geçit bölgelerinde ekilmektedir (Özberk et al., 2016a). Ülkemizde yürütülen bir çalışma kapsamında 65 ilde toplanan yerel buğday popülasyonu materyalinin %58'i ekmeklik, %38'i makarnalık ve %4'ü ise yemlik olarak sınıflandırılmıştır (Kan et al., 2017). Türkiye'de ilk sıralarda yer alan buğday popülasyonları; Zerun, Kırmızı buğday, Ak buğday, Sarı buğday, Karakılçık, Siyez, Kırık, Koca buğday, Şahman, Topbaş, Üveyik ve Göderedi'dir (Kan et al., 2017). Ekmek yapımı için

kullanılan olan yerel buğdaylar, Zerun, Kırmızı Buğday ve Kırik iken, bulgur yapımı için kullanılan yerel buğdaylar ise Siyez, Şahman ve Sarı Buğdaydır (Kan et al., 2017). Baklavalık un için Köse, Zerun ve Mısri, Aşurelik/dövmelik buğday için ise Karakılçıktır (Özberk et al., 2016a).

Özellikle Yeşil Devrim sonrasında yerel buğday çeşitlerinin ekim alanları büyük bir hızla azalmış, hatta bazı yörelerde tamamen ortadan kakmıştır (Özberk et al., 2016b).

Dr. Borlaug'a 1970 Nobel Barış Ödülü'nü kazandıran Yeşil Devrim ile; azotlu gübre kullanımında yatmaya dirençli, fazla uzun olmayan yeni buğday çeşitleri ile küresel buğday verimi en az ikiye katlanmıştır. Buğday üretimindeki bu süreç kısaca aşağıdaki gibi gelişmiştir (Perkins, 1997).

i) Japon bilim insanları 19. yüzyılda Daruma isimli yerel buğday çeşidini Kırmızı Kışlık Türk buğdayıyla melezleyerek verimli Norin 10 çeşidini geliştirmiştir (Powell et al., 2013).
ii) Amerikalı bilim insanları ise, Norin 10 çeşidini Brevor (yerel Amerikan çeşidi) ile melezleyerek oluşan hatları Meksika'ya götürmüştür.
iii) Bu buğdaylar Dr. Borlaug ve ekibi tarafından Meksika'da denemelere alınarak verimi yüksek buğday çeşitleri elde edilmiştir (Özberk et al., 2016a).

Ülkemiz ekonomisinde çok önemli bir yere sahip buğdayda çeşit geliştirilmesi ilk kez Eskişehir Tohum Islah İstasyonu'nda 1925 yılında başlamıştır (Altay, 2006). İlk yıllarda bölgeden toplanan köy çeşitleri üzerinde yapılan seleksiyon ve adaptasyon çalışmaları ile öncelikle ekmeklik ve makarnalık çeşit ihtiyacının karşılanması hedeflenmiştir. 1950'li yıllara kadar ülkenin çeşit ihtiyacını karşılayan yerel çeşitler, genellikle uzun boylu, yatmaya eğilimli, gübreye tepkisi zayıf, yaprak hastalıklarına genel olarak hassas ve verimi sınırlıydı (Özberk et al., 2016b). Genel olarak popülasyon olan bu çeşitlerin tane kalitesi ve adaptasyonu tatmin edicidir. Fakat, 1950'li yıllarda makineli tarımın yaygınlaşması, sulama imkanlarının ve gübre kullanımının artmasıyla çeşitte aranan özellikler değişmiştir. 1960-70 yıllarında yeşil devrim ile dünyada olduğu gibi ülkemizde de yarı cüce çeşitlerin yaygınlaşmasıyla yerel x yerel çeşit melezleri yerlerini modern x yerel çeşit melezlerine bırakmışlar (Özberk et al., 2016b). Cumhuriyetin kuruluşunu takip eden 1925'li yıllardan itibaren köy çeşitlerden seleksiyon ıslahı yapılarak geliştirilen ekmeklik buğday çeşitleri; Ak 702, Ankara 093-44, Sertak 52, Köse 220-39, Sivas 111-33, Yayla 305, makarnalık buğday çeşitleri ise Akbaşak 073-44, Sarıbuğday 710,

Sarıbursa 7113, Kunduru 414-44, Karakılçık 1133, Kunduru 1149 ve Fata "S" 185-1'dir (Salantur, 2018).

Yerel buğday popülasyonlarında varyasyon oldukça yüksek olup, yerel genotipler erkencilik, koleoptil uzunluğu, tuza tolerans, kurağa ve hastalıklara dayanıklılık, protein oranı, mineral madde içeriği, antioksidan ve lutein miktarlarının artırılması bakımından ıslah çalışmalarında gen kaynağı kullanılmaktadır (Salantur, 2018). Verimli ve kaliteli buğday yetiştirmeye elverişli bir ekolojiye sahip olan ülkemizde, günümüzde 449 adet ekmeklik buğday (*T. aestivum* L.), 108 adet makarnalık buğday (*T. durum* Desf.), 3 adet kaplıca buğdayı (*T. monococcum* L.), 2 adet kavılca buğdayı (*T. dicoccum* L.) ve 2 adet kavuzlu buğday (*T. spelta* L.) olmak üzere toplamda 564 adet tescilli buğday çeşidi bulunaktadır (TTSMM, 2023).

Anadolu'da yerel çeşitlerin yetiştirilmesinde binlerce yıllık bir deneyimin bir sonucu olarak çiftçiler çoğu çeşide ayırt edici özelliklerine göre farklı isimler vermişlerdir. Gökgöl (1939) tarafından belirlenen isimler esas alınarak yapılan derleme sonucunda; çeşitlerin %26.9'unun tane rengine, %18.5'inin ekim zamanına (kışlık-yazlık), %7.7'sinin menşeine, %5.6'sının başak özelliklerine ve %3.0'ünün ise tane özelliklerine göre isimlendirildiği belirtilmiştir (Morgounov et al., 2016).

**Tane Verimi**

Üreticilerin yeni buğday çeşitleri ile yerel buğday çeşitleri arasında seçimini etkileyen en önemli faktörlerden biri birim alandan elde edilen tane verimidir. Geleneksel üretim koşullarında tane verimi açısından yeni çeşitlerin yerel çeşitlere göre mutlak bir üstünlüğü bulunmaktadır. Çünkü yeni buğday çeşitleri genel olarak verimli şartlara yani geleneksel tarım sistemlerine göre ıslah edilmişlerdir. Özellikle kısa boylu buğday çeşitlerinin ıslahı yeşil devrime yol açmış, fazla gübre ve su kullanımından dolayı bu buğdayların yatma riski neredeyse hiç kalmamıştır (Kaplan Evlice ve Akkaya, 2020).

Buğday dünyada temel gıda maddesi olarak yerini korumakta olup, ekmek gibi buğdaya dayalı gıda maddeleri özellikle gelişmekte olan ülkelerin enerji ihtiyacının büyük bir kısmını karşılamaktadır. Gıda güvenliği açısından verimli yeni buğday çeşitlerinin yetiştirilmesi oldukça önemlidir. Bu nedenle buğdayın dünyada üretimi ve ticareti büyük önem kazanmaktadır. Dünya buğday üretimi 2021-2022 üretim sezonunda 790 milyon ton, ticareti ise 181 milyon ton olarak gerçekleştirmiştir (TMO, 2023). Ülkemizde 2021-2022 üretim sezonunda yaklaşık 5.4 milyon ha ekmeklik, 1.2 milyon ha makarnalık buğday ekilmiştir. Ekmeklik ve makarnalık buğdaylara ait üretim miktarları ise sırasıyla yaklaşık 16.0 ve 3.8

milyon ton'dur. Ekmeklik buğdayın verimi 2960 kg/ha iken, makarnalık buğdayın verimi ise 3140 kg/ha olarak gerçekleşmiştir (TÜİK, 2023).

Yakın dönemlerdeki çalışmalarda yerel buğday çeşitlerinin ekildiği alanların günden güne azalmaktadır (Karagöz, 2014; Kan et al., 2015; Morgounov et al., 2016). Yerel buğday çeşitlerinin ekiliş alanlarına ilişkin resmi bir istatistiki veri bulunmamakla birlikte, Türkiye'de yerel buğday ve arpa ekim alanlarının 565.312 ha kadar olduğu tahmin edilmektedir (Karagöz, 2014; Özberk et al., 2016b).

**Organik Tarım**

Geleneksel tarımda kullanılan kimyasalların çevre ve insan sağlığına olumsuz etkileri organik tarıma olan ilgiyi giderek artırmaktadır. Organik tarım dünyada son 15 yılda giderek artmış (Ponti et al., 2012), ülkemizde de benzer bir durum yaşanmıştır. Ülkemizde 2005 yılında organik tarımla uğraşan üretici sayısı 14.401, organik tarım yapılan arazi alanı 203.811 ha (doğal toplama alanları dahil), organik bitkisel üretim miktarı ise 422 bin ton iken, bu rakamlar 2017 yılında sırasıyla 75.067 kişi, 543.033 ha ve 2.4 milyon tona ulaşmıştır (Anonim, 2018).

Organik buğday, ülkemizin toplam buğday ekim alanı ve üretim miktarı içerisinde oldukça düşük bir paya sahiptir. Organik üretimin çeşitli zorlukları olmasına rağmen, ülkemiz insanının temel besin kaynağı olan buğdayda da organik üretime yer verilmelidir (Kaplan Evlice ve Akkaya, 2020). Organik buğday tarımında verimin %20-30 kadar düşük olması (Mader et al., 2002; Aydın et al., 2010), organik buğday tarımının geleneksel buğday tarımına göre en zayıf yönüdür. Ancak, verim farkı sınırlarının yetiştirme tekniği, iklim koşulları gibi çeşitli faktörlere bağlı olarak değiştiği, geleneksel tarımda verim düştükçe organik tarım ile arasındaki verim farkının da azaldığı belirtilmektedir (Ponti et al., 2012).

**Yerel Ürünler ve Kalite**

Buğday, mineraller ve B vitamini gibi mikro besin maddeleri açısından oldukça zengin olup, dünya nüfusunun enerji ihtiyacının yaklaşık %20'sini karşılamaktadır (Cummins & Robert-Thomson, 2009). Bu oran gelişmiş ülkelerde daha az iken, gelişmekte olan ülkelerde daha fazladır. Son yıllarda hem dünyada hem de ülkemizde sağlıklı gıdalara olan ilginin artmasıyla birlikte yerel buğday çeşitleri giderek popüler hale gelmektedir. Yerel çeşitler modern buğday çeşitlerine göre daha az verime sahip olsa da, tüketiciler yerel çeşitlerden elde edilen ürünlerin tat, lezzet ve aromalarının farklı olduğunu belirtilmektedir (Kan et al., 2017).

Yerel buğday çeşitleri verim açısından modern çeşitlerle rekabet edemeseler de bazı besin elementleri bakımından daha zengindir. Islah çalışmaları sonucu geliştirilen modern buğday çeşitlerinin mikro element içeriği yerel buğdaylarınki ile karşılaştırıldığında, yerel buğday çeşitlerinin modern buğday çeşitlerinden daha fazla mikro element içeriğine sahip olduğu belirtilmiştir (Shewry, 2009). Yerel buğdayların mineral madde yanında protein, karotenoid gibi içerikleri de yeni çeşitlerden daha yüksektir (Piergiovanni et al., 1997; Erba et al., 2011). Sağlığa yararlı ve fitik asit gibi antibesinsel bileşenlerin büyük bir kısmı tanenin kepek ve embriyo kısımlarına lokalize olmuştur. Tanenin bu bölümlerinin oranı, modern buğday çeşitlerine göre genellikle küçük veya cılız tane yapısına sahip olan yerel buğdaylarda daha fazladır. Bu nedenle de yerel buğdaylar bu bileşenler bakımından daha zengindir. Ayrıca, yerel buğdayların kök derinliği çoğunlukla modern buğdaylara göre daha fazla olup, toprağın derin katmanlarındaki su ve besin maddelerinden daha fazla yaralanabilmektedir. Bu iki faktör yerel buğdaylarda bu besinsel bileşenlerin neden daha fazla olduğunu açıklamaktadır.

Ülkemizde yerel buğdaylar, çok eski zamanlardan beri çoğunlukla ekmek ve bulgur olarak tüketilmektedir. Fakat, yerel buğdayların kalitesi ve besleyicilik değeri üzerine sınırlı sayıda çalışma yapılmıştır. Bu yönde yapılan bir çalışmada, modern ekmeklik, makarnalık ve yerel buğdaylar bazı kalite parametreleri bakımından karşılaştırılmıştır. Çalışma sonucunda, ortalama olarak daha yumuşak tane yapısına sahip olan yerel buğdayların bin tane ağırlığı daha düşük çıkmıştır. Ayrıca, yerel buğdayların tane protein oranı ve *b* sarılık değeri, ekmeklik buğdaya benzer fakat makarnalık buğdaydan daha düşük bulunmuştur. SDS sedimentasyon değeri ise makarnalık buğdaydan daha yüksek, ekmeklik buğdaydan daha düşük olmuştur (Şanal, 2017). Mineral madde bakımından 86 adet yerel buğday ve 14 adet tescilli buğday çeşidini karşılaştıran bir başka çalışmada ise; yerel buğdaylardan seçilen bazı saf hatlar, kültür çeşitlerine göre daha fazla Fe, Zn ve Mn (sırasıyla % 9.25, 14.82 ve 6.75) içermiştir (Akcura ve Kokten, 2017). Yine aynı araştırıcı tarafından yürütülen bir başka çalışmada; yerel buğday popülasyonlarından seçilen bazı makarnalık buğday saf hatlarının tane verimi, protein içeriği, mini SDS sedimentasyon değeri ve irmik rengi bakımından kültür çeşitlerinden üstün olduğu bulunmuştur (Akçura, 2009). Partigöç (2009) tarafından 2006-2007 üretim yılında Konya'da yürütülen tez çalışmasında ise; 20 adet yerel, 10 adet tescilli ekmeklik buğday çeşidi hem sulu hem de kuru koşullarda yetiştirilmiştir. Çalışmada yer alan genotiplerin bin tane ağırlığı 22.44 g ile 40.88 g arasında, tane protein oranı %12.09 ile %15.24 arasında, kuru gluten miktarı %10.10 ile %13.19 arasında, sertlik değeri (PSI) 28.63 ile73.88 arasında, mini SDS sedimentasyon değeri ise 8.75 ml ile 16.5 ml arasında değişim göstermiştir.

**Sonuç**

Yerel buğday çeşitleri genel olarak modern buğday çeşitlerine göre çok daha geniş bir genetik çeşitliliği temsil eder; dolayısıyla modern buğday çeşitlerinin genetik tabanının genişletilmesine rol oynamaktadır. Yerel buğday çeşitleri, bazı kalite özellikleri bakımından ıslah çalışmalarında ebeveyn olarak kullanılmaktadır. Daha düşük verime sahip olmasına rağmen biyotik ve abiyotik streslere karşı toleranslı olan yerel buğday çeşitleri, daha düşük girdi ile yetiştirilmektedir. Ayrıca, marjinal tarım alanlarında veya organik koşullarda yetiştirilen yerel buğday çeşitleri, modern buğday çeşitlerine göre çiftçilere daha yüksek gelir sağlamaktadır. Fakat, artan nüfusun gıda güvenliğinin sağlanmasında yüksek verimli modern buğday çeşitlerinin önemi unutulmamalı, yüksek tane verimi elde edilebilecek koşullarda yüksek verimli modern buğday çeşitleri yetiştirilmelidir.

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**Özet**
Kuluçkada başarılı koşulların oluşturulabilmesi ve civcivlerin çıkış sonrası performansının arttırılabilmesi için embriyonun gerek kuluçka döneminde gerekse çıkış sonrası ilk günlerde sarı kesesinden etkin bir biçimde yararlanması önem taşımaktadır. Bunun temel nedeni, kuluçkadan çıktıktan sonra etlik civcivler 36 ile 48 saat çıkış ünitesinde kaldıkları süre boyunca kalıntı sarı kesesindeki besin maddelerinden yararlanmaktadırlar. Alternatif bir erken besleme yöntemi olan in ovo besleme uygulaması da bu nedenden dolayı önem kazanmaktadır. Son yıllarda, etlik piliçlere gelişme hızı yönünde uygulanan yoğun seleksiyon sonucunda metabolik hızı artan embriyoların değişen besin madde ihtiyaçlarını karşılamak için in ovo besleme tekniğinin kullanıldığı birçok çalışma sonucu mevcuttur. Embriyonun in ovo aracılıklı beslenmesi kuluçkanın 17 ile 18. günleri arasında embriyonun amniyon kesesine amino asit, vitamin, mineral maddeler, antioksidanlar ve farklı etken maddelerin enjekte edilmesidir. İn ovo beslemenin amacı besin maddelerinin yumurtaya enjeksiyonunun amacı, civciv gelişimini hızlandırmak, bağışıklık sistemi ve sindirim sistem etkinliğini arttırmak, hormon ve enzim aktivitesine bağlı olarak birçok fizyolojik parametreyi olumlu yönde etkilemektir. Bu çalışmada, gelişmeye dayalı birçok fizyolojik sistemin artan etkinliği sayesinde etlik piliçlerde performansı artırmaya yönelik kuluçkada in ovo besleme konusundaki çalışma sonuçları irdelenmiştir.
**Anahtar kelimeler:** Etlik damızlık, in ovo besleme, amino asit, karbonhidrat, vitamin, mineral

# IN OVO FEEDING PRACTICES IN BROILER BREEDER EGGS

**Abstract**

It is important that embryo utilizes from its yolk sac both during incubation period and at the first days after hatching to create successful incubation conditions and to increase the post-hatching performance, The main reason for this is that broiler chicks effectively utilize from nutrients in the residual yolk sac during 36 to 48 hours after the hatching. In ovo feeding, which is an alternative early feeding method, is gaining importance for this reason. In recent years, there have been many studies about in ovo feeding used to meet the changing nutrient needs of embryos whose metabolic rate has increased as a result of intensive selection for growth rate in broiler chickens. In ovo-mediated feeding of the embryo is the injection of amino acids, vitamins, minerals, antioxidants and different active substances into the amniotic sac of the embryo between the 17th and 18th days of incubation. The aim of in ovo feeding is to accelerate chick development, increase the efficiency of the immune system and digestive system, and positively affect many physiological parameters depending on hormone and enzyme activity. In this study, the results of studies on in ovo feeding to improve the performance of broiler chickens by increasing the efficiency of many physiological systems based on development were examined.

**Keywords:** Broiler breeder, In ovo feeding, Amino acid, Carbonhydrate, Vitamin, Mineral

## Giriş

Etlik civcivlerin yumurtadan çıkış ağırlığı yaklaşık 40-45 g'dır. Kuluçkadan çıkıştan sonra ilk iki haftalık dönemde etlik civcivler hızlı bir canlı ağırlık artışı kazanarak kesim ağırlığının yaklaşık % 25 ile % 33 ünü bu dönemde kazanırlar (Leeson ve Summers, 2001). Yumurtadan çıkıştan sonra civcivlerin bağırsak ve kas gelişimleri de özellikle ilk haftalık yaşta oldukça önemlidir (Jin ve ark., 1998). Civciv gelişim dönemindeki bu değişiklikler, civcivlerin erken yaşlarda beslenmesindeki önemi ortaya koymaktadır. Kuluçka döneminde civcivin en önemli besin ve enerji kaynağı embriyonun sarı kesesi kuluçkanın sonuna doğru civcivin karın boşluğuna taşınır. Çıkış yapan etlik civciv yem ve su olmadan çıkış sonrası ilk 48 saat boyunca metabolik ihtiyaçları için gerekli enerjiyi kalıntı sarı kesede bulunan besin maddelerinden özellikle lipitlerden karşılar (Çelik ve Açıkgöz, 2006). Civcivin yemsiz ve susuz kaldığı bu dönemde erken besleme uygulamaları arasında yer alan kuluçkada in ovo besleme uygulaması civciv gelişimimi, sindirim sistem etkinliğini ve enerji metabolizmasını olumlu yönde etkilediği için (Uni ve Ferket, 2004) son yıllarda in ovo beslemeye yönelik uygulamalar konusunda birçok çalışma sonuçlanmıştır. Bu nedenle bu çalışmada, kuluçkada erken besleme etkisi ile gelişmeye dayalı birçok fizyolojik sistemin artan etkinliği sayesinde etlik piliçlerde performansı artırmaya yönelik in ovo besleme konusundaki çalışma sonuçları irdelenmiştir.

## İn ovo enjeksiyon yöntemi

İn ovo yöntem kuluçkalık yumurtaların uygun embriyonik gelişme döneminde embriyo veya ilgili embriyonik keselere çeşitli besin maddesi (karbonhidrat, aminoasit, antioksidan, vitamin, mineral) ve aşı enjekte edilmesine dayalı biyoteknolojik bir uygulamadır (Abdulqader ve ark., 2017; Babacanoğlu ve Cellak, 2018). İn ovo yöntemin, kuluçkada uygun embriyonik yaşlarda ve uygun embriyonik sitelere aşı ve besin maddelerinin enjeksiyonu sayesinde etlik civcivlerin sindirim sistem etkinliğinin artması, hastalıkların kontrolü ve iş gücünden tasarruf sağlanması gibi pek çok olumlu katkısı olduğu ortaya çıkmıştır (Sharma and Burmester, 1984). İn ovo enjeksiyon yöntemi ilk olarak 1970'li yılların sonunda kullanılmaya başlanmış ancak aktif olarak 1982 yılında marek aşısının etkinliğini saptamak amacı ile aşının orta/geç embriyo gelişim döneminde özellikle embriyoya (tüm keseler ve yumurtanın hava boşluğuna kıyasla) enjekte edilmesi ile bu yöntemin etkili olduğu bildirilmiştir (Sharma ve Burmester, 1982). Amerika'da 1990 yılında yüksek hızlı otomatik enjeksiyon sistemi uygulamalarda kullanılmıştır. Ancak, kanatlı hayvanlarda hastalık kontrolü ve çıkış gücünü artırmak için 1992'de çeşitli solüsyonlar ve enjektöre ait birtakım aparatların geliştirilmesi ile (Sheeks and

Sheeks, 1992) tam otomatik enjeksiyon sistemleri 1995 yılında kullanılmıştır (Sarma ve ark., 1995). Bu sayede, etlik damızlık yumurtalarına 1995 yılında in ovo aşı uygulaması 70.000 ve üstü başlıklı enjeksiyon aletleri ile uygulanmıştır (Sarma ve ark., 1995). Uni ve Ferket, (2003) tarafından 2003 yılında in ovo beslenme konusunda patent alınarak, in ovo besleme tekniği geliştirilmiştir. Dolayısıyla, in ovo yöntem in ovo uygulama ve in ovo besleme olarak sınıflandırılmıştır (Babacanoğlu ve Cellak., 2019). Kuluçkanın 0, 1, 7, 8, 11, 12, 13, 14, 15, 16, 17 ve 18. günlerinde in ovo uygulama kullanılarak etlik damızlıkların embriyo içeren yumurtalarına çeşitli besin maddeleri ve bileşikler enjekte edilmiştir (Babacanoğlu ve Cellak, 2019). Kuluçkanın 17. ve 18. günlerinin in ovo besleme uygulamalarında en uygun embriyonik yaş aralığı olduğu bildirilmiştir (Uni ve Ferket, 2003). İn ovo uygulama kuluçkadan önce yumurtaya veya kuluçkanın herhangi bir döneminde embriyonun amniyon sıvısı dışındaki diğer sitelere yapılan enjeksiyonların hepsini içine almaktadır. Bu siteler, kuluçkadan önce albümin, sarı ve hava boşluğu; kuluçka döneminde ise embriyo, hava boşluğu, sarı ve allantoik keselerdir (Keralapurath ve ark., 2010; Molenaar ve ark., 2010; Babacanoğlu ve Cellak., 2019). İn ovo uygulamada enjeksiyon sitesi yani uygulama yeri ve zamanına göre farklı çalışmalar bulunmaktadır. İn ovo uygulama özellikle sarı keseye uygulandığında hormon, aminoasit, karbonhidrat, vitamin ve arı sütü gibi gıda takviyelerin etkin olduğu, aşı uygulamaların ise en etkin olduğu sitenin amniyon sıvı ve embriyonun kendisi olduğu bildirilmektedir. Bu nedenle, in ovo uygulamada enjeksiyonun uygulama zamanı ve yerinin belirlenmesinde embriyonik gelişim aşamalarının bilinmesi önemlidir.

**İn ovo besleme**

İn ovo besleme etlik damızlıklara ait embriyoların özellikle amniyon kesesinin geliştiği dönemde amniyon sıvısına çeşitli solüsyonlar içerisinde verilen besin maddelerinin (karbonhidrat, aminoasit, vitamin, minarel, vd.) enjeksiyonuna dayalı bir in ovo yöntemdir (Babacanoğlu ve Cellak., 2019). İn ovo beslemede besin maddelerinin amniyon kesesinde bulunan amniyon sıvısına verilmesinin nedeni, embriyonun yumurtadan çıkmadan önce ağız yoluyla amniyon sıvısından beslenmesidir (Uni ve Ferket, 2003). Kuluçkanın ilk haftasında albüminden suyun yumurta sarısına geçmesinden dolayı yumurta sarı ağırlığı artar ve albümin ağırlığı azalır. Kuluçkanın 13.gününe kadar albüminden katı maddelerin kaybı devam eder ve bu maddeler amniyonun sıvı kısmına aktarılır ve daha sonra bu katı maddeler embriyo tarafından ağızdan alınarak sindirim işlemi ilk olarak başlar (Sunny, 2007). Çıkış yapan günlük civcivler kuluçkada 36, 48 ve hatta 72 saat kadar açlık durumu ile karşılaşır ve bu açlığın

oluşturduğu stres birçok olumsuz sonuçlar ortaya koyabilir. Çıkıştan sonra civcivin maruz kaldığı açlık süresi uzarsa sarı kese rezervleri yetersiz kalabilir ve gelişmede gerilik, düşük yem tüketimi, hastalıklara karşı direnç düşüklüğü ve et kalitesinde olumsuzluklar şekillenebilir (Uni ve Ferket, 2003). Bu olumsuzluklar civcivin iki veya üç günlük sınırlı besin madde rezervlerinin in ovo besleme yöntemiyle arttırılması sayesinde civciv gelişimine ait birçok özellik olumlu yönde aktive edilerek minimize edilmiş olur (Uni ve Ferket, 2003).

### 1.1.1. İn ovo beslemede kullanılan besin maddeleri

Etlik damızlıklara ait yumurtalarda bulunan embriyonun amniyon kesesine enjekte edilen bileşenler: karbonhidratlar, amino asitler, vitaminler, mineraller, antioksidanlar, organik asitler, nanopartiküller, antikorlar, probiyotikler, prebiyotikler ve/veya bunların kombinasyonları ile aşılardır. Amniyotik boşluğa in ovo enjekte edilen amino asitler: lizin, metiyonin, arjinin, metiyonin, treonin, glisin, valin; minareller: selenyum, çinko, bakır, manganez, demir, iyot; vitaminler ve yağ asitleri: vitamin A, D3, E, C ve pantotenik asit, linoleik asit bu bileşenlerden bazılarıdır (Bakyaraj ve ark., 2012). Kuluçkanın 18,5.gününde karbonhidratlar (Zhai ve ark., 2011), 18 ve 19. günlerinde propolis (Kop Bozbay, 2015), 17,5. gününde hydro-hidroksi-β-metilbütirat (Uni ve ark., 2005), 17. gününde nano çinko, bakır ve selenyum (Joshua ve ark., 2016) amniyon keseye enjeksiyonu yapılan uygulamalara ait çalışmalardır.

### İn ovo beslemede kullanılan besin maddelerinin etkileri

İn ovo beslemede kullanılan bileşiklerin enjeksiyonunun; çıkış gücünün artması, sindirim sistem etkinliğinin gelişimi (fizyolojik, morfolojik, mikrobiyota hızlandırılması), yem tüketiminin azalması, yemden yararlanmanın iyileşmesi, kas gelişiminin ve göğüs eti randımanının artması, ölüm oranının azalması, iskelet gelişiminin desteklenmesi, bağışıklık sisteminin güçlenmesi, canlı ağırlığın artması, stresin olumsuz etkilerinin giderilmesi gibi bir çok etkileri bulunmaktadır (Li ve ark.,2016; Zhai ve ark., 2011; Uni ve Ferket, 2003; Uni ve ark., 2005). Örneğin, etlik damızlık yumurtalarına in ovo amino asit besleme uygulamasının sarı kese amino asit düzeyini arttırdığı ve bu artışa bağlı olarak civcivlerin amino asitlerden etkin bir şekilde yararlanarak civciv gelişiminin arttığı bildirilmiştir (Ohta ve ark., 2001a,b). Yapılan bir diğer çalışmada, embriyonun amniyon kesesine glikoz ve fruktoz gibi karbonhidrat enjeksiyonlarının bağışıklık ve gelişme ile ilgili incelenen gen ekspresyon düzeylerini arttırdığını bildirmişlerdir (Bhanja ve ark., 2015). Etlik damızlık yumurtalarına kuluçkanın 18.5 gününde glikoz, fruktoz, sukroz, maltoz ve dekstrin enjeksiyon uygulamasının civcivlerin çıkış

ağırlığını arttırması sonucu in ovo karbonhidrat besleme uygulamasına örnek olarak verilecek bir araştırma sonucudur (Zhai ve ark., 2011). Kuluçkanın 17. gününde farklı seviyelerde organik çinko, bakır ve manganez kombinasyonuna ait in ovo enjeksiyonun tibia mineralizasyonunu önemli düzeyde artırması in ovo minarel besleme uygulamasına verilecek bir diğer örnek çalışmadır (Oliveira ve ark., 2015).

**Sonuç ve öneriler**

Sonuç olarak, etlik piliç yetiştiriciliğinde in ovo besleme tekniği kullanılarak kuluçkada beslemenin başlatılması ile gelişmeye dayalı birçok fizyolojik sistemin etkinliği arttırılarak performansı artan verimli piliçler elde edilmektedir. Ayrıca, in ovo besleme uygulamalarının etlik piliçlerin verim performansını ve üretim karlılığını önemli ölçüde arttırmasından dolayı kuluçka işletmelerinde in ovo besleme yönteminin uygulanabilirliğinin hızla artacak olması da irdelenen çalışma sonuçları ile ön görülmektedir.

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# DETERMINATION OF BIOGAS AMOUNT AND BIOMETHANIZATION ENERGY POTENTIAL OF ANIMAL AND AGRICULTURAL WASTES, THE CASE OF KIRŞEHİR-ÇİÇEKDAĞI

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**Abstract**
In parallel with the development of agriculture and animal husbandry, the potential of animal and agricultural wastes is increasing day by day. Although our country has a great potential in terms of agricultural wastes and animal wastes, these wastes cannot be used properly. A small part of it is kept in open areas for a long time and then used as fertiliser in agricultural areas. Animal wastes cannot be taken under regular control and unconsciously poured into cultivation areas, pastures, open areas and rivers, the biological structure of the soil is destroyed due to pollution. In addition, human and environmental health is threatened by excessive unpleasant odour and mosquito formation, especially in summer months. (Onurbaş Avcıoğlu et al. 2013). The need for energy increases with the technological developments in the world and in our country. As a result of this increasing need in recent years, humanity has turned to different energy systems. Exhaustible energy sources (oil, natural gas, coal, etc.) are unable to meet the need and the damage to the environment supports this orientation. Along with renewable energy sources, there has been a tendency towards energy obtaining methods that provide different and continuous use. Due to the large amount of organic wastes, domestic and animal wastes and the necessity to dispose of them, many countries have introduced legal obligations for the utilisation of these wastes. In this study, the amounts of animal waste and agricultural waste were determined for Çiçekdağı district of Kırşehir province. The economic energy equivalent values that can be obtained by using the biogas resulting from anaerobic fermentation of these wastes were determined. The number of cattle, ovine and poultry in Kırşehir Çiçekdağı district in 2023 is 21270, 46383 and 17850, respectively. The amount of animal waste obtained from these animals is 159421.1, 46734.2 and 221 tons, respectively. The amount of agricultural production in the district is 123159 tons and the amount of waste generated from agricultural production is 84026.5 tons. 1 ton of cattle manure can produce 33 $m^3$ biogas, 1 ton of poultry manure can produce 78 $m^3$ biogas, 1 ton of sheep manure can produce 58 $m^3$ biogas (Yaldız, 2004). The amounts of biogas that can be produced within the framework of the waste amounts mentioned above were determined as 5260896.3, 2710583.6, 17288 $m^3$/year from animal wastes, respectively. Biomethanization energy equivalent values were determined as 327.2 TEP/year from animal wastes and 133.22 TEP/year from wastes from agricultural production.
**Keywords:** biogas, biomethanization, renewable energy sources, biomethanization energy potential

## 1. Introduction

The need for energy is increasing with the technological developments in the world and in our country. As a result of this increasing need in recent years, humanity has turned to different energy systems. The fact that exhaustible energy resources (oil, natural gas, coal, etc.) have become insufficient to meet the need and the damage they cause to the environment supports this tendency. Along with renewable energy sources, there has been a trend towards different and continuous energy production methods.

In parallel with the development of agriculture and animal husbandry, the potential of livestock and animal and agricultural waste is increasing day by day. Although our country has a great potential in terms of agricultural waste and animal waste, these wastes cannot be used correctly. These wastes are burned directly or dispersed into the environment. A small part of it is used as fertilizer in agricultural areas after being kept in open areas for a long time. Animal waste cannot be taken under regular control and is unconsciously dumped into growing areas, pastures, open areas and rivers, thus destroying the biological structure of the soil due to pollution. In addition, human and environmental health are threatened by excessive unpleasant odor and mosquito formation, especially in the summer months. (Onurbaş Avcıoğlu et al. 2013).

**Biomass**

Biomass has a serious technical potential within the world's renewable energy potential. All substances of plant and animal origin, the main components of which are carbohydrate compounds, are called Biomass Energy Sources and the energy produced from these sources is called Biomass Energy. Vegetable biomass is formed as a result of green plants storing solar energy by converting it directly into chemical energy through photosynthesis. The energy generated annually through photosynthesis is approximately 10 times the world's energy consumption. Biomass provides heat, produces fuel and is also used to generate electricity. Biogas energy obtained from biomass was used for the first time in the world in the 19th century in England to illuminate street lamps using methane gas produced in septic tanks.

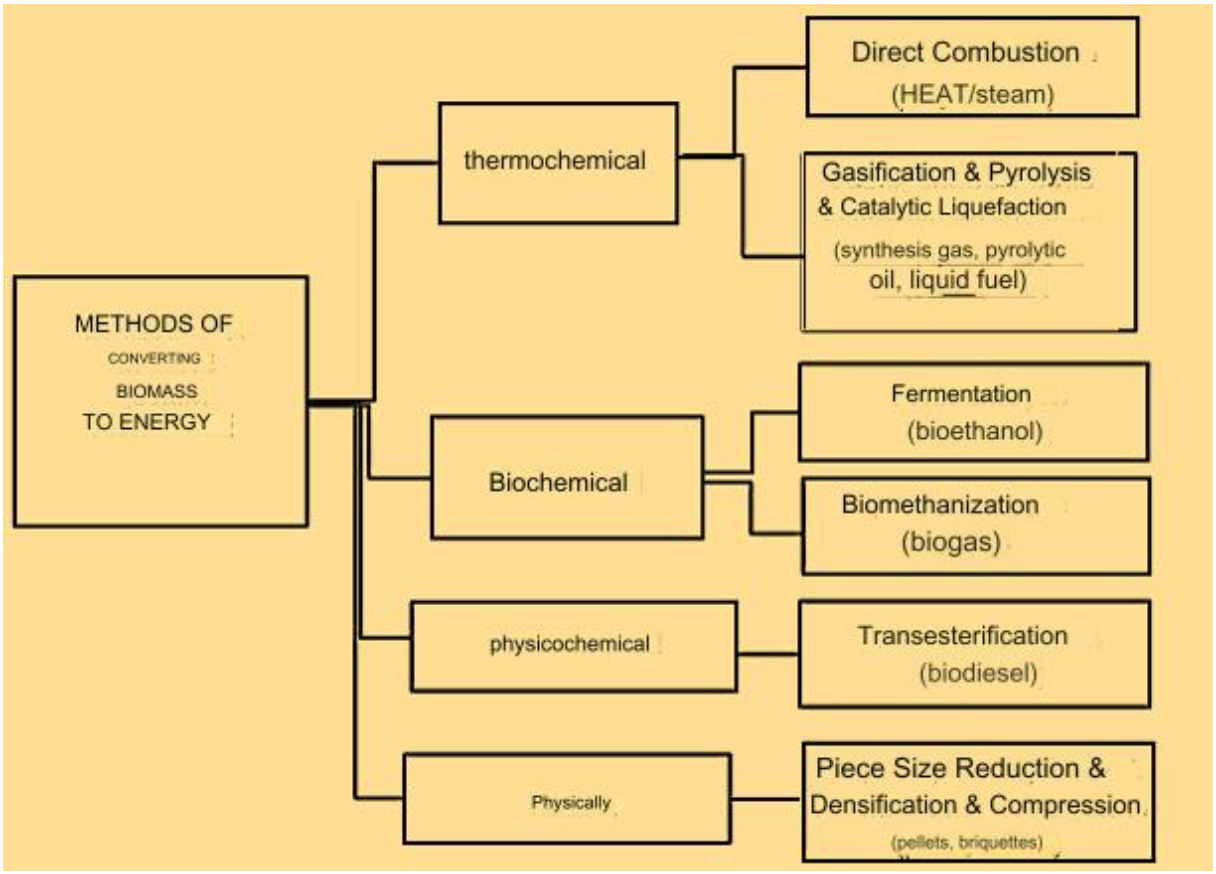


**Figure 1.1.** Biomass to energy conversion methods

According to the Biomass Energy Potential Atlas (BEPA) data prepared by our Ministry to determine the biomass energy potential, the total economic energy equivalent of our wastes that can be collected is approximately 3.9 MTEP/year.

The installed power based on biomass and waste heat energy is 2,172 MW as of the end of June 2022, its ratio in the total installed power is 2.14%, and the change in installed power by years and its ratio in the total installed power are shown in Figure 1.2. and is shown in Figure 1.3.

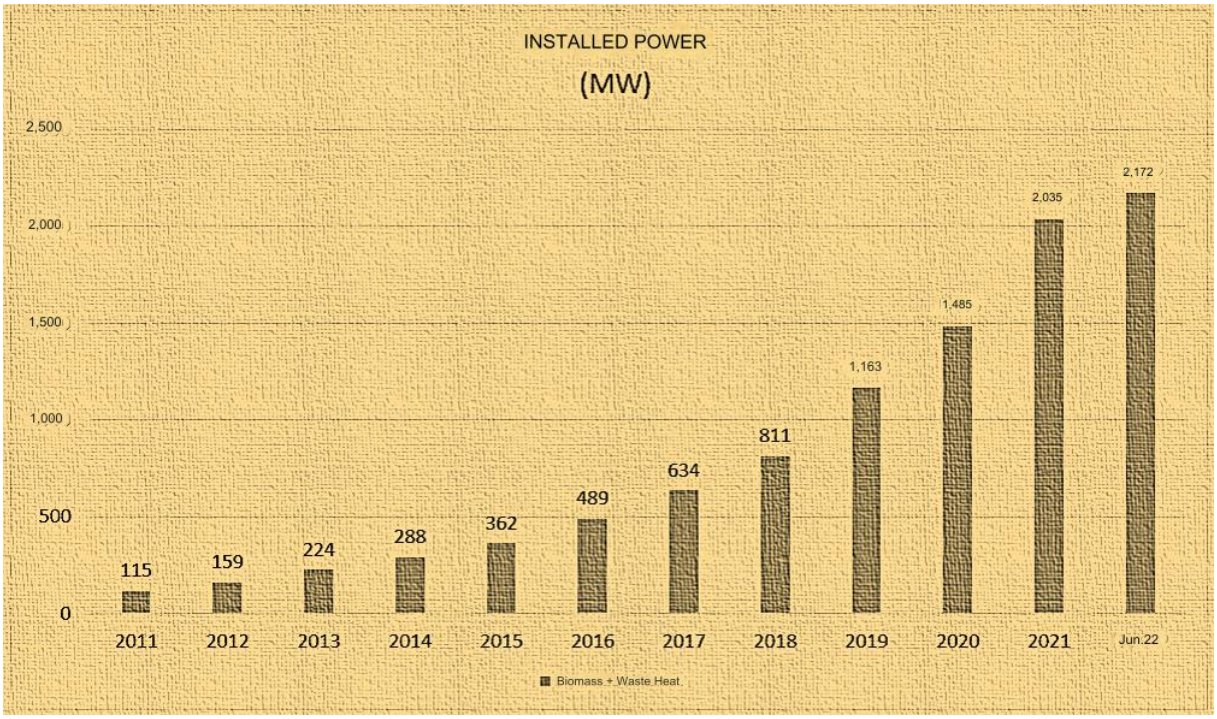


**Figure 1.2.** İnstalled power

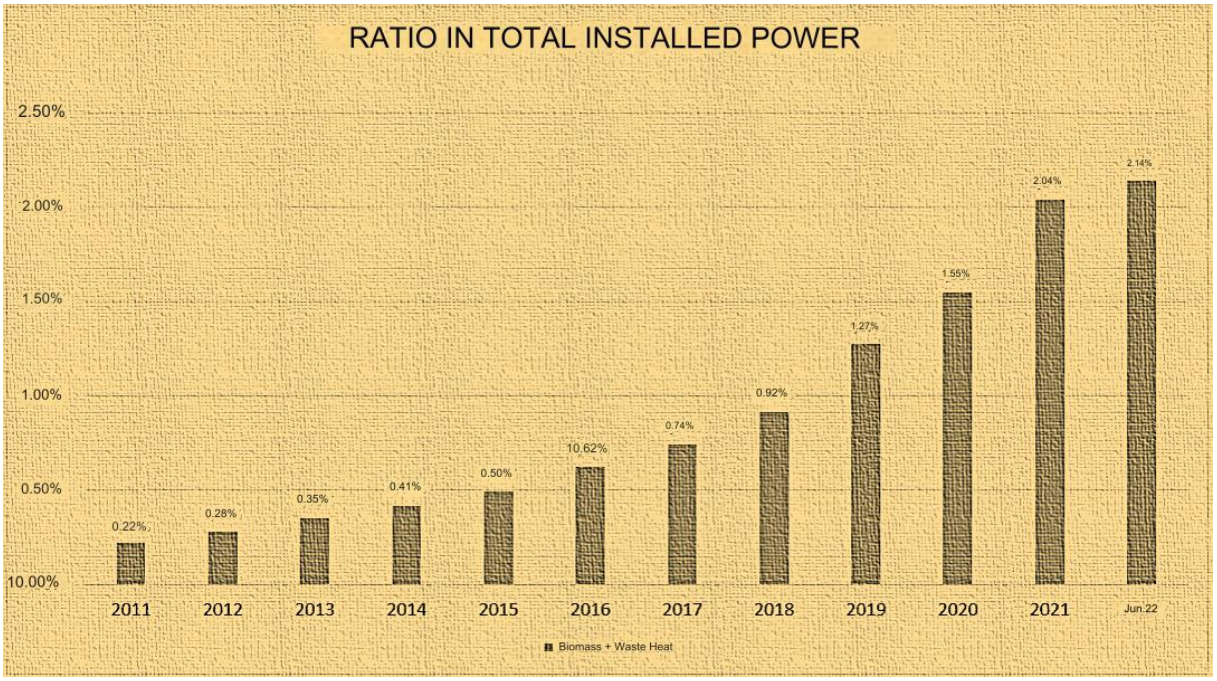


**Figure 1.3.** Ratio İn The Total İnstalled Power

**Biogas**

Biogas is a gas produced as a result of the reactions of methanogenic anaerobic archaea that break down organic matter. It is generally produced by anaerobic fermentation from highly charged wastewater rich in organic matter, domestic solid waste, agricultural and animal waste, and energy crops (Rulkens 2008). Methane gas, an important fuel source, is produced in the methanogenesis step. It is used in the production of mechanical, electrical and heat energy (Pind et al. 2003).

Biogas is a colorless and flammable gas that is formed as a result of the fermentation of organic materials such as plant and animal wastes in airless (oxygen-free) environments and contains 40-75% methane, 20-50% carbon dioxide and small amounts of hydrogen sulphide, hydrogen, water vapor, ammonia, carbon monoxide and nitrogen. It is a gas mixture. (Table 1.1.)

**Table 1.1.** Composition Ratios

| | Chemical Formula | Rate(%) |
|---|---|---|
| **Methane** | $CH_4$ | 40-75 |
| **Carbon dioxide** | $CO_2$ | 20-50 |
| **Water vapor** | $H_2O$ | 0.10 |
| **Nitrogen** | $N_2$ | 0-2 |
| **Oxygen** | that $_2$ | 0-0.5 |
| **Hydrogen** | $H_2$ | 0-1 |
| **Ammonia** | $NH_3$ | 0-0.5 |
| **Hydrogen Sulfide** | $H_2S$ | 20-4000ppm |

Due to the abundance of organic waste, domestic and animal waste and the necessity to dispose of them, many countries have introduced legal obligations for the evaluation of these wastes. In our country, there are many laws, regulations, directives, statutes, decree laws and international agreements regarding this issue.

In the regulation on the control of solid waste that came into force in our country in 1991, some methods and criteria on the subject have been limited and set forth. One of these methods in question is; Composting method is the process of decomposing organic waste by aerobic microorganisms. As a result of this process, methane gas, namely biogas, is obtained.

Table 1.2. Substances that can be used in biogas production and biogas yields (Yokuş, 2011)

| Source | Biogas Yield (Litre/kg) | Methane Rate (%) |
|---|---|---|
| Cattle Manure | 90-300 | 65 |
| Poultry Manure | 310-620 | 60 |
| Wheat Straw | 200-300 | 50-60 |
| Rye Straw | 200-300 | 59 |
| Barley Straw | 290-310 | 59 |
| Corn Stalks and Waste | 380-460 | 59 |
| Flax and Hemp | 360 | 59 |
| Grass | 280-550 | 59 |

Table 1.2. Substances that can be used in biogas production and biogas yields (Yokuş, 2011 ) (Continue )

| Source | Biogas Yield (Litre/kg) | Methane Rate (%) |
|---|---|---|
| Vegetable Waste | 330-360 | Variable |
| Agricultural Waste | 310-360 | 60-70 |
| Peanut Shell | 365 | - |
| Fallen Tree Leaves | 210-290 | 58 |
| algae | 420-500 | 63 |
| Wastewater Sludge | 310-800 | 65-80 |

## 2. Materials and Methods

In this study, the density of dairy and livestock farms in Çiçekdağı district of Kırşehir province was observed and the biogas and biomethanization energy potential was determined with the help of the equations used with the Biomass Energy Potential Atlas (BEPA) data of the Republic of Turkey Ministry of Energy and Natural Resources, General Directorate of Energy Affairs.

### 2.1.Land distribution of Kırşehir-Çiçekdağı District

**Table 2.1 . Land Distribution**

| Land Distribution (in) Year | Fruits, Beverage and Spice Plants Area (Da) | Fallow Field (In) | Vegetable Field (In) | Ornamental Plants Area (In) | Area of Cereals and Other Plant Products (In) |
|---|---|---|---|---|---|
| 2013 | 2149 | 63952 | 716 | - | 262180 |
| 2014 | 2272 | 76868 | 876 | - | 259926 |
| 2015 | 2355 | 74494 | 895 | - | 258125 |
| 2016 | 2182 | 113097 | 1347 | - | 269117 |
| 2017 | 2195 | 52840 | 1025 | - | 272191 |
| 2018 | 2210 | 43000 | 985 | - | 315882 |
| 2019 | 2440 | 42000 | 1095 | - | 312138 |
| 2020 | 2440 | 45120 | 728 | - | 289707 |
| 2021 | 5885 | 46000 | 649 | - | 299661 |
| 2022 | 3272 | 62000 | 546 | - | 293549 |

### 2.2.Animal presence and waste amount of

**Table 2.2. Animal Existence and Waste Amount of Kırşehir-Çiçekdağı District**

| Animal Name | Number of Animals (piece) | Amount of Waste (tons) |
|---|---|---|
| Donkey | 190 | 520.1 |
| Mandate | 60 | 438.0 |
| Cattle (Culture) | 8,640 | 78,840.0 |
| Cattle (Hybrid) | 10,815 | 71,054.6 |
| Cattle (Native) | 1,565 | 8,568.4 |
| Goat (Hair) | 11,110 | 8,110.3 |
| Sheep (Native) | 35,273 | 38,623.9 |
| Meat Chicken | - | 0.0 |
| Turkey | 3,200 | 120.0 |
| Goose | 4,500 | 210.6 |
| Duck | 350 | 16.4 |
| Egg Chicken | 9,800 | 536.6 |

### 2.3.Agricultural Production And Agricultural Waste Amount Of Kirşehir-Çiçekdağı District

**Table 2.3. Agricultural Production and Agricultural Waste Amount of Kırşehir-Çiçekdağı District**

| Plant Name | Crop Production (tons) | Amount of Waste (tons) |
|---|---|---|
| Barley | 21,778 | 17,422.4 |
| Sunflower | 373 | 857.9 |
| Wheat | 56,112 | 44889.6 |
| Rye | one | 0.8 |
| Sainfoin (Green Grass) | 5 | 0.0 |
| Lentil | 1,065 | 1,597.5 |
| Lentils (red) | 469 | 703.5 |
| Corn (Silage) - 1st Planting | 9,360 | 0.0 |
| Chickpeas | 2,480 | 3,720.0 |
| Sugar beet | 20,170 | 806.8 |

**Table 2.4. Agricultural Production and Agricultural Waste Amount of Kırşehir-Çiçekdağı District (continued)**

| Plant Name | Crop Production (tons) | Amount of Waste (tons) |
|---|---|---|
| Clover (Green Grass) | 3,780 | 0.0 |
| Almond | 42 | 9.0 |
| Walnut | 86 | 35.0 |
| Apple (Other) | 281 | 7.8 |
| Apricot | 58 | 2,3 |
| Cherry | 82 | 1.8 |
| Grape | 67 | 460.0 |
| Tomato (table, tomato paste) | 5,740 | 1,894.2 |
| Pumpkin (Gum and snack) | 10 | 4.0 |
| Watermelon | 110 | 33.0 |
| Melon | 775 | 232.5 |
| Onion (Dry) | 315 | 126.0 |

## 2.4.Waste Usability And Unit Heat Values Of Field Products In Turkey

**Table 2.5. Waste availability and unit calorific values of field crops in Turkey (Anonymous, 2014 b.)**

| Products | Wastes | Availability (%) | Unit Calorific Value (Mj/kg) |
|---|---|---|---|
| Wheat | Straw | 15 | 17.9 |
| Barley | Straw | 15 | 17.5 |
| Rye | Straw | 15 | 17.5 |
| Oat | Straw | 15 | 17.4 |
| Sweetcorn | Handle | 60 | 18.5 |
| | Somek | 60 | 18.4 |
| Rice | Straw | 60 | 16.7 |
| | Shell | 80 | 12.98 |
| Tobacco | Handle | 60 | 16.1 |
| Cotton | Handle | 60 | 18.2 |
| | Ginning Waste | 80 | 15.65 |
| Sunflower | Handle | 60 | 14.2 |
| Peanut | Straw | 80 | 20.74 |
| | Shell | 80 | 20.74 |
| Soy | Straw | 60 | 19.4 |

## 2.5.Waste characteristics

**Table 2.6. Waste characteristics**

| Animal Breed | Live Weight (Kg) | Amount of Fresh Waste | | TK(%) | UK(%) | availability |
|---|---|---|---|---|---|---|
| | | Percentage of Weight | kg/day | | | Duration of Stay in the Stable (%) |
| cattle | 135-800 | 5-6 | 10-20 | 5-25 | 75-85 | milk 65<br>Meat 25 |
| ovine | 30-75 | 4-5 | 2 | 30 | 20 | 13 |
| Winged | 1.5-2.0 | 3-4 | 0.08-1.00 | 10-35<br>50-90 | 70-75<br>60-80 | 99 |

**Table 2.7. Animal waste quantity acceptances (Anonymous, 2012 a.)**

| Animal Breed | Accepted Daily Feces Amount (kg/Animal.day) |
|---|---|
| **cattle** | **37.5** |
| **ovine** | **2** |
| **Winged** | **0.16 (avg.)** |

### 2.6.Biogas and biomethanization Determination of energy value

The number of animals, animal waste and agricultural production and agricultural waste amounts of Çiçekdağı district of Kırşehir province have been determined with assumptions in line with statistical data. Biogas potential and energy values were calculated with the given formulas, and biogas production potential and biomethanization energy values of

C yyam = (A x B x 365)/1000

C yya = Amount of wet waste per year (tons)

A: Number of animals (pieces)

B: Waste amount acceptance

C ykmm = C yyam x D x E

C ykmm : Amount of dry matter per year (tons)

C yyam : Amount of wet waste per year (tons)

D: Percent total dry

C ybp = C ykmm x F

C ybp : m³ biogas potential per year

C ykmm : Amount of dry matter per year (tons)

F : Assuming 1 ton of solid waste biogas yield

C energy equivalent = C ybp xH

C energy equivalent : Energy Equivalent

C ybp : m³ biogas potential per year

H : 1m³ /year calorific value

## 3. Findings and Discussion

### 3.1. Kırşehir-Çiçekdağı Biomethanization of Animal waste Economic energy equivalents

**Table 3.1.** Kırşehir-Çiçekdağı Biomethanization Economic Energy Equivalents of Animal Wastes (BEPA,2023)

| Animal Name | Energy Equivalent (TOE/year) |
|---|---|
| Donkey | 1.7 |
| Mandate | 3.3 |
| Cattle (Culture) | 633.1 |
| Cattle (Hybrid) | 456.5 |
| Cattle (Native) | 45.9 |
| Goat (Hair) | 13.0 |
| Sheep (Native) | 93.0 |
| Meat Chicken | 0.0 |
| Turkey | 30.0 |
| Goose | 52.7 |
| Duck | 4.1 |
| Egg Chicken | 134.2 |

### 3.2. Kirşehir-Çiçekdağı Biometanization Of Agricultural Wastes Economic Energy Equivalents

Economic energy equivalents of biomethanization that can be produced in line with the amount of biogas that can be produced from the agricultural wastes of Kırşehir-Çiçekdağı district. Table 3.2. is also given.

**Table 3.2.** Biomethanization Economic Energy Equivalents of Kırşehir-Çiçekdağı Agricultural Wastes (BEPA, 2023)

| Plant Name | Energy Equivalent (TOE/year) |
|---|---|
| Barley | 7,423.3 |
| Sunflower | 346.7 |
| Wheat | 24,278.4 |
| Rye | 0.3 |
| Sainfoin (Green Grass) | 0.0 |
| Lentil | 659.9 |
| Lentils (red) | 290.6 |
| Corn (Silage) - 1st Planting | 0.0 |
| Chickpeas | 1,481.6 |
| Sugar beet | 298.9 |
| Clover (Green Grass) | 0.0 |

Agricultural and Animal Waste amounts of Çiçekdağı district were determined within the framework of the Biomass Energy Potential Atlas (BEPA) data of the Republic of Turkey Ministry of Energy and Natural Resources, General Directorate of Energy Affairs . With the help of some equations used with these data, the annual wet waste amount (Table 3.3), annual dry matter amount (Table 3.4) , annual biogas potential ( Table 3.5) and energy equivalent value ( Table 3.6 ) were calculated, respectively. The changes of these calculated values are shown with graphs (Figure 3.1, Figure 3.2, Figure 3.3).

**Table 3.3.** Annual Wet Waste Amount of Animal Waste (tons)

| Animal Name | Cyyam: Annual amount of wet waste (tons) | A: Number of animals (pieces) | B: Waste amount acceptance |
|---|---|---|---|
| Donkey | 2600,625 | 190 | 37.5 |
| Mandate | 821.25 | 60 | 37.5 |
| Cattle (Culture) | 118260 | 8,640 | 37.5 |
| Cattle (Hybrid) | 148030,3125 | 10,815 | 37.5 |
| Cattle (Native) | 21420.9375 | 1,565 | 37.5 |
| Goat (Hair) | 8110.3 | 11,110 | 2.00 |
| Sheep (Native) | 25749.29 | 35,273 | 2.00 |
| Meat Chicken | 0 | - | 0.19 |
| Turkey | 221.92 | 3,200 | 0.19 |
| Goose | 312,075 | 4,500 | 0.19 |
| Duck | 24.2725 | 350 | 0.19 |
| Egg Chicken | 679.63 | 9,800 | 0.19 |

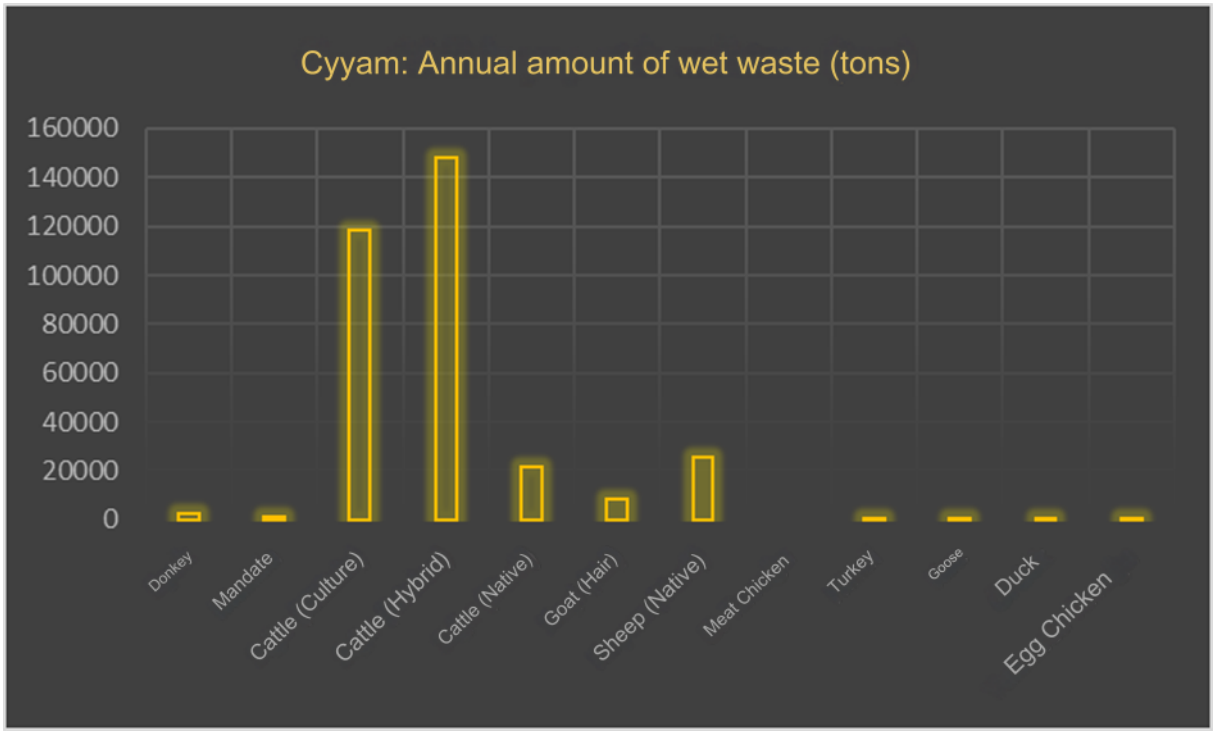


**Figure 3.1.** Annual Wet Waste Amount of

**Table 3.4.** Annual Dry Matter Amount of Animal Wastes (tons)

| Animal Name | C ykmm : Amount of dry matter per year (tons) | C yyam : Amount of wet waste per year (tons) | D: Percent total dry | E: Percent availability |
|---|---|---|---|---|
| Donkey | 175.5421875 | 2600,625 | 0.15 | 0.45 |
| Mandate | 55.434375 | 821.25 | 0.15 | 0.45 |
| Cattle (Culture) | 7982.55 | 118260 | 0.15 | 0.45 |
| Cattle (Hybrid) | 9992.046094 | 148030,3125 | 0.15 | 0.45 |
| Cattle (Native) | 1445.913281 | 21420.9375 | 0.15 | 0.45 |
| Goat (Hair) | 316,3017 | 8110.3 | 0.3 | 0.13 |
| Sheep (Native) | 1004.22231 | 25749.29 | 0.3 | 0.13 |
| Meat Chicken | 0 | 0 | 0.46 | 0.99 |
| Turkey | 101.062368 | 221.92 | 0.46 | 0.99 |
| Goose | 142.118955 | 312,075 | 0.46 | 0.99 |
| Duck | 11.0536965 | 24.2725 | 0.46 | 0.99 |
| Egg Chicken | 309.503502 | 679.63 | 0.46 | 0.99 |

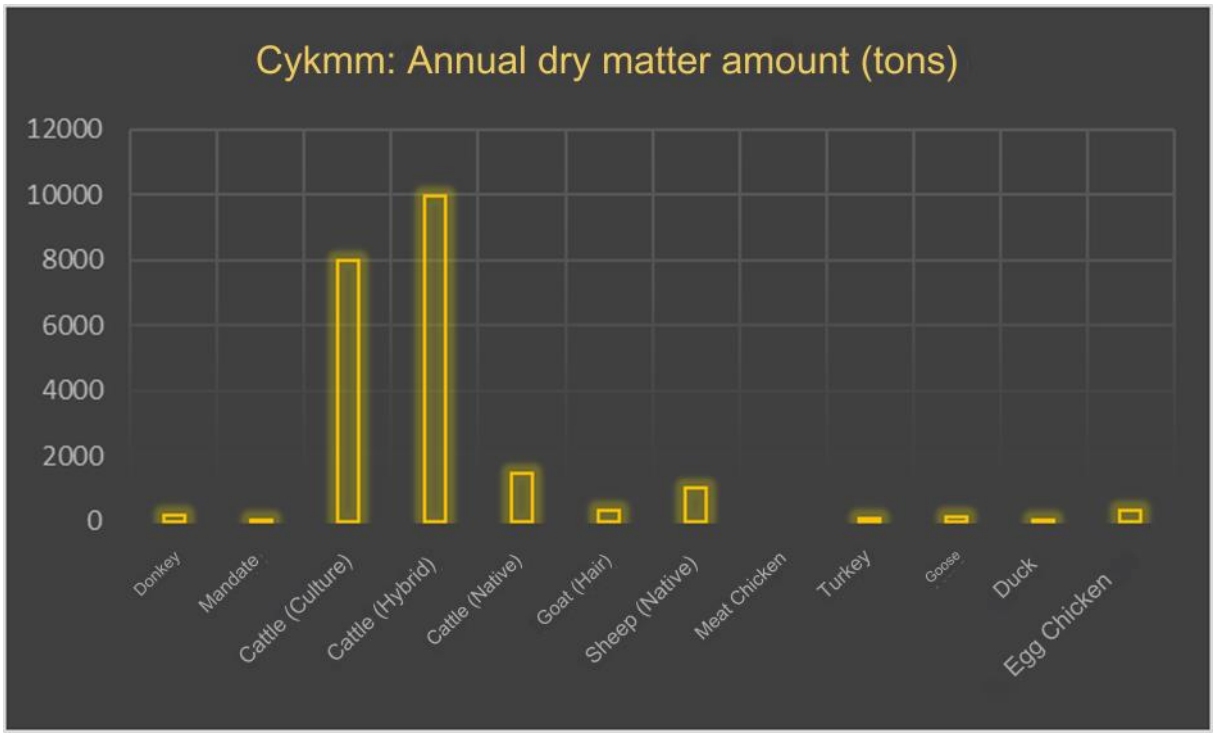


**Figure 3.2.** Annual Dry Matter Amount of Animal Wastes (tons)

**Table 3.6.** Annual Energy Equivalent of Animal Waste (m³ )

| Animal Name | C energy equivalent : Energy Equivalent (Mj/Kg) | C ybp : m3 biogas potential per year ( m³) | H: 1m³/year calorific value acceptance |
|---|---|---|---|
| Donkey | 1337192,613 | 48274,10156 | 27.7 |
| Mandate | 422271,3516 | 15244,45313 | 27.7 |
| Cattle (Culture) | 60807074.63 | 2195201.25 | 27.7 |
| Cattle (Hybrid) | 76114411.12 | 2747812,676 | 27.7 |
| Cattle (Native) | 11014244.42 | 397626,1523 | 27.7 |
| Goat (Hair) | 1796119,203 | 64841,8485 | 27.7 |
| Sheep (Native) | 5702476,387 | 205865,5736 | 27.7 |
| Meat Chicken | 0 | 0 | 27.7 |
| Turkey | 1497693,763 | 54068,36688 | 27.7 |
| Goose | 2106131,854 | 76033,64093 | 27.7 |
| Duck | 163810,2553 | 5913.727628 | 27.7 |
| Egg Chicken | 4586687,148 | 165584.3736 | 27.7 |

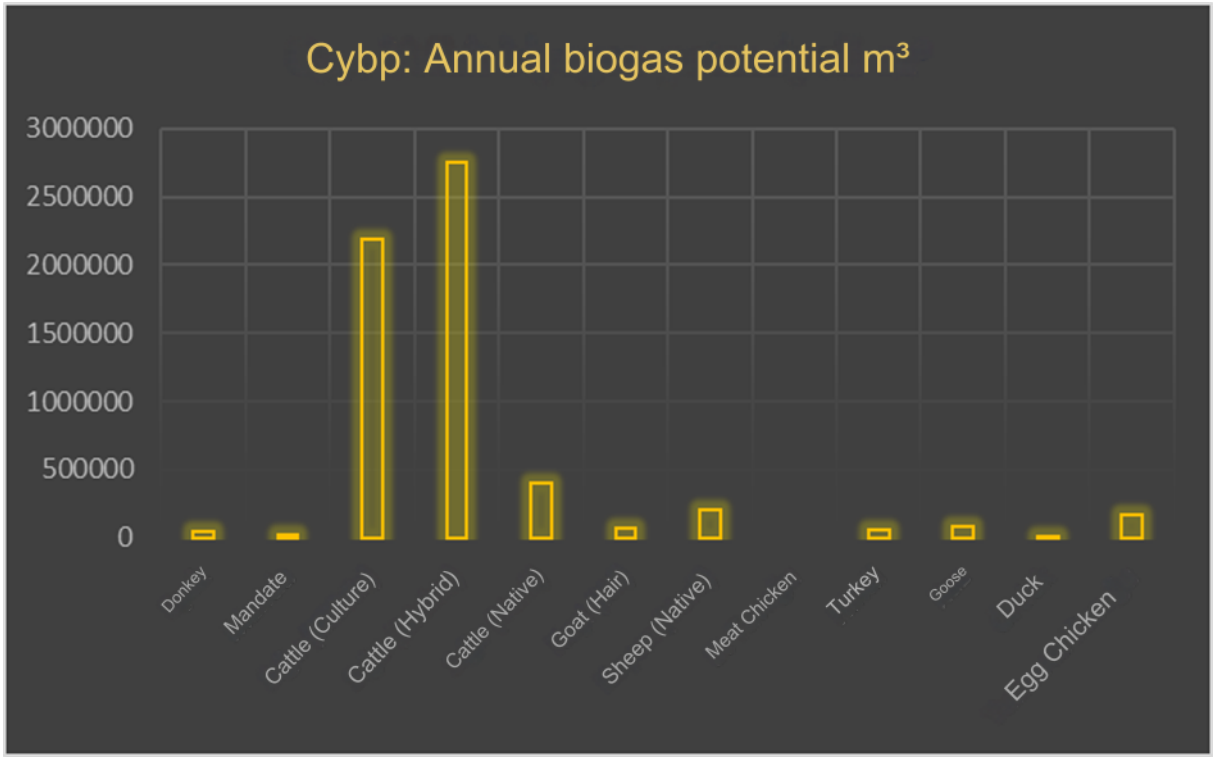


**Figure 3.3.** Annual Energy Equivalent of Animal Waste (m³)

**Table 3.6.** Annual Energy Equivalent of Animal Waste (m³ )

| Animal Name | C energy equivalent : Energy Equivalent (Mj/Kg) | C ybp : m3 biogas potential per year ( m³) | H: 1m³/year calorific value acceptance |
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| Donkey | 1337192,613 | 48274,10156 | 27.7 |
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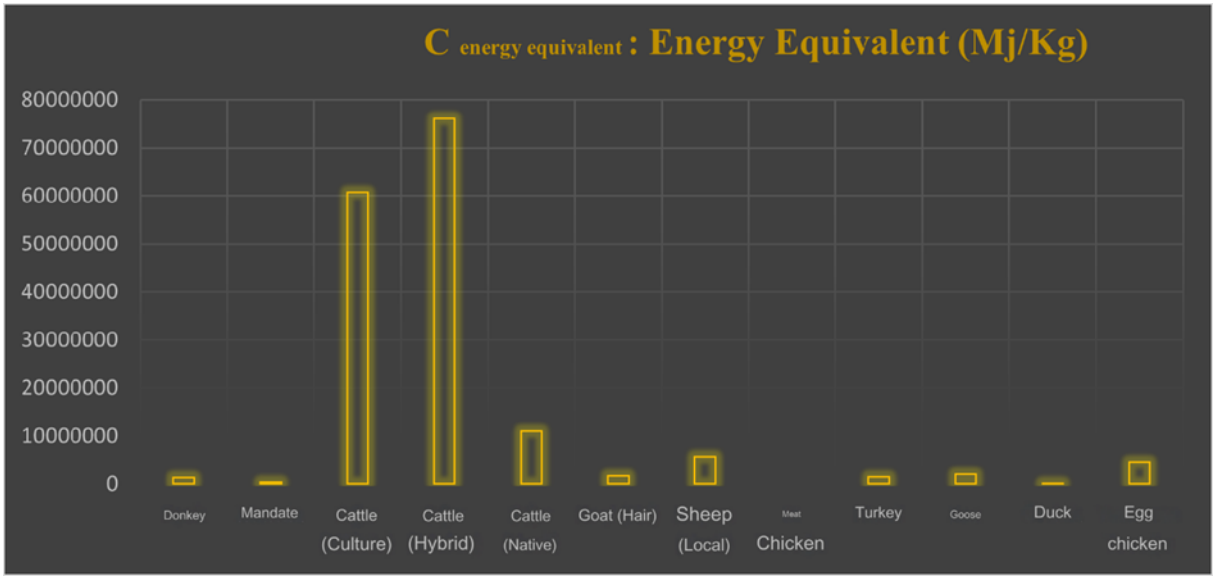


**Figure 3.4.** Annual Energy Equivalent of Animal Waste (m³)

**Conclusion and Recommendations**

In the study, the density of existing dairy and fattening farms in Kırşehir-Çiçekdağı district was observed and the biogas potential and the energy equivalent that can be obtained from this biogas were revealed in line with the number of animals and the amount of existing agricultural waste.

A total of 291133.125 tons of waste in cattle, a total of 33859.59 tons in sheep and a total of 1237.8975 tons in poultry, and therefore the amount of waste that can be used in biogas production is calculated as 19651.48594, 1320.52401 , 563.7385215 tons, respectively.

In the research, the annual biogas potential from animal waste is a total of 5976466.164 $m^3$ / year and the energy equivalent is a total of 165548112.7 Calculated as Mj/Kg.

The high initial investment cost (Year of Installation) shows biogas systems as an expensive alternative energy source. It is estimated that small-scale biogas plants can pay for themselves in approximately 8-10 months when operated at full efficiency. However, in the first place, financing is needed to establish the facility. This financing can be provided with state-supported foreign loans or can be covered by private individuals. In many countries, programs have been initiated by the government, considering the benefits of biogas technology in terms of environment and health.

Biogas systems have been tried to be made widespread by reducing the cost burden with the incentives and loans applied . Considering the climatic conditions and production possibilities; Designing biogas systems with low investment costs, high efficiency, easy installation, use and maintenance will enable the development of biogas technology in our country.

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# DOKTOR N. KIRYAKO'YA GÖRE PATATES ZİRAATİ

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**Özet**
Patates bitkisi kökeni çok eskilere dayanmakla birlikte özellikle Coğrafi Keşiflerden sonra tüm dünyaya yayılmış olup, günümüzde temel besin kaynakları arasında yer almayı sürdürmektedir. Ortaya çıkış yeri Güney Amerika olan patatesin Avrupa geneline yayılması ise uzun bir zaman dilimi içerisinde gerçekleşmiştir. Türkiye'de ise patatesin 19. yüzyılda Kafkas göçlerinden sonra Anadolu'nun çeşitli yerlerinde kullanılmaya başladığına dair yaygın bir kanaat bulunmaktadır. Patates, Osmanlı Devleti tarafından çeşitli sebeplerle ortaya çıkan kıtlık durumlarıyla mücadelede bir teşvik unsuru olarak kullanılmış ve patates ziraati bizzat devlet politikası haline getirilerek ekimine önem verilmiştir. Patatesin geçmişten bugüne temel besin kaynakları arasında yer alması ve hatta toplum tarafından tercih edilen tüketim maddeleri arasında ilk sıralarda bulunması bu çalışmanın ortaya çıkmasının temel gerekçelerinden birisidir. Bu çalışma, Heidelberg Darülfünunu İlm-i Tabii ve Felsefe Fakültesinden mezun Ticaret ve Ziraat Nezareti sabık kimyageri Doktor N. Kiryako'nun "Patates Ziraati ve Kimyevi Gübre" başlıklı, 1915 tarihinde Osmanlı Türkçesi ile Matbaa-i Hayriye ve Şürekâsı (İstanbul)'da basılan eserinden esinlenerek ortaya konulmuştur. Çalışmanın amacı, temel besin maddesi olan patatesin 20. yüzyılın hemen başlarında yayımlanan Doktor N. Kiryako'nun eseri ışığında patates ziraati ile ilgili bilgilere ulaşmak ve ilgili sahadaki çalışmalara katkı sağlamaktır. Aynı zamanda çalışmanın temelini oluşturan eserde yer alan kimyevi gübreler hakkında da bilgi verilerek Kiryako'nun Osmanlı Türkçesi ile yayımlanan eserinin günümüz Türkçesine kazandırılma gayesi de bu çalışmanın ana hedefleri içerisindedir. Bu bağlamda patates ziraatı ile ilgili iklim ve toprak, toprağın işlenmesi, gübreleme, kimyevi gübreler, patatesin nasıl ekileceği gibi Kiryako'nun eserinde yer alan tüm ayrıntılar ortaya çıkarılacaktır.
**Anahtar Kelimeler:** Doktor N. Kiryako, Patates Ziraati, Kimyevi Gübre.

# POTATO FARMING ACCORDING TO DR. N. KIRYAKO

**Abstract**
Although the potato plant originated in ancient times, it has spread all over the world, especially after the Geographical Discoveries, and continues to be one of the main food sources today. The potato, which originated in South America, spread throughout Europe over a long period of time. In Turkey, there is a widespread belief that potatoes started to be used in various parts of Anatolia after the Caucasian migrations in the 19th century. Potatoes were used by the Ottoman Empire as an incentive to combat famine situations that arose for various reasons, and potato cultivation was made a state policy and its cultivation was emphasized. The fact that potatoes have been among the main food sources from the past to the present and even among the first place among the consumption items preferred by the society is one of the main reasons for the emergence of this study. This study was inspired by the work titled "Potato Agriculture and Chemical Fertilizer" by Dr. N. Kiryako, the former chemist of the Ministry of Commerce and Agriculture, who graduated from the Faculty of Natural Sciences and Philosophy of the Heidelberg Darülfünunu, published in 1915 in Ottoman Turkish at Matbaa-i Hayriye ve Şürekâsı (Istanbul). The aim of the study is to provide information on potato cultivation in the light of the work of Dr. N. Kiryako, published in the early 20th century, and to contribute to the studies in the related field. At the same time, the main objectives of this study are to provide information about the chemical fertilizers in the work that forms the basis of the study and to bring Kiryako's work published in Ottoman Turkish into today's Turkish. In this context, all the details about potato cultivation in Kiryako's work such as climate and soil, soil cultivation, fertilization, chemical fertilizers, how to plant potatoes will be revealed.
**Keywords:** Dr. N. Kiryako, Potato Farming, Chemical Fertilizer.

## Giriş

Dünyada temel besin maddeleri arasında yer alan ve hatta buğday, çeltik (pirinç) ve mısırdan sonra dördüncü sırayı teşkil eden patates bitkisi keşfedildiği andan itibaren insanların hayatında önemli bir yer edinmiştir. En önemlisi ise bu bitki, insanlar tarafından tüketilmeye başladığı günden bugüne kadar temel besin maddesi olarak önemini korumayı başarmıştır. Patates bitkisinin kökeni çok eskilere dayanmakla birlikte özellikle Coğrafi Keşiflerden sonra patatesin tüm dünyaya yayılmış olduğu bilinmektedir. İlk olarak ortaya çıkış yerinin neresi olduğu hakkında genel kabul olarak Güney Amerika olduğuna dair yaygın bir kanaat bulunmaktadır (Akay, 2019; Yurtoğlu, 2018). Heidelberg Darülfünunu İlm-i Tabii ve Felsefe Fakültesinden mezun Ticaret ve Ziraat Nezareti sabık kimyageri Doktor N. Kiryako ise eserinde patatesin menşeinin Garbi Amerika olduğunu ve 16. yüzyılın ortalarında İspanyalılar tarafından Avrupa'ya taşındığını belirtmiştir. Kiryako bununla ilgili ayrıca o dönemlerde Avrupa'nın çoğu bölgelerinde sıklıkla kıtlık hüküm sürdüğü için patatesin ithalinin zaruri ihtiyaçların eksikliğini gidermeye yardımcı olduğunu da açıklamıştır (Kiryako, 1915). Bu bilgiler ışığında gerçekten de bakıldığında patates bitkisi, Avrupa'da yaşanan savaşlar ve sıklıkla ortaya çıkan kıtlık dönemlerinde adeta hayati bir rol üstlenerek dikkatleri çekmiştir. Patatesin dünya geneline yayılması ve ardından patates ekilen sahaların miktarlarının her geçen gün artması ile patates bir anda Avrupa ülkeleri açısından birçok bakımdan (sosyo-ekonomik, askeri vb.) stratejik bir gıda maddesi konumuna erişmiştir (Akay, 2019).

Türkiye'nin patatesle tanışması hakkında ise Yurtoğlu, patatesin Türkiye'ye ilk kez 1850 senesi itibarıyla Rusya'dan Kafkasya yoluyla geldiğini ve bu sayede ilk olarak Doğu Anadolu ve Karadeniz bölgesi yaylalarında yetiştirilmeye başlandığını belirtmiştir (Yurtoğlu, 2018). Doğu Karadeniz bölgesinden sonra ise Batı Trakya bölgesinde ekimi yapılmaya başlanan patatesin daha sonra tüm Türkiye'ye yayıldığı görülmüştür (Abed & Demirhan, 2018). Bağcıtek, günümüzde Türkiye'de yoğun bir biçimde yetiştirilen ve her düzeyden bireyin rahatlıkla tüketebilme imkanına sahip olduğu patatesin, kullanım alanlarına ve gelişim düzeylerine göre sınıflandırıldığını açıklamıştır. Bağcıtek'in ifadesine göre kullanım alanlarına göre yapılan sınıflandırma şu şekildedir: yemeklik patates, sanayi tipi patates ve yemlik patates. Yemeklik patates tahmin edilececeği üzere oldukça leezetli olan ve insanlar tarafından tercih edilen patatestir. Sanayi tipi patates ise adından da anlaşılacağı üzere sanayide kullanılan özellikle nişasta ve ispirto yapımlarında tercih edilen patatestir. Yemlik patates de diğer iki sınıflandırmaya girmeyen ve diğerlerine nazaran daha dayanıksız olan patatesleri ifade etmek için kullanılır. Ayrıca yemlik patateslerin en belirgin özelliği hayvancılık sahasında yem olarak

kullanılmalarıdır. Yine Bağcıtek, gelişme sürelerine göre yapılan sınıflandırma ile ilgili ise patateslerin genel olarak erkenci, orta erkenci ve geççi patates şeklinde sınıflandırılsa da bu çeşitlerin de kendi içlerinde ayrıldığını; çok erkenci, erkenci, orta erkenci, orta geççi, geççi ve çok geççi olarak da sınıflandırıldıklarını belirtmiştir. Ancak Bağcıtek her ne kadar kullanım alanları ve gelişme süreleri bakımından patateslerin oldukça çeşitli gruplara ayrılmasına rağmen her birinin aslında aynı türe ait ve köken bakımından da aynı olduğunu da belirtmiştir (Bağcıtek, 2017). Türkiye'nin farklı bölgelerinde farklı adlarla yapılan patates ziraatına dair Yurtoğlu'nun vermiş olduğu bilgiler patates bitkisinin çeşitliliğine somut bir örnek niteliği taşır. Bakıldığında Yurtoğlu bu çeşitlilikle ilgili şu ifadelere yer vermiştir:

> "Türkiye'nin birçok bölgesinde çeşitli isimler adı altında patates ziraatı yapılmıştır. Adapazarı'nda Deli Osman, Sarı Patates, Beyaz Patates Karakız; Bolu'da Bolu Patatesi; Kayseri'de Kırmızı; Ödemiş'te Kırmızı Göz, Ak Göz, Kaşlı Göz; Erzurum'da Hususi Bir; Trabzon'da Dirodyum, Rus Beyazı ve Karagöz bu patates türlerinden bir kısmına örnek olarak verilebilir." (Yurtoğlu, 2018).

Netice itibarıyla bakıldığında Türkiye, Osmanlı Devleti döneminde tanışmış olduğu patates bitkisini yetiştirme noktasında oldukça zengin bir geçmişe sahiptir. Günümüzde de devam eden bu zenginlik ve patatesin insan beslenmesinde kapladığı yer bu çalışmanın ortaya çıkmasında etkili olmuştur. Ayrıca çalışmanın konusunu teşkil eden Doktor N. Kiryako'nun eserinin 1915 yılında basılmış olması da dikkat çeken bir ayrıntıdır. Çünkü 1915 senesi aynı zamanda Birinci Dünya Harbi'nin de yaşandığı yıllara rastlar ve böyle bir dönemde yayımlanan bu çalışma aslında patatesin insan hayatındaki önemini de doğrulamaktadır.

**Materyal ve Yöntem**

Bu çalışmanın ana kaynağını Heidelberg Darülfünunu İlm-i Tabii ve Felsefe Fakültesinden mezun Ticaret ve Ziraat Nezareti sabık kimyageri Doktor N. Kiryako'nun "Patates Ziraati ve Kimyevi Gübre" başlıklı çalışması oluşturmaktadır. Doktor N. Kiryako'nun bu eseri (1331) 1915 yılında Osmanlı Türkçesi ile Dersaadet'te Matbaa-i Hayriye ve Şürekâsı tarafından basılan bir çalışmadır. Çalışma, Doktor N. Kiryako'nun bu eserinden yola çıkılarak oluşturulmuştur. Patates bitkisine baktığımızda keşfedildiği andan bugüne kadar temel besin maddesi olarak önemini korumayı başarmış olması ve Birinci Dünya Savaşı'nın yaşandığı senelerde patates bitkisini konu alan risale tarzındaki böyle bir eserin yayımlanması çalışmanın çıkış noktası olmuştur. Çalışmada yöntem olarak Doktor N. Kiryako'nun Osmanlı Türkçesi ile

yayımlanan "Patates Ziraati ve Kimyevi Gübre" başlıklı eserinin günümüz Türkçesine aktarılması ve bu sayede patates ziraatına ilişkin adı geçen eserde yer alan bilgilerin ortaya konulması seçilmiştir.

**Bulgular ve Tartışma**

Doktor N. Kiryako'nun çalışması incelendiğinde patates ziraatına dair önemli ayrıntılar içermektedir. İlk olarak çalışmanın başında yer alan şu ifadeler patates ekimine verilen önemin somut bir göstergesi sayılabilir:

> "Bugün Almanya'da birtakım yeni ziraat yöntemlerinin uygulanması ve özellikle yenilip içilecek bitkileri oluşturan kimyevi gübrelerin kullanımı sayesinde patates ziraatında olağanüstü başarılar elde edilmiştir. Orada dönüm başına 4000 kilo patates mahsulü alındığı ender görülen bir durum değildir. Hatta halihazırdaki devam eden savaşta düşmanlarımızın bizi açlıktan öldürmek hususundaki istekleri bu sayede neticesiz kalmaktadır. Bizim de bu hallerden ders ve ibret alarak kurtarıcılarımıza müracaat etmemiz ve patates yetiştirmeye acele etmemiz icap eder." (Kiryako, 1915).

Kiryako'nun ifadesine göre patates, her iklim ve toprakta başarılı bir biçimde yetiştirilebilir. Yeter ki toprak hafif ve iyice işlenmiş olsun. Arazinin daha ziyade kumlu ve az killi olması tercih edilendir. Toprağın işlenmesine ilişkin ise yine dikkat çeken ayrıntılar yer almaktadır. Örneğin patates ekilecek araziye kışın erkenden derince bir sapan geçirilmelidir. Bu suretle bir taraftan yüzeydeki toprakta kalan ve aksi takdirde boş yere kaybolup gidecek olan bitkisel maddeler toprağa karışarak toprağın bitkilerin filiz verip yetişme yeteneğini ve bilhassa asidini artırır ve diğer taraftan ekilecek toprak üzerindeki tesirlere hayat veren ve inkâr edilemez olan yağmur sularının muhafazasına, tarlalara ve havadaki oksitlerin karbonik asit, soğukluk, hararet yönlerinden kerki (büyük balta) gibi meydana getirilmesine yardım edilmiş olur. Daha sonra da gübre atılarak karıştırılır. Ve ekim zamanı yaklaştığında hafifçe bir sapan dahi geçirilerek patates ekilir (Kiryako, 1915).

Kimyevi gübreler ile ilgili ise; Kimyevi gübreler maden ve taş şeklinde olup, memleketimizde dahi bütün Avrupa'ya bile yeterli gelecek miktarda mevcut olmasına rağmen ne yazık ki kullanmaya elverişli bir halde bulunmamaktadır. Kimyevi gübreler azotlu, potaslı ve fosforlu olmak üzere üç sınıfa ayrılırlar. Toprağın köküne ekilecek bitkilerin ihtiyaç derecelerine göre bu üç çeşitten yapılacak karışım zamanımızın en mükemmel kimyevi gübresini vücuda getirir ki son asırda ziraatın bu derecede ilerlemesinin tek sebebidir. Bugün kimyevi gübrelerden bütün

dünyada yaklaşık iki buçuk milyar franklık yani yüz 100 milyon liralıktan fazla bir tüketim gerçekleşmektedir. Sadece Almanya 1910 senesinde 600 milyar mark yani 33 milyon Osmanlı lirası değerinde kimyevi gübre tüketmiştir. Hatta Kiryako bu tüketim miktarlarıyla ilgili şöyle bir çıkış da yapmıştır: Ne uzağa gidiyoruz; resmi istatistiklere göre Mısır bile 1911 senesinde 496.900 ve 1912 senesinde de 666.900 Mısır lirası değerinde kimyevi gübre tüketmiştir (Kiryako, 1915).

Patates ziraatında hangi tür kimyevi gübrenin kullanılacağına ilişkin ise şu ifadeler tespit edilmiştir:

> "Bugün sanayi-i istihsaliye fiyatça ucuz ve bitkilerin filiz verip yetişme yeteneğince pek zengin olmak üzere çiftçilere, potaslı fosforlu ve azotlu gübreler arz ve ihzar eylemektedir. Bu kabil gübrelerde (1000) okkada 520 okkaya kadar potas yahut 470 kıyye kadar hamız fosfor veyahut 210 okka azot bulunur halbuki aynı miktar yani 1000 kıyye koyun ve keçi gübresinde ancak 6 kıyye potas 2 - 1/1 kıyye hamız fosfor ve 8 kıyye azot bulunabilir. Şu hâlde kimyevi gübre kullanımıyla; tarlaya öyle bir mükemmel bir gıda verilmiş olur ki bu gıda bitkinin büyüyüp gelişmesine gerekli olan bütün maddeleri yeterli derecede içermekten başka ayrıca az masrafla tedarik edilir çünkü bu şekilde dönüm başına yapılacak masraf 50 ile 70 kuruşu geçmez. Her çeşit kimyevi gübreden bir tarlaya ne miktar ve ne oranda konulması lazım geldiğini tayin için ekilecek bitkinin ilk iş olarak her şeyden önce tahlili ve bu konuda bir istatistik hazırlanması lazım gelir. Halbuki bu muamele çoktan Batı Avrupa tarafından uygulanmış olup şimdi bizim yapacağımız onların elde ettikleri sonuçları tatbik etmektir. Potaslı fosfatlı azotlu kimyevi gübrelerin patates üzerinde uygulanmasının neticesinde; bu hususta ziraatla iştigal edenler için şunu söyleyebiliriz ki patatesin türlerini iyileştiren ve verimini artıran potastır." (Kiryako, 1915).

Yani potaslı kimyevi gübrelerin patates bitkisinin yetişmesinde ve verimliliğinde tesiri diğerlerine göre oldukça fazladır.

Ayrıca Kiryako kimyevi gübreler karışımının nasıl yapılacağına dair de ayrıntılı bir izahatta bulunmuş olup bununla ilgili, "en iyisi, basit kimyevi gübrelerden olup bil ahire gösterilmiş olan düstura göre karıştırmaktır. Bu kimyevi gübreleri belirli tüccarlardan satın almalı ve bunların sıhhat ve safiyeti hakkında teminat talep etmekle beraber resmi tahlil raporunu dahi istemelidir" demiştir (Kiryako, 1915). Yine Kiryako, hazırlanan karışımla ilgili olarak karışımı

yapmak için çuvalları kuru ve düz bir mahale boşaltırız içinde topak halinde iri parçalar varsa bunları kürekle ezer toz haline getiririz. Her üç türden olan bu kimyevi maddeleri en aşağı yarım saat güzelce karıştırırız. Şöyle ki biri diğerine iyice karışsın ve topaçlardan eser kalmasın bu suretle ortaya çıkan karışımı rutubetten uzak bir mahalde muhafaza eder ve icabında tarlanın genişliği nispetinde kullanırız şeklinde çiftçilere yol gösterici bilgiler de sunmuştur.

Hazırlanan bu gübrelerin tarlaya ne zaman ve ne şekilde atılacağı da Kiryako tarafından açıklanmıştır ki şöyledir:

> "Kışın erkenden sürülmüş ve hazırlanmış tarlaya Ocak, Şubat veya Mart aylarından birinde tarlanın hafif bir sapanla sürülmesi mümkün olduğu kurak bir günde bu kimyevi gübrelerden atılabilir. Ancak gübrenin tarlaya yayılması görevini yetkin bir çiftçiye vermelidir ki çoğunluğu buğday ekiminde olduğu gibi bu gübre tarlanın her bir noktasına aynı miktarda isabet etsin. En çok, bu karışımın toz halinde yayılmasına ve bir tarafta çok diğer tarafta az kalmamasına dikkat etmeli çünkü topaç halinde düşenlerin toprak üzerindeki tesirleri daha yavaştır. Bu yayma işlemini takiben hafif bir tırmık geçirilerek gübre 2-3 parmak derinliğinde toprağa karıştırılır. Patates tarlalarını gübrelemek için en uygun zaman yine ocak, şubat ve mart aylarıdır. Bununla beraber ihtiyaç olduğu vakit patates dikilmezden on beş gün evvel dahi gübrelendiği gibi ekildikten on beş gün sonra dahi gübre atılabilir. Çünkü kimyevi gübrelerin patates tarlalarında kullanımı fevkalade faydalı ve elverişlidir." (Kiryako, 1915).

Doktor N. Kiryako'ya göre patates nasıl ekilmelidir?

Patates ekmekte en sade usul; biri diğerinden elli santimetre uzak mesafede sapan ile çukurlar açılarak bunların derinine 7-8 santimetre derinliğine oldukça büyük bir patates yerleştirilir. Tohum olmak üzere kullanılacak patates ilk olarak rutubetli bir mahalde bırakılarak biraz filizlenmelidir. Tohumluk patatesin seçimi ise oldukça mühim bir mesele olup burada bu konuda ayrıntılı bir bilgi vermenin mümkün olmadığını belirten Kiryako, bu hususla ilgili sadece şunu söylemiştir:

> "Yalnız şunu zikrederiz ki tohumluk için alınacak patates bütün, sağlam ve cins diye tabir olunan dişi patateslerden olmalıdır. Patatesin sureti ve filiz mahalleri yani gözleri kalın olmalıdır. Tarif edilen çukurlara 6-7 santimetre derinliğine oldukça büyük bir patates konulur ve müteakiben toprak ayak ile

hafifçe basınçlanır. Otuz santimetre mesafeye diğer bir patates daha konulur ve bu şekilde devam edilir." (Kiryako, 1915).

Patates fidanının tımarı ise Kiryako'ya göre toprağın çapalanıp karıştırılmasından ibarettir. Bu işlem bir taraftan lüzumsuz otların imhasına ve diğer taraftan ise topraktaki rutubetin yok olmasına yardım eder. Patatesin büyüyüp gelişmesi esnasında tarla en az, iki defa karıştırılmalıdır. Birincisi patates bitkisi biraz filizlenip toprağın üstünde göründüğünde ikincisi de bitki oldukça büyüdükten sonra olmalıdır.

Patates bitkisi 10-15 santimetre büyür büyümez bir sabah henüz yapraklar nem iken fidanların burunları koparılır. Bu uçların koparılması durumu meyvenin ortaya çıkmasına yardım eder ve mümkün mertebe erken yapılmalıdır. Hava kuru olduğunda patates fidanlarını akşam yahut sabahları sulamalıdır.

Patatesin toplanması ise çapa yahut sapan vasıtasıyla olur ve yığın yapılır ve patatesler; üzerlerindeki topraklar kuruyup kolayca ayrıldıktan sonra tarladan kaldırılırlar, rutubetsiz ve kuraklık (kara kışlık) bir yere serilir ve ara sıra havalandırılmak suretiyle muhafaza edilirler. Yerli cins patateslerden; Bir usul vergilendirmeye uygun olarak ziraat edilmek şartıyla dönüm başına 2000 ile 2500 kilogram patates üretilebilir.

Alman cinsi patateslerle bu miktar mahsul dönüm başına kolaylıkla 4000 kilograma kadar artış gösterir (Kiryako, 1915).

**Sonuç ve Öneriler**

Netice itibarıyla baktığımızda Doktor Nikola Kiryako'nun "Patates Ziraati ve Kimyevi Gübreler" başlıklı bu eseri, yayımlandığı tarihin 1915 olmasından dolayı ayrıca dikkat çekici bulunmuştur. Kısa ama oldukça ayrıntılı ve zengin bir içeriğe sahip olan bu çalışmanın Birinci Dünya Savaşının devam ettiği bir dönemde yayımlanmış olması birden fazla gerçeği de gün yüzüne çıkarmaktadır ki bunlardan ilki savaşın yarattığı gıda kıtlığıyla mücadelede patates bitkisinin yetiştirilmesinin taşıdığı önemdir. O dönemde hem patates bitkisi yetiştiren çiftçileri hem de yetiştirmeye girişecek olanları bilgilendirme vazifesini de üstlenen Kiryako'nun aynı zamanda tarımın bilinçli bir biçimde yapılmasının gerekliliği noktasında üstlendiği rol ayrıca değerlidir. Çünkü Kiryako'nun 1915 yılında yayımlanan bu çalışması patates bitkisinin ziraatı üzerine ayrıntılı ve oldukça kıymetli bilgiler sunmaktadır. Keşfedildiği andan itibaren insanların en çok tükettiği besin maddeleri arasına girmeyi başaran ve hatta kıtlık, savaş ortamı gibi olağanüstü durumlarda hayati bir rol üstlenen patates bitkisi günümüzde de bu konumunu korumaktadır. Böylesine önemli bir besin maddesi üzerine Osmanlı Türkçesi ile yayımlanan

eserdeki bilgileri Günümüz Türkçesine aktarılarak ortaya çıkan bu çalışmanın ilgili literatüre katkıda bulunması ve hedeflenmiştir. Ayrıca çalışmanın en somut önerisi, benzer şekilde Osmanlı Türkçesi ya da farklı dillerde yayımlanan başka çalışmaların da günümüz Türkçesine kazandırılması ve nihayetinde bu çalışmaların sonraki ilmi araştırmalara ışık tutmasıdır.

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# MOLECULAR METHODS IN DETERMINING GENETIC DIVERSITY IN SEEDS

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**Abstract**
From the date it was first discovered until today, the seed has created many effects not only in the transition to a settled lifestyle, but also in the social and economic fields. Due to the ecological diversity of our country, it has enabled the emergence of variation in tomatoes over many years, as in almost all plant species. Tomato is botanically a species belonging to the Solanaceae family. Besides its worldwide importance, it is a leading model system for genetic studies in plants. Molecular marker maps have been created for many agriculturally important species. Molecular techniques offer important opportunities to increase agricultural production. Molecular diagnosis is a discipline that aims to diagnose diseases using molecular methods. It is used in agricultural biosecurity to diagnose disease, identify risk and decide which treatments will work. The use of molecular markers can facilitate tomato breeding to improve agriculturally important traits such as yield and disease resistance. In general, the lack of availability of high-yielding varieties and lack of genetic diversity are the main reasons for low seed production. Therefore, it is imperative to increase genetic diversity to develop high-yielding tomato varieties by utilizing the existing germplasm. The rapid progress seen in molecular biology in recent years has contributed greatly to its use in plant genetics studies in line with goals such as preserving genetic diversity. However, these marker-assisted molecular biological applications are complementary to molecular markers. In conclusion, genetic technologies can be very useful when directed and supported correctly, so studies on this subject should continue meticulously. It will help countries with rich genetic resources, such as Turkey, to determine their priority areas, create an adequate infrastructure for molecular biology studies, and train a number of competent researchers to form a critical mass, to make the best use of their genetic potential.
**Keywords:** Tomato, moleculer method, seed, genetic diversity

## Introduction

In the globalizing world, the importance of the agricultural sector is increasing due to the speed of change in market conditions and competition. Because the agricultural sector is an indispensable sector for all countries with its contributions such as food reliability, natural resources, rural development, biological and ecological diversity, as well as the production of basic food products (Assoc. Dr. Gökhan Özertan, 2013). Seed, which is the beginning of agricultural production and the propagation material of many plants, has great importance for the food sectors and agriculture of countries. All other production inputs used in cultivation only help realize the production potential of the seed. Seed is one of the basic inputs of agricultural production. Use of quality seeds; In addition to increasing production and efficiency, it also enables the production of more durable, less costly and competitive products (Ermiş, 2021). Increase in agricultural productivity depends on the use of quality seeds. Horticultural plants seed industry in our country; It is a sector with high economic value that produces, breeds, processes and grows seeds, seedlings, saplings and ornamental plants production materials and covers different specializations (Balkaya, 2009).

Molecular marker maps have been generated for a large number of agriculturally important species. Although there are many resources and potential in this field in the world, commercial breeding programs for agricultural products developed with indicator-assisted selection (MAS) have not yet yielded the expected benefits (Vardar, 2010). Molecular diagnosis is a field that aims to diagnose diseases using molecular methods (Elçin, 2021). Molecular diagnostics is a set of techniques used to analyze biological markers in the genome and proteome and how cells express their genes as proteins, applying molecular biology to medical testing (George, 2001).

**Types of markers used in plant breeding include:**

Morphological markers, biochemical markers, DNA markers. The most reliable and most used of these are DNA markers.

The main DNA markers are divided into two:

1. Non-sequence specific: Randomly amplified polymorphic DNA (RAPD), Amplified fragment length polymorphism (AFLP).

2. Sequence specific ones: Simple sequence repeat (SSR), Simple sequence repeat polymorphism (ISSR) and in addition to these techniques used in recent years; Organelle microsatellites, Sequence characterized amplified regions (SCAR), Sequence linked amplified polymorphism (SRAP), Cleavage amplified polymorphic sequences (CAPS), Random

amplified microsatellite polymorphism (RAMP), Target site duplication polymorphism (TRAP), Single strand conformation polymorphism (SSCP) (Vardar, 2010).

**Advantages of DNA markers:**

The advantage of molecular marker systems over breeding studies through phenotypic characters is that they are independent of biotic and abiotic stress conditions. The breeding technique through molecular markers is one of the methods that has been easily adapted in cereals and other crops. They speed up breeding efforts considerably. It can be used for purposes such as verification or identification, detection and identification of genetic resources, and determination of genetic diversity. Breeding programs can be based solely on phenotypic or molecular information or can combine both (Vardar, 2010). Molecular techniques are also widely used to characterize animal, plant and microbial genetic resources. It is also frequently used in the diagnosis of disease factors. With the use of new technologies, research aimed at determining the functions of all genes or gene groups within a particular organism, instead of isolating and identifying individual genes, comes to the fore. In such matters, the development of large-scale DNA sequencing methods and the creation of software programs make it possible to evaluate data at this scale. It is an undeniable fact that molecular techniques offer important opportunities to increase agricultural production (Çetiner, 2010).

Today's plant breeders face numerous global challenges affecting food security, accessibility, productivity and nutritional quality. One of the biggest challenges for plant breeders is that they must develop more environmentally resilient plant varieties in response to rapid changes in cultivation conditions and resources due to climate change. Plant breeders rely on different plant genetic resources, breeding tools and methods to introduce genetic diversity into commercialized varieties. Breeders are using genetic diversity to develop new varieties with improved yields, biotic and abiotic stress tolerance, as well as to improve the nutritional quality of foods for the growing world population. Genetic diversity can be defined as the range of genetic traits in a crop or species. Also genetic diversity is the genetic differences between individuals for a particular trait where genetic differences are found in one or more DNA sequences. Genetic diversity can be assessed by examining differences in DNA sequence within a population of individuals (Chouldhury, 2014). It is of great importance for our country in terms of developing superior cultured varieties in the plant breeding program. First, genetic diversity is used to estimate the level of genetic difference that exists between different species. The genetic diversity present in plant populations is useful for conservation and plant breeding

(Rai, 2010). Genetic diversity in plants provides opportunities for the development of plants (Bhandari, 2017).

**The Importance of Genetic Diversity in Plant Breeding**

Genetic diversity is the key to evolutionary diversity (Dyer, 2004). It is also a gift of nature. Genetic diversity has an important role in ensuring food security by increasing productivity. It is very important for farmers' income and current and future food production (Bhandari, 2017).

**Advantages of Genetic Diversity**

Genetic diversity is the basis of any crop improvement. It is programmed and presented to plants so that the plants can survive in nature. Diversity in the breeding program of plants helps improve existing genetic variation for stress. Genetic diversity is achieved through the development of high-yielding crop varieties and preferred varieties with improved quality. Genetic diversity plays an important role in increasing the potential of varieties against new insect pests, diseases, and heat and cold stress (Smale, 2002). Plant genomes are dynamic and evolutionarily unstable, resulting in more frequent genetic and epigenetic changes in plants, a source of large amounts of genetic and phenotypic diversity even among varieties within a species (Adams, 2005). Having more genetic diversity in plants gives them the ability to adapt to sudden environmental changes (Raza, 2019). Various breeding methods and genomic tools have improved efficiency and sensitivity to introduce genetic diversity into commercialized plant varieties (Andersen, 2003). It is predicted that climate change will lead to unfavorable conditions for growing many existing plant varieties and will significantly impair food security (Deutsch, 2018). Agricultural regions around the world are experiencing increasingly variable weather conditions (for example, typical ambient temperatures are both higher and lower, floods or droughts are more intense), resulting in shifts in planting dates and the emergence of new plant diseases and pests. (Laux, 2010). To overcome such challenges, plant breeders need to develop climate-tolerant crops with a high ability to withstand intense and frequent seasonal changes (Lobell, 2008).

In our country, vegetable production areas and quantities have increased over the years over the last forty years. The vegetable growing sector has undergone great change and development for many reasons such as production systems, production technologies, diversity in produced and processed products, and differences in consumer preferences and habits. Among the vegetable species, tomato is one of the most produced species in our country and in the world. Tomato, which is the most important vegetable type in both field and greenhouse agriculture, is evaluated as fresh or processed (Tomato production technologies, diseases and pests, nutritional

deficiencies, 2017). Our country has an important diversity area for many vegetable species. Due to the fact that Anatolian lands have hosted many civilizations and their ecological diversity, variation has emerged in tomatoes over many years, as in almost all plant species, and local tomato varieties with different characteristics have been formed.

Anatolian lands are the homeland of many plant species and are of strategic importance in terms of vegetable species that are still cultivated today and have economic importance all over the world (Oğuz, 2010). Tomato (Lycopersicon esculentum Mill.) is a diploid, self-pollinating cultivar (Karpechenko, 1925) from the nightshade (Solanaceae) family, with 2n = 24 chromosomes (Spooner, 2005). Its homeland is the mountainous regions of Ecuador, Peru, the Galapagus Islands and Chile (Raiola, 2014). Nutritionally, tomatoes contain a variety of health-promoting compounds, including vitamins, carotenoids, and phenolic compounds. These bioactive compounds have a wide range of physiological properties, including anti-inflammatory, anti-allergic, vasodilator, antimicrobial, antithrombotic, cardioprotective and antioxidant effects (Raiola, 2014). Additionally, tomatoes are rich in carotenoids, which represent the main source of lycopene in the human diet (Viuda Martos, 2014). Carotenoids and polyphenolic compounds contribute to the nutritional value of tomatoes and enable them to improve their functional properties and qualities, including taste, aroma and texture (Rai, 2010). The tomato plant also has naturally occurring antioxidants Vitamin C and E (Agarwal, 2000) and large amounts of metabolites such as sucrose, hexoses, citrate, malate, and ascorbic acid (Li., 2012). Tomato is a plant in the group of edible vegetables with a wide range of uses. In addition to being consumed as a fresh fruit in almost every season, it can be consumed in many different ways such as canned food, ketchup, tomato juice and tomato paste (Oğuz, 2010). Tomato seeds are covered with a dark slippery liquid during their development to prevent them from germinating inside the fruit. Seeds in the fruit do not germinate due to the effect of inhibitory substances such as caffeic acid and ferulic acid in tomato juice. The flat, flattened kidney-shaped seeds are 2-4 mm long, 2-4 mm wide, 0.5-1 mm thick, camel or ash colored, and slightly hairy. The number of uncoated seeds in 1 gram (average 280-300) varies between 220-400 depending on the variety and whether it is coated or not. The weight of 1 liter of seed is between 300-350 grams. The weight of 1000 seeds is 2.7-3.3 grams. On average, there are 81 seeds in one fruit. By transferring genes to tomatoes using biotechnological methods, success has been achieved in solving problems that cannot be solved by conventional breeding methods (resistance to diseases and pests, extending shelf life, increasing aroma, etc.). However, transgenic plants cause significant problems because they carry different genes originating from

plants, bacteria and viruses (Çınar, 2015). Moreover, in addition to its worldwide agricultural and economic importance, tomato is a leading model system for genetic studies in plants (Solomon Benor, 2008). In recent years, after the genome sequencing, scientists' interest in tomato as a model plant has increased significantly (Cömlekçioğlu, Şimşek, & Boncuk, 2010). Tomato is a suitable model plant for both basic and applied research programs. This is due to its ability to grow under different growing conditions, relatively short life cycle, seed production ability, relatively small genome (950 Mb), gene duplication, high self-fertilization and homozygosity, ease of pollination and hybridization, ability to asexual reproduction by grafting, and complete adaptation from different artificial tissues. It has many different features, such as the possibility of producing a plant (Elnaga & Mona, 2018).

Molecular markers can provide an effective tool for efficient selection of desired agronomic traits because they are based on plant genotypes and are therefore independent of environmental variation. The use of molecular markers can facilitate tomato breeding by different methods to improve agronomically important traits such as yield, fruit quality and disease resistance. In many studies, the genetic diversity of tomato has been investigated using different molecular techniques. So far, there are only a few studies confirming the genetic diversity among tomato strains collected from different geographical origins (He, 2003). However, little research has been conducted on the analysis of genetic similarity between determinate and indeterminate tomatoes in bred lines (Jin, 2006 ). Morphological and phenotypic characterizations have been used to assess genetic variability because morphological and phenotypic characterizations offer an easy way to measure genetic differentiation (El Aziz & Elkomey, 2016). Phenotypic assessment in tomatoes has traditionally been based on seed and fruit characteristics (El-Mansy, Metwally, Elkasas, El-Tantawy, & Mahmoud, 2015). Additionally, karyological studies have been used in plant identification and taxonomy. These have provided important information about plant origin, evolution, and mutual relationships (Wang, Gao, Sheng, & Yin, 2020). Local and global production, consumption and economic income of the tomato plant is increasing every year. Producing tomatoes with plant tissue culture, which is one of the first steps of plant biotechnology and genetic engineering, is an alternative production method (Fisher, 1918).

**An example of research on the genetic diversity of tomato plants:**

One of the most important tasks undertaken by plant breeders is to introduce genetic diversity into breeding populations. To illustrate this concept, two simulated tomato (Lycopersicon esculentum Mill.) breeding populations, each with the same number of individual plants (n = 1,000), were used to describe the strategic integration of genetic diversity in a plant breeding

program. The phenotypic trait of interest is tomato fruit weight. Both populations have the same fruit weight value (100 g on average). Following Fisher's infinitesimal model, in this simulation phenotypic variation is assumed to follow a normal distribution, typical for a trait such as fruit weight (Fisher, 1918). However, the first population was simulated to have lower phenotypic variance than the second population. Each of the populations has the same average 100 g fruit weight. First of all, the grower's goal is to increase tomato fruit weight. As mentioned above, both populations have the same phenotypic mean tomato fruit weight value of 100 g, but the mean phenotypic trait value from the low-variation population is considerably lower than 100 g. This is due to the difference in phenotypic variance between populations. Therefore, given these two populations, the breeder has made greater progress towards increasing weight from the second population with higher phenotypic variation (Edwards, 2000). Genetic diversity has been the basis of plant breeding since the early days of agriculture. It serves as raw material for plant breeders to develop new varieties that can meet the needs of growers, adapt to climate change and meet the increasing demand for food. The inclusion of agronomic and consumer characteristics in agricultural products has led to an increase in product diversity over time due to breeding efforts to improve the plant. Plant breeding is a highly time- and resource-intensive process that relies on a variety of genomic tools and breeding methods to incorporate genetic diversity and improve crop varieties (Schouten, 2019).

**Conclusion and Recommendations**

Lack of genetic diversity at sufficient and desired levels and the lack of availability of high-yielding varieties are the main reasons for low seed production in some countries. Therefore, it is necessary to increase genetic diversity to develop high-yielding tomato varieties by utilizing the existing germplasm. Tomato yield is a multigenic trait and is greatly affected by environmental factors. Breeders use potential hybridization techniques to obtain tomatoes with high yield potential. Genetic diversity enables the selection of superior varieties and their characteristics. Studies have shown that genetic diversity is necessary for the development of high-yield genotypes (Liu, 2021). The rapid progress seen in molecular biology in recent years has made a great and important contribution to its use in plant genetics studies in line with targets such as the preservation, production and protection of genetic diversity. However, these marker-assisted molecular biological applications are complementary to molecular markers. Researchers' genetic technologies can be beneficial to humanity when directed and supported correctly, so studies on this subject should continue meticulously. Turkey has a very important advantage in the field of agricultural biotechnology due to its rich genetic resources. However,

in order for Turkey to benefit from the opportunities offered by modern biotechnological methods, it needs to determine its priorities very well within the framework of developments in the world and the current situation in Turkey. Not giving the necessary importance to basic science fields such as biochemistry and molecular biology, which are absolutely necessary for the development of biotechnology in Turkey, has kept the number of trained personnel in this field low, and this has prevented the creation of research units with a critical mass that can carry out research. Although this problem has been emphasized in all five-year development plans prepared since 1980, it cannot be said that any significant progress has been made in this regard yet. The most important problem identified here arises from the creation of individual laboratories instead of creating "centers of expertise" by bringing together researchers with a certain level of knowledge and experience. Although the number of young researchers who have studied abroad in the field of molecular biotechnology or molecular plant breeding has been increasing in recent years, unfortunately there is no effort to bring these researchers together and create "expertise centers" or laboratories to work on the necessary projects. If the necessary measures are not taken, it will not be possible for Turkey to reach a different position in the field of agricultural biotechnology than it is today, despite the initiatives taken over the past thirty years and the significant amount of resources spent. Modern gene technologies, also called biotechnology, provide important opportunities to increase agricultural production in order to provide adequate and balanced nutrition for the rapidly growing world population. Here, in addition to the application of sustainable agricultural techniques, it is very important to develop high-yield and high-quality plant varieties that are resistant to biotic and abiotic stress conditions. In the development of these plants, it would be better to focus mainly on molecular plant breeding techniques, rather than just transgenic plants obtained through transformation. Developing countries with rich genetic resources, such as Turkey, will help them make the best use of their genetic potential by identifying their priority areas, creating an adequate infrastructure for molecular biology studies, and training a number of competent researchers to form a critical mass. However, in parallel with technological developments, legal regulations regarding biosafety must be made both during the development of these techniques and products and their release into nature, and competent people who will implement this legislation must be trained. Making regulations that will inform and support researchers in all these areas is important for us to be in a position to compete in the globalizing world trade (Çetiner, 2010).

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# EXAMINING THE CHALLENGES FACED BY ORGANIC RAISIN PRODUCERS AND THEIR WILLINGNESS TO SUSTAIN ORGANIC AGRICULTURE

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## Abstract
Organic agriculture contributes to environmental preservation as well positively impacting the health and well-being of farmers and consumers. Turkiye plays a significant role in global organic raisin production, with the majority of organic raisins produced in the country being exported. The province of Manisa is the region where the highest amount of organic raisins is produced. Manisa accounts for 62.20% of Turkiye's organic grape production and 92.65% of its organic raisin production. The objective of this study is to determine the challenges faced by organic raisin producers and estimate their willingness to continue organic production in the future. The data of this research was collected through face-to-face questionnaires to 130 organic raisin producers in Manisa in January 2023. Logistic regression analysis was used in the research. Results show that 11.3% of the surveyed producers stated that they are not willing to continue to produce organic raisins in the near future. Insufficient prices of organic products, low yield, and challenges in disease management play an important role in their willingness. Furthermore, among the key challenges faced by organic raisin producers are, high costs, difficulties in marketing the product, and heavy workload. Understanding these challenges is vital for policymakers and stakeholders to develop strategies that support organic farming, contributing to a sustainable agricultural system.
**Keywords:** Organic Agriculture, Organic Raisin, Logistic Regression, Turkiye.

## Introduction

Sustainable agriculture is based on sustainable growth where the sustained development of agriculture merges the usage and preservation of environmental resources for both the present and future (Siemianowska, 2017). Organic farming is one of the sustainable agriculture methods and it provides an environmentally friendly alternative method for the natural recycling of organic matter to reduce nutrient losses and decrease waste accumulation (Eryılmaz et al., 2019; Anastacia, 2021). Many scholarly publications and technical reports have highlighted the environmental, social, and economic well-being of organic farming (El Bilali, 2020). Studies have examined farmers' adoption of environmentally sustainable practices and organic agriculture (Mills et. al., 2018; Casagrande, 2016). Research into this matter is increasingly important in comprehending how to mitigate the detrimental impact of agriculture on the environment (Ataei et al., 2022; Brown et al., 2021). Ensuring the sustainability of farmers' organic production and keeping their involvement in organic agriculture is as important as directing farmers to organic agriculture.

Turkiye is known for its diverse and fertile agricultural lands, providing a favourable environment for organic farming practices (Gurses & Turhan, 2011). In 1986, organic agriculture started on raisins and dried figs initiated in Manisa, a city located Aegean region of Turkiye. Subsequently, organic agricultural production started with 8 product diversity, such as raisins, dried figs, and dried apricots, hazelnuts, cotton which are important traditional export products of Turkiye. By 2001, the scope expanded to 98 varieties of agricultural products, and by 2006, it further soared to 203 diversities. It can be asserted that the increasing diversities reason is driven by the growing demand of the global market for organic agriculture products. This has led not only to product diversity but also to the expansion of production areas and the number of farmers involved in organic agriculture over the years (Kose & Odabas, 2005). Turkiye is a leader in organic raisin production worldwide (Gundogmus & Bayramoglu, 2005). In Turkiye, organic grapes are grown on 13,961 hectares of land, accounting for 3.2% of the total production area. Predominantly cultivated for raisins, the entire yield is exported abroad (Ates et al., 2021). Organic raisins accounted for 13% of Turkiye's organic product exports in 2022. Manisa is also the main region in Turkiye where seedless raisins are produced. Manisa accounts for 10.8% of organic produce production in Turkiye. Moreover, there are 4,143 organic farmers in Manisa. In other words, 4 out of 74,545 organic farmers in Turkiye are in Manisa (Republic of Turkiye Ministry of Agriculture and Forestry, 2022).

The main focus of this study is to evaluate the willingness of organic raisin producers in Manisa to continue organic raisin production. Therefore, the research question is Which factors affect the willingness of organic raisin producers in Manisa to continue organic production? Furthermore, the challenges faced by the producers in organic raisin production are also analysed in the content of this study. This research has the potential to make substantial contributions to the existing literature regarding food safety and the sustainability of agricultural practices.A thorough understanding of the challenges faced by organic raisin farmers is a pivotal first step in shaping agricultural policies for governments, companies, universities, and other entities committed to advancing organic farming practices. Moreover, the focus of this research is to develop a qualitative understanding of organic agriculture research.

**Materials and Methods**

The study's primary data was sourced from organic raisin producers in Manisa in 2022. The Farmer Registration System in Manisa indicated 3172 registered organic farmers in 2020. A proportional sample size formula was used to determine the participating farmers in the face-to-face survey.

In determining the sample volume;

$$n = \frac{Np(1-p)}{(N-1)\sigma^2_{\hat{p}_x} + p(1-p)}$$

A formula is used.

In the Formula:

n=Sample volume

N=Number of organic farmers in the province (Manisa = 3172)

p= Organic raisin producer proportion (taken as p = 0.50 to attain maximum sample volume)

= Deviation of population (95 % confidence interval and 8 % error margin)

The sample size was determined by considering a 95% confidence interval with an 8% margin of error, considering a population of 3172 farmers with a maximum proportion of 0.50. This resulted in a final sample size of 130 farmers, which included 2 backup questionnaires. In the questionnaire form 25 attitudinal questions were administered to determine the organic raisin farmers' willingness to continue organic raisin production, assessed using a 5-point Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree). The reliability of

the attitude scale was assessed, and the Cronbach's alpha score based on standardized items (.798 for Manisa) confirmed its reliability.

The study utilized descriptive statistics in the statistical software SPSS 29.0 to analyze the socio-economic aspects and challenges faced by producers of organic raisins. Furthermore, a logistic regression model was used to estimate the determinants that influence the willingness of organic raisin producers in Manisa to continue in organic production. The logistic regression model was selected because the dependent variable is discrete and the independent variable can take both discrete and continuous values. This model offers numerous advantages such as the ability to accommodate a high number of parameters in the function, no limit to the distribution of probability functions of the independent variables, and increased resilience to hypothetical distortions. In the logistic regression model, the observed value of the dependent variable takes the value (1) if the event occurs and (0) if it does not occur. The dependent variable in the logistic regression of organic raisin farmers' willingness to continue their organic production in the future is coded as; 0 no (not willing), 1 yes (willing).

1= Producers are willing to continue their organic raisin production activities.

0= Producers are not willing to continue their organic raisin production activities

The assumptions regarding the logistic regression model is briefly shown in the function below.

$$P_i = E\,(Y=1/X_i) = \alpha + \beta X_i$$

$$P_i = E\,(Y_i=1/X_i) = \frac{1}{1+e^{-(\alpha+\beta Xi)}} \qquad (1)$$

$$= \frac{1}{1+e^{Zi}} \qquad (2)$$

Here

$Z_i = \alpha + \beta X_i$

Equation (2) is called the logit model. Since the exponential term in the function will always be positive when X takes any value, the lower limit of $P_i$ is also 0. This function fulfills $0 \leq P_i \leq 1$ condition required for probability. β = Constant coefficient, βi = The parameter to be estimated for each independent variable, Xi = denotes the i'th independent variable (İnal M, et al., 2006). The logit transformation of the nonlinear logistic regression function given in the equation can be applied and linearized.

$$L_i=Ln(\frac{P(Y)}{1-P(Y)})= \ln e^{\beta_0+\beta_1 X_1} =\beta_0+\beta_1 X_1$$

The linear model shows how much a change in the dependent variable by 1 unit of change in $\beta_1$ independent variable x causes a change in the dependent variable, while in the logit model, it shows how much change in logit is caused by 1 unit of change in X (Aldrich and Nelson, 1984).

As independent variables included in the model are shown in Table 1.

**Table 1.** Independent variables included in the logistic regression model

| Independent variables | Unit of measurement |
|---|---|
| Farmers education | In years |
| Organic agriculture experience | In years |
| I am aware of organic agriculture incentives given by the state. | 5-point Likert scale |
| I am concerned about low yields during organic production. | 5-point Likert scale |
| I believe that I have done my responsibility to protect the soil and water resources while doing organic production. | 5-point Likert scale |
| I have high concerns about marketing my organic products. | 5-point Likert scale |
| I am satisfied with the income from organic production. | 5-point Likert scale |
| I think the complexity of biological methods. (challenges in disease management) makes it difficult to continue organic agriculture. | 5-point Likert scale |
| I think state support has an impact on continuing organic agriculture production. | 5-point Likert scale |
| I care that organic seeds, fertilizers, and pesticides do not cause soil and water pollution. | 5-point Likert scale |
| If farmers around abandon organic farming, I intend to abandon it too. | 5-point Likert scale |

## Findings and Discussion

Descriptive statistics were employed to evaluate the responses of organic raisin producers. Table 2 illustrates the socio-economic features of organic raisin producers in Manisa. The mean age of organic raisin producers in Manisa was 52.97 years. The organic farming experience of organic raisin producers in Manisa was found to be 11.17 years. In addition, 93.8% of organic raisin producers hold qualifications lower than high school, with 88.5% of them holding organic farming certifications.

**Table 2.** Descriptive characteristics of organic raisin producers

| | Min | Max | Mean |
|---|---|---|---|
| Age | 20 | 81 | 52.97 |
| Agriculture experience (in year) | 3 | 65 | 26.03 |
| Organic agriculture experience (in year) | 3 | 32 | 11.17 |
| | | N | % |
| Education level | | | |
| Primary | | 46 | 35.8 |
| Secondry | | 36 | 27.7 |
| High School | | 40 | 30.3 |
| 2 years collage | | 5 | 3.8 |
| Bachelor's degree | | 3 | 2.4 |
| Having organic certification | No | 15 | 11.5 |
| | Yes | 115 | 88.5 |

Table 3 presents the main challenges faced by organic raisin producers. Significantly, a noteworthy 93.30% of participants recognized high production costs as a major worry, which demonstrates the economic pressure confronted by producers. Furthermore, the shortage of agricultural labour (70.90%) and low agricultural productivity (67.91%) were important difficulties, underscoring the necessity for measures to tackle these labour and efficiency challenges. Organic marketing obstacles were prevalent, with 63.41% of producers facing difficulties, highlighting the need to enhance market strategies. In addition, 62.70% expressed concerns about chemical issues from neighbouring non-organic farms, which emphasises the broader environmental impact on organic production.

**Table 3.** Agricultural challenges faced by organic raisin producers

| Challenges encountered | N | % |
|---|---|---|
| High production cost | 125 | 93.30 |
| Shortage of agricultural labour | 95 | 70.90 |
| Low agricultural productivity | 91 | 67.91 |
| Problems encountered in the marketing of organic products | 85 | 63.41 |
| Chemical problems that can be transported from nearby non-organic farms | 84 | 62.70 |
| Land fragmentation problem | 56 | 41.84 |
| High cost of organic certification | 49 | 36.68 |
| Lack of advisors (no advisors) for organic farming | 39 | 29.10 |
| The lack of training in organic farming | 33 | 20.20 |
| Inadequate tools and equipment for agricultural machinery | 27 | 17.90 |
| The physical challenges of farming | 6 | 4.51 |

Organic raisin producers were asked if they would like to continue their organic production in the future, and it has been found that 88.7% of organic raisin producers are willing to continue their organic production. The logistic regression model estimates organic raisin producers' willingness to continue their organic agriculture activity based on explanatory variables. Table 4 shows the test of the models, and the Hosmer and Lemeshow test of the goodness of fit suggests the model is a good fit to the data ($p > 0.05$). The overall model was found to be statistically significant, with a Nagelkerke R-squared value of .712, indicating a 71.2% relationship between the predictor variable and the outcome variable. Moreover, the percentage of correct recognition of the model is 93% indicating that the model provides a correct classification of the cases.

**Table 4.** Test of model

| Omnibus test of model coefficients | | | |
|---|---|---|---|
| | Chi-square | df | Sig. |
| Step | 61,227 | 13 | .001 |
| Block | 61,227 | 13 | .001 |
| Model | 61,227 | 13 | .001 |

| Model Summary | | |
|---|---|---|
| -2 Log likelihood | Cox and Snell R square | Nagalkerke R square |
| 38,197[a] | .596 | .712 |

| Hosmer and Lemoshow test | | |
|---|---|---|
| Chi-square | df | Sig. |
| 4,136 | 8 | .967 |

According to the results of the logistic model, eight factors were identified as influencing the likelihood of organic raisin producers continuing their organic production activities. These factors include organic agriculture experience, producer education level, statements expressing concerns about low yields during organic production, apprehensions about marketing organic products, perceptions of the complexity of biological methods (specifically, challenges in disease management), and satisfaction with income from organic production.

In the logistic regression model, the Exp (B) value, representing the exponential value of B (coefficient of the variable), is defined as an odds ratio. Therefore, for every unit increase in organic raisin producers' experience, there is a 0.14 times greater likelihood of their willingness to continue organic production in the future. Similarly, with an increase in the education level of organic raisin producers, there is a 0.34 times greater likelihood of their willingness to continue organic production in the future.

Furthermore, as organic raisin producers express higher levels of concern about low yields during organic production (0.96 times), high concerns about marketing their organic products (0.99 times) and perceive the complexity of biological methods as a challenge in continuing organic agriculture (1.75 times), they are less likely to be willing to continue their organic production in the future. On the other hand, if producers express higher satisfaction with the

income from organic production (1.60 times), they are more likely to be willing to continue their organic production in the future.

**Table 5.** Result of the logistic regression model

| Independent Variables Description | B | S.E. | Wald | df | Sig. | Exp (B) |
|---|---|---|---|---|---|---|
| Organic agriculture experience | .140 | .080 | 3.082 | 1 | .049* | .870 |
| Producers' education level | .339 | .173 | 3.842 | 1 | .050* | .712 |
| I am aware of organic agriculture incentives given by the state. | -.580 | .452 | 1.651 | 1 | .199 | 1.787 |
| I am concerned about low yields during organic production. | -.964 | .391 | 6.086 | 1 | .014* | .381 |
| I believe that I have done my responsibility to protect the soil and water resources of organic agriculture. | 1.758 | 1.032 | 2.903 | 1 | .088** | 5.800 |
| I have high concerns about marketing my organic products (raisins). | -.991 | .394 | 3.935 | 1 | .047* | .458 |
| I am satisfied with the income from organic production. | 1.604 | .594 | 7.283 | 1 | .007* | 4.972 |
| I think the complexity of biological methods (challenges in disease management) makes it difficult to continue organic agriculture. | -1.751 | .803 | 4.748 | 1 | .029* | .174 |
| I think state support has an impact on maintaining organic agriculture production. | -1.663 | 1.088 | 2.335 | 1 | .126 | 5.273 |
| I care that organic seeds, fertilizers, and pesticides do not cause soil and water pollution. | -.044 | .770 | .003 | 1 | .955 | .957 |
| If farmers around abandon organic farming, I intend to abandon it too. | .446 | .515 | .751 | 1 | .386 | 1.563 |
| Constant | 3.899 | 6.277 | .386 | 1 | .535 | 49.358 |

The study was conducted to determine the factors affecting the willingness of organic raisin producer to continue their adoption of organic production in Manisa province. The results reveal that economic factors significantly impact producers' willingness to continue with organic production. Home, et al. (2014) also reported that organic farmers' motivation is based on economic factors such as profit maximization, and financial incentives. Similarly, Duff et al. (1991) identified financial factors as obstacles to the adoption of sustainable agriculture practices. Hanley et al. (2012) argued that some farmers are primarily motivated by profit

maximization, making financial incentives an effective means to encourage them to provide biodiversity benefits. Additionally, studies like that of Duvaleix et al. (2022) found economic motives to be the strongest driver for the support of environmentally friendly practices in specific agricultural sectors, such as Brittany's pig sector. These collective findings support our conclusion that the income derived from organic raisins is satisfactory, there is no concern about low yields, and organic marketing is not a significant worry.

Furthermore, Afshari et al. (2019) suggested that factors such as the level of education, knowledge of sustainable agriculture, and land area directly influence farmers' behaviors related to sustainable agriculture. Consistent with this, our research underscores the importance of producers' education level and experience in organic raisins in shaping their willingness to continue organic raisin production. Cukur et al. (2019) argued that farmers require technical knowledge about organic farming. In our study, it was highlighted that the complexity of biological methods in disease management poses a challenge to farmers, making the continuation of organic agriculture difficult. Therefore, it is imperative to enhance farmers' knowledge of organic agriculture by providing the necessary training in biological methods."

**Conclusion and Recommendations**

This study reveals that the education level and practical expertise of producers in organic agriculture positively impact their inclination to further engage in organic farming. Factors adversely affecting producers' willingness to continue organic agriculture include low productivity, concerns about the marketing and pricing of organic products, and challenges in disease management, particularly with biological pest control. Organic raisin producers also face obstacles such as high production expenses, decreased agricultural productivity, and marketing difficulties for their organic products. Additionally, issues like a shortage of farm labor and the transportation of chemicals from neighbouring non-organic farms present challenges to organic raisin growers. The concern about chemical residues in products, with implications for marketing and exports, amplifies worries about the potential transfer of chemicals from nearby fields by wind or insects, even among producers who do not use chemicals. Effectively addressing these multifaceted challenges necessitates more robust control procedures, the development of sustainable and safe agricultural practices, and the implementation of stringent quality control measures. Policymakers play a pivotal role in supporting sustainable agriculture and facilitating access to resources and knowledge for organic raisin producers. Foreign clients demand high-quality processing infrastructure and transparent procedures concerning product quality and traceability. Overall, the contamination

risks associated with pesticide residues pose a significant challenge for organic production in Turkey. To tackle this issue effectively, policymakers should collaborate with producers and companies to implement more rigorous and efficient control procedures. By fostering cooperation among farmers, the government, and international partners, the region can not only enhance the competitiveness of its organic raisin industry but also contribute to a more sustainable and environmentally friendly agricultural landscape.

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# SÜT SIĞIRLARINDA SÜT VERİMİ VE KALİTESİNDE ETKİLİ POLİMORFİK GENLER

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**Özet**
Süt sığırcılığında verim ve süt kalitesi büyük önem arz etmekle birlikte süt verimini arttırmaya yönelik ıslah çalışmaları uzun yıllardır sürmektedir. Yapılan çalışmalarda genetik ilerlemeyi hızlandırabilmek için generasyon aralığının kısa olması gerekmektedir. Sığırlarda süt verim özelliği, ergin yaşta ve tek cinsiyette tespit edilebildiğinden dolayı damızlık adayı seçilen hayvanın uzun süre işletmede tutulması gerekmektedir. Damızlık adayı olan hayvanların damızlık değerlerinin düşük olması durumunda ise bu ciddi bir ekonomik kayba sebep olmaktadır. Damızlık adaylarının değerlerinin erken yaşta ve doğru olarak seçilebilmesinde genetik çalışmalar çok önemlidir. Islah çalışmalarının başarısının en büyük etmenlerinden biri; genetik yapı tespitinin doğru olmasıdır. Günümüzde genetik varyasyonların belirlenmesinde DNA düzeyinde yapılan çalışmalar ile gen polimorfizmleri belirlenebilmektedir. Gen polimorfizmleri, sığırlarda istenmeyen durumlara sebep olduğu gibi verim özelliklerini olumlu yönde etkileyebilmektedir. Süt proteinlerindeki ve hormonlardaki polimorfizmler süt verimi, sütün yağ oranı ve sütün protein oranına etki etmektedir. Bu çalışmada; süt proteinleri olan kazein (α-kazein, β-kazein, K-kazein) ve serum proteini (β-laktoglobin, α-albümin, immünoglobulinler) ile leptin, prolaktin ve büyüme hormonuna ait gen polimorfizmlerinin süt verim ve kalitesine olan etkileri derlenmiştir.
**Anahtar Kelimeler:** Süt sığırcılığı, süt proteini, hormonlar, polimorfizm

# POLYMORPHIC GENES AFFECTING MILK PRODUCTION AND QUALITY IN DAIRY CATTLE

**Abstract**

Although productivity and milk quality are of great importance in dairy farming, breeding studies to increase milk yield have been ongoing for many years. In studies conducted, the generation interval must be short in order to accelerate genetic progress. Since the milk yield characteristic of cattle is determined at an adult age and in single sex, the animal selected as a breeding candidate must be kept in the enterprise for a long time. If the breeding value of the animals that are candidates for breeding is low, this causes a serious economic loss. Genetic studies are very important in selecting breeding stock at an early age and correctly. One of the biggest factors in the success of breeding efforts is; The genetic structure determination is accurate. Today, gene polymorphisms can be determined by studies carried out at the DNA level to determine genetic variations. Gene polymorphisms not only cause undesirable conditions in cattle, but can also positively affect productivity characteristics. Polymorphisms in milk proteins and hormones affect milk yield, milk fat ratio and milk protein ratio. In this study; The effects of gene polymorphisms of milk proteins casein (α-casein, β-casein, K-casein) and serum protein (β-lactoglobin, α-albumin, immunoglobulins) as well as leptin, prolactin and growth hormone on milk yield and quality were compiled.

**Keywords:** Dairy cattle, milk proteins, polymorphism, hormones.

## Giriş

Gıda endüstrisinin temel bileşenlerinden biri olan süt, sağlıklı bir yaşam tarzının vazgeçilmez bir parçasıdır. Dünyada süt en çok ineklerden elde edilmektedir. İneklerde süt verimi başta genetik yapı olmak üzere bir çok faktörden etkilenmektedir. Süt üretiminde yağ ve protein oranları ile mikrobiyal kalitenin yanı sıra sütün kalitesi de önemlidir, Süt verimi ve kalitesini belirleyen genetik faktörlerin başında ise polimorfik genler gelmektedir. Süt verimini olumlu yönde etkileyen polimorfik genler, süt endüstrisinde yüksek verimlilik ve sürdürülebilirlik için önemli bir faktördür.

Polimorfik genlerin tespit edilmesinde kullanılan DNA sekans analizleri, PCR, Restriksiyon enzimi analizi, genotipleme teknikleri, sekanslama teknolojileri gibi birçok yöntem vardır. Bu yöntemlerin ışığında ıslah çalışmalarında damızlık değer tahmini daha doğru olmakla birlikte genetik ilerleme hızı da artmaktadır. (Çoban, 2015) Süt kalitesi ve veriminin arttırılması için yapılan çalışmalarda etkili hormonlar ve süt protein genlerinin polimorfizmleri tespit edilmiştir. Bu çalışmada süt sığırlarında süt verimi ve kalitesine etki eden polimorfik genler ile ilgili bilgiler derlenmiştir.

## Materyal ve Yöntem

Süt sığırlarında süt verimi ve kalitesi üzerinde etkili olan çok sayıda polimorfik gen bulunmaktadır. Bunlardan en önemlileri şunlardır:

### Kazein

Sütün başlıca proteini olup süt proteinin %80'ini oluşturmakta ve sadece sütte bulunmaktadır (Doğru & Dayıoğlu, 1996). Laktasyonda büyük kalsiyum içeren miseller tarafından salgılanır. Kazein misellerinin büyük bir kısmı (%93'ü) kazeinden, geride kalan kısım ise inorganik maddelerden (kalsiyum, fosfat, magnezyum, sodyum ve sitrat) oluşmaktadır (Demirel, 2019). Sütün çökmeyen kısmını olmakla birlikte dört farklı doğal kazeinden ($\alpha S_1$-kazein, $\alpha S_2$-kazein, β-kazein, Kappa kazein) oluşmaktadır (Yardibi, 2008).

***$\alpha S_1$-kazein:*** Ruminant hayvanların süt proteininin takriben % 95'i altı yapısal gen tarafından kodlanmaktadır. $\alpha S_1$-kazein CSN1S1 geni tarafından kodlanır. Toplam kazeinin %40'ını oluşturmaktadır ve 199 aminoasitten meydana gelmektedir. CSN1S1 geninde en çok B ve C varyantları görülmekte olup; A, B, C, D, E, F, G, H, I olmak üzere 9 varyantı bulunmaktadır. B varyantı Avrupa orjinli ırklarda ve en yüksek frekans Siyah Alaca ırkı sığırlarda görülmüştür. Simental ve Esmer ırkı sığırlarda orta frekansta C; Yak ve Zebu sığırlarında ise C varyantının daha baskın olduğu tespit edilmiştir (Demirel, 2019). $\alpha S_1$-kazein fenotiplerinin gerçek süt verimi, 305 günlük süt verimi, günlük süt verimi ve gerçek yağ verimi üzerinde etkileri önemli

bulunmuştur. Gerçek süt verimi, 305 günlük süt verimi ve günlük süt verimi bakımından ırklar genelinde BC fenotipine sahip hayvanların daha fazla süt verimine sahip oldukları tespit edilmiştir. Yağ verimi bakımından ise ırklar genelinde yine BC fenotipli hayvanlar üstünlük sağlamıştır (Özdemir, 2001).

***αS₂-kazein:***CSN1S2 geni tarafından kodlanmaktadır. Toplam kazeinin %14'ünü oluşturmakta ve 207 aminoasitten meydana gelmektedir. 4 varyantı bulunmakla birlikte, A varyantı Avrupa orjinli, B varyantı Taurus ve İndicus, C varyantı Yak, D varyantı da Fransız Vosgienne ile Montebeliarde ırkı sığırlarda tespit edilmiştir (Demirel, 2019).

***β-kazein:***CSN2 geni tarafından kodlanmaktadır ve 209 aminoasit içermektedir. 13 adet genetik varyantı bulunmakta ve en yaygın $A^1$, $A^2$ varyantları görülürken; B daha az, $A^3$ ve C varyantları nadir olarak görülmektedir (Demirel, 2019). Yapılan çalışmada süt verimi ve yağ verimi bakımından fenotiplerin etkisi önemsiz bulunmuştur (Özdemir, 2001).

***Kappa kazein:*** CSN3 geni tarafından kodlanmaktadır (Demirel, 2019). Toplam kazeinin %12'sini oluşturmaktadır ve 169 aminoasidi ve 6 minor komponenti bulunmaktadır. Birçok varyantı bulunmasına rağmen en çok A ve B allelleri izlenmiştir (Kabasakal ve ark. 2015) Sahiwal sığırlarında yapılan bir çalışmada süt verimi ve içeriğine etkisi önemli bulunmuştur. BB genotipine sahip hayvanlar aylık ve 305 günlük süt verimi ile protein içeriği bakımından daha üstün bulunmuştur (Rachagani & Gupta, 2008)

**Serum Proteinleri**

Sütün içeriğindeki proteinlerin %20'sini serum proteinleri diğer adıyla whey proteinleri ya da peynir altı suyu proteinleri oluşturmaktadır. Globüler yapıda bulunmakta olup β-laktoglobulin, α-laktalbümin, serum albümini, immünoglobulinler**,** proteoz-peptonlar ve diğer minör protein fraksiyonlarını (laktoferrin) ihtiva etmektedir. Isıya duyarlı ve doğal halinde suda çözünür formdadır ve biyolojik değeri yüksektir (Gür ve ark., 2010).

***β-laktoglobulin:*** 11. kromozom üzerinde bulunan LGB geni tarafından kodlanmaktadır (Demirel, 2019). LGB genindeki polimorfizmler süt içeriği ile peynir yapım özellikleri arasındaki ilişkiler önemli bulunmuştur. Bazı çalışmalarda döl verim özellikleri ve mastitise dirençle ilişkisi olduğu saptanmıştır (Öner ve ark., 2011). 15 adet varyantı tespit edilmiştir ve bunlardan frekansı en yüksek olan A ile B allelleridir. Türkiye'de bulunan Siyah Alaca ırkında yapılan bir çalışmada BB genotip frekansının daha yüksek olduğu izlenmiştir. Fakat AA genotipli hayvanların üstlerinde daha kısa sürede mayalanma, AB genotipli bireylerden alınan sütlerde Mg, Ca, P oranları diğer genotipli hayvanlardan fazlayken AA genotipli hayvanların sütündeki potasyum oranı daha fazla bulunmuştur (Demirci & Akyüz, 2014).

***α-laktalbümin:*** Meme bezinde laktoz biyosentezi için elzem olduğundan süt sentezinde önemli bir rolü bulunmaktadır (Yardibi, 2008). 5. kromozom üzerinde bulunan LAA geni tarafından kodlanmaktadır (Demirel, 2019). 2 adet genetik varyantı bulunmaktadır. Bunlar A ve B allelleridir. Yapılan bir çalışmada A allellinin frekansının Hindistan ineklerinde Rus ırklarına göre daha fazla olmasına rağmen Avrupa sığır ırklarından daha düşük olduğu tespit edilmiştir (Yardibi, 2008).

**Leptin**

Protein yapısında olan bir hormondur ve yağ dokudan sentezlenmektedir. İskelet kasları, mide, plasenta ve fötal dokulardan da salgılanmaktadır. Enerji metabolizması, vücut ağırlığı ve üreme fonksiyonlarının düzenlenmesinde görev almaktadır. İştahı baskılar ve enerji tüketimini arttırır. Leptin geni 4. kromozom üzerinde haritalanmıştır. Leptin geni, karkas randımanı ile kompozisyonu, süt verimi ve protein düzeyleri ile ilişkili olduğu tespit edilmiştir. Yapılan bir çalışmada leptin geni polimorfizmleri tespit edilmiş; laktasyon boyunca TT genotipli ineklerin göstermiş olduğu yüksek süt verimi ekonomik açıdan büyük önem taşıdığı saptamıştır (Gürses, 2010).

**Prolaktin**

Kızgınlıkta korpus luteumun olgunlaşması ve salgı üretmesinde, gebelikte östrojen ve progesteronla beraber süt bezlerinin olgunlaşmasında görev almaktadır. Laktasyonun başlamasında önemli bir yere sahiptir. Süt bezlerinin uyarılması ve analık özelliklerinin ortaya çıkmasını sağlar. Hipofiz bezi tarafından salgılanmaktadır fakat plasenta, amniyon gibi çeşitli bölgelerden de salgılandığı tespit edilmiştir. Prolaktin, prolaktin geni tarafından (PRL) kodlanmaktadır. 23. Kromozom üzerinde haritalanmıştır. Tespit edilen polimorfik bölgelerindeki varyantları süt verim özellikleri arasında ilişkiler önemli bulunmuştur. Yapılan çalışmalarda A ve G varyantları arasında homozigot A allelline sahip hayvanlarda yüksek süt verimine sahip olduğu tespit edilmiştir (Şahin, 2012).

**Büyüme Hormonu (GH)**

Büyüme hormonu geninin (bGH) ürünü olan büyüme hormonu, memeli hayvanlarda doğum sonrası büyüme sağlar ve metabolizmayı düzenler. Büyüme hızı, vücut sağlığı, süt verimi gibi özellikleri etkilemektedir. Sığırlarda büyüme hormonu (bGH) geni, 19. kromozoma yerleşmiştir. BGH genindeki polimorfizmler; süt verimi ve süt protein/yağ oranı, döl verim özellikleri, karkas kalitesi ile ilişkili olduğu tespit edilmiştir. Meme gelişiminde ve laktasyonda önemli bir işlevi vardır (Akış, 2009; Özdemir, 2011).

**Sonuç ve Öneriler**

Bu çalışma, süt sığırlarında süt verimi ve kalitesini etkileyen polimorfik genlerin önemli bir rol oynadığını göstermektedir. Yapılan genetik analizler, belirli gen varyasyonlarının süt üretiminde ve kalitesinde belirgin farklılıklara neden olduğunu ortaya koymaktadır. Bu genetik faktörlerin süt endüstrisinde verimliliği artırma ve süt kalitesini iyileştirme potansiyeli bulunmaktadır. Sonuç olarak, süt sığırlarında süt verimi ve kalitesini etkileyen polimorfik genler süt endüstrisinin temelini oluşturur. Genetik mirasın doğru bir şekilde anlaşılması ve yönetilmesi, daha sağlıklı ve besleyici süt ürünleri elde etmek için önemlidir. Bu noktada, genetik araştırmaların ve modern teknolojinin sunduğu imkanların kullanılması, süt endüstrisinin gelecekteki potansiyelini daha da artırabilir. Araştırmalar genellikle sığırların genetik yapısını anlama, özellikle süt üretimi üzerindeki genetik etkileşimleri belirleme amacı güder. Bu genlerin belirlenmesi, genetik seleksiyon süreçlerini optimize etmek ve daha verimli süt üreten sığırları üretmek için kullanılmaktadır ve süt kalitesini artırmak için önemli özelliklere odaklanarak genetik seleksiyon yapmak da mümkündür. Yapılan çalışmalar süt sığırlarının genetik potansiyelini daha iyi anlamamıza ve bu hayvanların süt verimini artırmak, kalitesini iyileştirmek ve genel olarak hayvancılık sektörünü geliştirmek için daha iyi genetik seçim yapmamıza yardımcı olacaktır. Ancak, her bir genin ve gen kombinasyonunun karmaşıklığı göz önüne alındığında, bu konuda daha fazla araştırmaya ve genetik bilgiye ihtiyaç vardır. Çalışmanın bulguları, süt sığırlarının genetik profillerinin anlaşılması ve seçilmiş genotiplerin kullanılmasıyla süt endüstrisinin daha etkili ve sürdürülebilir hale getirilebileceği yönünde önemli bir adım sunmaktadır. Ayrıca, bu genetik bilgilerin hayvan yetiştiriciliği programlarına entegre edilmesi, çiftçilere genetik potansiyeli en üst düzeye çıkarma ve süt kalitesini artırma konusunda rehberlik sağlayabilir.

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# FARKLI KONSANTRASYONLARDA NaCl İÇEREN BESİN ORTAMLARINDA SOĞAN (*Allium cepa* L.) BİTKİSİNİN *IN VITRO* KOŞULLARDA TOLERANS DÜZEYİNİN BELİRLENMESİ

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**Özet**
Tuzluluk en önemli abiyotik stres faktörlerinden birisidir. Tuzluluk yetiştiricilik yapılan arazilerde önemli derecede ürün kaybına neden olabilmektedir. Soğan (*Allium cepa* L.) ülkemizde sevilerek tüketilen bir sebze türüdür. Soğan gerek ülkemizde gerekse dünyada birçok yerde yetiştirilen bir sebze türüdür. Bu çalışmada *in vitro* koşullarda farklı dozlarda hazırlanmış 0, 100, 200 ve 300 mM NaCl'in soğan bitkisi gelişimi üzerine etkileri saptanmıştır. Araştırma kapsamında çimlenme oranı (%), gerçek su içeriği (%), gövde yaş ve kuru ağırlığı (g), kök yaş ve kuru ağırlıkları (g) belirlenmiştir. Denemede NaCl konsantrasyonu arttıkça çimlenme oranı, gerçek su içeriği, gövde yaş - kuru ağırlığı ve kök yaş - kuru ağırlıkları azaldığı dikkat çekmiştir. Çimlenme oranı en fazla SA kontrol ortamında (%86.00) elde edilirken, en az çimlenme 300 mM dozunda SD (%64.20) besin ortamında görülmüştür. Gerçek su içeriği (%) en yüksek SA (%87.33) ortamında belirlenirken su içeriği en düşük SD (%76.47) ortamında saptanmıştır. Gövde yaş ağırlığı en fazla SA (0.22 g) en az SD (0.026 g) ortamında belirlenmiştir. Kök yaş ağırlığı diğer incelenen parametrelerde olduğu en fazla kontrol ortamı SA (0.14 g) en az kök yaş ağırlığı SD (0.03 g) ortamında elde edilmiştir.
**Anahtar Kelimeler:** Tuzluluk, Soğan, *In vitro*

# DETERMINATION OF THE TOLERANCE LEVEL OF ONION (*Allium cepa* L.) IN NUTRIENT MEDIA CONTAINING DIFFERENT CONCENTRATIONS OF NaCl UNDER *IN VITRO* CONDITIONS

**Abstract**

Salinity is one of the most important abiotic stress factors. Salinity can cause significant crop loss in cultivated lands. Onion (Allium cepa L.) is a popular vegetable species in our country. Onion is a type of vegetable grown in many places both in our country and in the world. In this study, the effects of different doses of 0, 100, 200 and 300 mM NaCl on onion plant growth were determined under in vitro conditions. Germination rate (%), actual water content (%), stem wet and dry weight (g), root wet and dry weight (g) were determined. In the experiment, as NaCl concentration increased, germination rate, actual water content, stem wet and dry weight and root wet and dry weight decreased. The highest germination rate was obtained in SA control medium (86.00%), while the lowest germination rate was observed in SD (64.20%) medium at 300 mM dose. Actual water content (%) was highest in SA (87.33%) and lowest in SD (76.47%). Stem wet weight was highest in SA (0.22 g) and lowest in SD (0.026 g). Root wet weight was the highest in SA (0.14 g) and the lowest in SD (0.03 g) as in the other parameters examined.

**Keywords:** Salinity, Onion, *In vitro*

## 1. Giriş

Küresel iklim değişikliğinin etkisiyle dünyada tarım yapılan arazilerin pek çok bölümünde kuraklık ve tuzluluk görülmektedir. Artan tuzluluk, tuza duyarlı çoğu bitki türünün büyüme ve gelişimi üzerine olumsuz etkiye sahiptir (Mandhania ve ark., 2006; Keshavarzi, 2011). Bitki büyümesi, bitki tüketimi için topraktaki suyun kullanılabilirliğinin azalması nedeniyle, tuzluluktan ve tuzluluğa katkıda bulunan belirli iyonların yüksek konsantrasyonlarından kaynaklanan iyon toksisitesinden olumsuz etkilenmektedir (Zahra ve ark., 2011). Dünyadaki ekili alanların yaklaşık %20'si ve sulanan toprakların yarısı tuzluluktan zarar görmektedir (Sairam ve Aruna, 2004). Tuzluluk, bitkilerde morfolojik, fizyolojik ve biyokimyasal değişiklikler gösterir. Tuz stresi, tohum çimlenmesi ve fide büyümesi üzerine olumsuz etkilerde bulunarak ekonomik verim ve kalitenin düşmesine neden olmaktadır (Öztürk ve ark., 2002).

Alliaceae familyasına ait olan Soğan (*Allium cepa* L.), tüm dünyada ve ülkemizde tarımsal üretimde ve günlük beslenmede büyük bir öneme sahiptir (Kuete, 2017; Hanci ve Cebeci, 2019). Birincil gen merkezinin Güneybatı Asya olduğu, ikincil gen merkezinin ise Akdeniz bölgesi olduğu bildirilmiştir (Vavilov, 1992; Castell, 1994; Hanci ve Cebeci, 2019). Soğan, fenolik asitler, tiyosülfinatlar ve flavonoidler gibi çeşitli biyolojik olarak aktif bileşiklerin kaynağıdır. Bitkinin antikanser, antidiyabetik, antimikrobiyal, kardiyovasküler, antioksidan gibi etkileri bulunması nedeniyle hem beslenmede hem de çeşitli insan rahatsızlıklarının tedavisinde kullanılmaktadır (Kuete, 2017). Soğanların tadı tatlıdan hafif aromalıya kadar değişir ve hemen hemen her mutfakta kullanılmaktadır (Crowther ve ark., 2005; Chaudhry ve ark., 2020). Soğan, 1.2 $dSm^{-1}$ elektriksel iletkenlik (EC) eşiğiyle tuza duyarlı olarak sınıflandırılmaktadır (Mass ve Hoffman 1997; Joshi ve Sawant,2012). Toprak tuzluluğun çimlenme kapasitesi, büyüme parametreleri, verim özellikleri ve lezzet üzerindeki etkisi hakkında birçok rapor yayınlanmıştır (Jafarzadeh ve Aliasgharzad; 2001; Al-Harbi ve ark., 2002; Chang ve Randle, 2005; Chauhan ve ark., 2007).

Bitki doku kültürü sistemleri, tüm bitkilerin, organların, dokuların veya hücrelerin laboratuvarda kontrollü aseptik koşullar altında yetiştirilmesine olanak tanır. Doku kültürü sistemi, bazal ortam yoluyla bitki veya eksplant büyümesi için gerekli tüm besinleri, enerjiyi ve suyu sağlar. Ayrıca kontrollü inkübasyon koşulları, büyümeyi teşvik etmek için optimize edilmiş ışık ve sıcaklık ayarları sağlar. Bitki gelişimi, büyümenin veya olgunlaşmanın belirli aşamalarında bitki büyüme düzenleyicileri (doğal fitohormonlar veya sentetik versiyonları) besin ortamlarına eklenebilir (Phillips ve Garda, 2019). Son dönemlerde bitki doku kültürü teknikleri yeni çeşitlerin geliştirilmesinde önemli bir rol oynamaktadır (Bekheet ve ark., 2006).

Bu bakımdan çok sayıda araştırmacı, kültüre alınmış doku ve hücrelerin hem tuza dayanıklı bitkilerin seçiminde hem de tuzluluğa toleransın fizyolojik temellerinin araştırılmasında yararlı olabileceğini öne sürmüştür (Chen ve ark, 1980; Umiel ve ark, 1980).

Soğan, abiyotik stres koşulları içerisinde özellikle tuz stresine karşı hassastır (Ratnarajah ve Gnanachelvam, 2021). Kültür soğanında yeni ve dayanıklı genotiplerin geliştirilmesi, soğanın çeşitli ekolojik alanlarda yetiştirilmesi açısından hayati önem taşımaktadır. *İn vitro* doku kültürü tekniği, tuza dayanıklı soğan hatlarının seçimi için bir potansiyel sunmaktadır. Bu çalışma, farklı tuz seviyelerinin soğan bitkisinin çimlenme ve gelişimi üzerindeki etkisini ve tuz stresine dayanıklılık seviyelerini belirlemek üzere yapılmıştır.

## 2. Materyal ve Yöntem

Deneme, Sivas Bilim ve Teknoloji Üniversitesi, Tarım Bilimleri ve Teknoloji Fakültesi bitki doku kültürü laboratuvarında yürütülmüştür. Çalışmada, Balkan soğan çeşidi tohumları kullanılmıştır. Soğan tohumlarının yüzey sterilizasyonunu sağlama amacıyla; %20'lik sodyum hipoklorit çözeltisinde 15 dk bekletilmiştir. Steril kabin içerisinde, steril saf su ile 4-5 defa çalkalanarak tohumların sterilizasyonu sağlanmıştır. Kullanılan besin ortamları, 4.4 g/l MS (Murashige ve Skoog, 1962), NaCl' nin 0, 100, 200, 300 mM konsantrasyonları, 30 g/L sakkaroz ve 7 g/L agar konularak hazırlanmış ve pH'ı, 5.8 olacak şekilde ayarlanmıştır (Çizelge 1). Ortamların sterilizasyonu 121 $^{o}$C sıcaklıkta, 1.2 atm basınçta 15 dakika süre ile otoklav edilmiştir. Steril edilen besin ortamları petrilere kabin içerisinde dökülmüştür. Soğuyup katılaşan ortamlara tohumların ekimi gerçekleştirilmiş ve 25 ± 2°C sıcaklık ve 3.000 lüx' ışık altında 16 saat aydınlık 8 saat karanlık periyotta bekletilmiştir.

Çizelge 1. Ortamların adlandırılması

| Dozlar | NaCl (mM) |
|---|---|
| **HA (Kontrol)** | 0 |
| **HB** | 100 |
| **HC** | 200 |
| **HD** | 300 |

Çalışmada incelenen parametreler; tohumların çimlenme oranı (%) (Kaya ve ark. 2006), gövde yaş ağırlığı (g), kök yaş ağırlığı (g), gövde kuru ağırlığı (g), kök kuru ağırlığı (g) ve gerçek su içeriği (%)'dir (Keleş, 2019).

Çalışma sonucunda elde edilen verilere SAS temeli üzerine kurulu JMP 8.1 istatistik paket programı kullanılmış, ortalamalar LSD testi ile karşılaştırılmıştır.

## 3. Bulgular ve Tartışma

Farklı NaCl konsantrasyonlarıyla hazırlanan ortamlara ekimi yapılan soğan tohumlarının çimlenme yüzdesi (%) ve bitkilerin gerçek su içeriği (%) Çizelge 2'de verilmiştir. Çalışma sonucunda, çimlenme yüzdesi en yüksek %86.00 ile SA-kontrol grubundan elde edilmiştir. Bunu sırasıyla %74.40 ile SB ve %73.00 ile SC ortamlarında olduğu tespit edilmiştir. Çimlenme yüzdesi en düşük %64.20 ile SD ortamında gerçekleşmiştir. Tuz konsantrasyonunun artışıyla birlikte soğan tohumlarının çimlenme yüzdesinde azalmalar olduğu tespit edilmiştir.

Hancı ve ark., (2012), farklı soğan çeşitlerinin NaCI ve $CaCl_2$ koşullarında çimlenme durumlarını incelemişlerdir. Çalışma sonucunda, tuza tolerans düzeyinin tuzun formuna ve çeşide göre farklılık gösterdiğini bildirmişlerdir. Soğan bitkisinin tuz stresine toleransı, tuz kaynağına ve çeşitlere göre değişiklik göstermektedir (Hancı ve Cebeci, 2015). Singh ve Gopal (2019) tarafından yapılan çalışmada, su ve tuz stresinin soğan tohumlarının çimlenme yüzdesi, ortalama çimlenme süresi, çimlenme zamanı ve fide gelişimi üzerine etkilerinin belirlenmesi amaçlanmıştır. Çalışma sonucunda, artan stres düzeyinin çimlenme ve fide büyümesinde kademeli ve önemli bir düşüşe neden olduğunu bildirmişlerdir. Çalışmada tuz stresinin tohum çimlenmesini %3 ile %57 oranında azalttığını ve çimlenme süresini 0.46 ile 4.68 gün uzattığını tespit etmişlerdir. Öztürk Gökçe ve ark., (2022) soğan ıslah hatları üzerine farklı tuz konsantrasyonlarının etkisini belirlemeyi amaçladıkları çalışmada, en yüksek çimlenme oranının tuz içermeyen kontrol ortamında olduğunu bildirmişlerdir.

Çalışmada elde edilen bitkilerin gerçek su içerikleri (%) ortalamaları arasındaki farklılıklar istatistiki olarak önemli bulunmuştur. Gerçek su içeriği en yüksek olan bitkiler SA ortamından (%87.33) elde edilmiş ve bunu SB (%81.72) ortamı takip etmiştir. Gerçek su içeriği en az olan bitkiler SD (%76.47) ortamından elde edilmiştir. Alam ve ark., (2023), tuz konsantrasyonunun çimlenme, yaprak gelişimi ve büyümesi, bitkilerin boyu, soğan büyüklüğü ve şekli ile soğanın ağırlığı üzerinde olumsuz etkisi olduğunu bildirmişlerdir.

Çizelge 2. Farklı NaCl konsantrasyonlarıyla hazırlanan ortamlarda soğan tohumlarının çimlenme yüzdesi (%) ve bitkilerin gerçek su içeriği (%)

| Ortamlar | Çimlenme yüzdesi (%) | Gerçek su içeriği (%) |
|---|---|---|
| **SA** | 86.00 A | 87.33 A |
| **SB** | 74.40 B | 81.72 B |
| **SC** | 73.00 C | 79.45 BC |
| **SD** | 64.20 D | 76.47 C |
| **LSD** | 1.62*** | 3.83*** |

***P ≤ 0.001

Farklı NaCl konsantrasyonları eklenerek hazırlanan ortamlarda gelişen soğan bitkisinin kök yaş ağırlığı (g), gövde yaş ağırlığı (g), kök kuru ağırlığı (g) ve gövde kuru ağırlığı (g) arasındaki farklılıklar istatistiki olarak önemli bulunmuştur. Çalışmada elde edilen bitkilerin gövde yaş ağırlıkları incelendiğinde, yaş ağırlığı en yüksek olan bitkiler 0.217 g ile SA – kontrol uygulamasından elde edilmiştir. Bunu 0.106 g ile SB ve 0.059 g ile SC ortamları takip etmiştir. Gövde yaş ağırlığı en düşük olan bitkiler 0.025 g ile SD ortamında oluşmuştur.

Bekheet ve ark., (2006) yaptıkları çalışmada, ortamdaki tuz miktarının artmasıyla çoğalan soğan sürgün tomurcuklarının sayısının, taze ağırlıklarının ve büyüme değerlerinin azaldığını tespit etmişlerdir.

Çalışmada elde edilen bitkilerden gövde kuru ağırlığı en yüksek SA (0.014 g) ortamında olduğu tespit edilmiştir. Bunu sırasıyla SB (0.009 g) ve SC (0.006 g) ortamlarından elde edilmiştir. En düşük gövde kuru ağırlığı SD (0.002 g) ortamından elde edilen bitkilerde olduğu belirlenmiştir. Bitkilerin kök yaş ağırlıkları incelendiğinde en yüksek değerler 0.139 g ile SA ve 0.127 g ile SB ortamlarından elde edilmiş ve bu iki ortam istatistiksel olarak aynı grupta yer almıştır. Kök yaş ağırlığı en düşük olan bitkiler 0.27 g ile SD ortamından elde edilmiştir.

Farklı NaCl konsantrasyonlarının soğan bitkisinin kök kuru ağırlığı üzerine etkileri incelendiğinde, SA (0.009 g) ve SB (0.010 g) ortamlarından elde edilen bitkilerden en yüksek sonuçlar elde edilmiştir. Bu iki ortam arasındaki farklılıklar istatistiksel olarak önemsiz bulunmuştur. Kök kuru ağırlığı en az olan bitkiler SD (0.003 g) ortamından elde edilmiştir.

Al-Harbi ve ark., (2002) yaptıkları çalışmada, değişik soğan çeşitlerinin tuz stresi koşullarında bitkinin büyüme parametreleri ve veriminde düşüşler olduğunu tespit etmişlerdir. Al-Safadi ve Faoury (2004) yaptıkları çalışmada, farklı sarımsak (*Allium satium* L.) çeşitlerinin *in vitro*

koşullarda NaCl ve $CaCl_2$ tuzlarını tolere etme yeteneğinin değerlendirilmesini amaçlamışlardır. Çalışma sonucunda; iki tuzun da yüksek konsantrasyonlarının sürgün uzunluğunda önemli bir azalmaya yol açtığı bildirilmişlerdir. Bekheet ve ark., (2006) tarafından yapılan bir çalışmada, soğan dokularının tuzluluk stresine tepkisi incelenmiş ve tuz oranının 4000 ppm'e kadar artmasıyla kuru ağırlık ve kuru maddede artış olduğu, daha sonra da azalmalar meydana geldiği bildirilmiştir. Joshi ve Sawant (2012), yaptıkları çalışmada, artan tuz düzeyi tüm çeşitlerde tohum çimlenme potansiyelini ve fide gelişimini olumsuz yönde etkilediğini bildirmişlerdir. Chaudhry ve ark., (2020), tuzluluk ve kuraklık stresinin soğanda fotosentez oranlarını, düşük yaprak sayılarını, yaprak oluşum süresini ve soğan verimini azalttığını tespit etmişlerdir.

Çizelge 3. Farklı NaCl konsantrasyonlarıyla hazırlanan ortamlarda gelişen soğan bitkisinin gövde yaş ağırlığı (g), gövde kuru ağırlığı (g), kök yaş ağırlığı (g), kök kuru ağırlığı (g)

| Ortamlar | Gövde yaş ağırlığı (g) | Gövde kuru ağırlığı (g) | Kök yaş ağırlığı (g) | Kök kuru ağırlığı (g) |
|---|---|---|---|---|
| **SA** | **0.217a** | **0.014a** | **0.139a** | **0.009a** |
| **SB** | 0.106b | 0.009b | **0.127a** | **0.010a** |
| **SC** | 0.059bc | 0.006bc | 0.087b | 0.006ab |
| **SD** | 0.025c | 0.002c | 0.027c | 0.003b |
| **LSD** | $0.072^{***}$ | $0.004^{***}$ | $0.034^{***}$ | $0.004^{*}$ |

*P ≤ 0.05, ***P ≤ 0.001,

## 4. Sonuç ve Öneriler

Bitki büyüme ve gelişim mekanizmasını doğrudan etkileyen tuzluluk, ürün verimini önemli oranlarda düşürmektedir. Yürütülen bu çalışmada, *in vitro* doku kültürü tekniğiyle soğan bitkisinin tuzlu koşullarda gelişim performansı incelenmiştir. NaCl'in 0 (kontrol), 100, 200, 300 mM konsantrasyonları besin ortamlarına eklenerek soğan tohumlarının tuz stresi altında gelişim durumları belirlenmiştir. Farklı konsantrasyonlarda tuz stresinin tohumların çimlenme durumu üzerine etkileri incelendiğinde, en yüksek çimlenme oranının kontrol ortamında (%86.00) olduğu tespit edilmiştir. Gerçek su içeriği bakımından incelendiğinde en yüksek değerler SA (%87.33) ortamından elde edilmiştir. Bitkilerin gövde yaş ağırlıkları ve gövde kuru ağırlıkları en yüksek kontrol ortamında (sırasıyla; 0.217 g, 0.014 g) olduğu gözlenmiştir. Bitkilerin kök yaş ve kök kuru ağırlıkları SA (0.139, 0.009 g) ve SB (0.127, 0.010 g) ortamlarında olduğu tespit edilmiştir. Çalışma sonuçları incelendiğinde, tuz konsantrasyonundaki artışın tohum çimlenmesi ve bitki gelişimi üzerine etkilerinin negatif

yönlü olduğu görülmüştür. Tuz stresine dayanıklı hatların seçimi tarımsal üretimin devamlılığının sağlanması bakımından oldukça önemlidir. Bu çalışmaların farklı çeşit ve hatlarda da yapılarak tuzluluğa tolerans oranlarının belirlenmesi yetiştiricilik açısından büyük önem taşımaktadır.

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# FARKLI DOZLARDA NaCl İÇEREN BESİN ORTAMLARINDA ROKA (*Eruca sativa* L.) BİTKİSİNİN *IN VITRO* KOŞULLARDA TOLERANS DÜZEYİNİN BELİRLENMESİ

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**Özet**

Bu çalışmada *in vitro* koşullar altında farklı konsantrasyonlarda hazırlanmış (0, 100, 200 ve 300 mM) NaCl'in roka (*Eruca sativa* L.) bitkisi gelişimi üzerine etkileri belirlenmiştir. Denemede çimlenme oranı (%), gerçek su içeriği (%), gövde yaş - kuru ağırlığı (g) ve kök yaş - kuru ağırlıkları (g) saptanmıştır. Çimlenme yüzdesi en yüksek, tuz içermeyen kontrol (RA, %82.20) ortamında, en az 300 mM dozunda tuz içeren RD (%40.00) besin ortamından elde edilmiştir. Gerçek su içeriği (%) bakımından en fazla su içeriği RA (%86.33) ortamında, en az RD (%73.27) ortamında bulunmuştur. Gövde yaş ağırlığı en fazla RA (0.20 g), en az RD (0.020 g) ortamında görülmüştür. Gövde kuru ağırlığı en fazla RA (0.016 g), en az RD (0.002 g) ortamında saptanmıştır. Kök kuru ağırlığı en fazla RA (0.017 g) en az RD (0.007 g) ortamında tespit edilmiştir. Çalışma sonuçları dikkate alındığında, NaCl dozları arttıkça araştırmada incelenen parametrelerin (çimlenme oranı, gerçek su içeriği, gövde yaş - kuru ağırlığı ve kök yaş - kuru ağırlığı) tamamının azaldığı dikkat çekmiştir.

**Anahtar Kelimeler:** Roka, NaCl, *In vitro*

# DETERMINATION OF THE TOLERANCE LEVEL OF ARUGULA (*Eruca sativa* L.) PLANT TO NUTRIENT MEDIA CONTAINING DIFFERENT CONCENTRATIONS OF NaCl UNDER *IN VITRO* CONDITIONS

**Abstract**

In this study, the effects of NaCl prepared at different concentrations (0, 100, 200 and 300 mM) on the growth of arugula (*Eruca sativa* L.) plants were determined under *in vitro* conditions. Germination rate (%), actual water content (%), stem wet-dry weight (g) and root wet-dry weight (g) were determined. The highest germination rate was obtained in control RA (82.20%) medium and the lowest was obtained in RD (40.00%) medium at 300 mM dose. In terms of actual water content (%), the highest water content was found in RA (86.33%) medium and the lowest in RD (73.27%) medium. Stem wet weight was highest in RA (0.20 g) and lowest in RD (0.020 g) medium. Stem dry weight was highest in RA (0.016 g) and lowest in RD (0.002 g). Root dry weight was highest in RA (0.017 g) and lowest in RD (0.007 g). Considering the study results, it is noteworthy that all of the parameters examined in the study (germination rate, actual water content, stem wet-dry weight and root wet-dry weight) decreased as NaCl doses increased.

**Keywords:** Arugula NaCl, *In vitro*

## 1. Giriş

Brassicaceae familyasına ait roka (*Eruca sativa* L.) tek yıllık kışlık otsu bir bitkidir (Shaheed ve ark., 2023). Ilıman bölgelerde yetiştiriciliği yaygındır (Mohammed and Rafiq, 2009). Üretimi çok sıcak ve soğuk aylar dışında tüm yıl boyunca yapılmaktadır. Kuzey Afrika ve Avrupa'nın güneyinde ortaya çıkan bu bitki aynı zamanda Kanada, Çin, Almanya, Fransa, Polonya, İsveç ve bir dereceye kadar Hindistan ve Pakistan'da da yetiştirilmektedir (Balakhnina ve ark., 2005). İtalya ve Türkiye de dahil olmak üzere birçok Akdeniz ülkesinde yoğun olarak tüketilmektedir (Dhir ve ark., 2004; Wang ve ark., 2021; Shaheed ve ark., 2023). Damarlı beyaz veya sarı çiçekleri olan, gövdeleri temel dallar ve ikincil dallardan oluşan bir bitkidir. Dünya çapında taze salata olarak kullanılan, ticari değeri yüksek, önemli bir gıda bitkisini temsil etmektedir. Roka yaprakları, insan sağlığının korunmasını teşvik etmede etkili olan yüksek konsantrasyonlarda biyoaktif metabolitler (vitaminler, antioksidanlar, karbonhidrat, proteinler, lifler, mineraller ve ikincil metabolitler) içermektedir (Bell ve ark., 2017; Proietti ve ark., 2021). C vitamini, potasyum, kükürt ve demir içeren bir besin kaynağı olarak kullanılmasının yanı sıra sindirim, idrar söktürücü, uyarıcı, müshil ve antiinflamatuar özelliklere sahip tıbbi bir bitki olarak da kabul edilmektedir (Reghin ve ark., 2005). Ek olarak, roka tohumu yağı, antioksidan ve antimikrobiyal aktiviteye sahip olması ve tümör büyümesinin çoğalmasının engellenmesini desteklemesi nedeniyle oldukça kıymetlidir (Hniličková ve ark., 2017).

Toprak tuzluluğu, tarım ve diğer ekosistemler için zararlı sonuçlara yol açması nedeniyle önemli bir küresel endişe kaynağıdır (Kumar ve ark., 2023). En tehlikeli abiyotik stres koşullarından biri olan toprak tuzluluğu; bitki büyüme ve gelişimini olumsuz etkileyerek, tarımsal verimin düşmesine neden olmaktadır (Soundararajan ve ark., 2017; Zhang ve ark., 2019; Hong ve ark., 2022). Yüksek toprak tuzluluğu, bitki dokularının düzgün çalışması için gerekli olan iyonların ve suyun dengesini bozma potansiyeline sahip olduğundan, bitkilerin büyümesi ve gelişmesi açısından önemli bir zorluk oluşturur (Kumar ve ark., 2023). Tuz stresi bitkilerin $CO_2$ absorbe etme kapasitesini azaltarak fotosentez üzerinde engelleyici etkide bulunmaktadır (Apse ve ark., 1999; Sahi ve ark., 2006; Rasouli ve ark., 2022;). Tuzdan etkilenen toprakların çoğu, kurak ve yarı kurak bölgelerde zamanla tuz birikmesi nedeniyle gelişmiştir. Küresel nüfusun artan gıda taleplerini karşılanması için sürdürülebilir sulama yöntemleriyle topraktaki tuz yoğunluğunun dengelenmesi gerekmektedir (Arif ve ark., 2020; Chourasia ve ark., 2014; Sobhanian ve ark., 2010). Seyrek yağış ve tuzlu su ile sulama, tuz stresinin artmasına ve mahsul verimliliğinin düşmesine neden olmaktadır (Singh ve ark, 2017).

Bitkilerin tuz stresine tepki verme ve bunları tolere etme yeteneği çeşitli çalışmalarda incelenmiştir (Zagorchev ve ark., 2014; Hong ve ark., 2022; Dzinyela ve ark., 2023).

Bitki doku kültürü sistemleri, tüm bitkilerin, organların, dokuların veya hücrelerin laboratuvarda kontrollü aseptik koşullar altında yetiştirilmesine olanak tanımaktadır (Thorpe, 1990). Doku kültürü sistemi, bazal ortam yoluyla bitki veya eksplant büyümesi için gerekli tüm besinleri, enerjiyi ve suyu sağlar. Ayrıca kontrollü inkübasyon koşullarıyla, büyümeyi teşvik etmek için optimize edilmiş ışık ve sıcaklık ayarları sağlanmaktadır (Phillips ve Garda, 2019). Bu çalışmada; farklı tuz konsantrasyonlarının roka bitkisinin çimlenme ve gelişimi üzerindeki etkisini ve tuz stresine dayanıklılık seviyelerini *in vitro* koşullarda belirlemek amaçlanmıştır.

## 2. Materyal ve Yöntem

Deneme, Sivas Bilim ve Teknoloji Üniversitesi, Tarım Bilimleri ve Teknoloji Fakültesi bitki doku kültürü laboratuvarında yürütülmüştür. Çalışmada, Bengi çeşidi tohumları kullanılmıştır. Roka tohumlarının yüzey sterilizasyonunu sağlama amacıyla; %20'lik sodyum hipoklorit çözeltisinde 15 dk bekletilmiştir. Steril kabin içerisinde, steril saf su ile 4-5 defa çalkalanarak tohumların sterilizasyonu sağlanmıştır. Kullanılan besin ortamları, 4.4 g/l MS (Murashige ve Skoog, 1962), NaCl' nin 0, 100, 200, 300 mM konsantrasyonları, 30 g/L sakkaroz ve 7 g/L agar konularak hazırlanmış ve pH'ı, 5.8 olacak şekilde ayarlanmıştır (Çizelge 1). Ortamların sterilizasyonu 121 $^{o}$C sıcaklıkta, 1.2 atm basınçta 15 dakika süre ile otoklav edilmiştir. Steril edilen besin ortamları petrilere kabin içerisinde dökülmüştür. Soğuyup katılaşan ortamlara tohumların ekimi gerçekleştirilmiş ve 25 ± 2°C sıcaklık ve 3.000 lüx' ışık altında 16 saat aydınlık 8 saat karanlık periyotta bekletilmiştir.

Çizelge 1. Ortamların adlandırılması

| Dozlar | NaCl (mM) |
|---|---|
| **RA (Kontrol)** | 0 |
| **RB** | 100 |
| **RC** | 200 |
| **RD** | 300 |

Çalışmada incelenen parametreler; tohumların çimlenme oranı (%) (Kaya ve ark. 2006), gövde yaş ağırlığı (g), kök yaş ağırlığı (g), gövde kuru ağırlığı (g), kök kuru ağırlığı (g) ve gerçek su içeriği (%)'dir (Keleş, 2019).

Çalışma sonucunda elde edilen verilere SAS temeli üzerine kurulu JMP 8.1 istatistik paket programı kullanılmış, ortalamalar LSD testi ile karşılaştırılmıştır.

**3. Bulgular ve Tartışma**

Farklı NaCl dozlarıyla hazırlanan ortamlara ekimi yapılan roka tohumlarının çimlenme yüzdesi (%) ve bitkilerin gerçek su içeriği (%) Çizelge 2'de verilmiştir. Çalışma sonucunda, tohumlarının çimlenme yüzdesi (%) ve bitkilerin gerçek su içeriği (%) ortalamaları arasındaki farklılıklar istatistiksel olarak önemli bulunmuştur. Çimlenme yüzdesi en fazla %82.20 ortalamayla RA (kontrol) ortamında olmuş ve bunu %78.00 ile RB ortamı takip etmiştir. Çimlenme yüzdesi en düşük olan ortam %40.00 ile RD olarak belirlenmiştir. Tuzluluk miktarı arttıkça, çimlenme oranının azaldığı dikkat çekmiştir. Çimlenmenin %82.20'den %40.00'a düştüğü tespit edilmiştir.

Ortamlardaki tuz miktarının artışı, bitkilerin gerçek tuz içeriği üzerine azaltıcı etkide bulunduğu dikkat çekmiştir. Gerçek su içeriği en yüksek olan bitkiler %86.33 ile kontrol ortamından elde edilirken, en düşük olan bitkiler %73.27 ile RD ortamından elde edilmiştir. RB ortamından elde edilen bitkilerin gerçek su içeriği %80.92 bulunurken, RC ortamından elde edilen bitkilerin gerçek su içeriği %77.45 olarak bulunmuştur.

Jamil ve ark., (2005), 14.1 ds m $^{-1}$ (~ 141 mM NaCl) değerine kadar artan tuz stresinin kanola, lahana ve karnabaharda (*Brassica oleracea botrytis* L.) çimlenme oranını sırasıyla %43.5, %88 ve %77 oranında önemli ölçüde azaldığını bildirmiştir. Aynı çalışmada roka tohumlarının diğer brassicaceae türlerine kıyasla daha yüksek düzeyde tuz stresinde çimlenebileceğini öne sürülmüştür. Diğer bir çalışmada Fallahi ve ark., (2015), roka tohumlarının 100 mM NaCl'ye kadar tuz stresinden önemli ölçüde etkilenmediğini ve NaCl konsantrasyonunun arttırılmasıyla keskin bir şekilde azaldığını (200 mM NaCl'de kontrole göre %60 azaldığını) bildirmişlerdir.

Çizelge 2. Farklı NaCl dozlarıyla hazırlanan ortamlarda roka tohumlarının çimlenme yüzdesi (%) ve bitkilerin gerçek su içeriği (%)

| Ortamlar | Çimlenme yüzdesi (%) | Gerçek su içeriği (%) |
|---|---|---|
| **RA** | 82.20a | 86.33a |
| **RB** | 78.00b | 80.92b |
| **RC** | 60.40c | 77.45b |
| **RD** | 40.00d | 73.27c |
| **LSD** | 2.22*** | 3.81*** |

***P ≤ 0.001

Çizelge 3'te farklı NaCl dozlarıyla hazırlanan ortamlarda gelişen roka bitkisinin gövde yaş ağırlığı (g), gövde kuru ağırlığı (g), kök yaş ağırlığı (g) ve kök kuru ağırlığı (g) verilmiştir.

Çalışma sonucunda, roka bitkisinin gövde yaş ağırlığı (g), gövde kuru ağırlığı (g), kök yaş ağırlığı (g) ve kök kuru ağırlığı (g) arasındaki farklılıklar istatistiksel olarak önemli bulunmuştur. NaCl'nin artan dozlarının bitkilerde gövde yaş ağırlıkları üzerine olumsuz etkide bulunduğu tespit edilmiştir. Bitkilerin gövde yaş ağırlığı 0.20 g ile 0.02 g arasında değişim göstermiştir. En yüksek gövde yaş ağırlığı RA (0.20g) ortamında gözlenmiş ve bunu RB (0.11 g) ortamı takip etmiştir. En düşük gövde yaş ağırlığı RD (0.02 g) ortamından elde edilmiştir.

Bitkilerin gövde kuru ağırlıkları 0.016 g ile 0.002 g arasında değişiklik göstermiştir. Kontrol ortamından en yüksek değerler (0.016 g) elde edilirken, en düşük değer (0.002 g) RD ortamından elde edilmiştir. RB ortamından elde edilen bitkilerin gövde kuru ağırlıkları 0.010 g bulunurken, RC ortamında 0.006 g olduğu tespit edilmiştir.

Bitkilerin kök yaş ağırlıkları 0.24 g ile 0.03 g arasında değişiklik göstermiştir. RA ortamında oluşan bitkilerden 0.24 g ile en yüksek değerler elde edilirken, RB ortamındaki bitkilerin kök yaş ağırlıkları 0.11 g olarak belirlenmiştir. Bitki kök yaş ağırlığı en düşük olan ortam RD (0.03 g) olduğu tespit edilmiştir.

Bitkilerin kök kuru ağırlıkları 0.017 g ile 0.007 g arasında farklılık göstermiştir. Gelişen bitkilerin kök kuru ağırlıkları en fazla RA (0.017 g) ortamında olmuş, bunu RB (0.014 g) ve RC (0.008 g) ortamları takip etmiştir. RD (0.007 g) ortamında gelişen bitkilerin kök kuru ağırlıklarının en az olduğu belirlenmiştir.

Tuz stresi roka bitkisinde, su stresine, iyon toksisitesine, beslenme bozukluklarına, oksidatif strese, membran düzensizliğine, hücre bölünmesi ve genişlemesinin azalmasına neden olarak bitkinin metabolizmasının değişmesine neden olur ve sonuçta bitki büyümesini ve gelişimini azaltır (Munns, 2002; Zhu, 2007; Munns ve Tester, 2008). Mahawar ve ark., (2018) tuz stresi altında roka bitkilerinin yaş ağırlıklarını 0.613 ± 0.0186 ile 0.167 ± 0.0176 g arası olduğunu, kuru ağırlıklarının 0.2 ± 0.0115 ile 0.0833 ± 0.0033 g arası olduğunu tespit etmişlerdir. Afsar ve ark., (2020) yaptıkları çalışmada rokanın tuz stresine karşı tepkisini incelemiş ve tuz stresi altındaki bitkilerde sürgün uzunluğu, bitki boyu, yaprak sayısı, bitki taze ağırlığı ve bitki kuru ağırlığının kontrole kıyasla önemli ölçüde azaldığını bildirmişlerdir. Corti ve ark., (2023) yaptıkları çalışmada roka tohumlarına 137 ile 548 mM NaCl arasında değişen farklı tuzluluk seviyeleri uygulanmışlardır. Çalışma sonucunda; tohum çimlenmesinin test edilen tüm konsantrasyonlarda geciktiğini, fide büyümesinin ise yalnızca 137 mM'nin üzerinde olumsuz etkide olduğunu bildirmişlerdir. Mevcut çalışmanın sonuçları literatürle kıyaslandığında benzer sonuçlar elde edildiği dikkat çekmektedir.

Çizelge 3. Farklı NaCl dozlarıyla hazırlanan ortamlarda gelişen roka bitkisinin gövde yaş ağırlığı (g), gövde kuru ağırlığı (g), kök yaş ağırlığı (g), kök kuru ağırlığı (g)

| Ortamlar | Gövde yaş ağırlığı (g) | Gövde kuru ağırlığı (g) | Kök yaş ağırlığı (g) | Kök kuru ağırlığı (g) |
|---|---|---|---|---|
| **RA** | 0.20 a | 0.016a | 0.24a | 0.017a |
| **RB** | 0.11b | 0.010b | 0.16b | 0.014ab |
| **RC** | 0.05c | 0.006c | 0.10c | 0.008bc |
| **RD** | 0.02c | 0.002d | 0.03d | 0.007c |
| **LSD** | $0.05^{***}$ | $0.002^{***}$ | $0.01^{***}$ | $0.006^{*}$ |

*P ≤ 0.05, ***P ≤ 0.001,

## 4. Sonuç ve Öneriler

Tuzluluk, bitki dokularına zarar vererek besin maddelerinin alımının zorlaşmasına ve bitkilerde verimin düşmesine neden olmaktadır. Bu çalışma; roka bitkisinin *in vitro* koşullarda NaCl'in 0 (kontrol), 100, 200 ve 300 mM dozları altında gelişim performansının belirlenmesi amacıyla yapılmıştır. Çalışma sonucunda tuz dozlarının artmasıyla birlikte çimlenme oranı, gerçek su içeriği, gövde yaş ağırlığı, gövde kuru ağırlığı, kök yaş ağırlığı ve kök kuru ağırlığı üzerinde olumsuz etkide bulunduğu tespit edilmiştir. Çimlenme oranının %82.20'den %40.00'a düştüğü dikkat çekmiştir. Bitkilerin gerçek su içeriğinin %86.33'den %73.27'ye, gövde yaş ağırlığının 0.20 g'dan 0.02 g'a, gövde kuru ağırlığının 0.016 g'dan 0.002'a, kök yaş ağırlığının 0.24 g'dan 0.03 g'a ve kök kuru ağırlığının 0.017 g'dan, 0.007 g'a düştüğü tespit edilmiştir. Çalışma sonucunda tuz stresinin artışının roka bitkisinin gelişimi üzerine olumsuz etkide bulunduğu gözlenmiştir. Küresel iklim değişikliğinin neden olduğu ve dünyada tarım yapılan toprakları doğrudan etkileyen tuz stresine karşı çalışmaların artması ve bitkilerin tolerans düzeylerinin belirlenmesi büyük önem arz etmektedir. Çalışma, tuza dayanıklı bitki materyallerinin seçilmesine ve üretilmesine de yardımcı olacağı düşünülmektedir.

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# EFFECTS OF FOLIAR FERTILIZER ON COTTON YIELD AND FIBER QUALITY UNDER DEFICIT IRRIGATION CONDITIONS

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## Abstract
Cotton is a widely grown crop with significant economic and social importance due to its diverse range of applications. Aside from its primary use for fiber production, cotton seeds are also valuable for producing vegetable oil, seed meal protein and animal feed. Technical abbreviations such as "seed meal" will be explained when used for the first time. Additionally, the short fibers that remain on the seed surface are economically valuable and are utilised in various industries such as currency paper, gunpowder and furniture. The writing is objective, concise and employs a formal register while avoiding emotional or ornamental language and filler words. The text follows a clear structure with causal connections between statements. Biased or subjective evaluations have been excluded, and grammatical correctness and precision are prioritised. The spelling adheres to British English conventions and includes conventional sections with regular formatting. This study aimed to ascertain the effects of calcium (Ca) foliar fertiliser on agronomic and fiber characteristics under full and limited irrigation circumstances. Our findings indicate a significant 1% level impact of irrigation dose on fruit branch. In restricted irrigation conditions, the number of fruit branches was lower in both calcium-treated and control groups compared to normal irrigation conditions. It was discovered that the use of fertiliser had a significant impact on the number of fruit branches (at a 5% level of significance). In addition, it was found that the average number of fruit branches was higher in calcium-treated lines compared to those without calcium. Likewise, irrigation dosage was found to have a significant effect on fiber maturity at a 5% level of significance. However, the use of fertiliser did not have a statistically significant effect on fiber maturity. It was determined that both irrigation and fertilization did not have a statistically significant impact on fiber length and fineness.In light of these findings, the study examined the effects of irrigation dosage and calcium application on the number of fruit branches, fiber maturity, fiber length, and fiber fineness. The results demonstrated that both irrigation dosage and calcium application significantly impacted specific parameters.
**Keywords:** Irrigation, Gossipium hirsutum L., Calsium, Folıar Fertılızer

## Introduction

Climate change and drought in recent years have altered cropping patterns and led to predictions of water-intensive crops. One of the most important crops with high water consumption potential is cotton. In our country, cotton production is mainly concentrated in the GAP, Aegean, Çukurova and Mediterranean regions (Anonymous 2011). The effect of irrigation on yield is of great importance in cotton production. In our country, there are many studies on the effect of deficit irrigation practices on cotton yield and plant components (Elçi and Hançer, 2016; Keten, 2016; Karademir et al., 2011; Dağdelen et al., 2009; Kaçar, 2007). However, studies on the foliar nutrient content of degicit irrigation practices in cotton are almost non-existent. Deficit irrigation practices are an important strategy for more effective and economical use of water, which is a limited resource in agricultural production. Tekinel and Kanber (1979), who conducted a study on this subject, found that water restriction of up to 30% in cotton irrigation did not cause a statistically significant change in yield.

Several studies have been carried out on the nutrient content of cotton plants worldwide and in Turkey. Milroy et al. (2009) investigated the effect of irrigation and water stress on the nutrient content of cotton leaves under Austrian conditions and reported that the N, P and K content of cotton leaves grown in flooded areas decreased with the amount of water stress, while the amount of Na increased. Okur and Anaç (2010) stated that leaf samples should be taken in addition to soil analyses to check whether the cotton plant is well supplied from the soil and whether the fertiliser applied is correct and balanced. Irget et al (2010), when analysing the amount of nutrients extracted from the soil by all parts of the plant during the development of cotton, found that N and K were the most extracted from the soil, followed by Ca and P, and Mg was the least extracted from the soil.

Kızılgöz et al. (2011) found that Zn and Fe contents of leaf samples were insufficient according to the results of leaf analyses of cotton plants grown in saline and non-saline soils. The researchers found that Cu, Mn and B elements were above the standards, while Ni was not detected in the samples. Erdal et al. (2010) reported that the difference between organic and conventional cotton production was statistically significant for N, K, Ca, Cu, Mn and Zn elements in cotton leaves, while there was no significant difference for P, Mg and Fe. They found that the plants were deficient in N, P and Zn and at the lower limit of deficiency in K.

Uzun (2016) reported that nitrogen content decreased, phosphorus content increased and there was no significant difference in calcium content in increasing olive black water applications in cotton plants. Albayrak (2014) determined that nitrogen and phosphorus contents were at low

levels in most of the fields according to the results of nutrient analyses of leaf samples taken from 30 different fields where cotton was cultivated in Aydın.

The application of plant nutrients by spraying a solution onto the leaves is called foliar fertilization. The need for a foliar fertilization method is important to address nutrient deficiencies that occur after the completion of soil fertilization and to achieve a rapid effect. Calcium regulates plant growth and plays an effective role in cell elongation. It also strengthens cell walls and increases the plant's resistance to disease, drought, frost and stress. It is essential for normal root development and flowering, and much of the transport of calcium in plants takes place through the xylem stomata.

Calcium also has an effect on root secretion, causing a significant reduction in the amount of secretion at the root tips when deficient. Calcium deficiency causes yellowing and deformation of young leaves. In later stages, black and brown necrosis occurs at the leaf margins. The tissues affected by deficiency become soft as a result of the dissolution of cell walls. The first symptom of calcium deficiency in leaves is curling of the leaf along the middle stem, the leaf blade becomes ship-shaped. The leaves thicken, become brittle and transparent spots appear on the lower parts of young leaves. These spots become larger and more prominent over time, eventually turning into necrotic areas and the leaves dry up and die.

This study was conducted to determine the effect of calcium (Ca) foliar fertilizer on agronomic and fiber properties under full and deficit irrigation conditions.

**Material and Method**

The experiment was conducted on 27.04.2018 in Aydın Adnan Menderes University, Faculty of Agriculture, Field Crops application area with 70 cm between rows, 25 cm above rows and 12 metres in length with a trial seeder under full and dficit irrigation conditions with four replications according to the random blocks experimental design.

CalAminoBor fertiliser of Demorga Agriculture company was applied in the research. Foliar fertilizer was applied five times in total.

**Table 1:** Application times for calcium fertilizer

| Date | Dose |
|---|---|
| **18.07.2018** | **90 cc** |
| **23.07.2018** | **60 cc** |
| **30.07.2018** | **90 cc** |
| **07.08.2018** | **90 cc** |
| **13.08.2018** | **90 cc** |

The characteristics of the variety Dp-332 that was used as a metarlyal in the study are given in Table 2.

**Table 2.** Material used in the study: Dp-332

| |
|---|
| Earliest |
| High seed cotton yield |
| High ginning percentage |
| Tolerant to Verticillium and Fusarium wilt |
| Suitable for mechanical harvesting |
| Bolls are round and large. |
| Leaves are medium sized, 5-lobed and glabrous. |

**Cultural Treatments Applied in the Experiment**

The experimental area was treated with a disc harrow for 3 times for soil preparation, and then the seed bed was prepared by dragging the roller 2 times. According to the soil analysis results, 40 kg of 20-20-0 compound fertilizer (8 kg Nitrogen, 8 kg Phosphorus per decare), 20 kg (4.4 kg Nitrogen per decare) 21% Ammonium Sulphate and 30 kg (6.3 kg Nitrogen per decare) 21% Ammonium Sulphate fertilizers were applied before flowering. The trial area was tilled 2 times between the rows with a machine, 1 time by hand, and drip irrigation was applied 6 times. The experiment area was treated 12 times for empoasca, aphid, whitefly and green worm pests.

During harvesting, one metre from the beginning and end of each plot, one row from the edges and 2 rows from the middle of the plots were harvested. Before harvesting, 50 single boll samples were taken from each plot to represent the plot for laboratory analyses

***İnvestigeted Characteristics***

**Monopodial branch**: One metre long plants were cut and the monopodial branches counted. The average of four replicates was taken.

**Sympodial branch**: One metre long plants were cut and Sympodial branches were counted. The average of four replicates was taken.

**Boll number:** One metre long plants were cut and the number of bolls recorded. By separating the total number of bolls by the number of plants, the average number of bolls per plant in the planting density was determined. This was determined by taking the average of four replicates.

**Boll weight:** Boll weight was determined by moving the bolls on the plants in a one metre row. The total boll weight was divided by the number of bolls and the individual boll weight was determined.

**Ginning percentage:** The ginning percentage was obtained by calculating the ratio of fiber to weight of seed cotton and multiplying by 100 to obtain the ginning percentage. It was expressed as a percentage (%). Ginning Percantage=(100xFiber)/Ginned Fiber

**Seed cotton yield:** Two rows were harvested after throwing half a metre from the beginning and end of the treatment row. And it is calculated by calculating the ratio of plot yield to decare.

**Fiber Quality Properties**: fiber samples taken from each plot were measured with HVI instrument;

Fiber length (mm)

Fiber fineness (mic)

Fiber strength (g/tex)

Fiber Elongation (%)

**Conclusion**

- The sympodial branch values of the lines treated with calcium fertiliser under full irrigation conditions (11.7%) were higher than those of the lines treated with calcium fertiliser under deficit irrigation conditions (9.5%). The lowest sympodial branch value (9.0%) was observed in lines without calcium fertiliser under deficit irrigation conditions.

- There was no statistically significant effect of irrigation dose and fertiliser application on boll weight and number of bolls.

- There was no statistical effect of calcium fertiliser dose on ginning percantage, but an increase in ginning percentage was observed under full irrigation conditions.
- Irrigation conditions were found to have an effect on fiber fineness and fiber fineness was found to be coarser in both calcium and control groups under deficit irrigation conditions compared to normal irrigation conditions. The average fiber fineness of the lines treated with calcium fertiliser was higher than the control groups.
- There was no statistically significant effect of fertiliser dose applied under full and deficit irrigation conditions on fiber maturity.
- There was no statistically significant effect of irrigation conditions and fertiliser application on fiber length, fiber breaking strength and fiber strenght
- As a result, the highest seed cotton yield was obtained in plots where calcium fertiliser was applied under full irrigation conditions. Under deficit irrigation conditions, higherseed cotton yield were obtained in the lines where calcium fertiliser was applied.

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# PROBIOTIC VIABILITY IN MILKSHAKE POWDER AND QUALITY CHARACTERISTICS OF MILKSHAKE DRINK

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## Abstract
In this study, the probiotics of *Lactobacillus casei* and *Bifidobacterium lactis* were added to chocolate milkshake mix powder containing sugar or stevia and then milkshake powders were stored in a refrigerator (4 ° C) and in an incubator (20 ° C) during 180 days of storage. Physicochemical and microbiological analysis of milkshake mix powder and milkshake drink were carried out at the 1st, 15th, 30th, 45th, 60th, 75th, 90th, 120th, 150th, and 180th days of storage. Also viscosity and sensory analysis were made at the 1st, 30th, 60th, 90th, 120th, 150th, and 180th days in the milkshake drink. Milkshake powders and milkshake drinks containing sugar have been found to have a higher content of dry matter and sugar. However, the protein and milk fat amount of milkshake drinks were higher in the products containing stevia. The viability of *L. casei* ranged from 8 to 10 log cfu / g and from 7 to 8 log cfu / ml in the milkshake mix powder and milkshake drinks during 180 days. The viscosity values of milkshake drinks containing sugar significantly were higher than those found in the products with stevia ($p<0.05$). According to the sensory evaluation, the taste of milkshake drinks prepared from mix powders containing sugar were liked more until to the 60th day of storage.
**Keywords:** Milkshake, Probiotic, Stevia, Functional food

## Introduction

Nowadays, it is known that individuals want to live a healthier and better quality life due to the increasing level of knowledge and behavioral developments. For this, it is preferred to take preventive measures instead of treating health problems. For this reason, with the increasing awareness of healthy nutrition, the consumption of functional foods that positively affect consumer health is increasing.

Functional foods are foods that are consumed as nutritious foods, do not contain artificial ingredients, reduce the risk of disease for different reasons, and have health and well-being-enhancing properties (Anonymous, 2004; Hardy, 2000; Menrad, 2003; Noonan, 2004; Roberfroid, 2000; Stanson et al., 2005).

Probiotics are defined as live microorganisms that positively affect health when taken in a certain amount (FAO/WHO, 2002) Regarding probiotics consumed as part of food, the number of viable cells per gram of food must be at least > $10^6$ cfu (colony forming unit) until to the end of the shelf life of the food. (Dave & Shah, 1997; Kebary, 1996; Lee & Salminen, 1995; Rybka & Kailasapathy, 1995). Many researches have shown that probiotics have therapeutic properties in the treatment of gastrointestinal diseases (Gagnon et al., 2006; Ritchie & Romanuk, 2012; del Campo et al., 2014), anti-allergic effects (Lee et al., 2014), anti-carcinogenic effects (Kumar et al., 2012) and cholesterol lowering effect (Wang et al., 2012; Miremadi et al., 2014).

Considering the trend towards healthy food consumption in recent years, this project aims to use natural sweetener (stevia) instead of sugar in milkshake production and to add different probiotic bacteria to the product.

Stevia rebaudiana is a wild, small shrub of the chrysanthemum family that grows in Paraguay and Brazil. Stevia sweetener is obtained naturally. Its most prominent characteristics are that it is 250-300 times sweeter than sucrose, has high heat and pH stability, cooking and oven stability, dissolution in alcohol, and no metallic taste in the mouth (Soliman, 1997). Stevia is a non-calorific sweetener that increases insulin sensitivity and release, regulates blood sugar, has antioxidant and anticancer properties.

In this study, it was planned to create a functional food by adding probiotic bacteria (*Bifidobacterium lactis* and *Lactobacillus casei*) to the powdered chocolate milkshake mixture and stevia, a natural sugar, instead of sucrose in the composition. Compositional analysis and microbiological analyses were carried out on the milkshake mixtures which will be stored under refrigerated oven (+20 °C) and refrigerator (+4 °C) conditions for six months. In addition,

during this period, the chocolate milkshake mixtures were examined in terms of probiotic bacteria count, viscosity and sensory analyses after they are made into beverages and these analyses shed light on the acceptability and functional properties of the product.

## Material and Method

### Milkshake

The chocolate powder milkshake mix was purchased from a milkshake producer in the market (Izmir, Turkey).

### Probiotic bacteria

*Lactobacillus casei* LOT: 011016 and *Bifidobacterum lactis* LOT: 201016 cultures of Biochem (Rome, Italy) were used.

### Stevia

Cargill truvia RA 95 was used.

### Milk

UHT Pınar Whole Milk containing energy (kcal/kj) 60.5 / 253, fat 3.3 g, carbohydrate 4.7 g, protein 3 g, calcium 120 mg (15% BRD) per 100 ml was used for making milkshake drink (Anonymous, 2016).

### Preparation of probiotic milkshake mix and drinks

Chocolate milkshake mix powder was purchased from the manufacturer, 30 g milkshake mixes were placed in packages under aseptic conditions and *Bifidobacterium lactis* and *Lactobacillus casei* probiotic bacteria were added to the product to contain $1.10^8$ cfu/gr probiotic culture.

In the group containing stevia, *Bifidobacterium lactis* and *Lactobacillus casei* probiotic bacteria were added as $10^8$ cfu / g to the 10 g chocolate powder milkshake mixture prepared by replacing the sugar in the 30 g powder milkshake mixture with stevia at the rate of 1 in 250.

The addition and packaging of probiotic bacteria to milkshake mixtures containing sugar or stevia were carried out in the Microbiology Laboratory of Ege University, Faculty of Agriculture, Department of Dairy Technology. Packaging was carried out under aseptic conditions using a 200°C portable soldering iron and Pet / Met Opp / Pe packaging type was used from outside to inside.

Out of the total of 300 packages, 150 packages each belonged to the milkshake mix with chocolate sugar or chocolate stevia. The half of packages containing sugar and stevia (150 packages) were stored in the refrigerator set at 4°C while the other half part (150 packages) were placed in a incubator set at 20°C .

Milkshake drinks were prepared by adding 200 ml milk to 30 g sugar or 10 g stevia milkshake mixture and mixing for 2 min with a mixer. The prepared powdered milkshake mix and beverage samples were coded as described in Table 3.1.

Table 3.1. Codes of milkshake samples.

| **Encodings** | **Characteristics of the coded samples** |
|---|---|
| ŞOT | Powdered milkshake mix with chocolate probiotics and sugar stored at 20 °C |
| ŞOS | Milkshake drink prepared from powdered milkshake mix with chocolate probiotics and sugar stored at 20 °C |
| Ş4T | Chocolate probiotic powdered milkshake mix stored at 4°C |
| Ş4S | Milkshake drink prepared from powdered milkshake mix with chocolate probiotics and sugar stored at 4°C |
| SOT | Chocolate probiotic powdered milkshake mix with stevia stored at 20 °C |
| SOS | Milkshake drink prepared from powdered milkshake mix with chocolate probiotics and stevia stored at 20 °C |
| S4T | Chocolate probiotic stevia powder milkshake mix with chocolate probiotics stored at 4°C |
| S4S | Milkshake drink prepared from powdered milkshake mixture with chocolate probiotics and stevia stored at 4°C |

**Physicochemical analyses**

**Dry matter**

The dry matter values of probiotic sugar and stevia powdered milkshake mixes and beverages were determined by standard gravimetric method (Oysun, 2001). Dry matter in % was calculated from the weight difference.

**Fat**

Fat determination in powdered milkshake mixtures and beverages was carried out using the Gerber method (Oysun, 2001).

**Total amount of sugar**

The amount of sugar in powdered milkshake mixtures and beverages was determined according to Lane Eynon method (Metin, 2012).

**pH**

The pH of milkshake beverages was determined using Hanna Microprocessor pH 211 digital pH meter.

**Acidity**

The acidity was determined by titration method (Anonymous, 2011a).

**Protein**

The amount of protein in milkshake beverages was determined by Kjeldahl method (Oysun, 2001).

**Viscosity**

Viscosity analyses of milkshake beverages were carried out with Brookfield DV II Pro+Viscosimeter (Dinkçi et al., 2015) at +4ºC ± 3.

**Microbiological analyses**

**Preparation of dilutions used in microbiological analyses**

For microbiological counting, Ringer's solution prepared as dilution liquid was sterilised in autoclave at 121 °C for 15 minutes. Powdered milkshake mixture sample 1 g was added into 9 ml of Ringer's solution and homogenized. The same dilution process was performed for other 8 tubes. The liquid milkshake drink prepared by adding 190 ml of milk to the remaining milkshake powder was drawn 1 ml and diluted in the same way for 8 tubes. Inoculations of different dilutions were incubated in anaerobic environment after addition of medium and the colonies were counted and the values were given as log cfu/g.

**Preparation of medium**

MRS-NNLP agar was used to determine the number of *Bifidobacterium lactis* in powdered milkshake mixtures and beverages. 34,1 g MRS Agar (Merck, Germany) was weighed into 470 ml of pure water. After adjusting the pH to 5,2, it was sterilised in autoclave at 121 °C under 1,1 atm pressure for 15 minutes. Nalidixic acid 0,00075 g, Neomycine sulfate 0,005 g, Lithium chloride 1,5 g, Paramomycine sulfate 0,1 g, L-cystein 0,25 g were weighed into 30 ml of pure water and added to MRS Agar by sterile filter. For *Lactobacillus casei counts*, MRS-Vancomycine (MRS-V) agar pouring plate method was applied and 34.1 g of MRS Agar was added to 490 ml of pure water and sterilized in autoclave at 121 °C for 15 minutes after adjusting the pH to 5.2. 0.0005 g Vancomycin dissolved in 10 ml of MRS Agar was added to the autoclaved MRS Agar with the help of sterile filter and syringe.

***Bifidobacterium lactis* enumeration**

MRS-NNLP was used for *Bifidobacterium lactis* enumeration. Sterile medium was poured 15-20 ml into sterile petri dishes containing the diluted samples. The cultured petri dishes were incubated in anaerobic jars at 37°C for 72 hours using Anaerocult® A (Merck, Germany). At the end of the incubation period, opaque white, 1-1.5 mm diameter colonies with a central bump were evaluated.

***Lactobacillus casei* enumeration**

MRS-V was used for *Lactobacillus casei* enumeration. Sterile medium was poured 15-20 ml into sterile petri dishes containing the diluted samples. The cultured petri dishes were incubated at 37 °C for 72 hours using anaerobic jars Anaerocult® A (Merck, Germany). At the end of the incubation period, opaque white, 1-1.5 mm diameter colonies with a central bump were evaluated.

**Yeast, Mould and Enterococcus enumeration**

Enterococci analysis was performed based on ISO 21528-2 standard. Mould and yeast analyses were performed based on ISO21527-1 and ISO 21527-2 standards.

**VRBD Agar - Enterococci enumeration**

Dehydrated medium was boiled in distilled water to 39.5 g/l by stirring and kept at boiling temperature for maximum 2 minutes after boiling started and cooled rapidly to 45-50°C. The pH was 7.3± 0.2 at 25°C. 12.5 ml was poured into sterile petri dishes and the application was made as double layer cultivation. The second layer was made by pouring 5 ml of medium into the petri dishes after waiting at room temperature for 15 min. Petri dishes were incubated at 37°C for 24 hours and the small pink colonies formed were considered as Enterococci colonies.

**DRBC Agar Yeast - Mould enumeration**

Dehydrated medium was dissolved by boiling in distilled water to 31.6 g/l. The pH is 5,6± 0,2 at 25°C. The medium is sterilized in autoclave at 121°C for 15 min. It was cooled to 45-50°C and 12.5 ml was placed in sterile containers.

**Sensory evaluation**

A 5-point hedonic test scale was used for the sensory evaluation of the milkshake beverages (1 point for I don't like it at all - 5 points for I like it very much). The sensory analyses were carried out by a panel of academicians and graduate students of Ege University Faculty of Agriculture, Department of Dairy Technology. Sensory analyses were carried out on each milkshake beverage on days 1, 30, 60, 90, 120, 150 and 180 of storage. An example of the sensory analysis form is shown in Table 3.2.

Table 3.2. Example of sensory analysis form.

**Panelist name…….. Date……**

| | A1 | A2 | A3 | A4 |
|---|---|---|---|---|
| **Colour and Appearance (1-5)** | | | | |
| **Structure and Consistency (1-5)** | | | | |
| **Taste (1-5)** | | | | |
| **Odour (1-5)** | | | | |

**Statistical evaluation**

Analysis of variance (ANOVA) was applied to determine the effects of stevia use and storage temperature on the properties of probiotic powdered milkshake mixtures and beverages, and the significant data were grouped according to Duncan multiple comparison test at $p<0.05$ level (SPSS, V8).

**Research Findings and Discussion**

In this section, the findings and comments were given obtained from the analyses applied to the chocolate powder milkshake mixture stored at 4°C and 20°C and the milkshake drinks prepared from these mixtures stored at the same temperatures for the 1st, 15th, 30th, 45th, 60th, 75th, 90th, 120th, 150th, and 180th days.

**Properties of Milkshake Mixes**

**Dry matter**

The results of the dry matter analysis of the powdered milkshake mixture on the 1st day of storage are shown in Table 4.1. The highest dry matter in the milkshake mixture was found in the samples containing sugar.

Table 4.1. Dry matter content (%) in the milkshake mixture (n=6).

| Product | Dry matter (%) |
|---|---|
| Ş4T | $98,89\pm0,10^{A}$ |
| ŞOT | $98,89\pm0,04^{A}$ |
| S4T | $97,18\pm0,04^{B}$ |
| SOT | $97,28\pm0,06^{B}$ |

Ş4T: Powdered milkshake mix with sugar stored at 4°C, S4T: Powdered milkshake mix with stevia stored at 4°C, ŞOT: Powdered milkshake mix stored at with sugar 20°C, SOT: Powdered milkshake mix with stevia stored at 20°C, A,B : The difference between the means shown with

different letters is significant ($p<0.05$). According to the results of statistical analysis, no significant difference was found between milkshakes stored at 4°C and milkshakes stored at 20°C in terms of dry matter values ($p>0.05$). The statistical difference between the milkshake mixtures containing sugar and stevia was found to be significant ($p<0.05$).

**Fat**

The results of the fat analysis of the powdered milkshake mixture on the 1st day of storage are shown in Figure 4.1.

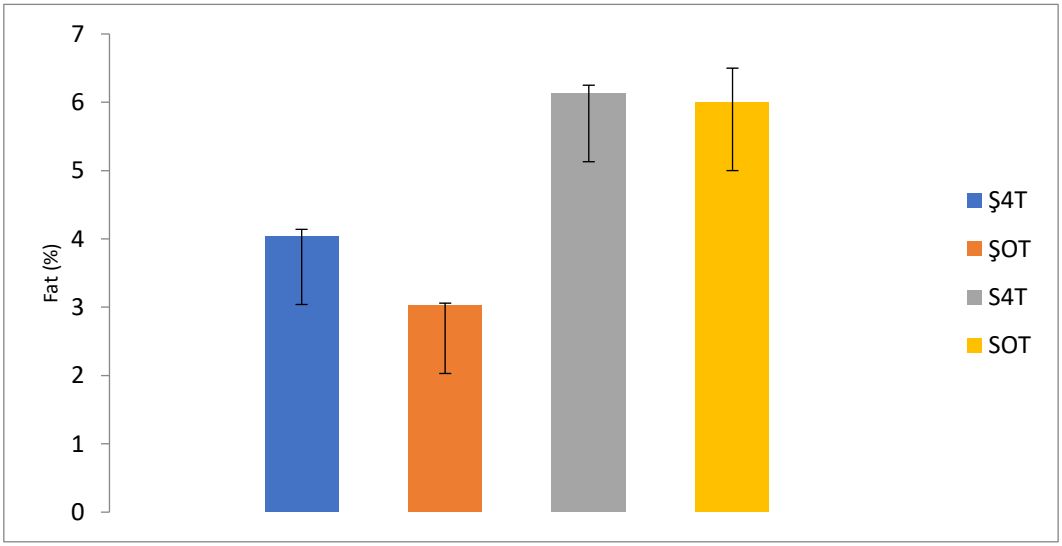


Figure 4.1. Average fat content (%) in milkshake mixtures.

There is a statistical difference between the fat content of powdered milkshake mixtures ($p<0.05$). The amount of fat in stevia milkshake mixtures was found to be higher than the amount of fat in sugar milkshake mixtures ($p<0.05$).

**Total sugar**

The powdered milkshake mix with sugar contains the disaccharide sucrose, while the powdered milkshake mix with stevia contains Reb A, a substance in the stevia extract that has a sweetening effect. The sweetened milkshake drink contains lactose, the milk sugar from milk, and sucrose. The stevia milkshake drink contains lactose and Reb A. The results of the total sugar values in the powdered milkshake mixture are shown in Figure 4.2.

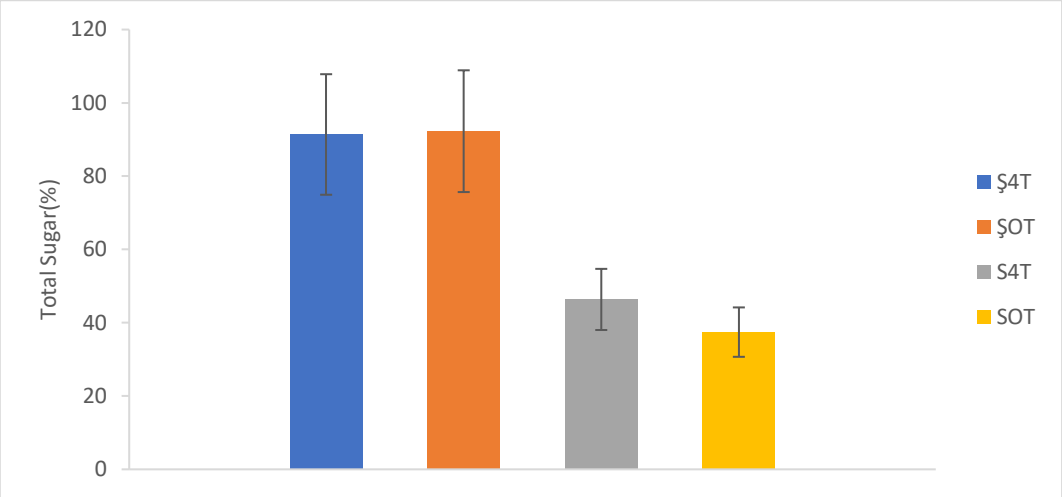


Figure 4.2. Total sugar amounts in milkshake mixtures.

The sugar content of the powder mixtures containing stevia was found to be naturally lower. The highest sugar content was found in the milkshake mixture stored at 20°C with sugar. The milkshake with the lowest sugar content was the milkshake powder mixture with stevia stored at 20°C.

### *B. lactis* count

The log values of *B. lactis* counts determined in powdered milkshake mixtures during storage are given in Table 4.2.

Table 4.2. *B. lactis* counts (log cfu/g) in milkshake mixtures during storage (n=3).

| Product | STORAGE DAYS | | | |
|---|---|---|---|---|
| | 1 | 15 | 30 | 45 |
| ŞŞT | 9,16±0,14$^{Bb}$ | 9,25±0,08$^{Aab}$ | 9,10±0,09$^{Ab}$ | 9,38±0,16$^{Aa}$ |
| ŞOT | 10,34±0,16$^{Aa}$ | 9,07±0,09$^{Bb}$ | 8,93±0,06$^{Bb}$ | 8,56±0,21$^{Cc}$ |
| SŞT | 9,16±0,14$^{Bb}$ | 9,25±0,08$^{Aab}$ | 9,10±0,09$^{Ab}$ | 9,38±0,16$^{Aa}$ |
| SOT | 9,09±0,04$^{Ba}$ | 8,81±0,07$^{Cb}$ | 8,96±0,06$^{Ba}$ | 9,07±0,19$^{Ba}$ |

ŞŞT: Powdered milkshake mix with sugar stored at 4°C, SŞT: Powdered milkshake mix with stevia stored at 4°C, ŞOT: Powdered milkshake mix stored at with sugar 20°C, SOT: Powdered milkshake mix with stevia stored at 20°C, A,B,C: The difference between the means shown with different letters in the same column is significant ($p<0.05$), a,b,c: The difference between the means indicated by different letters in the same row is significant ($p<0.05$).

It was observed that the storage period caused a significant decrease in the number of *B. lactis* especially after 45 days. After 45 days, the highest number of *B.lactis* was found in the powdered milkshake mixture with sugar stored at 4°C on the 90th day of storage (4.90 log cfu/g) and the lowest number was found in the powdered milkshake mixture with sugar stored at 20°C on the 180th day (1.30 log cfu/g). During 45 days of storage, the highest number of *B. lactis* was found in the sweetened milkshake mixture stored at 20°C on day 1 (10.34 log cfu/g), while the bacterial count of this sample was lower than the other samples on day 45 (8.56 log cfu/g). It was determined that the number of *B. lactis* was higher in the samples stored at 4 °C with sugar or stevia on the 15th, 30th, and 45th days. In the samples with sugar stored at 20°C, a significant decrease in the number of probiotic bacteria was found for 45 days.

***L. casei* count**

It was observed that the number of *L. casei* determined in powdered milkshake mixtures during storage was above 8 log cfu/g. Throughout the 180 days, the numbers of *L. casei* in powdered milkshake mixtures are given in Table 4.3.

Table 4.3. L. casei counts (log cfu/g) in milkshake mixtures during storage (n=3).

| | STORAGE DAYS | | | | |
|---|---|---|---|---|---|
| **Product** | **1** | **15** | **30** | **45** | **60** |
| Ş4T | 9,52±0,09$^{Bd}$ | 9,58±0,04$^{Acd}$ | 9,15±0,15$^{Cg}$ | 9,37±0,07$^{Ce}$ | 9,91±0,07$^{Aa}$ |
| ŞOT | 10,72±0,01$^{Aa}$ | 9,43±0,07$^{Bbc}$ | 9,50±0,07$^{Ab}$ | 9,49±0,24$^{Bb}$ | 9,62±0,43$^{Bb}$ |
| S4T | 9,42±0,06$^{Cabc}$ | 9,40±0,07$^{Babc}$ | 9,22±0,04$^{ABc}$ | 9,57±0,05$^{ABa}$ | 9,49±0,04$^{Babc}$ |
| SOT | 9,34±0,05$^{Cb}$ | 8,94±0,14$^{Cd}$ | 9,32±0,04$^{Bb}$ | 9,70±0,07$^{Aa}$ | 9,10±0,08$^{Cc}$ |

| | STORAGE DAYS | | | | |
|---|---|---|---|---|---|
| **Product** | **75** | **90** | **120** | **150** | **180** |
| Ş4T | 9,57±0,05$^{Acd}$ | 9,62±0,07$^{Abc}$ | 9,25±0,05$^{Af}$ | 9,72±0,06$^{Ab}$ | 9,69±0,07$^{Ab}$ |
| ŞOT | 9,12±0,06$^{Ccd}$ | 8,88±0,08$^{Cde}$ | 8,61±0,07$^{Be}$ | 8,93±0,7$^{Bde}$ | 8,80±0,13$^{Dde}$ |
| S4T | 9,23±0,07$^{Bc}$ | 9,50±0,1$^{Bab}$ | 8,93±0,52$^{ABd}$ | 9,32±0,13$^{ABbc}$ | 9,29±0,07$^{Bbc}$ |
| SOT | 8,99±0,1$^{Dd}$ | 8,90±0,07$^{Cd}$ | 9,14±0,09$^{Ac}$ | 8,45±0,13$^{Ce}$ | 9,16±0,06$^{Cc}$ |

Ş4T: Ş4T: Powdered milkshake mix with sugar stored at 4°C, S4T: Powdered milkshake mix with stevia stored at 4°C, ŞOT: Powdered milkshake mix stored at with sugar 20°C, SOT: Powdered milkshake mix with stevia stored at 20°C A,B,C,D: The difference between the means shown with different letters in the same column is significant ($p<0.05$), a,b,c,d,e,f: The difference between the means shown with different letters in the same row is significant ($p<0.05$).

The highest *L. casei* count was found in the sugar milkshake mix stored at 20°C on day 1 (10.72 log cfu/g), while at the end of storage, the bacteria count of this sample was lower than the other samples (8.80 log cfu/g). During storage, the stevia milkshake mix stored at 20°C was generally found to contain lower bacterial counts. From the second month of storage, the highest

number of *L.casei* was detected in the sugar milkshake mixture stored at 4°C. During the 180-day storage period, it was observed that the number of live bacteria decreased more in the sugar milkshake mixture stored at 20°C than in the other samples (from 10.72 to 8.80 log cfu/g) ($p<0.05$).

**Yeast, mould and enterococci counts**

According to the results of the analysis performed on the milkshake powders on the 1st and 90th days of storage, yeast, mould and enterococci were not detected.

**Characteristics of Milkshake Drinks**

**Dry Matter**

The result of the dry matter analysis of the milkshake drink prepared from the powdered milkshake mixture on the 1st day of storage is shown in Figure 4.3.

The highest values of dry matter content in milkshake drinks belong to the milkshake drinks containing sugar. According to the results of the statistical analysis, no significant difference was found between the beverages obtained from milkshake mixtures stored under refrigerator condition and the beverages obtained from milkshake mixtures stored under room condition ($p>0.05$). The difference in dry matter content between milkshake drinks containing sugar and stevia was found to be significant ($p<0.05$).

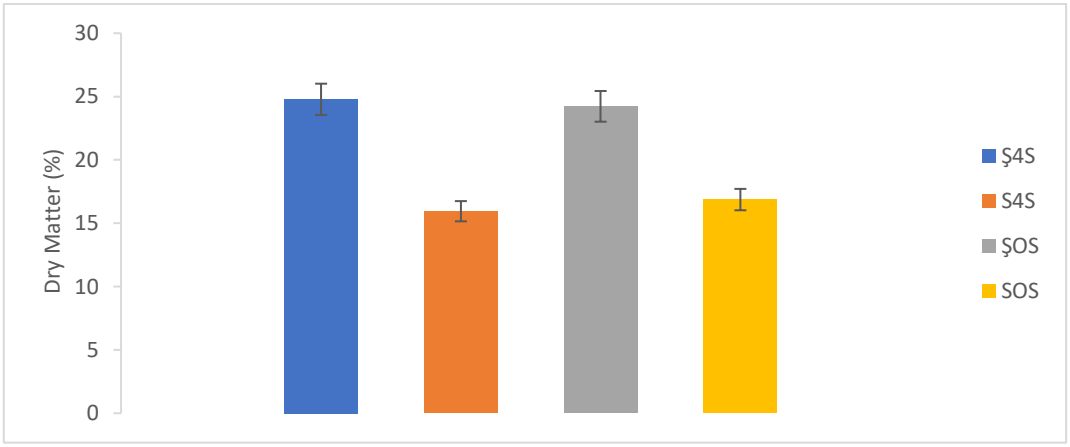


Figure 4.3. Dry matter (%) in milkshake drink

According to the results of the analyses, the reason why the dry matter of the milkshake drinks containing stevia was lower than those containing sugar was due to the addition of 10 g of powdered milkshake mixture to 200 ml milk instead of 30 g.

**Fat**

The results of the fat analysis of the milkshake drink prepared from the powdered milkshake mixture on the 1st day of storage are given in Figure 4.4.

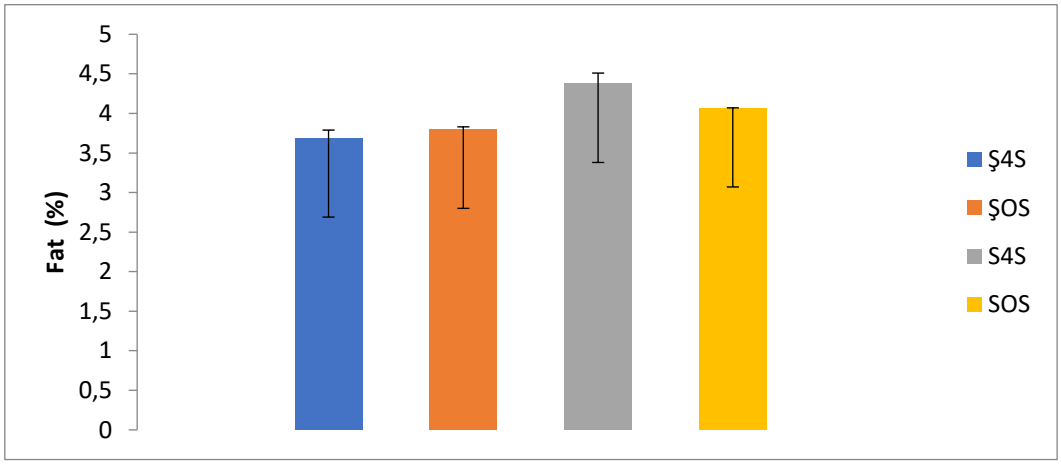


Figure 4.4. Fat content (%) in milkshake drinks.

When the fat content of the milkshake drinks was analyzed, it was observed that there was a statistical difference between them ($p<0.05$). The amount of fat in stevia milkshake beverage was found to be higher than the amount of fat in sugar milkshakes. This is related to the higher fat percent in powdered milkshake mixtures containing stevia.

**pH**

The pH changes in the milkshake beverages prepared during the storage period are shown in Table 4.4.

Table 4.4. pH values of milkshake beverages during storage period (n=4).

| Product | STORAGE DAYS | | | | | | |
|---|---|---|---|---|---|---|---|
| | **1** | **30** | **60** | **90** | **120** | **150** | **180** |
| ŞAS | 6,58±0,03$^{Ad}$ | 6,56±0,00$^{Ad}$ | 6,48±0,00$^{ABe}$ | 6,64±0,00$^{Bc}$ | 6,76±0,00$^{Ab}$ | 6,76±0,01$^{Ab}$ | 6,82±0,01$^{Aa}$ |
| ŞOS | 6,60±0,00$^{Ad}$ | 6,57±0,00$^{Ae}$ | 6,47±0,00$^{Bf}$ | 6,57±0,00$^{Ce}$ | 6,72±0,00$^{BCc}$ | 6,75±0,01$^{Ab}$ | 6,76±0,01$^{Ba}$ |
| SAS | 6,60±0,00$^{Ae}$ | 6,55±0,00$^{Af}$ | 6,50±±0,02$^{Ag}$ | 6,65±0,00$^{Bd}$ | 6,74±0,02$^{ABc}$ | 6,76±0,01$^{Ab}$ | 6,83±0,01$^{Aa}$ |
| SOS | 6,60±0,00$^{Ad}$ | 6,55±0,03$^{Ae}$ | 6,49±0,00$^{ABf}$ | 6,68±0,00$^{Ac}$ | 6,71±0,00$^{Cb}$ | 6,73±0,01$^{Bb}$ | 6,82±0,01$^{Aa}$ |

ŞAS: Milkshake drink with sugar stored at 4°C, SAS: Milkshake drink with stevia stored at 4°C, ŞOS: Milkshake drink with sugar stored at 20°C, SOS: Milkshake drink with stevia stored at 20°C, A,B,C: The difference between the means shown with different letters in the same column is significant ($p<0.05$). a,b,c,d,e: The difference between the means shown with different letters in the same row is significant ($p<0.05$).

The pH values of milkshake beverages varied between 6.47 and 6.83 (Table 4.8). There was a slight increase in pH values during storage, especially after the 90th day. It was also observed that the use of stevia or sugar had no effect on pH in milkshake drinks, especially in the first month ($p>0.05$).

**Acidity**

The % acidity values in terms of lactic acid determined in the milkshake beverages prepared during the storage period are given in Table 4.5.

Table 4.5. % Acidity values determined in milkshake beverages during storage (n=4).

| **Product** | **STORAGE DAYS** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **1** | **30** | **60** | **90** | **120** | **150** | **180** |
| ŞÖS | 0,18±0,01$^{Ab}$ | 0,18±0,01$^{Ab}$ | 0,22±0,02$^{Aa}$ | 0,17±0,01$^{Ab}$ | 0,09±0,01$^{Bc}$ | 0,09±0,01$^{Bc}$ | 0,06±0,01$^{Bd}$ |
| ŞOS | 0,16±0,01$^{Bc}$ | 0,18±0,01$^{Aab}$ | 0,18±0,02$^{Ca}$ | 0,17±0,01$^{Abc}$ | 0,10±0,00$^{Ad}$ | 0,10±0,01$^{Bd}$ | 0,08±0,01$^{Ae}$ |
| S4S | 0,16±0,01$^{Bc}$ | 0,18±0,01$^{Ab}$ | 0,21 ±0,01$^{ABa}$ | 0,16±0,01$^{Ac}$ | 0,11±0,01$^{Ad}$ | 0,11±0,00$^{Ad}$ | 0,08±0,01$^{Ae}$ |
| SOS | 0,16±0,00$^{Bb}$ | 0,17±0,01$^{Bb}$ | 0,19±0,01$^{BCa}$ | 0,17±0,01$^{Ab}$ | 0,11±0,00$^{Ac}$ | 0,11±0,00$^{Ac}$ | 0,09±0,0$^{Ad}$ |

ŞÖS: Milkshake drink with sugar stored at 4°C, S4S: Milkshake drink with stevia stored at 4°C, ŞOS: Milkshake drink with sugar stored at 20°C, SOS: Milkshake drink with stevia stored at 20°C, A,B: The difference between the means shown with different letters in the same column is significant ($p<0.05$). a,b,c: The difference between the means indicated by different letters in the same row is significant ($p<0.05$).

According to the results; acidity values vary between 0,06 % and 0,22 %. While the acidity value of the milkshake drinks obtained from the sweetened milkshake mixture stored at 4°C on the 1st day of storage was high, it was determined that the acidity of this sample was lower than the others on the 180th day. A decrease in acidity values was observed during storage ($p<0.05$). The results of acidity and pH analyses support each other. The reason for the decrease in the values can be attributed to the significant loss of viability of *B.lactis* after the 45th day.

**Protein**

The results of protein analysis of milkshake beverages on day 1 are given in Figure 4.5. According to the results of the statistical evaluation, the amount of protein in the milkshake beverages containing stevia was higher than the milkshake beverages containing sugar ($p<0.05$).

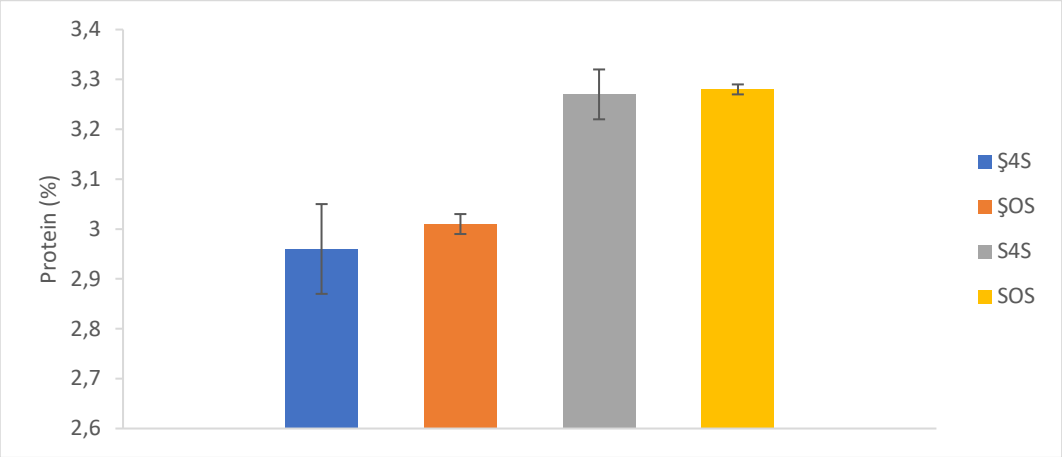


Figure 4.5. Protein values (%) in milkshake drinks.

Sucrose is a disaccharide with high water binding capacity, water solubility and molecular weight. The dry matter content is also high in milkshake samples containing sugar. However, although stevia is used less because its sweetening degree is 250 times higher than sugar, it was observed that the amount of protein from milk and skimmed milk powder increased when compared to the total mass.

**Total sugar**

The result of total sugar analysis in milkshake beverages is shown in Figure 4.6.

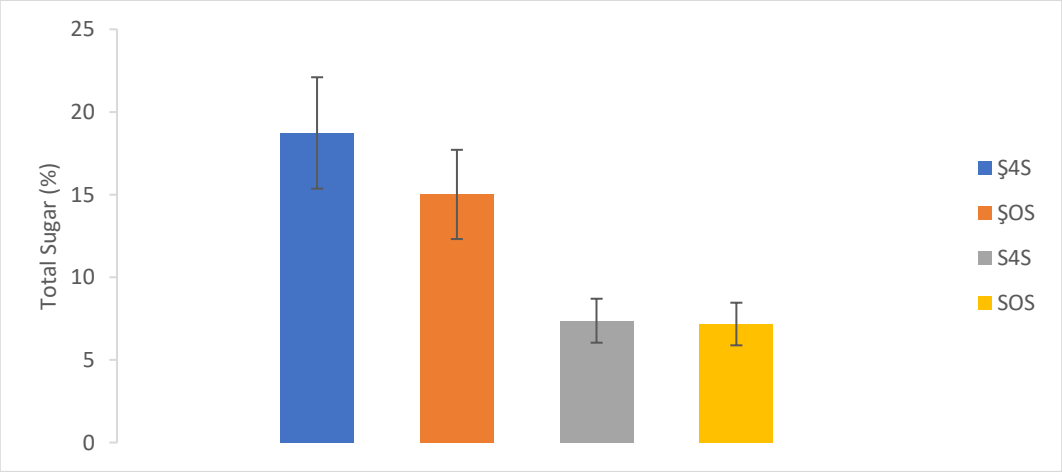


Figure 4.6. % of total sugar in milkshake drinks.

According to the total sugar analyses of milkshake drinks, it was naturally determined that the sugar content was higher in sugary drinks. The total sugar contents were higher in the sweetened milkshake mix and sweetened milkshake drink ($p<0.05$).

**Viscosity**

Viscosity is the resistance of the liquid to flow. The amount of fat, dry matter and storage time affect the viscosity. Table 4.6 and 4.7 shows the viscosity values at 10 rpm and 20 rpm of the drinks prepared from chocolate powder milkshake mixture stored for 180 days, respectively.

Table 4.6. Viscosity values (cP) (10 rpm) in milkshake drinks

| | STORAGE DAYS | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 30 | 60 | 90 | 120 | 150 | 180 |
| Ş4S | 1115,33±2,08$^{Bc}$ | 1326,00±0,00$^{Aa}$ | 1253,00±50,41$^{Ab}$ | 1111,00±45,13$^{Ac}$ | 1027,00±18,33$^{Ad}$ | 1010,33±0,58$^{Ad}$ | 933,00±0,00$^{Ae}$ |
| ŞOS | 1269,00±0,00$^{Aa}$ | 1156,00±1,73$^{Bb}$ | 1141,00±1,73$^{Bc}$ | 1027,00±4,58$^{Bd}$ | 996,00±0,00$^{Bf}$ | 1008,00±0,00$^{Be}$ | 930,00±0,00$^{Ag}$ |
| S4S | 1117,00±4,58$^{Ba}$ | 1092,00±3,00$^{Cb}$ | 975,00±0,00$^{Cd}$ | 921,00±0,00$^{Ce}$ | 1014,00±0,00$^{Ac}$ | 774,00±0,00$^{Cg}$ | 819,00±0,00$^{Bf}$ |
| SOS | 1046,00±12,12$^{Cb}$ | 1081,00±1,73$^{Da}$ | 930,00±0,00$^{Cc}$ | 732,00±0,00$^{Dg}$ | 756,00±0,00$^{Cf}$ | 774,00±0,00$^{Ce}$ | 806,00±3,46$^{Cd}$ |

Ş4S: Milkshake drink with sugar stored at 4°C, S4S: Milkshake drink with stevia stored at 4°C, ŞOS: Milkshake drink with sugar stored at 20°C, SOS: Milkshake drink with stevia stored at 20°C, A,B,C,D: The difference between the means shown with different letters in the same column is significant ($p<0.05$), a,b,c,d,e,f,g: The difference between the means shown with different letters in the same row is significant ($p<0.05$).

Table 4.7. Viscosity values (cP) (20 rpm) in milkshake drinks

| Product | STORAGE DAYS | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 30 | 60 | 90 | 120 | 150 | 180 |
| Ş4S | 830,00±1,73$^{Bb}$ | 989,00±9,17$^{Aa}$ | 832,67±18,45$^{Ab}$ | 735,00±0,00$^{Ac}$ | 741,00±0,00$^{Ac}$ | 819,00±0,00$^{Ab}$ | 624,00±0,00$^{Cd}$ |
| ŞOS | 904,00±0,00$^{Aa}$ | 868,33±11,06$^{Bb}$ | 812,33±1,15$^{Bc}$ | 728,67±0,58$^{Bd}$ | 687,00±12,00$^{Ce}$ | 650,00±0,00$^{Cf}$ | 685,00±0,00$^{Ae}$ |
| S4S | 817,00±0,00$^{Ca}$ | 810,00±0,00$^{Cb}$ | 711,00±0,00$^{Cd}$ | 552,00±0,00$^{Cf}$ | 723,00±0,00$^{Bc}$ | 633,33±0,58$^{De}$ | 525,00±0,00$^{Dg}$ |
| SOS | 742,00±0,00$^{Dc}$ | 805,00±0,00$^{Ca}$ | 718,00±0,00$^{Cd}$ | 490,00±0,00$^{Dg}$ | 558,00±0,00$^{Df}$ | 774,00±0,00$^{Bb}$ | 641,00±0,58$^{Be}$ |

Ş4S: Milkshake drink with sugar stored at 4°C, S4S: Milkshake drink with stevia stored at 4°C, ŞOS: Milkshake drink with sugar stored at 20°C, SOS: Milkshake drink with stevia stored at 20°C, A,B,C,D: The difference between the means shown with different letters in the same column is significant ($p<0.05$), a,b,c,d,e,f,g, : The difference between the means shown with different letters in the same row is significant ($p<0.05$).

In the viscosity analyses of milkshake beverages, viscosity values were first taken at 10 rpm and then at 20 rpm for the same sample.

As seen in the table, the viscosity value of the milkshake drinks containing sugar was found to be higher than the milkshake drinks containing stevia. In other words, it was observed that the viscosity of sugar milkshake beverages with high dry matter was also high.

According to the results, the viscosity of the drink obtained from the sugary milkshake drink stored at 4°C was found to be higher than the drink stored at room temperature except for the 1st and 180th days of storage. The viscosity value of the beverage obtained from the powder milkshake sample containing stevia stored at 4°C was found to be higher than the beverage obtained from the powder milkshake sample with stevia stored at room temperature except for the 60th and 150th days of storage.

In this case, it is thought that storage under refrigerator conditions provided an increase in viscosity values of milkshake beverages obtained from powdered milkshake mixtures.

**_B. lactis_ counts**

The results of *B.lactis* counts determined in beverages prepared from powdered milkshake mixtures during the storage period are given in Table 4.8.

Table 4.8. *B. lactis* counts (log cfu/g) in milkshake beverages during storage (n=3).

| **Product** | **STORAGE DAYS** | | | |
|---|---|---|---|---|
| | **1** | **15** | **30** | **45** |
| Ş4S | 8,67±0,10$^{Aa}$ | 8,33±0,05$^{Ac}$ | 8,35±0,03$^{Abc}$ | 8,46±0,14$^{Ab}$ |
| ŞOS | 8,70±0,02$^{Aa}$ | 8,40±0,28$^{Ab}$ | 7,60±0,21$^{Cc}$ | 7,16±0,28$^{Cd}$ |
| S4S | 8,24±0,13$^{Ba}$ | 7,94±0,02$^{Bb}$ | 8,00±0,10$^{Bb}$ | 8,02±0,08$^{Bb}$ |
| SOS | 8,17±0,30$^{Ba}$ | 8,05±0,13$^{Bab}$ | 7,88±0,07$^{Bb}$ | 7,18±0,25$^{Cc}$ |

Ş4S: Milkshake drink with sugar stored at 4°C, S4S: Milkshake drink with stevia stored at 4°C, ŞOS: Milkshake drink with sugar stored at 20°C, SOS: Milkshake drink with stevia stored at 20°C, A,B,C: The difference between the means shown with different letters in the same column is significant ($p<0.05$), a,b,c,d :The difference between the means indicated by different letters in the same row is significant ($p<0.05$).

The difference between *B. lactis* counts of milkshake beverage types was found to be statistically significant ($p<0.05$). It was observed that *B. lactis* counts were higher in sugary beverages on the 1st and 15th days of storage, and the highest counts on the 30th and 45th days were detected in sugary beverages prepared from powder mixtures stored at 4°C (Table 4.14.). After the 45th day, the highest number of *B.lactis* was found in the milkshake drink obtained from the sugary milkshake mixture stored at 4°C on the 75th day of storage (4.89 log cfu/g) and the lowest number was found in the milkshake drink obtained from the stevia milkshake mixture stored at 20°C on the 180th day (1.00 log cfu/ml).

*B. lactis* counts of the samples decreased during the storage period. It was determined that the decrease in the number of *B. lactis* during storage was higher in beverages prepared from powdered milkshake mixtures stored at room temperature.

### *L. casei* counts

The numbers of *L.casei*, whose viability was determined for 180 days in milkshake drinks prepared from powdered milkshake mixtures are given in Table 4.9.

Table 4.9. *L. casei* variation (log cfu/ml) in milkshake beverages during storage (n=3).

| Product | STORAGE DAYS | | | | |
|---|---|---|---|---|---|
| | **1** | **15** | **30** | **45** | **60** |
| Ş4S | 8,93±0,16$^{Aa}$ | 8,46±0,12$^{Acd}$ | 8,63±0,11$^{Ab}$ | 8,67±0,04$^{Ab}$ | 8,55±0,11$^{Abc}$ |
| ŞOS | 8,85±0,03$^{Aa}$ | 8,54±0,05$^{Ab}$ | 8,48±0,07$^{Bb}$ | 8,15±0,1$^{Bc}$ | 7,54±0,36$^{Cc}$ |
| S4S | 8,46±0,09$^{Ba}$ | 8,07±0,14$^{Bcde}$ | 8,18±0,07$^{Cbc}$ | 8,17±0,10$^{Bbcd}$ | 8,03±0,05$^{Bced}$ |
| SOS | 7,86±0,10$^{Cbcd}$ | 8,15±0,13$^{Ba}$ | 8,24±0,04$^{Ca}$ | 7,78±0,10$^{Ccd}$ | 8,01±0,08$^{Babc}$ |

| Product | STORAGE DAYS | | | | |
|---|---|---|---|---|---|
| | **75** | **90** | **120** | **150** | **180** |
| Ş4S | 8,58±0,07$^{Abc}$ | 8,34±0,05$^{Ad}$ | 8,58±0,25$^{Abc}$ | 8,52±0,03$^{Abc}$ | 8,56±0,07$^{Abc}$ |
| ŞOS | 8,10±0,13$^{BCd}$ | 7,63±0,02$^{Cd}$ | 7,44±0,08$^{Cd}$ | 7,49±0,15$^{Cd}$ | 7,23±0,21$^{Ce}$ |
| S4S | 8,30±0,19$^{ABab}$ | 7,97±0,16$^{Be}$ | 7,53±0,14$^{Cf}$ | 8,17±0,26$^{Bbcd}$ | 7,99±0,05$^{Bde}$ |
| SOS | 7,86±0,52$^{Cbcd}$ | 7,61±0,15$^{Cde}$ | 8,10±0,13$^{Bab}$ | 7,37±0,19$^{Cef}$ | 7,15±0,28$^{Cf}$ |

Ş4S: Milkshake drink with sugar stored at 4°C, S4S: Milkshake drink with stevia stored at 4°C, ŞOS: Milkshake drink with sugar stored at 20°C, SOS: Milkshake drink with stevia stored at 20°C, A,B,C,D: The difference between the means shown with different letters in the same column is significant ($p<0.05$), a,b,c,d,e,f : The difference between the means indicated by different letters in the same row is significant ($p<0.05$).

As can be seen, *L. casei* counts ranged between 7.15 log cfu/ml and 8.93 log cfu/ml and the difference between milkshake drinks was statistically significant ($p<0.05$). The highest *L. casei* counts during storage were found in the drinks obtained from the sugary milkshake mixture stored at 4°C (8.93 - 8.34 log cfu/ml), while the lowest counts were found in the drinks obtained from powdered milkshakes containing stevia stored at room temperature (8.24 - 7.15

log cfu/ml) ($p<0.05$). There was a general decrease in the number of *L.casei* during storage ($p<0.05$). At the end of storage, the highest decrease was observed in the beverage obtained from the sugary milkshake mixture stored at room temperature.

**Sensory characteristics of milkshake beverages**

Sensory evaluation, which is defined as perceiving the properties of food through our sense organs, was applied to beverages prepared from chocolate milkshake mixtures stored for 180 days. Sensory properties of milkshake beverages were evaluated in terms of odour (1-5 points), colour and appearance (1-5 points), taste (1-5 points) and texture and consistency (1-5 points).

In general, the effect of storage time on the sensory properties of milkshakes was not significant ($p>0.05$). However, a significant difference was observed between the milkshake beverages containing stevia and sugar for taste ($p<0.05$).

**Odour**

In the study, odour values varied between 4.75 - 5.00 out of 5. No significant difference was observed between milkshake beverage varieties in terms of odour values ($p>0.05$). In terms of storage days, it was determined that the odour value was lower only in the sample prepared at the 150th day of the milkshake drinks containing sugar stored at 4°C ($p<0.05$).

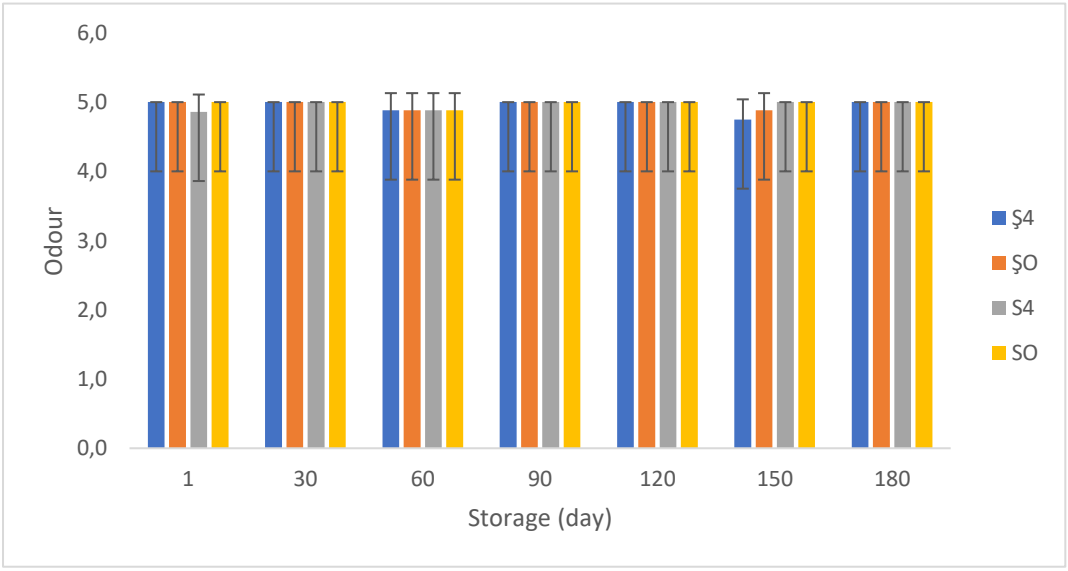


Figure 4.6. Variation of mean odour values of milkshake beverages during storage.

**Colour and appearance**

Appearance is the first sensory criterion that the consumer evaluates the product and has a significant effect on the purchase of the product. As can be seen in Figure 4.7, the scores of milkshake drinks in terms of colour and appearance ranged between 4.38-5.00. According to the results of the statistical analysis, no significant difference was found between the milkshake drinks prepared on storage days other than day 60 in terms of colour and appearance values ($p>0.05$).

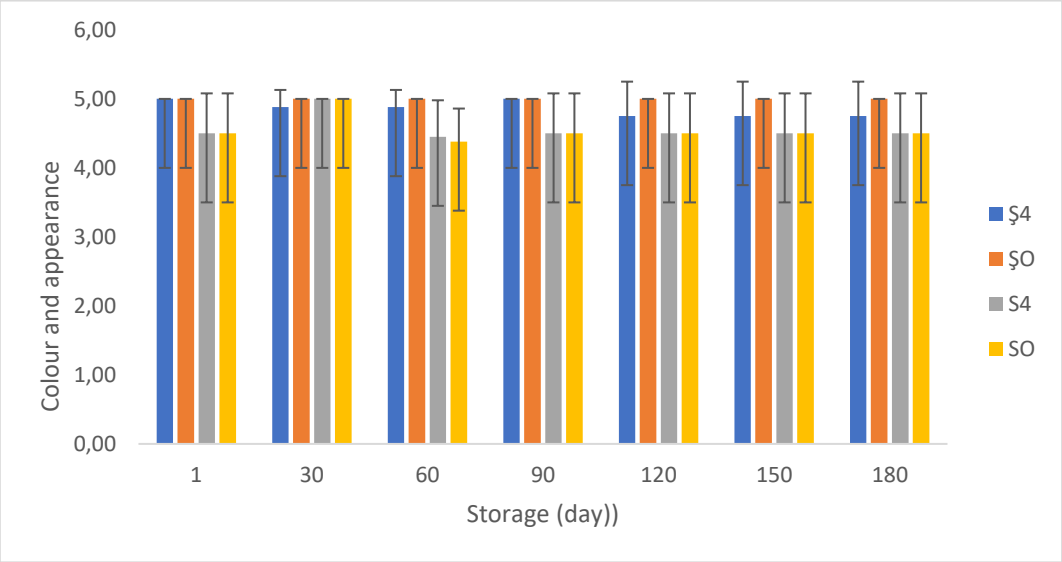


Figure 4.7. Changes in mean colour and appearance values of milkshake beverages during storage.

It was also found that there was no statistical difference between the scores evaluated in terms of colour and appearance during the storage period ($p>0.05$).

**Taste**

Although taste varies from person to person, it is one of the most important criteria for preferring a product. In the study, the mean values of the taste parameter for milkshake drinks varied between 3.86 and 5.00 and are shown in Figure 4.8. When the difference between the product types was examined, it was seen that the drinks prepared from sugary mixtures were more liked in terms of taste than the ones with stevia in the first two months ($p<0.05$). This was due to the fact that the panellists gave a higher score to the general taste of the milkshakes, but it was determined that there was no difference between the products in terms of taste in the 3rd, 4th, 5th, and 6th months. It was also determined that the taste scores of the sugary milkshakes prepared during storage were different depending on the storage day ($p<0.05$).

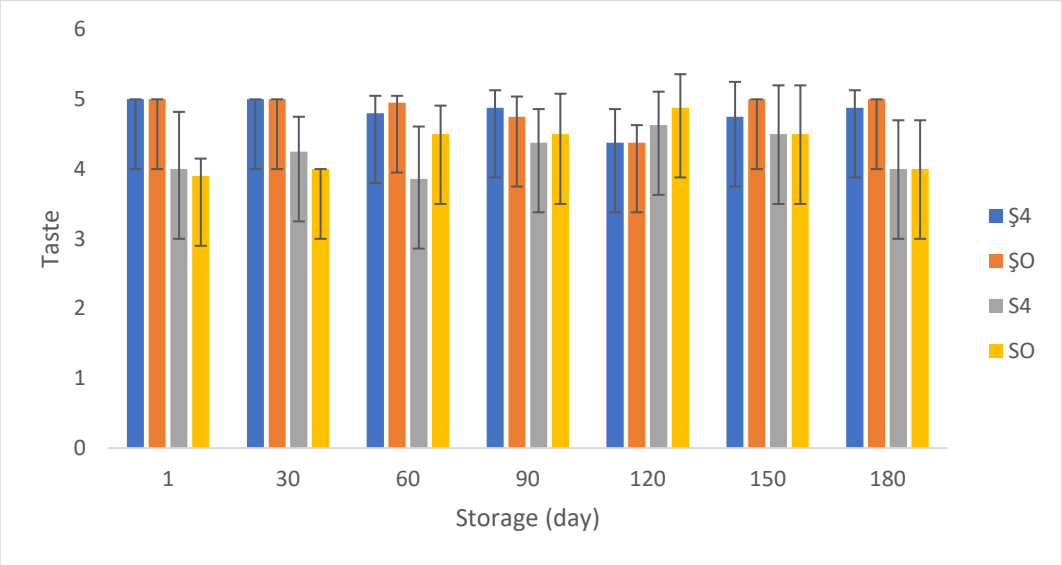


Figure 4.8. Average flavour values of milkshake beverages during storage.

**Texture and consistency**

The texture and consistency values given for milkshake beverages are shown in Table 4.9. It is seen that the values vary between 4.25 - 5.00. While there was no significant difference between the product types until to the 15th day ($p>0.05$), a decrease in texture and consistency was observed in S4S and SOS milkshake drinks prepared on the 150th and 180th days of storage ($p<0.05$).

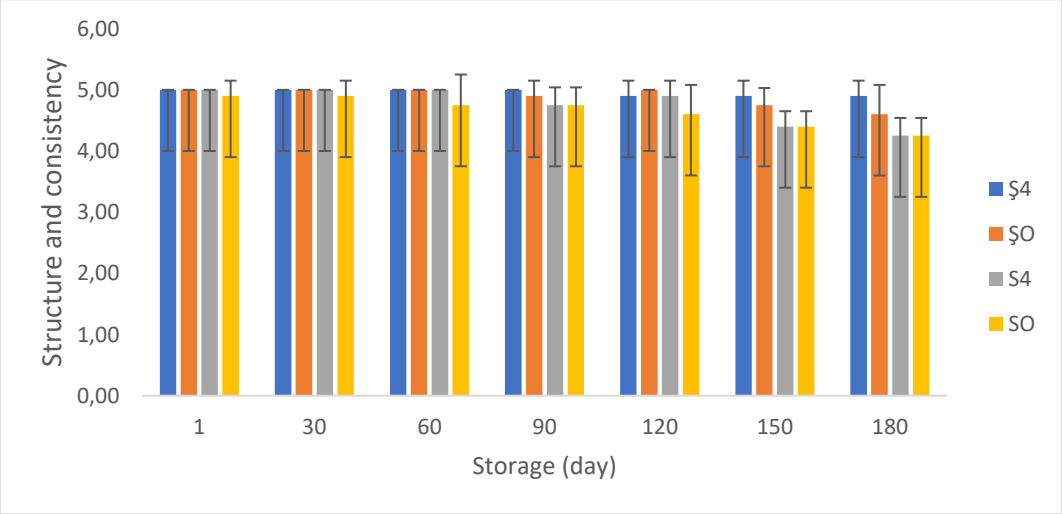


Figure 4.9. Average texture and consistency values of milkshake beverages during storage.

**Conclusions and Recommendations**

When the milkshake beverages were examined in terms of "odour, taste, colour and appearance, texture and consistency" in sensory evaluation, it was observed that storage time

did not significantly affect the degree of liking. Milkshake drinks prepared from sugary mixtures were more liked on taste than the drinks with stevia in the first two months of storage.

According to the results obtained from microbiological analyses, it was observed that the selected probiotics maintained their viability in the sugary and stevia milkshake mix and beverage during 45 days for *B. lactis* and 180 days for *L.casei*. Thus, it is thought that milkshake products containing probiotic bacteria and stevia may be an alternative product to functional food diversity for the future.

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# EFFECTS OF SPECIAL MODIFIED ATMOSPHERE AND DYNAMIC CONTROLLED ATMOSPHERE STORAGE ON STORAGE QUALITY OF LATE PEACH VARIETIES FOR EXPORT

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**Özet**
Çalışma kapsamında geç şeftali çeşitlerinin depolama ve raf ömrünü uzatacak depolama koşulları belirlenerek ürünlerin yurt içi ve yurt dışı pazarlama sürelerinin uzatılması amacıyla farklı depolama uygulamalarının meyve kalitesine etkileri araştırılmıştır. İhracatta yaygın olarak tercih edilenler belirlendi. Proje kapsamında taze ve IQF(Bireysel Hızlı Dondurma) işlemleri yapıldı. En çok tercih edilen ANET 30 - ANET 33 - ANET 55 şeftali çeşitlerinde depolama öncesi 1-MCP kullanımı Sanayide değerlendirmeye uygun ve dış pazarlarda yüksek talep gören, uçucu bitkisel yağlarla emprenye edilmiş modifiye atmosfer ambalajlarında (MAP) ve dinamik kontrollü atmosfer (DKA) koşullarında depolanarak besin değerini artırır ve çürümeyi artırır. Meyve ve sebze aroması gibi kalite özelliklerindeki kayıpların en aza indirilmesi ve depolama süresinin 60 güne kadar uzatılması amaçlanmaktadır. Taze meyve sebze muhafazasında başarının önemli faktörlerinden biri de ürünün sentezlediği olgunluk ve yaşlanma hormonu olan etilen sentezini yavaşlatarak ürünün dayanıklılığını arttırmaktır. Ayrıca 1-MCP uygulandıktan sonra şeftali meyvelerinin depolama süresinin diğer depolama uygulamaları olan MAP ve DKA ile birleştirilerek daha da uzatılma olanakları araştırılmıştır. 1-MCP kullanımı yapılan çalışma insan sağlığına herhangi bir zararının olmaması ve insanların son yıllarda kimyasallardan uzak durması nedeniyle önem taşımaktadır. Çalışma çıktılarına göre 1-MCP'nin tüm çeşitlerde meyve renk değişimini geciktirme, meyve yumuşamasını azaltma ve şeker birikimini yavaşlatmada etkili olduğu tespit edilmiştir. Bu özelliğinden dolayı olgunlaşmanın kullanılabilecek bir uygulama olduğu sonucuna varılmıştır.DKA koşullarında depolamada 60 günlük depolama sonrasında başlangıç kalite değerlerine göre önemli bir değişiklik tespit edilmemiştir. Meyvelerde yapılan MES, SSC, TEA, şeker içeriği, kabuk ve et renginde değişiklikler, mantar çürüklüğü ve tat testleri sonucunda Şeftali çeşitlerinin DKA şartlarında önemli bir kalite kaybı olmaksızın 60 gün saklanabileceği belirlenmiştir.
**Anahtar Kelime:** MAP,DKA depolama,1-MCP,şeftali,depolama

**Giriş**

Yaş meyve ve sebze sektörü dünyadaki tüm insanları doğrudan ilgilendiren ve yaşamlarına doğrudan etki eden bir sektördür. Türkiye, üretime müsait verimli ve geniş tarım alanları, değişik bölgelerin ekolojik farklılıkları sayesinde meyve ve sebzelerinin iyi koşullarda ve kaliteli olarak yetiştirildiği nadir ülkelerden biridir.

Uludağ İhracatçı Birlikleri Genel Sekreterliği AR-GE Şubesi'nin 2019 Ocak ayında yayınladığı Yaş Meyve Sebze Sektörü raporuna göre Türkiye, 2016 yılı verilerine göre dünya yaş sebze üretiminde 5., yaş meyve üretiminde 4. sırada yer almaktadır (Anonim, 2016).

Dünya şeftali ve nektarin üretim miktarı 25 milyon ton civarında olup, 14,5 milyon ton üretimi ile Çin en fazla üretim yapan ülkedir. Türkiye 475 bin ton üretimi ile ülkeler arasında 7. sırada yer almaktadır (Anonim, 2016). 2019 yılı verilerine göre Türkiye'de şeftali ve nektarin üretimi 2016 yılına göre hemen hemen %100 artarak 856.5 bin ton üretim gerçekleştirilmiştir. Türkiye içinde Çanakkale ili 126.489 ton şeftali ve 36.654 ton nektarin üretimi ile birinci sırada yer almaktadır (Anonim, 2019)

Türkiye'nin şeftali ihracatı, 2018 yılında bir önceki yıla göre yüzde 43,7 artışla 128,6 bin tona ulaşmıştır. Diğer taze meyve ve sebze ihracat rakamlarına göre şeftali ihracatımızda görülen yüksek orandaki bu artış sonucu elde edilen gelir bir önceki yıla göre %24,6 artış ile 70,3 milyon dolardan 87,6 milyon dolara yükselmiştir. İhracat geliri olarak GTİP-809 ürün grubunda (şeftali, nektarin, erik, kayısı ve çakal eriği) toplam 5,89 milyar dolarlık ticaret hacminde şeftalinin payı her geçen yıl artmaktadır.

Türkiye'de bugüne kadar şeftali ihracatının gelişmesinin önündeki temel engellerden biri diğer ülkelere göre geçci, pazar isteklerine uygun, şeftali çeşitlerinin yetiştirilmemesi ve şeftali meyvesinin çok kısıtlı depolama süresi ve raf ömrüdür.

Şeftali ideal depolama koşullarında (0$^{o}$C sıcaklık, %90 oransal nem) en fazla 3 hafta depolanabilen fizyolojik olarak hızla bozulan ve mantari çürümelere çok hassas bir meyve türüdür. Proje kapsamında özellikle ihracatta değeri yüksek ve diğer çeşitlere göre geç olgunlaşan AEP Anadolu Etap Penkon Gıda ve Tarım Ürünleri Sanayi ve Tic. A.Ş.'ne ait 3 şeftali çeşidinin (ANET 30 - ANET 33 - ANET 55) farklı modifiye atmosfer (MA) ve dinamik kontrollü atmosfer (DKA) koşullarında depolanarak besin değeri, aroma gibi kalite özelliklerindeki kayıpların en az düzeye çekilmesi amaçlanmaktadır. Böylelikle iç ve dış pazara daha geniş bir zaman aralığında ürün sunulmasını sağlayacak yöntemi araştırmak ve uygulamaya koyarak ulusal ekonomiye artı bir değer kazandırmaktır. Bu çeşitler özellikle IQF

(Individual Quick Freezing - Bireysel Hızlı Dondurma) yapılarak sanayide değerlendirmeye en uygun çeşitler olup, dış pazarlarda bu ürün için yoğun talep bulunmaktadır.

Genel olarak, meyve, sebze ve kesme çiçeklerin depolanabilme süreleri solunum hızı ile doğrudan bağlantılıdır (Kader, 2002). Özellikle klimakterik meyvelerde (elma, armut, muz, domates, bazı şeftali çeşitleri vb.) olduğu gibi klimakterik göstermeyen ürünlerde olgunlaşmaya başlama, olgunlaşma hızı ve süresi etilen hormonu ile doğrudan ilişkilidir. Etilen, meyvelerde doğal olarak bulunan ve klimakterik meyvelerde olgunlaşma prosesini gerçekleştiren doğal bir hormondur. Olgunlaşma süresi ve hızı, ürünün içsel etilen üretim değeri ve ürünün içinde bulunduğu ortamdaki etilen konsantrasyonu ile bağlantılıdır. Etilen seviyesi arttıkça olgunlaşma da hızlanmaktadır. Meyvelerin soğuk hava depolarında muhafaza edilmesinin amacı düşük sıcaklıklarda solunumu ve dolayısıyla etilen üretimini azaltmaktadır fakat tek başına soğukta muhafaza ile olgunlaşma prosesinin engellenmesi mümkün olmamaktadır. Meyvelerdeki olgunlaşma prosesinin yavaşlatılması, etilen üretiminin inhibe edilmesi amacıyla uzun yıllar boyunca birçok yöntem geliştirilmiştir. Örneğin uzun süreli depolamalarda, düşük $O_2$ ve yüksek $CO_2$ konsantrasyonlarına şartlandırılabilen kontrollü atmosferli depolarda elmalardaki etilen üretimi azaltılabilmektedir (Gorney ve Kader, 1996). Kontrollü atmosfer depolama (KA) sistemi günümüzde birçok bahçe ürününü depolama ve pazarlama periyodunun uzatılması için kullanılan yaygın bir depolama sistemidir. KA depolama sistemi özellikle ürünlerin depolama süresini uzatmakta (Drake ve Elfying, 2004) ve olgunlaşmanın gecikmesini (Ma ve Chen, 2003) sağlamaktadır

Son yıllarda kontrollü atmosfer sisteminin daha da geliştirilmiş bir şekli olan DKA sistemi de meyve muhafazasında gelişmiş birçok ülkede kullanılmaktadır. Bu teknolojide oda içi atmosfer değerlerini dinamik olarak kontrol etmek ve meyveleri minimum solunum seviyesinde muhafaza edebilmek amacıyla *Flourescence Interactive Response Monitor* adı verilen *chlorophyll fluorescence* sensörleri kullanılmaktadır. Bu sistemin çalışma prensibi; bir kaynaktan gönderilen ışığın meyve kabuğu tarafından geri yansıtılan miktarının veya meyvelerde anaerobik solunumun göstergesi olan etanol sentezinin başlamasının ölçülmesi şeklinde olmaktadır. Bu sayede meyvenin anaerobik solunuma geçtiği en düşük $O_2$ seviyesi tespit edilip, meyvelerin en düşük solunum seviyesinde muhafaza edilmesi sağlanmaktadır. DKA sisteminin konsepti depoda atmosfer bileşimindeki oksijen düzeyinin meyvenin tolerans gösterebileceği en alt seviyeye kadar indirilmesidir. Bu durum anaerobik kompanse noktası (ACP) olarak da tanımlanmaktadır (DeEll ve ark.,1995). Gelişmiş ülkelerin kullandığı DKA koşullarında depolama, elma, armut, avokado gibi meyvelerde başarılı sonuçlar vermiş ve

uygulamaya geçmiştir (Burdon ve ark., 2010; Yalav ve Kaynaş, 2019). Şeftali çeşitleri için dünyada dinamik kontrollü atmosfer koşullarında depolama konusunda az sayıda çalışma yapılmıştır (Gil ve Beaundry, 2020). Halbuki şeftalilerde uzun süre depolamada en büyük kayıp üşüme zararı, fungal bozulmalar kabukta ve ette kararmalar ile aroma kaybının önlenmesi için KA veya DKA depolama başarılı sonuç vermektedir. Ferrer-Mairal ve ark. 2012), geçci ve et şeftali çeşitlerinden Jesca ve Evaisa meyvelerinin KA koşullarında 45 güne kadar depolandığını açıklamışlardır. Diğer yandan Cano-Salazar ve ark. (2013), Big Top, Early Rich, Venus ve Sweet Dream nektarin çeşitlerinde KA koşullarında (%2 $O_2$ + %5 $CO_2$) aroma ve diğer kalite ögelerinin kaybının en az olduğunu saptamışlardır. Truque ve ark. (2012) Miraflores şeftali çeşidinde KA'de depolama ile fungal çürümelerin tamamen önlendiğini, $CO_2$ konsantrasyonunun 10 kPa değerinin üzerine çıkıldığı zaman aroma kaybının görüldüğünün açıklamışlardır. Şeftali ve nektarinlerin KA koşullarında araştırma çalışmaları bulunmasına karşılık DKA koşullarında depolanması ve raf ömrü konusunda Türkiye'de yapılmış çalışma yoktur.

Benzer şekilde modifiye atmosfer koşulları kullanılarak çeşitli ürünleri taze ve uzun süre saklamak mümkün olabilmektedir (James ve Kollman, 2003). Daha önce MA'de yapılan çalışmalar farklı geçirgenliklere sahip olan torbaların kullanılmasına yöneliktir. Bunun yanında hasattan sonra depolama aşamasında organik bileşiklerin kullanılması ile su kaybı ve mantari çürümelerin önlenmesi üzerine de bir çok çalışma bulunmaktadır.Çalışmada MA'de kullanılan poşetlere üretim aşamasında uçucu yağların emdirilmesi ve meyvelerin bu yağlara temasının olmadığı bir MA paket sistemi kullanılması üzerinde ülkemizde yapılmış bir araştırma bulunmamaktadır. Dolayısıyla uçucu (esansiyel) yağlar emdirilerek üretimi yapılan torbaların modifiye atmosfer çalışmasında kullanılması da projenin özgünlüğünü artırmaktadır.

Taze meyve ve sebze muhafazasında başarının önemli etkenlerinden biri de ürün tarafından sentezlenen etilenin kontrolüdür. Olgunlaşma hormonu olarak bilinen hormon hücreler tarafından sentezlenmekte ve ürünü hızla olgunlaşmaya ve yaşlanmaya götürmektedir. Bugüne kadar etilen sentezinin yavaşlatılması veya durdurulması konusunda pek çok çalışma yapılmıştır. Bunlar içerisinde depo atmosferinden etilenin temizlenmesi, etilen emici kimyasalların kullanımı yanında son yıllarda 1-MCP (1-metilsiklopropan) taze meyve ve sebzelerde özellikle klimakterik gösteren meyvelerde ticari olarak çok yaygın kullanılmaya başlanmıştır. Hücre zarındaki etilen reseptörlerine yerleşerek etilen sentezini yavaşlatan/durduran 1-MCP adeta depolamada bir devrim yaratmıştır (Sisler ve ve Serek, 1997; Watkins ve ark., 2000; Blankeship ve Dole, 2003). Bununla ilgili olarak tüm dünyada ve

Türkiye'de çok fazla araştırma yapılmıştır. Ancak diğer meyve türlerine göre şeftali için kullanma şansının yaratılacağı araştırma sayısı azdır. Diğer şeftali ve nektarin çeşitlerinde 1-MCP kullanımı üzerinde yapılan çalışmalarda olgunluğun - yaşlanmanın geciktirilmesi üzerine etkili olduğu özellikle meyve eti sertliği ve kabuk renginin muhafaza süresince korunduğu gözlenmiştir. Ancak araştırma projesinin bitkisel materyalini oluşturan şeftali çeşitlerinde hiçbir çalışma yapılmamıştır. Gerek DKA gerekse MA çalışmaları kapsamında mantari çürümelere karşı herhangi bir kimyasal kullanılmadığı gibi 1-MCP kullanılmasının da insan sağlığı yönünden herhangi bir sakıncası yoktur. Dolayısıyla projede incelenecek konuların tamamında herhangi bir kimyasal madde kullanımı ve etkisi bulunmayacaktır.

Şeftali raf ömrü çok uzun olmayan sert çekirdekli bir meyve türü olup, hasat sonrasında çeşitli fizyolojik ve patolojik bozulmalar yaygın görülmektedir. Şeftali için en ideal depolama koşulları olarak 0ºC sıcaklık ve %90-95 oransal nem koşulları önerilmekte ve bu koşullarda çeşitlere göre değişmekle beraber depolama ömrü 2 hafta, modifiye atmosfer koşullarında 3 hafta olarak kadar depolanabileceği belirtilmiştir (Claypool ve Davis, 1956; Ertan ve ark., 1983; Kurnaz ve ark.,1993; Ağar ve ark.,1994; Akbudak, 1999; Akbudak ve Eriş, 2004; Lurie ve Crisosto, 2005; Neves ve ark.,2013; Kesmen ve Kaynaş, 2018). Depolama süresi boyunca şeftalideki kayıp oranı %12-28 aralığında değişmekte olup bu kayıpların en büyük kısmını yünlüleşme, meyve eti kahverengileşmesi, üşüme zararı gibi fizyolojik bozulmalar ile kahverengi çürüklük (Brown rot), (*Sclerontina fructicola*), monilia çürüklüğü (*Monilinia fructicola*) ve rizopus çürüklüğü (*Rhizopus stolonifer*) gibi mantari etmenlerden kaynaklanmaktadır. Su kaybı ile birlikte bu bozulmalar önemli ticari kayıplara neden olmaktadır (Crisosto, 2002; Crisosto ve Mitchell, 1999; Karaçalı, 2012; Karaman ve ark., 2014, Bal, 2016). Hasattan önce kimyasal mücadele ilaçların uygulanması ile fungal çürümelerin engellenmesi mümkün olmakla beraber bu kimyasal uygulamaların ortaya çıkardığı kalıntı sorunu mevcut dış pazarlarımızdaki potansiyelimizin azalmasına neden olmaktadır.

Dinamik Kontrollü Atmosfer (DKA) sistemi patentli bir teknoloji olup patenti Kanada Laimburg Tarımsal Araştırma Enstitüsü'nden Dr. Azgelo Zanella'ya aittir. Ticari olarak pazarlanması İtalyan Isolcell firmasına aittir. DKA; statik kontrollü atmosferli muhafazadan farklı olarak oda içi atmosfer değerlerinin anlık olarak ölçülebildiği ve depolanan ürünün isteğine göre yine bu oda atmosfer değerlerin anlık olarak değiştirilebildiği dinamik bir sistemdir. Bu sistemde; içine 6 adet meyve konulabilen ve içinde bir ışık kaynağı ile klorofil flüoresans sensörleri bulunan özel kaplar kullanılmaktadır. Çalışma prensibi ise; aerobik solunum süresince üzerine yansıtılan ışığı absorbe eden meyveler anaerobik solunuma

geçtiklerinde ise tüm ışığı geri yansıtmaktadırlar. Klorofil Flüoresans sensörleri ile geri yansıtılan ışığın şiddeti ölçülüp grafiksel olarak izlenerek meyvenin aerobik-anaerobik solunum durumu anlık olarak takip edilebilmektedir. Bu düzenek yardımı ile meyvenin anaerobik solunuma geçme eşiğindeki en düşük $O_2$ seviyesi belirlenerek, meyveler mümkün olabilen en düşük solunum hızında muhafaza edilebilmektedirler. DKA depolama sisteminde etanol ile çalışan modelleri de vardır.

1.1. Diğer yandan şeftali – nektarin muhafazasında farklı gaz geçirgenlik özelliklerine sahip torbalar kullanılarak MA koşullarında muhafaza çalışmaları yapılmıştır. Özellikle nektarinlerde tüysüz olması nedeniyle su kaybı ve fizyolojik, fungal bozulmaları önlemek amacıyla çeşitli yağ ve yağ esterleri ile kaplama ve kimyasal fungusitle muamele çalışmaları da yapılmıştır. Son yıllarda tüketici bilincinin yükselmesi sonucu hasattan hemen önce ve sonrasında kimyasal madde kullanımından kaçışla bitkisel kökenli organik ürünlerin kullanımı arayışına geçilmiştir. Bu kapsamda özellikle mantari ve bakteriyel çürümelere karşı çevre dostu olmaları nedeniyle bitkisel kökenli çeşitli uçucu yağların kullanımına yönelik araştırma programları ön plana çıkmıştır. Bu organik yağların doğrudan meyve ile temasını sağlayan daldırma, püskürtme, yıkama gibi yöntemlerle yapılmıştır. Ancak uçucu yağların kokusunun meyvelere geçmesi ve çok yüksek dozlarda kullanılması halinde toksik etki göstermeleri nedeniyle yüksek basınçta gaz şeklinde uygulama ve bu yağların polietilen ambalaj materyallerinin üretiminde yapıya emdirilmesi şeklinde de uygulanmaktadır. Kabuk yapısı ve kabuktaki havlar nedeniyle şeftali gibi meyvelerde son yöntem daha çok tercih edilmektedir (Antunes ve Cavacob, 1986; Snowdon, 1990; Ziedan ve Farrag, 2008; Lopez ve Martos, 2018).

Şeftali depolamasında mantari çürümelerin başında gelen kahverengi çürüklük, monilia çürüklüğü ve rhizopus çürüklüğüne neden olan etmenlerin kontrolü için özellikle sentetik kimyasal maddelerin uygulanması sorunu çözebilmektedir. Ancak bitkisel yağlardan özellikle kolza yağı, kekik yağı ve tarçın yağının bu etmenlere karşı antimikrobiyal etki gösterdikleri yumuşak çekirdekli meyvelerden elma ve armutta, sert çekirdekli meyvelerden şeftali ve kirazda başarılı sonuçlar alınmıştır. Şeftalide naneyağı ve fesleğen yağının hasat sonrası çürümeleri önlemede çok etkili olduğunu ve rhizopus çürüklüğü ile monilia çürüklüğüne karşı doğal biosit olarak kullanılabileceğini saptanmıştır.

**Materyal Ve Method**

Çalışmanın materyali, müşteri kuruluş olan AEP'ne ait Çanakkale ili Kumkale yöresinde bulunan 6.200 dekarlık alanda tesis edilmiş bahçede bulunan ve orjini İspanya olan ANET 30,

ANET 33 ve ANET 55 şeftali çeşitlerinden hasat edilen meyveler olacaktır. Araştırmada yer alan çeşitler, çok geçci olup, sarı et ve sarı kabuk rengindeki meyveler lifli et yapıları ve yüksek su oranı içermesi nedeniyle, taze tüketim ve sanayide (IQF) kullanılan çeşitlerdir. Çeşitlerin ağaç başı verimleri 40-50 kg arasında değişmektedir.

Şeftali parseli 2013 yılında kurulmuş olup, çalışmada yer alan çeşitler Cadaman anacı üzerine aşılı olup, ANET 33 çeşidi spinder, ANET 33 çeşidi palmet ve ANET 55 çeşidi vazo terbiye sistemi ile yetiştirilmişlerdir. Meyve bahçesinde sulama, gübreleme ve mücadele işlemleri analiz ve gözlem sonuçlarına göre standart olarak yapılmaktadır. Meyvelerin gelişimine göre bu uygulamalar revize edilecektir.

Proje kapsamında meyve kabuk rengi, meyve eti sertliği, suda çözünebilir kuru madde oranı dikkate alınarak yörede takvimsel olarak yaklaşık Ekim 10-20 tarihlerinde hasatlar yapılacaktır. Hasattan sonra meyve büyüklüğü ve kabuk rengi dikkate alınarak sağlıklı meyveler depolama için seçilecektir.

Çalışmada yer alan uygulamalar;

A- Kontrol Normal atmosferde soğukta depolama (0$^{o}$C sıcaklık ve %90-95 oransal nem)

B- DKA. Dinamik kontrollü atmosferde depolama (<%1 $O_2$, 0$^{o}$C sıcaklık ve %90-95 oransal nem)

C- MAP I. Modifiye atmosferde soğukta muhafaza (LDPE torbalarda depolama, 0$^{o}$C sıcaklık ve %90-95 oransal nem)

D- MAP II. Uçucu yağlar emdirilmiş LDPE torbalarda depolama (%0,5 Kekik yağı + %0,5 Nane yağı emdirilmiş torbalarda depolama, 0$^{o}$C sıcaklık ve %90-95 oransal nem)

E- Hasattan sonra 1-MCP (625 ppb) uygulaması (0$^{o}$C sıcaklık ve %90-95 oransal nem)

F- Hasattan sonra 1-MCP (625 ppb) uygulaması + MAP'de LDPE torbada depolama (0$^{o}$C sıcaklık ve %90-95 oransal nem)

G- Hasattan sonra 1-MCP (625 ppb) uygulaması + MAP'de uçucu yağlar emdirilmiş LDPE torbada depolama (0$^{o}$C sıcaklık ve %90-95 oransal nem)

H- Hasattan sonra 1-MCP (625 ppb) uygulaması + DKA'de depolama (<%1 $O_2$, O$^{o}$C sıcaklık ve %90-95 oransal nem)

Hasat edilip seçilen sağlıklı meyvelerin bir kısmı aynı gün içerisinde müşteri kuruluşun (AEP Anadolu Etap) Balıkesir ili Gönen ilçesinde bulunan depolama tesislerine götürülecektir. Çalışmada yer alan 1-MCP uygulaması ve DKA depolaması bu tesislerde yapılacaktır. Bu kapsamda B ve H uygulamalarında her çeşit için (2 uygulama x 4 depolama dönemi x 3 yineleme x 20 meyve) toplam 480 adet meyve kullanılacaktır. 1-MCP için yapılan ön çalışma

sonucu seçilen 625 ppb dozu kullanılacaktır. DKA'de depolama (<%1 $O_2$, O°C sıcaklık ve %90-95 oransal nem) koşullarında yapılacaktır. Depolama süresince $O_2$ seviyesi anlık olarak ölçülecektir ve gerektiğinde müdahale edilecektir.

Uçucu yağlardan daha önce daldırma veya püskürtme şeklindeki uygulamalarından başarılı sonuç alınmış olan kekik yağı (Thymol), nane yağı (Mentol) kullanılacaktır. Kekik yağı ve mentol yağlarının LDPE torbalara emdirilme ve üretim aşaması Aypek Ambalaj Ltd.Sti. tesislerinde gerçekleştirilecektir. Bu kapsamda kekik yağı ve nane yağı hacimsel olarak %0,5 dozunda su içerisinde yüksek hızda mikserlerle karıştırılarak homojenize edilecek ve tam dağılım sağlanarak polietilen torbalara ekstrüzyon yapılacaktır. Bu aşamada elde edilen polietilen torbalar MA çalışmalarında kullanılacaktır. Ayrıca uçucu yağlar emdirilmiş polietilen torbaların etkisinin saptamak amacıyla LDPE torbalar kontrol olarak kullanılacaktır.

Projede yer alan MAP uygulamaları, 1-MCP uygulanmış meyveler ve kontrol meyveleri Çanakkale ÇOMÜ Ziraat Fakültesi Bahçe Bitkileri Bölümü soğuk depo tesislerinde muhafazaya alınacaktır. Muhafaza süresince oda sıcaklığı 0°C, oransal nemi %90-95 arasında olacaktır. Bu kapsamda A - C - D – E - F ve G uygulamaları için her çeşitten toplam (6 uygulama x 4 dönem x 3 yineleme x 20 meyve) 1440 meyve kullanılacaktır. Dolayısıyla ağırlık kaybı ve başlangıç analizleriyle birlikte her çeşit şeftaliden yaklaşık 2000 adet meyve çalışmalarda kullanılacaktır.

Çalışmada başlangıçta ve depolama süresince meyve kalitelerindeki değişimi saptamak amacıyla analizler, gözlemler ve ölçümler 0 - 15 – 30 - 45 – 60 gün depolama sonunda ilgili bölümün laboratuvarında yapılacaktır. Bu kapsamda incelenecek özellikler aşağıda verilmiştir.

1. **Ağırlık kaybı**: Uygulamalara göre meyvelerdeki ağırlık kaybı elektronik terazi ile tartılarak depolama süreleri sonunda başlangıca göre % olarak saptanacak ve kümülatif olarak değerlendirilecektir.
2. **Meyve eti sertliği** (MES): Uygulamalar esas alınarak tekerrürdeki her meyvenin iki yanağından el penatrometresi (8 mm uç) kullanılarak kg olarak ölçülecektir.
3. **Meyve kabuk rengi:** Uygulamalar esas alınarak tekerrürleri temsil eden 5 adet meyvenin ekvator düzeyinde Minolta Kolorimetresi (CR 300) kullanılarak L*, a*, b* değerleri saptanacak ve a*, b* değerlerine göre hesaplanan Hue açısı (h°) ve kroma (C*) değerleri ile L* değerleri kullanılacaktır.
4. **Titre edilebilir toplam asitlik** (TETA): Meyve pürelerinde elektrometrik olarak pH metre yardımıyla nötralizasyon esasına göre yapılacak ve şeftalide etkin asit formu olan malik asit cinsinden %g değerlendirilecektir (Cemeroğlu, 1992)

5. **Suda çözünebilir kuru madde oranı:** (SÇKM): Meyvelerin SÇKM içerikleri tekerrürlere göre elde edilecek meyve sularında digital refraktometre kullanılarak doğrudan okuma yoluyla tespit edilecektir.

Yukarıda verilen depolama uygulamaları ve her uygulamanın kontrol meyvelere göre kalite özelliklerindeki değişime olan etkisi, başlangıçtaki meyvelerin kalite girdileri ile karşılaştırılarak en iyi, en ekonomik, uygulama basamakları oluşturularak ürüne katma değer kazandırılacaktır.

**A) ANET 33 Şeftali çeşidi**

Çizelge 1. ANET 33 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde MES, SÇKM v e TEA değerlerindeki değişimler

| **Uygulamalar** | **Meyve Eti Sertliği (kg)** | | **SÇKM (%)** | | **TEA (g.100 g$^{-1}$ malik asit)** | |
|---|---|---|---|---|---|---|
| | 0.Gün | 60.Gün | 0.Gün | 60.Gün | 0.Gün | 60.Gün |
| **KONTROL** | 4.56 | 4.09 | 11.40 | 12.70 | 0.95 | 0.50 |
| **1-MCP + DKA** | 4.56 | 4.08 | 11.40 | 11.50 | 0.95 | 0.41 |
| **DKA** | 4.56 | 3.95 | 11.40 | 10.60 | 0.95 | 0.45 |

Çizelge 2. ANET 30 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde meyve kabuk L*, h$^{o}$ ve C* değerindeki değişimler

| **Uygulamalar** | **Meyve Kabuk Rengi (L*)** | | **Meyve Kabuk Rengi (h$^{o}$)** | | **Meyve Kabuk Rengi (C*)** | |
|---|---|---|---|---|---|---|
| | 0.Gün | 60.Gün | 0.Gün | 60.Gün | 0.Gün | 60.Gün |
| **KONTROL** | 64.38 | 52.18 | 90.42 | 83.90 | 57.48 | 27.40 |
| **1-MCP + DKA** | 64.38 | 51.60 | 90.42 | 82.90 | 57.48 | 26.25 |
| **DKA** | 64.38 | 50.24 | 90.42 | 85.85 | 57.48 | 27.41 |

Çizelge 3. ANET 30 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde meyve eti L*, h$^o$ ve C* değerindeki değişimler

| **Uygulamalar** | **Meyve Et Rengi (L*)** | | **Meyve Et Rengi (h$^o$)** | | **Meyve Et Rengi (C*)** | |
|---|---|---|---|---|---|---|
| | 0.Gün | 60.Gün | 0.Gün | 60.Gün | 0.Gün | 60.Gün |
| **KONTROL** | 61.75 | 46.17 | 84.23 | 71.93 | 58.78 | 25.77 |
| **1-MCP + DKA** | 61.75 | 42.87 | 84.23 | 72.07 | 58.78 | 25.84 |
| **DKA** | 61.75 | 41.24 | 84.23 | 71.01 | 58.78 | 24.46 |

Çizelge 4. ANET 30 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde toplam fenolik bileşikler miktarındaki değişimler

| **Uygulamalar** | **Fenolik Bileşikler (mg.100g$^{-1}$GAE)** | |
|---|---|---|
| | 0.Gün | 60.Gün |
| **KONTROL** | 217.31 | 53.51 |
| **1-MCP + DKA** | 217.31 | 111.44 |
| **DKA** | 217.31 | 90.70 |

Çizelge 5. ANET 30 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde toplam şeker, indirgen şekerler ve sakaroz miktarındaki değişimler

| **Uygulamalar** | **İndirgen şeker (g.100g$^{-1}$)** | | **Sakaroz (g.100g$^{-1}$)** | | **Toplam şeker (g.100g$^{-1}$)** | |
|---|---|---|---|---|---|---|
| | 0.Gün | 60.Gün | 0.Gün | 60.Gün | 0.Gün | 60.Gün |
| **KONTROL** | 1.65 | 6.29 | 3.71 | 1.92 | 5.55 | 8.31 |
| **1-MCP + DKA** | 1.65 | 2.74 | 3.71 | 3.25 | 5.55 | 6.24 |
| **DKA** | 1.65 | 3.24 | 3.71 | 3.85 | 5.55 | 7.35 |

**B) ANET 55 Şeftali çeşidi**

Çizelge 6. ANET 55 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde MES, SÇKM v e TEA değerlerindeki değişimler

| **Uygulamalar** | **Meyve Eti Sertliği (kg)** | | **SÇKM (%)** | | **TEA (g.100 g$^{-1}$ malik asit)** | |
|---|---|---|---|---|---|---|
| | 0.Gün | 60.Gün | 0.Gün | 60.Gün | 0.Gün | 60.Gün |
| **KONTROL** | 5.86 | 3.66 | 10.17 | 13.00 | 1.30 | 0.33 |
| **1-MCP + DKA** | 5.86 | 4.57 | 10.17 | 12.50 | 1.30 | 0.34 |
| **DKA** | 5.86 | 4.64 | 10.17 | 12.57 | 1.30 | 0.32 |

Çizelge 7. ANET 30 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde meyve kabuk L*, h$^{o}$ ve C* değerindeki değişimler

| **Uygulamalar** | **Meyve Kabuk Rengi (L*)** | | **Meyve Kabuk Rengi (h$^{o}$)** | | **Meyve Kabuk Rengi (C*)** | |
|---|---|---|---|---|---|---|
| | 0.Gün | 60.Gün | 0.Gün | 60.Gün | 0.Gün | 60.Gün |
| **KONTROL** | 61.44 | 51.95 | 92.12 | 84.45 | 56.38 | 28.12 |
| **1-MCP + DKA** | 61.44 | 52.52 | 92.12 | 85.19 | 56.38 | 27.52 |
| **DKA** | 61.44 | 50.74 | 92.12 | 83.92 | 56.38 | 26.32 |

Çizelge 8. ANET 30 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde meyve eti L*, h$^{o}$ ve C* değerindeki değişimler

| **Uygulamalar** | **Meyve Et Rengi (L*)** | | **Meyve Et Rengi (h$^{o}$)** | | **Meyve Et Rengi (C*)** | |
|---|---|---|---|---|---|---|
| | 0.Gün | 60.Gün | 0.Gün | 60.Gün | 0.Gün | 60.Gün |
| **KONTROL** | 61.38 | 47.79 | 84.94 | 73.45 | 60.22 | 26.98 |
| **1-MCP + DKA** | 61.38 | 44.75 | 84.94 | 73.14 | 60.22 | 27.05 |
| **DKA** | 61.38 | 41.21 | 84.94 | 71.37 | 60.22 | 25.23 |

Çizelge 9. ANET 30 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde toplam fenolik bileşikler miktarındaki değişimler

| **Uygulamalar** | **Fenolik Bileşikler (mg.100g$^{-1}$GAE)** | |
|---|---|---|
| | 0.Gün | 60.Gün |
| **KONTROL** | 97.62 | 123.61 |
| **1-MCP + DKA** | 97.62 | 113.59 |
| **DKA** | 97.62 | 100.00 |

Çizelge 10. ANET 30 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde toplam şeker, indirgen şekerler ve sakaroz miktarındaki değişimler

| **Uygulamalar** | **İndirgen şeker (g.100g$^{-1}$)** | | **Sakaroz (g.100g$^{-1}$)** | | **Toplam şeker (g.100g$^{-1}$)** | |
|---|---|---|---|---|---|---|
| | 0.Gün | 60.Gün | 0.Gün | 60.Gün | 0.Gün | 60.Gün |
| KONTROL | 2.36 | 4.77 | 3.12 | 4.56 | 5.64 | 9.57 |
| 1-MCP + DKA | 2.36 | 2.85 | 3.12 | 3.58 | 5.64 | 5.65 |
| DKA | 2.36 | 3.43 | 3.12 | 4.51 | 5.64 | 6.98 |

### C) ANET 30 Şeftali çeşidi

Çizelge 11. ANET 55 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde MES, SÇKM v e TEA değerlerindeki değişimler

| **Uygulamalar** | **Meyve Eti Sertliği (kg)** | | **SÇKM (%)** | | **TEA (g.100 g$^{-1}$ malik asit)** | |
|---|---|---|---|---|---|---|
| | 0.Gün | 60.Gün | 0.Gün | 60.Gün | 0.Gün | 60.Gün |
| **KONTROL** | 4.48 | 3.54 | 11.80 | 13.37 | 1.02 | 0.25 |
| **1-MCP + DKA** | 4.48 | 3.86 | 11.80 | 11.80 | 1.02 | 0.32 |
| **DKA** | 4.48 | 3.96 | 11.80 | 11.78 | 1.02 | 0.34 |

Çizelge 12. ANET 30 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde meyve kabuk L*, h$^o$ ve C* değerindeki değişimler

| **Uygulamalar** | **Meyve Kabuk Rengi (L*)** | | **Meyve Kabuk Rengi (h$^o$)** | | **Meyve Kabuk Rengi (C*)** | |
|---|---|---|---|---|---|---|
| | 0.Gün | 60.Gün | 0.Gün | 60.Gün | 0.Gün | 60.Gün |
| **KONTROL** | 64.73 | 51.41 | 92.58 | 86.41 | 55.52 | 26.17 |
| **1-MCP + DKA** | 64.73 | 53.80 | 92.58 | 90.11 | 55.52 | 26.56 |
| **DKA** | 64.73 | 53.02 | 92.58 | 88.45 | 55.52 | 25.41 |

Çizelge 13. ANET 30 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde meyve eti L*, h$^o$ ve C* değerindeki değişimler

| **Uygulamalar** | **Meyve Et Rengi (L*)** | | **Meyve Et Rengi (h$^o$)** | | **Meyve Et Rengi (C*)** | |
|---|---|---|---|---|---|---|
| | 0.Gün | 60.Gün | 0.Gün | 60.Gün | 0.Gün | 60.Gün |
| **KONTROL** | 64.59 | 49.42 | 92.70 | 83.17 | 60.26 | 26.76 |
| **1-MCP + DKA** | 64.59 | 50.24 | 92.70 | 85.15 | 60.26 | 28.78 |
| **DKA** | 64.59 | 51.23 | 92.70 | 84.90 | 60.26 | 28.45 |

Çizelge 14. ANET 30 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde toplam fenolik bileşikler miktarındaki değişimler

| **Uygulamalar** | **Fenolik Bileşikler (mg.100g$^{-1}$GAE)** | |
|---|---|---|
| | 0.Gün | 60.Gün |
| **KONTROL** | 102.86 | 296.71 |
| **1-MCP + DKA** | 102.86 | 181.55 |
| **DKA** | 102.86 | 133.06 |

Çizelge 15. ANET 30 şeftali çeşidinde 1-MCP uygulanarak DKA koşullarında depolanan meyvelerde toplam şeker, indirgen şekerler ve sakaroz miktarındaki değişimler

| **Uygulamalar** | **İndirgen şeker ($g.100g^{-1}$)** | | **Sakaroz ($g.100g^{-1}$)** | | **Toplam şeker ($g.100g^{-1}$)** | |
|---|---|---|---|---|---|---|
| | 0.Gün | 60.Gün | 0.Gün | 60.Gün | 0.Gün | 60.Gün |
| **KONTROL** | 2.63 | 4.85 | 3.05 | 2.89 | 5.84 | 7.89 |
| **1-MCP + DKA** | 2.63 | 3.12 | 3.05 | 2.87 | 5.84 | 6.21 |
| **DKA** | 2.63 | 3.05 | 3.05 | 2.68 | 5.84 | 5.86 |

Çok geçci olan ANET 33, ANET 55 ve ANET 30 şeftali çeşitlerinde hem taze tüketim hemde sanayide kullanılmak üzere Bireysel Hızlı Dondurma (IQF) işlemine uygun olacak şekilde depolama süresinin uzatılması konusunda; çalışmada depolama öncesi 1-MCP uygulanarak kullanılan MAP ve DKA sistemlerinde depolama ile bu çeşitlerin çok rahatlıkla 60 güne kadar depolanabileceği ortaya çıkmıştır. Elde edilen bulgular ve yapılan gözlemlerde DKA depolama sisteminde bu depolama süresinin 75-80 güne çıkarılmasının mümkün olduğu görülmüştür.

Diğer taraftan bitkisel uçucu yağ emdirilmiş LDPE torbalar içinde ambalajlama yapılarak 60 gün depolama ile özellikle ağırlık kaybı ve çürümelerin hemen hemen tamamen control altına alınabileceği ve depolama ile oluşacak kalite unsurlarındaki değişimin kontrol altında tutulabileceği tespit edilmiştir.

Depolama öncesi uygulanan 1-MCP'nin diğer klimakterik meyvelerde elde edilen olgunlaşmayı yavaşlatması / durdurması net olarak tüm kalite özelliklerinde görülmemiştir. Ancak meyve kabuki renginin korunması, meyve yumuşamasının yavaşlatılması ve şeker birikimi ile asitlikteki kayıpların yavaşlatılması konusunda etkili olmuştur. Ancak 1-MCP uygulaması ile onun yerine MAP içinde depolamanın tercih edilmesi tamamen ekonomik bir değerlendirme sonucunda açıklığa çıkacaktır. Biz yürütücüler olarak şeftali depolamsında 1-MCP kullanımı yerine MAP içinde depolama yapmanın teknik ve ticari olarak daha avantajlı olacağı görülmüştür.

Günümüzde en ileri depolama teknolojisi olan ve müşteri kuruluşun alt yapısında mevcut Dinamik Kontrollu Atmosfer sistemi başarıyla çalıştırılmış ve bu koşullarda 70-80 gün şeftali depolaması yapılabileceği saptanmıştır. Bu mealde sadece müşteri kuruluş değil tüm soğuk

depo işletmecileri için kullanılabilecek uygulama olduğu ortaya konmuştur. Uygulamadaki başarısı DKA sisteminin kurulması ve işletilmesi ile oluşacak ek girdinin depolama süresini uzatarak elde edilecek ek kazancın objektif bir şekilde irdelenmesine bağlı olacaktır.

Bunun dışında proje önerisinde hedef olarak ortaya konan bitkisel uçucu yağ emdirilmiş LDPE torbaların MAP olarak kullanılmasında beklenen oranda bir başarı elde edilmiştir. Şöyle ki; kekik ve acı badem yağının LDPE torbaların üretimi aşamasında emdirilmesi depolamada mantari etmenlerin enfeksiyonu ve yayılmasından ileri gelen çürüme oranlarının düşmesini sağlamıştır. Daha önce bir çok çalışmada elde edilen sonuçlarına göre torbalara emdirilmiş bu uçucu yağların meyvelerle teması olmadığı ve çok hızlı difüzyon yetenekleri nedeniyle bir olumsuzluk yaşanmamış, uçucu yağların kokuları meyve aromasında bir olumsuzluk yaratmamıştır. Ayrıca bu torbaların içinde oransal nemin daha yüksek olması ve ortamla meyveler arasında bir bariyer görevi görmesi nedeniyle aynı zamanda ağırlık kaybının önlenmesinde çok etkili olmuştur. İnsan ve çevre sağlığı yönünden de bitkisel uçucu yağların kullanımı son yıllarda ortaya çıkan kimyasallardan kaçınmak adına da önemli bir uygulamadır.

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# FARKLI TUZLULUK SEVİYELERİNİN BAZI ÇOK YILLIK ÇİM (*Lolium perenne*) ÇEŞİTLERİN ÇİMLENME VE FİDE GELİŞİMİ ÜZERİNE ETKİSİ

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**Özet**
Bazı çok yıllık çim çeşitlerinin farklı seviyelerde tuz içeren ortamda çimlenme ve fide performanslarını belirlemek amacıyla yapılan bu çalışmada, farklı tuzluluk konsantrasyonları için 0.01 mol KCl, NaCl, $MgCl^2$ ve $CaCl^2$ kullanılarak stok çözeltiler hazırlanmıştır. Stok çözeltilerden 7 farklı Elektriksel iletkenliğe (EC) sahip tuzluluk dozları hazırlanmıştır: Çimlendirme ortamlarında Kontrol (saf su) ve EC 4,000, 8,000, 12,000, 16,000, 20,000 ve 24,000 $dSm^{-1}$ olan sular kullanılmıştır. Araştırmada fide boyu, fide radikula (kök) uzunluğu, fide plumula (gövde) boyu, fide taze ağırlığı, fide radikula (kök) taze ağırlığı, fide plumula (gövde) taze ağırlığı, fide kuru ağırlığı, fide radikula (kök) kuru ağırlığı, fide plumula (gövde) kuru ağırlığı ve çimlenme oranı özellikleri incelenmiştir. Elde edilen verilere göre; farklı tuzluluk seviyelerindeki çeşitlerin fide özellikleri dikkate alındığında en yüksek fide boyu, plumula ve radikula boyunun sırasıyla 59.61, 30.24 ve 29.37 mm değerleri ile Belida çeşidinden elde edildiği belirlenmiştir. Bu değerler Troya ve Esquire çeşitlerinden istatistiksel olarak önemli düzeyde farklılık göstermiştir. Tüm çeşitler için taze ve kuru fide, plumula ve radikula ağırlığı açısından benzer sonuçlar elde edilmiştir. En yüksek çimlenme oranı %91.05 ile Belida'dan elde edilmiş olup, bu değer diğerlerinden istatistiksel olarak önemli derecede farklı bulunmuş ve artan tuzluluk tüm çeşitler için çimlenme oranında düşüşlere neden olmuştur.
**Anahtar Kelime**: Çok yıllık Çim, Tuzluluk, Fide Gelişimi

# EFFECT OF DIFFERENT SALINITY LEVELS ON GERMINATION AND SEEDLING DEVELOPMENT OF SOME LAWN LOLIUM (*Lolum perenne*) CULTIVARS

**Abstract**

The stock solutions were prepared by using 0.01 mol KCl, NaCl, $MgCl^2$ and $CaCl^2$ for different salinity concentrations. Salinity doses with 7 different Electrical conductivities (EC) prepared from stock solutions: Control (pure water) and water with EC 4,000, 8,000, 12,000, 16,000, 20,000 or 24,000 $dSm^{-1}$ were used. In the research, seedling height, seedling radicle (root) length, seedling plumula (stem) height, seedling fresh weight, seedling radicle (root) fresh weight, seedling plumula (stem) fresh weight, seedling dry weight, seedling radicle (root) dry weight, seedling plumula (stem) dry weight and germination rate characteristics were examined. According to the date obtained; considering the varieties at different salinity levels, it was determined that the highest seedling length, plumula and radicula length was obtained from Belida with the values of 59.61, 30.24 and 29.37 mm, respectively. These values was statistically different than those of Troya and Esquire cv. Similar results was obtained in terms of fresh and dry seedling, plumula and radicula weight for all cultivars. The highest germination rate was from Belida with a value of 91.05% which is statistically different than others and increasing salinity caused a decrease in germination rate for all cultivars.

**Keywords:** Prennial ryegrass, Salinity, Seedling growth

## Introduction

Çok yıllık çim (*Lolium perenne* L.), bir serin iklim bitkisi olup geniş adaptasyon kabiliyeti olan, hızlı gelişen ve çiğnenmeye toleranslı olması nedeniyle çim alanlarında yaygın olarak kullanılan bir $C_3$ bitkisidir (Christians, 2007; Duble, 1996; Song ve ark., 2017; Marcum ve Pessarakli, 2010). Ayrıca üstün çim kalitesi ve yoğun kardeşlenmesi nedeniyle, genellikle peyzaj, spor, rekreasyon alanlarında kullanılmaktadır. Ne yazık ki, dünyanın çoğu kurak ve yarı kurak bölgelerinde, iklim değişikliği, kuraklık ve yeraltı su kaynaklarının aşırı kullanımı nedeniyle oluşan tarımsal su eksikliği ve toprak tuzluluğundan olumsuz etkilenmektedir (Rahim ve ark., 2021). Ancak tuzluluktan etkilenme şiddeti çeşitten çeşide farklılık gösterebilmektedir. Çok yıllık çimin sulama suyundaki 6 ila 10 $dSm^{-1}$ tuzluluk seviyelerine kadar orta derecede dayanıklı olduğu bildirilmiştir (Koch, 2017; Harivandi ve ark., 1992). Dünyadaki gıdanın üçte birini üreten, toplam sulanan arazilerin %20 kadarı, aşırı tuzluluk etkisi altındadır (Kuşvuran ve ark., 2015). Kötü sulama suyu kalitesi, yükselen su tablası ve insan faaliyetleri nedeniyle dünya çapında yaklaşık 954 milyon hektar alanda tuzluluk sorunu yaşanmakta olup, bu oran her yıl artmaya devam etmektedir (Xu ve ark., 2020).

Tuzluluk, toprakta ve suda bulunan tuz miktarının ölçüsüdür. Topraktaki tuz içeriğinin artmasıyla, bitkilerin sodyum (Na) gibi iyonları daha fazla miktarda bünyesine alması sonucunu doğurur. $Na^+$ iyonlarının girişini dengelemek için $K^+$ 'nın bünyeden atılması, $K^+$'ya bağlı olan birçok hücresel işlevi, yani protein sentezini veya stoma hareketlerini bozar veya kısıtlar, CO miktarını azaltır, fotosentetik aktiviteyi ve sonuç olarak bitkinin büyüme oranlarını olumsuz etkiler (Venâncio ve ark, 2020). Ayrıca, toprak tuzluluğu, toprak su potansiyelini ve yaprak su potansiyelini düşürür; bitki-su ilişkilerini bozar ve sonuçta ozmotik strese yol açan bitkinin turgorunu azaltır. Bitkiler, iyon toksisitesi oluşturan ve mineral alımını ve bitki iyon dengesi bozulur.

Tuzluluk, bitki büyümesini ve üretkenliğini sınırlayan önemli bir abiyotik strestir. Çoğu tarımsal ürün ve yüksek bitki türü, yüksek NaCl koşulları altında büyüme inhibisyonuna maruz kalır (Kuşvuran ve ark., 2015). Tuzluluk, çeşitli morfolojik, fizyolojik, biyokimyasal ve moleküler fonksiyonları bozarak bitkisel üretimi olumsuz yönde etkileyen, küresel olarak sürdürülebilir tarımın önündeki en büyük zorluklardan biridir. Aşırı $Na^+$ birikimi ve sitozolik $K^+$ ve $Ca^{+2}$'nin dışarı akışı nedeniyle, hücresel homeostazda bir dengesizliğe ve besin eksikliğine yol açar. Tuzluluk, tohum çimlenmesini engellediği gibi bitki büyümesini, gelişmesini ve verimini de engellemektedir. Bu problem, klorofil ve karotenoidlerin içeriğini azaltarak, kloroplast yapısını bozar; stoma iletkenliğini azaltarak fotosentetik mekanizmayı,

terlemeyi ve gaz değişimini engeller. Tuzluluk, yüksek miktarda iyon birikimine yol açar ($Na^+$ ve Cl), $K^+$ ve $Ca^{2+}$ alımını engeller ve iyonik dengesizliğe neden olur. Tuzluluk, bitki hücrelerinde reaktif oksijen türlerinin (ROS) içeriğini arttırır ve oksidatif stres yaratır. ROS'un toksik etkisi, lipit peroksidasyonu, membran bozulması ve ayrıca DNA ve protein hasarına yol açar (Arif ve ark., 2020). Çok yıllık çimde tuzluluk stresi, sürgün ve kökün $Na^+$ içeriğini önemli ölçüde arttırır ve $K^+/Na^+$ oranını düşürerek sürgün yaş ve kuru ağırlığını ve kök hacmini olumsuz yönde etkiler (Rahimi ve ark., 2021). Tuz stresi, ozmotik basıncı değiştirerek bitki köklerinin çevre ortamdan alabileceği su miktarını azaltarak ani etkiler gösterebilir (Tang ve ark., 2013).

Bu çalışmada, çim alanlarda kullanılan farklı çok yıllık çim çeşitlerinin, farklı tuzluluk seviyelerindeki çimlenme ve fide gelişim performansları incelenmiştir.

**Materyal ve Metot**

Çalışma laboratuvar şartlarında tesadüf parselleri deneme desenine göre 3 tekrarlamalı olarak yürütülmüştür. Çalışmada kullanılan çeşitlere ait tohumlar İzmir ilinde faaliyet gösteren bir tedarikçi firmadan temin edilmiştir. Çalışmada bitki materyali olarak *Lolium perenne* türüne ait Belida, Troya ve Esquire çeşitleri kullanılmıştır. Çalışma kapsamında 4, 8, 12, 16, 18, 22 ve 24 $dSm^{-1}$ dozları ile birlikte, hiç tuz içermeyen kontrol parseli uygulamalar olarak ele alınmıştır. Kullanılacak en yüksek doz olan 24 $dSm^{-1}$ yoğunluktaki çözeltiyi elde etmek ve stok çözelti olarak kullanmak için, 0.74 g KCL (potasyum klorür), 1.47 g NaCL (sodyum klorür), 1.4 g CaCl (kalsiyum klorür) ve 2.03 g MgCl (magnezyum klorür) yeteri kadar saf su içerisinde eritilmiştir. Söz konusu tuz kaynaklarının seçiminde, sulama sularında ve tarımsal alanlarda en çok bulunan tuz türleri (Marcum, 2006) dikkate alınmıştır. Stok çözelti (EC1), EC1 * ML1 = EC2 * ML2 formülüne göre, seyreltilerek diğer tüm farklı yoğunlukta tuz içeren su çözeltileri elde edilmiştir. Çözeltilerin 4, 8, 12, 16, 18, 22 ve 24 $dSm^{-1}$ değerlerine ulaştığını ölçmek için, EC (elektriksel iletkenlik) ölçüm cihazı kullanılmıştır. Çalışma kapsamında 9 cm çapında petriler kullanılmış ve her bir petriye uygun şekilde iki kat kurutma kâğıdı kesilerek petrilerin altına konulmuş ve üzerine 25'şer adet tohum bırakılmıştır. Daha sonra petrilere uygun çözeltilerden 5 ml ilave edilmiştir. Petri kabında bulunan çözeltinin buharlaşarak tuz konsantrasyonunda değişikliğe neden olmaması amacıyla tüm petri kaplarının kapakları konulduktan sonra etrafı parafilm ile kapatılmış ve 15 $^0$C'ye ayarlanan çimlendirme dolabına konulmuştur. Çimlendirme dolabındaki petriler 3 günde bir incelenmiş, her bir petride çimlenen bitki sayısı kaydedilmiştir. Eksilen çimlendirme suları uygun konsantrasyonlarda yeniden ilave

edilmiştir. Çimlendirmenin 12. gününde, çimlenen bitkiler sayılmış ve petrideki toplam tohum sayısına oranlanarak çimlenme oranı hesaplanmıştır. Ayrıca, 12. günün sonunda, her bir uygulamaya ait petri kaplarından tesadüfen alınan 10 fidede, fide boyu, plumula boyu ve radikula boyu cetvel yardımı ile mm cinsinden ölçülmüş ve ortalaması alınarak hesaplanmıştır. Aynı 10 fidenin üzerinde kalan tohum kavuzları ayrılarak alındıktan sonra, 0.0001 g hassasiyetli terazide tartılıp 10'a bölünerek, fide yaş ağırlığı değeri bulunmuştur. Daha sonra 10 fide, kök boğazından neşter ile kesilerek, plumula ve radikula kısımlarına ayrılmış ve yaş plumula ve radikula ağırlıkları aynı yöntemle belirlenmiştir. Örnekler kurutma kâğıtları arasına konularak, 78 $^{0}$C'de 48 saat kurutulduktan sonra desikatöre alınmış ve tekrar tartılarak kuru plumula ve kuru radikula kuru ağırlıkları belirlenmiştir. Bu ağırlıklar toplanarak fide kuru ağırlığı hesaplanmıştır. Elde edilen veriler, SAS istatistik paket programı kullanılarak Tesadüf Parsellerinde Faktöriyel Düzenleme deneme desenine göre varyans analizine tabi tutulmuş, aralarındaki farkların önemli olduğu ($P<0.05$) ortalamalar ise LSD testi ile gruplandırılmıştır.

**Bulgular ve Tartışma**

Farklı tuzluluk seviyelerinde çimlendirilen *L.perenne* çeşitlerinin fide, plumula ve radikula boylarının verildiği Çizelge 1 incelendiğinde, fide boyu bakımından çeşitlerin tuzluluk derecelerinden farklı derecelerde etkilendiği, en yüksek değerin 59.61 mm ile Belida çeşidinden, en düşük değerin de 27.16 mm ile Esquire çeşidinden elde edildiği görülmektedir. Fide boyu üzerine tuzluluk derecelerinin etkileri incelendiğinde, en yüksek değerin 108.13 mm ile Kontrol uygulamasından elde edildiği, tuzluluğun artmasıyla fide boyunun önemli ölçüde kısaldığı, en düşük değerin ise 8.13 mm ile 24 $dSm^{-1}$ uygulamasından elde edildiği belirlenmiştir.

Aynı çizelgeden, radikula boyuna ilişkin ortalama değerler ve oluşan guruplar incelendiğinde, çeşitler bakımından en yüksek değerin 29.37 mm ile Belida çeşidinden elde edildiği, bunu önemli bir farklılıkla Troya çeşidinin izlediği, en düşük değerin ise 11.25 mm ile Esquire çeşidinden elde edildiği görülmektedir. Fide, plumula ve radikula boyu değerleri bakımından Belida çeşidinin diğer iki çeşide göre daha yüksek değerlere sahip olduğu, bu özellikler bakımından bir değerlendirme yapıldığında, tuzluluğa en tolerant çeşidin Belida olabileceği söylenebilir. Nitekim *L. perenne* çeşitlerinin tuzluluk derecelerine farklı tepkiler verdiğini belirten çalışmalar mevcuttur (Borawska ve ark. 2017; Kusvuran ve ark., 2015).

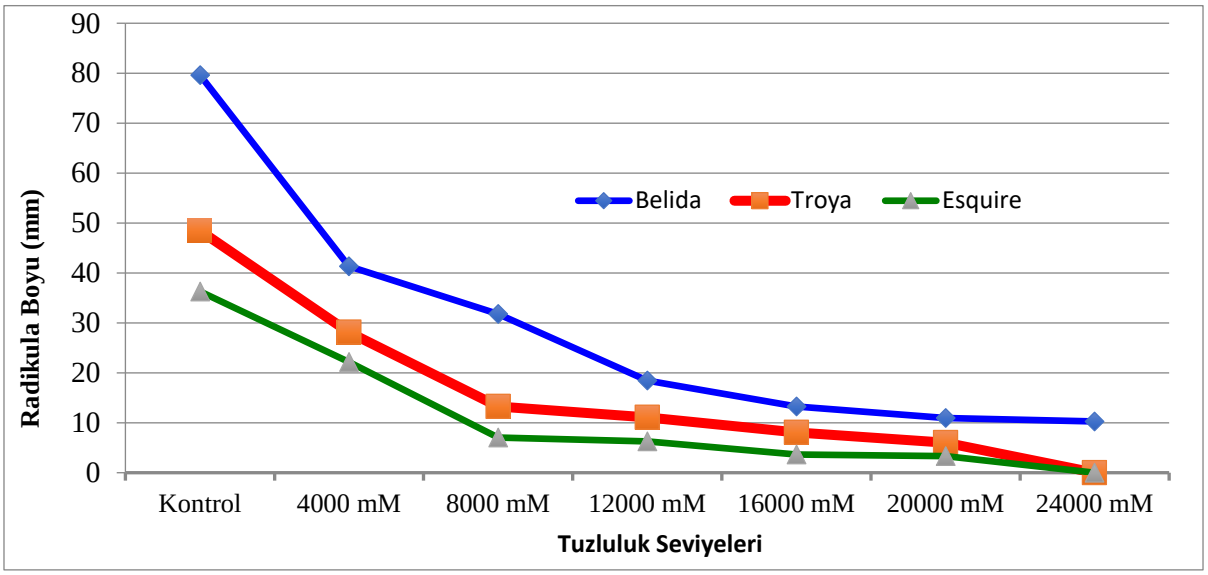
***Çizelge 1. Farklı Tuzluluk Dozlarında Çimlendirilen L. perene Çeşitlerinden Elde Edilen Ortalama Fide, Plumula ve Radikula Uzunlukları ve Oluşan Gruplar.***

Table 1. Mean Seedling, Plumula and Radikula Lengths and Statistical Groups Obtained from *L. perenne* Cultivars Germinated at Different Salinity Levels.

| Tuzluluk Derecesi | Fde Boyu (mm) | | | | Plumula Boyu (mm) | | | | Radikula Boyu (mm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Belida | Troya | Esquire | Ort. | Belida | Troya | Esquire | Ort. | Belida | Troya | Esquire | Ort. |
| Kontrol | 135.20 | 102.1 | 87.10 | 108.1 | 55.57 | 53.63 | 50.80 | 53.33 | 79.63 | 48.47 | 36.30 | 54.80 |
| 4 $dSm^{-1}$ | 82.07 | 58.07 | 47.72 | 62.62 | 40.73 | 29.97 | 25.52 | 32.07 | 41.33 | 28.10 | 22.20 | 30.54 |
| 8 $dSm^{-1}$ | 62.77 | 29.37 | 18.70 | 36.94 | 31.00 | 16.13 | 11.67 | 19.60 c | 31.77 | 13.23 | 7.03 | 17.34 |
| 12 $dSm^{-1}$ | 46.61 | 23.03 | 15.77 | 28.47 | 28.17 | 11.93 | 9.52 | 16.54 | 18.43 | 11.10 | 6.25 | 11.93 |
| 16 $dSm^{-1}$ | 35.00 | 18.97 | 13.07 | 22.34 | 21.77 | 10.90 | 9.40 | 14.02 | 13.2 | 8.07 | 3.67 | 8.32 |
| 20 $dSm^{-1}$ | 31.23 | 14.33 | 7.77 | 17.78 | 20.30 | 8.30 | 4.43 | 11.01 | 10.93 | 6.03 | 3.33 | 6.77 |
| 24 $dSm^{-1}$ | 24.40 | 0.00 | 0.00 | 8.13 | 14.13 | 0.00 | 0.00 | 4.71 | 10.27 | 0.00 | 0.00 | 3.42 |
| Ortalama | 59.61 | 35.12 | 27.16 | | 30.24 | 18.70 | 15.91 | | 29.37 | 16.43 | 11.25 | |
| LSD | Çeşit:4.16 Tuz:6.35 ÇxT: Ö.D. | | | | Çeşit:3.94 Tuz: 6.01 ÇxT: Ö.D. | | | | Çeşit:4.35 Tuz: ÇxT: 7.84 | | | |

Radikula boyu üzerine tuzluluk derecelerinin etkileri incelendiğinde, tuzluluk uygulaması yapılmayan Kontrol uygulamasında en yüksek radikula uzunluğunun elde edildiği, tuzluluğun artmasıyla bu değerin önemli derecede azaldığı, buna karşın 20 $dSm^{-1}$ veya 24 $dSm^{-1}$ gibi yüksek tuzluluk derecelerinde bile çeşitlerin çok sınırlı da olsa gelişebildiği belirlenmiştir. Belida çeşidi 24 $dSm^{-1}$ tuzluluk derecesinde bile bir gelişme gösterebilirken, Troya ve Esquire çeşitleri 20 $dSm^{-1}$ seviyesinden sonra hiç gelişememişlerdir. Bu durum *L. perenne* çeşitlerinin tuzluluğa yüksek tolerans gösterdiği ancak, çeşitlerin tolerantlık derecelerinde değişkenlik olduğunu göstermektedir. Bununla birlikte, çeşitlerin farklı tuzluluk derecelerine farklı tepkiler vermesi nedeniyle bir Çeşit x Tuzluluk interaksiyonu ortaya çıkmış ve buna ilişkin veriler Şekil 1'de gösterilmiştir. Farklı tuzluluk seviyelerinde çimlendirilen *L. perenne* çeşitlerinin ortalama radikula boyu değerlerine ilişkin çeşit x tuzluluk interaksiyon grafiğinden, tuzluluk derecesi arttıkça, tüm çeşitlerin radikula uzunluklarında azalmalar olduğu açıkça görülmektedir. Ancak, herhangi bir tuzluluk seviyesinde, bir önceki seviyeye kıyasla ortaya çıkan bu azalmalar, her çeşitte aynı olmamış ve çeşitten çeşide değişkenlik göstermiştir. Örneğin, 4 $dSm^{-1}$ seviyesinde bir önceki seviye olan kontrol uygulamasına göre olan azalmalar, Belida, Troya ve Esquire çeşitleri için sırasıyla %47.97, %42.02 ve %22.58 seviyesinde gerçekleşmiştir. Benzer şekilde 8 $dSm^{-1}$ seviyesinde bir önceki 4 $dSm^{-1}$ seviyesine kıyasla ortaya çıkan radikula boyu azalması aynı çeşitler için sırasıyla %23.88, %46.17 ve %54.27 olarak hesaplanmıştır. Dolayısıyla tuzluluk dereceleri artışında her üç çeşidin de radikula boyları azalmış, ancak bu azalmalar her bir tuzluluk seviyesi için çeşitten çeşide değişkenlik göstermiştir. Çeşitlerin farklı tuzluluk

derecelerinde farklı tepkiler vermesi nedeniyle bir çeşit x tuzluluk interaksiyonu ortaya çıkmıştır.




Şekil 1. Farklı Tuzluluk Seviyeleri Uygulanmış *L.perenne* Çeşitlerinin Radikula Boyuna ilişkin ÇeşitxTuzluluk interaksiyonu.

Figure 1. CultivarxSalinity Interaction Regarding Radicle Length of *L. perenne* Treated with Different Salinity Levels

Birçok araştırıcı, tuzluluk derecesine dayanımın asıl göstergesi olarak radikula uzunluğunun esas alınması gerektiğini bildirmişlerdir (Kızılşimşek ve Süren, 2020). Yani radikula uzunluğu tuzluluğa toleransı belirlemede en önemli parametrelerden biridir. Çimlenme esnasında bitkinin bünyesine su alımında engel görevi gören tuz engeli yoksa bitki kök sistemi normal gelişim gösterir. Toprak çözeltisinde veya çimlendirmede kullanılan su içerisinde var olan tuz stresine maruz kalan bitkilerin gelişimi olumsuz etkilenmektedir. Nitekim Çizelge 1'de verilen değerler incelendiğinde, hem fide boyunun, hem de plumula boyunun radikula boyuna paralel olarak gelişme gösterdiği, radikula uzunluğundaki azalmanın diğer iki özellik üzerine de olumsuz etkilerde bulunduğu görülmektedir. Tuzun radikula uzunluğu üzerindeki negatif etkileri birçok araştırıcı tarafından da tespit edilmiştir (Yeşil ve ark., 2022; Javaid, 2022). Artan tuz yoğunluğuna bağlı olarak sap uzunluğunda azalma olduğu (Nizam, 2011; Kuşvuran ve ark., 2014a; Kuşvuran ve ark., 2014b; Hokmalipour, 2015; Topcu ve ark., 2016;) belirlenmiştir

Ortalama fide yaş ağırlığı değerleri incelendiğinde, en yüksek değerin 4.9 mg/fide ile Belida çeşidinden elde edildiği, Troya ve Esquire çeşitlerinin ise en düşük değerlere sahip oldukları görülmektedir. Radikula yaş ağırlığı değerleri bakımından da çeşitler arasındaki

farklılıklar önemli bulunmuş ve Belida çeşidi diğer iki çeşide göre daha yüksek radikula yaş ağırlığı değerlerine sahip olmuştur. Plumula yaş ağırlığı bakımından çeşitler arasında istatistiksel olarak önemli bir farklılık bulunmamakla birlikte, Belida çeşidi yine öne çıkan çeşit olarak kendini göstermiştir. Tuzluluk dereceleri her üç özellik bakımından da istatistiksel bakımdan anlamlı farklılıklar yaratmış ve bu özellikler için en yüksek değerler daima Kontrol uygulamasından elde edilmiştir. Tuzluluk derecesinin artmasıyla birlikte, fide, plumula ve radikula yaş ağırlık değerlerinde önemli azalmalar olduğu saptanmıştır (Khayatnezhad ve Gholamin, 2011; Topcu ve ark., 2016). Belida çeşidi 24 $dSm^{-1}$ tuzluluk derecesinde bile fide gelişimi yapabilirken, Troya ve Esquire çeşitleri 20 $dSm^{-1}$ seviyesinden sonra fide geliştirememişlerdir. Bu durumda, *L. perenne* türüne ait çeşitlerin yüksek tuzluluk derecelerine toleranslı oldukları, ancak bu toleransın çeşitten çeşide değişkenlik gösterebileceği sonucuna varılmıştır.

Tuzluluğa toleransı belirlemede radikula gelişimi önemli bir gösterge olarak bilinmektedir. Belida çeşidinin çimlenme sırasındaki radikula gelişimi tuzluluk uygulamalarından olumsuz etkilenmekle birlikte, en yüksek tuzluluk derecesinde bile bir gelişim gösterebilmiştir. Bitkilerin kök bölgesinde tuzluluk şartlarının bulunması, radikula gelişimini olumsuz olarak etkilemekte olup köklere ihtiyacı olan besin ve su alımını minimum düzeylere indirmekte veya tamamen engelleyerek bitkinin gelişimini durdurmaktadır (Soysal ve ark., 2021). Yapılan çalışmada elde edilen veriler, artan tuzlulukla bitki gelişiminin, kontrole göre olumsuz etkilendiğini bildiren birçok araştırıcının bulguları ile uyum içerisindedir (Xu ve ark., 2020; Khaleghi, 2005). Artan tuz konsantrasyonlarının yaş kök ağırlığını kayda değer ölçülerde azaltması, literatür bilgileri ile uyumlu niteliktedir.

***Çizelge 2. Farklı Tuzluluk Dozlarında Çimlendirilen L. Perene L. Çeşitlerinden Elde Edilen Ortalama Fide, Plumula ve Radikula yaş ağırlıkları ve Oluşan Gruplar.***

Table 2. Mean Seedling, Plumula and Radikula Wet Weights and Statistical Groups Obtained from *L. perenne* Cultivars Germinated at Different Salinity Levels.

| Tuzluluk Derecesi | Fide Yaş Ağırlığı | | | | Plumula Yaş Ağırlığı | | | | Radikula Yaş Ağırlığı | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Belida | Troy | Esquir | Ort. | Belid | Troy | Esquir | Ort. | Belida | Troya | Esquir | Ort. |
| Kontrol | 10.8 | 8.0 | 6.7 | 8.5 a | 8.06 | 6.26 | 5.67 | 6.66 a | 2.78 | 1.77 | 1.01 | 1.85 a |
| 4 $dSm^{-1}$ | 5.4 | 4.5 | 4.0 | 4.7 b | 4.55 | 3.76 | 3.40 | 3.90 b | 0.89 | 0.75 | 0.63 | 0.76 b |
| 8 $dSm^{-1}$ | 5.0 | 3.6 | 3.1 | 3.9 bc | 4.31 | 2.98 | 2.55 | 3.28 b | 0.73 | 0.63 | 0.51 | 0.62 bc |
| 12 $dSm^{-1}$ | 4.5 | 2.9 | 2.7 | 3.4 bc | 3.88 | 2.39 | 2.32 | 2.86 | 0.66 | 0.56 | 0.41 | 0.54 bc |
| 16 $dSm^{-1}$ | 3.5 | 2.5 | 3.2 | 3.1 bc | 2.95 | 2.03 | 2.81 | 2.60 | 0.59 | 0.51 | 0.36 | 0.49 bc |
| 20 $dSm^{-1}$ | 3.1 | 1.6 | 1.3 | 2.0 cd | 2.53 | 1.21 | 1.03 | 1.59 | 0.52 | 0.42 | 0.25 | 0.40 bc |
| 24 $dSm^{-1}$ | 2.2 | 0.0 | 0.0 | 0.7 d | 1.87 | 0.0 | 0.0 | 0.62 c | 0.29 | 0.0 | 0.0 | 0.10 c |
| Ortalama | 4.9 a | 3.3 b | 2.9 b | | 4.023 | 2.66 | 2.54 | | 0.92 a | 0.66 | 0.45 b | |
| LSD | Çeşit:1.39 Tuz:2.12 ÇxT: | | | | Çeşit:Ö.D. Tuz:2.36 ÇxT: | | | | Çeşit:0.35 Tuz:0.54 ÇxT: Ö.D | | | |

Ortalama fide, plumula ve radikula kuru ağırlığı değerleri ve oluşan guruplara ilişkin veriler Çizelge 3'de verilmiştir.

***Çizelge 3. Farklı Tuzluluk Dozlarında Çimlendirilen L. Perene L. Çeşitlerinden Elde Edilen Ortalama Fide, Plumula ve Radikula kuru ağırlıkları ve Oluşan Gruplar.***

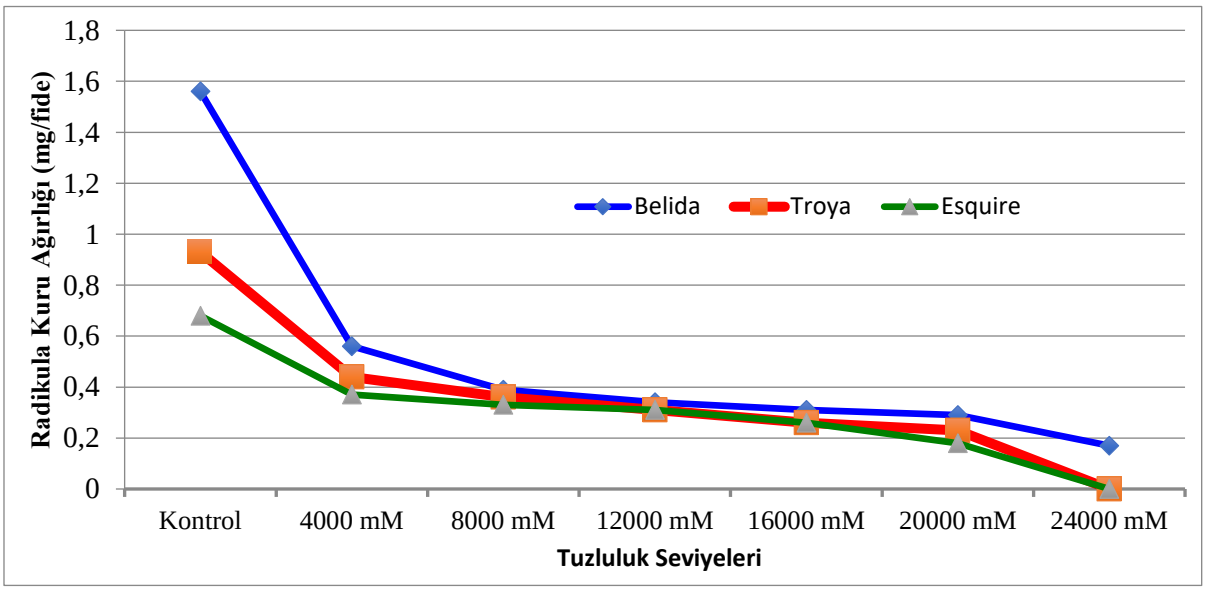
Table 3. Mean Seedling, Plumula and Radikula Dry Weights and Statistical Groups Obtained from *L. perenne* Cultivars Germinated at Different Salinity Levels.

| Tuzluluk Derecesi | Fide Kuru Ağırlığı | | | | Plumula Kuru Ağırlığı | | | | Radikula Kuru Ağırlığı | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Belida | Troya | Esquire | Ort. | Belida | Troya | Esquire | Ort. | Belida | Troya | Esquire | Ort. |
| Kontrol | 6.68 | 4.87 | 3.69 | 5.08 a | 5.12 | 3.94 | 3.01 | 4.02 a | 1.56 A | 0.93 B | 0.68 C | 1.06 a |
| 4 $dSm^{-1}$ | 3.54 | 2.59 | 2.23 | 2.79 b | 2.98 | 2.15 | 1.86 | 2.33 b | 0.56 CD | 0.44CDE | 0.37DEF | 0.46 b |
| 8 $dSm^{-1}$ | 2.96 | 1.99 | 1.72 | 2.22bc | 2.57 | 1.63 | 1.39 | 1.86 bc | 0.39DEF | 0.36DEF | 0.33DEF | 0.36bc |
| 12 $dSm^{-1}$ | 2.82 | 1.78 | 1.53 | 2.04bcd | 2.48 | 1.47 | 1.22 | 1.72bc | 0.34DEF | 0.31 EF | 0.31 EF | 0.32bc |
| 16 $dSm^{-1}$ | 2.14 | 1.44 | 1.24 | 1.61 cd | 1.83 | 1.18 | 0.98 | 1.33bcd | 0.31 EF | 0.26 EF | 0.26 EF | 0.28 c |
| 20 $dSm^{-1}$ | 1.74 | 1.02 | 0.76 | 1.17 de | 1.45 | 0.79 | 0.58 | 0.94 cd | 0.29 EF | 0.23 EF | 0.18 F | 0.23 c |
| 24 $dSm^{-1}$ | 1.32 | 0.0 | 0.0 | 0.44 e | 1.15 | 0.0 | 0.0 | 0.38 d | 0.17 F | 0.0 G | 0.0 G | 0.06 d |
| Ortalama | 3.03 a | 1.96 b | 1.60 b | | 2.51 a | 1.59 b | 1.29 b | | 0.52 a | 0.36 b | 0.30 b | |
| LSD | Çeşit:0.66 Tuzluluk:1.00 | | | | Çeşit:0.71 Tuzluluk:1.08 | | | | Çeşit:0.10 Tuzluluk:0.15 | | | |

Çizelge 3 incelendiğinde plumula kuru ağırlık değerlerine ilişkin ortalamalar ve oluşan guruplar incelendiğinde, fide kuru ağırlığı özelliğine paralel sonuçların elde edildiği, çeşitler bakımından Belida çeşidinin en yüksek değere sahip olduğu görülmektedir. Tuzluluk uygulamalarının plumula kuru ağırlığı değerlerini önemli derecede etkilediği, tuzluluk derecesinin artmasıyla plumula kuru ağırlık değerlerinin önemli ölçüde azalttığı ve en düşük

değerin en yüksek tuzluluk derecesinden elde edildiği saptanmıştır (Tatar ve ark., 2018; Alagöz ve Türk, 2020)

Radikula kuru ağırlık ortalamaları ve oluşan guruplar incelendiğinde, istaatistiki olarak fide kuru ağırlığı ve plumula kuru ağırlığı değerleri ile çok paralel sonuçların elde edildiği söylenebilir. Ancak, radikula kuru ağırlığı değerleri ile ilgili olarak bir çeşit x tuzluluk interaksiyonu söz konusudur. Bu interaksiyona ait veriler Şekil 2'de verilmiştir.




Şekil 2. Farklı Tuzluluk Seviyeleri Uygulanmış *L.perenne* Çeşitlerinin Radikula Kuru Ağırlığına ilişkin ÇeşitxTuzluluk interaksiyonu.

Figure 2. CultivarxSalinity Interaction Regarding Radicle Dry Weight of *L. perenne* Treated with Different Salinity Levels.

Radikula kuru ağırlığı değerlerine ait çeşit x tuzluluk interaksiyonunun verildiği Şekil 2'den, Kontrol uygulamasından itibaren, tuzluluğun artmasıyla birlikte tüm çeşitlerin radikula kuru ağırlıklarının azaldığı açıkça görülmektedir. Ancak her tuzluluk dozunun bir birim artmasıyla ortaya çıkan radikula kuru ağırlığındaki azalmalar, her çeşit için aynı olmamıştır. Örneğin, 4 $dSm^{-1}$ seviyesinde elde edilen radikula kuru ağırlıkları, kontrol uygulamasına göre tüm çeşitler için azalmış, ancak bu azalma Belida, Troya ve Esquire çeşitleri için sırasıyla %64.10, %52.69 ve %45.59 oranında gerçekleşmiştir. Benzer şekilde, 8 $dSm^{-1}$ seviyesinde elde edilen değerler, bir önceki tuzluluk uygulamasına göre, anılan çeşitler için yine sırasıyla %30.35, %18.18 ve %10.81 oranında gerçekleşmiştir. Bu verilerden, düşük tuzluluk uygulamalarında oransal olarak en fazla etkilenen çeşidin Belida olduğu, diğer çeşitlerin hafif derecede tuzluluk uygulamasından oransal olarak daha az etkilendiği söylenebilir. Ancak

tuzluluk şiddeti arttıkça, Belida çeşidinin radikula kuru ağırlık değerleri diğer çeşitlere göre oransal olarak daha az etkilenmiş, hatta Troya ve Esquire çeşitleri 20 $dSm^{-1}$ seviyesinden sonra radikula gelişimi yapamazken, Belida çeşidi 24 $dSm^{-1}$ seviyesinde bile radikula gelişimi yapabilmiştir. Diğer bir ifade ile çeşitlerin her bir tuzluluk deresine verdiği tepki birbirinden farklı olmuş ve bir çeşit x tuzluluk interaksiyonu ortaya çıkmıştır.

Farklı tuzluluk derecelerinde çimlendirilen *L. perenne* çeşitlerinin ortalama çimlenme oranları ve oluşan guruplarının Çizelge 4'de verilmiştir. Söz konusu çizelgede, çeşitler arasındaki farklılığın önemli olduğu, en yüksek ortalama çimlenme oranının %91.05 ile Belida çeşidinden elde edildiği, bunu önemli farklılıklarla ve %70.29 ve %60 değerleri ile sırasıyla Troya ve Esquire çeşitlerinin izlediği saptanmıştır.

***Çizelge 4. Farklı Tuzluluk Derecelerinde Çimlendirilen L. perenne Çeşitlerinden Elde Edilen Ortalama Çimlenme Oranı (%) Değerleri ve Oluşan Guruplar.***

Çizelge 4. Avarage Germination Rate (%) Values and Statistical Groups Obtained from *L. perenne* Cultivars Germinated at Different Salinity Levels.

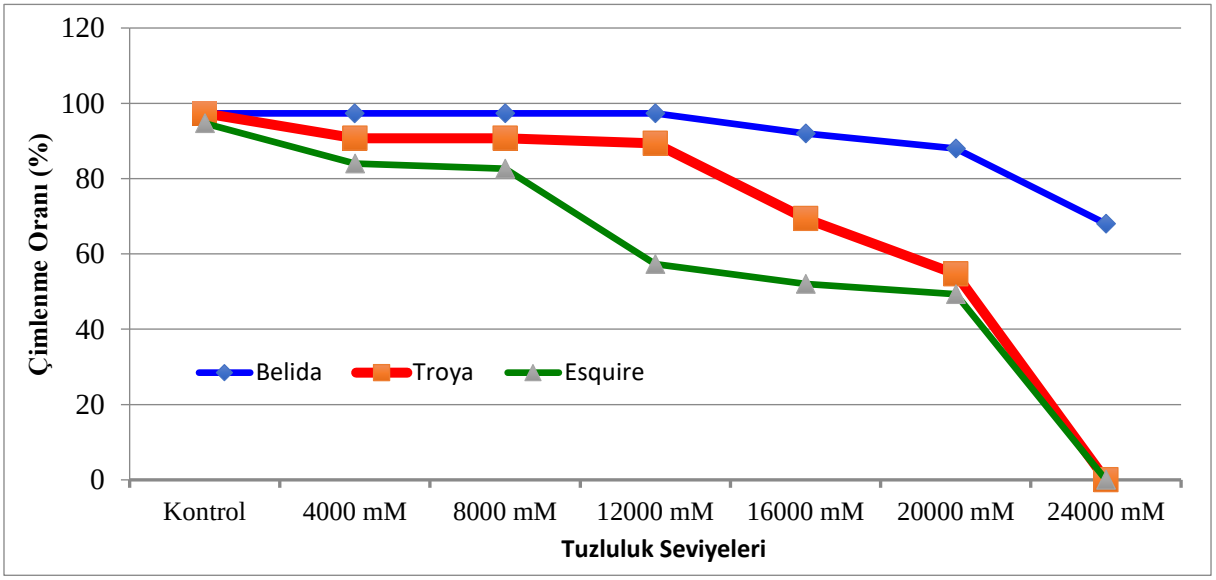
| **Tuzluluk** | **Çeşitler** | | | **Ortalama** |
|---|---|---|---|---|
| | **Belida** | **Troya** | **Esquire** | |
| **Kontrol** | 97.33 A | 97.33 A | 94.67 A | 96.44 a |
| **4 $dSm^{-1}$** | 97.33 A | 90.67 A | 84.00 AB | 90.67 ab |
| **8 $dSm^{-1}$** | 97.33 A | 90.67 A | 82.67 AB | 90.22 ab |
| **12 $dSm^{-1}$** | 97.33 A | 89.33 A | 57.33 CDE | 81.33 b |
| **16 $dSm^{-1}$** | 92.00 A | 69.33 BC | 52.00 DE | 71.11 c |
| **20 $dSm^{-1}$** | 88.00 A | 54.67 CDE | 49.33 E | 64.00 c |
| **24 $dSm^{-1}$** | 68.00 BCD | 0.00 F | 0.00 F | 22.67 d |
| **Ortalama** | 91.05 a | 70.29 b | 60.00 c | |
| **LSD** | Çeşit:6.23; Tuzluluk:9.53; ÇxT:17.18 | | | |

Tuz uygulamalarına ait ortalama değerler incelendiğinde, en yüksek değerin %96.44 çimlenme oranı ile Kontrol uygulamasından elde edildiği, tuzluluğun artmasıyla birlikte çimlenme oranının azaldığı (Akgün ve ark., 2011; Burhan ve ark., 2011; Ertekin ve ark., 2018) ve en düşük değerin %22.67 ile en yüksek tuzluluk seviyesi uygulamasından elde edildiği belirlenmiştir. Farklı bitki tür ve çeşitlerle yapılan çalışmalarda (Turhan ve ark., 2011; Atak ve

Mavi, 2016; Ertekin ve ark., 2017; Yılmaz ve ark., 2021) tuz stresine farklı tür ve çeşitler çimlenme oranı bakımından farklı tepki gösterdiklerini tespit etmişlerdir.

Bununla birlikte çimlenme oranı değerleri bakımından bir çeşit x tuzluluk interaksiyonu ortaya çıkmış ve bu interaksiyon Şekil 3' te gösterilmiştir.

Farklı tuzluluk seviyelerinde çimlendirilen *L. perenne* çeşitlerinin çimlenme oranlarına ait çeşit x tuzluluk interaksiyonunun verildiği Grafik 2'den, kontrol uygulamasında tüm çeşitlerin çimlenme oranının %95'in üzerinde ve birbirlerine yakın değerlere sahip olduğu, tuzluluğun artmasıyla birlikte tüm çeşitlerin çimlenme oranlarının azaldığı (Güngör ve ark., 2017; Aşcı, 2011; Aşcı ve Üney, 2016; Özkorkmaz ve Yılmaz, 2017) ancak bu azalmanın çeşitlere göre değişkenlik gösterdiği izlenmektedir.




Şekil 3. Farklı Tuzluluk Seviyeleri Uygulanmış *L.perenne* Çeşitlerinin Çimlenme Oranına İlişkin ÇeşitxTuzluluk İnteraksiyonu.

Figure 3. CultivarxSalinity Interaction Regarding the Germination Rate of *L. Perenne* Cultivars Applied to Different Salinity Levels

Örneğin Belida çeşidinde tuzluluk derecesine bağlı olarak ortaya çıkan azalmaların 20 $dSm^{-1}$ seviyesine kadar önemli derecelerde olmadığı, yalnızca 24 $dSm^{-1}$ tuzluluk derecesinde önemli azalmalar olduğu görülürken, Troya çeşidi için 16 $dSm^{-1}$, Esquire çeşidi için ise 8 $dSm^{-1}$ seviyesinden sonra çimlenme oranlarında önemli azalmalar başlamıştır. Çeşitlerin her bir tuzluluk derecesinde gösterdikleri çimlenme performansları da bir birinden farklı olmuştur. Örneğin 8 $dSm^{-1}$seviyesindeki çimlenme oranları Belida ve Troya çeşitleri için 4 $dSm^{-1}$seviyesine göre bir değişiklik göstermemiş, Esquire çeşidi için ise sadece %1.58 düzeyinde

azalmıştır. Ancak, 8 $dSm^{-1}$ seviyesinden 12 $dSm^{-1}$ seviyesine geçildiğine ise, Belida çeşidinin çimlenme oranı değişmemiş, Troya çeşidinin çimlenme oranı sadece %1.48 oranında azalmış, buna karşılık Esquire çeşidinin çimlenme oranı %30.65 oranında azalmıştır. Benzer şekilde 16 $dSm^{-1}$ seviyesindeki değerler incelendiğinde, Troya çeşidi için bir önceki tuzluluk seviyesine göre ortaya çıkan çimlenme oranındaki azalma, diğer iki çeşide kıyasla çok daha fazla olmuştur. Dolayısıyla, her bir çeşit, her bir tuzluluk oranına birbirinden farklı tepkiler vererek bir çeşit x tuzluluk interaksiyonunun çıkmasına neden olmuştur.

**Sonuç ve Öneriler**

Farklı tuzluluk derecelerin *L. perenne* çeşitlerinin çimlenme performansları üzerine etkilerinin incelendiği bu çalışmada, aşağıdaki sonuçlara ulaşılmıştır.

1. İncelenen her bir özellik için, her çeşitte en yüksek değerlere hiç bir tuzluluğun uygulanmadığı Kontrol grubunda ulaşılmıştır. Hafif derecede tuzluluk uygulamalarında bile tüm çeşitlerde incelenen fide özelliklerinde ve çimlenme oranlarında az veya çok miktarda azalmalar görülmüştür. Bu nedenle tuzluluğun, *L. perenne* çeşitlerinin çimlenme ve fide gelişimi üzerine olumsuz etkilerde bulunduğu belirlenmiştir. Çok yıllık çimde tuzluluk stresi, sürgün ve kökün $Na^+$ içeriğini önemli ölçüde arttırmış ve $K^+/Na^+$ oranını düşürerek sürgün yaş ve kuru ağırlığını ve kök hacmini olumsuz yönde etkilemiştir (Rahimi ve ark., 2021).

2. *L. perenne* çeşitlerinin genel olarak tuzluluğa toleranslarının yüksek olduğu, hatta yüksek tuzluluk derecelerine dayanıklı oldukları belirlenmiştir. *L. perenne* çeşitleri içerisinde Belida çeşidinin, Troya ve Esquire çeşitlerine göre tuzluluğa daha dayanıklı olduğu belirlenmiş, tuzluluk sorunu bulunan bölgelerde Belida çeşidinin karışımlara girmesi ve hatta karışımların dominant türü olması gerektiği saptanmıştır.

3. *L. perenne* çeşitleri ile ilgili olarak, daha fazla çeşidin yer aldığı, çok yıllık, saksı veya tarla çalışmalarının yapılması gerektiği, toprak altı ve toprak üstü organların gelişiminin inceleneceği, tuzluluk sorunu olan alanlarda veya sulama suyunun tuzlu olduğu durumlarda hangi çeşidin daha avantajlı olacağı veya diğer tuza dayanıklı türler ile hangi oranda karışıma gireceği ile ilgili detaylı çalışmaların yapılması gerektiği sonucuna varılmıştır.

**Bilgi Notu**

Bu makalenin verileri Eylül Nezahat Süren'in yükseklisans tezinin bir kısmından üretilmiştir.

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# NEW PROTEINS FOR RUMINANTS: INSECT PROTEINS AND MICROALGAE

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## Abstract
Soybean meal (SBM) has been the prominent protein source in the intensive livestock systems since 2001, due to the ban of meat and bone meal products for livestock by the European Commission (EC directive 999/2001). Soybean proteins have low ruminal degradability and well-portioned non-structural carbohydrates. However, SBM solvent extract has been banned in the organic livestock (EC directive 834/2007). In addition, its high costs, the need for agricultural land and unstable global market highlight the need to find alternative protein sources to maintain self-sufficiency at a country level. Two such promising alternatives are microalgae and insect proteins (IP). Microalgae can be added to ruminant diets as an energy source instead of corn or concentrated feed, and as a protein source instead of SBM or rapeseed meal, or to improve the antioxidant content of the feed. Ruminants appear to be promising target of this new feed ingredient, as they can utilize the non-protein nitrogen found in microalgae and also digest the cell wall contents. Several studies have characterized the effects of microalgae as feed for livestock and their potential to manipulate rumen fermentation and methane production. The use of IP as feed for poultry, fish and pets is allowed in EU since 2022 (EC Regulation No 1069/2009). Yet, only insect fats and hydrolysed IP are accepted for ruminants feed. Edible insects are comparable to SBM in protein contents (42% to 63% in dry matter). Animal studies with these new proteins are scarce, but results have shown lower *in vitro* degradability of IP compared to SBM, however, indicated higher intestinal digestibility. Both, whole insect and de-fatted insect meal have also shown to reduce methane production *in vitro*. The aim is to discuss the use of these new protein sources for ruminants in conjunction with the regulations.
**Keywords:** ruminants, insect proteins, microalgae.

## Introduction

Insects are the most dominant fauna with 1.4 million known species on the planet (FAO, 2013). High versatility and ability to thrive on various food resources have recently raised insects into spotlight to combat waste and improve food security. Humans are known to use about 2000 insect species for food (FAO, 2013), but depending on feed source and regional traditions not all insects are suitable for direct human consumption. Ability to consume food industry leftovers and organic waste with high feed efficiency and with protein quality similar or even surpassing that of soya (Finke, 2002) makes insects an intriguing protein source for livestock feed. However, the use of insect proteins in ruminant diet is still obstructed by the fear over mad cow disease (Bovine Spongiform Encephalopathy). Insect meals are classified as processed-animal-proteins or considered animal-by-product and are therefore prohibited to use as ruminant feed in EU (Regulation No 142/2011; IPIFF 2022) and China and Japan. However many regions either lack legislation on insect use (US) or are authorized to be used for ruminants (Brazil, India, Australia; Renna et al., 2023). Currently, only hydrolysed insect fat and proteins are authorized for ruminant use (Regulation (EC) No 1069/2009). Regarding the global food and feed challenges, insects as feed deserve deeper discussions and increased research as potential to strengthen local food security.

The term "microalgae" summarizes a diverse group of plant-like, photosynthetic, unicellular or simple multicellular organisms and does not belong to a single monophyletic group, it includes eukaryotes as well as prokaryotes. It refers to aquatic organisms (freshwater and seawater) that emerged on Earth about 3.5 billion years ago and are considered the first life form (Margulis, 1981). Microalgae can be grown in unfavourable lands without further compelling competition with food production, and provides the opportunity for forage production in areas unsuitable for cultivation. On 15 November 2022, the European Commission published its communication “Towards a Strong and Sustainable EU Algae Sector”, also known as the EU Algae Initiative. This initiative sets out a strategic approach for developing algae production and associated value chains in the Union. The communication follows up on different Commission reports, publications and policy initiatives, largely associated with the European Green Deal. The aim of the initiative is to unlock the potential of algae production as part of the Blue Bioeconomy.

The build-up of the aforementioned files culminated in the publication of the Commission’s communication “Towards a Strong and Sustainable EU Algae Sector” in November 2022 (Table 1).

**Table 1.** Towards a Strong and Sustainable EU Algae Sector (Kuech, Breuer & Popescu, 2023)

| **Commission document** | **Relevant content** | **Publication date** |
|---|---|---|
| The European Green Deal, COM(2019) 640 | "The Farm to Fork Strategy will [...] launch a process to identify new innovative food and feed products, such as seafood based on algae." | 11/12/2019 |
| Roadmap for the Blue Bioeconomy − Publication by DG MARE | Report concluding consultations with stakeholders and desk research regarding challenges associated with the Blue Bioeconomy sector, including micro- and macroalgae applications. | 03/02/2020 |

The most common seaweed applications include food, food-related products, as well as cosmetics and wellbeing. Seaweed production, particularly aquaculture, is well positioned to play a key role for sustainable aquaculture operations, food security and climate change mitigation. Microalgae production in Europe is land-based and occurs in photobioreactors (71%), ponds (19%) and fermenters (10%). Common microalgae applications include food supplements and nutraceuticals, cosmetics and well-being products, as well as feed. The European microalgae sector is in a unique position for producing high-value algae products, such as nutraceuticals, with a variety of additional potential applications under development. Scalability limitations of reactors, high production costs, as well as administrative barriers, are some of the main challenges associated with the sector.

For microalgae, Spain (16 companies), Germany (14 companies), as well as France and Italy with 10 companies each, host the most companies in the EU. Germany, Italy, Austria, Croatia, the Czech Republic, Belgium and Hungary have microalgae and Spirulina producing companies, but they have no companies involved in seaweed production. For Spirulina production, the vast majority of companies are based in France (129 companies), followed by Italy (22 companies) and Spain (18 companies).

The aim of this review is to describe the chemical composition and *in vitro* feed values of some insect proteins and microalgae for ruminants. In addition, the usage of these new proteins will be discussed on the basis of the regulations.

**Benefits of insect protein**

Historically insect consumption is manly based on wild collection which is time consuming and limited to do seasonality and environmental conditions (warm and humid; FAO, 2013). Implementation of industrial insect productions have made it viable feed production alternative

even in modern and nordic climate regions. As of date in EU eight species of insects have been regulated for food and feed industry: black soldier fly (*Hermetia illucens*), Common Housefly (*Musca domestica*), Yellow Mealworm (*Tenebrio molitor*) Lesser Mealworm (Alphitobius diaperinus), Silkworm (*Bombyx mori*), House cricket (*Acheta domesticus*), Banded cricket (*Gryllodes sigillatus*) and Field Cricket (*Gryllus assimilis*) (Regulation (EU) No 142/2011).

The driving forces behind alternative protein sources is the overdependence of livestock production on soya and the need to reduce environmental impact while maintaining or preferably improving livestock production. Majority of insects have CP between 42-76% in DM exceeding the 52% of soybeans (Table 2; Makkar et. al., 2014). Also the main limiting amino acids for lactating dairy cattle, methionine, lysine and histidine are present in insects at similar concentrations than in SBM (Makker et al., 2014) suggesting insect proteins to be ideal replacement for SBM in dairy cattle diet.

Due do prohibition of insects use and lack of cultural and historical habits of using insects in livestock production not much research has been conducted so far. In a review by Renna et al. (2023) only eight published sources were found where either *in vitro* OM or DM digestibility (IVOMD or IVDMD) had been evaluated with cattle or sheep and only three known *in vivo* studies have looked at effect of insect meals on feed intake in cattle or goat. Most research so far have found insect meal to decrease *in vitro* degradability of a diet compared to SBM. Jayanegara et al. (2017a) replaced SBM with BSFL of different age in a mixed diet of 60% napier grass and 40% SBM and reported that diets where BSFL replaced 100% of SBM had IVOMD 52-59% compared to 80% of SBM diets. In contrast, Phesatcha et al. (2022) reported up to 3% increase of INDMD diet of 60:40 roughage:concentrate when SBM was replaced 100% by cricket meal. High fat content of whole insect meals has been suggested as main factor reducing ruminal degradability of insect meals. Mulianda et al. (2022) included intact, chemically or mechanically defatted BSFL to TMR diet at a 20% level and reported no significant effect of defatted BSFL on IVOMD compared to TMR only diet (77.5% vs 77.2%, respectively), but significantly lower degradability ($P<0.05$; 50.7%) for TMR containing intact BSFL meal. Lipids have low ruminal degradability, but decrease ruminal methane production and could improve dietary energy availability postruminally. In all know studies to date, the inclusion of insect meal or insect oils have degreased *in vitro* methane production even as low as 0.5% inclusion levels (Renna et al., 2023). Defatting can be viable method to improve insect meal nutritional value, considering that ruminal diets are generally characterized by low lipid content, whereas insect fats can be better utilised in fish and poultry feed or in other industry.

**Table 2.** Crude protein, ether extract and main amino content of four main feed insects and soybean meal (Makkar et al., 2014)

| **Analysis, % in DM** | ***Hermetia illucens*** | **Acheta domesticus** | **Bombyx mori** | **Tenebrio molitor** | **Soybean meal** |
|---|---|---|---|---|---|
| Crude protein | 42-58 | 55-67 | 52-71 | 47-60 | 52 |
| Ether extract | 39 | 10-22 | 6-37 | 31-43 | 2 |
| **g/16 g N** | | | | | |
| Alanine | 7.7 ± 0.8 | 8.8 | 4.4 ± 0.2 | 7.3 ± 1.0 | 4.54 |
| Arginine | 5.6 ± 0.3 | 6.1 | 5.1 ± 0.3 | 4.8 ± 1.0 | 7.64 |
| Aspartic acid | 11.0 ± 1.8 | 7.7 | 7.8 ± 0.7 | 7.5 ± 1.7 | 14.4 |
| Cystine | 0.1 | 0.8 | 0.8 ± 0.5 | 0.8 ± 0.0 | 1.38 |
| Methionine | 2.1 ± 0.3 | 1.4 | 3.0 ± 0.4 | 1.5 ± 0.4 | 1.32 |
| Lysine | 6.6 ± 0.9 | 5.4 | 6.1 ± 0.4 | 5.4 ± 0.8 | 6.18 |
| Isoleucine | 5.1 ± 0.5 | 4.4 | 3.9 ± 0.2 | 4.6 ± 0.5 | 4.16 |
| Leucine | 7.9 ± 0.6 | 9.8 | 5.8 ± 0.2 | 8.6 ± 1.8 | 7.58 |
| Phenylalanine | 5.2 ± 0.4 | 3 | 4.4 ± 0.3 | 4.0 ± 0.4 | 5.16 |
| Threonine | 3.7 ± 1.7 | 3.6 | 4.8 ± 0.3 | 4.0 ± 0.5 | 3.78 |
| Tryptophan | 0.5 | 0.6 | 1.4 ± 0.2 | 0.6 ± 0.5 | 1.36 |
| Glutamic acid | 10.9 ± 2.4 | 10 | 8.3 ± 0.7 | 11.3 ± 1.1 | 19.92 |
| Histidine | 3.0 ± 1.0 | 2.3 | 2.6 ± 0.1 | 3.4 ± 0.2 | 3.06 |
| Proline | 6.6 | 5.6 | 5.2 | 6.8 ± 0.2 | 5.99 |
| Serine | 3.1 ± 1.9 | 4.6 | 4.5 ± 0.2 | 7.0 ± 3.5 | 5.18 |
| Tyrosine | 6.9 ± 0.7 | 5.2 | 5.5 ± 0.2 | 7.4 ± 0.3 | 3.35 |
| Valine | 8.2 ± 1.4 | 5.1 | 4.9 ± 0.2 | 6.0 ± 0.6 | 4.5 |

Chitin is another major insect constituent suggested to reduce degradability of whole insect meals. However, Jayanegara et al. (2017b) found no reduction in digestibility characteristics when lowering chitin content in *Gryllus assimilis*. Similarily, Renna et al. (2022) reported highest fermentation results for *B. lateralis* which had the highest chitin content of all the tested insect species used in the study. Chitin is an N containing polysaccharide that makes up to 12% of insect DM and is considered indigestible in monogastric animals. However, in ruminant diet chitin can fill some of the fibre needs of the animal and may be partially degradable. Furthermore, 1-2% addition of BSF chitin or chitosan to TMR diet at incremental levels also reduced *in vitro* methane concertation linearly from 4.6 to 4.57 % in total gas (Haryati et al.,

2019), strengthening insects value as both protein supplement and mitigating strategy in livestock farming.

Since *in vivo* studies are scarce it's difficult to get definitive answers to nutritive value of insects since reduced rumen degradability may be both negative and positive. In response to lower *in vitro* and *in situ* N degradability of *Tenebrio molitor* compared to SBM ($P<0.05$; 46% vs 85%), the *in vitro* intestinal digestion of *Tenebrio molitor* was 0.782 compared to 0.680 of SBM (Toral et al., 2022). And the *in vitro* intestinal digestibility of other insects *Zophobas morio Alphitobius diaperinus* and *Acheta domesticus* was not significantly different, but numerically higher than that of SBM. These results are supported by the findings of Astuti et al. (2019) who reported higher final weight of post-weaning goat kids that received diet with concentrate consisting of 30% cricket meal compared to kids that received normal concentrate. Insect meal inclusion to cat diet have shown to reduce palatability (Bosch and Swanson, 2021), however in cattle (Fukuda et al., 2022; Rashmi et al., 2022) no significant adverse effect on palatability and feed intake was found. Astuti et al. (2019) noted reduced concentrate intake of post-weaning goat kids when fed concentrate consisting of 30% cricket meal compared to typical concentrate containing diet, but the reduced intake was associated with higher crude fat and energy in cricket meal containing diet.

**Microalgea advantages over terrestrial plants;**

1. Microalgea have higher productivity than conventional feeds (e.g., microalgae produces **21 times more protein** per unit area compared to soybean grain and **49 times more protein** compared to corn (Çevre ve Şehircilik Bakanlığı, 2013).
2. Microalgea can be grown in harsh climatic conditions - in areas where crops cannot be grown, such as desert and coastal areas,
3. Microalgae contain **substances of high biological value** such as polyunsaturated fatty acids, proteins, amino acids, pigments, antioxidants, vitamins and minerals and,
4. However, the main advantage of microalgae is that they **retain excess $CO_2$ and produce $O_2$ in the atmosphere**, thus helping to reduce the 'greenhouse effect' (Gouveia & Oliveira, 2009).

Table 3. Crude protein, ether extract and main amino content of five microalgae species (all values are expressed on a dry weight basis)

| | ***Arthrospira platensis*** | ***Chlorella sp.*** | ***Isochrysis sp.*** | ***Porphyridium sp.*** | ***Schizochytrium sp.*** |
|---|---|---|---|---|---|
| **Crude protein** | 60.3-65.8 | 37.7-47.8 | 27.0-45.4 | 29.7-38.5 | 12.1 |
| Alanine (%) | 5.4–6.5 | 4.6 | 2.4–3.2 | NA | 0.6 |
| Arginine (%) | 4.0–4.9 | 3.1 | 2.1–2.5 | NA | 1.2 |
| Aspartic acid (%) | 2.4–9.2 | 4.7 | 2.5–4.2 | NA | 4.8 |
| Cystine (%) | 0.4–0.5 | 0.7 | 0.2–1.4 | NA | < 0.1 |
| Glutamic acid (%) | 5.7–10.7 | 5.8 | 3.0–4.6 | NA | 1.2 |
| Glycine (%) | 1.8-5.2 | 3.4 | 1.8-2.6 | NA | 0.4 |
| Histidine (%) | 1.5-2.7 | 2.2 | 0.6-0.9 | NA | 0.1 |
| Isoleucine (%) | 4.2-4.4 | 2.0 | 1.5-1.8 | NA | 0.2 |
| Leucine (%) | 5.5-8.0 | 4.7 | 2.7-3.9 | NA | 0.8 |
| Lysine (%) | 2.9-3.0 | 4.0 | 1.8-2.5 | NA | 0.4 |
| Methionine (%) | 1.2-1.6 | 1.2 | 0.8-1.4 | NA | < 0.1 |
| Phenylalanine (%) | 3.0-5.8 | 2.7 | 1.8-3.8 | NA | 0.3 |
| Proline (%) | 2.0-4.0 | 2.5 | 1.8-2.4 | NA | 0.3 |
| Serine (%) | 2.8-4.3 | 1.0 | 1.5-2.2 | NA | 0.5 |
| Threonine (%) | 2.9-4.9 | 2.5 | 1.5-2.4 | NA | 0.5 |
| Tryptophan (%) | 0.1-2.5 | 1.0 | 0.5-0.6 | NA | < 0.1 |
| Tyrosine (%) | 3.2-3.3 | 2.4 | 1.2-3.8 | NA | 0.2 |
| Valine (%) | 4.2–4.6 | 3.0 | 1.8-2.4 | NA | 0.3 |
| **Crude carbonhydrates** | 17.8-22.6 | 18.1-27.5 | 13.3-18.0 | 26.5-57.0 | 32.0 |
| **Crude fat (%)** | 1.8-7.3 | 13.3-20.9 | 17.2-27.3 | 6.1-14.0 | 38.0-71.1 |
| **Ash (%)** | 6.5-9.5 | 6.2-7.3 | 9.7-16.1 | 17.6-22.4 | 8.2 |

Hyphenated values are ranges on the basis of several studies; NA–Not available.

**Microalgae effects on meat quality for ruminants**

In their study with weaned male lambs, Fuente-Vázquez et al., (2014) revealed that n-3 LCPUFA levels in lamb meat increased through seaweed diet applications, resulting in

significantly higher amounts of both EPA and DHA. Additionally, *Isochrysis sp.* decreases in vitamin E content in meat have been reported with its inclusion. In the study conducted by Nute et al. (2007), it was observed that seaweed supplementation in the diet produced the lowest vitamin E content in the muscles, thus a negative relationship between PUFA and vitamin E content in the muscle was explained. Therefore, the use of vitamin E *in vivo* has been suggested to prevent essential PUFA oxidation in muscle tissues. Many researchers have reported that the CLA content in meat increases with the addition of n-3 LCPUFA to the diet, mainly due to a higher yield of transvaccenic acid (18:1t11), which serves as a substrate for endogenous CLA synthesis (Scollan et al., 2001; Noci et al., 2011).

**Microalgae effects of the milk yield and quality for ruminants**

Tsiplakou et al. (2018) reported that higher superoxide dismutase activity in blood and milk and higher catalase activity in blood plasma were found in goats to which *Chlorella vulgaris* was added to the diet. While superoxide dismutase and catalase are among the main components of intracellular antioxidant defense mechanisms that regulate the accumulation of reactive oxygen species in tissues, the lactoperoxidase enzyme in milk is known to be associated with the oxidation of lipids. The study reported above also found a reduction in anoxidative stress biomarkers (protein carbonyls) in milk (Altamonte et al., 2018).

On the other hand, administration of *Spirulina* (200 g per day, approximately 10-14 g/kg DM) has been reported to result in higher milk yield in cows, with a maximum increase of 25% in daily production over a 90-day period (Kulpys et al., 2009). The authors reported that the recovery was caused by both the biological activity of the rumen flora and the physiological state of the animal due to the chemical content of the microalgae *Spirulina Platensis.*

Additionally, studies have reported an increase in total daily water consumption in heifers with the addition of *Spirulina Platensis* to the ration (Panjaitan et al., 2010[a,b]). More research should be done on this condition in dairy cows because increased water intake may affect milk yield and quality.

Microalgae can be **added to ruminant diets as an energy source** instead of corn or concentrated feed, **as a protein source** to partially substitute soybean or rapeseed meal, or to **improve the antioxidant content** of the feed. Ruminants appear to be promising targets of this new feed ingredient, as they can utilize the non-protein nitrogen found in microalgae and digest the cell wall contents of algae organisms *(*Esmail, 2019*).* Therefore, in the last few years, microalgae have been used to enrich ruminant diets for animal products (especially meat) with

valuable **Omega-3 Long Chain Polyunsaturated Fatty Acids** (n-3 LCPUFA) and docosahexaenoic acid (DHA).

**Conclusion and Recommendations**

The greatest changes with microalgae have been found in the milk fatty acid profile and are related to the long chain fatty acids and fatty acids of the omega 3 series, especially DHA and EPA. Excessive supplementation has negative effects on palatability, feed intake, the ruminal metabolism, as well as negatively impacting milk production and fat. Microalgae offer a wide range of excellent compounds, from proteins, lipids and carbohydrates to vitamins, minerals and antioxidants, thus justifying their usefulness as feed supplement for livestock production and meat quality. However, microalgae can easily accumulate heavy metals, such as arsenic and lead, which are potentially deleterious for animal or human health, thus requiring monitoring to avoid toxic effects. A careful attention is needed regarding the amount of supplemented algae and rumen-protected forms should be considered in order to prevent reductions in feed intake, and a deterioration in milk yield and quality. Moreover, the following issue should be further clarified: the effects of microalgae on animal metabolic status and welfare; the possible presence of anti-nutritional factors in the various species and the effects of a prolonged supplementation. In addition, the quality and the organoleptic characteristics of dairy products from animals fed microalgae should be deepened. Given the effects of the different cultivation conditions on microalgae compositions, and the several points that have yet to be clarified, at the moment it is still too early to clearly define future applications in the dairy sector. The microalgae inclusion in feed varies according to both microalgae and animal species. For instance, dietary *Arthrospira platensis* inclusion at high percentages for ruminants (< 20%), improved productivity with minor effects on meat quality.

As indicated by a series of 23 targeted actions set out by the European Commission in its EU Algae Initiative, increasing micro- and macroalgae production will require a collective effort (industry, Member States, EU, scientific community, etc.) for removing barriers, particularly associated with high production costs, administrative barriers and the need for scientific and technological advancements. The EU Algae Initiative paves the way for unlocking the potential of this sector through the implementation of 23 targeted actions, addressing governance framework, business, R&I and market development. The implementation period of these actions is set between 2023 and 2027. By the end of 2027, a progress report regarding the implementation of the proposed actions will be published (Kuech, Breuer & Popescu, 2023).

Use of insect based feeds for ruminants is currently still prohibited in EU and many countries and therefore no dietary recommendation can be offered for these regions. However, based on current available research a recommendation of up to 40% inclusion of insect meal into ruminant diets seem feasible without negative impact on feed intake or loss of production. Insect species should be chosen based on local availability and dietary requirements. BSFL and house fly larva can be produced on farm by using feed leftovers and organic waste, where in addition to protein feed for livestock, the insect frass can be used as valuable fertilizer. More studies are required to estimate post-ruminal digestion and total protein value of insects based feeds to ruminants, however the existing research tend to promote insects as suitable replacement for SBM with increased potential to mitigate ruminal methane production.

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# THE PRODUCTION, CONSUMPTION AND MARKETING STRUCTURE OF PITAYA IN TURKEY

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**Abstract**
Dragon fruit (Pitaya) has becoming popular by day by because of ease of cultivation and management with even backyards, smallholder cultivators, on terraces or as garden fruits. In addition, this product provides a quick return on investment in three years. It is a product that can be gain in a profit economically in a very short time. Although its homeland is not Turkey, the importance of dragon is increasing day by day in our country. Turkey consists of 7 regions and 81 provinces. It differs in climate and soil characteristics. Since it is located between the terrestrial, temperate and subtropical zones in Turkey, the most suitable region for dragon breeding is in Antalya and Mersin, which is closest to the subtropical zone. Pitaya is a native plant of South America. It is grown in the open in tropical climatic conditions and under the greenhouses for in subtropical climatic conditions. The wrapper is in the form of a cactus. Pitaya is a type of fruit that is especially rich in vitamin C, phosphorus and calcium minerals. Due to these properties, it is consumed as a fresh fruit, as well as used as a dessert, fruit juice, and also in fruit salads. It is beneficial for health. Firstly, according to the data obtained as a result of the project study titled "Research on the Adaptation of Different Tropical Fruit Species to Antalya Conditions", which was carried out with the support of the Special Provincial Administration, in cooperation with Antalya Agriculture and Forest Directorate, Batı Akdeniz Agricultural Research Institute (BATEM) and Akdeniz University; The suitability of the tested species in terms of adaptation to the region was determined as passiflora, pitaya, guava, longan, litchi and mango, respectively. In addition, when yield, quality, consumer demand, shelf life, recognition and economic return are taken into account, it is seen that pitaya, mango, passiflora and litchi species come to the fore. The study aims to examine the production, consumption and marketing structure of pitaya in Turkey. The main material of the study is the data obtained from relevant institutions and the results obtained from previous researches on the subject.
**Keywords:** Tropical fruits, pitaya, pitaya growing, pitaya marketing, economic analysis.

## Introduction

Turkey's natural environment makes it possible for a wide variety of fruits to grow there. Numerous tropical fruits can be grown, primarily due to of the Mediterranean Region's microclimate. As is the case most of the world, Turkey produces plenty of tropical fruits, with the avocado and bananas ranking among them. Recent global warming-related climate changes have made it possible to cultivate and consume new tropical fruits. In addition, people's interest in tropical fruits has grown, encouraging producers to plant them due to the fruits' extensive marketing potential and high economic benefits (Nizamlıoğlu et al., 2021; Attar et al., 2022).

Pitaya production, which first started in Turkey, especially in Mersin, has recently started to be produced in Antalya, Izmir and other regions. The homeland of pitaya, a tropical fruit known as "dragon fruit" in Turkey, is not exactly known. It is known that it was produced in Vietnam in the late 1920s. Pitaya, which is widely produced in the Far East and South American countries, is a fruit that is also widely produced in Israel. In Turkey, pitaya, which was first produced in Mersin, is spreading to other regions as it grows in greenhouses.

Firstly, according to the data obtained as a result of the project study titled "Research on the Adaptation of Different Tropical Fruit Species to Antalya Conditions", which was carried out with the support of the Special Provincial Administration, in cooperation with Antalya Agriculture and Forest Directorate, Batı Akdeniz Agricultural Research Institute (BATEM) and Akdeniz University; The suitability of the tested species in terms of adaptation to the region was determined as passiflora, pitaya, guava, longan, litchi and mango, respectively. Pitaya or dragon fruit, is a unique and exotic fruit that has become popular all over the world because of its many health advantages, refreshing taste, and eye-catching look.

The first fruit is harvested after a year from the saplings of the pitaya fruit, which is a cactus family, planted as cuttings. The product can be purchased several times between May and November. While 3-5 fruits are harvested in the first year, an average of 40-50 fruits can be harvested from the second year. It is a completely organic fruit. Very little water is given. It is fed with more moisture. There is no disease encountered in its production. It is more suitable to grow in a greenhouse. Because it can be damaged by excessive rainfall and temperature drops below zero. After the investment is made, it can pay for itself in the second year under the right care and conditions.

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In order for pitaya production to become widespread, studies on this subject need to be increased. Guidance research results are needed for producers and entrepreneurs who want to invest in this field. In particular, studies that reveal the economic aspects of pitaya growing can make significant contributions.

**Materials and Methods**

The study aims to examine the production, consumption and marketing structure of pitaya in Turkey. The main material of the study is the data obtained from relevant institutions and the results obtained from previous researches on the subject. Some collected data were summarized in tables and simple statistical methods were used.

**Findings and Discussion**

**Dragon Fruit Varieties**

It's important to comprehend the various dragon fruit varieties before getting into production and consumption ( Al-Mekhlafi et al., 2021). Three main categories exist;

- **Hylocereus Undatus (White-Fleshed Pitaya):** Known for its bright pink or yellow skin and sweet white flesh.
- **Hylocereus Costaricensis (Red-Fleshed Pitaya):** Characterized by vibrant pink or red skin with red or purple flesh. This variety is sweeter and has a unique taste.
- **Hylocereus Megalanthus (Yellow-Fleshed Pitaya):** This variety has yellow skin and white flesh, known for its slightly sour taste.

**Global Dragon Fruit Production**

In the world, over 93% of dragon fruit is produced in Vietnam, China, and Indonesia. Over an area of 55, 419 hectares, Vietnam accounts for more than half (51.1%) of global production, with an average productivity of 22–35 tonnes / hector (ha) / year. The ability of dragon fruit to adapt to a variety of environmental situations is responsible for the fruit's global production (Sharma et al., 2021).

The demand for exotic fruits, rising health consciousness, and expanding international trade have all contributed to the astonishing expansion in dragon fruit production and exports in

recent years. These elements have encouraged numerous nations, including Turkey, to investigate the cultivation of dragon fruit.

**Overview of dragon fruit exports and imports in the world**

As of right now, Vietnam is the biggest supplier of dragon fruit worldwide, with the highest payout in Asia, Europe, and occasionally the US. The second and third biggest activities in the European market are in Thailand and Israel. Due to their respective business practices, the United States, Mexico, Central America, and South America represent Asian dragon fruit suppliers' main rivals. Asian Americans have long been known for their Vietnamese dragon fruit.

Because of its flavor and form, Columbia's yellow dragon fruit -the brightest and sweetest of all the dragon fruit varieties - is extremely popular in the American market. Compared to other dragon fruits, these dragon fruits usually become apparent from November to February each year. Websites providing to American consumers claim that while Vietnam's red dragon fruit has a striking appearance and is typically larger than other varieties, its yellow color is not as bright and sweet as other varieties. In contrast, Vietnam's red dragon fruit is much more highly regarded in form and has a better taste than other red dragon fruits (Chen & Paull, 2019).

**Market Demand of Dragon Fruit**

In contrast to other commodities such as rice or coffee, dragon fruit is not well-known to consumers worldwide (apart from the Asian community). Investigations, however, indicate that there's an increasing worldwide market for dragon fruit, particularly in developing nations other than Asia (Sharma et al., 2021). The marketing of the products, particularly the information about the health benefits of dragon fruit, is mostly accountable for this demand, and it also determines into prices and increases the fruit's sweetness.

- **Asian market:**

As of the Chinese belief that the name, shapes, and colors of dragon fruit bring good luck, Asia has the largest and easiest-to-consume dragon fruit market. China is currently the world's largest consumer of dragon fruit, as well as the largest consumer in Asia. In recent years, there has been an increase in demand for dragon fruit in Indonesia, Singapore, Thailand, and the Philippines. Due to the health benefits attributed to dragon fruit, some Asian nations uninfluenced by Chinese culture, such as Japan and Korea, are also becoming increasingly interested in dragon fruit.

- **European market:**

The world's largest importer of vegetables and fruits, the European market is extremely open to new products. Thus, despite the fact that dragon fruit is still relatively new, not well-known, and expensive, it remains to have a lot of potential and is drawing in an increasing amount of consumers throughout the continent. A significant proportion of the population in European nations will certainly have access to dragon fruit if the price can be reduced while retaining or even promoting its nutritional value.

The dragon fruit market size is expected to grow from USD 14.11 billion in 2023 to USD 17.50 billion by 2028, at a CAGR of 4.40% during the forecast period (2023-2028). In addition to the serious implications on people's health and healthcare services, the COVID-19 pandemic has had a significant impact on the global dragon fruit market as well. In terms of demand, low demand was observed in supermarkets where consumers are mostly focused on healthy products with a long shelf life, and hence, demand for fruits remained low in many Asian countries, such as China. Further, as the restaurants were closed during the COVID-19 pandemic, the market demand for dragon fruit suddenly dropped. Intermediaries were afraid of unmarketable conditions, so they reduced their purchase volume in production areas. This widened the demand supply gap in many countries (Anonymous, 2023a).

**Dragon Fruit Production in Turkey**

Dragon fruit cultivation is a relatively new but quickly growing industry in Turkey. Turkey's western and southern areas have distinct climates that are ideal for growing dragon fruit. Turkish farmers have been experimenting with several kinds of dragon fruit, such as pitayas with red and white flesh (Bozkurt, 2020; Attar et al., 2022).

Based on information obtained from the Ministry of Agriculture and Forestry's Antalya Provincial Directorate, 296 producers in the province are growing pitaya on an area of 1270 decares. Manavgat is home to 38% of producers, Gazipaşa to 16%, Alanya to 14%, and Serik district to 9%. Producers cultivate pitaya on plots of land ranging in size from 0.2 to 14 decares. 4.29 decares is the average size of the land (Table 1).

**Table 1.** Pitaya Production Area by District in Antalya (2023)

| Districts | The number of producers | Production area (da) | Average production area (da) |
|---|---|---|---|
| Akseki | 1 | 8 | 8.00 |
| Aksu | 16 | 59 | 3.69 |
| Alanya | 42 | 115 | 2.74 |
| Demre | 2 | 2 | 1.00 |
| Finike | 4 | 5 | 1.25 |
| Gazipaşa | 47 | 83 | 1.77 |
| Kaş | 4 | 20 | 5.00 |
| Kemer | 3 | 7 | 2.33 |
| Kepez | 4 | 18 | 4.50 |
| Konyaaltı | 9 | 19 | 2.11 |
| Kumluca | 21 | 64 | 3.05 |
| Manavgat | 114 | 688 | 6.03 |
| Muratpaşa | 1 | 1 | 1.00 |
| Serik | 28 | 181 | 6.46 |
| Total | 296 | 1270 | 4.29 |

Source: Anonymous, 2023b.

Turkey's production of dragon fruit has increased in response to both local and foreign demand. (Tunç & Yılmaz, 2023). In order to promote dragon fruit as a profitable crop, the government and agricultural organizations have been providing guidance and financial rewards to farmers who cultivate it. When the economic aspects of pitaya are evaluated, it is seen that it can provide more profit than many fruits. For example, it has been determined that even if an average of 1,600 kg of product is purchased from pitaya per decare in 2023 in Antalya, producers can earn a net income of 2,148 USD dollar per decare (Table 2).

**Table 2.** Net income from pitaya in Antalya (2023)

| | |
|---|---|
| 1.Yield (kg/da) | 1,600 |
| 2. Pitaya price ($/kg) | 2.60 |
| 3. Gross income ($/da) (1x2) | 4,160 |
| 4. Total production costs ($/da) | 2,012 |
| 5. Unit costs ($/kg) (4/1) | 1.26 |
| 6. Net income ($/da) (3-4) | 2,148 |

Source: Anonymous, 2023b.

**Consumption and Health Benefits**

The recent rise in demand for dragon fruit can be attributed to both its attractive appearance and certain beneficial health effects (Ünver, 2023). Dragon fruit is high in fiber, antioxidants, and essential vitamins but low in calories. It has been shown that it provides potential health benefits like better immunity, better digestion, and a reduced likelihood of developing long-term illnesses. This has helped explained why its usage has risen globally.

Dragon fruit is becoming more widely available to Turkish consumers in cities, and the fruit has been consumed at an increasing rate. Although the fruit is frequently eaten uncooked, it can also be added to salads, smoothies, and desserts, as well as other gastronomic creations (Çağla et al., 2020).

**Marketing Structure**

The marketing structure of dragon fruit in Turkey and around the world is evolving to meet the growing demand. According to Lobo et al. (2013), dragon fruit is primarily marketed through the following channels in many countries;

**Local Markets and Grocery Stores:** Dragon fruit is available in local markets and grocery stores, making it easily accessible to consumers.

**Exports:** Countries with surplus production, like Vietnam and Thailand, export dragon fruit to international markets, helping to satisfy global demand.

**Online Retail:** The rise of e-commerce has opened up new avenues for the sale of dragon fruit, allowing consumers to purchase the fruit online.

**Restaurants and Food Service:** Many restaurants and food service providers incorporate dragon fruit into their menus, contributing to its popularity.

**Health and Organic Stores:** Dragon fruit is frequently encountered in health and organic food stores as a result of its perceived advantages for overall well-being.

**Challenges and Future Prospects**

Pests, illnesses, and the need for specialized knowledge are just a few of the challenges faced by dragon fruit growers in Turkey and around the world, despite the rising trend in dragon fruit production and consumption (Chen & Paull, 2019: Ilhan, 2023). Furthermore, the commercial viability of dragon fruit cultivation may be affected by changes in the market and competition from other exotic fruits.

However, the potential of dragon fruit shows up bright, within Turkey and globally. As more people become conscious of the health advantages and distinctive flavor of dragon fruit, demand is likely to keep on rising (Soydal et al., 2019; Ilhan, 2023). Given government support and technological advancements, production obstacles will be overwhelmed and dragon fruit will become a major role in the world fruit market.

**Conclusion**

Pitaya, or dragon fruit, has become incredibly popular due to its exotic taste, potential health benefits, and exotic taste. Turkey's government and favorable climatic conditions contribute to the rapid increase in dragon fruit production. As a result, it seems likely that dragon fruit will be widely stocked in Turkish and international fruit markets, providing a 'sustainable source of income' for farmers and being incredibly healthy and delicious for consumers. The worldwide rise in popularity of this remarkable fruit reflects the growing desire for diversity and conscious nutrition in the contemporary food landscape. For this reason, it would be beneficial to increase technical and economic comprehensive research on this product and to announce the results to the relevant people.

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# EKMEKLİK BUĞDAY YEREL ÇEŞİTLERİNİN VERİM VE BAZI AGRONOMİK ÖZELLİKLERE GÖRE DEĞERLENDİRİLMESİ

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## Özet

Kültürel mirasın bir parçası olan yerel buğday çeşitlerinde genetik erozyonun önüne geçebilmek ve kendine özgü kalite özelliklerini koruyabilmek için, genetik çeşitliliğin güvence altına alınması ve sürdürebilir tarım uygulamalarına yeniden entegrasyonu açısından yerel buğday çeşitlerinin ekimi teşvik edilmelidir. Bu çalışmanın amacı, Ege Bölgesinde yetiştirilen üç standart çeşit (Efe, Kayra, Meltem-Ege Tarımsal Araştırma Enstitüsü'nden temin edilen) ve yedi yerel buğday çeşidinin (Çalıbasan, Zerun, Kızılca, Kars Kırmızı, Krik, Ak Buğday, Üveyik) verim ve agronomik özelliklerini değerlendirmektir. Deneme, Yakaköy/Bornova lokasyonunda, 2021-2022 yılları yetiştirme döneminde gerçekleştirilmiştir. Denemeler, tesadüf blokları deneme desenine göre 3 tekerrürlü olarak düzenlenmiştir. İncelenen özelliklere ait ortalama değerler ve değişim aralıkları: bitki boyu 98.3 cm (83.7- 118.0), kardeş sayısı 1.5 adet (1.0- 2.4), hektolitre 77.5 kg/hl (75.8- 80.1), bin tane ağırlığı 35.4 g (24.4- 40.2), parsel tane verimi 1270.9 g (2000- 653) ve dekara tane verimi 211.8 kg/da (109.0- 333.3) olarak saptanmıştır. Varyans analiz sonuçlarına göre hektolitre ağırlığı dışındaki tüm özellikler bakımından çeşitler arasında %0.1 önemli farklılıklar tespit edilmiştir. Yerel ekmeklik buğday çeşitlerinin; bitki boyu ve kardeş sayısı bakımından standart çeşitlere (Efe, Kayra ve Meltem) göre daha yüksek ortalama değerler verdiği gözlemlenmiştir. Diğer özellikler bakımından standart çeşit ortalamaları öne çıkmıştır. Ortalama tane verimi bakımından yerel çeşitlerin ıslah çeşitlerinden %46.3 daha düşük verime sahip olduğu tespit edilmiştir. Ancak, Üveyik ve Ak Buğday çeşitlerinin genel ortalamadan, Zerun çeşidi de yerel çeşit ortalamasından daha yüksek değerler vererek verim yönünden farklılık yaratmışlardır. Ayrıca, Üveyik ve Ak Buğday çeşitleri Kayra ıslah çeşidinden daha fazla tane verimi vermiştir. Parsel ve dekara verim bakımından geniş bir varyasyon gözlemlenmiştir.

**Anahtar Kelimeler:** Buğday yerel çeşitleri, genetik çeşitlilik, sürdürülebilir tarım, genetik erozyon

# ASSESSMENT OF BREAD WHEAT LANDRACES BASED ON YIELD AND SOME AGRONOMIC CHARACTERISTICS

**Abstract**

To prevent genetic erosion in wheat landraces, which are a part of cultural heritage, and to preserve their unique quality characteristics, the cultivation of wheat landraces should be encouraged in terms of securing genetic diversity and reintegrating them into sustainable agricultural practices. This study aimed to objectively evaluate the yield and yield characteristics of three standard wheat cultivars (Efe, Kayra, Meltem) and seven wheat landraces (Çalıbasan, Zerun, Kızılca, Kars Kırmızı, Krik, Ak Buğday, Üveyik) sourced from various regions across Turkey. The trials were carried out during the 2021-2022 growing season in the Yakaköy/Bornova location and were designed using a randomized block design with three replications. Mean values and ranges of variation for the traits examined were: plant height 98.3 cm (83.7- 118.0), number of tillers 1.5 (1.0- 2.4), hectoliter 77.5 kg/hl (75.8- 80.1), thousand grain weight 35.4 g (24.4- 40.2), plot grain yield 1270.9 g (2000- 653) and decare grain yield 211.8 kg/ha (109.0- 333.3). According to the results of variance analysis, 0.1% significant differences were found among the varieties for all traits except hectoliter weight. It was observed that bread wheat landraces gave higher mean values in terms of plant height and number of tillers than the standard varieties (Efe, Kayra and Meltem). In terms of other traits, the standard varieties averages stood out. In terms of average grain yield, it was determined that landraces had 46.3% lower yield than the standad varieties. However, Üveyik and Ak Buğday gave higher values than the general average and Zerun gave higher values than the landraces average, making a difference in terms of yield. In addition, Üveyik and Ak Buğday gave higher grain yield than Kayra breeding variety. A wide variation was observed in terms of yield per plot and per decare.

**Keywords:** Wheat landraces, genetic diversity, sustainable agriculture, genetic erosion

## 1. Introductıon

Wheat is one of the first cultivated crops and has a very important place as a basic food raw material in human nutrition in the world and in Turkey. Today, it has the largest cultivation area among cultivated plants (FAO, 2021). Wheat is one of the most important and strategic agricultural products in Turkey, which is among the top 10 countries in the world in terms of production. The total production area is approximately 6.7 million hectares and production is around 20 million tons (TUIK, 2022).

Durum and bread wheat species are reported to originate from wild species growing in the so-called Fertile Crescent, which includes the Southeastern Region of Turkey (Heun et al., 1997). Turkey hosts a wide genetic diversity of wheat as it covers two centers of origin defined by Vavilov. As a result of natural evolution and hybridization from wild relatives of wheat in Anatolia and selection by humans, varieties suitable for regions and local needs began to emerge. This process resulted in the formation of wheat landraces that were intensively cultivated until the 20th century through natural and human-made selections. During the so-called the Green Revolution, the cultivation of wheat landraces gradually decreased as a result of the transfer of short height genes to wheat plants and the use of intensive fertilizers and pesticides (Çığ and Karaman, 2019). Today, the cultivation of wheat landraces has continued, especially in drought-stricken areas and areas lacking agricultural technology (Baloch et al., 2017). However, genetic diversity in landraces has gradually decreased and some varieties are only preserved in seed genebanks (Özkan et al., 2011). Some landraces, which have beneficial characteristics in terms of some commercial characters, especially quality, taste and aroma, have a satisfactory yield potential in terms of grain yield compared to modern breeding varieties, especially in areas where irrigation is limited (Aktaş, 2016). Wheat landraces are genotypes with population characteristics that are developed by farmers using traditional methods and have adapted to a certain region with the effect of natural selection (Zencirci, 2018). In recent years, interest in wheat landraces and products has been increasing in our country. Wheat landraces have started to be in demand by consumers due to their high nutritional value compared to other cereales and have been rediscovered as healthy foods. In addition, the importance of wheat landraces is increasing day by day due to its resistance to abiotic and biotic stress factors, its high adaptability to poor soils, and its low input cost, making it a suitable grain for organic farming. Today, landraces are used in a very low proportion of the wheat cultivation areas in Turkey. In order to ensure the sustainability of local varieties, farmers should be encouraged to protect local varieties, which are disappearing with the

widespread use of modern wheat varieties. This study was carried out to determine and characterize some agronomic properties of wheat varieties obtained from different locations of Turkey, under Yakaköy/Bornova conditions.

## 2. Materials and Methods

A total of 10 genotypes including 7 local bread varieties (Çalıbasan, Zerun, Kızılca, Kars Kırmızı, Krik, Ak Buğday and Üveyik) collected from different regions of Turkey and 3 standard varieties (Efe, Kayra, Meltem) obtained from the Aegean Agricultural Research Institute were used as material. The research was conducted in the Bornova Natural Agriculture Center and Farm located in Bornova / Yakaköy in the forest area in the 2021-2022 growing season. The location of the trial area is 38°50'08" north latitude and 27°18'09" east longitude coordinates and its altitude is 320 m.

Precipitation, temperature and relative humidity values for the 2021-2022 growing period and long-term averages are given in Table 1.

The average temperature measured during the experimental season was 12.4 $^{o}$C, the same as the long-term average. Total precipitation during the season was 617 mm, which is approximately 18% below the long-term average. When the distribution of precipitation during the vegetation period is examined, it is seen that the highest amount of precipitation fell in December and was 115.9% more than the long-term average. In January, 172.2% less precipitation fell than the long-term average. In February, precipitation increased again, 38% more than the long year average. In the following months, until the harvest period, very low rainfall was reported (Table 2).

**Table 1.** Climatic data for Yakaköy/Bornova location

| | Temperature (°C) | | Precipitation (mm) | | Relative Humidity (%) | |
|---|---|---|---|---|---|---|
| Months/Years | 2021-2022 | Long Years | 2021-2022 | Long Years | 2021-2022 | Long Years |
| October | 15.4 | 16.8 | 47.0 | 50.6 | 68.3 | 68.9 |
| November | 12.9 | 12.1 | 63.4 | 61.5 | 80.8 | 76.1 |
| December | 8.0 | 7.4 | 225.0 | 104.2 | 92.8 | 83.8 |
| January | 4.5 | 6.0 | 68.4 | 186.2 | 81.3 | 84.3 |
| February | 7.0 | 8.1 | 130.6 | 94.6 | 85.0 | 80.3 |
| March | 5.3 | 10.2 | 26.0 | 89.0 | 64.6 | 73.7 |
| April | 14.8 | 14.1 | 29.1 | 46.4 | 61.9 | 64.2 |
| May | 19.7 | 19.1 | 7.9 | 41.5 | 50.2 | 59.3 |
| June | 24,2 | 23.0 | 19.7 | 55.1 | 49.6 | 58.2 |
| Average | 12.4 | 12.4 | 617* | 729.0* | 70.5 | 72.05 |

General Directorate of Meteorology, *: Total value

The soil structure, chemical and organic matter contents of Bornova/Yakaköy Bornova Natural Agriculture Center and Farm (BDTMÇ) during the 2021-2022 wheat growing season were analyzed at Ege University Soil Science and Nutrition department laboratory. Soil analysis values are given in Table 2.

**Table 2.** Soil properties of the study area

| | |
|---|---|
| Depth (cm) | 0-30 |
| Soil reaction (pH) | 8.1 medium alkaline) |
| Salinity (%) | 0.05 (Unsalted) |
| Lime ($CaCO_3$) (%) | 22.1 (Very Calcareous) |
| Sand (%) | 44.96 |
| Mile (%) | 28 |
| Clay (%) | 27.04 |
| Soil structure | Clay-Loam |
| Organic matter (%) | 3.22 (Adequate) |
| Total N (%) | 0.319 (Excess) |

According to the results of the soil sample analysis taken from the soil surface and 30 cm depth, the soil has a clay-loam structure, high lime content and medium alkaline character. Salt content is low (0.05%), total nitrogen content is high (0.319%) and organic matter content is sufficient (3.22%).

The experiment was established according to the randomized block design with 3 replications. The plot size of the trials was planned as 6 rows with 1.20 m x 5 m = 6 $m^2$ at harvest. Sowing was done on November 13. The sowing norm was 500 seeds per $m^2$. When the plants reached harvest maturity, on June 25, 2022, the plots were harvested by hand and the spike was grained in a threshing machine.

Plant height (cm), number of tillers (number), hectoliter (kg/hl), thousand grain weight (g), plot grain yield (g) and grain yield per decare (kg/da) traits were analyzed. Analysis of variance was applied to the data of the examined traits using the SPPSS V.22 statistical program and the differences between the averages were grouped by applying the least significant difference (LSD) test.

**3. Results and Discussion**

In this study conducted under Bornova/Yakaköy conditions, analysis of variance results of plant height, number of tillers, hectolitre, thousand grain weight, plot grain yield and decare grain yield of seven landraces and three improved bread wheat varieties are given in Table 3. According to the analysis of variance results of the data obtained, significant differences at

0.1% level were found among the varieties for all traits except hectolitre. The mean of the traits analyzed and the groups formed are given in Table 4.

***Plant Height***

When the analysis of variance table of plant height of bread wheat used in the study was examined, it was found that it was significant between the varieties at $p < 0.01$ significance level and with a coefficient of variation of 7.9 (Table 3).

The mean plant height of bread wheat genotypes varied between 84.9 cm and 118.0 cm and the general mean was 98.3 cm. Seven different groups were formed among wheat genotypes. Among the landraces, Çalıbasan had the longest plant height of 118.0 cm, followed by Zerun 111.7 cm. The landrace Üveyik had the shortest plant height of 90.5 cm. The average of landraces was 102.1 cm (Table 4).

**Table 3.** Analysis of variance results of the mean squares for the examined traits

| Source of Variation | DF | PH | NT | Hektolitre | TGW | PY | Yield |
|---|---|---|---|---|---|---|---|
| Genotype | 9 | 419.825 | 0.532 | 5.553 | 58.364 | 426150.245 | 11837.538 |
| Repetition | 2 | 28.592 | 0.025 | 7.012 | 22.185 | 140673.157 | 3907.660 |
| Error | 18 | 60.165 | 0.014 | 7.044 | 9.038 | 107807.670 | 2994.605 |
| General | 29 | 169.606 | 0.176 | 6.579 | 25.832 | 208870.227 | 5801.933 |
| F value | | 6.978** | 37.406** | 0.788ns | 6.458** | 3.953** | 3.953** |
| Coefficient Variation (%) | | 7.9 | 8.2 | 3.4 | 8.5 | 25.8 | 25.8 |

**: p<0.01; ns: not significant; DF: degrees of freedom; PH: Plant Height (cm); NT: Number of Tillering (number); Hectolitre: Hectolitre Weight (kg/hl); TGW: Thousand Grain Weight (g); PY: Plot Yield (g); Yield: Yield per Decare (Kg/da)

Among the bread standard varieties, the tallest was Efe with 93.1 cm. Kayra 90.5 cm and Meltem 84.9 cm were in the same group. The average height of standard varieties was 89.5 cm (Table 4).

**Table 4.** Mean values and groups formed for the analyzed traits

| Genotypes | Plant Height (cm) | N. of Tillering (number) | Hektolitre (kg/hl) | TGW (g) | Plot Yield (g) | Yield (Kg/da) |
|---|---|---|---|---|---|---|
| Çalıbasan | 118.0 *a* | 1.0 *f* | 78.7 | 36.5 *abc* | 1065.0 *bcd* | 177.5 *bcd* |
| Zerun | 111.7 *ab* | 1.9 *b* | 78.4 | 32.4 *c* | 1258.8 *bc* | 209.8 *bc* |
| Kızılca | 104.0 b*cd* | 1.1 *fg* | 80.1 | 38.5 *ab* | 1085.0 *bcd* | 180.8 *bcd* |
| Kars Kırmızı | 109.1 a*bc* | 1.6 *c* | 75.8 | 24.4 *d* | 886.3 *cd* | 147.7 *cd* |
| Krik buğdayı | 97.5 *cde* | 2.4 *a* | 76.1 | 38.1 *ab* | 653.8 *d* | 109.0 *d* |
| Ak Buğday | 83.7 *f* | 1.5 *cd* | 77.6 | 37.5 *abc* | 1377.5 *bc* | 229.6 *bc* |
| Üveyik | 90.5 *ef* | 1.3 *def* | 76.0 | 40.2 *a* | 1485.0 *ab* | 247.5 *ab* |
| Efe (SV) | 93.1 *def* | 1.4 *de* | 77.7 | 36.1 *abc* | 1550.0 *ab* | 258.3 *ab* |
| Kayra (SV) | 90.5 *ef* | 1.2 *efg* | 76.6 | 36.0 *abc* | 1347.5 *bc* | 224.6 *bc* |
| Meltem (SV) | 84.9 *ef* | 1.1 *f* | 77.9 | 34.3 *bc* | 2000.0 *a* | 333.3 *a* |
| Average of Landraces | 102.1 | 1.5 | 77.5 | 35.4 | 1115.9 | 186.0 |
| Avr.of Standard Varieties | 89.5 | 1.2 | 77.4 | 35.5 | 1632.5 | 272.1 |
| Overall Avr. | 98.3 | 1.5 | 77.5 | 35.4 | 1270.9 | 211.8 |
| LSD (0.05) | 13.31 | 0.21 | 4.55 | 5.18 | 563.26 | 93.88 |

LSD: Least significant difference; SV: Standard Variety

It was observed that wheat landraces gave higher average values in terms of plant height than the standard varieties (Efe, Kayra and Meltem). In terms of plant height, landraces were 12.3% taller than standard varieties. Çalıbasan, Zerun, Kars Kırmızı, Kızılca differed in terms of stem-straw yield. The lodging tates of these genotypes should be evaluated. The fact that the plant height of wheat landraces is higher than standard varieties has been reported that lodging problems may occur when landraces are grown in fertile areas (Austin et al., 1989). However, it can be said that tall wheat landraces in dry farming areas are important for breeding research since they utilize the substances they accumulated in their structures before spring drought stress for grain (Miralles and Slafer, 1995; Seidel, 1996).

According to a study conducted on winter bread wheat landraces populations collected from seven regions of Turkey, bread wheat landraces were found to be between 51-140 cm in height classification (Akçura and Topal, 2016). In a study conducted by Koç et al. (2020) with a total of 25 bread wheat varieties, including 15 wheat landraces, plant height was found to be 102.5 cm, which is similar to this study.

***Number of Tillers***

When the tiller number data of the bread wheat genotypes used in the study were analyzed, the differences among the wheat genotypes were found statistically significant at $p<0.01$ level with a coefficient of variation of 8.2% (Table 3).

The number of tillers of bread wheat genotypes varied between 1.0-2.4. The general average was determined as 1.5. According to the results of statistically significant difference test, 9 different groups were formed (Table 4). Among the wheat landraces, Krik had the highest number of tillers with an average of 2.4, followed by Zerun 1.9, Kars Kırmızı 1.6 and Ak Buğday 1.5. The least tillered landraces was Çalıbasan with 1.0 tillering. Among the standard varieties, Efe showed the highest tillering with 1.4, while Kayra ranked second among the standard varieties with 1.2 units. The lowest tillering was observed in Meltem variety with 1.1 units. The average of the standard varieties was determined as 1.2. It was observed that bread wheat landraces tillered more than the standard varieties except for Çalıbasan and Kızılca genotypes (Table 4). In terms of number of tillers, landraces had 25% more average value than standard varieties. The number of tillers is one of the main factors affecting grain yield (Sade, 1999). Akçura, (2006) found that the number of fertile tillers in wheat landraces varied between 3.33 and 5.83. Since the research was conducted on the basis of regions and with many genotypes, it is thought that the variation may have been higher than this study. It is stated that if wheat decreases plant density due to environmental conditions, the number of tillers increases as an adaptation feature, and in case of dense sowing, there is an inverse proportion in the direction of decreasing the number of fertile tillers (Darwinkel, 1978; Akkaya, 1994).

***Hectoliter***

When the hectoliter values of bread wheat varieties were analyzed, it was found that the difference between genotypes was not significant. The coefficient of variation was found to be 3.4% (Table 3).

No groups were formed in the least significant difference (LSD) test on hectoliter weights of wheat varieties. Hectoliter weights of the genotypes varied between 80.1 kg/hl and 75.8 kg/hl. The overal hectoliter average value was 77.5 kg/hl (Table 4). Among the bread wheat landraces, Kızılca had the highest value in terms of hectoliter with 80.1 kg/hl. It was followed by Çalıbasan with 78.7 kg/hl and Zerun with 78.4 kg/hl. Kars Kırmızı gave the lowest data with 75.8 kg/hl. It was followed by Üveyik with 76.0 kg/hl and Krik with 76.1 kg/hl. The average of landraces was recorded as 67.7 kg/hl. Among the standard varieties, the variety with the highest hectoliter value was Meltem with 77.9 kg/hl, while Kayra had the lowest hectoliter weight with 76.6 kg/hl.

The average hectoliter weight of standard varieties was 77.4 kg/hl. If we compare the averages of landraces and standard varieties, there is a difference of 0.4%. The varieties above the general average were Kızılca (80.1), Çalıbasan (78.7), Zerun (78.4), Meltem (77.9), Efe (77.7) and Ak Buğday (77.6). Kızılca had a value above the standard varieties. Mut et al. (2005), reported that the hectoliter weights of bread wheat varieties were found between 68.4 and 74.9 kg/hl in their research on quality characteristics under Amasya and Samsun conditions. The shape, size and homogeneity of the grain are the characteristics that determine the hectoliter weight (Özkaya and Kahveci 1990).

***Thousand Grain Weight***

When the table related to thousand grain weight of bread wheat genotypes was examined, it was determined that the difference between genotypes was significant at $p<0.01$ level and 8.5% coefficient of variation (Table 3).

The LSD test was applied to the thousand grain weight data of wheat varieties and 6 different groups were recorded. It was determined that the thousand grain weights of the genotypes varied between 40.2 grams and 24.4 grams. The overall thousand grain average of the varieties was found to be 35.4 grams (Table 4). Among the wheat landraces, Üveyik had the highest thousand grain weight with 40.2 grams, followed by Kızılca with 38.5 grams and Krik with 38.1 grams. The lowest weight was recorded as Kars Red with 24.4 grams, followed by Zerun local variety with 32.4 grams. The average weight of landraces was 35.4 grams (Table 4.20.). Among the standard varieties, the highest thousand grain weight was observed in Efe variety with 36.1 grams, followed by Kayra variety in the same group. The standard variety Meltem was behind Efe and Kayra with a weight of 34.3 grams. The average of the standard varieties was recorded as 35.5 grams (Table 4.20.). When the average thousand grain weights were compared, the standard varieties had 0.3% more average value than the local varieties. Steppe genotype was recorded to have a value above the standard varieties. Çalıbasan (36.5 g) and Ak Buğday (37.5 g) were in the same group with Efe and Kayra, which are standard varieties. It was determined that the standard varieties were above the averages (Table 4.20.). Gençtan and Balkan (2006), in their research on yield characteristics, determined that thousand grain weights were between 31.53 and 44.02 grams. In another study conducted with 122 local bread wheat varieties collected from Bingöl province and its districts, thousand grain weight was reported between 22.61-40.96 g (Uçar, 2016). Foy and Peterson (1994) reported that thousand grain weight has a great effect on grain yield.

***Plots Grain yield***

When the variance table of wheat genotypes was examined, it was found that the difference between genotypes was significant at p<0.01 level with a coefficient of variation of 25.8% (Table 3). The yields of the plots of bread wheat varieties varied between 2000 grams and 653 grams. Five different groups were formed in the minimum significance test and the overall plot average was recorded as 1270 grams.

The highest plot yield of local wheat genotypes was recorded as Üveyik with 1485.0 grams, followed by Ak Wheat with 1377.0 grams, Zerun with 1258.8 grams, Kızılca with 1085.0 grams and Çalıbasan with 1065.0 grams. The lowest plot yield was obtained from Krik wheat with 653.8 grams. This was followed by Kars Red with 886.3 grams. The average plot yield of local wheats was 1115.9 grams. When the plot yields of standard varieties were analyzed, the highest yield was obtained from Meltem variety with 2000.0 grams. This was followed by Efe with 1550.0 grams. The lowest yield was obtained from Kayra variety with 1347.5 grams. The average of standard varieties was recorded as 1632.5 grams. When the average of local and standard varieties are compared, it is seen that the standard varieties are above the landraces with a difference of 46.3%. Efe and Üveyik, Kayra and White Wheat, Kars Kırmızı and Zerun, Çalıbasan and Kızılca were in the same group (Table 4).

***Decare Grain Yield***

When the analysis of variance table of decare grain yield of bread wheat genotypes used in the study was examined, it was found that the difference between genotypes was statistically significant at p<0.01 level and with 25.8% coefficient of variation (Table 3).

Decare grain yield of the varieties varied between 109.0 kg and 333.3 kg, while the general average was 211.8 kg. According to the results of the minimum significance test applied to the varieties, five different groups were formed. The highest grain yield among the local bread wheat varieties was Üveyik with 247.5 kg. It was followed by Ak Wheat with 229.6 kg, Zerun with 209.8 kg and Kars Red with 147.7 kg. The lowest decare grain yield was given by Krik wheat with 109.0 kg. The average yield of local wheats was 186.0 kg. Among the standard varieties, the highest decare grain yield was obtained from Meltem variety with 333.3 kg and the lowest yield was obtained from Kayra variety with 224.6 kg. The average yield of standard varieties was recorded as 272.1 kg. When the average yield per decare is analyzed, it is seen that the standard varieties are ahead of the local varieties. There was a 46.3% difference between the averages of breeding and local varieties. The low yield average of Krik wheat decreases the average of local varieties. Steppe wheat was found to be in the same group with Efe, one of the

standard varieties (Table 4). Bozkurt (2023) determined grain yield per decare between 152.59 kg/ha and 331.04 kg/ha in Eskişehir irrigated conditions. Kettlewell et al. (1998) stated that grain yield per hectare is the result of the interaction of environmental effects, genetic effects and conventional or modern breeding methods. Smith and Googing (1999) reported that rainfall regime and temperature variation during the growing season affect yield.

## 4. Conclusion

This study was carried out to determine and characterize some agronomic and agronomic traits of wheat landraces obtained from different locations of Turkey under Yakaköy/Bornova conditions. According to the results of variance analysis, significant differences of 0.1% were found among the varieties for all traits except hectoliter weight.

It was observed that local bread wheat varieties gave higher mean values in terms of plant height and number of tillers than the breeding genotypes (Efe, Kayra and Meltem). In terms of other traits, the standard varieties stood out. In terms of plant height, landraces were 14.1% taller than the breeding varieties. Çalıbasan, Zerun, Kars Kırmızı and Kızılca varieties made a difference in terms of stem-straw yield. In terms of the number of tillers, the landraces had 25% more tillers on average than the breeding varieties. Krik wheat had the highest number of siblings (2.4). In terms of average grain yield, landraces had 46.3% lower yield than the standard varieties. However, Steppe and Ak wheat varieties had higher values than the general average and Zerun variety had higher values than the local variety average, which made a difference in terms of yield. In addition, Steppe and Ak wheat varieties gave higher grain yield than Kayra cultivar. A wide variation was observed in terms of yield per plot and per decare.

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# BİTKİ VİRÜS DAYANIKLILIK GENLERİNİN BELİRLENMESİ VE BULK SEKREKANT ANALİZİ

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## Özet

Birçok hastalık için dayanıklı çeşitlerin kullanımı büyük önem taşımaktadır. Bitki virüs hastalıklarından korunmada en sürdürülebilir, etkili ve ekonomik mücadele yöntemi dayanıklı çeşitlerin kullanımıdır. Dayanıklılık biyokimyasal, fiziksel ve genetik dayanıklılık olmak üzere üç başlıkta incelenebilir. Direnç genlerinin sağladığı genetik direnç, tek bir gen tarafından kontrol edilenler ve birden fazla gen tarafından kontrol edilenler olarak gruplandırılabilir. Bitki virüsü dayanıklılık genleri resesif veya baskın olabilir, ancak çoğu baskın genlerdir. Dayanıklılık ıslahında bu genlerin tespiti ve markörlerin keşfi ilgili çalışmaları oldukça hızlandırmıştır. Dayanıklılık ıslahında çok önemli bir yere sahiptir olan markerler hibridizasyona ve PCR'a dayalı olarak sınıflandırılabilmekdir. Bulk sekretant analizi, dayanıklılık genlerini tespit etmek için kullanılan yaygın bir yöntemdir. Bitki genetiğinde kullanımı ilk olarak Michelmore vd., (1991) tarafından gerçekleşmiştir. Belirli bir gene veya genomik bölgeye bağlı belirteçleri hızlı bir şekilde tanımlamak için geliştirilmişlerdir. Toplu sekretant analizi gerçekleştirmek için öncelikle bir bitki popülasyonu oluşturulmalıdır. Bunun için öncelikle tüm genotipler yetiştirildikten ve virüsle enfekte edildikten sonra gözlemlenmelidir. Hassas ve dayanıklı genotiplerden DNA örnekleri alındıktan sonra hassas ve dirençli genotipler çaprazlanarak F1 hattı elde edilir. F2 hatları, %100 heterozigot bitkilerden oluşan F1 hattının kendilenmesiyle elde edilir. F2 hatlarından elde edilen ve ebeveynlerden alınan DNA örnekleri markerlerle karşılaştırılır. Konakçı bitki kendi mevcut markörleriyle tarandıktan sonra genetik haritalama yapılır. Ardından genin işaretleyiciye olan mesafesi hesaplanır. Dayanıklılık geninin frekansı, homozigotluk ve heterozigotluğun belirlenmesiyle bir oran elde edilir. Bu oran %30 ile %90 arasında olursa toleranslı, %90'ın üzerinde ise dayanıklı genotipler elde edilmiş olur.

**Anahtar Kelimeler:** Bulk Sekrekant Analizi, Virüs, Dayanıklılık, Bitki Dayanıklılığı, Dayanıklılık Geni, Bitkide Virüs Dayanıklılığı

# DETECTION OF VIRUS RESISTANCE GENES AND THE USE OF BULK SECRETANT ANALYSIS IN THE DETECTION OF RESISTANCE GENES

**Abstract**

The use of resistant varieties is of great importance for many diseases, but the most sustainable, effective and economical control method for plant virus diseases is the use of resistant varieties. Resilience can be examined under three headings: biochemical, physical and genetic endurance. Genetic resistance provided by resistance genes can be grouped as those controlled by a single gene and those controlled by multiple genes. Plant virus resistance genes can be recessive or dominant, but many are dominant genes. The discovery of markers in the detection of these genes and resistance breeding has accelerated the work very much. Markers can be classified based on hybridization and PCR moreever they have a very important place in resistance breeding. Bulk secretant analysis is a common method used to detect resistance genes. Its use in plant genetics was first developed by Michelmore et al. (1991). Developed to quickly identify markers linked to a specific gene or genomic region. To perform bulk secretant analysis, a plant population must first be created. All genotypes are observed after being grown and then infected with the virus. DNA samples are taken from Sensitive and Resistant genotypes and these genotypes are grown again. The sensitive and resistant genotypes are crossed and F1 line is obtained. F2 lines are obtained by self- pollination the F1 line, which consists of 100% heterozygous plants. DNA samples obtained from F2 lines and taken from the parents are compared with the markers. It is screened with existing markers of the host plant. Genetic mapping is done. The distance of the gene to the marker is calculated. Ratio is obtained by determining the frequency of the resistant gene, homozygosity and heterozygosity. If this ratio is between 30% and 90%, a tolerant variety is obtained, and if it is above 90%, a resistant variety is obtained.

**Keywords:** Resistance gene, virus resistance, Bulk secretant analysis

## 1. Giriş

Kültür bitkilerinde hastalık ve zararlılar önemli verim kayıplarına neden olmaktadır. Bitki hastalıkları içerisinde bitki virüsleri önemli hastalık grupları arasında yer almaktadır. Verimi ve kaliteyi önemli oranda düşürürler ve bazı durumlarda bitkilerin ölümüne dahi sebebiyet verebilmektedirler. Diğer hastalıkların aksine bitki virüs hastalıklarının kimyasal mücadelesinin olmaması virüs hastalıklarını önemli bir hale getirmektedir (Agrios, 2005; Yeşil ve Ertunç ,2012; Kang, Yeam ve Jhan, 2005). Bitki virüs hastalıklarından korunmada kültürel önlemler tavsiye edilmektedir. Kültürel önlemler içerisinde de en etkili, sürdürülebilir ve ekonomik olanı Zhang vd, (2002)' de belirtildiği gibi dayanıklı çeşit kullanımıdır.

## 2. Bitki Virüs Hastalıklarında Dayanıklılık

Dayanıklılık bitkinin hastalık etmeniyle karşılaşması durumunda enfeksiyona karşı koyabilmesi durumu olarak nitelendirilebilir. Dayanıklılık kalıtsal bir özelliktir ama bazı durumlarda sonradan da kazanılabilir (Agrios, 2005). Bitkilerde virüs hastalıklarına karşı dayanıklılığı morfolojik dayanıklılık, biyokimyasal dayanıklılık ve genetik dayanıklılık olarak 3 başlık altında inceleyebiliriz.

### 2.1. Bitki Virüs Hastalıklarında Biyokimyasal Dayanıklılık

Biyokimyasal dayanıklılık konukçunun bitkinin salgıladığı kimyasallarla ilişkilidir. Enfeksiyondan önce ya da sonra gerçekleşebilir. Enfeksiyondan önce gerçekleşmesi bitkinin hali hazırda içerdiği biyokimyasal maddelerin virüs patojeninin gelişimine engel olması şeklinde ya da virüsün kendini replike edebilmesi için gerekli moleküllerin eksikliğinden ötürü virüsün çoğalmaması şeklinde kendini gösterebilir. Enfeksiyon sonrası gerçekleşen biyokimyasal dayanıklılıksa, konukçu bitkinin enfekte olduktan sonra salgıladığı bazı kimyasalların virüsün gelişimine yahut virüsün replikasyonuna engel olmasıdır. Ket vurucular, virüs replikasyonunu engelleyebilecek bazı inhibitörler, fitoalaksinler ve fenollü bileşikler enfeksiyon sonrası sağlanan biyokimyasal dayanıklılık geliştirilmesi için gerekli bazı kimyasallardır (İlbağı ve Çıtır, 2006; Yeşil ve Ertunç, 2012). HR (hipersensif resistance) olarak bilinen bitkinin enfekte olduktan sonra enfeksiyon bölgesini çevreleyen hücrelerin hızla programlanmış şekilde hücre ölümüne uğramasıyla gerçekleşen lokal lezyonlardır. Bu lezyonlar virüsün yayılmasını engeller ve bu da enfeksiyon sonrasında oluşan biyokimyasal dayanıklılık başlığı içerinde yer almaktadır (Goldbach, Bucher ve Prins, 2003).

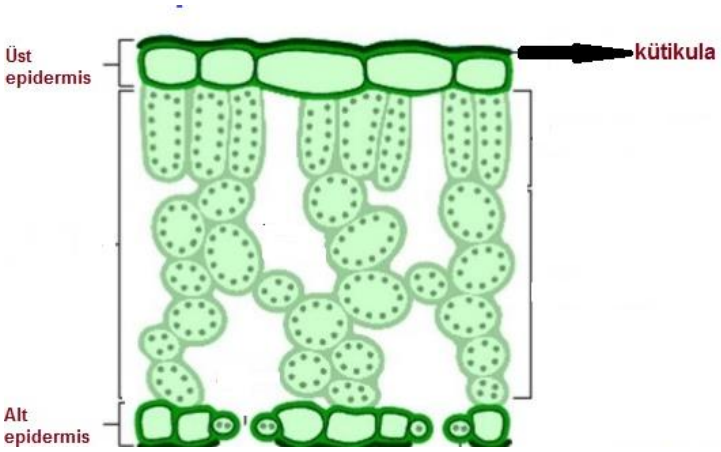
### 2.2. Bitki Virüs Hastalıklarında Morfolojik Dayanıklılık

Morfolojik dayanıklılık konukçu bitkinin morfolojik, yapısal özellikleriyle oluşan dayanıklılık türüdür. Konukçu bitkinin gelişen bazı özellikleri virüs bulaşmasını engelleyerek ya da

zorlaştırarak konukçu bitkinin daha dayanıklı olmasını sağlayabilmektedir. Birçok virüs hastalığının taşınma yolu vektörlerle olduğu için Şekil 1.'de görüldüğü gibi tüylü yaprak yapısı veya Şekil 2.'deki gibi kalın epidermis tabakası ve kalın kütiküla tabakası vektörlerin beslenmesini zorlaştırarak virüsün bulaşmasını engeller ve böylece morfolojik özelliklere dayanan bir dayanıklılık oluşmuş olur. Bazı durumlarda konukçu bitkinin olgunlaşmasından sonra enfeksiyona yakalanmaması olarak bilinen olgun bitki dayanıklılığı da morfolojik yani yapısal dayanıklılık başlığının içerisinde yer almaktadır. Bitkilerdeki sert hücre duvarı da pasif bir dayanıklılık oluşturarak morfolojik dayanıklılık başlığı altında incelenebilir (Goldbach vd., 2003; İlbağı ve Çıtır, 2006; Yeşil ve Ertunç, 2012).



**Şekil 1. Menekşe bitkisinde tüylü yaprak (https://www.menekse.gen.tr/menekse-yapragi.html)**




**Şekil 2. Yaprak enine kesitinde kütikula ve epidermis tabakaları (https://webders.net/350/mezofil-tabakasi.html)**

### 2.3. Bitki Virüs Hastalıklarında Genetik Dayanıklılık

Bitkinin genom yapısının özellikleriyle bağlantılı bir dayanıklılık çeşidi olup dayanıklılık genlerle yeni nesillere aktarılabilir. Bu dayanıklılık türü morfolojik ve biyokimyasal dayanıklılığın temelini oluşturur (Agrios, 2005). Genetik dayanıklılık kalitatif ve kantitatif şekilde kendini gösterebilir. Monogenik, tek gen ile kontrol edilen dayanıklılık kalitatif,

poligenik ise birden fazla genle kontrol edilen dayanıklılık kantitatif dayanıklılıktır. Genetik dayanıklılık bitkilerde sert hücre duvarının sağladığı morfolojik dayanıklılık gibi pasif olarak, Şekil3.'de görülen hipersensif yanıt (HR) ile oluşan enfeksiyon çevresindeki indüklenmiş programlı hızlı hücre ölümleri gibi aktif olarak da kendini gösterebilir (Goldbach vd., 2003).



**Şekil 3. Tütün bitkisinde HR (hipersensif resistance) reaksiyonu (https://docplayer.biz.tr/113180016-T-c-selcuk-undversdtesd-fen-bdldmlerd-enstdtusu.html)**

Konukçu bitkinin enfeksiyona karşı dayanıklılık gösterebilmesi için patojeni tanıması gerekmektedir. Konukçu bitkinin virüsü tanıması, bitkideki resistance (R) genlerinin patajende virülensliği sağlayan avirülens (Avr) genlerini tanımasıyla gerçekleşir (Frasser, 1990). Bitki virüs hastalıklarına direnç genleri aksi görülmekle birlikte genel olarak dominant genlerdir (Goldbach vd., 2003). Hull (2002) bitki virüs dayanıklılık genlerinin büyük bir kısmının, 139 genden 81'nin dominant olduğunu çalışmasında belirtmiştir. Patojen taksonlarının geniş yelpazesine rağmen bugüne kadar tanımlanan R genleri yalnızca 5 sınıfa ayrılmakta olup birçoğu NBS-LRR ( Nucleotide Biding Site- Leucine Rich Pepeat) sınıfındadır (Dangl ve Jones, 2001). Doku nekrozu, hücre ölümü, aşırı duyarlılık gibi şekillerde kendilerini gösterebilirler (Maule vd., 2007). Resesif dayanıklılık genleri ise dominant dayanıklılık genlerine oranla daha azdır. Hull (2002) 139 bitki virüs dayanıklılık geninin yalnızca 43'nün resesif olduğunu bildirmiştir. Resesif dayanıklılık genlerinde dayanıklılık aktif veya pasif olarak kendini gösterebilir. Virüsün yaşam çemberi için gerekli olan maddelerin eksikliği pasif, bitkinin virüsü tanıyarak virüsün gelişimini engelleyici maddeler salgılaması aktif mekanizmalardır (Maule vd., 2007). Tablo 1.'de şimdiye kadar tanımlanan bazı dayanıklılık genleri, konukçuları ve ilgili virüs etmenleri verilmiştir. Görüldüğü gibi virüs etmenlerine karşı bilinen birçok dayanıklılık geni mevcuttur (Tablo 1).

Bitkilerin virüs hastalıklarına karşı oluşturduğu bazı doğal mekanizmalar mevcuttur. Bu mekanizmalar içerisinde üzerinde en fazla durulan konu çapraz dayanıklılıktır (Cross prodection). Çapraz dayanıklılık virüsün zayıf (mild) ırklarının, şiddetli (severe) ırklarından korunmak için kullanılmasıdır (Açıkgöz, 1994). Bunun ilk örneği 1929 yılında TMV'nin zayıf ırklarıyla bulaştırılan bitkilerin diğer ırklarına direnç kazandığının görülmesidir (Frasser, 1990; Akbulut ve Gülşen, 2010). Bitki virüslerinin bitki dayanıklılığı için kullanımı ilk olarak Hamilton (1985) tarafından patojen temelli direnç olarak gündeme getirilmiştir. Bazı bulgular göz önünde bulundurulduğunda viral kapsül genlerinin patojenlere aktarılmasıyla direnç elde edilebileceği düşünülmektedir (Açıkgöz, 1994). Bitki virüs hastalıklarına karşı dayanıklılık oluşturmada virüslerin kullanılması konusunda bazı alternatifler mevcuttur. Açıkgöz (1994) viral protein geni, tüm viral genom, antisense dizilişi, satellite dizilişi olarak bazı alternatifler belirtmiş ve bunların kullanılabilirliğini tartışmıştır.

Birçok moleküler yöntemin mevcut olmasıyla birlikte bu yöntemlerin çoğunun gen nakli ile gerçekleştirilerek elde edilen transgen bitki sayılması ve transgenik bitkilerin üretiminin çoğu ülkede yasal olmaması nedeniyle belirlenmiş bitki virüs dayanıklılık genlerinin çeşitlerde saptanması ya da henüz belirlenmemiş bitki virüs dayanıklılık genlerinin saptanması araştırıcılar için çok önemli bir husustur. Bitki genotiplerinde, virüs dayanıklılığı oluşturan genler önceden belirlenmiş ise bu dayanıklılık genlerinin saptanmasında moleküler markörlerin kullanılması araştırmaları büyük oranda hızlandırmıştır (Filiz ve Koç, 2011).

**Tablo 1. Belirlenen bazı dayanıklılık genleri, virüs ve konukçuları**

| GEN | VİRÜS | KONUKÇU | KAYNAK |
|---|---|---|---|
| N | TMV | *Nicotiana glutinosa* | (Holmes, 1929) |
| Tm-2 | TMV | *Lycopersicon esculentum* | (Pilowski vd., 1981) |
| By, By-2 | BYMV | *Phaseolus vulgaris* | (Schroeder ve Provvidenti, 1968) |
| Ry | PVY | *Patato* | (Barker ve Harrison, 1984) |
| zym | ZYMV | *Cucumber* | (Provvidenti ve Alconero, 1987) |
| Bdv1 | BYDV | *Triticum aestivum* | (Singh vd., 1993) |
| Rx1, Rx2 | PVX | *Solanum tuberosum* | (Bendahmane vd., 1999; 2000) |
| Sw5 | TSWV | *S. esculentum* | (Brommonschenkel vd., 2000) |
| Y-1 | PVY | *Solanum tuberosum* | (Vidal vd., 2002) |
| $mol^1$ $mol^2$ | LMV | *L. sativa* | (Nicaise vd., 2003) |
| sbm1 | PSbMV | *P. sativum* | (Gao vd., 2004) |
| RT4-4 | CMV | *Phaseolus vulgaris* | (Seo vd., 2006) |
| Rym4-5 | BaYMV2<br>BaMMV<br>BaYMV | *Hordeum vulgare* | (Stein vd, 2005: Kanyuka vd., 2005) |
| nsm | MNSV | *Cucumis melo* | (Nieto vd., 2006) |
| rymv1 | RYMV | *Oryza sativa* | (Albar vd., 2006) |

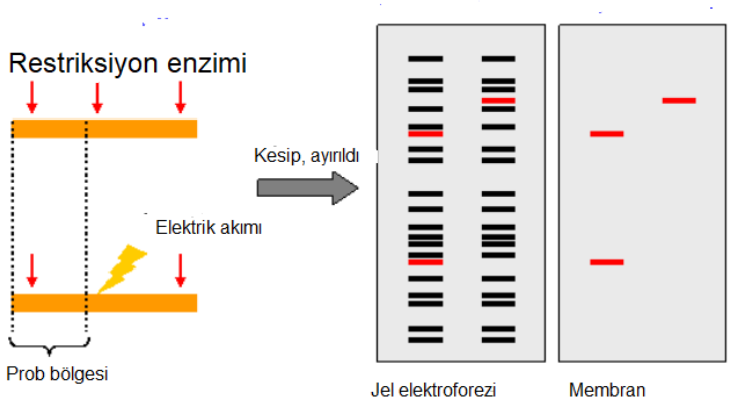
## 3. Moleküler Markör Sistemleri

Moleküler markörler genomda belirli bir bölgenin çoğaltılması için kullanılan dizelerdir. Bitki dayanıklılık ıslahında moleküler markörlerin kullanımı ıslah sürecini oldukça kısaltmaktadır. Moleküler markörler PCR temelli olanlar ve PCR temelli olmayan olmak üzere ikiye ayrılırlar.

En çok kullanılan bazı markör sistemlerine örnek olarak RFLP, RAPD, AFLP, SSR, ISSR verilebilir (Staub vd, 1996; Ridout ve Donini, 1999).

### 3.1. RPLF, Kesilen Fragmentlerin Uzunluk Polimorfizmi (Restriction Fragment Lenght Polymorphisms)

Keşfedilen ilk moleküler markör tekniği olup hibridizasyon temeline dayanır ( Yorgancılar vd., 2015: Devran, 2016). İzole edilen DNA'lar restriksiyon enzimleri ile kesilir ve markör olarak problar kullanılır. RFLP markörlerinin çalışma mekanizması Şekil 4.'de verilmiştir. Kodominant yani eş baskın olmaları sebebiyle heterozigot bireylerin tanılanmasını sağlarlar ve bu RPLF markörlerinin avantajları arasındadır (Bark ve Havey, 1995).

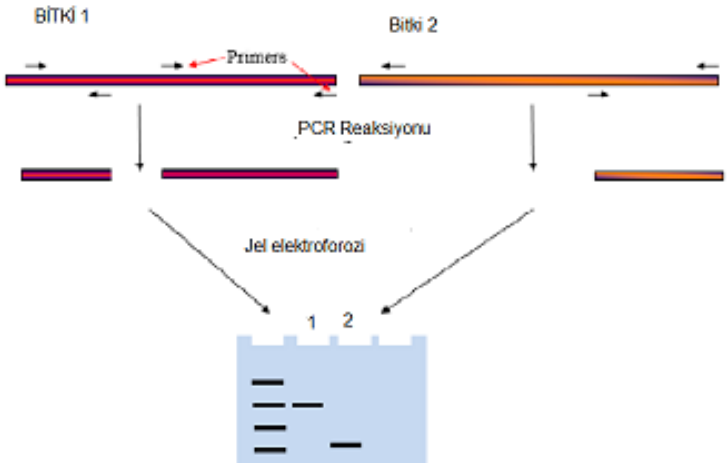



**Şekil 4.** RPLF (Restriction Fragment Lenght Polymorphisms)

**markörünün çalışma mekanizması (https://www.ncbi.nlm.nih.gov/probe/docs/techrflp/)**

### 3.2. RAPD, Değişken DNA Dizilerinin Tesadüfen Çoğaltılması (Random Amplified Polymorphic DNA)

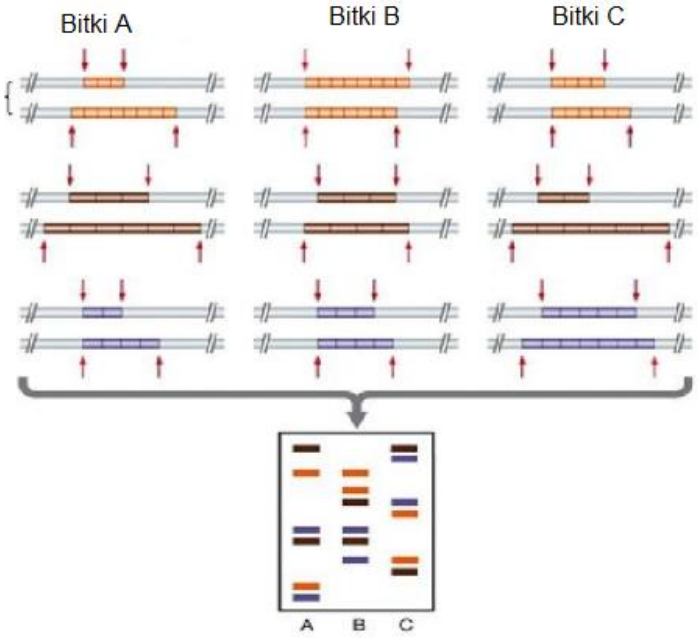
Oligonükleotid primerlerle DNA'nın rastgele olarak çoğaltılmasıdır (Williams vd., 1990). 6-10 nükleotidlik diziler kullanılır. RAPD markörlerinin çalışma mekanizması Şekil 5.'de verilmiştir. Ancak rastgele bölgeleri çoğalttığı için RAPD markörlerinin tekrarlanması çok zordur. Dominant markörler oldukları için yorumlanmaları daha zordur (Yorgancılar vd., 2015).




**Şekil 5. RAPD (Random Amplified Polymorphic DNA) markörünün çalışma mekanizması (https://www.differencebetween.com/difference-between-rapd-and-vs-rflp/)**

### 3.2. SSR, Basit Tekrarlı Diziler (Simple Sequence Repeats)

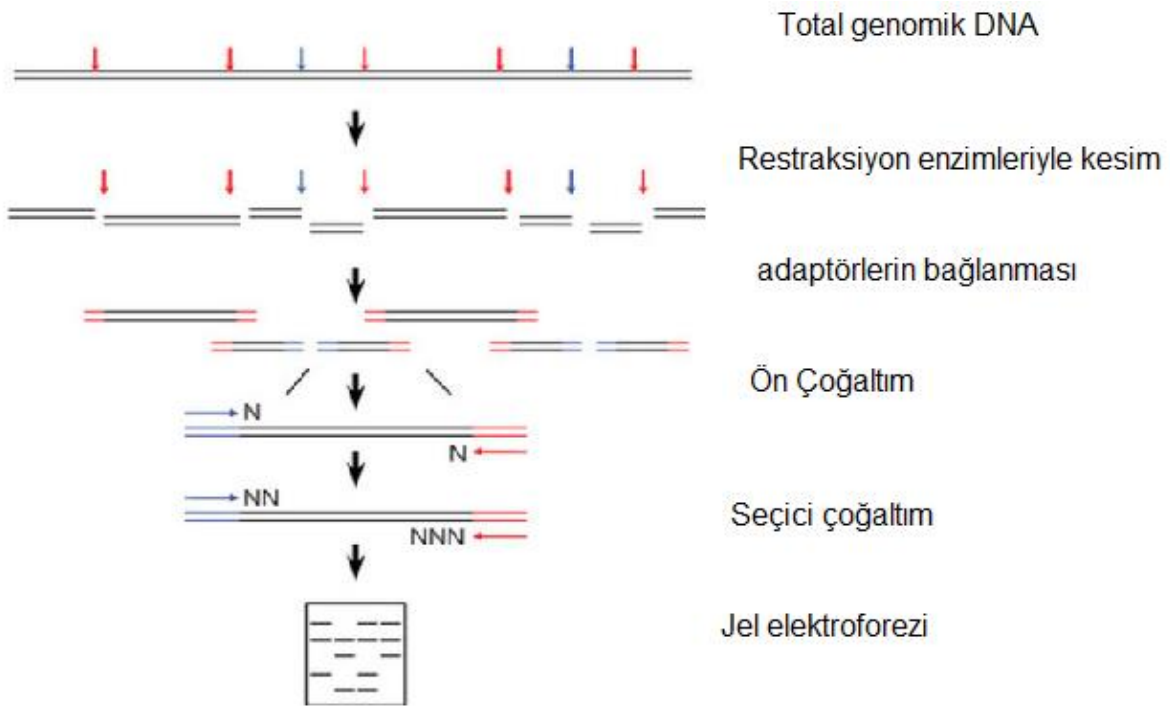
Canlı genomunda birden çok tekrarlanan belirli diziler vardır ve bu dizilerin yeri ve sıklığı bize bitki karakterizasyonu hakkında birçok bilgi verir. Bu tekrarlanan bölgeleri çoğaltmak için kullanılan 2-5 nükleotidli markörler SSR markörleridir (Rangwen vd., 1995). SSR markörlerinin çalışma mekanizması Şekil 6.'da verilmiştir. Kodominant yapı göstermesi ve tekrarlanabilirliğinin yüksek olması mikrosatellitlerin en önemli avantajlarıdır (Ridout ve Donini, 1999).




3.3. **Şekil 6.** SSR (Simple Sequence Repeats) markörünün Çalışma Mekanizması **(https://www.researchgate.net/publication/295860543_Assessment_of_plant_genetic_variability_by_molecular_markers/figures?lo=1)**

### 3.4. AFLP Çoğaltılan Fragmentlerin Uzunluk Polimorfizmi (Amplified Fragment Length Polymorphisms)

Vos vd. (1995) tarafından geliştirilmiştir. Bu teknikte çoğaltım iki aşamada gerçekleştiği için daha spesifik sonuçlar elde edilebilmektedir (Yorgancılar vd., 2015). AFLP markörlerinin çalışma mekanizması Şekil 7.'de verilmiştir. Bir reaksiyonda 30 ila 150 bölgeyi çoğaltabilmesi ve tekrarlanabilirliği en önemli avantajlarındandır. Dominant olması ve pahalı olması ise dezavantajları arasında gösterilebilir (Vos vd., 1995).

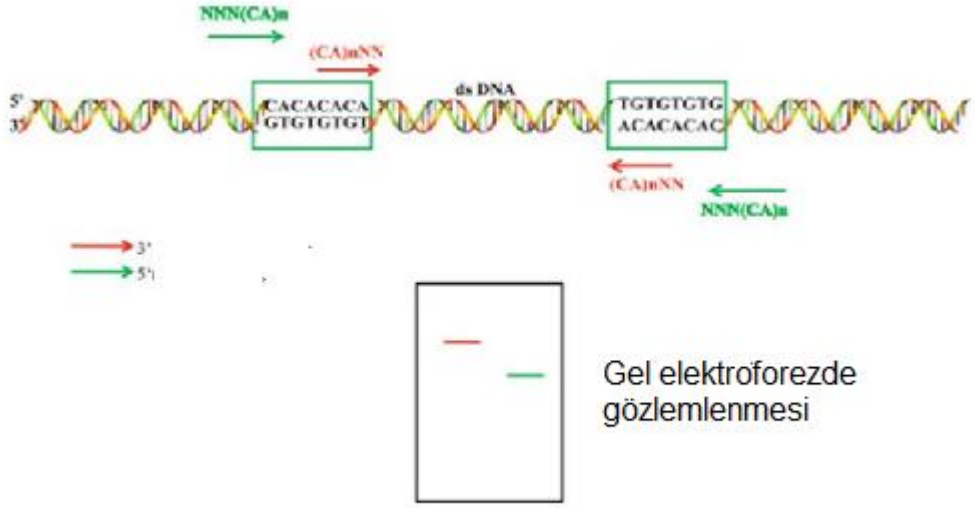



**Şekil 7.** AFLP (Amplified Fragment Length Polymorphisms) markörünün çalışma mekanizması

**(https://www.researchgate.net/publication/6290524_AFLP_technology_for_DNA_fingerprinting/figures?lo=19)**

### 3.2. ISSR Basit Tekrarlı Diziler Arası Polimorfizm (Inter simple sequence repeat)

Ökaryotik genomlarda tekrar eden dizilerin lokustan bağımsız şekilde rastgele dizilimlerini esas alır. ISSR markörlerinin çalışma mekanizması Şekil 8.'de verilmiştir. RAPD tekniğine göre tekrarlanabilirliği yüksektir (Yorgancılar vd., 2015).




3.2. **Şekil 8.** ISSR (Amplified Fragment Length Polymorphisms) markörünün çalışma mekanizması **(https://www.researchgate.net/publication/221897012_ISSR_A_Reliable_and_Cost-Effective_Technique_for_Detection_of_DNA_Polymorphism/figures?lo=1)**

Her markör sisteminin birbirinden farklı avantajları ve dezavantajları mevcut olduğu görülmektedir. Herhangi bir markörün her durumda, diğerinden daha iyi olduğu savunulamaz. Kullanılacağı durum göz önünde bulundurularak en doğru markör tercihi yapılabilir. Moleküler markörler bitki genotiplerinde virüs dayanıklılık genlerini belirlemek amacıyla kullanılabilir.

## 4. Bitkilerde Dayanıklılık Genleri Nasıl Belirlenir?

Bunun için öncelikle dayanıklılık geninin bulunması istenilen bitki virüs hastalığının konukçu bitkisinden bir popülasyon oluşturulmalı ve bu popülasyon kontrollü koşullarda yetiştirilmelidir. Şekil.9'da serada kontrollü koşullarda yetiştirilen bir bitki popülasyonu görülmektedir.



**Şekil 9. Sera koşullarında yetiştirilen bitki popülasyonu (© Neslihan Yıldız)**

Öncelikle virüs simptomlarını gösteren bitkiler arazi koşullarında toplanmalıdır. Bu bitkilerden total nükleik asit izolasyonu yapıldıktan sonra virüse spesifik primerlerle PCR yapılarak virüsle bulaşık olduğu teyit edilmelidir. Arazi çalışması sırasında virüs taşıdığı düşülen bir bitki Şekil 9.'da görülmektedir. Virüs içerdiği PCR ile belirlenen bitkilerden virüs taşınma yöntemine göre etmen, yetiştirilmiş olan popülasyondaki genotiplere taşınır**.**



**Şekil 9. Araziden alınan virüs simptomu gösteren bitki örneği (© Neslihan Yıldız)**

Virüs mekanik olarak bulaşabilen bir virüs türü ise Şekil 10.'daki gibi mekanik inakülasyon ile taşınır. Virüs vektörle taşınıyorsa Şekil 11.'deki gibi virüsten ari şekilde çoğaltılan vektörün önce virüslü bitkide, ardından sağlıklı bitkide beslenmesi sağlanarak virüs taşınır.





**Şekil 10. Mekanik inakülasyonla virüs bulaştırma Şekil 11. Virüsle enfekteli bitkide beslenen ve ardından sağlıklı bitki ile beslenen vektör (© Neslihan Yıldız)**

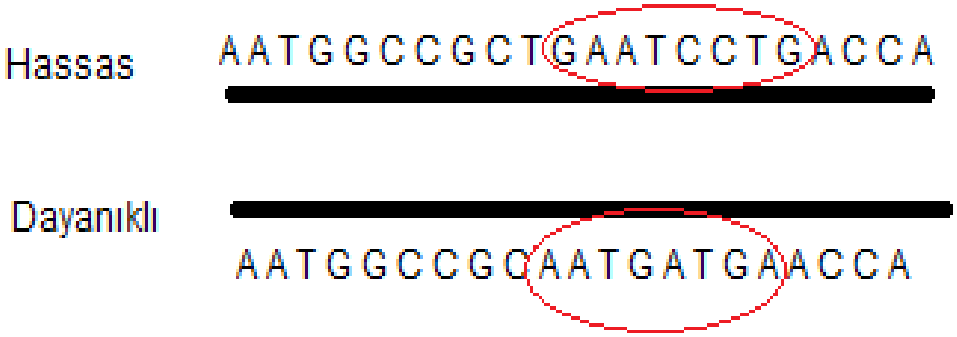
Virüsle bulaşık hale getirilen popülasyon gözlemlenir ve fenotipik özellikleri tek tek kaydedilerek belirti durumuna göre gruplandırılır. Şekil 12.'de örnek bir popülasyon verilmiştir.



**Şekil 12. Popülasyonda belirlenen hassas, toleranslı ve dayanıklı olabileceği düşünülen çeşitler**

Bitkinin hastalanmasını/ hastalanmamasını sağlayan morfolojik ve biyokimyasal özellikler tespit edilir ve bu özelliklerin oluşmasını sağlayan genomun belirlenmesi için;

Hastalanmayan dayanıklı bitki ve hastalanan hassas bitkiden izole edilen DNA'ların dizi ve genom haritaları biyoinformatik analizler ile karşılaştırılarak dayanıklılığı sağlayan gen belirlenir. Şekil 13.'de karşılaştırmaya temsili bir örnek verilmiştir.




**Şekil 13. Hassas ve dayanıklı genotiplerden alınan DNA örneklerinin karşılaştırılması ve farklı bölgenin belirlenmesi**

Belirlenen bu gen için primerler tasarlanır ve bu primerler daha sonraki çalışmalarda markör olarak kullanılabilirler. Bilinen bir dizinin primerini tasarlamak için bazı programlar

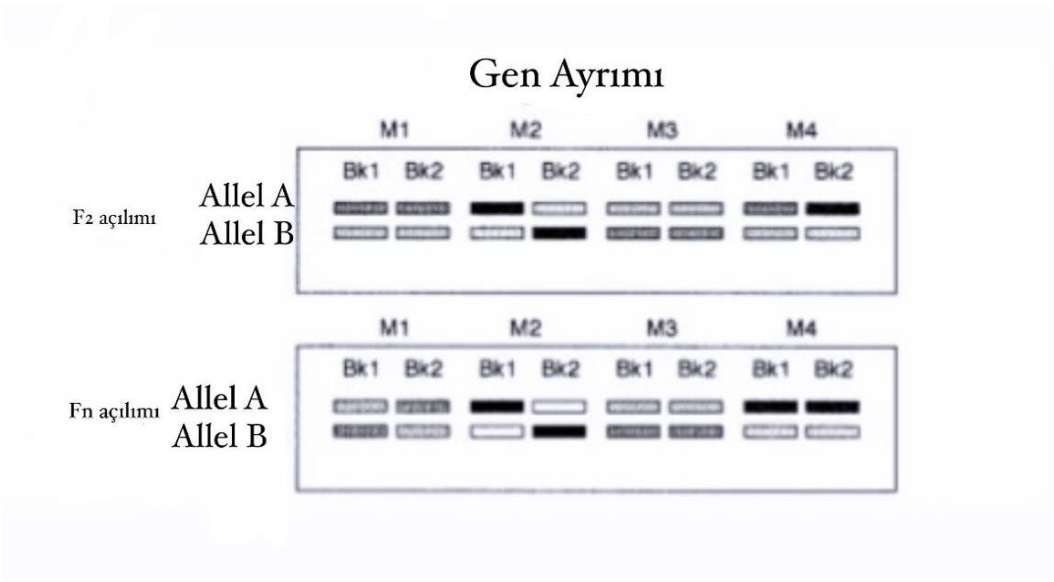
kullanılabilir. Örneğin snapgene, primer3, primer 3 plus. Program kullanılabilir. Primer tasarlanırken dikkat edilmesi gereken bazı hususlar vardır; G-C oranın A-T oranından fazla olması gerekir. Guanin ve sitozin arasında üçlü hidrojen bağı olduğu için tasarlanan primerin daha sağlam olması sağlanır. Primerin 20 ila 30 baz uzunluğunda olması bağlanma sırasında karışıklık riskini azaltır. Belirlenen gen bölgesine özgü tasarlanan primer ile tekrar PCR yapılır ve jel elektroforez ile gözlemlenir. Böylece primerin çalışması doğrulanmış olur. Bu bölge tekrar sekanslanarak kontrolleri sağlanır (Agrios, 2005).

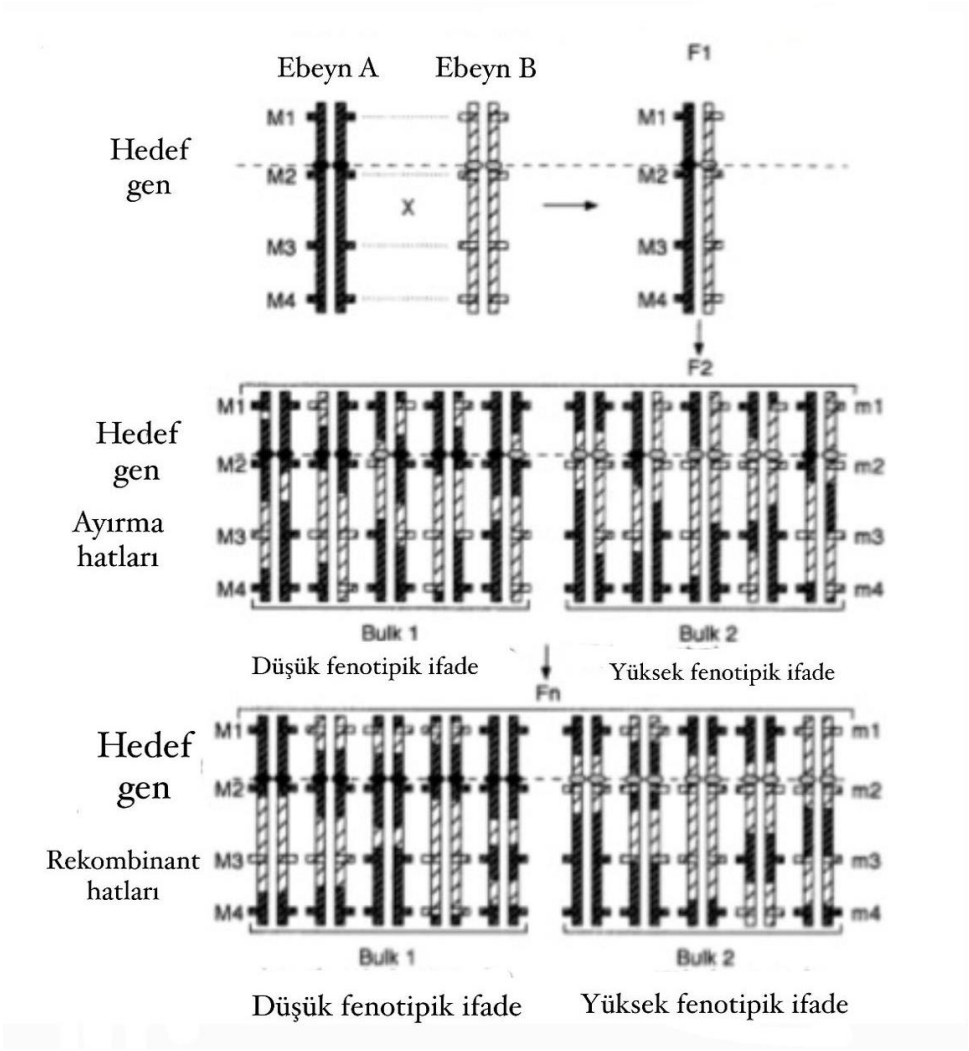
Varlığı henüz belirlenmemiş bir bitki virüs dayanıklılık geninin tanımlanabileceği yöntemlerden biri de Bulk sekrekant analizidir.

**4.1. Bulk Sekrekant Analizi**

Bulk sekrekant analizi dayanıklılık genlerinin tespiti için kullanılabilecek yöntemlerden birisidir. Bulk sekrekant analizinin bitki genetiğinde kullanımı ilk olarak Michelmore vd., (1991) tarafından geliştirilmiştir. Spesifik bir gen veya genomik bölgeye bağlı belirteçleri hızlı bir şekilde tanımlamak için geliştirilmiştir (Michelmore vd., 1991). Elde edilen DNA örnekleri arasındaki farkların tanımlanmasını içerir.

Bulk sekrekent analizini gerçekleştirmek için öncelikle virüs için konukçu olan bitkiden oluşan bir popülasyon oluşturulur. Toplanan tüm genotipleri saksılarda kontrollü koşullarda yetiştirilir. Dayanıklılık genini aranan virüs hastalığının taşınma şekline göre vektör yardımıyla ya da mekanik inokülasyonla virüsle bulaştırılır (Quarrie vd., 1999: Hayten vd., 2009: Liu vd., 2012: Gyawali vd., 2019). Hassas ve dayanıklılık gösteren çeşitler tekrar yetiştirilir ve DNA örnekleri alınır. Hassas genotiple dayanıklılık gösteren genotip melezlenir ve F1 açılımı elde edilir. F1 %100 heterozigot bitkilerden oluşur. F1 kendilenerek F2 açılımları elde edilir (Quarrie vd., 1999: Hayten vd., 2009: Liu vd., 2012: Jialo vd., 2012: Gyawali vd., 2019). Şekil14. a'da bulk sekrekant analizinde melezme örneklemesi bulunmaktadır. F2 açılımlarından elde edilen ve ebeveynlerden alının DNA örnekleri markörlerle karşılaştırılır. Konukçu bitkide dayanıklılık geni varlığı mevcut markörler kullanılarak araştırılır. PCR sonucu elde edilen bantlar yorumlanarak ve bazı biyoinformatik programlar kullanılarak genetik haritalama yapılır. Genin markörle olan mesafesi hesaplanır. Dayanıklı genin frekansı homozigot ve heterozigotluğu tespit edilerek oran elde edilir. Bu oran %30 ila %90 arasında ise toleranslı genotip, %90'nın üzerindeyse dayanıklı genotip elde edilmiş olur (Quarrie vd., 1999: Hayten vd., 2009: Liu vd., 2012). Şekil 14.b'de Bulk sekrekant analizinden elde edilen bantların gözlemlenmesi örneklemesi bulunmaktadır.




**Şekil 14. Bulk sekrekant analizinde melezleme ve bantların gözlemlenmesi (Quarrie vd., 1999)**

## 5. Sonuç

Sonuç olarak bitki virüs hastalıklarından korunmada, en etkili, sürdürülebilir ve ekonomik kültürel mücadele yönteminin dayanıklı çeşit kullanımı olduğu Zhang (2002) tarafından ifade edilmiştir. Bitkide virüs dayanıklılık genlerinin belirlenmesinde moleküler markörlerin kullanılması bitki dayanıklılık ıslah sürecini kısaltmıştır. Aynı zamanda dayanıklılık genleri mutasyonlarla etkisiz hale gelebildiğinden ve bazı virüs hastalıkları için dayanıklılık geni bulunamadığından bitkilerde virüs dayanıklılık genlerini bulmak araştırıcılar için çok önemlidir. Bu yüzden her geçen gün dayanıklılık genlerini bulmak ve bu genleri taşımak için birçok yeni teknikler geliştirilmektedir.

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# POSSIBILITIES OF USING ANNUAL FORAGE CROPS AS GREEN MANURE

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**Abstract**
The rise in mineral fertilizer prices, global policies for the protection of natural resources, and sustainable agricultural management have led to the increased use of different organic fertilizer sources in agricultural production. Among these fertilizer sources, animal manure and sewage sludge cannot be fully included in agricultural production due to some of the negative effects they have. In addition to such sources, green manures have become preferable today. Crop sources used for green manure are generally annual winter forage crops. Using annual forage crops as green manure offers several compelling possibilities for sustainable agriculture. These crops can be leveraged to enhance soil health and productivity in various ways. By incorporating annual forage crops into the soil, farmers can improve soil structure, boost organic matter content, and reduce erosion risks. Moreover, these crops have the capacity to accumulate essential nutrients and nitrogen, reducing the reliance on mineral fertilizers. Green manure crops also contribute to weed suppression, either by outcompeting weeds or through the release of allelopathic chemicals. They can disrupt pest and disease cycles when integrated into crop rotations, thus diminishing the need for chemical treatments. Furthermore, annual forage crops promote biodiversity, attract pollinators, and can help alleviate soil compaction. The selection of the right forage crops and the proper timing for their incorporation into the soil are key factors in maximizing these benefits. Overall, annual forage crops serve as a versatile and sustainable tool for improving agricultural practices and soil management.
**Keywords:** green manure, annual forage legumes, annual grasses, nitrogen budget, sustainability

## Introduction

Green manure is a sustainable and environmentally friendly agricultural practice that involves growing specific cover crops with the primary purpose of improving soil fertility and structure. This method harnesses the power of certain plants to enhance soil health by increasing organic matter, nitrogen content, and microbial activity. Unlike traditional fallow periods where fields are left bare, green manure allows for continuous soil cover, preventing erosion and nutrient leaching while promoting biodiversity (Cherr et. al. 2006).

The concept of green manure has deep historical roots, with ancient agricultural practices recognizing the benefits of cover crops. In modern farming, the utilization of green manure has gained renewed attention due to its potential to reduce the reliance on synthetic fertilizers and chemical inputs. The choice of cover crops can be tailored to the specific needs of a particular crop rotation or soil type. Legumes, such as clover and peas, are often employed for their ability to fix atmospheric nitrogen, enriching the soil for subsequent crops. Other plants, such as rye and vetch, contribute to soil structure and suppress weeds (. Green manure, therefore, stands as a natural and holistic approach to soil management, fostering sustainability and resilience in agriculture.

## The role annual forage crops as green manure

### *Legume forage crops*

Annual legume crops play a crucial role in sustainable agriculture as effective green manure options due to their unique ability to fix atmospheric nitrogen through a process known as nitrogen fixation. Legumes, including clover, peas, and vetch, form symbiotic relationships with nitrogen-fixing bacteria in their root nodules. This symbiosis allows these plants to convert atmospheric nitrogen into a form that is readily available to other crops, thus enriching the soil with a vital nutrient. The incorporation of annual legumes as green manure helps reduce the dependency on synthetic nitrogen fertilizers, mitigating the environmental impact associated with their production and use.(Northup and Rao, 2016).

Beyond nitrogen fixation, annual legume crops contribute to soil health by enhancing organic matter content. As these plants decompose, they add valuable organic material to the soil, improving its structure, water retention, and overall fertility. This organic matter serves as a nutrient reservoir, releasing essential elements for subsequent crops and fostering a healthy microbial environment. Additionally, the deep root systems of many legumes help break up compacted soils, promoting better aeration and drainage. The combination of nitrogen fixation

and organic matter enrichment makes annual legume crops a multifaceted solution for enhancing soil fertility and structure (Mihailović et. al. 2007).

Moreover, the use of annual legumes as green manure offers weed suppression benefits. Their vigorous growth and canopy formation shade the soil, creating a natural barrier that inhibits weed germination and growth. This weed-suppressive quality not only reduces the competition for nutrients and sunlight but also lessens the need for herbicides. By integrating annual legume crops into crop rotations as green manure, farmers can harness these ecological benefits to create more resilient and sustainable agricultural systems, promoting long-term soil health and productivity (Liu et. al. 2022).

***Cereal or grass forage crops***

Annual cereals and grasses serve as valuable green manure crops, playing a pivotal role in sustainable agriculture by contributing to soil health and fertility. These plants, including rye, oats, and barley, are known for their rapid growth and extensive root systems. When incorporated into the soil as green manure, they help prevent erosion by stabilizing the soil structure with their dense root networks. This erosion control is particularly significant in areas prone to soil degradation, ensuring that valuable topsoil is retained, and nutrient-rich layers are preserved. (Olesen et. al. 2009).

One of the key benefits of annual cereals and grasses as green manure lies in their capacity to add organic matter to the soil. As these plants decompose, they release organic materials into the soil, enhancing its structure, water retention, and microbial activity. This organic matter acts as a reservoir of nutrients, providing a sustained source of nourishment for subsequent crops. The incorporation of annual cereals and grasses thus promotes long-term soil fertility, reducing the need for external inputs and fostering a more self-sustaining agricultural ecosystem (Loes et. al. 2011).

Furthermore, annual cereals and grasses contribute to weed management in agricultural fields. Their vigorous growth creates a competitive environment that suppresses weed germination and growth. By shading the soil and outcompeting weeds for sunlight and nutrients, these green manure crops help minimize the weed pressure on subsequent crops. This natural weed-suppressive quality not only reduces the reliance on herbicides but also contributes to overall resource efficiency in farming practices. In summary, the role of annual cereals and grasses as green manure extends beyond soil fertility to encompass erosion control and weed suppression, making them valuable components of sustainable and regenerative agricultural systems.

**Possible advantages and disadvantages of annual forage crops as green manure**

Annual forage crops offer several advantages as green manure in sustainable agricultural practices. One notable advantage is their rapid growth and ability to produce large amounts of biomass within a relatively short period. Forages such as legumes (e.g., clover) and grasses (e.g., ryegrass) can be quick-establishing cover crops, allowing for effective weed suppression and erosion control. The extensive root systems of many forage crops enhance soil structure, promoting better aeration and water infiltration, which are essential for overall soil health. Additionally, these plants contribute organic matter to the soil upon decomposition, enriching it with essential nutrients and fostering a conducive environment for beneficial soil microorganisms (Rayns and Rosenfeld, 2010).

However, there are also potential disadvantages associated with the use of annual forage crops as green manure. One challenge lies in managing the timing of cover crop termination. If not terminated at the right stage, certain forage crops may compete with cash crops for nutrients and water, potentially impacting yields. Balancing the need for sufficient biomass production and timely termination requires careful planning. Additionally, some forage crops may have allelopathic effects, releasing chemicals that inhibit the germination and growth of other plants. While this can contribute to weed suppression, it may also affect the establishment of desired crops if not managed properly. It's crucial for farmers to select forage crops that align with their specific goals and cropping systems and to consider the potential impact on subsequent crops in their rotation (Chisha–Kasumu and Zulu, 2016).

In summary, the advantages of annual forage crops as green manure, such as rapid growth, weed suppression, and soil improvement, make them valuable tools in sustainable agriculture. However, careful management and consideration of potential disadvantages, such as competition with cash crops and allelopathic effects, are essential to maximize the benefits of incorporating annual forage crops into crop rotations.

**Conclusion**

Green manure represents a sustainable and regenerative agricultural practice, encompassing a diverse array of cover crops strategically grown to enhance soil fertility, structure, and overall health. Whether through the nitrogen-fixing capabilities of legumes like clover, the rapid biomass production of annual cereals and grasses, or the weed-suppressing qualities of various cover crops, the integration of green manure into farming systems offers a holistic approach to soil management. By mitigating erosion, enriching the soil with organic matter, and promoting

beneficial microbial activity, green manure contributes to long-term sustainability, reducing dependence on synthetic fertilizers and pesticides. Its role extends beyond a mere fallow period, fostering resilient ecosystems and paving the way for more environmentally conscious and productive agricultural practices.

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# ECONOMIC ANALYSIS OF DIFFERENT ORGANIC FERTILIZER APPLICATIONS IN DOUBLE-ANNUAL FORAGE CROP ROTATIONS

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## Abstract
Double-annual forage crop rotations are a production model applied in regions where livestock production is intensive. In this production model, annual forage crops such as maize and sorghum are grown as main or second crops after annual legume and grass forage crops and their mixtures, which are considered winter cover crops. The use of organic fertilizers is very important in sustainable farms in terms of reducing production costs in this production model where production activities are carried out throughout the year. The rise in mineral fertilizer prices has led to the use of different fertilizer sources as alternatives to such fertilizers. At the same time, care is taken to ensure that these sources are generally organic sources in order to be sustainable. In the study conducted for this purpose, 4 different organic fertilizers (cattle manure, solid biogas digestate, liquid biogas digestate, vermicompost) and mineral fertilizers were applied to 5 different double-annual forage crop rotations (barley/silage sorghum; annual ryegrass/silage maize; common vetch+oat/silage maize; forage pea+oat/silage maize). Between the years 2018-2020, winter production plots and summer production plots were designed in a randomized block split-plot experimental design with 3 replications. After the yield and quality characteristics obtained from the experiment, all income and expense cost calculations were entered according to the prices of the day and cost economic analysis was made. As a result of the analysis, it was determined that higher incomes could be obtained due to the faster response of mineral fertilizer applications in production. However, considering that the increase in costs may reverse this situation, it was seen that solid biogas digestate and cattle manure have promising results in terms of organic fertilizer applications that are close to mineral fertilizers. These values showed themselves with higher net gains especially in the forage pea+oat/silage maize rotation.
**Keywords:** forage crop rotation, organic fertilizer, sustainable agriculture, biogas digestate, vermicompost, farm budget

## Introduction

A sustainable and economical crop production will only be possible with quality soil. Soil quality is defined as "the capacity of a soil to function within ecosystem boundaries to maintain biological productivity, protect environmental quality, and improve plant and animal health" (Pellegrino et al., 2020). The most important ways to protect and increase soil quality are fertilisation management and crop rotation systems. In particular, forage crop rotation systems can meet the quality roughage requirements of livestock throughout the year. These systems, which will be a complementary alternative to grazing in pasture areas that do not meet the demand for quality roughage, show that not only sustainability but also the contribution to decreasing the quality roughage deficit should be taken into consideration (Islam and Garcia, 2012).

The deficit in quality forage production can be reduced by the rotation of forage crops. Crop rotation affects the sustainability of agricultural production systems. Most of the time, legume species are used in crop rotations to reduce the use of nitrogen fertilizer. Rotations including legumes are reported to diversify crop rotation systems and improve soil fertility (Ćupina et al., 2011; Wang et al., 2020). Appropriate crop rotation systems are also beneficial for better quality forage. In addition, when warm-climate grass forage crops such as sorghum and maize are sown after some legumes, an increase in yield and quality is observed (Borrelli et al., 2014; Gupta and Dey, 2019). Borrelli et al. (2014) suggested that rotation can reduce fertilizer use and can be seen as insurance in years when yields may be low. At the same time, the longer and more diverse these crop rotation systems are, the more favorable effects are likely to be for yield (Reheul et al., 2017).

Forage crop rotation systems including these species have an important place in order to reduce the quality forage deficit. However, in order for these crop rotation systems to be sustainable, fertilization programs should be carried out properly. Taking into account the nutrient demand of each species, fertilization at the appropriate time will ensure the sustainable use of the soil while ensuring the optimum level of yield and quality obtained from the unit area.

Different organic fertilizer sources were applied to the rotation production of forage crops for these purposes. Yield and acuity data were then interpreted by economic analysis.

## Materials and Methods

The experiment was conducted in the ecological conditions of Aydın province between 2018 and 2020. In the study, 4 different forage crop rotations (annual ryegrass - silage maize; barley

- forage maize; common vetch-oat mixture - silage maize; forage pea-oat mixture - silage maize) were applied with 5 different fertilization programs (mineral fertilizer, cattle manure, vermicompost, biogas digestate, biogas slurry). The climatic data of the experiment are given in Table 1. In terms of climatic data, in the years when the experiment was carried out, the temperature showed differences in autumn months compared to the long-term climate data. According to the precipitation data, in the 2018/2019 production season, although there was a similarity with the long-term precipitation data in total, very large differences were observed in the precipitation regime. This situation reflected positively or negatively on yield and quality.

**Table 1.** Climatic data for the period of the experiment and long-term averages

| | Temperature | | | Precipitation | | |
|---|---|---|---|---|---|---|
| | 2018/19 | 2019/20 | Long Term | 2018/19 | 2019/20 | Long Term |
| November | 8.8 | 16.5 | 13.4 | 127.3 | 65.1 | 85.6 |
| December | 4.2 | 10.5 | 9.4 | 93 | 117.7 | 111.5 |
| January | 8.5 | 7.7 | 8.2 | 206 | 91.5 | 109.8 |
| February | 10.6 | 10.4 | 9.4 | 58.3 | 90.7 | 86.1 |
| March | 13.3 | 13.3 | 12.1 | 28.6 | 65.6 | 71.8 |
| April | 16 | 16.8 | 16.2 | 56.9 | 57.7 | 50.9 |
| May | 21.6 | 22 | 21 | 11.9 | 33.9 | 40.3 |
| June | 26.9 | 25.3 | 26 | 26.9 | 20.2 | 14.5 |
| July | 28.5 | 29.8 | 28.6 | 1.2 | 0 | 6.1 |
| August | 29.3 | 29.1 | 28.1 | 0 | 0.7 | 6.7 |
| September | 24.4 | 27 | 23.9 | 16.6 | 0 | 16.9 |
| October | 21.4 | 21.2 | 18.8 | 29.4 | 42.8 | 41.1 |
| Mean | 17.8 | 19.1 | 17.9 | | | |
| Total | | | | 656.1 | 585.9 | 641.3 |

Soil and fertilizer properties and all practices of cultivation are described in detail in the Ph.D. thesis of this experiment. After examining the yield and quality characteristics in the experiment, cost analysis was carried out in order to examine the economic sustainability of the systems. Labor, general cost and selling prices were obtained from agricultural enterprises and cooperatives in the region. Seed prices were obtained from the relevant seed companies, while fertilizer prices were obtained from the Ministry of Agriculture and Forestry. The cost data obtained were calculated based on the herbage and silage yields obtained from the trial.

**Findings and Discussion**

The economic analysis obtained from the one-year grass-silage maize system is given in Table 2. Looking at the seasonal net gain of one-year grass, it was observed that higher values were generally obtained in the second year, while mineral fertilizer application was the highest application. Among the organic fertilizers, cattle manure and biogas slurry stood out with higher net gain compared to other organic fertilizers.

**Table 2.** General cost analysis of annual ryegrass with prices for the period when the trial was conducted

| TL/da | Mineral Fertilizer | | Cattle Manure | | Vermicompost | | Biogas Digestate | | Biogas Slurry | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| SOIL PREP. | | | | | | | | | | |
| 1st Plough | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 |
| 2nd Plough | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 |
| 3rd Plough | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Sowing | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Seed | 60 | 75 | 60 | 75 | 60 | 75 | 60 | 75 | 60 | 75 |
| Maintenance | | | | | | | | | | |
| Fertilization | 153.8 | 159.4 | 300 | 325 | 750 | 960 | 200 | 200 | 150 | 150 |
| Spraying | | | | | | | | | | |
| Irrigation | 30 | 40 | 30 | 40 | 30 | 40 | 30 | 40 | 30 | 40 |
| Mowing | 25.72 | 24.28 | 25.72 | 24.28 | 25.72 | 24.28 | 25.72 | 24.28 | 25.72 | 24.28 |
| Bailing | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| Total Exp. (TL) | 370.96 | 397.24 | 517.16 | 562.84 | 967.16 | 1197.84 | 417.16 | 437.84 | 367.16 | 387.84 |
| Annual ryegrass price(TL/kg) | 1.2 | 1.6 | 1.2 | 1.6 | 1.2 | 1.6 | 1.2 | 1.6 | 1.2 | 1.6 |
| Annual ryegrass income (TL) | 1380.96 | 2010.08 | 1291.56 | 1763.68 | 1103.04 | 1366.56 | 1177.68 | 1336.48 | 1135.32 | 1608.48 |
| NET INCOME (TL/da) | 1010 | 1612.84 | 774.4 | 1200.84 | 135.88 | 168.72 | 760.52 | 898.64 | 768.16 | 1220.64 |

The net gain obtained in silage maize as the second crop in the annual ryegrass - silage maize system and the net gain values in the system can be found in Table 3. According to these results, it can be seen that cattle manure and vermicompost stand out in certain periods. In the total net gain in the system, it can be seen that cattle manure and mineral fertilizer are more profitable fertilizers, while cattle manure can be an alternative to mineral fertilizer (Table 3.).

**Table 3.** General cost analysis and total system cost of silage maize (annual ryegrass- silage maize system) with prices for the period the trial was conducted

| TL/da | Mineral Fertilizer | | Cattle Manure | | Vermicompost | | Biogas Digestate | | Biogas Slurry | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| SOIL PREP. | | | | | | | | | | |
| 1st Plough | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 |
| 2nd Plough | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 |
| 3rd Plough | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Sowing | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Seed | 100 | 120 | 100 | 120 | 100 | 120 | 100 | 120 | 100 | 120 |
| Maintenance | | | | | | | | | | |
| Fertilization | 170.25 | 177.69 | 84.756 | 92.19 | 84.756 | 92.19 | 84.756 | 92.19 | 84.756 | 92.19 |
| Spraying | 3.215 | 3.035 | 3.215 | 3.035 | 3.215 | 3.035 | 3.215 | 3.035 | 3.215 | 3.035 |
| Irrigation | 150 | 200 | 150 | 200 | 150 | 200 | 150 | 200 | 150 | 200 |
| Mowing | 40 | 45 | 40 | 45 | 40 | 45 | 40 | 45 | 40 | 45 |
| Total Exp. (TL) | 514.905 | 594.285 | 429.411 | 508.785 | 429.411 | 508.785 | 429.411 | 508.785 | 429.411 | 508.785 |
| S.Maize price (TL/kg) | 0.28 | 0.35 | 0.28 | 0.35 | 0.28 | 0.35 | 0.28 | 0.35 | 0.28 | 0.35 |
| S.Maize Income(TL) | 1394.4 | 1855 | 1825.6 | 2184.56 | 2146.648 | 1662.5 | 1433.6 | 1831.655 | 1405.6 | 1757 |
| NET INCOME (TL/da) | 879.495 | 1260.715 | 1396.189 | 1675.775 | 1717.237 | 1153.715 | 1004.189 | 1322.87 | 976.189 | 1248.215 |
| Annual Net INCOME (SYSTEM) | 1889.50 | 2873.56 | 2170.59 | 2876.62 | 1853.12 | 1322.44 | 1764.71 | 2221.51 | 1744.35 | 2468.86 |

It can be seen in Table 4 that in the barley-sorghum production system, mineral fertilization stands out with a significantly better net gain in barley. Especially with the increase in barley yield in the second year, this difference widened more. In terms of organic fertilizers, it can be seen that the fertilization program in terms of vermicompost is not very profitable.

**Table 4.** General cost analysis of barley with prices for the period the trial was conducted

| TL/da | Mineral Fertilizer | | Cattle Manure | | Vermicompost | | Biogas Digestate | | Biogas Slurry | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| SOIL PREP. | | | | | | | | | | |
| 1st Plough | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 |
| 2nd Plough | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 |
| 3rd Plough | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Sowing | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Seed | 69 | 96 | 69 | 96 | 69 | 96 | 69 | 96 | 69 | 96 |
| Maintenance | | | | | | | | | | |
| Fertilization | 102 | 110 | 300 | 325 | 750 | 960 | 200 | 200 | 150 | 150 |
| Spraying | | | | | | | | | | |
| Irrigation | | | | | | | | | | |
| Mowing | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 |
| Bailing | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| Total Exp. (TL) | 285.3 | 316.7 | 483.3 | 531.7 | 933.3 | 1166.7 | 383.3 | 406.7 | 333.3 | 356.7 |
| Barley prices (TL/kg) | 1.2 | 1.6 | 1.2 | 1.6 | 1.2 | 1.6 | 1.2 | 1.6 | 1.2 | 1.6 |
| Barley Income (TL) | 1640.76 | 2413.76 | 1553.4 | 1866.4 | 1143 | 1531.84 | 1279.56 | 1679.52 | 1000.32 | 1596.16 |
| NET INCOME (TL/da) | 1355.46 | 2097.06 | 1070.1 | 1334.7 | 209.7 | 365.14 | 896.26 | 1272.82 | 667.02 | 1239.46 |

According to the results of sorghum cost analysis, it can be seen in Table 5. that organic fertilizer sources have higher net profit results. Among these, vermicompost stands out more. In terms of annual net profit, it is understood that it is a system where high profits can be obtained from all fertilizer sources except vermicompost.

**Table 5.** General cost analysis and total system cost of sorghum (barley- sorghum system) with prices for the period the trial was conducted

| TL/da | Mineral Fertilizer | | Cattle Manure | | Vermicompost | | Biogas Digestate | | Biogas Slurry | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| SOIL PREP. | | | | | | | | | | |
| 1st Plough | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 |
| 2nd Plough | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 |
| 3rd Plough | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Sowing | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Seed | 33 | 42 | 33 | 42 | 33 | 42 | 33 | 42 | 33 | 42 |
| Maintenance | | | | | | | | | | |
| Fertilization | 127.65 | 131.35 | 40.2 | 43.9 | 40.2 | 43.9 | 40.2 | 43.9 | 40.2 | 43.9 |
| Spraying | | | | | | | | | | 3.035 |
| Irrigation | 120 | 160 | 120 | 160 | 120 | 160 | 120 | 160 | 120 | 160 |
| Mowing | 40 | 45 | 40 | 45 | 40 | 45 | 40 | 45 | 40 | 45 |
| TOTAL EXPENSES | 372.09 | 426.91 | 284.64 | 339.46 | 284.64 | 339.46 | 284.64 | 339.46 | 284.64 | 342.495 |
| Sorghum Prices (TL/kg) | 0.28 | 0.35 | 0.28 | 0.35 | 0.28 | 0.35 | 0.28 | 0.35 | 0.28 | 0.35 |
| Sorgum Income | 1247.5 | 1506.85 | 1133.04 | 1621.65 | 1306.64 | 1682.1 | 1231.04 | 1579.65 | 1286.12 | 1625.4 |
| NET INCOME(TL/da) | 875.45 | 1079.94 | 848.408 | 1282.19 | 1022.00 | 1342.6 | 946.408 | 1240.19 | 1001.48 | 1282.9 |
| ANNUAL NET INCOME (TL/da) (system) | 2230.9 | 3177.00 | 1918.50 | 2616.89 | 1231.70 | 1707.7 | 1842.66 | 2513.01 | 1668.50 | 2522.3 |

The cost analysis of the forage crop production system including oat-vetch mixture and silage maize can be seen in Table 6 and Table 7. In terms of the effect of fertilization on the annual gain in the mixture, it was determined that vermicompost could not benefit the producer with a good gain. Apart from this, it is possible to say that mineral fertilization has higher values in terms of gain. When the total system economy is analyzed, it is understood that the systems including mixtures and silage maize are in the group that can generate higher income than the others. In this respect, in addition to mineral fertilizer, biogas digestate data were also found to be at a considerable level.

**Table 6.** General cost analysis of oat-vetch mixture with prices for the period the trial was conducted

| TL/da | Mineral Fertilizer | | Cattle Manure | | Vermicompost | | Biogas Digestate | | Biogas Slurry | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| SOIL PREP. | | | | | | | | | | |
| 1st Plough | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 |
| 2nd Plough | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 |
| 3rd Plough | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Sowing | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Seed | 85.5 | 102 | 85.5 | 102 | 85.5 | 102 | 85.5 | 102 | 85.5 | 102 |
| Maintenance | | | | | | | | | | |
| Fertilization | 62.2 | 63.6 | 300 | 325 | 750 | 960 | 200 | 200 | 150 | 150 |
| Spraying | | | | | | | | | | |
| Irrigation | | | | | | | | | | |
| Mowing | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 |
| Bailing | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| Total Exp. (TL) | 262 | 276.3 | 499.8 | 537.7 | 949.8 | 1172.7 | 399.8 | 412.7 | 349.8 | 362.7 |
| Oat-Vetch Forage Prices (TL/kg) | 1 | 1.25 | 1 | 1.25 | 1 | 1.25 | 1 | 1.25 | 1 | 1.25 |
| Oat-Vecth Income(TL) | 1367.3 | 1885.75 | 1294.5 | 1458.1 | 952.5 | 1196.75 | 1066.3 | 1312.1 | 833.6 | 1247 |
| NET INCOME (TL/da) | 1105.3 | 1609.45 | 794.7 | 920.42 | 2.7 | 24.05 | 666.5 | 899.425 | 483.8 | 884.3 |

**Table 7.** Overall cost analysis and total system cost of silage maize (oat-vetch mixture- silage maize system) with prices for the period of the trial

| TL/da | Mineral Fertilizer | | Cattle Manure | | Vermicompost | | Biogas Digestate | | Biogas Slurry | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| SOIL PREP. | | | | | | | | | | |
| 1st Plough | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 |
| 2nd Plough | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 |
| 3rd Plough | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Sowing | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Seed | 100 | 120 | 100 | 120 | 100 | 120 | 100 | 120 | 100 | 120 |
| Maintenance | | | | | | | | | | |
| Fertilization | 170.25 | 177.69 | 84.756 | 92.19 | 84.756 | 92.19 | 84.756 | 92.19 | 84.756 | 92.19 |
| Spraying | 3.215 | 3.035 | 3.215 | 3.035 | 3.215 | 3.035 | 3.215 | 3.035 | 3.215 | 3.035 |
| Irrigation | 150 | 200 | 150 | 200 | 150 | 200 | 150 | 200 | 150 | 200 |
| Mowing | 40 | 45 | 40 | 45 | 40 | 45 | 40 | 45 | 40 | 45 |
| Total Exp. (TL) | 514.905 | 594.285 | 429.411 | 508.785 | 429.411 | 508.785 | 429.411 | 508.785 | 429.411 | 508.785 |
| S.Maize prices (TL/kg) | 0.28 | 0.35 | 0.28 | 0.35 | 0.28 | 0.35 | 0.28 | 0.35 | 0.28 | 0.35 |
| S.Maize Income(TL) | 3010.92 | 3622.5 | 2746.8 | 3151.15 | 2191.14 | 3061.31 | 2622.64 | 3406.65 | 2612.4 | 3097.5 |
| NET INCOME (TL/da) | 2496.01 | 3028.2 | 2317.3 | 2642.37 | 1761.7 | 2552.5 | 2193.23 | 2897.87 | 2182.98 | 2588.71 |
| ANNUAL NET INCOME (TL/da) (system) | 3601.31 | 4637.6 | 3112.0 | 3562.79 | 1764.4 | 2576.5 | 2859.73 | 3797.29 | 2666.7 | 3473.01 |

The results of the economic analysis of another mixture, oat-fodder pea mixture, are given in Table 8. Here and in Table 9, according to the silage maize and total annual economic analysis, it is seen that the annual earnings are at good values compared to other systems. It can be understood that in addition to mineral fertilizer and barnyard manure, the solid biogas mix has higher values in terms of earnings.

**Table 8.** General cost analysis of oat-pea mixture with prices for the period the trial was conducted

| TL/da | Mineral Fertilizer | | Cattle Manure | | Vermicompost | | Biogas Digestate | | Biogas Slurry | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| SOIL PREP. | | | | | | | | | | |
| 1st Plough | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 |
| 2nd Plough | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 |
| 3rd Plough | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.645 | 9.10 |
| Sowing | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.645 | 9.10 |
| Seed | 90 | 111 | 90 | 111 | 90 | 111 | 90 | 111 | 90 | 111 |
| Maintenance | | | | | | | | | | |
| Fertilization | 62.2 | 63.6 | 300 | 325 | 750 | 960 | 200 | 200 | 150 | 150 |
| Spraying | | | | | | | | | | |
| Irrigation | | | | | | | | | | |
| Mowing | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 |
| Bailing | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| Total Exp. (TL) | 266.5 | 285.3 | 504.3 | 546.7 | 954.3 | 1181.7 | 404.3 | 421.7 | 354.3 | 371.7 |
| Oat-Pea Forage Prices (TL/kg) | 1 | 1.25 | 1 | 1.25 | 1 | 1.25 | 1 | 1.25 | 1 | 1.25 |
| Oat-Pea Incoem (TL) | 946.4 | 1664.2 | 835.3 | 1734.62 | 841.3 | 1840 | 879.6 | 2000.25 | 863.2 | 1600.6 |
| NET INCOME (TL/da) | 679.9 | 1378.9 | 331 | 1187.92 | -113 | 658.3 | 475.3 | 1578.55 | 508.9 | 1228.9 |

**Table 9.** General cost analysis and total system cost of silage maize (oat-pea - silage maize system) with prices for the period of the trial

| TL/da | Mineral Fertilizer | | Cattle Manure | | Vermicompost | | Biogas Digestate | | Biogas Slurry | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| SOIL PREP. | | | | | | | | | | |
| 1st Plough | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 | 19.29 | 18.21 |
| 2nd Plough | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 | 12.86 | 12.14 |
| 3rd Plough | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Sowing | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 | 9.64 | 9.10 |
| Seed | 100 | 120 | 100 | 120 | 100 | 120 | 100 | 120 | 100 | 120 |
| Maintenance | | | | | | | | | | |
| Fertilization | 170.25 | 177.69 | 84.756 | 92.19 | 84.756 | 92.19 | 84.756 | 92.19 | 84.756 | 92.19 |
| Spraying | 3.215 | 3.035 | 3.215 | 3.035 | 3.215 | 3.035 | 3.215 | 3.035 | 3.215 | 3.035 |
| Irrigation | 150 | 200 | 150 | 200 | 150 | 200 | 150 | 200 | 150 | 200 |
| Mowing | 40 | 45 | 40 | 45 | 40 | 45 | 40 | 45 | 40 | 45 |
| Total Exp. (TL) | 514.905 | 594.285 | 429.411 | 508.785 | 429.411 | 508.785 | 429.411 | 508.785 | 429.411 | 508.785 |
| S.Maize price (TL/kg) | 0.28 | 0.35 | 0.28 | 0.35 | 0.28 | 0.35 | 0.28 | 0.35 | 0.28 | 0.35 |
| S.Maize Income(TL) | 2885.23 | 3628.31 | 2836.4 | 3605 | 2707.6 | 3111.01 | 2614.86 | 3619 | 2577.84 | 3319.4 |
| NET INCOME (TL/da) | 2370.32 | 3034.02 | 2406.98 | 3096.2 | 2278.18 | 2602.22 | 2185.45 | 3110.21 | 2148.43 | 2810.6 |
| ANNUAL NET INCOME (TL/da) (system) | 3050.22 | 4412.97 | 2737.98 | 4284.14 | 2165.18 | 3260.52 | 2660.75 | 4688.76 | 2657.33 | 4039.5 |

As a result, although the fertilizer applications to be applied to different forage crop production systems reflect the period in which the trial was conducted economically, the profit obtained from the systems may be at high levels due to the changing buying and selling prices today. In addition, the net gains obtained may vary according to the environmental variables at that time.

**Conclusion and Recommendations**

In today's world where the importance of sustainability is increasing day by day, improvements need to be made in different crop rotation systems and fertilization programs applied to these systems. The Aegean region is known for year-round agricultural production. However, negative effects on soil properties are revealed with single production. The irregular increase in mineral fertilizer prices has led producers to organic fertilizers. In this experiment, the effects of different organic fertilizers and mineral fertilizers in different rotations of forage crops were compared. In the economic analyses based on yield characteristics, mineral fertilizer was found to be in the lead in all systems, while cattle manure and biogas digestate were also found to be important in terms of sustainability. Among the systems, the highest economic values were obtained in the mixtures and maize silage systems sown afterward.

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# EKMEKLİK BUĞDAY YEREL ÇEŞİTLERİNİN VERİM VE BAZI AGRONOMİK ÖZELLİKLERE GÖRE DEĞERLENDİRİLMESİ

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**Özet**
Kültürel mirasın bir parçası olan yerel buğday çeşitlerinde genetik erozyonun önüne geçebilmek ve kendine özgü kalite özelliklerini koruyabilmek için, genetik çeşitliliğin güvence altına alınması ve sürdürebilir tarım uygulamalarına yeniden entegrasyonu açısından yerel buğday çeşitlerinin ekimi teşvik edilmelidir. Bu çalışmanın amacı, Ege Bölgesinde yetiştirilen üç standart çeşit (Efe, Kayra, Meltem-Ege Tarımsal Araştırma Enstitüsü'nden temin edilen) ve yedi yerel buğday çeşidinin (Çalıbasan, Zerun, Kızılca, Kars Kırmızı, Krik, Ak Buğday, Üveyik) verim ve agronomik özelliklerini değerlendirmektir. Deneme, Yakaköy/Bornova lokasyonunda, 2021-2022 yılları yetiştirme döneminde gerçekleştirilmiştir. Denemeler, tesadüf blokları deneme desenine göre 3 tekerrürlü olarak düzenlenmiştir. İncelenen özelliklere ait ortalama değerler ve değişim aralıkları: bitki boyu 98.3 cm (83.7- 118.0), kardeş sayısı 1.5 adet (1.0- 2.4), hektolitre 77.5 kg/hl (75.8- 80.1), bin tane ağırlığı 35.4 g (24.4- 40.2), parsel tane verimi 1270.9 g (2000- 653) ve dekara tane verimi 211.8 kg/da (109.0- 333.3) olarak saptanmıştır. Varyans analiz sonuçlarına göre hektolitre ağırlığı dışındaki tüm özellikler bakımından çeşitler arasında %0.1 önemli farklılıklar tespit edilmiştir. Yerel ekmeklik buğday çeşitlerinin; bitki boyu ve kardeş sayısı bakımından standart çeşitlere (Efe, Kayra ve Meltem) göre daha yüksek ortalama değerler verdiği gözlemlenmiştir. Diğer özellikler bakımından standart çeşit ortalamaları öne çıkmıştır. Ortalama tane verimi bakımından yerel çeşitlerin ıslah çeşitlerinden %46.3 daha düşük verime sahip olduğu tespit edilmiştir. Ancak, Üveyik ve Ak Buğday çeşitlerinin genel ortalamadan, Zerun çeşidi de yerel çeşit ortalamasından daha yüksek değerler vererek verim yönünden farklılık yaratmışlardır. Ayrıca, Üveyik ve Ak Buğday çeşitleri Kayra ıslah çeşidinden daha fazla tane verimi vermiştir. Parsel ve dekara verim bakımından geniş bir varyasyon gözlemlenmiştir.
**Anahtar Kelimeler:** Buğday yerel çeşitleri, genetik çeşitlilik, sürdürülebilir tarım, genetik erozyon

# ASSESSMENT OF BREAD WHEAT LANDRACES BASED ON YIELD AND SOME AGRONOMIC CHARACTERISTICS

**Abstract**

To prevent genetic erosion in wheat landraces, which are a part of cultural heritage, and to preserve their unique quality characteristics, the cultivation of wheat landraces should be encouraged in terms of securing genetic diversity and reintegrating them into sustainable agricultural practices. This study aimed to objectively evaluate the yield and yield characteristics of three standard wheat cultivars (Efe, Kayra, Meltem) and seven wheat landraces (Çalıbasan, Zerun, Kızılca, Kars Kırmızı, Krik, Ak Buğday, Üveyik) sourced from various regions across Turkey. The trials were carried out during the 2021-2022 growing season in the Yakaköy/Bornova location and were designed using a randomized block design with three replications. Mean values and ranges of variation for the traits examined were: plant height 98.3 cm (83.7- 118.0), number of tillers 1.5 (1.0- 2.4), hectoliter 77.5 kg/hl (75.8- 80.1), thousand grain weight 35.4 g (24.4- 40.2), plot grain yield 1270.9 g (2000- 653) and decare grain yield 211.8 kg/ha (109.0- 333.3). According to the results of variance analysis, 0.1% significant differences were found among the varieties for all traits except hectoliter weight. It was observed that bread wheat landraces gave higher mean values in terms of plant height and number of tillers than the standard varieties (Efe, Kayra and Meltem). In terms of other traits, the standard varieties averages stood out. In terms of average grain yield, it was determined that landraces had 46.3% lower yield than the standad varieties. However, Üveyik and Ak Buğday gave higher values than the general average and Zerun gave higher values than the landraces average, making a difference in terms of yield. In addition, Üveyik and Ak Buğday gave higher grain yield than Kayra breeding variety. A wide variation was observed in terms of yield per plot and per decare.

**Keywords:** Wheat landraces, genetic diversity, sustainable agriculture, genetic erosion

## 1. Introductıon

Wheat is one of the first cultivated crops and has a very important place as a basic food raw material in human nutrition in the world and in Turkey. Today, it has the largest cultivation area among cultivated plants (FAO, 2021). Wheat is one of the most important and strategic agricultural products in Turkey, which is among the top 10 countries in the world in terms of production. The total production area is approximately 6.7 million hectares and production is around 20 million tons (TUIK, 2022).

Durum and bread wheat species are reported to originate from wild species growing in the so-called Fertile Crescent, which includes the Southeastern Region of Turkey (Heun et al., 1997). Turkey hosts a wide genetic diversity of wheat as it covers two centers of origin defined by Vavilov. As a result of natural evolution and hybridization from wild relatives of wheat in Anatolia and selection by humans, varieties suitable for regions and local needs began to emerge. This process resulted in the formation of wheat landraces that were intensively cultivated until the 20th century through natural and human-made selections. During the so-called the Green Revolution, the cultivation of wheat landraces gradually decreased as a result of the transfer of short height genes to wheat plants and the use of intensive fertilizers and pesticides (Çığ and Karaman, 2019). Today, the cultivation of wheat landraces has continued, especially in drought-stricken areas and areas lacking agricultural technology (Baloch et al., 2017). However, genetic diversity in landraces has gradually decreased and some varieties are only preserved in seed genebanks (Özkan et al., 2011). Some landraces, which have beneficial characteristics in terms of some commercial characters, especially quality, taste and aroma, have a satisfactory yield potential in terms of grain yield compared to modern breeding varieties, especially in areas where irrigation is limited (Aktaş, 2016). Wheat landraces are genotypes with population characteristics that are developed by farmers using traditional methods and have adapted to a certain region with the effect of natural selection (Zencirci, 2018). In recent years, interest in wheat landraces and products has been increasing in our country. Wheat landraces have started to be in demand by consumers due to their high nutritional value compared to other cereales and have been rediscovered as healthy foods. In addition, the importance of wheat landraces is increasing day by day due to its resistance to abiotic and biotic stress factors, its high adaptability to poor soils, and its low input cost, making it a suitable grain for organic farming. Today, landraces are used in a very low proportion of the wheat cultivation areas in Turkey. In order to ensure the sustainability of local varieties, farmers should be encouraged to protect local varieties, which are disappearing with the

widespread use of modern wheat varieties. This study was carried out to determine and characterize some agronomic properties of wheat varieties obtained from different locations of Turkey, under Yakaköy/Bornova conditions.

## 2. Materials And Methods

A total of 10 genotypes including 7 local bread varieties (Çalıbasan, Zerun, Kızılca, Kars Kırmızı, Krik, Ak Buğday and Üveyik) collected from different regions of Turkey and 3 standard varieties (Efe, Kayra, Meltem) obtained from the Aegean Agricultural Research Institute were used as material. The research was conducted in the Bornova Natural Agriculture Center and Farm located in Bornova / Yakaköy in the forest area in the 2021-2022 growing season. The location of the trial area is 38°50'08" north latitude and 27°18'09" east longitude coordinates and its altitude is 320 m.

Precipitation, temperature and relative humidity values for the 2021-2022 growing period and long-term averages are given in Table 1.

The average temperature measured during the experimental season was 12.4 $^{o}$C, the same as the long-term average. Total precipitation during the season was 617 mm, which is approximately 18% below the long-term average. When the distribution of precipitation during the vegetation period is examined, it is seen that the highest amount of precipitation fell in December and was 115.9% more than the long-term average. In January, 172.2% less precipitation fell than the long-term average. In February, precipitation increased again, 38% more than the long year average. In the following months, until the harvest period, very low rainfall was reported (Table 2).

**Table 1.** Climatic data for Yakaköy/Bornova location

| | Temperature (°C) | | Precipitation (mm) | | Relative Humidity (%) | |
|---|---|---|---|---|---|---|
| Months/Years | 2021-2022 | Long Years | 2021-2022 | Long Years | 2021-2022 | Long Years |
| October | 15.4 | 16.8 | 47.0 | 50.6 | 68.3 | 68.9 |
| November | 12.9 | 12.1 | 63.4 | 61.5 | 80.8 | 76.1 |
| December | 8.0 | 7.4 | 225.0 | 104.2 | 92.8 | 83.8 |
| January | 4.5 | 6.0 | 68.4 | 186.2 | 81.3 | 84.3 |
| February | 7.0 | 8.1 | 130.6 | 94.6 | 85.0 | 80.3 |
| March | 5.3 | 10.2 | 26.0 | 89.0 | 64.6 | 73.7 |
| April | 14.8 | 14.1 | 29.1 | 46.4 | 61.9 | 64.2 |
| May | 19.7 | 19.1 | 7.9 | 41.5 | 50.2 | 59.3 |
| June | 24,2 | 23.0 | 19.7 | 55.1 | 49.6 | 58.2 |
| Average | 12.4 | 12.4 | 617* | 729.0* | 70.5 | 72.05 |

General Directorate of Meteorology, *: Total value

The soil structure, chemical and organic matter contents of Bornova/Yakaköy Bornova Natural Agriculture Center and Farm (BDTMÇ) during the 2021-2022 wheat growing season were analyzed at Ege University Soil Science and Nutrition department laboratory. Soil analysis values are given in Table 2.

**Table 2.** Soil properties of the study area

| | |
|---|---|
| Depth (cm) | 0-30 |
| Soil reaction (pH) | 8.1 medium alkaline) |
| Salinity (%) | 0.05 (Unsalted) |
| Lime ($CaCO_3$) (%) | 22.1 (Very Calcareous) |
| Sand (%) | 44.96 |
| Mile (%) | 28 |
| Clay (%) | 27.04 |
| Soil structure | Clay-Loam |
| Organic matter (%) | 3.22 (Adequate) |
| Total N (%) | 0.319 (Excess) |

According to the results of the soil sample analysis taken from the soil surface and 30 cm depth, the soil has a clay-loam structure, high lime content and medium alkaline character. Salt content is low (0.05%), total nitrogen content is high (0.319%) and organic matter content is sufficient (3.22%).

The experiment was established according to the randomized block design with 3 replications. The plot size of the trials was planned as 6 rows with 1.20 m x 5 m = 6 $m^2$ at harvest. Sowing was done on November 13. The sowing norm was 500 seeds per $m^2$. When the plants reached harvest maturity, on June 25, 2022, the plots were harvested by hand and the spike was grained in a threshing machine.

Plant height (cm), number of tillers (number), hectoliter (kg/hl), thousand grain weight (g), plot grain yield (g) and grain yield per decare (kg/da) traits were analyzed. Analysis of variance was applied to the data of the examined traits using the SPPSS V.22 statistical program and the differences between The Averages Were Grouped By Applying The Least Significant Difference (LSD) Test.

## 3. RESULTS AND DISCUSSION

In this study conducted under Bornova/Yakaköy conditions, analysis of variance results of plant height, number of tillers, hectolitre, thousand grain weight, plot grain yield and decare grain yield of seven landraces and three improved bread wheat varieties are given in Table 3. According to the analysis of variance results of the data obtained, significant differences at 0.1% level were found among the varieties for all traits except hectolitre. The mean of the traits analyzed and the groups formed are given in Table 4.

***Plant Height***

When the analysis of variance table of plant height of bread wheat used in the study was examined, it was found that it was significant between the varieties at $p < 0.01$ significance level and with a coefficient of variation of 7.9 (Table 3).

The mean plant height of bread wheat genotypes varied between 84.9 cm and 118.0 cm and the general mean was 98.3 cm. Seven different groups were formed among wheat genotypes. Among the landraces, Çalıbasan had the longest plant height of 118.0 cm, followed by Zerun 111.7 cm. The landrace Üveyik had the shortest plant height of 90.5 cm. The average of landraces was 102.1 cm (Table 4).

**Table 3.** Analysis of variance results of the mean squares for the examined traits

| Source of Variation | DF | PH | NT | Hektolitre | TGW | PY | Yield |
|---|---|---|---|---|---|---|---|
| Genotype | 9 | 419.825 | 0.532 | 5.553 | 58.364 | 426150.245 | 11837.538 |
| Repetition | 2 | 28.592 | 0.025 | 7.012 | 22.185 | 140673.157 | 3907.660 |
| Error | 18 | 60.165 | 0.014 | 7.044 | 9.038 | 107807.670 | 2994.605 |
| General | 29 | 169.606 | 0.176 | 6.579 | 25.832 | 208870.227 | 5801.933 |
| F value | | 6.978** | 37.406** | 0.788ns | 6.458** | 3.953** | 3.953** |
| Coefficient Variation (%) | | 7.9 | 8.2 | 3.4 | 8.5 | 25.8 | 25.8 |

**: p<0.01; ns: not significant; DF: degrees of freedom; PH: Plant Height (cm); NT: Number of Tillering (number); Hectolitre: Hectolitre Weight (kg/hl); TGW: Thousand Grain Weight (g); PY: Plot Yield (g); Yield: Yield per Decare (Kg/da)

Among the bread standard varieties, the tallest was Efe with 93.1 cm. Kayra 90.5 cm and Meltem 84.9 cm were in the same group. The average height of standard varieties was 89.5 cm (Table 4).

**Table 4.** Mean values and groups formed for the analyzed traits

| Genotypes | Plant Height (cm) | N. of Tillering (number) | Hektolitre (kg/hl) | TGW (g) | Plot Yield (g) | Yield (Kg/da) |
|---|---|---|---|---|---|---|
| Çalıbasan | 118.0 *a* | 1.0 *f* | 78.7 | 36.5 *abc* | 1065.0 *bcd* | 177.5 *bcd* |
| Zerun | 111.7 *ab* | 1.9 *b* | 78.4 | 32.4 *c* | 1258.8 *bc* | 209.8 *bc* |
| Kızılca | 104.0 b*cd* | 1.1 *fg* | 80.1 | 38.5 *ab* | 1085.0 *bcd* | 180.8 *bcd* |
| Kars Kırmızı | 109.1 a*bc* | 1.6 *c* | 75.8 | 24.4 *d* | 886.3 *cd* | 147.7 *cd* |
| Krik buğdayı | 97.5 *cde* | 2.4 *a* | 76.1 | 38.1 *ab* | 653.8 *d* | 109.0 *d* |
| Ak Buğday | 83.7 *f* | 1.5 *cd* | 77.6 | 37.5 *abc* | 1377.5 *bc* | 229.6 *bc* |
| Üveyik | 90.5 *ef* | 1.3 *def* | 76.0 | 40.2 *a* | 1485.0 *ab* | 247.5 *ab* |
| Efe (SV) | 93.1 *def* | 1.4 *de* | 77.7 | 36.1 *abc* | 1550.0 *ab* | 258.3 *ab* |
| Kayra (SV) | 90.5 *ef* | 1.2 *efg* | 76.6 | 36.0 *abc* | 1347.5 *bc* | 224.6 *bc* |
| Meltem (SV) | 84.9 *ef* | 1.1 *f* | 77.9 | 34.3 *bc* | 2000.0 *a* | 333.3 *a* |
| Average of Landraces | 102.1 | 1.5 | 77.5 | 35.4 | 1115.9 | 186.0 |
| Avr.of Standard Varieties | 89.5 | 1.2 | 77.4 | 35.5 | 1632.5 | 272.1 |
| Overall Avr. | 98.3 | 1.5 | 77.5 | 35.4 | 1270.9 | 211.8 |
| LSD (0.05) | 13.31 | 0.21 | 4.55 | 5.18 | 563.26 | 93.88 |

LSD: Least significant difference; SV: Standard Variety

It was observed that wheat landraces gave higher average values in terms of plant height than the standard varieties (Efe, Kayra and Meltem). In terms of plant height, landraces were 12.3% taller than standard varieties. Çalıbasan, Zerun, Kars Kırmızı, Kızılca differed in terms of stem-straw yield. The lodging tates of these genotypes should be evaluated. The fact that the plant height of wheat landraces is higher than standard varieties has been reported that lodging problems may occur when landraces are grown in fertile areas (Austin et al., 1989). However, it can be said that tall wheat landraces in dry farming areas are important for breeding research since they utilize the substances they accumulated in their structures before spring drought stress for grain (Miralles and Slafer, 1995; Seidel, 1996).

According to a study conducted on winter bread wheat landraces populations collected from seven regions of Turkey, bread wheat landraces were found to be between 51-140 cm in height classification (Akçura and Topal, 2016). In a study conducted by Koç et al. (2020) with a total of 25 bread wheat varieties, including 15 wheat landraces, plant height was found to be 102.5 cm, which is similar to this study.

***Number of Tillers***

When the tiller number data of the bread wheat genotypes used in the study were analyzed, the differences among the wheat genotypes were found statistically significant at $p<0.01$ level with a coefficient of variation of 8.2% (Table 3).

The number of tillers of bread wheat genotypes varied between 1.0-2.4. The general average was determined as 1.5. According to the results of statistically significant difference test, 9 different groups were formed (Table 4). Among the wheat landraces, Krik had the highest number of tillers with an average of 2.4, followed by Zerun 1.9, Kars Kırmızı 1.6 and Ak Buğday 1.5. The least tillered landraces was Çalıbasan with 1.0 tillering. Among the standard varieties, Efe showed the highest tillering with 1.4, while Kayra ranked second among the standard varieties with 1.2 units. The lowest tillering was observed in Meltem variety with 1.1 units. The average of the standard varieties was determined as 1.2. It was observed that bread wheat landraces tillered more than the standard varieties except for Çalıbasan and Kızılca genotypes (Table 4). In terms of number of tillers, landraces had 25% more average value than standard varieties. The number of tillers is one of the main factors affecting grain yield (Sade, 1999). Akçura, (2006) found that the number of fertile tillers in wheat landraces varied between 3.33 and 5.83. Since the research was conducted on the basis of regions and with many genotypes, it is thought that the variation may have been higher than this study. It is stated that if wheat decreases plant density due to environmental conditions, the number of tillers increases as an adaptation feature, and in case of dense sowing, there is an inverse proportion in the direction of decreasing the number of fertile tillers (Darwinkel, 1978; Akkaya, 1994).

***Hectoliter***

When the hectoliter values of bread wheat varieties were analyzed, it was found that the difference between genotypes was not significant. The coefficient of variation was found to be 3.4% (Table 3).

No groups were formed in the least significant difference (LSD) test on hectoliter weights of wheat varieties. Hectoliter weights of the genotypes varied between 80.1 kg/hl and 75.8 kg/hl. The overal hectoliter average value was 77.5 kg/hl (Table 4). Among the bread wheat landraces, Kızılca had the highest value in terms of hectoliter with 80.1 kg/hl. It was followed by Çalıbasan with 78.7 kg/hl and Zerun with 78.4 kg/hl. Kars Kırmızı gave the lowest data with 75.8 kg/hl. It was followed by Üveyik with 76.0 kg/hl and Krik with 76.1 kg/hl. The average of landraces was recorded as 67.7 kg/hl. Among the standard varieties, the variety with the highest hectoliter value was Meltem with 77.9 kg/hl, while Kayra had the lowest hectoliter weight with 76.6 kg/hl. The average hectoliter weight of standard varieties was 77.4 kg/hl. If we compare the averages of landraces and standard varieties, there is a difference of 0.4%. The varieties above the general average were Kızılca (80.1), Çalıbasan (78.7), Zerun (78.4), Meltem (77.9), Efe (77.7) and Ak Buğday (77.6). Kızılca had a value above the standard varieties. Mut et al. (2005), reported that the hectoliter weights of bread wheat varieties were found between 68.4 and 74.9 kg/hl in their research on quality characteristics under Amasya and Samsun

conditions. The shape, size and homogeneity of the grain are the characteristics that determine the hectoliter weight (Özkaya and Kahveci 1990).

***Thousand Grain Weight***

When the table related to thousand grain weight of bread wheat genotypes was examined, it was determined that the difference between genotypes was significant at $p<0.01$ level and 8.5% coefficient of variation (Table 3).

The LSD test was applied to the thousand grain weight data of wheat varieties and 6 different groups were recorded. It was determined that the thousand grain weights of the genotypes varied between 40.2 grams and 24.4 grams. The overall thousand grain average of the varieties was found to be 35.4 grams (Table 4). Among the wheat landraces, Üveyik had the highest thousand grain weight with 40.2 grams, followed by Kızılca with 38.5 grams and Krik with 38.1 grams. The lowest weight was recorded as Kars Red with 24.4 grams, followed by Zerun local variety with 32.4 grams. The average weight of landraces was 35.4 grams (Table 4.20.). Among the standard varieties, the highest thousand grain weight was observed in Efe variety with 36.1 grams, followed by Kayra variety in the same group. The standard variety Meltem was behind Efe and Kayra with a weight of 34.3 grams. The average of the standard varieties was recorded as 35.5 grams (Table 4.20.). When the average thousand grain weights were compared, the standard varieties had 0.3% more average value than the local varieties. Steppe genotype was recorded to have a value above the standard varieties. Çalıbasan (36.5 g) and Ak Buğday (37.5 g) were in the same group with Efe and Kayra, which are standard varieties. It was determined that the standard varieties were above the averages (Table 4.20.). Gençtan and Balkan (2006), in their research on yield characteristics, determined that thousand grain weights were between 31.53 and 44.02 grams. In another study conducted with 122 local bread wheat varieties collected from Bingöl province and its districts, thousand grain weight was reported between 22.61-40.96 g (Uçar, 2016). Foy and Peterson (1994) reported that thousand grain weight has a great effect on grain yield.

***Plots Grain yield***

When the variance table of wheat genotypes was examined, it was found that the difference between genotypes was significant at $p<0.01$ level with a coefficient of variation of 25.8% (Table 3). The yields of the plots of bread wheat varieties varied between 2000 grams and 653 grams. Five different groups were formed in the minimum significance test and the overall plot average was recorded as 1270 grams. The highest plot yield of local wheat genotypes was recorded as Üveyik with 1485.0 grams, followed by Ak Wheat with 1377.0 grams, Zerun with 1258.8 grams, Kızılca with 1085.0 grams and Çalıbasan with 1065.0 grams. The lowest plot yield was obtained from Krik wheat with 653.8 grams. This was followed by Kars Red with 886.3 grams. The average plot yield of local wheats was 1115.9 grams. When the plot yields of standard varieties were analyzed, the highest yield was obtained from Meltem variety with 2000.0 grams. This was followed by Efe with 1550.0 grams. The lowest yield was obtained from Kayra variety with 1347.5 grams. The average of standard varieties was recorded as 1632.5 grams.

When the average of local and standard varieties are compared, it is seen that the standard varieties are above the landraces with a difference of 46.3%. Efe and Üveyik, Kayra and White Wheat, Kars Kırmızı and Zerun, Çalıbasan and Kızılca were in the same group (Table 4).

***Decare Grain Yield***

When the analysis of variance table of decare grain yield of bread wheat genotypes used in the study was examined, it was found that the difference between genotypes was statistically significant at $p<0.01$ level and with 25.8% coefficient of variation (Table 3).

Decare grain yield of the varieties varied between 109.0 kg and 333.3 kg, while the general average was 211.8 kg. According to the results of the minimum significance test applied to the varieties, five different groups were formed. The highest grain yield among the local bread wheat varieties was Üveyik with 247.5 kg. It was followed by Ak Wheat with 229.6 kg, Zerun with 209.8 kg and Kars Red with 147.7 kg. The lowest decare grain yield was given by Krik wheat with 109.0 kg. The average yield of local wheats was 186.0 kg. Among the standard varieties, the highest decare grain yield was obtained from Meltem variety with 333.3 kg and the lowest yield was obtained from Kayra variety with 224.6 kg. The average yield of standard varieties was recorded as 272.1 kg. When the average yield per decare is analyzed, it is seen that the standard varieties are ahead of the local varieties. There was a 46.3% difference between the averages of breeding and local varieties. The low yield average of Krik wheat decreases the average of local varieties. Steppe wheat was found to be in the same group with Efe, one of the standard varieties (Table 4). Bozkurt (2023) determined grain yield per decare between 152.59 kg/ha and 331.04 kg/ha in Eskişehir irrigated conditions. Kettlewell et al. (1998) stated that grain yield per hectare is the result of the interaction of environmental effects, genetic effects and conventional or modern breeding methods. Smith and Googing (1999) reported that rainfall regime and temperature variation during the growing season affect yield.

## 4. CONCLUSION

This study was carried out to determine and characterize some agronomic and agronomic traits of wheat landraces obtained from different locations of Turkey under Yakaköy/Bornova conditions. According to the results of variance analysis, significant differences of 0.1% were found among the varieties for all traits except hectoliter weight.

It was observed that local bread wheat varieties gave higher mean values in terms of plant height and number of tillers than the breeding genotypes (Efe, Kayra and Meltem). In terms of other traits, the standard varieties stood out. In terms of plant height, landraces were 14.1% taller than the breeding varieties. Çalıbasan, Zerun, Kars Kırmızı and Kızılca varieties made a difference in terms of stem-straw yield. In terms of the number of tillers, the landraces had 25% more tillers on average than the breeding varieties. Krik wheat had the highest number of siblings (2.4). In terms of average grain yield, landraces had 46.3% lower yield than the standard varieties. However, Steppe and Ak wheat varieties had higher values than the general average and Zerun variety had higher values than the local variety average,

which made a difference in terms of yield. In addition, Steppe and Ak wheat varieties gave higher grain yield than Kayra cultivar. A wide variation was observed in terms of yield per plot and per decare.

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# OPTIMIZING GROWTH: UNRAVELING THE INLUENTIAL ENVIROMENTAL FACTORS IN THE GRAZING AND DEVELOPMENT PERIODS OF AKKARAMAN LAMBS

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## Abstract
In lamb rearing programs, lambs in pasture-based farming enterprises are raised with contributions from both the ewe and the pasture condition until weaning. One of the widely practiced livestock farming models in the Central Anatolia region is pasture-based production. In this study, characterization of distributions of first time to grazing weight, return period from grazing weight and average daily gain as well as estimation of effects of certain environmental factors on these traits were aimed in Akkaraman sheep raised around Ankara province. For this purpose, the linear mixed models were fitted to estimate the effect of factors and to obtain the least mean square for the traits. Finally, the multiple comparison tests were applied to obtain significance level of differences between groups of factors. The effect of all studied fixed factors on birth weight (FTG), weaning weight (RPG) and average daily weight gain (ADWG) were found to be significant. The average ages of going to grazing, time spent in grazing and total ages are 56.08, 119.26 and 63.18 days, respectively. The results obtained are FTG, RPG and ADGW 21.28 kg 35.71 kg and 226.22 g respectively. Additionally, the most significant proposal made in our study is to evaluate the heritability of these variables using full pedigree and to improve the breed genetically in addition to improving environmental conditions in order to analyze the grazing time attributes of Akkaraman sheep in more detail.
**Keywords:** Grazing period, environmental factors, Akkaraman.

## Introduction

In lamb breeding programs, lambs in grazing-based farming enterprises are raised with contributions from both the ewe and the grazing condition until weaning. One of the widely practiced livestock farming models in the Central Anatolia region is grazing-based production. This region is generally influenced by a continental climate, characterized by hot and dry summers, cold and snowy winters, with an average precipitation of around 400 mm. (Celepoğlu, 2007). These climatic conditions have a negative impact on the quality of pastures. Therefore, the prevalence of poor pastures and indigenous breeds resistant to diseases in the region has led people to engage in small ruminant farming and benefit from indigenous breeds.

Ankara province, located within the Central Anatolia Region, is an important region that offers favorable climatic conditions, pasture areas, and feed resources for small ruminant farming (Ceyhan et al., 2012). This situation contributes to the local economy while also allowing the continuation of traditional livestock culture and the production of animal products. Sheep farming is widely practiced within small ruminant breeding in the region. The Akkaraman sheep breed is known to be the most commonly raised breed in the region due to its high adaptability to the local environment and its resistance to diseases (Yakan et al., 2012).

The Akkaraman breed is not only known as a fat-tailed sheep breed but is also described as a dual-purpose breed (Şirin et al., 2017). The importance of the Akkaraman breed is highlighted by its utilization in crossbreeding efforts conducted in the early years of the Republic to increase meat and wool production, resulting in the development of the Anatolian Merino, Central Anatolian Merino, and Malya sheep breeds (Yalcin, 1986). It is an important breed in lamb farming in the Ankara region and holds economic significance in meeting meat consumption. In lamb rearing methods, lambs are typically nourished with maternal milk from birth until they are introduced to the pasture. During the grazing period, they join their mothers in the pasture, benefiting both from maternal milk and natural grazing resources. At the end of the grazing period, breeding animals are carefully selected for the next generation, while non-breeding male and female lambs are separated for short-term fattening and sold as meat.

Since the inception of the Akkaraman community-based sheep breeding initiative in 2011, Ankara has made significant success. It is carried out as a sub-project of the Ministry of Agriculture and Forestry's "National Community-Based Small Ruminant Breeding Programme" in partnership with several universities, research institutions, sheep and goat breeder organisations, and breeders. In this study, the weights of lambs during their first entry into the grazing were recorded to assess the influence of grazing and maternal milk on their

weights throughout the grazing season. After the return from grazing, daily live weight gains were measured, and the environmental effects on these characteristics were examined.

## Materials and Methods

### Animals and Phenotype

The study's animal material included 4500 heads (4300 ewes and 200 rams) of Akkaraman sheep from 16 farms in Ankara province and its areas. Data from lambs born in 2018 were utilized in Ankara Akkaraman breeding, a sub-project of the National Community-Based Small Ruminant Breeding Programme.

Throughout the spring and summer months (from March to November), the small ruminants grazed on pastures of notably low quality, while during the winter season, they were provided with an average of 0.6 kg/day of concentrated feed per animal in their enclosure. Lambs, at an average age of 56 days, are introduced to the grazing alongside their mothers in March and April, benefiting both from maternal milk and natural grazing resources. Lambs spend an average of 63 days in the pasture alongside their mothers. At the end of the grazing period, breeding animals are carefully selected for the next generation, while non-breeding male and female lambs are separated for short-term fattening and sold as meat. Prior to mating, the male sheep (rams) were isolated from the herd and given concentrated feed for a period of two months.

**Table 1.** Descriptive statistics of grazing period growth traits.

| Trait | FTG (kg) | RPG (kg) | ADWG (g) |
|---|---|---|---|
| **Number of observations** | 4049 | 4049 | 4049 |
| **Mean** | 21.28 | 35.71 | 226.22 |
| **Standard error** | 0.07 | 0.11 | 0.147 |
| **Minimum** | 11.20 | 16.00 | 19.20 |
| **Maximum** | 35.40 | 63.10 | 488.24 |
| **Coefficient of Variation** | 19.71 | 19.00 | 41.22 |

FTG: First Time to Grazing. RPG: Return Period from Grazing. ADWG: Average Daily Weight Gain.

First time to grazing (FTG), return period from grazing (RPG), average daily weight gain (ADWG) 4049 observations were obtained as traits. Additionally, first time to grazing, return

period from grazing and average daily weight gain dates, sex (male, female), birth type (singlets/twins), district (Bala, Çankaya, Elmadağ, Haymana and Mamak), herd size (0-150, 150-300 and >300) and first time to grazing month (March/April) were regularly recorded. Age of lambs at grazing emergence day was of the animals to approximately 56.08 , age of lambs from birth to end of grazing day was of the animals to approximately 119.26 and grazing time was of the animals to approximately 63.18 days. Average daily weight gain (ADWG) was obtained via linear statistics by using FTP and RPP. Detailed description of the data structure with the sample size after removing the outliers were presented in Table 3.

**Tabe 2.** Descriptive statistics of grazing period days.

| **Parameters** | **ALGE(day)** | **ALBEG(day)** | **GT(day)** |
|---|---|---|---|
| **Number of observations** | 4049 | 4049 | 4049 |
| **Mean** | 56.08 | 119.26 | 63.18 |
| **Standard error** | 0.27 | 0.28 | 0.17 |
| **Minimum** | 14 | 57 | 34 |
| **Maximum** | 101 | 174 | 89 |
| **Coefficient of Variation** | 30.52 | 15.09 | 16.93 |

ALGE: Age of Lambs at Grazing Emergence ALBEG: Age of Lambs from Birth to End of Grazing GT: Grazing time

**Statistical Analyses**

We eliminated the outliers in the data by removing observations with values exceeding the mean ± 3 times the standard deviation. Normality of the responses were tested with Shapiro-Wilk test. Furthermore, the variance homogeneity was visually examined using a plot derived from the residual vs fitted value of the answers. Initially, we examined the influence of environmental factors (such as sex, birth type, herd size, first time to grazing month, and district) to construct the final linear mixed models. The data management and initial analysis were conducted using the core packages of the R statistical environment (R Core Team, 2020). For linear model analysıs “SPSS 26” program were used.

Generalized linear models were employed to assess the impact of environmental factors before fitting the final models for the traits. We calculated the mean least square differences of the factors using these mixed models, with the inclusion of herd effect as a random factor in the

model. Following this, conducted Duncan's Test to examine the differences between groups for the significant factors. Below is the description of the ultimate linear mixed model applied to the traits:

Model: $\mathbf{y_{ijklm} = \mu + h_i + d_j + m_k + t_l + s_m + Zh + e_{ijklm}}$

Where $\mathbf{y_{ijklmn}}$ are the observations of the dependent variables (i.e., FTG, RPG and ADWG); $\boldsymbol{\mu}$ is the intercept; $\mathbf{h_i}$ is the fixed effects of herd size (3 levels); $\mathbf{d_j}$ is the fixed effects of district (5 levels)**;** $\mathbf{m_k}$ is the fixed effects of month of going out to grazing (2 levels); $\mathbf{t_l}$ is the fixed effects of birth type (2 levels); $\mathbf{s_m}$ is the fixed effects of sex and **h** is the random herd effect where $\mathbf{e_{ijklmn}}$ is the residual error of observations in the models and Z is the incidence matrix.

**Result and Discussion**

The impact of environmental factors such as sex, birth type, district, herd size, and month of going out to graze on FTP, RPP, and ADWG of Akkaraman lambs were investigated in this study. The linear mixed models were fitted for this purpose in order to quantify the influence of variables and produce the mean least square estimates for the characteristics. The models' diagnostic tests and factor interactions were also carried out. Finally, multiple comparison tests were used to determine the level of significance of differences across groups of components.

Table 3 summarizes the elements that have substantial influence on the features after developing the suitable final models. The diagnostic tests revealed that the data had a normal distribution with homogeneous variance. In general, pairwise interactions among factors were not significant.

**Table 2.** The least square mean value (± SE) of the grazing time growth traits with the relevant p-values and sample sizes.

| | FTG (kg) | | | RPG (kg) | | | ADWG (g) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Fixed Effects** | **n** | **LSM ± SE** | **p-value** | **n** | **LSM ± SE** | **p-value** | **n** | **LSM ± SE** | **p-value** |
| **Sex** | | | *** | | | | | | *** |
| **Male** | 2044 | 21.14±0.12$^{a}$ | | 2044 | 36.35±0.18 | | 2044 | 229.04±2.78$^{a}$ | |
| **Female** | 2005 | 20.41±0.11$^{b}$ | | 2005 | 36.08±0.18 | | 2005 | 237.73±2.70$^{b}$ | |
| **Birth type** | | | *** | | | *** | | | *** |
| **Single** | 3422 | 21.63±0.09$^{a}$ | | 3422 | 36.60±0.15$^{a}$ | | 3422 | 226.85±2.24$^{a}$ | |
| **Twin** | 627 | 19.93±0.16$^{b}$ | | 627 | 35.83±0.24$^{b}$ | | 627 | 239.92±3.73$^{b}$ | |
| **District** | | | *** | | | *** | | | *** |
| **Bala** | 1388 | 20.34±0.17$^{b}$ | | 1388 | 39.70±0.26$^{c}$ | | 1388 | 286.55±3.98$^{c}$ | |
| **Çankaya** | 1559 | 19.59±0.17$^{c}$ | | 1559 | 34.78±0.27$^{d}$ | | 1559 | 226.50±4.12$^{c}$ | |
| **Elmadağ** | 255 | 18.23±0.27$^{a}$ | | 255 | 28.61±0.42$^{a}$ | | 255 | 196.88±6.41$^{a}$ | |
| **Haymana** | 530 | 26.13±0.24$^{d}$ | | 530 | 43.22±0.37$^{d}$ | | 530 | 230.50±5.63$^{a}$ | |
| **Mamak** | 317 | 19.59±0.17$^{b}$ | | 317 | 34.78±0.27$^{b}$ | | 317 | 226.50±4.12$^{b}$ | |
| **Herd Sıze** | | | *** | | | *** | | | *** |
| **0-150** | 975 | 20.49±0.17$^{a}$ | | 975 | 37.49±0.26$^{a}$ | | 975 | 254.51±3.95$^{b}$ | |
| **150-300** | 1515 | 19.21±0.21$^{b}$ | | 1515 | 33.52±0.33$^{b}$ | | 1515 | 209.65±4.95$^{a}$ | |
| **>300** | 1559 | 22.63±0.20$^{c}$ | | 1559 | 37.65±0.31$^{c}$ | | 1559 | 236.00±4.75$^{b}$ | |
| **Month of going out to grazing** | | | *** | | | *** | | | *** |
| **March** | 1108 | 20.73±0.17$^{a}$ | | 1108 | 39.71±0.27$^{a}$ | | 1108 | 260.29±4.14$^{a}$ | |
| **April** | 2941 | 20.83±0.11$^{b}$ | | 2941 | 32.72±0.17$^{b}$ | | 2941 | 206.48±2.55$^{b}$ | |
| **İntercept** | 4049 | 20.28±0.25 | | 4049 | 32.19±0.39 | | 4049 | 213.08±5.94 | |

Notes: The mean values which have different superscript are significantly different. ***P <0.001. **P <0.01. *P <0.05. SE = standard error; N=number of observations.

All fixed variables evaluated were shown to have a substantial influence on first time to grazing (FTG). Table 3 shows that the sex mean for male and female lambs was 21.14 ± 0.12 and 20.41 ± 0.11, respectively. Furthermore, a statistically significant difference between male and female groups was observed. (P-value <0.001). Tüfekçi, (2023) discovered that the mean 60-day weight of male and female Akkaraman lambs born between 2019 and 2020 was 15.53 and 15.54 kg, respectively. Another research on Akkaraman lambs indicated that corrected 60 days old

male and female lambs weighed 14.28 and 14.55 kg, respectively (Türkmen, 2021). While it was observed in this study that male lambs were heavier than female lambs, in the other two studies there was no difference between them. In the study, the first time to grazing weights of singlet and twin lambs were found as 21.63 ± 0.09 and 19.93 ± 0.16 kg, respectively and the differences was statistically significant (P-value<0.001). Many studies done in the same breed found that the 60-day weight of single born lambs was greater than that of twin born lambs, which was statistically significant. (Yağcı et al., 2018; Tüfekçi, 2023; Türkmen, 2021). When we compare the results of this study to the results of other studies, find that there are a lot of similarities. In this study, mean first time to grazing weights of lamb's district in Bala, Çankaya, Elmadağ, Haymana and Mamak were found to be 20.34 ± 0.17, 19.59 ± 0.17, 18.23±0.27, 26.13 ± 0.24 and 19.59 ± 0.17 kg respectively. Moreover, the difference between the groups was found to be significant (P-value <0.001) in the multiple comparison test between these districts. When we look at the results obtained in this study, it is observed that the highest weight was taken in Haymana district and the lowest weight was taken in Elmadağ district. It can be said that the nutritional differences of the mothers during the lamb raising period are more effective in the lambs kept in closed barns from birth to the pasture period, rather than district differences. Looking at the effect of Herd size, mean first time to grazing weights of lamb's herd size 0-150, 150-300 and>300 were found to be 20.49 ± 0.17, 19.21 ± 0.21 and 22.63±0.20 kg respectively. Furthermore, in the multiple comparison test between these herd size, the difference between the groups was determined to be significant (P-value 0.001). It was found that first time to grazing weights of lamb's were highest in farms with a flock size of 300 heads and above, and lowest in farms with a flock size of 150-300 heads. It can be thought that the management system in enterprises with large herds is better than in other enterprises. The other effect month of going out to grazing mean first time to grazing weights of lamb's March and April were found to be 20.73 ± 0.17 and 20.83 ± 0.11kg respectively. Month of going out to grazing It is observed that the difference between the groups is significant (P-value <0.001). It has been determined that lambs that go to pasture for the first time in April have higher live weight than those that go out to pasture in March. It can be said that this situation is affected by factors such as mothers, care, feeding and disease due to the differences between the farms during the lamb raising period of the breeders. This result from the study contribute that the feeding and many other strategies applied on herds are quite important on the first time to grazing weight of lambs.

Similar to FTG, several environmental variables excepting sex were crucial on RPG of lambs in the study. The detail information and the means of RPG were present in Table 3. Table 2 shows that the average time spent on pasture is 63.18 days, and the average return period from pasture is 119.26 days. The least squares mean of RPG of male and female lambs are 36.35 ± 0.18 and 36.08 ± 0.18 kg, respectively. it was determined that the difference between groups based on gender was insignificant. Tüfekçi, (2023) discovered that the mean 120-day weight of male and female Akkaraman lambs was 31.51 and 31.07 kg, respectively. Compared to this study, it is seen that the 120th day weight is lower in the study conducted. It can be thought that the effect of pasture between the 60th and 120th day, the effect of breast milk, and differences in extra care and feeding may cause this situation. The least square means return period from grazing of RPG of single and twin lambs are 36.60 ± 0.15 35.83 ± 0.24 kg, respectively. The difference between groups depending on birth type was found to be substantial (P-value <0.001). When compared with the other study Tüfekçi, (2023), the result obtained showed that the effect of birth type on the 120th day weight was insignificant, unlike this study. In this study, Moreover, means of the district in Bala, Çankaya, Elmadağ, Haymana and Mamak are 39.70 ± 0.26, 34.78 ± 0.27, 28.61 ± 0.42, 43.22 ± 0.37 and 34.78 ±0.27 kg, respectively. It has been determined that the difference between the districts in weight at the end of the grazing period is significant (P-value <0.001). While the result obtained in Haymana district was higher than other regions, the lowest was found in Elmadağ district. It can be said that the most important reason for this situation is that the pasture areas in Elmadag district are mountainous regions. The last square means effect of herd size, return period from grazing weights of lamb's herd size 0-150, 150-300 and>300 were found to be 37.49 ± 0.26, 33.52 ± 0.33 and 37.65 ± 0.31 kg respectively. Also, the difference between the groups was confirmed to be significant (P-value 0.001) in the multiple comparison test between these herd sizes. Return period from grazing weights of lambs were found to be highest on farms with flock sizes of 300 heads and above, and lowest in farms with flock sizes of 150-300 heads. It can be said that the reason for the high weight in large enterprises is that breast milk and pasture areas are better than other enterprises. Effect month of going out to grazing mean return period from grazing weights of lamb's March and April were found to be 39.71 ± 0.27 and 32.72 ± 0.17 kg respectively. Month of going out to grazing It is observed that the difference between the groups is significant (P-value <0.001). It has been determined that lambs that go to pasture for the first time in March have higher live weight than those that go out to pasture in April. It can be seen that the difference is a serious figure of seven kilos. This condition is influenced by elements such as mothers, care, nutrition,

district and sickness as a result of disparities between farms throughout the lamb growing phase of the breeders. As in this study, other studies show that environmental factors such as gender, type of birth, year and month of birth are effective on 90th day and 120th day weight. (Ceyhan et al., 2019; Çolakoğlu & Özbeyaz, 1999; Gül et al., 2020).

The effect of sex, birth type, district, herd size and month of going out to grazing were found significant on ADWG similar to FTG and RPG. The least square means of ADWG for male lambs and female lambs were 229.04 ± 2.78 and 237.73 ± 2.70 g, while they were 226.85 ± 2.24 and 239.92 ± 3.73 g for single-born lambs and twin-born lambs, respectively. The ADWG of district in Elmadağ were lower than those grazing time other district. ADWGs by herd size are 254.51 ± 3.95, 209.65 ± 4.95 and 236.00 ± 4.75 g, respectively. Effect month of going out to grazing mean the ADWG month March and April 260.29 ± 4.14 and 206.48±2.55 g, respectively. In the study conducted by Ceyhan et al. (2019) on Akkaraman lambs, it was reported that the ADWG of male lambs were higher than that of females. On the contrary this study, ADWG of twin-born lambs were higher than single-born lambs. Similarly, ADWG of females lambs were higher than that of male the results were consistent with the present study.

**Conclusion**

The majority of the fixed effects employed in the analysis were discovered to be extremely successful on the grazing time growth metrics FTP, RPG, and ADWG, which are essential markers of feed conversion in the study. In summary, the current study found that male lambs exhibit greater FTP and RPG than female lambs when expect to ADWG. Furthermore, single-born lambs had a longer return period from pasture growth features than twin-born lambs. The first time to grazing weights of the month of going out to graze in April were greater than the month of going out to graze in April, while the return period from grazing growth features in March was higher than the month of going out to graze in April. Herd and nutrition management, climate, and pasture condition have all been found to have a significant impact on lamb birth weight, weaning weight, and daily live weight increase. In general, the study found that many environmental conditions influenced grazing time growth features. As a result, it has been discovered that improving environmental conditions can boost animal output. The most effective improvement may be obtained by calculating the birth months in line with the feeding approach.

The most significant proposal made in our study is to evaluate the heritability of these variables using full pedigree and to improve the breed genetically in addition to improving environmental conditions in order to analyze the grazing time attributes of Akkaraman sheep in more detail.

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**Conflict of interest**

The authors of the study sincerely declare no conflict of interest.

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# FABRICATION AND CHARACTERIZATION OF $CO_3O_4$: CE GAS SENSOR PREPARED BY CHEMICAL SPRAYING PYROLYSIS TECHNIQUE

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## Abstract

$Co_3O_4$ metal oxide semiconductor is in principle suitable material for utilization as a resistive gas sensor. In this research, nanostructure cobalt oxide thin films were prepared by chemical spraying pyrolysis technique, by dissolving cobalt chloride with distilled water. The films were doped with serum Cr in different concentrations, and the structural properties of the doped and un doped films were studied, and the effect of doping on the structural of the material was studied. A gas sensor was prepared from doped and un doped cobalt oxide material. The response properties were studied and the operating temperature and response time of the manufactured sensor were found, the effect of doping on the sensor properties was studied.
**Keywords:** gas sensor; metal oxide; operating temperature; responsivity. response time.

## 1. Introduction

metal oxides (TCO) thin films such as(SnO2 ,ZnO, CdO, $Co_3O_4$, InO, and tin oxide have attracted wide attention in the recent period in the manufacture of gas sensors.

Chemical gas sensors are of great importance as they help us detect environmental pollution with toxic, flammable and harmful gases such as $SO_2$, $NO_2$, $H_2S$, $NH_3$, $H_2$, $CH_4$, $CO_2$, CO, ethanol, $C_2H_5OH$, ethanol, $C_2H_5OH$, and volatile organic compounds (VOCs) [1-6] of great danger to human life.

$Co_3O_4$ is a p-type semiconductor with an indirect energy gap of 1.6-2.2 eV [7]. In principle a suitable material for use as a gaseous sensor.

Cobalt oxide is one of the semiconductors that has gained wide attention because of its unique properties, as it possesses anti-magnetic properties in addition to the two types of energy gaps. Also, the most important characteristic of it is its effectiveness and chemical stability. Therefore, it is considered an important material in photovoltaic applications (PV) [8,9].

Cobalt oxide structure is a face-centered cubic (fcc), where cobalt ions $Co^{+2}$ are located in the tetrahedral site 8a and $Co^{+3}$ is located in the octahedral site 16D, while the oxygen ions are located in the face-centered cube (fcc) [10].

Cobalt oxide is involved in many electro-optical applications, such as the selective absorption of solar energy in solar cells, lithium batteries, super capacitors, and gas sensors, in addition to its applications in biomedical fields and pharmacology, especially in the diagnosis of cancer diseases due to the toxic properties of $Co_3O_4$ nanoparticles, and the packaging of some drugs (11,12). In our research, a gas sensor biased of pure $Co_3O_4$ cobalt oxide and doped with $Co_3O_4$: Ce, and its sensitive properties were studied.

## 2. Experimental Techniques

$Co_3O_4$ Nano-structured thin films prepared by spray pyrolysis technique on glass substrates. The saline solution of 0.1 M prepared by dissolved 2.3793 g of aqueous cobalt chloride ($CoCl_2.6H_2O$) (using precision electronic balance (HR-200 A&DCo.)) in 100 ml of distilled water . This process was done by Magnetic Stirrer (IKA® C-MAG HS 7) for one hour stirring with keeping temperature of the solvent at 30 °C to achieve a consistent solution mixing.

The solution has been sprayed via nozzle at 30 cm distance from the glass substrate to deposit the required thin film, while the substrate has been equipped with a heater to maintain a constant temperature of 400C during the deposition process.

The spraying process was carried out at a flow rate of 4ml/h, and intermittently, as each 10 second spraying, was followed by 2 min pause.

The doping gets using of cerium salt solution prepared by dissolving5.69 gm of cerium sulphate $(Ce_3)_2SO_4$ in 100 ml of distilled water with a continuous stirring for 30 min at room temperature to get 0.1M then used parts of it to prepare concentrations (0.04, 0.06, and 0.08 M) .

The following equation was used to calculate the molar concentration of the salt solution[13]:

$$M = \frac{w_t}{M_{WT} \times \frac{V}{1000}} \qquad (1)$$

Where M is the molar concentration, $W_t$ weight in gram, $M_{wt}$ molecular weight for $(CoCl_2.6H_2O)$ and $(Ce_3)_2SO_4$ is (237.93) and (568.4), respectively. V is volume of deionized water (100 ml).

The thickness of the film was measured by the optical interferometry method. This method depends on the interference of the rays reflected from the surface of the thin film and the the substrate. For this purpose, a He-Ne laser beam (0.632 μm) was used. As for the thickness of the film, it was measured using the FISOU method, and the following equation was applied to calculate the thickness [14]::

$$d = \frac{\Delta x}{x} \times \frac{\lambda}{2} \qquad (2)$$

Where $x$ is the width of the fringes, $\Delta x$ is the distance between two bright fringes and λ is the laser wavelength.

## 3. RESULTS AND DISCUSSION

### 3.1 Structural Measurements.

X-ray diffractometer device ( Philips company) with Cu (kα) radiation source that emits wavelength of λ=1.54059292 Å with Maximum output 1.2 kW has been employed to identify the crystal structure of the $Co_3O_4$ films. The data of scattered intensity vs. scattered angle has been collected and demonstrated graphically.

Figure (1) illustrated six peaks at (31.7863°, 36.8874°, 45.4956°, 56.5261°, 66.2693° and 75.3251°) which corresponding to the $Co_3O_4$ diffraction planes of (220), (311), (400), (422), (440) and (620) respectively. These obtained results of $Co_3O_4$ films are in accordance with the standard ICDD card (JCPDS Card 09-0418).

The diffraction patterns showed that the prepared samples have polycrystalline crystal structure in cubic phase nature, which is consistent with the literature [43]. The preferential orientation around (220) and structure parameter calculations were performed on it.

For the doped samples, new peaks observed in Figure (1) for $Co_3O_4$ films doped with cerium Ce at Braggs angles (28.7°, 47.57° and 56.39°), which correspond to diffraction planes (111), (220) and (222), respectively.

The results we obtained are consistent with the JCPDS Standard Card (34-0394). The appearance of CeO diffraction peaks indicates that the $Ce^{+3}$ ions obtained compensation sites in the cubic $Co_3O_4$ lattice, where they were replaced by $Co^{+2}$ / $^{+3}$ sites, or that the ions obtained interfacial sites in the $Co_3O_4$ lattice [15]. It was also observed that the cobalt oxide structure has a low crystallinity and a decrease in intensity due to the difference in the ionic radius of $Ce^{+3}$ ions and their replacement by $Co^{+3}$ ions in the lattice, as the ionic radius of $Co^{+3}$ (0.62 Å) and $Ce^{+3}$ (1.14Å) [16,17].

Using the following Sherrer's equation , the crystal size was calculated for the preferential orientation (220) at 2θ = 31.7863°:

$$D = \frac{0.9\lambda}{\beta \cos\theta} \qquad (3)$$

Where (β) is the full width of the mid-highest diffraction peak at an angle (θ) ) [18].

The structural parameters such as atomic level space ($d_{hkl}$), lattice constants (a), mean strain (ε) and the density of dislocation (δ), have been calculated using the following equations:[19-22]

$$n\lambda = 2d \sin\theta \qquad (4)$$

$$d_{hkl} = \frac{a_{hkl}}{\sqrt{h^2 + k^2 + l^2}} \qquad (5)$$

$$\varepsilon = \frac{a_{air} - a_{bulk}}{a_{bulk}} \qquad (6)$$

$$\delta = \frac{1}{D^2} \qquad (7)$$

The quantities of lattice parameters and crystallite size observed to be decreases with doping will the strain increases because of the substitution of $Ce^{+3}$ ions with large radii with small radii $Co^{+2}$ ions in cobalt oxide unit cell [16,17].

As for the crystal size D, it was observed that it decreases with increasing the percentage of doping with serum, as the width of the peaks increases with the increase indoping, which causes

a decrease in the size of the crystals as shown in Table (1), and this is agreement with the literature [23, 24], that is, an increase the percentage of doping leads to a decrease in the crystallinity of the nanostructured films [25,26]. The growth of small crystalline grains results from the replacement of cobalt atoms with cerium atoms, and thus the value of the crystal size decreases with an increase in the percentage of doping, and this is agreement with the literature [23, 24].

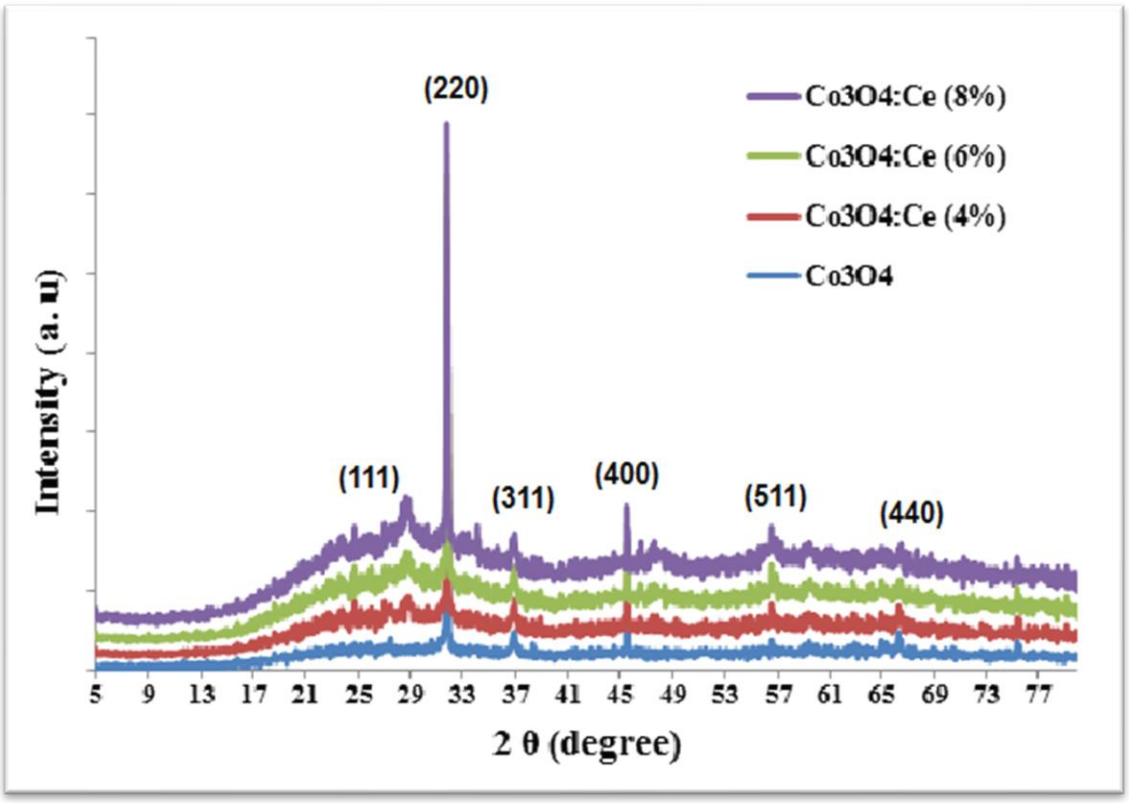


**FIGURE 1: The diffraction patterns of X-ray for $Co_3O_4:Ce$ thin film with different Ce concentration.**

**TABLE1. The datd of XRD analysis and the structure parameters of as-deposited $Co_3O_4$ and doped with deferent concentration of Ce for (220) peak.**

| $Co_3O_4$: Ce % | 2θ° | (hkl) | a (Å) | D (nm) | $d_{XRD}$ (Å) | $\varepsilon*10^{-3}$ | $\delta\times10^{16}$ (line/m$^2$) |
|---|---|---|---|---|---|---|---|
| 0 | **31.786** | **(220)** | **7.95** | **53.18** | **2.81** | **0.67** | **3.036** |
| 4 | **31.911** | **(220)** | **7.929** | **26.46** | **2.803** | **1.31** | **1.406** |
| 6 | **31.920** | **(220)** | **7.927** | **20.72** | **2.803** | **1.72** | **2.545** |
| 8 | **31.823** | **(220)** | **7.94** | **15.63** | **2.809** | **2.43** | **4.857** |

### 3.2 Sensing Measurements

The gas response tester was used, and it consists of a vacuum chamber equipped with an electric heater, through which the operating temperature of the sensor can be controlled. The chamber is also supplied with the gas to which the response is to be checked and mixed with the air in certain proportions that can be controlled by the flow valves. There are also electrodes through which the model is connected to an ohmmeter of a Keithley type to measure the change in resistance with the change in operating temperature.

The results obtained from the interaction of the gas with the samples were converted into an electrical signal as shown in Figure 2.

The response measurements of the sensor made of cobalt oxide were examined before and after doping to nitrogen dioxide ($NO_2$) at a concentration of 71 sccm and at different operating temperatures (RT, 50°, 100°, 150°, 200°, 250°, and 300°).

The responsivety of p-type semiconductor such as ($Co_3O_4$) film for oxidizer gas like $NO_2$ gas estimated by [27- 29]:

$$S = \frac{R_a - R_g}{R_a} \times 100\% \qquad (8)$$

where R: represents the electrical resistance of the film.

Figure 3 shows the relationship between the responsivety and the operating temperature for all samples doped and un doped, where that notice a significant increase in the sensor's response with the increase in the operating temperature, and the greatest value of the response was at an operating temperature of 220. This increase is attributed to the increase in the surface interaction of the gas with the sample [30]. With an increase in the operating temperature to more than 220 °C, the response obviously decreases for all samples.

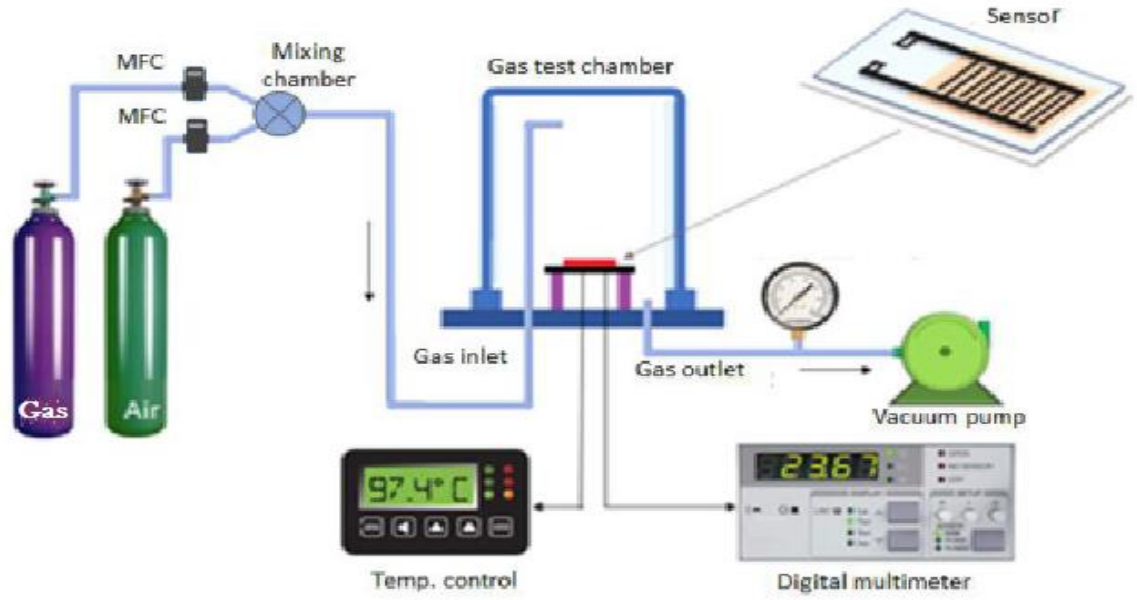


**FIGURE 2. Experiment setup, gas sensor testing system.**

Figure 3 also shows that the Ce -doped $Co_3O_4$ thin films as $NO_2$ gas sensors increased in response with increasing Ce concentration and the best value of response was at 8% concentration and this corresponds to X-ray examinations as the crystalline size decreases with increasing concentration and decreasing the crystal size helps in increasing the granular boundaries and roughness at which the gas interacts with the oxygen in the material. Also, the decrease in the crystal size increases adsorption and desorption, which increases the sensitivity of the sensor. It is well known that the responsivity of gas sensors, especially semiconductor metal oxide sensors, is highly dependent on the molecular composition like size and boundaries of the grain, crystallites, roughness, thickness and effective area [31,32].

The mechanism of gas sensing depend on the process of adsorption/desorption of the oxygen molecules via $Co_3O_4$ surface.

when exposed to air and the formation of $O^{-2}$ $O_2^-$ and $O^-$ which results in a depletion layer near the surfaces of the granules. This absorption occurs by capturing electrons from C.B, which leads to an increase in the resistance of the active layer and increase the sensor's resistance and produce a sensing response [33,34].

Figure 4 shows the values of the response and recovery times for the sensors based $Co_3O_4{:}Ce$ .for different concentration of Ce.(2 ,4, and 8%) at operating temperature 220°. The response time evaluated decreased with the increase Ce concentrations and the best value

observed at concentration 8% which its value is 2.4 s for response time and about 75 s for recovery time,. this decreases in response time accompanying concentration could be noted that the variation in the crystal structure and surface morphology of the films due to doping led to an improvement in the responsivity as a result of the increase in the surface roughness and the effective surface area for interaction with gas molecules.

Our result is agreement with [33] and [34]. The results of the present report were listed in Table 2.

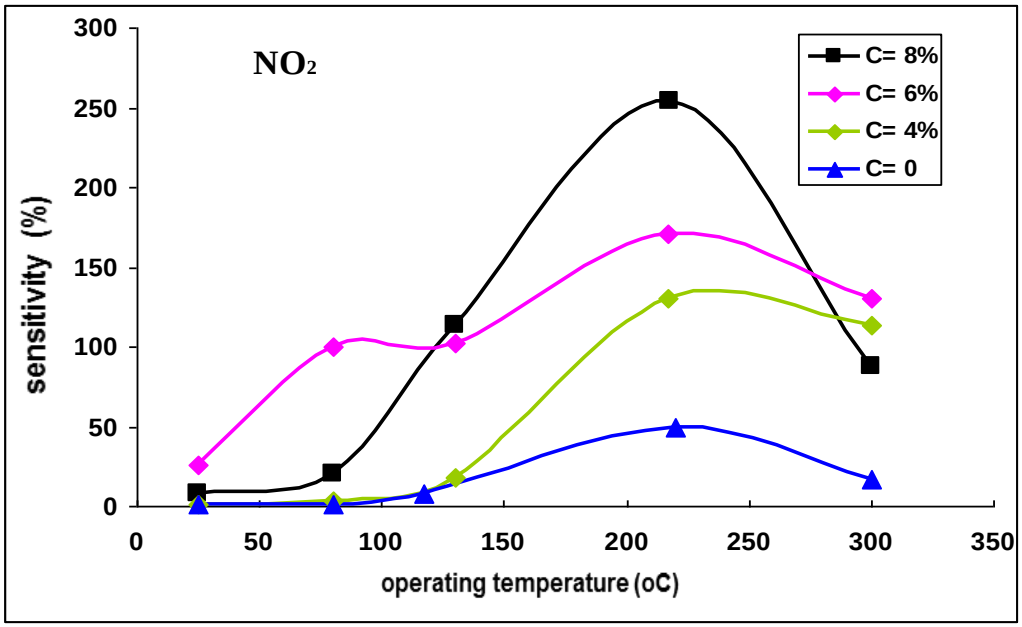


**FIGURE 3 The variation of the responsivety of $Co_3O_4:Ce$ gas sensor for $NO_2$ gas with operating temperature at different Ce concentrations.**

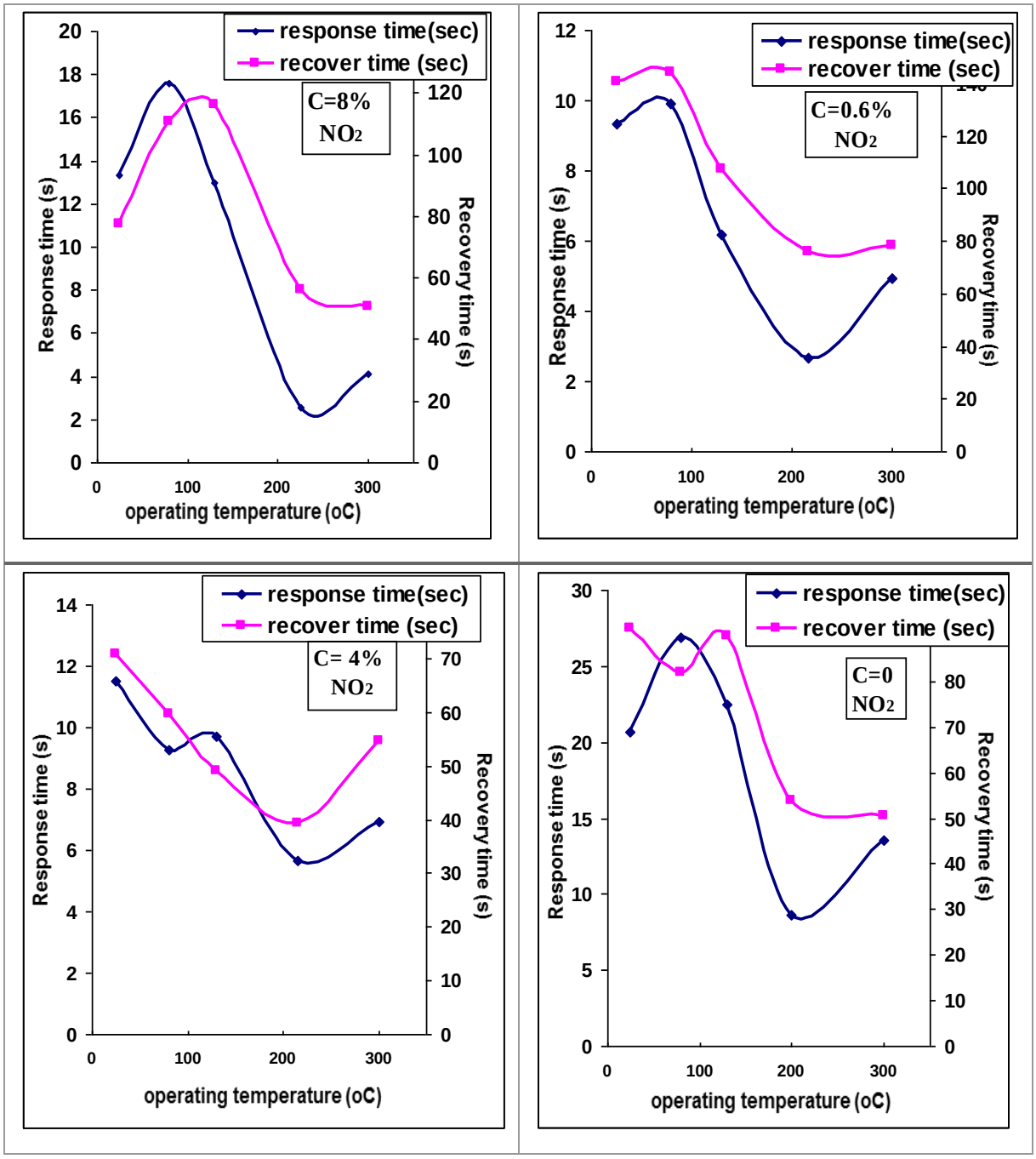


**FIGURE 5: Variation of Response and Recovery times with operating temperature for difference Ce concentrations (0, 4, 6, and 8%)**

**TABLE 2. The sensor parameters $Co_3O_4:Ce$ gas sensor when exposed to $NO_2$ gas at operating temperature 220°.**

| Concentrations % | Sensitivity for % | Operating temp (°C) | Response time (sec) | Recovery time (sec) |
|---|---|---|---|---|
| 0 | 248 | 220 | 7.79 | 55 |
| 4 | 155 | 220 | 5.68 | 40 |
| 6 | 125 | 220 | 2.21 | 74 |
| 8 | 40 | 220 | 1.84 | 59 |

## 4. Conclusion

The utilize of spray pyrolysis technique for fabricated $Co_3O_4:Ce$ gas sensor sensitive for $NO_2$ gas with varies Ce concentrations between 4-8% has been successfully studied.

The structural of the deposited films were characterized by X-ray diffraction, where concluded from its results that the films are polycrystalline and have a FCC cubic structure with preferential orientation around (220), and the crystallite size decreased from 53.18 to 15.63 nm.

From the results of our study of the properties of the gas sensor, we can conclude that $Co_3O_4:Ce$ gas sensors have high sensitivity and responsivity for $NO_2$ gas, on the other hand, we find that doping with substance Ce led to enhancing the response to the gas

As for the response and recovery times it was in the range of 7.79 -1.84 sec and 55-59 sec respectively, and the greatest responstivity being 248% for 8% doping concentration.

From the results of the gas-sensing can be concluded that $Co_3O_4:Ce$ thin films with 8% doping concentration very convenient to use as a sensor as it gave the best response and the least response time.

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# EXPLORING THE ADOPTION OF ENERGY-EFFICIENT TECHNOLOGIES AROUND BWINDI IMPENETRABLE NATIONAL PARK IN KISORO DISTRICT, UGANDA

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**Abstract**
This study delves into the assessment of energy-efficient technology adoption in the vicinity of Bwindi Impenetrable National Park, located in Kisoro District, Uganda. The research was guided by three specific objectives: (a) identifying and documenting the array of energy-efficient sources and technologies currently in use within the Southwestern region of Uganda, (b) quantifying the extent of utilization and adoption of efficient energy technologies among residents in the southern sector of Bwindi Impenetrable National Park, and (c) assessing the multifaceted factors influencing the utilization and adoption of energy-efficient technologies among community members within the park's southern sector. To achieve these goals, our study employed a mixed-methods research approach, combining qualitative and quantitative methodologies. Quantitative data collection was carried out through structured household surveys, which involved 204 respondents selected from a target pool of 160 households. Additionally, in-depth interviews were conducted with key informants, including local government officials and community leaders. The findings of this study reveal significant insights into the energy consumption patterns of the region's households. Notably, 90% of households primarily rely on firewood for cooking, followed by charcoal as the next most commonly used option. In contrast, only a minority (35%) opt for electricity for lighting, and a smaller number (19%) prefer solar energy for illumination. Surprisingly, biogas usage for cooking and lighting is virtually non-existent in the region, and there is a complete absence of households utilizing liquified petroleum gas (LPG). Further analysis indicates that households not using firewood are nearly three times more likely to explore alternative energy sources (cOR = 2.8, 95% CI: 0.5-15.65, p = 0.050*). Similarly, those who abstain from using charcoal or crop residues for cooking are significantly inclined to adopt alternative energy sources (cOR = 2.79, 95% CI: 1.0-7.83, p = 0.001*). The study identified several barriers to the adoption of energy-efficient technologies, including high costs, material scarcity, incompatibility with larger functions, the need for reliable suppliers, cultural and social factors, and a lack of information. In light of these findings, we recommend that the government of Uganda considers implementing subsidies or financial incentives to make efficient energy technologies more affordable for rural households. Collaborations between government agencies, non-governmental organizations, and the private sector are also encouraged to ensure the availability and affordability of energy-efficient technologies in the region.
**Keywords:** Energy-Efficient Technologies, Adoption, Bwindi Impenetrable National Park, Uganda, Household Energy Consumption, Barriers, Subsidies.

## Introduction

Energy security, climate change, and health concerns are pressing global and local issues (Smith & Johnson, 2020). However, there is limited knowledge regarding the adoption of renewable and efficient energy technologies in various regions of Uganda, including Kisoro. This knowledge gap contributes to climate change through the depletion and degradation of forests (IPCC, 2018). Therefore, this study aims to assess the factors influencing the adoption of renewable and energy-efficient technologies among communities adjacent to the southern sector of Bwindi Impenetrable National Park in Kisoro district.

Energy plays a crucial role in the development and sustainability of a nation's economy, impacting various socio-economic activities (Kanagawa, 2007; Kanagawa, 2008). Energy serves as a driving force for sectors such as agriculture, healthcare, the environment, and water resources (Kanagawa, 2007; Kanagawa, 2008).

The adoption of energy-efficient and renewable energy technologies presents an opportunity to mitigate greenhouse gas emissions (Puzzolo et al., 2013). Energy efficiency initiatives aim to promote the economical use of energy across all economic sectors (Puzzolo et al., 2013). It is reported that about three billion people, especially in developing countries like Uganda, rely on solid fuels and inefficient stove technologies for basic energy needs, such as cooking and heating (Puzzolo et al., 2013). Without rapid and effective action, this reliance is expected to increase, leading to global economic challenges and volatile energy prices (Puzzolo et al., 2013).

The use of solid fuels is associated with various problems, including health risks, deforestation, and climate change (Hoigt, 2019). Traditional household energy practices have significant consequences for health, the environment, and socio-economic development. Household air pollution from solid fuels is a risk factor for pneumonia, chronic respiratory diseases, and other health issues, resulting in over 3.5 million annual deaths (Puzzolo et al., 2013). Additionally, the inefficient burning of solid fuels contributes to deforestation and climate change by emitting pollutants like methane and black carbon (Puzzolo et al., 2013).

Furthermore, inefficient energy technologies lead to a significant time spent on fuel collection and cooking or a disproportionate amount of income spent on securing lower-quality fuels, thereby perpetuating poverty (Puzzolo et al., 2013).

Uganda possesses a diverse range of energy resources, including hydro, geothermal, biogas, biomass, wind, solar, and petroleum exploration in the rift valley area (NAPE, 2013). The majority of Uganda's energy comes from biomass (92%), followed by petroleum (6%) and

hydroelectricity (2% or less) (NAPE, 2013). Biomass, particularly firewood, charcoal, and crop residues, plays a crucial role in meeting the basic cooking and water heating needs of both rural and urban households, institutions, and commercial buildings (MEMD, 2015). Additionally, biomass serves as the primary energy source for rural industries (MEMD, 2015).

Forestry contributes significantly to Uganda's energy needs through the use of woody biomass by households and institutions (MEMD, 2015). Charcoal production also plays a vital role in rural incomes, tax revenue, and employment (MEMD, 2015). However, the high demand for fuelwood, coupled with inefficient energy technologies like wood and charcoal stoves, has led to deforestation and the rapid depletion of wood reserves in many regions (MEMD, 2015).

The Uganda Energy Policy of 2002 emphasizes the importance of prioritizing environmental considerations in energy supply and usage to protect the environment (MEMD, 2015). It promotes the use of alternative, environmentally-friendly energy sources and technologies to efficiently utilize energy resources (MEMD, 2015).

The energy sector in Uganda faces challenges that hinder energy adoption, including inadequate planning and monitoring within government institutions, inefficient energy resource supply and use due to historical neglect, poor coordination among projects and institutions, insufficient data on energy supply and demand, and limited access to modern energy services for rural populations (MEMD, 2015).

According to the Energy Policy of Uganda (2002), the adoption of biomass energy in Kisoro district is low, leading to conflicts related to inadequate fuelwood. To mitigate these conflicts, various initiatives have been undertaken by NGOs and the government, including the provision of tree seedlings, promotion of efficient cookstoves, biogas, rural electrification, and solar installations. However, the adoption levels of these technologies have not been adequately determined, making it unclear whether they contribute to reduced deforestation rates and conflicts in these areas. Therefore, this study is essential in assessing the adoption rate of efficient energy and renewable energy technologies.

**Problem Statement**

Energy plays a pivotal role in Uganda's economy, serving as the primary source for fulfilling essential needs such as cooking, lighting, and water heating in both rural and urban settings, including households, institutions, and commercial establishments (MEMD, 2015). In rural areas, biomass remains the dominant energy source, with a heavy reliance on it for daily energy needs. However, this dependence on biomass energy, coupled with the use of inefficient

methods, particularly traditional Cook-Stoves, has led to alarming rates of forest depletion, primarily driven by the demand for firewood and charcoal (MEMD, 2015).

Globally and nationally, the adoption of efficient energy technologies remains low, with many people still employing rudimentary and inefficient energy practices (IEA, 2019). In Kisoro district, similar challenges persist, despite efforts to promote energy-efficient technologies. Interventions have included the promotion of energy-efficient solutions such as improved Cook-Stoves, biogas systems, and solar energy (MEMD, 2015).

However, the adoption of efficient energy technologies in the communities surrounding the southern sector of Bwindi National Park remains distressingly low, despite the concerted efforts of various stakeholders. Furthermore, there is a lack of comprehensive data on the adoption levels of these technologies in the vicinity of the National Park. The adoption of efficient energy technologies is influenced by a multitude of factors, and a systematic assessment of these factors has not been undertaken. Consequently, inadequate access to fuelwood resources persists as a persistent challenge in this area, exacerbating conflicts between local communities and park management authorities. This situation also places the fragile forest ecosystem at risk of degradation.

The persistent use of rudimentary and energy-inefficient technologies not only contributes to forest depletion and conflicts but also exacerbates the adverse effects of climate change. Additionally, it hinders overall development, poses significant health-related problems, and leads to increased environmental degradation (IEA, 2019; IPCC, 2018).

Therefore, there is an urgent need to assess the current adoption levels of efficient energy technologies and comprehensively investigate the factors that influence their adoption in the vicinity of Bwindi National Park. Such an assessment holds the potential to mitigate conflicts in the area, promote sustainable development, and preserve the environment. Furthermore, determining the adoption baseline of efficient energy technologies will provide a foundation for implementing more organized initiatives aimed at reducing the reliance on fuelwood and advancing the use of energy-efficient alternatives (IEA, 2019).

**Methods and Materials**

This study adopted a mixed-methods research approach, combining both qualitative and quantitative methodologies. Household surveys, in the form of structured questionnaires, were administered to collect quantitative data. Additionally, in-depth interviews were conducted with key informants, including local government staff and community leaders. To gain further

insights, on-site observations were carried out within the communities, specifically at households, to identify and assess the adoption of various energy technologies.

The sample size was determined using Fischer's formula, considering a 99% confidence level and a precision level of 5%. The total sample size was calculated to be 204 households, distributed as follows: 69 households from Nkuringo Town Council, 63 from Bukimbiri Subcounty, and 72 from Rubuguri Town Council.

$$n = \frac{Z^2pq}{d^2}$$

Where

n=desired sample size (if the target population is greater than 10,000)

Z=the standard normal distribution at 95 % confidence level (standard value of 1.96)

P=Estimated prevalence of HTN complications of 50%

q=1-p

d=level of precision (Set at + or-5% or 0.05)

Substitution these figures for the above formula

$$n = \frac{(1.96)^2 (0.5) (0.5)}{(0.05)^2} = 204$$

Simple random sampling was employed to select households within the six purposively selected villages. Purposive sampling was employed to select villages adjacent to the National Park. The selected villages included Kahurire, Murore, Nyamiyaga, Nyamasinda, Nombe, and Igabira.

Structured questionnaires were utilized as research instruments. These questionnaires were administered through interviews with respondents and were designed to capture comprehensive information relevant to the research objectives. The questionnaires were pre-coded and structured to align with the study's research objectives, ensuring that the collected data addressed pertinent factors influencing energy technology adoption.

Structured questionnaires were administered to households to collect data on various energy sources, technologies, and factors influencing adoption. These questionnaires were used to capture quantitative data. In-depth interviews were conducted with key informants, including community leaders, district staff, and representatives from non-governmental organizations (NGOs). These interviews provided qualitative insights into the adoption of energy technologies.

Observations were made during data collection, allowing for real-time observations of energy technologies in use at households. Photographs were taken to document these observations. Data collection instruments included structured interview guides, questionnaires, key informant interview guides, and observation checklists. Additionally, photographic equipment was used to visually document the observed energy technologies and practices.

## Findings

*Table 1*: ***Demographic*** **Characteristics of the Respondents**

| Variables | | Yes | | No | | Statistic |
|---|---|---|---|---|---|---|
| | | Freq (n=87) | Percent | Freq (n=117) | Percent | |
| Age group | 18-29 years | 7 | 30.4% | 16 | 69.6% | $x^2$=4.378 p=0.039 |
| | 30-39 years | 9 | 34.6% | 17 | 65.4% | |
| | 40-49 years | 11 | 37.9% | 18 | 62.1% | |
| | 50-59 years | 23 | 39.7% | 35 | 60.3% | |
| | ≥ 60 years | 37 | 54.4% | 31 | 45.6% | |
| Gender | Male | 37 | 37.4% | 62 | 62.6% | $x^2$=2.082 p=0.069 |
| | Female | 50 | 47.6% | 55 | 52.4% | |
| Marital status | Single | 33 | 50.8% | 32 | 49.2% | $x^2$=1.321 p=0.113 |
| | Married | 54 | 38.8% | 85 | 61.2% | |
| Education | No formal education | 10 | 62.5% | 6 | 37.5% | $x^2$=1.013 p=0.223 |
| | Primary | 26 | 56.5% | 20 | 43.5% | |
| | Secondary | 38 | 37.6% | 63 | 62.4% | |
| | Tertiary | 13 | 31.7% | 28 | 68.3% | |
| Employment status | Unemployed | 60 | 60.6% | 39 | 39.4% | $x^2$=3.998 p=0.046 |
| | Employed | 12 | 29.3% | 29 | 70.7% | |
| | Self-employed | 15 | 23.4% | 49 | 76.6% | |
| Monthly income | Less than UGX 500,000 | 26 | 50.0% | 26 | 50.0% | $x^2$=4.454 p=0.040 |
| | UGX 500,000-1,000,000= | 20 | 43.5% | 26 | 56.5% | |
| | UGX 1500,000-2,000,000 | 17 | 42.5% | 23 | 57.5% | |
| | UGX 2,500,000-UGX 3000,000= | 10 | 38.5% | 16 | 61.5% | |
| | UGX 3,500,000= and 4000,000= | 8 | 36.4% | 14 | 63.6% | |
| | UGX. 4,500,000= and above. | 6 | 33.3% | 12 | 66.7% | |

The table 1 above presents demographic characteristics of the respondents in the study. First, respondents were categorized into different age groups. Notably, the age group of 50-59 years had the highest representation at 39.7%, while the youngest age group (18-29 years) had the lowest percentage at 30.4%. A statistical analysis, conducted using a chi-square test, revealed a significant association between age group and the adoption of efficient energy technologies, with a p-value of 0.039.

Regarding gender, the majority of respondents were female, comprising 47.6% of the total, while males accounted for 37.4%. Although the chi-square test yielded a p-value of 0.069, suggesting a potential influence of gender on technology adoption, it was not statistically significant at conventional levels.

Marital status was another demographic factor considered. Single individuals represented 50.8% of the respondents, while married individuals accounted for 38.8%. The statistical analysis indicated that marital status may not be significantly associated with technology adoption, as indicated by a p-value of 0.113.

Educational levels of the respondents were also examined. Those with secondary education constituted the largest group, representing 62.4%, while respondents with tertiary education comprised 31.7%. The analysis showed that educational level may not be significantly associated with technology adoption, with a p-value of 0.223.

Employment status was found to be a noteworthy factor. A majority of respondents were unemployed, making up 60.6% of the total, while employed individuals accounted for 29.3%, and self-employed individuals constituted 23.4%. The statistical analysis indicated a significant association between employment status and technology adoption, with a p-value of 0.046.

Lastly, respondents' monthly income levels were examined. Those with incomes less than UGX 500,000 and UGX 500,000-1,000,000 each represented 50.0% of the total. The analysis suggested a significant association between monthly income and technology adoption, as indicated by a p-value of 0.040.

In summary, this demographic analysis provides insights into the characteristics of the respondents and their potential connections with the adoption of efficient energy technologies. The p-values serve as indicators of the statistical significance of these associations.

*Table 2*: **Communities / Villages that Participated in the Study**

| **Villages** | | | | | |
|---|---|---|---|---|---|
| villages | | Frequency | Percent | Valid Percent | Cumulative Percent |
| | Kahurire | 26 | 16.3 | 16.3 | 16.3 |
| | Murole | 30 | 18.8 | 18.8 | 35.0 |
| | Nyamatsinda | 21 | 13.1 | 13.1 | 48.1 |
| | Nyamiyaga | 26 | 16.3 | 16.3 | 64.4 |
| | Nombe | 33 | 20.6 | 20.6 | 85.0 |
| | Igabiro | 24 | 15.0 | 15.0 | 100.0 |
| | Total | 160 | 100.0 | 100.0 | |

The study encompassed an examination of six villages situated in close proximity to the Southern sector of Bwindi Impenetrable National Park. Each of these villages contributed to the comprehensive assessment of the adoption of efficient energy technologies within the community. The villages and their corresponding levels of participation are as follows:

Kahurire had 26 individuals participating in the study, representing 16.3% of the total respondents. Murole had 30 respondents, making up 18.8% of the study's participants. Nyamatsinda had 21 individuals taking part in the research, contributing 13.1% to the total respondents.

Nyamiyaga had 26 respondents participating, constituting 16.3% of the overall study. Nombe boasted the highest level of participation, with 33 individuals from this village joining the study, representing 20.6% of the total participants. Igabiro had 24 respondents who participated in the study, making up 15% of the total participants. In total, the study involved 160 respondents from these six villages, providing a comprehensive understanding of the adoption of efficient energy technologies within the communities neighboring the Southern sector of Bwindi Impenetrable National Park.

Table 3**: Understanding the Chances of Utilizing Different Energy Sources**

| Variables | Energy Source Utilization | | cOR(95%CI) | P-value |
|---|---|---|---|---|
| | No | Yes | | |
| | | | | |
| Fire wood for cooking | 58 | 147 | 2.8(0.5-15.65) | 0.050* |
| | | | | |
| Charcoal for Cooking | 56 | 148 | 2.79(1.0-7.83) | 0.001* |
| | | | | |
| Crop Residues for cooking | 81 | 123 | 6.37(0.15-12.51) | 0.017* |
| | | | | |
| Biogas for Cooking | 146 | 58 | 0.53(1.0-7.83) | 0.229 |
| | | | | |
| Biogas for lighting | 160 | 44 | 0.3(0.61-8.74) | 0.674 |
| Electricity for lighting | 102 | 102 | 0.54(0.25-1.16) | 0.437 |
| Electricity for saloon use | | | 5.01(1.27-17.94) | 0.001* |
| Solar for cooking | 43 | 175 | 0.23(0.10-0.53) | 0.024* |
| | | | | |
| Solar for Lighting | 85 | 119 | 5.01(1.27-17.94) | 0.03 |
| Liquified Petroleum for gas | 204 | 0.0 | 0.03(1.0-7.83) | 0.674 |

Table 3 presents an insightful analysis of the likelihood of utilizing various energy sources, providing a comprehensive overview of the odds ratios (cOR) with their corresponding 95% confidence intervals (CI) and associated p-values.

For the utilization of firewood for cooking, the analysis indicates that those who did not use firewood were 2.8 times more likely to opt for alternative energy sources than those who relied on firewood (cOR = 2.8, 95% CI: 0.5-15.65, p = 0.050*).

Regarding the utilization of charcoal for cooking, the results are noteworthy. Respondents who did not employ charcoal for cooking were 2.79 times more likely to utilize other energy sources compared to those who preferred charcoal (cOR = 2.79, 95% CI: 1.0-7.83, p = 0.001*). Similarly, for crop residues used in cooking, respondents who abstained from this practice were 6.37 times more likely to choose alternative energy sources (cOR = 6.37, 95% CI: 0.15-12.51, p = 0.017*).

In contrast, when it comes to biogas utilization for cooking, there was no significant difference in the likelihood of choosing alternative energy sources for those who did not use biogas (cOR = 0.53, 95% CI: 1.0-7.83, p = 0.229). The data pertaining to biogas for lighting similarly showed no significant variation in the likelihood of opting for other energy sources among those who did not use biogas (cOR = 0.3, 95% CI: 0.61-8.74, p = 0.674).

For electricity used for lighting, the analysis revealed no substantial difference in the likelihood of selecting alternative energy sources for those who did not use electricity for lighting (cOR = 0.54, 95% CI: 0.25-1.16, p = 0.437). However, the use of electricity for salon purposes exhibited a noteworthy trend. Respondents who did not employ electricity for salon use were 5.01 times more inclined to choose alternative energy sources (cOR = 5.01, 95% CI: 1.27-17.94, p = 0.001*).

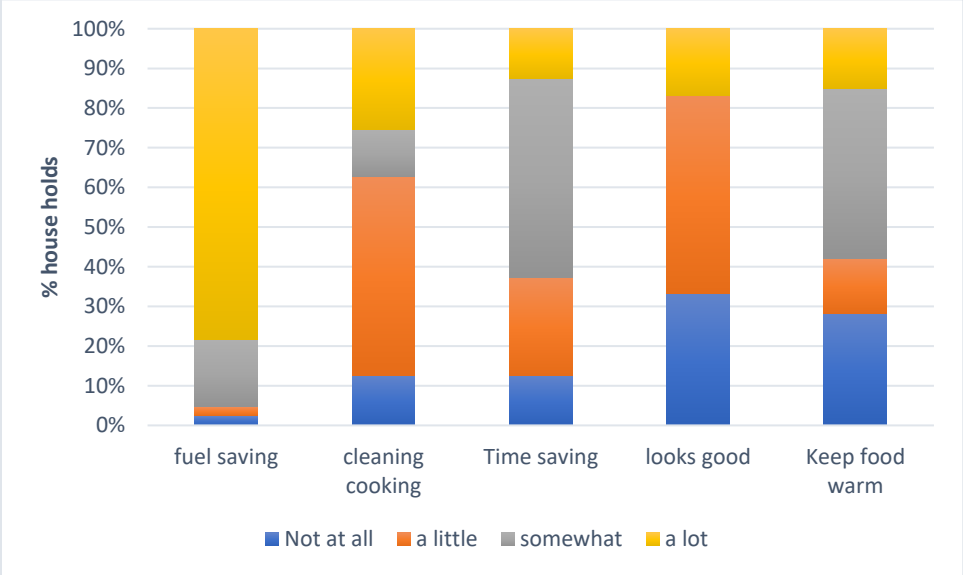
In contrast, the utilization of solar energy for cooking demonstrated a significant trend. Respondents who did not use solar energy for cooking were 4.35 times more likely to resort to alternative energy sources (cOR = 4.35, 95% CI: 0.10-0.53, p = 0.024*). Regarding solar energy for lighting, those who did not use solar lighting were 5.01 times more likely to explore alternative lighting sources (cOR = 5.01, 95% CI: 1.27-17.94, p = 0.03). Lastly, for liquified petroleum gas (LPG) usage, there was no substantial variation in the likelihood of choosing alternative energy sources among respondents who did not utilize LPG (cOR = 0.03, 95% CI: 1.0-7.83, p = 0.674).

These findings shed light on the preferences and tendencies of respondents regarding energy source utilization, offering valuable insights into the factors influencing their choices.

**Adoption of Efficient Energy Technologies**

The adoption of efficient and renewable energy technologies in the study area encompassed several key options, notably hydropower, biogas, Liquefied Petroleum Gas (LPG), solar energy, and the integration of efficient cooking stoves. These technologies were strategically introduced to address multiple objectives, including meeting energy demands, mitigating environmental impacts, and conserving natural resources, particularly forests and trees that are traditionally exploited for fuelwood. Among these technologies, hydropower, biogas, LPG, and solar energy were promoted to diversify the energy mix and alleviate the strain on forest resources. Additionally, efficient cooking stoves were embraced for their capacity to optimize energy usage, thus further contributing to the conservation of forests and trees. The adoption of these efficient energy technologies signifies a concerted effort to transition towards sustainable and environmentally responsible energy solutions in the study area.

**Factors influencing the adoption of efficient energy technologies**




The factors influencing the adoption of efficient energy technologies were examined and are depicted in Figure 6. It is evident that 80% of the surveyed households attributed their adoption of these technologies to their fuel-saving characteristics. In regions like those around Bwindi National Park, where access to fuel, especially fuelwood, is a challenge, the desire to reduce fuelwood consumption serves as a compelling motivator for adopting these technologies. This aligns with findings from a study by Allen Tebugulwa in 2015, conducted in Kenya, where the adoption of improved energy-saving technologies, specifically improved cookstoves, was linked to saving fuel costs by using less fuel through heat preservation. Similarly, research by

Julia Hoigt in 2019 and Inayat in 2011 revealed that concerns about the cost of firewood were the primary driving force behind adopting more efficient cooking stoves. Henry Stanley Mbowa et al. in 2020 also emphasized that saving on fuel costs was a significant influencing factor in the adoption of efficient energy technologies in Mateete Sub-County. Tigabu Alamir in 2014, Puzzolo et al. in 2013, and Axen in 2012 found that the price of fuelwood was a key incentive for people to adopt energy-saving cookstoves when compared to those who obtained fuelwood for free. The desire to economize on fuel expenses often intertwines with the goal of environmental protection, as using less fuelwood contributes to sustainability and reduces the impact on the environment.

Cleaning cooking emerged as another motivating factor for adopting efficient energy technologies among some community members residing near the Southern Sector of Bwindi National Park. Clean cooking practices are increasingly recognized as crucial for public health, gender equality, local environmental preservation, and global climate efforts. This echoes Julia Hoigt's 2019 study, which noted that some women adopted mud stoves due to their cleanliness in comparison to traditional stoves. The improved stoves prevented ashes from spreading throughout the kitchen and entering the food, thanks to their raised design and closed combustion chamber. Clean cooking is also linked to pollution reduction, as highlighted by Mbowa et al. in 2020, where respondents in Mateete subcounty preferred cookstoves that did not produce pollution.

Efficiency in cooking time was cited as another factor driving the adoption of efficient energy cookstoves by certain households around Bwindi. These stoves were appreciated for their ability to cook food more quickly, thanks to enhanced heat transfer efficiency and the option to simultaneously use multiple cooking pots. This observation aligns with Puzzle's 2013 findings, where efficient stoves were valued for their time-saving attributes, specifically their efficient heat transfer and capability for parallel cooking. Additionally, some households favored efficient cookstoves because of their capacity to keep food warm. This feature was attributed to the stoves' ability to retain heat even after cooking, a trait noted in Tebugulwa's 2015 study as well.

In summary, the adoption of efficient energy technologies is driven by a range of factors, including fuel-saving considerations, cleanliness in cooking, time efficiency, aesthetic appeal, and heat-retaining capabilities. These factors reflect the diverse needs and preferences of households in the studied communities surrounding Bwindi National Park.

**Barriers to adoption of Efficient**

Adoption of Efficient energy technologies around Bwindi National Park has got some barriers. These barriers affect adoption of efficient technologies as shown in the graph below.

Barriers to the adoption of efficient energy technologies in the communities surrounding Bwindi National Park have been identified, shedding light on the challenges faced by households in embracing these technologies. Among the key findings, the following barriers were highlighted:

**High Cost.** The most significant barrier cited by 90% of households is the high cost associated with efficient energy technologies, including materials and equipment. This aligns with national energy policies and previous research, such as Tebugulwa in 2015, Levine et al. in 2013, and Slaski and Thurber in 2009, which all noted that the cost of technologies and equipment was a major hindrance to adoption. High installation and maintenance costs, as well as financial barriers, deterred many households from investing in these technologies.

**Lack of Materials.** Approximately 55% of households reported that the unavailability of materials, especially for constructing efficient technologies like firewood stoves, was a significant obstacle. These materials include suitable soils and binders. This issue becomes especially acute during the dry season when resources are scarcer.

**Incompatibility with Large Functions.** A notable 68% of households mentioned that efficient energy technologies were not suitable for large functions or events. This could be attributed to the limited capacity of these technologies, which may not meet the demands of cooking for a large number of guests.

**Trustworthy Suppliers.** Around 71% of respondents expressed concerns about the reliability of suppliers of efficient energy technologies. This highlights the need for dependable sources of these technologies and raises questions about their accessibility and distribution in rural areas.

**Lack of Information.** Nearly 40% of households indicated that they lacked information about efficient energy technologies. This gap in knowledge encompasses the acquisition, use, maintenance, and benefits of these technologies. Similar findings are echoed by studies like Mustapa et al. in 2010 and Peidong et al. in 2009, which identified lack of public awareness as a significant barrier to renewable energy technology adoption.

**Slow Cooking.** About 32% of households perceived that efficient cookstoves did not cook food quickly enough. This aspect of cooking time efficiency was a notable hindrance to adoption, as faster cooking is a priority for many households.

**Transportation Costs.** For 32% of respondents, the costs associated with transporting heavy stoves and solar equipment were a significant barrier. This underscores the economic challenges faced by rural communities, as reported by Julia Hoigt in 2019, where transportation costs and potential damage to equipment deterred adoption.

**Cultural and Social Factors.** Some households expressed resistance to adopting efficient energy technologies due to cultural and social factors. They believed that traditional cooking methods were essential for certain dishes, and the technologies did not support these practices. This aligns with observations by Lilian et al. in 2019 and Agarwal in 1983, highlighting the influence of social and cultural practices on stove choice. Traditional ceremonies and specific food preparations are often linked to traditional three-stone stoves, which are perceived to enhance the flavor of certain dishes.

**Unreliable Electricity Supply.** While not explicitly mentioned, difficulties related to the reliability and accessibility of electricity may also play a role in hindering adoption, as observed by Joshua O. et al. in 2022.

In summary, the adoption of efficient energy technologies faces multifaceted challenges in the communities adjacent to Bwindi National Park. These barriers encompass economic, logistical, informational, cultural, and social factors. Addressing these issues is crucial for promoting the widespread adoption of efficient energy technologies and reducing the reliance on traditional and less sustainable energy sources.

**Discussions**

The findings of this study shed light on the adoption and utilization of efficient energy technologies in the communities surrounding Bwindi National Park. These communities, like many others in Uganda and globally, grapple with challenges and barriers to the uptake of sustainable energy alternatives. This discussion seeks to delve into the implications of the results in the context of existing research and recent developments in the field of renewable energy adoption.

One of the key findings of this study is the prevalence of traditional biomass energy sources, such as firewood and charcoal, among households in the study area. This aligns with the broader energy landscape in Uganda, where biomass accounts for a substantial portion of energy consumption (MEMD, 2019). The heavy reliance on traditional biomass fuels, as evidenced by 91.25% of respondents using firewood, signifies the pressing need for transitioning to more sustainable energy sources.

The high adoption of firewood for cooking, coupled with the barrier of high technology costs identified in this study, mirrors the challenges highlighted in previous research. Tebugulwa (2015) and Levine et al. (2013) also emphasized the cost factor as a significant hindrance to the adoption of improved cookstoves. These findings underscore the persistent economic barriers faced by households, particularly in rural areas, when attempting to embrace cleaner and more efficient cooking technologies. Furthermore, the lack of materials required for constructing efficient energy technologies, mentioned by more than half of the respondents, resonates with the findings of other studies (Asia and E. Unit, 2010; Makame, 2007). This constraint is particularly pronounced during dry seasons when resources become scarcer. The issue of material scarcity is a tangible challenge that policymakers and practitioners need to address when designing interventions to promote sustainable energy adoption.

The results also point to the importance of cooking efficiency and time-saving as factors influencing technology adoption. The desire for faster cooking and efficient heat transfer aligns with the observations of Puzzolo et al. (2013) and Julia Hoigt (2019). These findings underscore the significance of designing energy technologies that not only reduce environmental impact but also enhance the convenience and practicality of daily cooking practices.

One notable barrier identified in this study, which has broader implications for rural energy adoption, is the lack of information and training. Around 40% of households reported insufficient knowledge about efficient energy technologies. This knowledge gap echoes the findings of studies by Mustapa et al. (2010) and Jan et al. (2020), highlighting the pivotal role of awareness and information dissemination in shaping energy technology adoption decisions. In an era of rapid technological advancement, bridging this information divide is paramount.

Transportation challenges, with 32% of respondents citing difficulties in transporting heavy stoves and equipment, resemble the findings of Julia Hoigt (2019) and Joshua O. (2022). These logistical obstacles are especially relevant in rural settings where access to transportation infrastructure may be limited. Addressing these concerns is essential to ensure the accessibility of energy technologies in remote areas.

The study also revealed that social and cultural factors influence technology adoption decisions, as observed in the resistance to abandoning traditional cooking methods for certain dishes. This cultural context mirrors the findings of Lilian et al. (2019) and Agarwal (1983), emphasizing the need for culturally sensitive energy interventions that respect local practices and preferences.

Recent studies, such as those by MEDM (2019), Rhamz International (2020), and Joshua O. (2022), also highlight the persistence of high costs, inadequate financing, and supply reliability as major barriers to efficient energy technology adoption in Uganda. These findings align with the present study, reinforcing the systemic challenges faced by rural communities.

It is imperative to consider the broader policy context when interpreting these findings. The Ugandan government's commitment to promoting clean cooking technologies is evident in its energy policies (MEMD, 2019) and national electrification plans (UBOS, 2021). However, the translation of policies into practical, affordable, and accessible solutions remains a challenge, as indicated by the barriers identified in this study.

In conclusion, this study adds to the growing body of literature on the adoption of efficient energy technologies in rural contexts. The results underscore the multifaceted challenges faced by households, from economic constraints to cultural preferences. To accelerate the transition to sustainable energy sources, it is imperative to address these barriers comprehensively through a combination of targeted policies, awareness campaigns, financial support mechanisms, and culturally appropriate technology designs. This research contributes to the ongoing discourse on energy access and sustainability, highlighting the need for context-specific solutions that empower communities to make informed choices regarding their energy future.

**Recommendations**

**Government of Uganda:** The Government of Uganda, in collaboration with relevant ministries and agencies, should formulate and implement a comprehensive national energy policy that prioritizes the promotion of efficient and sustainable energy technologies, especially in rural areas like the communities around Bwindi Impenetrable National Park. This policy should include clear targets, timelines, and incentives to encourage the adoption of energy-efficient solutions.

**Ministry of Energy and Mineral Development:** The Ministry of Energy and Mineral Development should allocate sufficient resources and funding to support research and development efforts focused on energy-efficient technologies tailored to the needs of rural communities. Additionally, they should establish partnerships with international organizations and donors to secure financing for energy projects aimed at improving access to clean energy sources.

**Ministry of Water and Environment:** The Ministry of Water and Environment plays a crucial role in environmental conservation. To mitigate the impact of biomass energy use on deforestation and land productivity, this ministry should initiate reforestation and afforestation

programs in collaboration with local communities. Furthermore, they should promote sustainable land management practices that help preserve valuable ecosystems while providing alternative livelihoods.

**Local Government Authorities:** Local government authorities in the Southwestern region, where Bwindi Impenetrable National Park is located, should facilitate community awareness and training programs on the benefits of energy-efficient technologies. They should collaborate with NGOs and civil society organizations to organize workshops, demonstrations, and information campaigns to empower residents with knowledge on clean energy solutions.

**Non-Governmental Organizations (NGOs) and Development Partners:** NGOs and development partners should continue their support for community-based energy projects. They should focus on providing financial assistance, technical expertise, and capacity-building programs to promote the adoption of efficient energy technologies. Additionally, these organizations can play a pivotal role in facilitating access to affordable financing options for households seeking to invest in clean energy solutions.

These stakeholder-based recommendations emphasize the importance of a coordinated effort involving government agencies, local authorities, and development partners to drive the adoption of energy-efficient technologies in the communities surrounding Bwindi Impenetrable National Park. Such a collaborative approach is essential for addressing the complex challenges associated with energy transition and ensuring a sustainable and environmentally friendly future for the region.

Based on the research findings and conclusions, the following recommendations are proposed:

a) **Subsidized Technology Costs**: To overcome the economic barrier, government of Uganda should consider implementing subsidies or financial incentives that make efficient energy technologies more affordable for rural households. This can be achieved through public-private partnerships and targeted financing mechanisms.

b) **Material Accessibility**: The government of Uganda should develop programs that facilitate access to materials required for constructing efficient energy technologies, especially during periods of scarcity. This can involve local initiatives to ensure the availability of suitable soils and binders for technology construction.

c) **Awareness Campaigns**: Ministry of Energy of Uganda should launch awareness campaigns and training programs to educate communities about the benefits and usage of efficient energy technologies. These campaigns should emphasize fuel cost savings, health benefits, and environmental conservation.

d) **Local Capacity Building:** Ministry of Energy of Uganda should build local capacity for technology adoption by training community members to manufacture, maintain, and repair energy-efficient devices. This empowers communities to take ownership of the technology.

e) **Research and Development:** Ministry of Energy of Uganda should encourage research and development efforts to design energy-efficient technologies that align with user preferences and cultural practices. Involve local communities in the design process.

f) **Public-Private Partnerships:** Ministry of Energy of Uganda should foster collaborations between government agencies, non-governmental organizations, and the private sector to ensure the availability and affordability of efficient energy technologies.

g) **Monitoring and Evaluation:** The government of Uganda through the Ministry of Energy of should implement a robust monitoring and evaluation framework to track the adoption of efficient energy technologies and assess the impact of interventions over time.

In conclusion, addressing the energy challenges faced by communities around Bwindi National Park and similar rural areas in Uganda requires a multifaceted approach that considers economic, social, and cultural dimensions. By implementing these recommendations and fostering inclusive, sustainable energy solutions, Uganda can make significant strides toward achieving its energy access and sustainability goals.

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# DECISION-MAKING OF TOP MANAGEMENT AND ESTABLISHMENT OF INTERNAL FORM OF CONTROL IN RELATION TO THE TOURISM ECONOMY LIKE THE REPUBLIC OF SERBIA

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## Abstract
Decision-making by the top management as well as the establishment of control, especially some form of control in the business of tourist companies, should be implemented in relation to the strategic decisions of the company, as well as in relation to the establishment of modern trends in the tourist offer. This is of particular importance for the functioning of the tertiary sector in small economies. In essence, this means that it is understood that there is an appreciation of the real facts of the economic and social environment in which tourism companies operate, as well as the real functioning of numerous activities connecting tourism and other economic branches. However, decision-makers should take into account the fact that each tourist destination offers tourists a complex, complex and unique tourist product that is the result of the activities of tourist and non-tourist entities on the valorization of available natural resources and cultural heritage. This is the basis for respecting the characteristics of the tourist offer as the broadest basis for business decision-making by top management, and the contribution of this work lies in the fact that it is necessary to respect the internal forms of control in the business of tourist companies.
**Keywords**: tourism, agricultural products, consumption, tourist destination.

## 1. INTRODUCTION

Tourism, as an economic activity, has the main goal of contributing to the achievement of three priority goals of developing countries: generating income, employment and increasing foreign exchange earnings, which all in all can affect the improvement of real management. economy as a whole [1-6].

In this sense, the tertiary activity, i.e. the tourism sector, can play an important role as the driving force of economic development, especially in developing countries, but also the cooperation of tourism with other economic branches [7-13].

The impact of the tertiary sector, i.e. the tourism sector, depends on the specific characteristics of each country, which must be taken into account during the macroeconomic planning of managing the economy as a whole, and management decisions made in tourism companies are related to numerous activities, numerous considerations of important factors, as well as for the possibility of a decision on faster realization of the goals of accelerated development [14-18].

## 2. RESPECTING RISKS IN THE BUSINESS OF TOURIST ENTERPRISES

Risk assessment within the framework of observing internal factors that affect the operations of tourism companies is one of the possible ways to improve the work of a large number of tourism companies in their operations, especially in small economies like the Republic of Serbia.

In this way, it is possible to improve the level of making valid management decisions in the business of tourist companies.

An illustration of the impact is given in Figure 1.

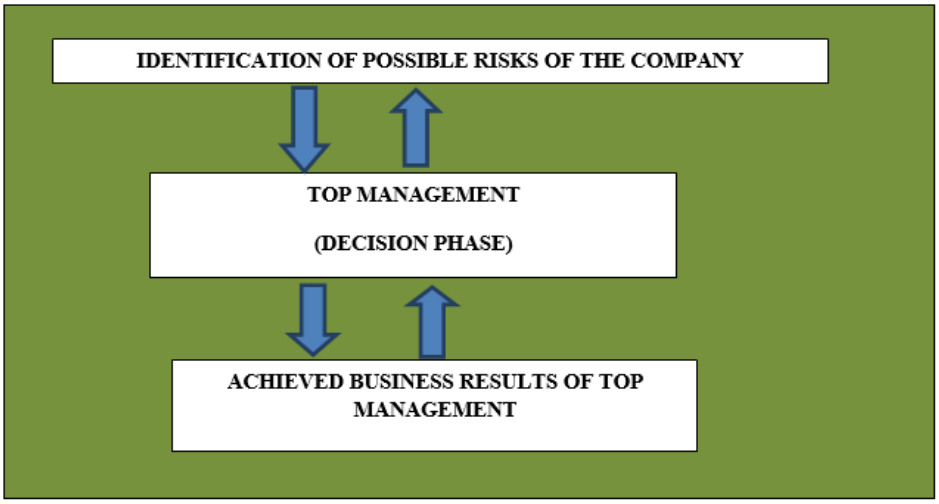


**Figure 1.** A possible organization of a general decision-making scheme in which the existence of most of the identified risks for the operations of a medium-sized enterprise in tourist companies.

In addition to risk assessment, it is necessary to carry out numerous analyzes of the business. One of the possible ways of improving the flow of analysis in the business of tourist companies is shown in Figure 2.

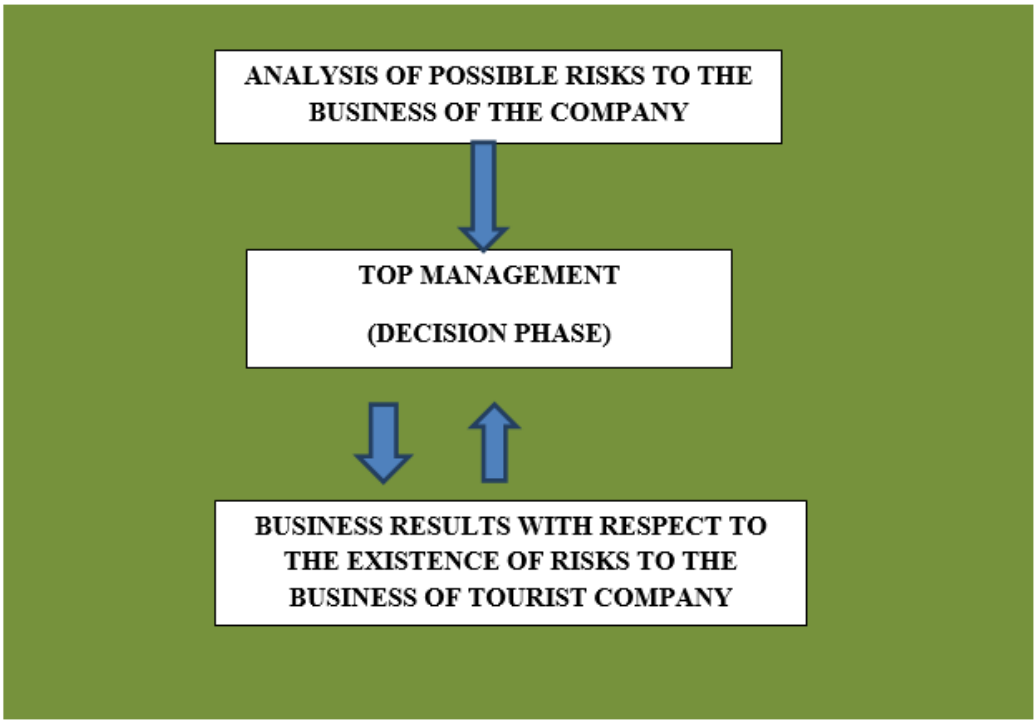


**Figure 2.** General presentation of the appreciation of risk analysis for the tourist company's operations in the process of business decision-making.

## 3. RESPECTING INTERNAL CONTROL FACTORS IN BUSINESS OF TOURIST ENTERPRISES

Controls should ensure the correct functioning of a specific application, and in particular:

• controls in data collection;

• input controls (Input);

• data protection controls;

• controls related to data processing;

• controls related to the result, i.e. outputting data (Output).

No application can function independently of the environment.

This means that when auditing a particular application, you must also consider some of the following controls:

• organizational and general controls;

• logical and physical access controls and environment-related controls;

• telecommunication controls;

• database controls;

• controls related to data security;

• controls related to the continuity of operations;

• controls related to change management;

• controls related to system software.

The basic steps in reviewing an application are:

• analysis of application architecture;

• determination of basic components and flow of information through documentation analysis and discussions;

• determining the weaknesses of the controls in the application and assessing the consequences of the weaknesses of the controls;

• testing the functionality of controls and their effectiveness;

• assessment of whether control objectives have been achieved;

• evaluation of the efficiency and effectiveness of the application in the operational sense;

• in addition, for the audit, it is necessary to determine whether the goals that were determined when approving the development of the application were achieved in a certain period of time;

• realistic reporting by the internal auditor on audit findings.

## 4. CONCLUSION

Tourist activities, i.e. tourist companies, should be oriented towards generating as much income as possible, but also towards connecting with numerous activities that are related to the functioning of tourism, especially if this observation is carried out within the framework of observing the economy of a country, because by strengthening those connections, conditions are created for business improvement, connection, expanding the range of business, etc.

Tourism as an economic activity can play a big role in improving foreign currency inflow, because it increases the entry of foreign tourists who spend large amounts of foreign currency based on the length of their stay but also based on the wide range of various services offered in a certain market.

The need for an increase in foreign exchange movements depends on the degree of development and diversification of a country's economy, as well as on the availability of substitutes for imported products and the qualitative level of tourist offer in each country, noting that such business is also related to the establishment of control mechanisms by the top management in the processes decision-making.

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# TOURISM AS AN ECONOMIC BRANCH WHICH CAN CONTRIBUTE TO THE POSSIBLE IMPROVEMENT OF TOP MANAGEMENT DECISION-MAKING

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## Abstract
Tourism as an economic branch that can contribute to the possible improvement of top management decision-making should be viewed as an important part of the real functioning of tourism as an economic branch. In addition, it should be emphasized that from the aspect of possible improvement of management decisions made by the top management of tourist companies, it is necessary to pay special attention to the observation of the tourist destination. In this sense, it is necessary to observe and analyze geographical entities, formed by developing selective forms of tourism, differentiating the offer and fragmenting the market with the aim of unique action on a certain market, and all with the aim of making valid management decisions by top management. In addition, the connection of various activities is essential in order to maximally satisfy the wishes and needs of potential tourists, observed during the so-called tourism chains with the aim of a possible framework for improving management decisions in the tourism market. In addition, it is necessary to respect the specificity and totality of the offer of tourist products, the formation of tourist demand, the respect of tourist competition, the connection of tourism and other economic branches, then the creation of conditions for increasing the total tourist offer of a country, all with the aim of increasing income from tourism.
**Keywords**: tourism, agricultural products, consumption, tourist destination.

## 1. INTRODUCTION

Tourism as an economic branch should contribute to the improvement of management decisions, as reflected in a large number of tourist and other companies with which tourism has developed relations, because in this way the sale of tourist products can be increased, which can contribute to better management at all levels [1-8] in heterogeneous economic enterprises, that is, in the economy as a whole.

Management decisions, especially in smaller tourism companies, are important for the functioning of all parts of the company, which is the focus of numerous researches that deal with this management problem in a practical way [9-12].

Management decisions are important especially in the functioning of touristic undeveloped areas, in order to achieve competitiveness, and therefore a better position on the tourist market, because it is important to build a valid tourist product, [13-18].

## 2. RESPECTING THE FLOW OR DECISION-MAKING PHASE IN TOURIST ENTERPRISES

Appreciation of the decision-making process in tourism companies is not defined in a standard way, but is adapted to the existing business conditions.

The authors presented how the flow of tourism business can be shown schematically in the form of a diagram in figure 1.

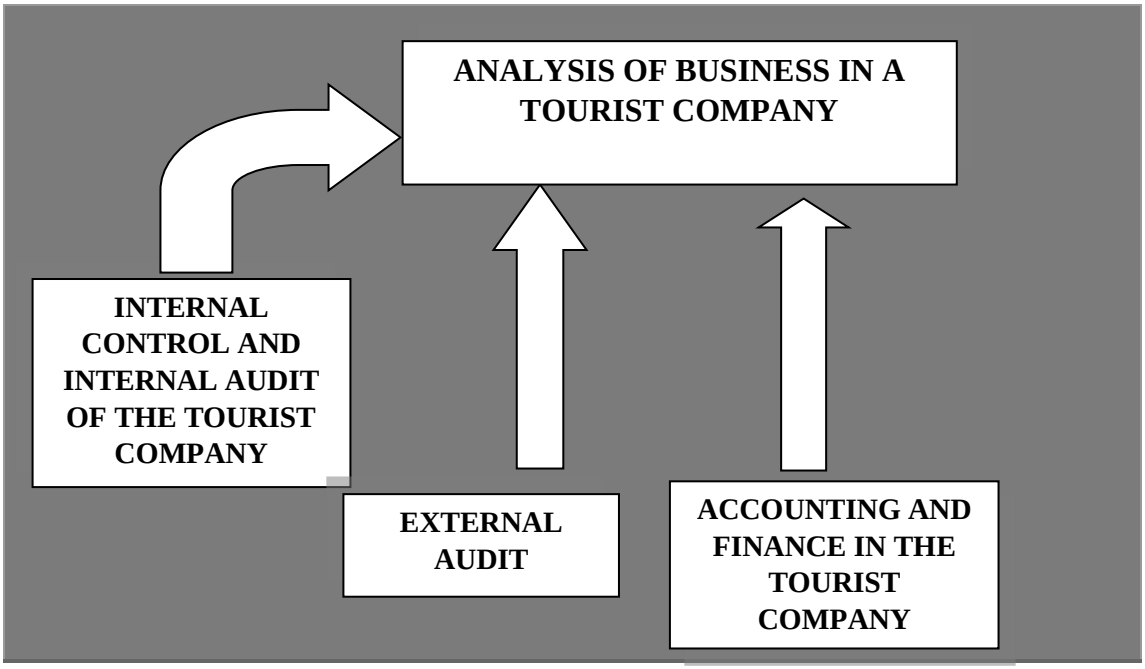


**Figure 1.** Presentation of the key stages of influence on the analysis in tourist companies.

## 3. THE IMPORTANCE OF ESTABLISHING INTERNAL CONTROL MECHANISMS IN THE OPERATION OF TOURIST ENTERPRISES

The importance of establishing internal control mechanisms in the work of tourist companies is of great importance, and below in Figure 2, the authors have provided an overview of such possible activities and movements.

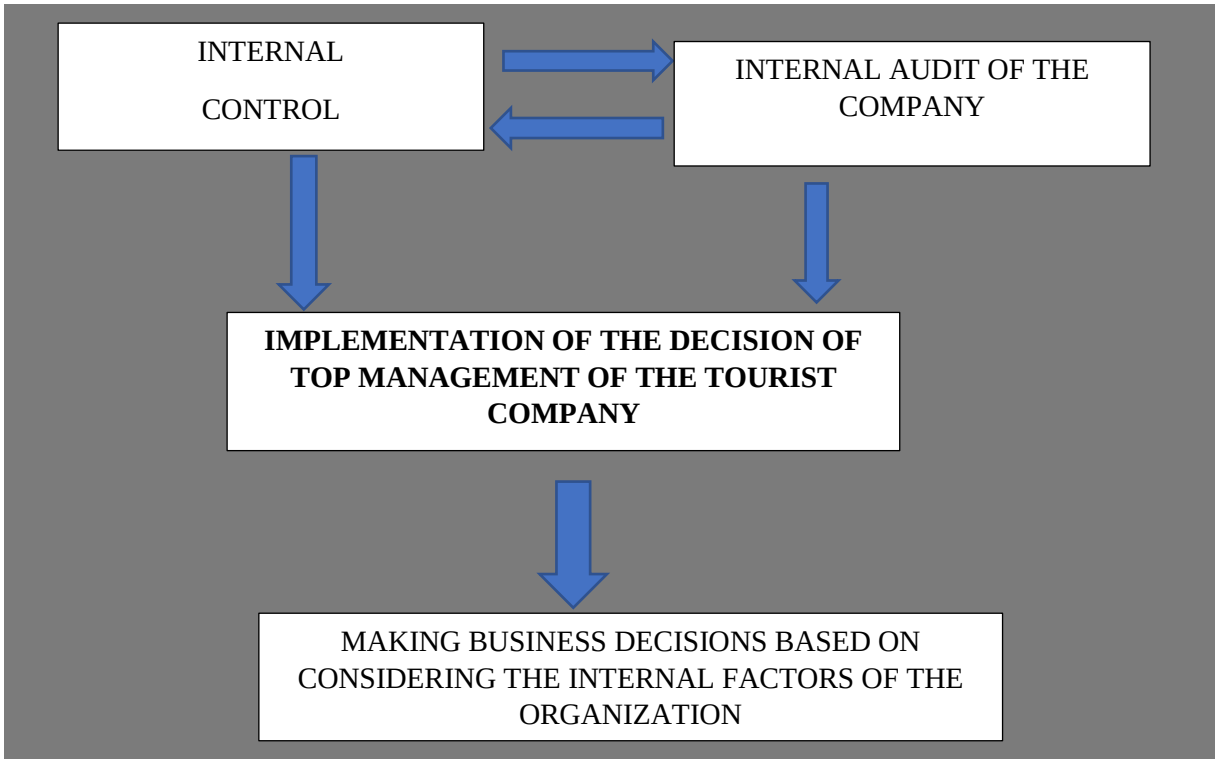


**Figure 2.** Introduction of internal control mechanisms with the aim of improving business performance in numerous tourist companies in transition countries.

## 4. CONCLUSION

In the paper, the authors emphasized the importance of tourism as an economic branch. It can contribute to the possible improvement of management decision-making by the top management if it adopts numerous mechanisms with which they can improve the real functioning of tourism as an economic branch. In the paper, the authors presented two important segments. The first is the proper formation of the flow that arises in the decision-making of tourism branch enterprises, and the second is the introduction of internal control mechanisms that can contribute to the improvement of overall activities from the point of view of business safety, the speed of correct decision-making from the aspect of the possible improvement of management decisions made by the top management of tourism enterprises, a special pay attention to the observation of the tourist destination and other things. In addition, the connection of various activities is essential in order to maximally satisfy the wishes and needs

of potential tourists, observed during the so-called tourism chains with the aim of a possible framework for improving management decisions in the tourism market.

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# ASSESSMENT OF THE IMPACT OF ABATTOIR EFFLUENT ON THE WATER QUALITY OF KAZAURE DAM JIGAWA STATE, NIGERIA

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**Abstracts**
During the study period, there were fluctuations in temperature and pH levels. In week four, the maximum reported pH was 7.07±0.74, compared to 7.67±0.44 in the control sample. The pH levels observed in weeks 1 and 2 were acidic when compared to the control week 3 and control, but they fell within the WHO 2011 permitted guideline range of 6.5-8.5. The low pH value reported may be due to the acidic content present in the abattoir waste water, which can lead to salt dissolution and alter the water's acidity or alkalinity. The temperature of the water observed at the sites remained within the same range. In terms of conductivity, the investigation found that the water sample from week 1 had the highest concentration of dissolved ions (513.6±30.19 S/cm), while week 3 had a slightly lower value of 498.7±10.00 S/cm. The control sample had the lowest conductivity of 341.7±10.00 S/cm. The higher electrical conductivity (EC) values may be attributed to the presence of chemicals in ionic form in the abattoir discharged waste. However, all the EC values observed were within the WHO (2011) recommended limit of 500-1500 S/cm.The total suspended solids (TSS) values were highest in week 3 (64.33±0.94), followed by weeks 4, 1, and 2 with values of 64.33±0.14, 55.67±2.72, and 54.51±3.09, respectively. The control sample had a TSS value of 44.33±0.47. The increase in TSS values can be attributed to the higher runoff of slaughterhouse water into the water, which resulted in reduced dilution of the river water. However, all TSS values were within the WHO's 40 mg/L limit, above which water becomes considerably unpleasant. For total dissolved solids (TDS), the highest values were found in week 1 (272.00±1.63), followed by weeks 4, 3, and 2 (213.33±0.15, 211.33±4.98, and 200.33±0.94, respectively). The control sample had a TDS value of 111.36±3.99. All the readings were below the WHO upper limit of 1000 mg/L, above which water becomes increasingly unpleasant. The investigation also measured biochemical oxygen demand (BOD) values, which ranged from 19.11±0.00 to 22.01±2.72 mg/L. All of the BOD values exceeded the WHO (2011) acceptable limit of 6 mg/L, indicating contamination of the water sources. Dissolved oxygen (DO) values ranged from 5.11±0.20 to 4.17±0.81 mg/L, with the lowest value in week 1 and the highest in the control sample (5.10±0.05). All DO values obtained were greater than the WHO (2011) allowed threshold of 5 mg/L, indicating the presence of contamination. A DO content of at least 5 mg/L is essential to support a diverse biota, including fish, in tropical aquatic ecosystems. Chloride concentrations ranged from 4.08±0.12 to 5.18±0.13 mg/L, with

the lowest concentration in water samples from week 1 and the highest in week 2, compared to 2.44±0.21 mg/L in the control. This variation may be attributed to the discharge of waste from the abattoir, which contains a considerable amount of nitrogen compounds. Furthermore, the heavy metals analysis revealed the presence of Pb, Cd, Fe, and Zn in the water sample from the Kanti, Kazaure abattoir. The concentrations of Cd, Pb, and Zn were somewhat higher than the WHO 1996 acceptable limits of 0.2 mg/L for Cd and 0.05 mg/L for Pb and Mn. The highest concentrations of Cd, Pb, and Zn were found in week 1, while the lowest concentrations of Fe were found in week 2. This could be related to the activities and locations within the abattoir, as the control sample had the lowest levels of these metals.
**Keywords:** Abattoir effluent, Physicochemical Parameters, Heavy Metals and Environment

## Introduction

Abattoirs are recognized worldwide for their significant contribution to environmental pollution due to various procedures (Adelegan, 2002). These facilities are licensed and regulated by authorities to ensure the sanitary slaughtering, inspection, processing, preservation, and storage of meat products for human consumption (Alorge, 1992). Animals grazing on contaminated vegetation and consuming polluted water, as well as marine life breeding in heavily polluted waters, can accumulate heavy metals in their tissues and milk (Yahaya et al., 2009).

Germs from abattoir waste can contaminate water sediments and pose long-term health risks when disturbed (Sobsey, et al., 2002). Pathogens such as rotaviruses, hepatitis E virus, Salmonella spp., E. coli O157: H7, Yersinia enterocolitica, Campylobacter spp., Cryptosporidium parvum, and Giardia lamblia are commonly found in animal carcasses or in animal feces (Sobsey, et al., 2002). Research conducted in Canada revealed that healthy cattle are the primary carriers of E. coli O157: H7, despite its presence in pigs and sheep as well (Sobsey, et al., 2002).

These zoonotic pathogens can infect humans through various routes, including contaminated air, contact with livestock or their waste products, swimming in water contaminated by animal feces, exposure to potential vectors like flies, mosquitoes, waterfowl, and rodents, or consuming food and water contaminated by animal wastes (Nafarnda et al., 2012). Infections resulting from microorganisms in animal feces can range from mild illnesses to death, particularly in high-risk individuals.

The study conducted by Terrumun and Oliver (2015) assessed the impact of abattoir wastewater discharge on the water quality of the Kaduna River. They found that the abattoir wastewater significantly affected the river water quality, as indicated by various parameters such as biochemical oxygen demand, suspended solids, chemical oxygen demand, ammonia-nitrogen, total nitrogen, total phosphorus, dissolved solids, dissolved oxygen, nitrate-N, iron, zinc, and cadmium. The levels of these indicators were higher downstream compared to upstream, suggesting a negative impact of abattoir wastewater on the river water.

Addy et al. (2015) analyzed water samples from the River Katsina-Ala to assess the heavy metal content of abattoir effluent. While most heavy metals were within acceptable limits.

Due to the challenges in directly measuring pathogens, fecal indicator bacteria such as coliform bacteria, fecal coliforms, E. coli, and Enterococci have been used for over a century to assess fecal pollution (Alonge, 2001). Epidemiological studies support the connection between these

indicator bacteria and the occurrence of gastrointestinal illnesses following exposure to recreational waters, forming the foundation for water quality legislation.

The release of untreated abattoir wastes into the environment continues to be a problem in the United States and other developing countries, despite the existence of the Federal Environmental Protection Agency (FEPA) since 1998 (Adeyemo, 2003). To address this issue, better abattoir inspections and stricter enforcement of laws are necessary to reduce environmental contamination and the spread of diseases, particularly zoonotic infections. Ensuring visually inspections of the premises and animals, and preventing the slaughter of visibly unclean or diseased animals, is crucial (Salami, 1998; Hinton et al., 2000; Inglis and Cohen, 2002; Amisu et al., 2003). Livestock production significantly contributes to river pollution, especially in terms of nutrient pollution (Akpan AW, 2004; Adewoye and Lateef, 2004). Animal feces and urine, if not handled correctly, can cause pollution, and grazing activities by unhoused animals can lead to erosion and sediment movement into surface waters, posing a contamination issue (Adesemoye and Adedire, 2005). Abattoir waste, with its high levels of biochemical oxygen demand (BOD), nutrients, and pathogens, poses an additional risk. In Nigeria, abattoirs are often situated near bodies of water for easy access to water for processing activities (Efe, 2005). Abattoir effluent consists primarily of water from cleaning operations, animal blood, dissolved particles, oil and grease, gut contents, and urine (Adewoye and Lateef, 2004). Due to the high concentrations of biodegradable organic matter, sufficient alkalinity, and appropriate levels of phosphorus, nitrogen, and micronutrients in abattoir effluent, contamination of surface water presents significant environmental and health risks (Yahaya et al., 2009).

Efforts have been made globally to reduce pollution, especially by institutions like the United Nations Environmental Programme. However, human activities, such as animal production, continue to severely impact the ecosystem and biodiversity in many areas of Kazaure. The consequences of this pollution include the spread of water-borne diseases, the excessive enrichment of natural water bodies, the accumulation of harmful substances in the soil, the disruption of ecological balance, and negative effects on human health. Therefore, it is important to assess the influence of abattoir effluent on the water quality of Kazaure Dam in Jigawa State.

**Heavy Metals**

Metals such as mercury, copper, and zinc are naturally prevalent in the environment; at low quantities, they are needed for ecosystem and human health, according to Addy et al. (2015).

However, prolonged or high-level exposure can have serious consequences for humans because these metals tend to bioaccumulate in tissues. Human activities, particularly the increase in mining and industrial processes since the 19th century, have increased the concentration of metals in the environment (Carr and Neary, 2008).

**Physic Parameter in water**

It is critical to analyze water before it is used for drinking, residential, agricultural, or industrial purposes. Water must be examined using various physicochemical criteria. The parameters used for water testing are purely determined by the purpose for which the water will be used and the degree to which its quality and purity are required. Water contains a variety of impurities, including floating, dissolved, suspended, microbiological, and bacteriological pollutants. Temperature, color, odor, pH, turbidity, TDS, and other physical tests should be undertaken, while chemical tests should be performed for BOD, COD, dissolved oxygen, alkalinity, hardness, and other characteristics. Water should be tested for trace metals, heavy metals, and organic contaminants, such as pesticide residue, in order to attain higher and higher quality and purity. It is evident that drinking water must pass all of these tests and contain the required amount of minerals. Only in industrialized countries are all of these conditions strictly enforced. Due to the low concentration of heavy metal and organic pesticide contaminants in water, extremely advanced analytical instruments and well-trained personnel are required. The following physical and chemical criteria are examined on a regular basis to assess water quality.

**Table 1: Different analytical water quality parameters used for testing of quality of water and potential health effects with USEPA guidelines (Patil et al., 2012)**

| S/N | Parameter | Parameter |
|---|---|---|
| **1** | Turbidity | Higher level of turbidity are associated with disease causing bacteria's |
| **2** | Colour | - |
| **3** | Odour | Bad odor unpleasant |
| **4** | pH | Affects mucous membrane; bitter taste; corrosion |
| **5** | Electrical Conductivity | Conductivity due to ionizable ions. High conductivity increases corrosive nature of water. |
| **6** | Dissolved oxygen | D. O. corrode water lines, boilers and heat exchangers, at low level marine animals cannot survive. |
| **7** | Total Hardness | Poor lathering with soap; deterioration of the quality of clothes; scale forming |
| **8** | Total Alkalinity | Embrittlement of boiler steel. Boiled rice turns yellowish |
| **9** | TDS | Undesirable taste; gastro-intestinal irritation; corrosion or incrustation |
| **10** | Calcium | Interference in dyeing, textile |
| **11** | Manganese | paper industry etc. |
| **12** | Ammonia | Corrosion of Cu and Zn alloys by formation of complex ions. |
| **13** | Biochemical Oxygen Demand (B.O.D.) | High BOD decreases level of dissolved oxygen. |
| **14** | Chloride | Eye/nose irritation; stomach discomfort. Increase corrosive character of water |
| **15** | Nitrate- | Effect on Infants below the age of six months Symptoms include shortness of breath and blue-baby syndrome. |
| **16** | Phosphate | stimulate microbial growth, Rancidity Mold growth |
| **17** | Sulphate | Taste affected; gastro-intestinal irritation. Calcium sulphate scale |

**Chemical Oxygen Demand**

(COD) COD is another measure of organic material contamination in water that is expressed in milligrams per liter. COD is the amount of dissolved oxygen necessary in water to produce chemical oxidation of organic material. Both BOD and COD are important markers of a surface water supply's environmental health. They are frequently employed in waste water treatment but are only seldom used in general water treatment. Milacron Marketing Company

**Table 2: Different analytical water quality parameters and guideline values as per who and Indian standard**

| S/N | Parameter | WHO standard I | Indian Standard | EPA guidelines |
|---|---|---|---|---|
| **1** | Temperature | - | - | - |
| **2** | Colour | - | 5 Hazen units | - |
| **3** | Odour | Acceptable | Acceptable | - |
| **4** | pH | 6.5 – 9.5 | 6.5 – 9.5 | 6.5 – 9.5 |
| **5** | Electrical Conductivity | - | - | 2500 us/cm |
| **6** | Dissolved oxygen | - | - | - |
| **7** | Total Hardness | 200 ppm | 300 ppm | 200 ppm |
| **8** | Alkalinity | - | 200 ppm | - |
| **9** | Acidity | - | - | - |
| **10** | Ammonia | 0.3 ppm | 0.5 ppm | 0 0.5 ppm |
| **11** | Biochemical Oxygen Demand (B.O.D.) | 6 | 30 | 5 |
| **12** | Chemical Oxygen Demand (C.O.D.) | 10 | - | 40 |
| **13** | Chloride | 250 ppm | 250 ppm | 250 ppm |
| **14** | Magnesium | 150 ppm | 30 ppm | |
| **15** | Nitrate | 45 ppm | 45 ppm | 0.5 ppm |
| **16** | Sulphate | 250 ppm | 180 ppm | 200 ppm |

## Material and Methods

### Materials

The materials to be use includes; Oven, Disposable petri-dish, DO meter, Measuring cylinder, pH meter, Conductivity Meter, Beakers, Desiccator, Weighing Balance, Cotton Wool, Reagent Bottle, Spectrophotometer and Atomic Absorption Spectroscopy (AAS)

### Reagents

Concentrated $HClO_4$, Distilled water, lead nitrate $Pb(NO_3)_2$, Zinc Chloride ($ZnCl_2$), anhydrous cadmium sulphate $CdSO_4.8H_2O$, Cobalt sulphate $CoSO_4$ $.7H_2O$, Concentrated $HNO_3$ and Concentrated HCl

### Method

A standard method of physicochemical analysis and Heavy metal analysis was used in this work

**Sample Collection**

Three samples of water was collected by immersing a sterilized 1litre plastic bottle in the Dam along Kanti abattoir in Kazaure and storing them in an ice-filled cooler. Another sample was collected as a control at a distance of 10 meters from the abattoir. Within four weeks of consecutive sampling, a total of eight water samples was collected at a week intervals, consisting of 4 samples and four controls. All was then transported to the Hussain Adamu Federal Polytechnic Laboratory, where they was preserved in a refrigerator at temperatures ranging from 0 to 4 °C before being analyzed for selected physicochemical parameters. Water samples was also collected in clean, sterilized 750 mL plastic bottles and labeled appropriately before being preserved in 5% v/v nitric acid and analyzed for the selected heavy metals.

The American Public Health Association (APHA) Standard Methods was used to determine the physicochemical parameters of the water samples. Temperature (T), turbidity (NTU), pH, electrical conductivity (EC), total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), biological oxygen demand (BOD), and chloride was among the parameters to be measured ($NH_4NO_3$). Hydrochloric acid digestion was used for heavy metal analysis. The concentrations of metal ions was measured using an atomic absorption spectrometer (model Philips PU 9100) equipped with a hollow cathode lamp and a fuel-rich flame (air acetylene). Zinc (Zn), cadmium (Cd), iron (Fe), and lead was among the parameters studied (Pb).

**Analysis of Physical parameters**

**Determination of pH (APHA, 2008) as stated in Sagagi et al., (2022)**

The pH was measured on-site using a HACH pH meter that had been calibrated with buffer solutions of pH 4.0 and 9.0 according to the manufacturer's instructions. To remove the buffer solution, the electrode was washed with distilled water and wiped with dry soft tissue paper after calibration. In a beaker, a 100mL aliquot of material was placed, and the pH probes was immersed for several minutes until a steady reading was obtained and recorded.

**Determination of Temperature (APHA, 2008) as stated in Polya and, Watts, (2017)**

This was determined at the site of collection. An aliquot of 50mL of sample was measured into a 100mL beaker and a 0-60$^{o}$C thermometer was immersed in to the water. The reading on the thermometer was recorded

**Determination of Conductivity (AOAC, 2004) as stated in González and Herrador, (2007)**

The conductivity of the water samples was determined using an AOAC-approved standard procedure (2004). We used a conductivity meter (Hach model CO150). The conductivity

meter's power and conductivity keys was turned on, and the temperature was adjusted; the instrument was calibrated with 0.001 M KCl to give a value of 14.7ms/m at 250C. Both samples had the probe dipped beneath the surface. Time was allowed for the reading to stabilize before it was recorded.

**Total Dissolve solid**

W1 was a previously evaporated empty dish weighted with an analytical balance. The sample was thoroughly mixed before being poured into a funnel lined with filter paper. After filtering, 80-100 mL of sample was transferred to the previously evaporated empty dish and placed in an oven. It was allowed to reach 105°C and then evaporate. The dish was then allowed to cool to a constant weight, W2, which was recorded. Furthermore, the total dissolve solid was calculated as follows:

TDS mg/l = 10 x ($W_2$-$W_1$)

**Total Suspended solid**

A 100ml sample of well-mixed water was poured onto a previously weighted filter paper, which was then placed on a filtration apparatus. Suction was used to draw water from the filtration apparatus until it was completely drained. After drying the filter paper in an oven at 103-105°C for 1 hour, the suspended solid was calculated as follows.

TSS mg/l = 10 x ($W_2$-$W_1$)

**Chemical Parameters**

**Determination of dissolved oxygen (DO) (APHA, 1998) as stated in Polya and, Watts, (2017)**

The dissolved oxygen (DO) content of the water and underground water samples was measured using the Jenway Model 9070 water proof meter according to the standard method described by APHA (2008).

**Determination of biochemical oxygen demand (BOD) (Oladoja, 2006)**

The BOD determination of the water samples was carried out using standard methods described by Oladoja, (2006). Samples was incubated for five days at $20^{O}$C in BOD bottles. The dissolved oxygen (DO) content of the samples was determined before and after the incubation. BOD was calculated after the incubation period.

BOD5= Dissolved oxygen after incubation period (5 days) - Dissolved oxygen of the first day.

**Determination of chloride**

The concentration of chloride ions is determined by subtracting the titration findings of the moles of silver ions that reacted with the thiocyanate from the total moles of silver nitrate added to the solution. This method is used when the pH of the solution, after the sample has been prepared, is acidic.

**Determination of some heavy metal**

**Sample digestion**

Each sample received 50ml in 250ml beakers. 5cm3 of concentrated nitric acid was added and carefully heated in a fume hood chamber on a powered electrically connected sand-bath with periodic additions of 10ml and Concentrated Nitric acid until the volume was reduced to 20 ml. The sample solution was then allowed to cool before 4ml of perchloric acid ($HClO_4$) was added and heated until it was clear. Prior to analysis, the samples was diluted with deionized water, filtered into 100ml volumetric flasks, made up to mark, transferred into a capped labeled plastic bottle, and refrigerated. The acid ratio used for digestion, $HNO_3$:$HClO_4$, was5:1 (Bluhm, et al., 2006).

A blank sample was also prepared by digesting the same proportion of the reagents used in the sample digestion without the sample under the same experimental conditions. The resulting solution was diluted to the appropriate concentration with distilled water, thoroughly mixed, and used to determine the heavy metals in the water sample.

**AAS analysis**

Standard stock solutions (1000 mg/L) of zinc, Iron, lead and cadmium high purity was used where an appropriate volumes was diluted to obtain the working standard solutions of various concentrations for plotting calibration curves (Sagagi, et al., 2022).

**Result and Discussion**

| Parameters | Week of sampling | | | | |
|---|---|---|---|---|---|
| | Week 1 | Week 2 | Week 3 | Week 4 | Control |
| Temp. ($^{O}$C) | 24.70±0.25 | 24.21±0.88 | 24.17±0.01 | 24.31±0.24 | 24.83±0.47 |
| pH | 6.17±0.11 | 6.18±0.14 | 7.01±0.74 | 6.76±0.54 | 7.67±0.44 |
| Conductivity | 513.63±0.19 | 511.86±0.00 | 498.71±0.00 | 501.86±0.00 | 341.71±0.00 |
| TDS | 272.00±1.63 | 200.33±0.94 | 211.33±4.99 | 213.33±0.15 | 111.36±3.99 |
| TSS | 55.67±2.72 | 54.51±3.09 | 64.33±0.94 | 64.33±0.14 | 44.33±0.47 |
| DO (mg/L) | 5.11±0.20 | 4.33±0.02 | 4.17±0.81 | 4.81±0.71 | 5.10±0.05 |
| BOD (mg/L) | 22.01±2.72 | 19.11±0.00 | 21.33±0.17 | 21.75±0.66 | 16.42±0.11 |
| Cl (mg/L) | 4.08±0.12 | 5.18±0.13 | 4.11±0.31 | 5.01±0.18 | 2.44±0.21 |

The result of physic and chemical parameters analysed from river along Kanti abattoir of Kazaure is presented in table 3, while that of heavy metal analysis are presented in Table 4 respectively for discussion.

**Table 3: Result of Physicochemical parameters analysed from Dam along Kanti abattoir of Kazaure, Jigawa sate**

**Result are presented as mean±standard deviation**

**Table 4: Result of Heavy Metal analysis of water sample from Dam along Kanti abattoir of Kazaure, Jigawa sate**

| Metals | Concentration (mg/l) | | | | |
|---|---|---|---|---|---|
| | Week 1 | Week 2 | Week 3 | Week 4 | Control |
| Cd | - | 0.60±0.01 | - | 0.11±0.07 | 0.02±0.01 |
| Zn | 0.21±0.01 | 0.22±0.00 | 0.54±0.01 | 0.43±0.00 | 0.16±0.01 |
| Pb | 0.14±0.03 | 0.10±0.01 | 0.14±0.00 | 0.10±0.01 | 0.04±0.00 |
| Fe | 40.55±0.04 | 56.41±0.21 | 44.14±0.00 | 37.51±0.01 | 12.07±0.70 |

**Result are presented as mean±standard deviation**

**Physicochemical parameters**

**pH, Temperature and Conductivity**

Temperature and pH levels fluctuated during the study period. The maximum pH reported was 7.07±0.74 in week four, compared to 7.67±0.44 in the control sample. When compared to the control week 3 and control, the pH levels observed in weeks 1 and 2 are acidic. However, they were within the WHO (2011) permitted guideline value range of 6.5-8.5. The low pH value reported may be attributed to acidic content in the abattoir waste water, which may cause salt dissolution and so change the acidity or alkalinity of the water. The temperature of the water observed at the sites was within the same range as shown in table 3. The temperature of a water supply has little direct impact on health (Wilson et al., 1989), but it does affect the availability of soluble oxygen. The amount of dissolved oxygen reduces as temperature rises.

The conductivity values obtained in this investigation revealed that the water sample from week 1 had the most dissolved ions (513.6±30.19 S/cm) compared to 498.7±10.00 S/cm in week 3.

Table 3 shows that the control sample has the lowest conductivity of 341.7±10.00 S/cm. The high EC values reported may be due to the chemicals present in ionic form in the abattoir discharged waste, yet all of the EC values observed fall within the WHO (2011) recommended limit of 500-1500S/cm.

**Total soluble solid (TSS) and total dissolve solid TDS.**

TSS values of 64.330.94 were reported in week 3, followed by 64.33±0.14, 55.67±2.72 and 54.51±3.09 in weeks 4, 1, and 2, compared to 44.330.47 in the control sample. This is due to increased slaughterhouse water runoff into the water, which lowered dilution of the river water. All of the values were under the WHO's 40 mg/L limit, above which water becomes considerably and increasingly unpleasant. Table 4.1 shows high TDS values of 272.00±1.63 in week 1, followed by 213.33±0.15, 211.33±4.98, and 200.33±0.94 in weeks 4, 3, and 2, compared to 111.36±3.99 in the control sample. All of the readings were less than the WHO upper limit of 1000 mg/L, above which water becomes considerably and increasingly unpleasant. This is consistent with earlier observations reported by Kumar & Sinha, (2010), who concluded that the increase in TDS can be ascribed to the increasing input of abattoir water into the river.

**Biological Oxygen Demand (BOD)**

The investigation yielded biochemical oxygen demand (BOD) values ranging from 19.110.00 to 22.012.72 mg/l. This is lower than the 43.77-235.64 mg/l range reported by Ibeh and Omoruyi (2011). All of the BOD values found in this investigation are greater than the WHO (2011) acceptable limit of 6mg/l. The observed dissolved oxygen (DO) values ranged from 5.11±0.20 to 4.17±0.81 mg/l, with week 1 having the lowest compared to 5.10±0.05 for the control, which had the highest DO reported. All of the results obtained were greater than the WHO (2011) allowed threshold of 5 mg/l. This suggests that the water sources were contaminated. To support a diverse biota, including fish, tropical aquatic ecosystems should have a DO content of at least 5mg/l (Jha et al., 2008).

Chloride concentrations ranged from 4.08±0.12 to 5.18±0.13 mg/l, with water samples from week 1 having the lowest concentration and week 2 having the highest, compared to 2.44±0.21mg/l in the control. This could be attributed waste discharged from the abattoir which a considerable amount of nitrogen compounds.

**Heavy metals**

The heavy metals analysis of the water sample from Kanti, Kazaure abattoir in, as shown in table 4.2, revealed amounts of Pb, Cd, Fe, and Zn. Both were somewhat higher than the WHO

1996 acceptable limits of 0.2 mg/L for Cd, 10 mg/L for Fe, and 0.05 mg/L for Pb and Mn, respectively. The highest concentrations of Cd, Pb, and Zn were found in week one, while the lowest concentrations of Fe were found in week two, which may be related to location activities in the abattoir because the lowest values of these metals were seen in the control sample. Lead is a typical cumulative poison that has been demonstrated to have an impact on children's academic growth and productivity, as well as adults' blood pressure and cardiovascular illness. It can also cause anemia, brain damage, stomach ache, convulsions, hypertension, infertility, tremors, renal tube nephrosis, and reduced infant IQ. It also causes damage to the kidneys and digestive organs (Sagagi et al., 2022). Cadmium is a possible carcinogen, and drinking water contaminated with Cd causes major human health problems (the "Itai-itai" sickness), which was first recorded in the 1970s (Sagagi et al., 2022).

**Conclusion**

The study looked into the impact of abattoir activities on river water quality near the abattoir in Kanti, Kazaure. The study's pollution impact found that the values of the physicochemical parameters were greater than those of the control sample due to variations in the values of the parameters except temperature. Except for cadmium, which was not detected in weeks 1 and 3, the majority of the analyzed metals, including lead and chromium, were within the recommended limits. The poor quality of water in Kazaure Dam is most likely owing to its proximity to the abattoir and the influence of abattoir wastewater percolation into the soil. This is supported by the fact that the parameters of the control region, which is further away from the abattoir, had lower values than the sampling area, which is close to the abattoir. Dissolved oxygen was also lower in the sampled region and greater in the control area, which was 10 meters distant from the abattoir. This renders the water from the abattoir Kanti, Kazaure unfit for human consumption unless properly treated, despite the fact that physical observations indicate that it is potable. If sufficient treatment is not implemented, communities along the river may suffer from severe effects of pollutants from abattoir activities.

**Recommendation**

It is, therefore, recommended that, pretreatment system should be constructed before the discharge of the waste to the water body. Proper sanitation should be strictly observed around the vicinity of the various water sources to prevent contamination. Proper and appropriate treatment should be done to the water if it is to be used both drinking and domestic purposed.

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# FOOD SECURITY: PARADIGM SHIFT IN PHILOSOPHY OF EDUCATION IN THE 21ST CENTURY AND BEYOND

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**ABSRTACT**
The survival and stainance of any nation depends on a continuum supply of regular food provision or else, the realization and fulfillment of SDGs in such a nation would be a wishful dream. Therefore, the need for a purposeful plan towards regular food supply now and beyond.

## Introduction

Sustainability is a continuous process of using the environment for better living. It means a conscious utilization of exploitable resources in a way to make them useful in future. Hence, sustainable development required putting in place factors of improved living and sources of good satisfaction that will not only serve the needs of the present generation but also satisfy the need of future generation.

The significant concern in sustainability is to endeavour to maintain a continuous flow of resources and other factors of action. Therefore, Nigeria has accepted, in line with the 1972 World Conference on the Environment and Development, and the World Summit on Sustainable Development (WSSD, 2002) to pursue the goal of sustainable development. The objectives are to integrate the environmental, social, and economic aspects of development in a holistic manner. This is in line with the challenges posed by the Sustainable Development Goals: 1, 2, 3, 7, 8, 11 12 and 13 (SDGs) aimed at achieving significant measurable improvement in peoples' lives, especially the less privilege.

However, Land is an important component of the natural environment of man. The location, extent and nature of the land in any human community are of significance to various activities of man, especially food production and security; since food consumption with regards to food availability, supply, purchase, and movements are instances of FOOD SECURITY. 'Healthy Nation , it is said, is Wealthy Nation", hence, when talking of food security, reference must be made to land and soil texture, cultivation, harvest, transportation, market demand and supply , sources of water and energy provision, as well as utilization must be emphasized to ascertain sustainability.

Moreover, Climate Change threatens food security in the area of water supply for irrigation purposes, energy conservation in order to power bole-holes as sources of water supply, draught against adequate rainfall. The profiles, characteristics and special location of different types of soil coupled with various human activities like road construction, irrigation, mining, and quarrying rendered the soil infertile, resulting in no small measures to soil erosion, land degradation, depletion and infertility becomes a challenge to FOOD SECURITY, hence, unsustainability evolves.

Food security implies the adequate crop cultivation, harvest, demand, supply, distribution, consumption, utilization for sustainable human existence in relation to hygiene and healthy living in the present as well as the future, with little or no –wastage of farm produces. Food security calls to mind sustainable farming as individual, family and community in general to

ensure self- reliance. That is, the ability to generate sources of livelihood as a relief for individuals, families and society in particular.

Furthermore, food security means individuals or group of persons skills acquisition to really generate wealth as source of survival, using Entrepreneurial-ship skill/ potential for creativity and innovation in the 21st century and beyond to ensure 'A United, Strong and Self –reliant nation", which is in consonant with Sustainable Development Goals 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13( SDGs) Therefore, the use of Multi-disciplinary Approach in the teaching and learning process in the 21st century and beyond demands vivid paradigm shift in course of our pluralistic classroom situation 'to secure availability of food on our tables at any given point in time", since learning is the result of mental construction. Knowledge is not received outside but it is reflecting on our experience, by fitting new information together with what we already know, hence, we construct knowledge in our head. Thus, we construct our own ideas, view and understanding of the World we live-in.

Obviously, from the above view points, the 21st century is challenging and dynamic for learners empowerment to ensure food security, acquisition of competitive adequate competence in Songs -composition, Drama-presentation, Poetry –articulation and Intellectual display in both Oral and Written expression, as well as Entrepreneurial-ship skill creativity and innovation. So, reasonable learners should ensure the acquisition of profitable entrepreneurial opportunities such as job creation, self reliance, employable involvement economic growth and development among others , which brings to mind resourceful learners as food- provider and food securer, hence, food security is the ANSWER for Sustainable growth and development, NOW and FOREVER. Let us learn to be creative and innovative, NOT just food consumers.

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# ANALYSIS OF OUTSOURCING SERVICES AS A TOOL FOR ORGANIZATIONAL SUSTAINABILITY

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## Abstract
The advent of globalization put outsourcing to grow into one of the far and wide incorporated commercial stratagems for conveying exceptional services to clients in the business area. Conversely, in spite of the amassed inclination in outsourcing engagements and still exist the derisory literature groundwork on how outsourcing undertakings upset organization routine in manufacturing sector. To bung up the lacuna this work craved to analyze the logistics outsourcing services as a tool for organizational sustainability in manufacturing sector in Nigerian firms. The paper sought to determine whether cost affects organizational performance, to assess whether quality of the goods manufactured influence organizational sustainability, to find out whether technology adaption has effects on organization performance and finally to establish whether risks has great effects on organization performance at Nigerian firms Limited. The researcher used descriptive research design method to conduct the study. The paper considered a population of 42 members of staff particularly the three major departments includes Production, Transport and Agriculture, Engineering for the interview. The investigator used census survey method to pick the sample size owing to the fact the population was small. The Primary source of data was applied by the use of questionnaires. The quantitative data was analyzed by means of Uni-variable, Bi-variable and Multi-variable analysis using statistical package for social sciences (SPSS) version 21 software. The findings appraised that: Cost, quality, technology adaption and organization performance exist between them a significant strong positive relationship. Also the study established an insignificant positive weak relationship that exists between risks and organization performance. Hence, the study recommended that manufacturing companies should do a thorough finding on the service provider in term of their tenacity, capability and resources if they can handle the core activity of the company before contracting out such services, Organization should engross the third party on the benchmark or quality of standards expected of them.
**Keywords:** Logistics, Outsourcing, Organization, Sustainability

## INTRODUCTION

Cost reduction and effectiveness has caused most of the organization to be specialized in the limited number crucial areas. This will pave the way for the organization to move towards the outsourcing activity. Traditionally, outsourcing has performed mainly for the peripheral activities such as cleaning, catering and security. But now it is mainly focused on more crucial activities of the business such as design, manufacture, marketing, distribution and information systems. Manufacturing industry was the leading business activity in Nigeria during the early 80''s both in terms of size and employment. The industry was employing over 200,000 family households and about 30% of the labor force in the national manufacturing sector. Later the sub-sector started declining in the mid-1980s until the 1990s. Efforts to boost growth in manufacturing industry have been undertaken with outsourcing being one of the strategies. Nigeria's share of manufacturing exports to the global market is estimated to be about 10.75 percent in 2019 and it was 6.3944% in 2021 that is favorable compared with its immediate neighbors Uganda, Tanzania and Nigeria, according to World Bank collection development indicators on August 2023 (Nigeria Institute for Public Policy Research and Analysis, 2013). Nigeria manufacturing output for 2021was $64.41B, a 17.65 percent increase from 2020 which was then at $54.73B, a 6.03% increase from 2019 which was $51.63B, a 26.89 % compared it was in 2018 which is $40.69B, a 23.89% increase from 2017(World Bank)

Agricultural manufacturing organizations are constantly in search of new solutions and strategies to develop and improve organization performance. One of the strategies which they have adopted is outsourcing for competitive advantage. Even though many studies have been done in relation to outsourcing, very few have focused on effects of outsourcing in manufacturing sector. Despite the rapid growing trend in outsourcing there are limited published sources of literature related to outsourcing in Nigeria. Meclah et al., (2010) mentioned that there are limited studies on outsourcing. Based on these facts, the present study will be carried out to fill this gap by finding out the effects of outsourcing on organization performance in a manufacturing sector with KK Nigeria Limited as a reference industry with intent to determine whether cost affects organizational performance of KK Nigeria Limited, to assess whether quality affects organizational performance at KK Nigeria Limited. To find out whether technology adaption affects organization performance KK Nigeria Limited and to establish whether risks affects organization performance at KK Nigeria limited

## RELATED WORKS AND THEORIES

Iborida, Emmanuel et al (2021) Worked on the Pros and Cons of outsourcing logistic Functions among Manufacturing Firms in Southwest, Nigeria and found out that there is a significant influence of outsourcing on a reduction in operational and project management cost. Also, it leads to competitive advantages, the flexibility of operation, and sufficient time for process planning

Muralitharan shanmugan et al (2019) researched on Manufacturing outsourcing to achieve organizational performance through manufacturing integrity capabilities but concluded that supply chain management played a significant role for successful outsourcing activity that meet the organization objective mainly on cost reduction and improvement of core function for business sustainability and growth. Another study comparative study of logistics outsourcing and in-house services on customer satisfaction among Nigerian manufacturing companies done by Omona-a Hamilton Horsfall et al (2018)

### Resource Based View (RBV) Theory

RBV theory puts more emphasis on the firm's internal resource rather than external opportunities and threats created by industry conditions. The theory maintains that in order to generate sustainable competitive advantage a resource must provide economic value and must be presently scarce, difficult to imitate, non-substitutable and not readily obtainable from markets. The theory also relies on two key points; first that resource are determinants of firm performance and second that resources must be rare, valuable, difficult to imitate and non-substitutable by other rare resources. When the latter occurs a competitive advantage has been created.

### Contractual Theory

For an outsourcing strategy to be implemented, it requires a legally bound contract which sets the institutional framework in which each party's rights, duties, and responsibilities are clearly defined. The goals, policies, practices, and strategies on which the arrangement is based are also specified in the contract. The purpose of the outsourcing contract is to facilitate proper exchange of services between the two parties, prevent misunderstanding, prohibit moral hazards in a cooperative relationship, and protect each party's proprietary knowledge. Properly written contracts prevents risks arising from non-performance and misunderstanding, and also reduces uncertainty likely to be faced by firm decision making process.

## METHODOLOGY

The researcher used descriptive research design method in carrying out his study. This research work used of both primary and secondary source of data. The primary data was collected through questionnaire, and personal interview. Two set of questionnaire and interview guide was employed in the course of this study. The questionnaire was designed in line with the objectives of the study and to elicit information on the logistics outsourcing services as tool for organizational sustainability from management and secondary data was achieved through the use of text books, thesis journals and internet materials, as well as publications related to logistics and distribution methods which was used mainly for literature review of Company, distributors. The study targeted a population of 42 management staff from three major departments of KK, namely: Production, Transport and Agriculture, and Engineering. Data was analyzed through descriptive statistics and inferential analysis by use of statistical package for social sciences (SPSS) version 21 software. Both Correlation and Multiple Regression analysis was used to test the relationship between the independent variables and the dependent variables. Regression model: the equation was expressed as follows:

$Y = \alpha + \beta 1\ (X1) + \beta 2\ (X2) + \beta 3\ (X3) + \beta 4\ (X4) + e$ Y – Organization Performance

α- Constant (coefficient of intercept)

X1 – Cost Reduction

X2 – Quality Improvement

X3 – Technology Adoption

X4 – Risk Reduction

e – Error term

β1, β2, β3, β4 – Regression coefficient for four variables.

## RESULT AND DISCUSSION

| | | Cost | Quality | Technology adaptation | Risks | Organizational performance |
|---|---|---|---|---|---|---|
| Cost | Pearson Correlation | 1 | -0.253** | .532** | .509** | .701** |
| | Sig. (2-tailed) | | 0.48 | .001 | .002 | .006 |
| Quality | | | 1 | .530** | .079 | .525** |
| | Pearson Correlation | | | 0.46 | .647 | .010 |
| | Sig. (2-tailed) | | | | | |
| Technology adaptation | Pearson Correlation | | | 1 | 0.494** | .670** |
| Risks | Sig. (2-tailed) | | | | .035 | .012 |
| Organizational performance | Pearson Correlation | | | | 1 | .140** |
| | Sig. (2-tailed) | | | | | .414 |
| | Pearson Correlation | | | | | 1 |
| | Sig. (2-tailed) | | | | | |

**N=36**

From the above table, it is shown that there was a significant weak negative relationship between cost reduction and quality improvement (r= -0.253, p=0.048). The more the quality is improved the less the cost is reduced on the products and services and vice versa. Technology adaption and cost reduction have a significant positive moderate relationship as explained by the Pearson correlation coefficient of 0.532 and a p value of 0.001. This can be interpreted to mean that the more the company adapts to new technologies in production and delivery of its goods and services the more the cost is reduced. There was also a moderate positive but significant relationship between risk reduction and cost reduction (r=0.509, p=0.002). The implication of this is that the more the risk reduced the more the cost is reduced. Cost reduction and organization performance have a significant strong positive relationship as implied by (r=0.701, p=0.006). The more the cost is reduced the more the organization performs.

Quality and technology adaption have a significant moderate positive relationship since the Pearson correlation coefficient is 0.530 and p value is 0.046. This implies that more adaption

to technology leads to more improvement in quality. There is an insignificant positive weak relationship between quality improvement and risk reduction (r=0.079, p=0.647), an indication that risk does not necessarily mean an increased quality improvement. Quality and organization performance have a significant moderate positive relationship as shown by correlation coefficient of 0.525 and a p value of 0.010. The interpretation of this relationship is that an increase in quality moderately increases the organization performance.

Technology adaption and risk were found to have a significant positive relationship (r=0.494, p=0.035). This is interpreted to mean that the more the technology is adapted the more the risk is reduced. There was a significant positive relationship between technology adaption and organization performance (r=0.670, p=0.012). More adaption to technology implies an increased organization performance. Finally, the results shows that there is an insignificant positive weak relationship between risk and organization performance as the correlation coefficient was found to be 0.140 and p-value was 0.414.This is interpreted to mean that an increased risk does not necessarily imply an increased organization performance.

**Regression Analysis results**

Regression is the determination of a statistical relationship between two or more variables (Kothari, 2004).This study utilized multiple linear regression analysis to examine the relationship of the predictor variables with the dependent variable. Adjusted R2 which is known as the coefficient of determination was used to explain how organization performance varied with cost, Quality, technology adaption and risk. The model summary table shows that 60.5% of change in organizational performance can be explained by four predictors namely cost, Quality, technology adaption and risk an implication that the remaining 39.5% of the variation in Organizational performance could be accounted for by other factors not considered in this study.

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .806a | .650 | .605 | .465 |

a. Predictors: (Constant), Cost, Quality, Technology adaption&Risks

Analysis of variance (ANOVA) was done to establish the fitness of the model used. The ANOVA table shows that the F-ratio (F=9.301, p=.000) was statistically significant. This means that the model used was appropriate and the relationship of the variables shown could not have occurred by chance.

| Model | Sum of squares | Df | Mean square | F | Sig |
|---|---|---|---|---|---|
| Regression | 21.759 | 4 | 5.440 | 9.301 | .000[b] |
| Residual | 18.130 | 31 | .585 | | |
| Total | 39.889 | 35 | | | |

a. Dependent variable = organizational sustainability

b. Predictors: (Constant), Cost, Quality, Technology adaption&Risks

**Regression coefficients**

| **Model** | **Unstandardized coefficients** | | **standardized coefficients** | **t** | **Sig** |
|---|---|---|---|---|---|
| | **B** | **Std error** | **Beta** | | |
| **Constant** | 1.828 | .701 | | 2.609 | .014 |
| **Cost** | | .148 | **.**142 | .797 | .007 |
| **1 Quality** | .118 | .153 | .277 | 1.474 | .036 |
| **Technology** | | .176 | .149 | 763 | .042 |
| **Risks** | .225 | .148 | .242 | 1.423 | .165 |
| | .134 | | | | |
| | .211 | | | | |

c. Dependent variable = organizational sustainability

The above table gives the results for the regression coefficient for the multiple linear equation.$Y=\beta 0+\beta 1X1+\beta 2X2+\beta 3X3+\beta 4X4+\varepsilon$) which by supplying the coefficients becomes: $Y=1.828+0.118X1+0.225X2+0.134X3+0.211X4$

Giving to the regression equation proven, holding all independent factors a constant then organization performance will be 1.828 units. From the regression equation holding all other independent variables a constant, a unit increase in cost will lead to a 0.118 improvement in organization performance; a unit change in quality will lead to a 0.225 increase in organization performance; a unit increase in technology adaption will lead to a 0.134 increase in organization performance and a unit increase in risks will lead to a 0.211 increase in organization performance. However, at 5% level of significance and 95% level of confidence, cost reduction, technology adaption and quality has a significance influence on the organizational performance with p-values of 0.007, 0.036 and 0.042 respectively and therefore their coefficients should be retained in the final model. The P-value associated with the coefficient for risk is 0.165 and

implication that though risk has an influence on the organizational performance, its effect is insignificant and so it may be dropped in reporting the final model. The results further infers that of all the predictors considered in this study quality improvement contributes the most to the organizational performance followed by technology adaption as implicated by their larger coefficients.

**CONCLUSIONS**

As for each the regression equation established, holding all independent factors constant, then organization performance will be 1.828 units. From the regression equation holding all other independent variables a constant, a unit increase in cost will lead to a 0.118 improvement in organization performance; a unit change in quality will lead to a 0.225 increase in organization performance; a unit increase in technology adaption will lead to a 0.134 increase in organization performance and a unit increase in risks will lead to a 0.211 increase in organization performance. However, at 5% level of significance and 95% level of confidence, cost, technology adaption and quality have a significance influence on the organizational performance with p-values of 0.007, 0.036 and 0.042 respectively and therefore their coefficients should be retained in the final model. The P-value associated with the coefficient for risk is 0.165 and implication that though risk has an influence on the organizational performance, its effect is insignificant and so it may be dropped in reporting the final model.

The results further infers that of all the predictors considered in this study quality contributes the most to the organizational performance followed by technology adaption as implicated by their larger coefficients.

**RECOMMENDATIONS**

Based on the objective one which is cost, organizations should not expect guaranteed cost reduction in all the year marked areas. Even though respondents agreed there was cost reduction, this was only moderate in some areas. Therefore organizations should not outsource an activity fully until they have confirmed beyond doubt that the service provider is capable of handling the activity. Based on the second objective on quality, it turned out that it was very difficult to measure quality. It is therefore recommended that organization should engage the service provider on the quality standards which are expected before entering into the contract. Based on the third objective on technology adoption and in line with the ever changing technology it is believed that manufacturing operations will continue to become more and more complex and challenging. It is therefore recommended that when outsourcing organizations should select the service provider on the basis of consistent technical and managerial

capabilities. The study finding show that technology has a significant influence on organization performance. Based on the fourth objective focusing on risks, organization ought to know that risk is a very sensitive issue which if wrongly handled can bring many problems for the firm. It was recommended that service providers should only handle particular risks which even if they occurred would not affect the entire organization performance. Organizations should never hand over all the responsibilities to service providers. Lastly the general recommendation was that organizations should outsource with a clear picture in mind as to why they want to outsource. When organizations outsource they should have measurable indicators in form of Key Performance Indicators (KPI) for the service provider

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# SEAPORT 4.0: COMPARATIVE ANALYSIS BETWEEN SINGAPORE PORT AND PORT KLANG

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**Abstract**
The increase of sea trade has become the primary factor boosting global economic growth and the development of every nation. Seaport has now begun implementing elements of IR4.0 in their daily operation. Certainly, huge investments are being made in order to keep up with modern technology, advanced tools and equipment, and many more. The efficient management of Seaport has proven to provide value added to the trading sectors and able to help in improving the GDP of a particular nation. Therefore, a comparative analysis between Singapore Port and Port Klang will be explored further to look into the uniqueness of both seaports. The objective of this article is to determine the critical success factors of Singapore Port in comparison with Port Klang. Secondly, this article would like to determine the advanced elements of Singapore Port that Port Klang can learn from. Even though their location is in the same region, the advancement and effectiveness of Singapore Port may give some value added and knowledge to its neighbour to acquire from. This study will employ qualitative research methodology using the Systematic Literature Review (SLR). Analysis will be done using the critical approach. Findings indicated what are the critical success factors of Singapore Port. Later on, Best Practice Model of Singapore Port would be able to retrieve. It was found that the main three elements of Singapore Port achievements are their advancement in technology implication, strong organizational structure and calculated investment. Further research may look into how Singapore able to leverage their investment from Port operation to the well being of its nation.
**Keywords**: Comparative Analysis, Singapore Port, Port Klang, Systematic Literature Review, Critical Approach.

## INTRODUCTION

The developments in sea trade have become the main source of driving up the world's economic growth and development of every country. Since international trade is booming nowadays, sea trade became the main source of transportation for every country to conduct trade.

Sea transportation or freight is booming nowadays because it's more flexible compared to other forms of transport because it can transport many types of goods. Apart from that, most of the sea routes are natural, reducing the cost of building and maintaining a new one (LEC, 2018). Continuously, sea freight has a high carrying capacity, and because of it, it has become the first choice for many countries when it comes to transporting large quantities of goods. Lastly, it has high usability to transport specialised containers and it is much cheaper than other forms of transportation (LEC, 2018).

A seaport is a hub in worldwide supply chains with high maritime power and a practical and spatial grouping of port-related exercises. Seaport improvement is important for the growth of a country because it creates wider job scopes and availability, more efficient trade, wider transportation options, and increases the supply of products and lower-priced goods (Urbanwired, 2017). Seaport is making the job scope wider because it creates many jobs in the import and export, tourism, and transport industries. Since sea transportation is safer and more cost-efficient, seaports are providing this service for all industries and manufacturing companies to transport their raw material and finished goods. Since many international trades are occurring via sea freight the seaport must be efficient in its shipping schedule to avoid congestion.

This study focused on comparing Singapore Port's advancement to Port Klang and the critical success factors of Singapore Port. There are several critical success factors of Singapore Port such as technology, investment, and organisation structure which can influence the advancement of Port Klang.

### Problem Statement

Referring to the problem statement, ports are significant as occupied business, industrial and transport hubs assuming a key part in the economic improvement of countries and districts whether in Malaysia or around the world. To arrive at this reason, some critical factors have contributed to the success of the Singapore Port in its port operation and efficiency. This can be seen as the port becoming the busiest and biggest port management around the world. In this modern era, people are inviting technologies so that all the industries are developing with their new and creative ideas.

Since the seaport industries are also moving towards Industrial Revolution 4.0 to achieve their success in managing seaport transportation activities such as trade in order to become successful seaport in their country. Yet, the factors that influence the critical success factors of the seaports are still questionable and how lengthy they are giving dependable information to improve and keep up with the productivity of ports activities. So, these means other factors also have been influencing the seaport success factors in becoming a world class port. In summary, apart from questioning the critical success factors of seaport, a comparative analysis study in analysing between Singapore Port and Port Klang.

## LITERATURE REVIEW

### Seaport's Operation and Efficiency

A nation's economic performance and conditions are used to gauge its stability and prosperity, and as a result, a variety of elements or industries may help boost a nation's income, or, to use another word, its GDP growth. The primary source of income for most developing countries is export, import, tax, FDI, currency exchange, and other factors affecting nations' GDPs. More precisely, the export and import forces involve the action of moving local or foreign items from one country's border to another. Usually, the transportation mode that would be used by most of the companies whether local or international companies are land, air and ocean as the medium of transportation.

Under conditions where according to the World Trade Organization (WTO) about 80 % of world trade is carried out by sea, an analysis of the relationship between the shares of countries in world trade and in container transportation shows that it tends to strengthen (Ilnytskyy et al., 2018). So, this can result that overall most of the economic development is based on the seaport trades as most of the activities are carried in the ocean. The reason that seaports become the biggest mode of transportation in the world is due to its price, which is very low compared to air transportation and effectively can travel all around the world.

### Issues and Challenges at the Port

There are many issues and challenges in operating a seaport. First of all, a rapid shift in tide levels can imprison vessels for days and possibly result in costly catastrophes.. By this, there is a huge possibility for seaports to incur heavy losses (Sennebogen, 2022). In order to avoid delays and accidents caused by these interruptions, port authorities should invest in equipment that enables them to foresee and precisely analyse water levels, current speed and direction, air temperature, and water salinity.

The second issue is that most industries are improving in terms of technology almost yearly, so if a seaport wants to remain efficient, governments should invest in deeper harbours, more jetties, wider entrances, and more hinterland areas. A modernised port will redefine the concept of 'economic gateway. A well-equipped port will make it possible to handle big ships and more cargo more quickly and efficiently (Sennebogen, 2022). Port developments will advance other firms and offshore industries since ports are growth engines.

The third issue is a problem faced by many ports for many years. Port congestion. It has been a huge problem for every seaport for years and it has increased nowadays with the new introduction of mega-ships. Mega-ships are larger compared to normal ships and take more space which will further increase the rate of congestion. Apart from that, large ships take more time to unload the cargoes which will increase the berth time (Sennebogen, 2022).

As a consequence of this, other ships have to wait in berth space even though they arrived on time, and this will affect vessel schedule integrity. To overcome these problems, the ports should be given more room to expand and operate more effectively. A streamlined method should also be developed by the terminal operators to ensure that containers are loaded and unloaded quickly and effectively (Sennebogen, 2022).

The fourth issue is environmental sustainability. Land use, water quality, and air quality can all be affected by port operations. To comply with national and international regulations, several ports are making investments in cleaner technologies and ecologically sustainable consumption. So, to cope with the situation, every port should start to implement Environmental Management Systems and Clean Air Programs regulations (EPA, 2022).

The fifth issue is the insufficient number of chassis. In most ports in the past, carriers provided the chassis for shipping containers. The quantity of chassis, however, decreased as most carriers auctioned off their remaining chassis. This resulted in a chassis problem that has been difficult to fix. Congestion and the chassis issue made it impossible for containers to move freely across international borders (Sennebogen, 2022). To overcome this problem, carriers should come forward to provide their own chassis for their shipments. Other than that, the ports should invent clever technology to make chassis service more convenient for the carriers.

**Theoretical Framework**

The theoretical framework that is pertinent to this study is depicted in Figure 1 in order to give a clear picture of the variables that have been chosen.

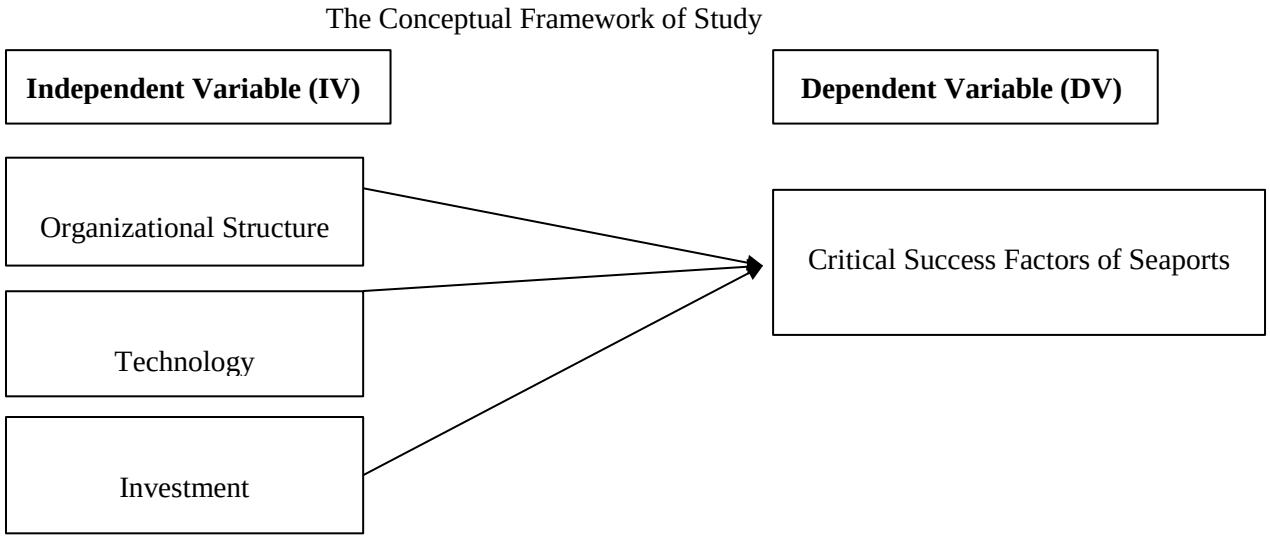


**Figure 1:** The theoretical Framework of Study

Figure 1 provides the basis for this study's identification of the key three indicators, namely organisational structure, technology and investment that has been chosen as the independent variable, whereas the critical success factors of seaport is chosen as the dependent variable.

## RESEARCH METHODOLOGY

The method used to gather the data is crucial to any research's ability to produce accurate results. There are typically two approaches to the method of collecting the data which are qualitative and quantitative. To explore natural phenomena, quantitative research methods were initially created in the natural sciences, and they are now widely used in social science investigations using survey methods, lab experiments, and numerical approaches like mathematical modelling (Myers ,2020)**.**

The value or level of different theoretical constructs is represented by numbers in quantitative research, and these values are seen as solid scientific proof of how a phenomena operates. Typically, researchers ask all participants the same questions in the same order in quantitative approaches like surveys and questionnaires, for instance.

Similarly, qualitative research methods were developed in social science to enable researchers to study social and cultural phenomena such as action research, case study research and

grounded theory which includes observation, interviews, questionnaires, documents and texts and the researcher's impressions and reactions (Myers, 2020).

The main purpose of qualitative research is to enable the researcher to perceive and comprehend the essence or substance of the choice or action that has been taken, which frequently aids in "explaining" why someone acted in a particular way, in order to achieve their objective with their reliable data.

**Sampling Method**

In the purpose of achieving the objective of this study, based on the purposeful sampling method, a collection of numbers of articles, newspapers and websites was collected regarding the study on the seaport operation at Singapore Port and Port Klang.

The collection of the articles, newspapers and website was first based on the differences in managing techniques involved in Singapore Port and Klang Port. Second, the differences of technology implication in both ports and followed by the investment that has been invested in both ports for their management. Last but not least, the differences of organisational structure by the both ports.

**Method of Analysis**

The method of analysis that is used in our study is Systematic Literature Review (SLR) method which has been frequently applied in psychology, medical and social sciences research for many decades to provide in-depth answers to specific questions, in support of practice and policy-making (Thomé et al., 2016)**.** Systematic Literature Review (SLR) is a scope of application that includes both research-related and non-research-related information.

The study has classified according to years and themes. The years that we used for our research to classify the differences between Singapore Port and Klang Port is from 2017 to 2022 which is five years in differences. The themes in finding the differences of Singapore Port and Klang Port that we have obtained during our research process was the differences in the usage of technology implication in both ports, the number of investments and the differences in the

organisational structure. In the following, we have obtained the relationship between the differences of the success of Singapore Port compared to Port Klang.

## ANALYSIS AND FINDINGS

### Critical Success Factors that Influence Singapore Port in Its Advancement Compared to Port Klang

The purpose of this study is to analyse and compare the findings gathered from various sources such as articles, newspapers, theses, websites, books, and other secondary data about Port Klang and Singapore Port. Through the reviews from chapter two which is the literature review, the main three critical success factors that help the advancement of Singapore Port are organisation structure, technology, and investment. Compare these three factors of both ports and analyse the differences to help Port Klang to achieve the same efficiency level as Singapore Port and sort out the challenges that Port Klang will face in its advancement.

### Technology

**Table 1:** The technology implication at Singapore Port and Port Klang

| Port Singapore | Port Klang |
|---|---|
| Vessel Traffic System (Zhang et al., 2019) | Vessel Traffic System (Zhang et al., 2019) |
| Automatic Identification System (Nofandi et al., 2022) | Automatic Identification System (Nofandi et al., 2022) |
| Radio Frequency Identification (RFID) (Czachorowski | Radio Frequency Identification (RFID) (Czachorowski et |
| Automated Guided Vehicle (AGV) (Robotics 24/7 Staff, | Roll On-Roll Off (RO-RO) (Zakaria et al., 2022) |
| 5th Generation Port (SMART PORT) (Kaliszewski, | Custom Identification System (CIS) (Perumal et al., 2020) |
| 5G Technology (Weeks,K et al..2016) | Fast Track Technology (Skender et al., 2020) |
| PORTNET Technology (D'Amico et al., 2021) | Digital Sharing Platform (Skender et al., 2020) |
| Flow-Through Gate (D'Amico et al., 2021) | |
| Blockchain Technology (Czachorowski et al., 2018) | |
| Drones (Bruno, 2022) | |
| Automated Terminal Technology (The Editorial Team, | |
| Location Detection Technology (Skender et al., 2020) | |

There are similar technologies that have been implemented for Singapore Port and Port Klang. First, the vessel traffic system (VTS) that is used at the terminal based on the system serves to provide reports on navigational and meteorological information for ships passing through certain waters (Nofandi et al. 2022).

The Automatic Identification System (ATS) that communicates the identification of the ship and its location to shore stations. Ships will be tracked and observed by ships, and data will be sent with the VTS Authority. In addition, the Automatic Identification System (ATS) will also provide a hidden hazard warning to the VTS authority for the safety management of the ships.

The uses of Radio Frequency Identification (RFID) that would assist ports and terminals in increasing productivity, security, and asset utilisation. RFID technology is a tool for communication purposes that is widely used in the terminals and warehouse operation efficiency.

As a comparative analysis, Singapore Port compared to Port Klang in terms of technology usage is first, Automated Guided Vehicles (AGV) has been used in Singapore Port compared to Port Klang where it uses Roll On- Roll Off (RO-RO). The differences between both technologies are the amount of carriage and the weight carried by the automatic robots.

Singapore Port management has implied 5$^{th}$ Generation Port Technologies which is also known as Smart Port compared to Port Klang uses Custom Identification System (CIS). The differences on the both technologies are Singapore Port uses on digitalization perceptive and advance compared to Port Klang.

Singapore Port has implied 5G technologies for an effective and efficient operation management in ports compared to Port Klang where it uses Fast Track technology. Both technologies use smart phone implication but the difference that is obtained is in the speed of the data travelling and receiving where Singapore Port is advanced compared to Port Klang. Last but not least, in Singapore Port PORTNET technology has been used as the communication with the authority of the Port of Singapore for an effective communication purpose compared to Port Klang a Digital Sharing platform is used.

In another comparative analysis of Singapore Port and Port Klang, Singapore Port has implied more advanced technologies in their port operation that are unavailable in Port Klang. First, Singapore Port has implied Flow-Through Gate technology, a completely automated system that recognizes container trucks and provides directions to drivers in under a minute. It manages an average traffic flow of 8,000 trucks per day and 700 trucks at peak hours. Then, Blockchain Technology which consists of Big Data, Artificial Intelligence and Internet of Things (IoT).

Furthermore, the use of drones in Singapore Port is wisely for the purpose of delivering the goods fast and reducing the emission. In addition, Automated Terminal Technology which helps the reduction of the traffic congestion problems of the vessels that arrive in the Singapore Port. Finally, Location Detection Technology which involves sensors and techniques for determining a person's, a mobile device's, or any moving object's geographic location of the ships is used by the Singapore Port. In order to improve the gathering, processing, monitoring, analysis, and evaluation of social, economic, environmental, and technological flows, Singapore Port implements the technologies for sustainable logistics initiatives with the assistance of technology firms like Cisco, IBM, SAP, Ericsson, and Huawei. (D'mico et al., 2021)

**Investment at the Port**

**Table 2:** The comparative analysis of Singapore Port and Port Klang

| PORT SINGAPORE | PORT KLANG |
|---|---|
| Investment in Zero-Carbon Shipping together with Port of Rotterdam (Ley & Castelein, 2022). | RM 2.3 million in financial incentives by PKA to enhance productivity and trade (MIDA, 2020). |
| $20 million in investments from industry players by 2024 (Fabian Koh, 2021). | Cargill invests US$20 million to expand and modernize the palm oil facility in Port Klang (Malaysian Investment Development Authority, 2020). |
| $36 million to invest in maritime startups (Liang, 2020). | |
| Issued new incentives for Singapore-flagged ships that undertake decarbonization efforts (Medina, 2022). | |
| $20.6 billion investment in building a fully automated container port (Financial Review, 2021). | |
| S$3.5 billion redevelopments at the Pasir Panjang terminal (Ship Technology, 2020). | |

The table displays the investments that have recently taken place at Port Klang and Singapore Port. There are more investments in Singapore Port than in Port Klang. The Singapore Port

Authority and the Port of Rotterdam have already begun to invest in green shipping. This type of investment will boost Singapore Port's international reputation in addition to moving the maritime sector toward a cleaner environment. Singapore Port Authority has allocated $36 million for marine startups (Liang, 2020), encouraging them to engage in international trade and elevating the port's reputation.

With new businesses entering the marine industry, the port's reputation will be enhanced in addition to the volume of exports and imports rising. Issuing new incentives for Singapore-flagged ships that undertake decarbonization efforts is also a step toward green shipping which will improve the Singapore Port's prestige in international transactions. With phase 1 of a four-phase operation starting this year, the investment in a fully automated container port is already beginning to pay off. Since no one has ever invested in a completely automated container port, it is dangerous, yet Singapore was successful in making this viable.

As a result, Singapore Port Authority established itself as a leader in the development of fully automated container ports. Along with investing in new sectors, Singapore Port also spent 3.5 billion SGD renovating Pasir Panjang Terminal to stay up with modern business trends. The Port Klang Authority invested RM 2.3 million to increase commerce and productivity at the port. In addition, Port Klang received $20 million from Cargill to upgrade and expand the palm oil factory.

By comparing the amount of money invested in the two ports, it is evident that Singapore Port receives far more investment than Port Klang. Singapore Port is already making investments at the worldwide level to boost its reputation in the sector, whereas Port Klang Authority is investing in the port itself to raise its efficiency. Any subject or industry constantly benefits from investments, therefore a lack of investment unquestionably slows the path of progress.

**Organisational Structure**

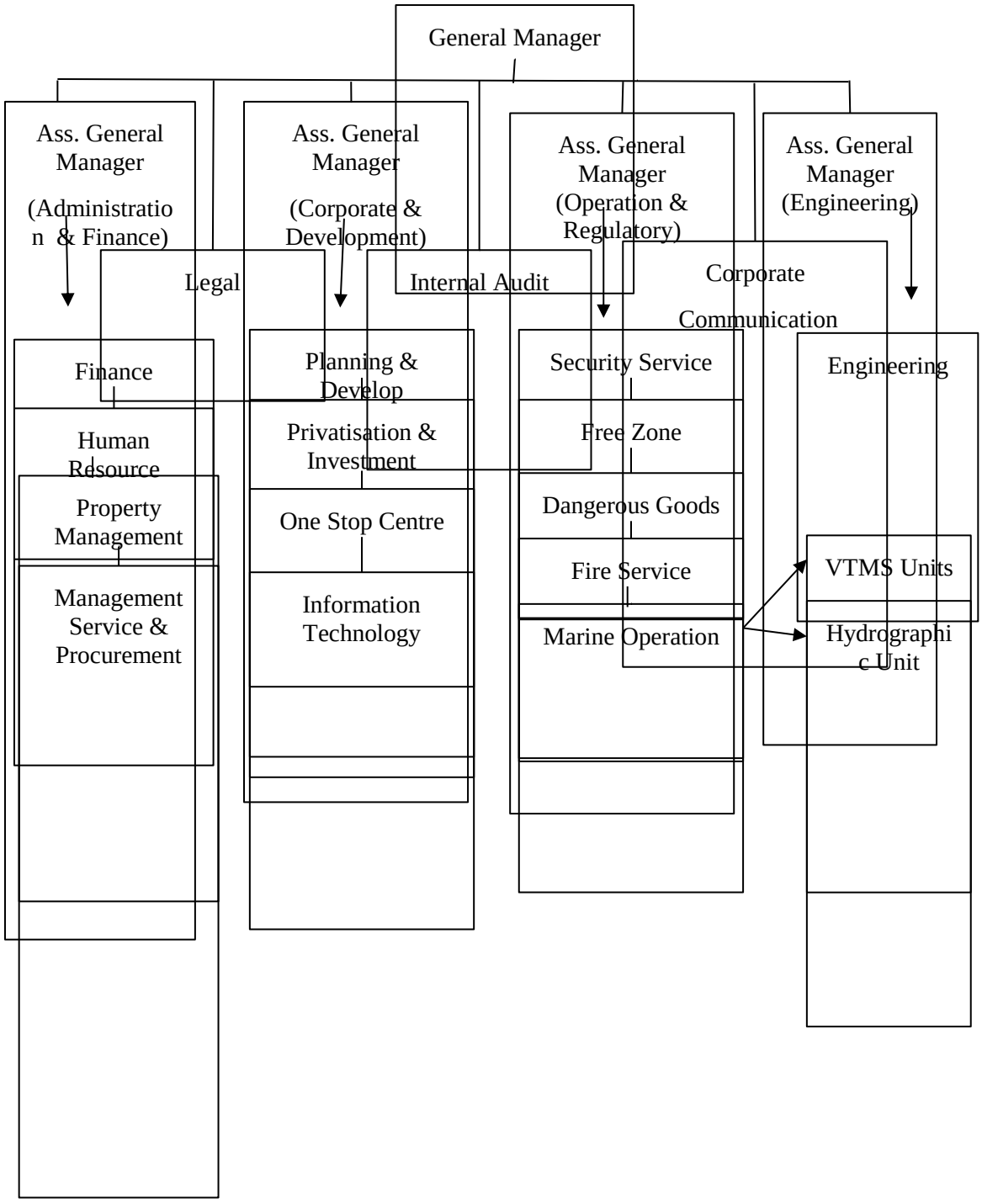


**Figure 2**: The Organisational Chart of Port of Klang

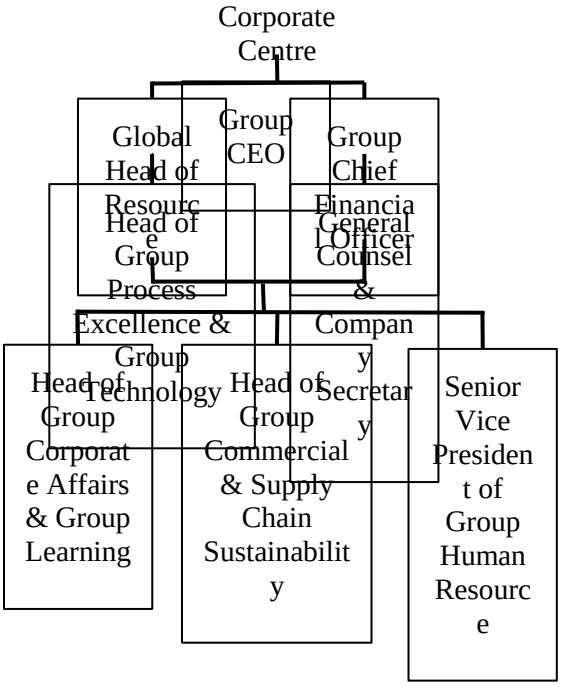


**Figure 3:** The Organisation Chart of Port of Singapore- Corporate Centre

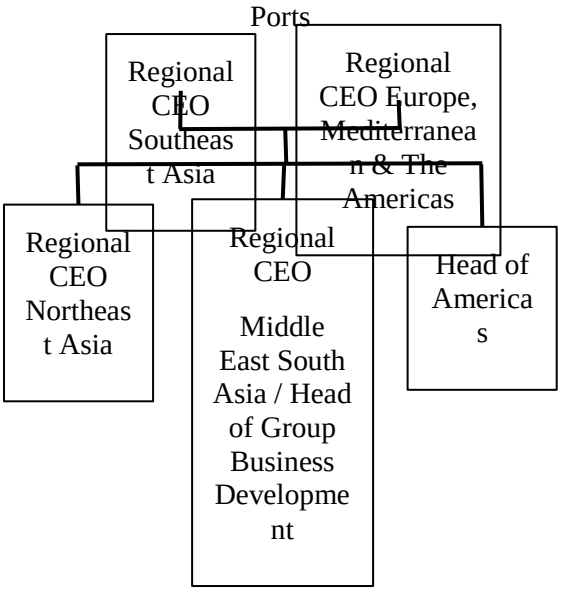


**Figure 4 :** The Organisation Chart of Port of Singapore- Ports

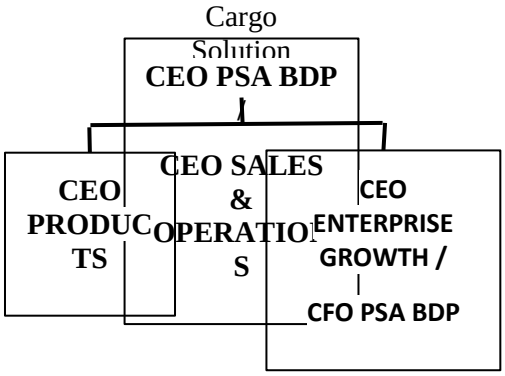


**Figure 5 :** The Organisation Chart of Port of Singapore- Cargo Solution

**Table 3 :** The comparative analysis between Singapore Port and Port Klang

| **PORT SINGAPORE** | **PORT KLANG** |
|---|---|
| Consist of 16 members | Consist of 22 members |
| Consist of three division | Consist of one division |
| Low Expenses | High Expenses |

In a comparative analysis between Singapore Port and Port Klang on organisational structure, Port Singapore is a more effective and profit making port compared to Port Klang. This is because the members that are involved in Port Singapore are 16 members compared to Port Klang were 22 members which is a huge number. Secondly, Port Singapore consists of three divisions such as the corporate centre, ports and cargo solution for the management of the port whereas, Port Klang consists of one division.

So, this helps the Port Singapore port to be more effective and manageable as this requires less work load. Other than that, it's easy and convenient to give and receive commands from superiors since the management team is divided into different divisions. Lastly, Port Singapore has low expenses compared to Port Klang due the number of members in Port Singapore is less. So, the salary which is the common expenses for the port authority for Port Singapore is less compared to Port Klang.

**Comparative SWOT Analysis**

In terms of strength, Singapore Port has several sectors where they are excelled in. First of all, they have a huge geographical advantage compared to other ports. Singapore's advantageous geographic location at the intersection of significant trade routes and its preeminence as a global hub port helps it achieve a huge victory in the maritime field. Secondly, it's a world-famous free port. Singapore Port has an undeniable financial advantage compared to Port Klang. We can see this problem in 4.1.3 Investment at the Port, where Singapore Port has already started to invest internationally to establish its prestige whereas Port Klang is still investing in itself to improve its performance.

Thirdly, in terms of technology, Singapore Port has already moved to another stage compared with Port Klang. As they already built a fully automated container port, Port Klang still uses RO-RO and RFID in their daily port activities. As for Port Klang's strength, it has a strong customer base. For example, Malaysia is one of the top palm oil manufacturers in the world, so the transactions have to go through Port Klang. Other than that, Port Klang is also strategically placed the same as Singapore Port, which indirectly increases their transaction. Furthermore, it encourages more local and international investors. Although it can't receive the same amount of investment as Singapore Port, it still upgrades its facilities.

In terms of weakness, Singapore Port doesn't have a significant economic hinterland for sustainability. It's a huge disadvantage that Singapore Port has because Singapore is considered as a small country with limited space for huge constructions compared to Malaysia. So, they have many limitations when it comes to huge construction because they have to utilise each and every inch of the land effectively to maximise its usage. Secondly, a huge amount of investment has been injected into this field so Singapore Port will take a long time to recover the capital they invested. Although investing long-term is a usual occurrence, investing highly in one field limits the growth of other sectors.

Thirdly, investing huge amounts of money will come with high-interest rates which will make things harder for foreign investors to invest in Singapore Port. Foreign investors have to invest a huge amount of money if they want to invest in Singapore Port compared to Port Klang. As for Port Klang, it's in shortage of local professionals in port management and building.

A good management team is an important factor in the success of a port's advancement. Singapore Port advanced compared to Port Klang because they have a better management team in possession which made several crucial investments at the correct time and ended up in profit. Secondly, the lack of responsibility in upgrading types of equipment and service. For example, unlike Port Klang, which employs roll-on-roll-off (RO-RO) transportation, the Singapore Port uses automated guided vehicles (AGV).

As the quantity of carriage and weight carried by the automated robots varied between the two methods. Singapore Port can be considered an advanced level port internationally with the development of a fully automated container port while Port Klang is lacking when compared to it. Thirdly, Port Klang lacks safety and technology equipment. Singapore Port is already starting to use drones in their warehouse whereas Port Klang is still using humans to manually organise the items in their warehouse. There are possibilities for accidents to occur in warehouses, so using drones in the warehouse process certainly can reduce the rate of accidents happening.

In terms of opportunity, Singapore Port has rising prospects for port operations from rising nations. Due to its prestige which has been rising in recent days with the initiative of green shipping and fully automated container port many rising countries are looking forward to working together with Singapore Port. Secondly, global trade is increasing as a result of loosened trade restrictions and more bilateral agreements. Singapore Port makes more allies such as the Port of Rotterdam which enables them to connect to other countries and increase their maritime circle. So, when other allies wanted to do business in Asia, their first choice would be Singapore Port since it's their ally and has good prestige in the international maritime circle.

This kind of partnership will enlarge the maritime circle of Singapore Port and help them reach a further reach in the maritime business. As for Port Klang, Malaysia is a top palm oil distributor in the world, so it will be the first choice for international trade. Apart from that, it can increase the name of the Port by having Singapore port nearer to Malaysia. The number of transactions will increase in Port Klang automatically since Singapore Port is already increasing its prestige in the international maritime circle and attracting many countries to conduct business with them.

In terms of threats, Singapore Port should be concerned that Fully Automated Container Port investment doesn't reach the expected efficiency level. Singapore Port has invested a huge amount of money in this project. Since this is the first time building a fully automated container port no one predicted its level of efficiency. So the automated port can become a failed investment. Secondly, every port will have this problem which is port congestion. Since Singapore Port is already increasing its prestige internationally, the number of ships also will increase which will end in port congestion without proper management. Port congestion will increase the dissatisfaction of customers which affects its prestige.

Thirdly, Singapore is a small country compared to Malaysia and China, so there is only limited space for expansion. Since PSA is continuously enlarging its ports, there will come a time when it will not have sufficient space for other government projects. As for Port Klang, there is a huge possibility for it to fall back in rankings due to a lack of technology. Many new systems and technologies are being invented nowadays that increase the level of efficiency of the port. Since Port Klang is already lacking behind compared to Singapore Port, other countries who are closely following Singapore Port also will overtake Port Klang in the following years if they remain at the same stage without any new technological implantation. Other than that, the emergence of new high-tech ports such as Tuas Port will attract Port Klang's customers.

## CHALLENGES

### Adaptation towards the Technology in Port

Technology is an important aspect of port development and the new technology adoption towards the port can cause some challenges to port development. First, the incompatible system as Port Klang uses mostly manual handling compared to Singapore port where the port uses mostly automatic handling system. This is because the port is a significantly large area and infrastructure which consists of a large number of investment and technology implications for its development and effective service. This causes IoT integration into the port infrastructure to be incremental and changeable (Brunila et al., 2021). IoT technology offers customizable solutions that can employ AI to reach optimal performance, which is its main advantage. Machine-to-machine communication and autonomous automated activities are essential to reaping the efficiency gains of digitalization.

Secondly, resources and a new management and storage viewpoint are needed because of digitalization. This is because the topic of information storage and warehousing in ports is sometimes confusing. Particularly in small ports, the whole information management can be

handled/operated only by one person, and/or information resources are not coordinated and thus may be scattered in several databases (Brunila et al., 2021).

So, this is because the implementation of IoT in Port Klang is important to become a digitalization port management. Additionally, the digitalization of ports creates new security risks. For instance, the volume, calibre, and sensitivity of data transmitted to digital formats include hazards to information security as well as other cybersecurity-related threats. Among the problematic components are the obligations of cloud service providers, the dependability of cloud service delivery, and intellectual property rights and copyright agreements. Finally, the technical expertise in managing the technology would be difficult to find as it requires more skills in managing.

**Adaption of New Organisational Structure**

In the adaptation of a new organisational structure compared to the current organisational structure, there would be a huge change in the organisational structure. First, the number of the organisation which consists of 22 members should be reduced to reduce the expenses such as salary for the employees, and make the organisational structure to be compact and effective in managing the port and increasing the revenue of the port.

In addition, the port authorities received regulatory powers, but at the same time, their status as state-owned enterprises (SOE) pushed them to become more market-oriented, for instance in terms of investment decisions (Notteboom & Yang, 2017). So, the changes in the organisational structure would help the growth of ports and terminals was constrained prior to the opening-up policy.

**Huge Amount of Investment**

Investment is an important perceptive for the development of the ports. Port investments consist of direct and indirect investments which the objective is to develop the port infrastructure and better management. So, in order for Port Klang to get investment, Port Klang authorities should find and create strategic alliance partners to get more investments. Furthermore, they should also find more foreign direct investments.

**Port Congestion**

An important challenge that Port Klang will face in its advancement is port congestion. Port congestion indicates that when ships arrive at the port, the terminal is already full, making it impossible to load or unload. Therefore, they have no choice except to wait in line for a slot at the port. So, in order to avoid that challenge Port Klang should enlarge or build more terminals and warehouses to store the goods and receive more ships to their port.

**Environmental Sustainability**

The industrial revolution gave rise to powerful new technologies. This was the transition to new industrial practices that took place between about 1760 and 1840 in Europe and the United States. Following this, industrialised nations throughout the world experienced an increase in industrialization and technological breakthroughs, which had an adverse effect on the environment by overusing and destroying our planet's natural resources. The two primary ways that these technologies have harmed our planet are through pollution and the loss of natural resources (Environmental Expert, 2019). So, Port Klang will also face this problem when it comes to implanting new technologies. To overcome it, PKA has to implant eco-free technologies as much as possible.

## CONCLUSION

In a nutshell, as previously stated seaport plays a major role in the growth of the GDP of the nation as most of the economic activities involve seaport trade. So, Port Klang should use Singapore Port as an example to develop their port. Furthermore, as highlighted throughout the research project, where the critical success factors of seaport are depending on the technology, investment and organisational structure. So, this causes the Singapore Port to be more advanced compared to Port Klang.

However, Port Klang can upgrade their port by studying the advancement of the Singapore Port. First, Port Klang should study the usage of Singapore Port technology usage as nowadays technology influences the growth of the many industries especially seaports. Secondly, the organisational structure of Singapore Port should make an example by the Port Klang as to make the communication linear among the port authority. Furthermore, Port Klang should find more investors to increase the funding at the port.

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# FREE TRADE ZONE: ISSUES AND CHALLENGES ON EMPLOYMENT OPPORTUNITY FOR YOUNG GRADUATES

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## Abstract
A free-trade zone (FTZ) is popularly defined as a class of special economic zone. The allocated geographic area is where goods may be imported, stored, handled, manufactured, or reconfigured and re-exported under specific customs rules, regulation and generally not subject to customs duty. The main objective of this study is to analyze issues and challenges on employment opportunities for young graduates at the Free Trade Zone located in northern Malaysia. Since there are many companies operating in FTZ, the development and urbanization of it would be able to provide a lot of opportunities that need further exploration. Secondly, this study would like to investigate the potential characteristics and skills needed by young graduates. This is important for them to secure a job, and to access the ways for them to capitalize themselves for industry operating in the Free Trade Zone (FTZ). Qualitative research methodology will be employed in this study. Respondents involved are companies operating in FTZ who are going to be the future potential employer for the young graduates. Findings indicated that companies operating in FTZ, highlighted the challenges and issues faced by them. These needs to be addressed accordingly in order for them to be sustainable. The study also elaborates on the skills and required elements for young graduates in making them more marketable for industries in the Free Trade Zone area. Future research may look into strategies to equip young graduates for securing jobs in the FTZ area. The challenges and issues in FTZ should be looked at from the positive sides and benefits of it rather than the negative ones.
**Keywords:** Free Trade zone (FTZ), issues, challenges, employment opportunity, young graduates.

The Chief Statistician, Datuk Seri Mohd Uzir Mahidin, stated in Berita Harian that when unemployment statistics reduce, it indicates that employment opportunities are developing. This free trade zone is well recognized to be one of the government's measures to rebuild the national economy during the coronavirus season.

The National Recovery Plan (NRP) allows most economic and social sectors to re-open full operation. At the same time, most industries create a lot of job opportunities, which is beneficial for the free trade area (Nesadurai, 1991).

A Free Trade Zone (FTZ) is an area supervised under the Minister of Finance that carries out industrial and commercial business. FTZ are under the Free Zone Act of 1990 and this act was passed on 23 April 1990, and was gazetted on 10 May 1990 (Natlex, 2014).

There are two types of FTZs which are Free Industrial Zone (FIZ) and Free Commercial Zone (FCZ). An FIZ is a business that produces goods for export activities, while a FCZ is a manufacturing area. In Malaysia, there are two popular industrial zones under the FIZ. The Bayan Lepas FIZ is Malaysia's first and is popular with high-tech manufacturing enterprises. Pasir Gudang Free Industrial Zone focuses on logistics, shipbuilding, transportation, heavy industries, and petrochemicals (Justin & Fatt, 2021).

Malaysia's Free Commercial Zones (FCZ) are governed by the same act as the Free Investment Zone (FIZ). FCZs are mainly located near international ports, making it easier to transfer commodities.

The Port Klang area acts as the main hub for commodities transportation via land, sea, and port. The Digital Free Trade Zone (DFTZ) is the third type of free trade zone that was established in partnership by Jack Ma, the former executive chairman of the Alibaba Group (Leong, 2017).

The purpose of DFTZ's existence is to advance trade in Malaysia to the international level through digitization.
Several agencies are involved in ensuring that this Free Trade Zone keeps growing. The aim of MITI in this FIZ is to make it more convenient for a company to establish a business in the area. Aside from intensive and tax benefits, there are also storage and repackaging facilities provided.

Every year there will be an increase in graduation for every university in Malaysia. Statement in Berita Harian showed that in 2017, there were 4.61 million students who graduated and increased to 4.96 million in 2018.

This will continue to increase to 5.36 million people in 2020 and increase also in 2021. The unemployment that occurs in young graduates is caused by various aspects. A country with low unemployment will be said to have good growth, but high unemployment will cause problems for the country due to waste and not utilizing human resources. Graduates who have completed their studies have less skills in terms of various skills, especially communication and leadership skills.

The dumping of young graduates is the result of unemployment which has increased due to the increase of graduates every year and the occurrence of job losses. This dumping of graduates is becoming more and more worrying in the country because young graduates are forced to become unemployed and look for jobs outside their field of study.

There are four objectives that need to be achieved for this research. To begin, the objectives are as follows with to determine the issues in the Free Trade Zone (FTZ) area, to evaluate any challenges in the Free Trade Zone (FTZ) area, to investigate the potential characteristics needed by young graduates to get a job and to access the ways young graduates capitalize into the free trade zone industry.

## LITERATURE REVIEW

### Free Trade Zone

Accordingly, Muzwardi (2007), FTZ is a natural area that includes buildings, services and infrastructure, in addition there is an administrative organization that helps businesses there involving foreign and domestic businesses. Muzwardi has classified FTZ into three types namely private, public and a mixture of both. Public FTZ investors can rent land from the government which is much cheaper and gives investors an advantage where they can avoid being tied to fixed capital such as buildings, infrastructure and construction.

This FTZ is considered to do business with more freedom due to its unique free trade status. This is unique in that it gets exemptions from taxes and customs and can create a more flexible policy for the export and import processes by Bost (2011). FTZ was created so that the workers could be paid wages. It was established to be able to control the social and destroy the environment. (De Bremond, 1993).

The latter is used in asserting the sovereignty of a country, oppressing the organization of labor and political parties, destroying self-sufficiency in food and basic goods and finally widening the gap between rich and poor according to Hall (1986).

### Young Graduates

According to UNESCO (2016), persons who are under the age of 30 are considered to be part of the "youth" category. Youth are those people who are between the ages of 15 and 24. The author's research indicates that a "young graduate" is a person who has completed their university education, graduated with the honorary title of "alumni," and is still under 35 at the time of their graduation.

Krishnan and Sethuramalingam's research (2017) defines a "youth" as a person who is still living. The most recent viewpoint that the general public is willing to acknowledge is that an individual is still in the stage of life that falls between childhood and maturity. It is possible to

draw the conclusion that this young person is an individual who has not yet achieved the level of maturity or maturity.

**Employment Opportunities**

Winoto (2019) states that employment opportunities can be defined as positions that are open or opportunities for employment that emerge from economic activity. It refers to recruitment, relocation, promotion, training, and non-disciplinary retention as well as in any restructuring or layoff.

It doesn't necessarily entail the development of a job or specialized training that isn't already available to other employees Puspanita, Militina and Effendi (2020) found that employment opportunities can be defined in a number of different ways, depending on how they are defined. The proportion of the labor force that is employed relative to the number of people seeking for employment is also defined as employment opportunity.

Furthermore, employment opportunities also can be said as a chance made available by specific economic development in the sense of potential job openings that may have gone unmet or filled. Esmara (1986) offers the concept of employment opportunities as the number of people who work or have obtained a job.

It is anticipated that the introduction of employment prospects or broad employment will be able to absorb labour, generating money for the working population. Sukirno (2000) found that all workers who desire to work at a particular salary level will readily seek jobs.

**Issues**

According Hainsworth and Meng (1988) stated that an issue can appear when a consequence for some actions that are done or proposed to be done, by one or several parties that can result in negotiations and adjustment of the public sector, court or criminal cases or become a problem through legislative actions or legislation. issues from another point of view, issues are described as a problem that has not been solved to make the right decision "an unsettled matter which is ready for decision" according to Chase & Jones.

Other experts such as Regester & Larkin (2003) say that in its basic form, an "issue" may mean a point of conflict between an organization and one or more audiences ('a point of conflict between an organization and one or more of its audiences'). to Heath & Nelson (1986) states that an issue is ('a contestable question of fact, value or policy') which means a question regarding wisdom, value and fact that can be debated.

Regester & Larkin 2003 also said issues can arise in terms of circumstances, events and can occur from inside or outside the organization when left will have a more significant impact on the function and way of working in the organization and cooperation with the organization in the future.

**Challenges**

Ormrod (2008) argues that the challenge in his research is the extent to which anything succeeds in reaching the desired aim by expending effort. Church et al., (2022) characterized this task as a representation of the difficult side, the delight in striving to acquire objective outcomes. This challenge was a depiction of the hard side of trying to obtain objective results. When one allows their feelings to direct their actions, they have entered what is known as the joy zone.

Following Kringelbach (2009) stated the challenges are when a person is confronted with challenges, they tend to prioritize gratifying their need for pleasure since pleasure is experienced at a high level.

According to Davis-Kean (2005), a challenge is anything that includes a test of strength, skill, ability, or skill in the accomplishment of a task in the best possible manner. This challenge may refer to anything that falls into this category.

As stated in the most current publication from Calikoglu (2019), a challenge is something that a human must triumph over in order to achieve something new and tough yet doing so requires a substantial amount of work and dedication on the part of the individual

The framework of this study are shown as below:

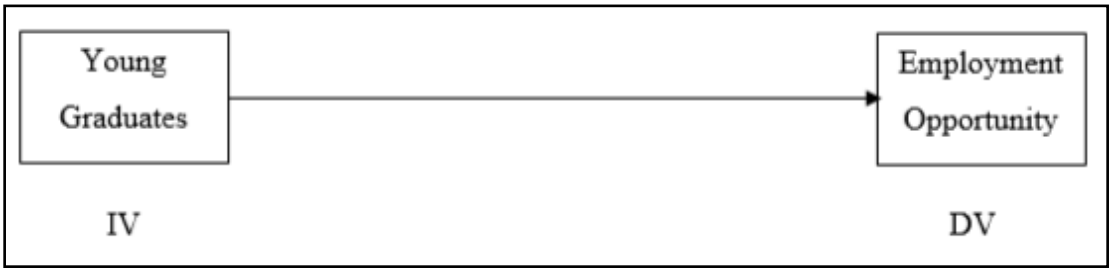


**Figure 1:** Theoretical Framework

## RESEARCH METHODOLOGY

In order to evaluate issues and challenges on employment opportunities in the Free Trade Zone area, an adoption of a specific method to achieve the study objectives was reviewed. In this research, researchers are using qualitative methods to analyze issues and challenges on employment opportunities in the Free Trade Zone area.

This approach is used to collect data or information, with the researcher conducting interviews with many firms that fall within the subject of our investigation. Each interview question chosen is intended to address the present research objectives.

The research took place for over 10 weeks, from October to January. A cross-sectional study in which numerous respondents were subjected to the research methodology at once. Similar to what researchers performed in research, thE interview was conducted starting from the end of November 2022 till the end of December 2022. The interview was only scheduled for a day only due to the time limitation.

The population of this study includes all companies that are located in the Bayan Lepas where the company is in the Free Trade Zone northern area. The sample used to conduct this study was 10 companies located in the Bayan Lepas free trade zone area consisting of various phases. The unit of analysis for this study is a company basis, where it focuses more on the company in terms of management that involves the Free Trade Zone.

Primary data are the main concern in this study where it can be gathered through video conference using google meet. As a result, all questions were answered via google meet during

the interview session. In addition, this study also employed secondary data. It was gathered from the other primary sources. These secondary data shall be obtained from public documents, books, journals, newspapers, websites, and other internet resources.

## RESULTS AND DISCUSSION

### Research Framework

Project research is carefully organized and planned so that the researcher can ensure that all the steps that need to be taken can be carried out well throughout the course of this study. Distribution of tasks consists of several stages that begin with the selection of an appropriate title, identify the problem statement, define the background and purpose of the research and end with a proposal for the study to next.

The research framework, consisting of the researchers' workflow, is outlined below:

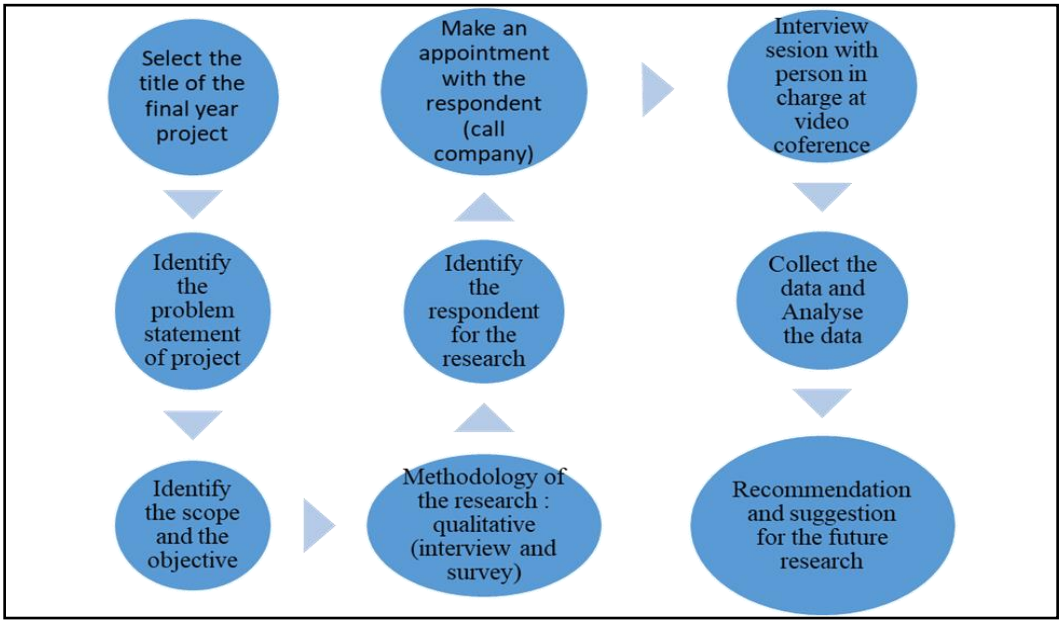


**Figure 2:** Research Framework

### Flow of the interview

The flow process of interviews with respondents to conduct this study will be shown as follows.

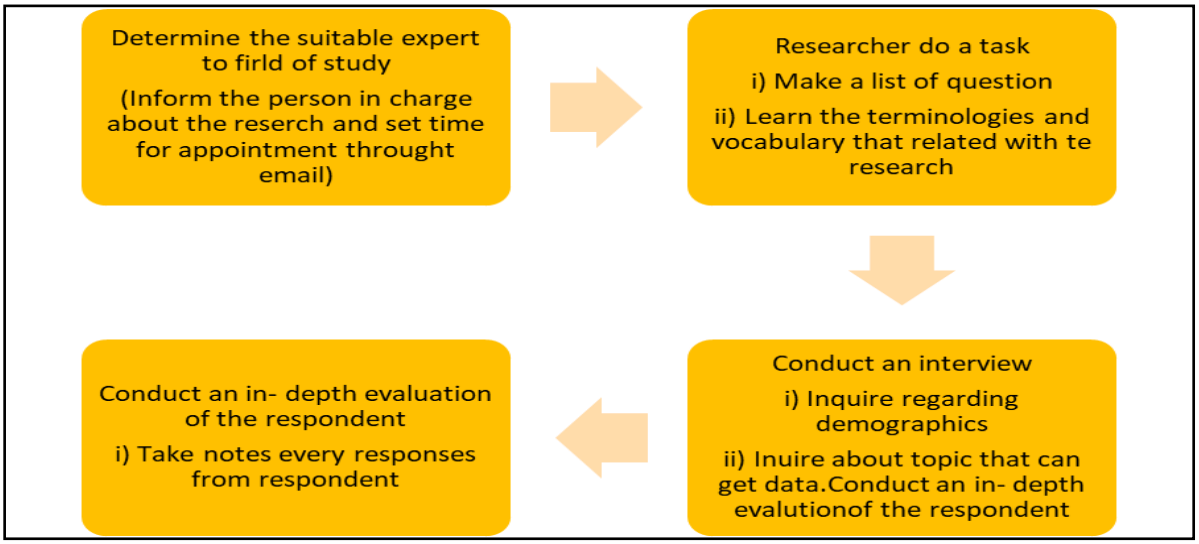


**Figure 3:** Interview Flow

**Overview of the data analysis**

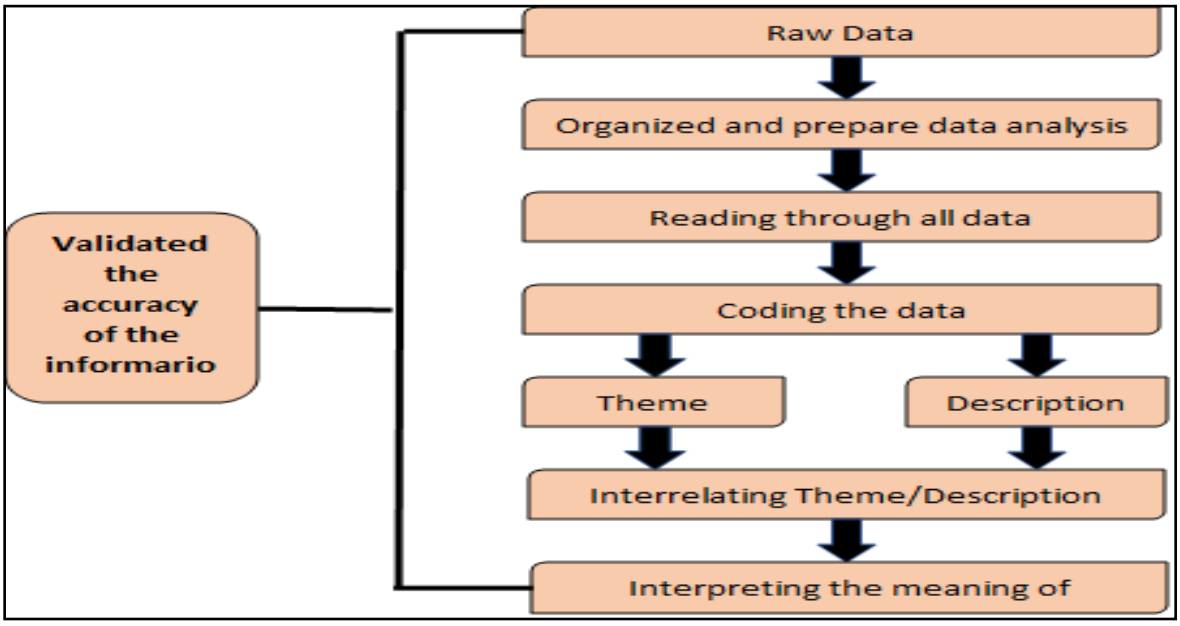


**Figure 4:** Overview of Analysis Data

Interviews conducted over the phone and via video conferencing were the preferred method by which the researcher acquired data for this research. Before the analysis can be conducted, it must first be subjectively appraised through a number of different stages.

**Findings from the interview**

The results show that there are only 3 companies that the researcher can interview to conduct this research. In this section, the researcher explains about the company and also the person in charge that has been interviewed at the time and date that has been set.

The first company that became researcher respondent to conduct this study was Globetronic Industries Sdn.Bhd together with Ms Shirin Tan, Human Resources Officer who has worked in the company after the company has been operating for 31 years. Ms Shirin Tan is the person who supports the development and implementation of human resources initiatives and systems and her task is to optimize what is posted on online job boards or career pages that are easily adapted for Globetronic Industries Sdn. Bhd. This interview was done by video conference using google meet that was created by the researcher. As a result, all questions related to this study were answered via google meet on December 21, 2022.

The second company that has been a respondent for this research interview is Miss Siew Wun Cheah who holds the position of Executive of Human Resources Department at Guh Holdings Bhd. Ms Siew Wun Cheah is responsible for supervising and coordinating all activities in the Human Resources Department to ensure consistency with the objectives and mission of the department and the company Guh Holdings Bhd. The interview was conducted via google meet on 21 December 2022 and Ms Siew Wun Cheah answered all the researcher's questions well.

Lastly, an interview was conducted by the researcher with Mr Mohammed Anwar bin Rahaman Saar, who is the Country Human Resources Lead of Motorola Solutions Malaysia Sdn Bhd. The interview was conducted using google meet on 22 December 2022. Mr Mohammed Anwar's responsibility is to monitor and organize actions or any activities from Human Resources and is responsible for the planning and development of Human Resources. The researcher has obtained a lot of information from all the questions that were raised during the interview session with Mr. Mohammed Anwar and Mr. Mohammed Anwar answered thoroughly and well.

The feedback from respondents received through interviews conducted by the researcher for companies located in the free trade zone based on all the objectives of the researcher's study have been shown in this section below.

| **Objective 1**<br>To determine the issues in the Free Trade Zone (FTZ) area. |
|---|
| **Findings**<br>1. Faced heavy traffic in phase 4 to phase 3.<br>2. The competitive employment benefits from multinational companies and then brand recognition like engineering students.<br>3. Due to pandemic and it induced lockdown, restriction in the movement impacted generally the business environment, production, business plan is disrupted and declined the economic growth. |

**Table 1:** Findings for Objective 1

| **Objective 2**<br>To evaluate any challenges in the Free Trade Zone (FTZ) area. |
|---|
| **Findings** |

| |
|---|
| 1. Looking for a potential candidate based on the budget given by the company due to the economy of the country having a crisis.<br>2. The custom is regulated because of the free trade zone so we must declare custom, and custom must be checked.<br>3. Companies facing a lot of job hopping by employees. People do not move much because of the pandemic but now people are changing jobs. |

**Table 2:** Findings for Objective 2

| **Objective 3** |
|---|
| To investigate the potential characteristics needed by young graduates to get a job. |
| **Findings** |
| 1. The graduates have the enthusiasm, hardworking, independent working with us being a sub-con company local base are not easy to maintain during an economic crisis.<br>2. Someone willing to learn, who is humble to others and elders. Look people who has initiative who open to take back, positive mind set, look to go extra marks like do what the given at the same time add on value also open to sharing knowledge about the job their getting and then someone has done their homework before interview or join company. Someone who has their stable. The attitude is very important.<br>3. Students need to be able to communicate in English. The student must have IT skills so needs to know some analytical tools. Undergraduates must be independent, able to do time planning and work prioritization, improve efficiency, and must be able to do some simple planning of work. |

**Table 3:** Findings for Objective 3

| **Objective 4** |
| --- |
| To access the ways young graduates, capitalize into the free trade zone industry. |
| **Findings**<br>1. Arranged the young graduates to undergo training.<br>2. Young graduates need to be proactive, get to know the people in the company, try to build connections and also build up their communication skills, some who are able to speak up. Somebody who is willing to do the teamwork. Try to be an organized person and capitalize their own strength.<br>3. Young graduates need to go to an internship program (practical training) and for students who do not have an internship, go to part time during semester break. students need to learn to organize functions, present papers and do problem solving analysis. |

**Table 4:** Findings for Objective 4

## Data Interpretation

The researcher used recording to collect data while conducting interview sessions. Medelyan, 2021 stated the method of organizing and analyzing data which also serves as a labeling mechanism is the definition for coding.

The coding approach is being used to interpret the data collected in this research. Each transcript was recorded by the researcher using the transcription, page, and line as a reference. The list of category evidence that contains the coding structure's central theme is displayed below:

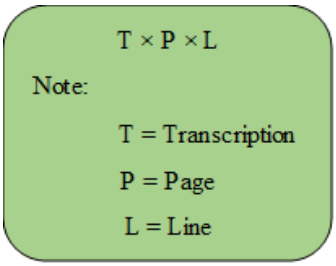


**Figure 5:** Coding of Structure Central Theme

## Coding analysis based on objectives

| **Objective 1 -** To determine the issues in the Free Trade Zone (FTZ) area. | |
|---|---|
| **Respondent** | **Coding** |
| 1. Ms Shirin Tan | T1, L20. L21, P50 |
| 2. Ms Siew Wun Cheah | T2, L20, L21, L22, L23, L24, L25, L26, L27, P53 |
| 3. Mr.Mohammed Anwar bin Rahaman Saar | T3, L46, L47, L48, L49. L50, L51, L52, L53, L54, L55, L56, L57, L57, L58, L59, L60, L61, L62, L63, L64, L65. L66, L67, L68. L69, L70, P58 |

**Table 5:** Coding for Objective 1

| **Objective 2 -** To evaluate any challenges in the Free Trade Zone (FTZ) area. | |
|---|---|
| **Respondent** | **Coding** |
| 1. Ms Shirin Tan | T1, L24, L25, L26, P50 |
| 2. Ms Siew Wun Cheah | T2, L30, L31, L32, P54 |
| 3. Mr. Mohammed Anwar bin Rahaman Saar | T3, L73, L74, L75, L76, L77, P60 |

**Table 6:** Coding for Objective 2

| **Objective 3** - To investigate the potential characteristics needed by young graduates to get a job. | |
|---|---|
| **Respondent** | **Coding** |
| 1. Ms Shirin Tan | T1, L30, L31, L32, L33, L34, L35, P51<br><br>T2, L36, L37, L37, L38, L39, L40, L41, L42, L43, L44, L45, L46, P54 |
| 2. Ms Siew Wun Cheah | T3, L81, L82, L83, L84, L85, L86, L87, L88, L89, L90, L91, P61 |
| 3. Mr. Mohammed Anwar bin Rahaman Saar | |

**Table 7:** Coding for Objective 3

| **Objective 4** - To access the ways young graduates capitalize into the free trade zone industry. | |
|---|---|
| **Respondent** | **Coding** |
| 1. Ms Shirin Tan | T1, L38, L39, L40, L41, P51<br><br>T2, L20, L51, L52, L53, L54 L55, L56, L57, P55 |
| 2. Ms Siew Wun Cheah | T3, L95, L96, L97, L98, L99, L100, L101, L102, L103, P61 |
| 3. Mr. Mohammed Anwar bin Rahaman Saar | |

**Tables 8:** Coding for Objective 4

## SUGGESTION FOR FUTURE RESEARCH

In order to obtain more precise results, future studies must examine even more influential groups. Another potential disadvantage of this study is the fact that respondents are only given a limited number of opportunities to respond to the interview questions which are 5-10 minutes and in one session only.

To enhance the information's results to be more diverse and useful, future researchers may also try to embrace additional underlying ideas with other research methodologies. They are also convinced to employ a number of techniques, such as the survey method, which enables the collection of more comprehensive data and conceptual understanding.

Future studies should look more into the issues and challenges that businesses in free trade zone areas have to deal with in terms of employment opportunities for young graduates, as well as whether and how those issues and challenges have changed over time and how they might affect those opportunities in general.

## CONCLUSION

The results showed that there are less employment prospects in the Free Trade Zone region, particularly in Bayan Lepas, Penang, as a result of various factors that have taken place over the previous five years.

Additionally, businesses prefer to hire experienced personnel over young graduates. Therefore, when the Covid-19 outbreak moves to endemic levels in Malaysia, job opportunities are growing. In order to overcome this and take advantage of the current situation, young graduates need to develop a certain set of skills, particularly those linked to communication and a foreign language.

Additionally, they must ensure that they are capable of employing specific analytical techniques that can bring value to their lives, particularly when they are involved in working life.

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# IMPACT OF CLIMATE CHANGE ON INDIAN AGRICULTURE

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**Abstract**
Global warming or to say local weather alternate is a developing risk that has to emerge as inevitable and more difficult to deal with seeing that the technology of post-industrialization and the procedure of technological revolution has begun. For a growing financial system such as India, it is posing exceptional challenges and thereby affecting its usual progress. India is essentially an agricultural state and the challenges of local weather exchange maintain a lot extra vital to get addressed on the first occasion than any different issue. The main purpose of this study was to understand how farmers perceive climate change. Climate change is the most imminent threat to the environment and agriculture. As an agricultural country, Indian farmers are the prime victims of climate change. In this research, the researcher focused on crop farming, which is only one aspect of agriculture. Also, among the various manifestations of climate change, the researcher only selected two, which are increased atmospheric temperature and changing rainfall patterns.
**Keywords:** Climate Change, Perception, Crop Farming, Agriculture, Rainfall, Temperature.

## INTRODUCTION

For an closing couple of decades, there have been large debates over the existence of world warming, today, the debate is generally over and a consensus has emerged in the world scientific nearby that Global Climate Change is occurring and that it will have a dramatic and damaging impact on the planet earth's ecosystem. According to a file for the World Bank, thru the Potsdam Institute for Climate Impact Research a German government-funded institute: the growth in earth's temperature ought to give up end result in a sea-level upward thrust of 0.5 to 1 meter with larger tiers moreover possible, with the useful resource of the with the aid of the yr 2100 AD, affecting some of the most densely populated and prone coastal cities and mega polis's located in Bangladesh, Indonesia, Madagascar, Mexico, Mozambique, Philippines, the USA, and Vietnam as well as small Island Nations all over the world, mainly in South Pacific like Fiji, Kiribati, Marshall Islands, Micronesia, Federated States of Nauru, Palau, Samoa, and the Solomon Islands. India moreover has been diagnosed as one of the 27 global places that are most inclined to sea stage upward jab brought on with the aid of ability of global warming **(Yadav, M. K., & Kumar, R. 2019)**

Agriculturists have become out to be susceptible due to the truth of bodily and financial losses, year after year. A locate out about reveals that out of the hundred percentage GHG emissions, sector-wise, agriculture and related sectors account for 23 percent. According to Scientists, India's contribution to worldwide warming is 4 percentages while that of China is 6 percent. The developing of rice, the sole grain used almost definitely for food, effects in the emission of some 12 to 14 percentage of the world's annual methane (CH4) budget, about 1/2 of which is produced in India. The agricultural location is the Achilles' heel of the Indian financial machine contributing 17-18 percentage of GDP, and 60 percentage of the labor. Indian agriculture is generally happening and the North Eastern states and the adjoining states are dealing with a serious threat. Therefore, in this paper, we try to analyze the impact of the disaster on Indian agriculture and the required combat mechanism, particularly from the element of civil society businesses.

## REVIEW OF LITERATURE

**Santos, R. M., & Bakhshoodeh, R. (2021)** this article gives and discusses the medical e book document from 1910 to 2020 on two subjects: "weather" (CL) and "climate change/global warming/weather emergency" (CC/GW/CE). **Yaduvanshi, et al (2020)** Moreover, the

workable modifications in local weather extremes at the regional stage are predicted to have far-reaching effects on the social and financial statuses of the respective local weather zones. This statistics at a regional scale also calls interest to the countrywide and country motion layout on local weather exchange and adaptation to be greater responsive in order to take coherent and built-in coverage decisions. **Trivedi, S. (2013)** the article offers commonly with the reasons and results of international warming and local weather trade on lifestyles on earth and the surroundings as a whole. The results and influences of world warming and local weather alternate have emerge as so dreadful in the twenty first century that it has modified the biodiversity of many ecosystems and have triggered many species to end up extinct already.

**Amutha, D. (2010)** takes a look at turned into performed in the Tuticorin District of Tamilnadu. This examination is compiled with the help of the number one statistics including the simplest 3 months period (2010). The number one information was accumulated with the help of a particularly organized interview agenda. In this study, a total of 364 interviewees were decided on in three villages in Tuticorin District. This is solely a descriptive look. **Paterson, P. (2018)** Global warming affords one of the most critical threats to South American countries. These international locations are prone to a selection of climate change-related issues: rising sea tiers, diminishing potable water elements, forest fires, extreme storms and flooding, heat waves, and the spread of sicknesses. These disasters are occurring greater frequently in the vicinity and will likely grow in depth additionally.

**Dryden, H., and Duncan, D. (2022)** We've been endorsed to anticipate that climate alternate is definitely a end result of the extra anthropogenic emission of carbon dioxide and methane and that the influences can also be mitigated by means of the usage of reducing our emission of greenhouse gases. This isn't always usually going to paintings. The entire international has over-centered on greenhouse gases to the detriment of nature. Climate trade is a easy equation, what is going into the surroundings ought to be removed. **Krusell, P., & Smith, A. A. (2022)** the economic results of local weather alternate vary throughout every time and area. To learn about these effects, this paper builds a world economy-climate model imparting an immoderate diploma of geographic resolution. Carbon emissions from the use of energy in manufacturing growth the Earth's temperature and nearby, or regional, temperatures reply more or much less sensitively to this growth.

**Chepeliev et al (2018)** the agricultural quarter performs a central feature in the climate alternate version and mitigation techniques. As one of the key worldwide emitters of greenhouse gasses (GHGs), such an strive need to be located as a way to lessen its carbon footprint. At the equal

time, in line with many studies, it is miles arguably the most prone quarter to face the influences of world warming with every land and water availability, as properly as yields productiveness, being underneath strain. One of the tactics that strive to always account for the international interactions between the weather-associated fashions and mitigation methods inside the agricultural area is the multi-place input-output (MRIO) framework.

## METHODOLOGY

This article is purely descriptive and required information collected from secondary sources like Journals, research paper, report ,newspaper, and other publications relating to climate change impact on in agriculture.

## OVERALL RESEARCH OBJECTIVES

The primary motive of this learn about used to be to apprehend the farmer's appreciation of local weather alternate and to apprehend how they give an explanation for the local weather exchange phenomena. Also, to recognize the consequences of rainfall and temperature on crops. The researcher tried to understand the results of local weather alternate from their point of view and how it is affecting their lives.

## OPERATIONAL DEFINITION

### Climate Change

Climate alternate is an alternate in international or regional local weather patterns, in particular, an exchange obvious from the mid to late twenty-first century onwards and attributed mostly to the improved degrees of atmospheric carbon dioxide produced by the use of fossil fuels. There are numerous manifestations of local weather change. Such as accelerated atmospheric temperature, alternate rainfall patterns, elevated herbal failures such as floods, cyclones, typhoons, droughts, sea stage rise, trade-in vegetation and fauna in exceptional geographical areas, and so on. However, for this lookup, local weather alternates the ability to extend temperature and alter rainfall patterns. The other factors are for this reason excluded

### Agriculture

Agriculture is the science and artwork of cultivating vegetation and livestock. It consists of crop farming, developing fruits, vegetables, flowers, or decorative plants, breeding and elevating livestock, and so on. However, for this research, agriculture capability is sole crops farming. Thus, the different branches of agriculture are excluded.

### Farmer

A farmer is a man or woman engaged in agriculture, elevating residing organisms for meals or uncooked materials. There are many types of farmers such as crop farmers, fish farmers, dairy

farmers, rooster farmers, and so on. However, for this research, farmers suggest crop farmers only. Thus, different sorts of farmers are excluded.

**INDIAN SCENARIO**

India will moreover be severely impacted with the aid of potential of neighborhood climate alternate as the health of the Indian monetary machine is tied to natural belongings and climate-sensitive sectors such as agriculture, water, and forestry. India can also moreover face an quintessential risk and would require a serious adaptive capacity to fight local weather change. Many lookup has underscored the nation‘s vulnerability to nearby climate change. With changes in key nearby climate variables, specifically, temperature, precipitation, and humidity, necessary sectors like agriculture and rural enchancment are in all possibility to be affected in the principal way. Impacts are already being viewed in unparalleled warmness waves, cyclones, floods, salinization of the shoreline, and penalties on agriculture, fisheries, and health.

**Climate trade in India**

Climate alternate in India is having profound consequences on India, it really is ranked fourth on the record of international locations most laid low with local weather alternate in 2015. India emits about three gigatonnes (Gt) CO2eq of greenhouse gases every yr; about two and a 1/2 heaps in preserving with man or woman, that is much less than the quarter common. The united states emit 7% of world emissions, no matter having 17% of the area population. The temperature rises on the Tibetan Plateau are inflicting Himalayan glaciers to retreat, threatening the floating charge of the Ganges, Brahmaputra, Yamuna, and exceptional primary rivers. A 2007 World Wide Fund for Nature (WWF) report states that the Indus River may additionally run dry for an equal purpose. Heat waves' frequency and power are developing in India due to climate alternations. Severe landslides and floods are projected to emerge as increasingly more not unusual in such states as Assam. Temperatures in India have risen through way of 0.7 °C (1. 3°F) between 1901 and 2018.

**Temperature and climate changes**

Temperatures in India have risen by using the usage of zero.7 °C (1. 3°F) between 1901 and 2018, thereby altering the local weather in India. In May 2022 excessive heatwave grew to become recorded in Pakistan and India. The temperature reached fifty one °C. Climate choice makes such heat waves one hundred instances a good deal extra likely. Without local weather exchange heatwaves, increased extreme than human beings that came about in 2010 are anticipated to attain 1 time in 312 years. Now they may also be anticipated to occur each and every three years. A 2018 appear at initiatives droughts to boom in Northern and North-western

India inside the shut to future. Around the supply up of the century, most elements of India will perchance face increasingly greater extreme droughts. Severe landslides and floods are projected to emerge as an increasing number of common in such states as Assam.

**INDIA'S CLIMATE CHANGE POLICY**

Today, India's populace remembers exceeding 1, 3 billion people. It is predicted that from 2025-2027 India will overtake China and come out on the pinnacle in phrases of population, and by using 2060 the populace of India will be 1.7 billion people. In 2019, the Indian economic system ranked fifth in the world in phrases of GDP, overtaking the UK, and in phrases of GDP in phrases of buying power, it is already at a 0.33 location in the world. The Indian economy has proven steady boom rates, averaging about 7% per 12 months over the previous decade. It is fairly probable that such dynamics will proceed in the future, regardless of the aftermath of the world pandemic. **(Kulik, L 2022)** India is advancing on a wide front to make sure an easy electricity future for its people, drawing upon its ingrained civilizational attributes and inserting in the region a huge variety of coverage interventions below the criminal framework of the Energy Conservation Act, masking 15 electricity-intensive industries and the Energy Conservation Building Code, overlaying all new city infrastructures. 32 states of the Indian Union have formulated and begun enforcing their very own State Action Plans on Climate Change. There is additionally an energetic and brilliant civic society that is promoting citizens' focus on the chance of Climate Change and what every one of us can do as people to meet this threat. It is hoped that India's management in dealing with its very own challenges of Climate Change and Energy Security will act as a spur to different international locations to elevate their very own contributions to assembly this world and existential challenge. Failure to do so condemns humanity to an unsure and perhaps catastrophic denouement.

At the UN local weather meeting, India as soon again highlighted that developed international locations have no longer solely failed to meet the USD a hundred billion desires yearly of assist to growing international locations due to the fact that 2009 however additionally proceed to current it as the ceiling of their ambition all the way to 2025. From pledging to turn out to be an internet zero emitter of carbon by means of 2070 to attain five hundred gigawatts of non-fossil strength potential by way of 2030, India led from the front on environmental troubles this year, grabbing eyeballs throughout the world. At the UN local weather meeting, India as soon once more highlighted that developed countries have no longer solely failed to meet the USD one hundred billion desires yearly of guide to creating international locations considering 2009 however additionally proceed to exist it as the ceiling of their ambition all the way to 2025.

## IMPACT OF CLIMATE CHANGE ON LIVESTOCK

In an present era, the cattle quarter contributes extraordinarily to the worldwide agriculture furnish chain. In dairying, India ranks as the world's biggest milk producer with an annual output of 1.16 million heaps approx. With an annual growth charge of 4%, India's milk manufacturing money owed for 16% of the entire worldwide output. India has a 52% of cattle populace and 15% of buffalo population. It ranks 1/3 in sheep populace and second in goat populace in the world. From the country of affairs of international consumption, Americans devour larger than 37 million loads of meat yearly. The country cattle corporation produced $100 billion properly really worth of gadgets in 2002. Changes in neighborhood climate may want to have an effect on animals every at as soon as and indirectly. Heat waves, which are projected to enlarge under nearby climate change, ought to at once threaten livestock. A extensive range of states have each said loss of increased than 5,000 animals from genuinely one warmness wave. Heat stress influences animals every at as soon as and indirectly. Over time, warmness stress can amplify vulnerability to disease, restriction fertility, and decrease milk production.

Drought may also moreover threaten pasture and feed supplies. Drought reduces the volume of quality forage on hand for grazing livestock. Some areas may also choose to outing longer, with greater extreme droughts, ensuing from larger summertime temperatures and lowered precipitation. For animals that keep in mind on grain, changes in crop manufacturing due to drought ought to moreover develop to be a problem. Climate exchange can additionally make better the incidence of parasites and illnesses that have an impact on livestock. The previously onset of spring and hotter winters can also prefer to allow some parasites and pathogens to stay to inform the story larger easily. In areas with accelerated rainfall, moisture-reliant pathogens may additionally prefer to thrive.

Increases in carbon dioxide (CO2) may also moreover enlarge the productiveness of pastures, however, can also moreover limit their quality. Increases in atmospheric CO2 can make higher the productiveness of vegetation on which cattle feed. However, lookup shows that the myth of some of the forage located in pasturelands decreases with higher CO2. As a result, cattle would desire to consume greater to get equal dietary benefits.

Hence, we choose to emphasize no longer totally crops, farm animal’s vicinity moreover sensitive extensively to neighborhood climate exchange factors. Since the quarter is fundamental for global ingredients and nutrition protection perspective, it is desired for an hour to undertake lookup on effect of neighborhood climate alternate on a quantity of cattle areas

and to make bigger model for inspecting nearby climate exchange cattle interaction. **Barua et al (2018)**

**IMPACT ON INDIAN AGRICULTURE**

India is the 2d populous country in the world. It aspires to be a developed country. in close to the future. But it is going through a large undertaking in the time period of local weather change. Irregular monsoon, depleting Glaciers in the Himalayas, and rising temperatures are some signals of local weather change. Due to local weather exchange agricultural manufacturing has been declining. It has an additional damaging effect on animal husbandry. So it has affected the livelihood of hundreds of thousands of people. The world's governments have agreed on a formidable agenda to radically change our world by using 2030, adopting the Sustainable Development Goals (SDGs) that intend to make certain no one is left behind, and anyone advantages from improvement efforts. Agenda 2030 is exceptional in scope and significance. There is a full-size departure from the preceding framework to now consist of a "harmonizing" of three elements: monetary growth, social inclusion, and environmental protection. But the fault line, as ever in world conferences, is the inappropriate stability between surroundings and development. But how a long way we organized to face the negative impact of local weather exchange on Indian agriculture. **Pradhan, R. K. (2021)**

The environmental and socio-economic dimensions are strongly intertwined in modeling the relationship between nearby climate trade and agriculture. Both favor to be exactly taken into account in order to in the give up produce a reliable image of the complexities involved. The subsequent subsections exist the most relevant factors to be considered. **Bosello, F., & Zhang, J. (2005)** Anthropogenic global warming is human-caused worldwide warming. This is the uppermost problem today. The twentieth century was once as soon as the warmest when you reflect onconsideration on that the 12 months 1400; of the twelve of the latest warmest years in India, eight had been recorded at some factor in the first decade of the twenty first century, 2009 being the warmest (temperature anomaly 0.913° C). About 20 percentages in monsoon rainfall, increased and more withdrawal of the glacier, developing soil salinity, warmness stress, and flood havoc at the same time as for the duration of regions, are all inflicting a net of a vulnerability affecting the future of Indian agriculture and the questions of meals security, employment, and income eventualities. Agriculture in India is in a weird situation of an extend in vulnerability (Hans, 2010). Estimates predict that with an enlarge in temperature through skill of 2080-2100 the feasible loss in crop manufacturing is 10-40 percent. There will be a 10% cut price in wheat manufacturing in the immoderate yield states of Punjab, Haryana, and Uttar

Pradesh Therefore, there will be foods insecurity, job insecurity, flooding, electricity challenges, accelerated migration, and metropolis challenges. All this is will be however India having more than 345 registered Clean Development Mechanism (CDM) projects, greater than any unique us of a and about a 1/3 of all duties globally (in phrases of the usual extent of CDM financial savings **Hans, V. B. (2014).**

## CLIMATE CHANGE AND ENVIRONMENTAL SUSTAINABILITY

Climate alternative is a burning difficulty the arena has been going through day after day. The rising of global temperature to 1.50 C is extraordinarily annoying for humanity's destiny on this planet. Natural and human sports are the foundation causes of it. Its impact is alarming and threatens the globe. Education is a critical element to solve weather alternate issues. It allows humans to make apprehend the impact of world warming, increase climate consciousness amongst human beings, encourages changing of their attitudes and conduct, and undertake climate change-related developments. Education also encourages them in decision making, trouble solving, resolving conflicts, and constructing a peace subculture.

It plays an important function in version and mitigation in weather exchange of groups and empowers the person for sustainable life. The development of fabric life ends in the erosion of values, growth of unconsciousness, ailment in family, society, and kingdom as well as in globe. Awakening of attention is barely had to shield the stunning cute Earth from its all leave out-happenings. Education will put together all of the societies to combat the challenges of weather exchange and make human beings and boom of economies with the understanding and skills as aware citizens in shaping green surroundings, low GHGs emissions, and weather-resilient societies. UNESCO, World Bank, UNDP, UNFCCC, WCPA, and different main organizations are taking full-size measures with long-standing climate movement expertise, combined with our worldwide, local, and country cooperation. Quality education can offer a holistic and humanistic vision of global, social, and financial improvement, poverty eradication, peacebuilding, and sustainable existence. **Dhal, P. K. (2021)**

## CONCLUSION

The findings of the learn about exhibit that farmers are very a good deal affected through local weather change. However, most of them do no longer comprehend about local weather alternate and can't give an explanation for why these adjustments are occurring. However, they sense that the common temperature is rising, the rainfall sample has modified in monsoon and the seasons are overlapping. This motives a lot of issues in agriculture. These consequences consist of decrease crop production, extended price of production, decreased income, adjustments in

profession, multiplied use of fertilizers and pesticides, and so on. All of these results are what the farmers perceive. Thus, no longer all of these have been scientifically accurate. However, it is essential to be aware of what the farmers assume and how they become aware of these things. To create a sustainable agricultural machine in the future, farmer's opinion and their perceived know-how are very vital to understand.

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# DETERMINATION OF PLANT NUTRITION CAPACITIES OF AGRICULTURAL AREAS BY SOIL ANALYSIS: THE EXAMPLE OF HAYRABOLU DISTRICT OF TEKIRDAĞ PROVINCE

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## Abstract
Successive cultivation of plants that benefit from different depths of the soil, use different nutrients in different amounts and have different root structures on the same field is effective in maintaining the fertility of the soil. In this study, a total of 26 soil samples, collected from areas located in the Hayrabolu district of Tekirdağ province, which are exposed to intensive agricultural activities, particularly under the crop rotation of sunflower and wheat, were analyzed, the aim was to determine the soil's sustainable productivity capacities based on the results obtained. The average pH, total salt, organic matter, and lime contents of the collected soil samples were determined to be 6.75, 0.16%, 1.38%, and 1.98%, respectively. It has been determined that the vast majority of soils (20 pieces) are in the “tin” texturing class. It was determined that the total N contents of the soil samples were the lowest “0.04%” and the highest “0.11%”. The average P, K, Ca, Mg, Fe, Mn, Zn and Cu contents of the soil samples were 18.35, respectively; 252.72; 5504.89; 502.46; 22.70; 20.38; It was found to be 0.33 and 1.36 ppm. Upon examination of the average organic matter and total nitrogen content in the collected soil samples, it has been determined that the soils in question are characterized by "low organic matter content”. Considering the average values of the soil samples, they fall into the categories of "excessive" for Ca, Mg, and Fe, "sufficient" for P, K, Mn, and Cu, and "deficient" for Zn. The most significant benefit of these studies is to ensure that the fertilizer input used in agricultural production meets the necessary requirements, with the correct use of fertilizers yielding positive economic and environmental advantages. While it is widely recognized that an excessive use of chemical fertilizers occurs in the Hayrabolu district, adhering to appropriate fertilization programs for crops such as wheat and sunflower can bring substantial benefits to both farmers and the environment.

**Keywords:** Soil analysis, organic matter, fertilization, Tekirdağ

## Introduction

In both the global and national contexts, we are confronted with a significant climate change, in addition to the growing population. Climate change contributes to various natural phenomena, such as severe and irregular rainfall, floods, water inundations, extreme droughts, dust storms, prolonged freezing events, storms, earthquakes, and more. Furthermore, due to climate change, the preference for fallowing is observed in regions with insufficient and irregular precipitation, as well as in areas with poor organic matter content in the soil, particularly in arid and semi-arid regions. This practice leads to leaving the soil fallow for a period of at least 14-15 months, according to the conditions. Therefore, future plans in agriculture should be directed toward addressing these realities, with a particular focus on preserving the productivity potential of soils. In recent years, it has been reported that soil organic matter, nutrient element contents, and water retention capacities have decreased due to intensive usage.

One of the most evident examples of this can be observed in many regions, including Hayrabolu, within the Thrace region. It has been determined that the indiscriminate use of chemical fertilizers and pesticides for maximizing yield per unit area has led to environmental pollution, contamination of underground water sources, and the emergence of chemical residues in the cultivated crops, posing a serious threat to human and animal health. Another factor that threatens the soils of the Thrace region is the common practice of crop rotation, particularly involving wheat and sunflower cultivation. Crop rotation, also known as crop sequence, refers to the set of practices and processes applied to a field during the period following the cultivation of any given crop or during the vegetation (growth) phase. In other words, crop rotation involves the sequential cultivation of different plants in a specific order on the same field. Through such practices, the aim is to increase the soil's organic matter content, enhance its water retention capacity, improve productivity, and ultimately create more favorable conditions for cultivated crops. One of the key objectives of crop rotation is to ensure the sustainability of soil productivity. Improper practices in agricultural areas, excessive use of chemicals, salinity increase, acidification, barrenness, etc. as a result of adverse situations, organic matter in the soil and nutrients useful to plants are decreasing, agricultural production is decreasing in quantity and quality, while producers' incomes are also decreasing (Bellitürk, 2013). For these and similar reasons, thanks to the protection of the soil with organic fertilizers obtained by environmentally friendly natural means that do not disturb the natural balance, it is aimed to increase not only the increase in yield, but also the cultivation of healthy crops.

One of the materials that can facilitate the natural and chemical-free restoration of soil balance without disruption is worm castings, also known as vermicompost. With the proliferation of worm castings and the recognition of their contributions to soil and the environment through academic research, scientists have started to refer to this as an "organic green revolution." Vermicompost is a fully organic fertilizer that has been certified by various organizations worldwide. Organic earthworms, or vermiculture, is the process of utilizing earthworms to compost organic waste materials, resulting in the production of vermicompost. Within the intestinal tracts of earthworms, numerous beneficial microorganisms, proteins, enzymes, and vitamins are integrated into the structure of vermicompost. Vermicompost is a high-quality organic fertilizer, and it is an environmentally friendly production material with superior attributes that can be readily employed in organic farming.

According to the data in Table 1 for the year 2022, it is observed that the total chemical fertilizer used in our country is 5.9 million tons, and the chemical fertilizer consumption in Tekirdağ province is 157,000 tons. However, due to the limited use of organic fertilizers, a specific figure for this cannot be provided. When looking at the long-term average of chemical fertilizer usage in Tekirdağ province, the highest consumption was recorded at 210,000 tons in 2016. It is noted in Table 1 that the highest chemical fertilizer usage in Turkey was 7.1 million tons in the year 2020. The fluctuations in chemical fertilizer usage observed in our country in the past few years are thought to be due to factors such as the pandemic, economic slowdown, global energy crisis, and so on.

**Table 1.** Relationship between the quantities of chemical fertilizers consumed in Turkey and Tekirdağ province (Anonymous, 2023a).

| **Years** | **Chemical fertilizer consumption in Tekirdağ province** | **Chemical fertilizer consumption in Turkey** |
|---|---|---|
| 2010 | 160.090 | 4.968.058 |
| 2011 | 145.215 | 4.766.356 |
| 2012 | 169.777 | 5.339.893 |
| 2013 | 180.713 | 5.813.612 |
| 2014 | 150.807 | 5.471.518 |
| 2015 | 159.501 | 5.507.779 |
| 2016 | 210.613 | 6.744.922 |
| 2017 | 187.159 | 6.332.872 |
| 2018 | 139.755 | 5.411.881 |
| 2019 | 186.414 | 6.087.714 |
| 2020 | 193.950 | 7.143.144 |
| 2021 | 151.329 | 6.480.101 |
| 2022 | 157.369 | 5.902.539 |
| **TOPLAM** | **2.192.692** | **75.970.389** |

As seen in Tables 2 and 3, between 2018 and 2022, the agricultural area in Hayrabolu district increased, and there was also an increase in the agricultural area of Tekirdağ province. However, during this period, the population of Hayrabolu decreased, while the population of Tekirdağ province increased. This suggests that Hayrabolu district is experiencing out-migration, and Tekirdağ province is receiving in-migration. Consequently, there is an increased demand for labor in agriculture in Hayrabolu district. To match the increase in agricultural area, efforts should be made to increase productivity in agriculture accordingly.

**Table 2.** Agricultural areas in Tekirdag province and Hayrabolu district (UIC, 2023).

| **Year of production** | **Agricultural area of Hayrabolu district** | **Agricultural area of Tekirdağ district** |
|---|---|---|
| | **da** | |
| 2018 | 768.771 | 3.971.345 |
| 2019 | 752.140 | 3.911.723 |
| 2020 | 759.009 | 3.927.950 |
| 2021 | 806.425 | 4.154.336 |
| 2022 | 806.393 | 4.152.437 |

**Table 3.** The population amounts of Tekirdağ province and Hayrabolu district (TUIK, 2023).

| Years | Population of Hayrabolu district | Population of Tekirdağ district |
|---|---|---|
| 2018 | 32.137 | 1.029.927 |
| 2019 | 32.268 | 1.055.412 |
| 2020 | 31.574 | 1.081.065 |
| 2021 | 31.245 | 1.113.400 |
| 2022 | 30.521 | 1.142.451 |

According to Table 4, in Hayrabolu district of Tekirdağ province, the wheat cultivation area was 385,000 da in 2018, with a yield of 343 kg/da and a production quantity of 132,386 tons. In the past year, 2022, the wheat cultivation area was 370,279 da, with a yield of 496 kg/da and a production quantity of 150,231 tons. The variability observed over the years could be attributed to climatic conditions and the soil's acquisition of an acidic character due to the use of chemical fertilizers. Data for sunflower and canola plants for the years 2018-2022 is provided in Tables 5 and 6. While the sunflower cultivation area has increased, there has been a decrease in yield, resulting in reduced production relative to the cultivated area. The reasons for this may include challenges in climatic conditions and unsound chemical fertilizer practices leading to soil structure deterioration (acidification). Among the preventive measures, reducing chemical fertilization and replacing it with the use of vermicompost, referred to as the "green organic revolution," could be considered. Since sunflower plants require micronutrients, it is advisable to use fertilizers containing micronutrients in accordance with soil analysis results.

**Table 4.** Wheat cultivation areas, yield, and production quantities in Hayrabolu district, Tekirdağ province (TUİK, 2023).

| Year of production | Planted area (da) | Yield (kg/da) | Production quantity (tons) |
|---|---|---|---|
| 2018 | 385.759 | 343 | 132.386 |
| 2019 | 354.840 | 456 | 161.856 |
| 2020 | 384.479 | 394 | 151.350 |
| 2021 | 377.647 | 483 | 182.588 |
| 2022 | 370.279 | 496 | 150.231 |

**Table 5.** Sunflower cultivation areas, yield, and production quantities in Hayrabolu district, Tekirdağ province (TUİK, 2023).

| Year of production | Planted area (da) | Yield (kg/da) | Production quantity (ton) |
|---|---|---|---|
| 2018 | 303.831 | 250 | 75.592 |
| 2019 | 302.367 | 270 | 81.616 |
| 2020 | 305.423 | 233 | 71.265 |
| 2021 | 350.935 | 230 | 80.570 |
| 2022 | 361.085 | 193 | 69.666 |

Canola, also known as rapeseed, is an oilseed crop that is planted in winter in the Thrace region (as the summer varieties are not economically viable due to low yields). In Hayrabolu district, the area planted with canola has been decreasing between 2018 and 2022, resulting in reduced yields and production quantities.

**Table 6.** Canola cultivation areas, yield, and production quantities in Hayrabolu district, Tekirdağ province (TUİK, 2023).

| Year of production | Planted area (da) | Yield (kg/da) | Production quantity (ton) |
|---|---|---|---|
| 2018 | 16.085 | 300 | 4.826 |
| 2019 | 16.811 | 300 | 5.043 |
| 2020 | 13.000 | 300 | 3.900 |
| 2021 | 13.250 | 349 | 4.630 |
| 2022 | 12.600 | 264 | 3.328 |

## Material and Method

In this research, soil samples were collected from various villages and locations within Hayrabolu district, Tekirdağ province, at depths of 0-30 cm, using the zig-zag method in compliance with proper procedures. These samples were obtained before any soil preparation or the application of fertilizers and agricultural chemicals (as indicated in Table 1). Subsequently, the samples were air-dried, and after that, they were sieved through a 2 mm mesh to prepare them for analysis, following the methodology described by Jackson (1958). The soil samples' texture class was determined based on soil moisture, while soil reaction (pH) was measured by diluting the soil with water in a 1:2.5 (soil:water) ratio and using a glass electrode pH meter, following the recommendations of the International Soil Science Society. Soil salinity (salt content) was measured using an EC (electrical conductivity) meter and expressed

in percentage units (Lindsay and Norvell, 1978; Richards, 1954). The determination of lime content was performed volumetrically using the Scheibler Calcimeter (Ülgen and Yurtsever, 1974). Soil organic matter content was determined using the Walley-Black method (Saglam, 2012). Available phosphorus was determined according to the Spectrophotometer-Olsen method. Calcium (Fr) and magnesium (Mg) were analyzed using ICP-OES (DTPA), while iron (Fe), manganese (Mn), copper (Cu), and zinc (Zn) contents were determined using the ICP-OES method (Lindsay and Norvell, 1978). Exchangeable potassium (K) was determined via flame photometry (ammonium acetate) (Jackson, 1958; Sağlam, 2012). The evaluation of soil analysis results was based on standard values provided in previous studies (Lindsay and Norwell, 1969; FAO, 1990; TOVEP, 1991; Güneş et al., 1996; Sun et al., 2010; Bellitürk, 2013).

Hayrabolu, located 52 km away from Tekirdağ, is surrounded by Kırklareli to the north, Edirne to the west, Tekirdağ to the south, and Muratlı to the east. It covers a total area of 1037 square kilometers. The region boasts some of the most fertile soils and is situated in the Ergene basin, in the Hayrabolu Creek valley, just northwest of the provincial center. Approximately 60% of its land is plains, 35% is gently hilly, and 5% is covered by forests. Hayrabolu district has a plateau-like appearance, with an average elevation of around 210-220 meters. The waters of the region are collected by the Hayrabolu Creek, which is one of the significant tributaries of the Ergene River. Flowing from south to north, the Hayrabolu Creek passes through the town center of Hayrabolu and joins the Ergene River to the north. It is one of the major tributaries of the Ergene River. The climate in Hayrabolu exhibits a Thracian transitional climate. Winters are quite rainy and very cold, while summers are relatively dry and hot. The annual average precipitation is 600 mm (Anonim, 2023b)

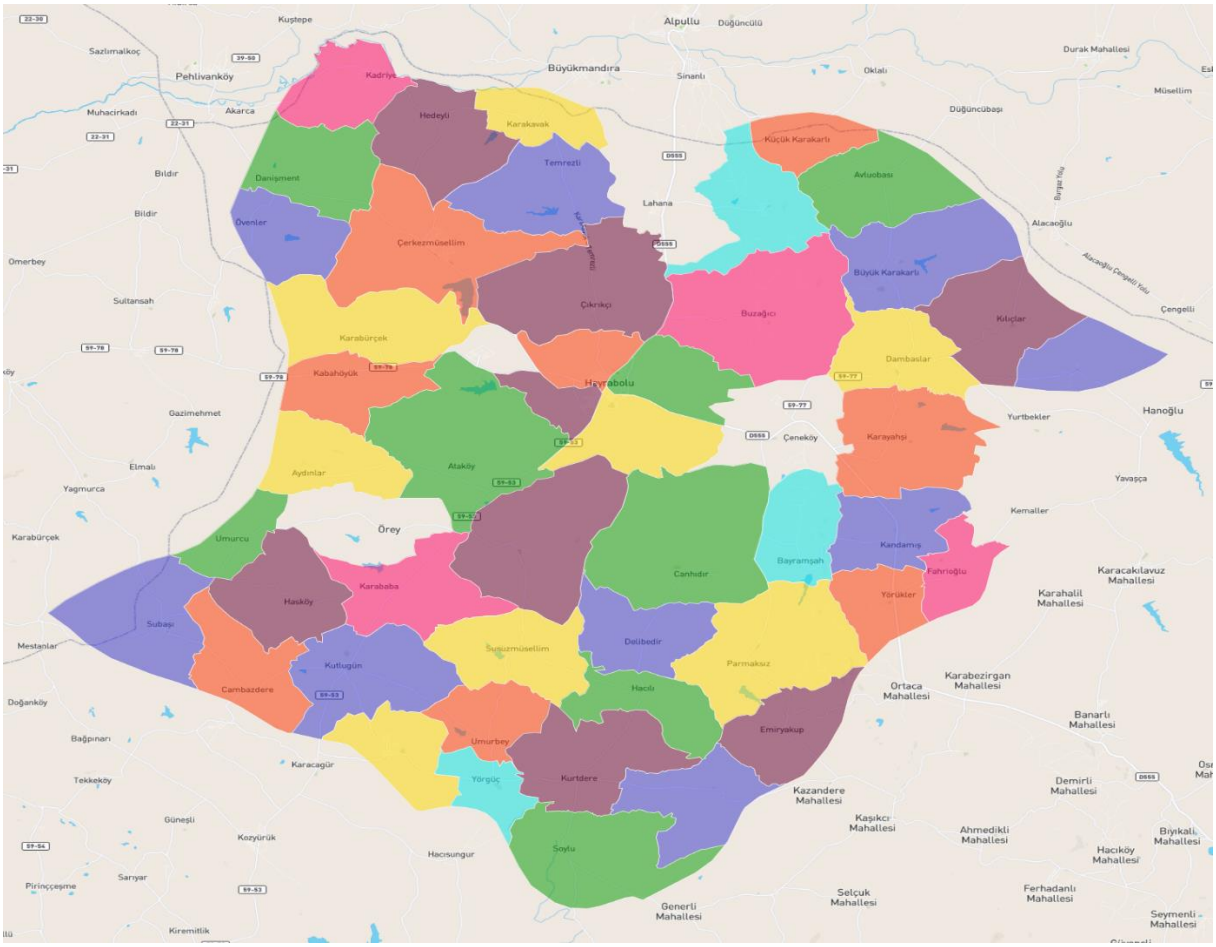


**Figure 1.** Map of Hayrabolu District in Tekirdag Province (Anonymous, 2023c).

## Results and Recommendations

Some of the chemical and physical analysis results for the examined soil samples from the research area are collectively presented in Table 7.

**Table 7.** Some of the physical and chemical analysis results for the soil samples.

| Example no | Places taken as examples | pH (1:2,5) | Salt (%) | Organicmat. (%) | Lime (%) | Saturation (%) | |
|---|---|---|---|---|---|---|---|
| | | | | | | (%) | Texture class |
| **1** | Doğucalı Mah. | 6.06 | 0.16 | 1.79 | 1.24 | 42.00 | Tın |
| **2** | Doğucalı Mah. | 7.61 | 0.14 | 1.85 | 7.59 | 46.00 | Tin |
| **3** | Doğucalı Mah. | 6.33 | 0.10 | 1.36 | 1.39 | 38.00 | Tin |
| **4** | Doğucalı Mah. | 7.74 | 0.22 | 1.20 | 1.55 | 46.00 | Tin |
| **5** | Doğucalı Mah. | 7.03 | 0.35 | 1.32 | 0.77 | 48.00 | Tin |
| **6** | Doğucalı Mah. | 7.21 | 0.13 | 0.81 | 1.08 | 45.00 | Tin |
| **7** | Kılıçlar Mah.. | 6.36 | 0.09 | 0.99 | 1.38 | 56.00 | Clay tin |
| **8** | Kandamış Mah. | 6.91 | 0.25 | 1.41 | 2.79 | 51.00 | Clay tin |
| **9** | Kandamış Mah. | 7.19 | 0.12 | 1.32 | 3.10 | 53.00 | Clay tin |
| **10** | Kandamış Mah. | 6.57 | 0.11 | 2.14 | 1.24 | 48.00 | Tin |
| **11** | Kandamış Mah. | 5.33 | 0.06 | 0.93 | 0.77 | 38.00 | Tin |
| **12** | Kandamış Mah. | 6.52 | 0.25 | 1.56 | 1.39 | 40.00 | Tin |
| **13** | Kandamış Mah. | 7.00 | 0.13 | 1.65 | 1.70 | 52.00 | Clay tin |
| **14** | Kandamış Mah. | 7.29 | 0.14 | 1.32 | 0.93 | 44.00 | Tin |
| **15** | Kandamış Mah. | 6.06 | 0.09 | 1.98 | 1.54 | 46.00 | Tin |
| **16** | Fahrioğlu Mah. | 6.91 | 0.10 | 1.78 | 1.08 | 49.00 | Tin |
| **17** | Fahrioğlu Mah. | 6.85 | 0.04 | 0.86 | 1.39 | 36.00 | Tin |
| **18** | Küçükkarakarlı Mah. | 7.36 | 0.28 | 1.28 | 1.70 | 36.00 | Tin |
| **19** | Muzruplu Mah. | 6.42 | 0.21 | 1.49 | 0.92 | 42.00 | Tin |
| **20** | Muzruplu Mah. | 6.21 | 0.14 | 2.33 | 1.23 | 49.00 | Tin |
| **21** | Muzruplu Mah. | 6.57 | 0.17 | 0.79 | 1.23 | 48.00 | Tin |
| **22** | Muzruplu Mah. | 6.72 | 0.15 | 1.05 | 1.07 | 52.00 | Clay tin |
| **23** | Muzruplu Mah. | 6.67 | 0.15 | 1.00 | 1.38 | 49.00 | Tin |
| **24** | Muzruplu Mah. | 7.56 | 0.13 | 1.02 | 1.69 | 44.00 | Tin |
| **25** | Muzruplu Mah. | 5.32 | 0.18 | 1.12 | 1.38 | 48.00 | Tin |
| **26** | Merkez | 7.58 | 0.27 | 1.59 | 9.01 | 54.00 | Clay tin |
| **Min.** | - | 5.32 | 0.04 | 0.79 | 0.77 | 42.00 | - |
| **Maks.** | - | 7.74 | 0.28 | 2.33 | 7.59 | 56.00 | - |
| **Ort.** | - | 6.75 | 0.16 | 1.38 | 1.98 | 46.00 | - |

**Table 8.** Some macro and micro-plant nutrient element results for the soil samples.

| Example No | N | P | K | Ca | Mg | Fe | Mn | Zn | Cu |
|---|---|---|---|---|---|---|---|---|---|
| | % | ppm | | | | | | | |
| **1** | 0.09 | 23.47 | 195.60 | 3009.00 | 390.30 | 27.36 | 37.65 | 0.37 | 1.45 |
| **2** | 0.09 | 13.43 | 238.50 | 5184.00 | 601.70 | 9.45 | 5.80 | 0.60 | 1.30 |
| **3** | 0.07 | 12.03 | 191.40 | 4218.00 | 423.10 | 43.03 | 36.89 | 0.37 | 1.55 |
| **4** | 0.06 | 9.23 | 321.30 | 4641.00 | 327.60 | 35.19 | 10.57 | 0.43 | 2.37 |
| **5** | 0.07 | 13.95 | 203.90 | 6571.00 | 596.70 | 35.35 | 12.14 | 0.36 | 2.34 |
| **6** | 0.04 | 7.31 | 419.60 | 7671.00 | 391.70 | 31.01 | 11.70 | 0.39 | 2.06 |
| **7** | 0.05 | 13.43 | 240.80 | 3759.00 | 545.80 | 19.23 | 15.68 | 0.25 | 1.21 |
| **8** | 0.07 | 89.22 | 237.40 | 7605.00 | 318.40 | 10.24 | 13.05 | 0.32 | 0.76 |
| **9** | 0.06 | 2.81 | 225.40 | 9562.00 | 273.50 | 14.85 | 11.55 | 0.20 | 1.05 |
| **10** | 0.11 | 16.61 | 251.30 | 6520.00 | 410.90 | 16.75 | 21.48 | 0.23 | 1.11 |
| **11** | 0.05 | 16.83 | 153.00 | 2548.00 | 404.70 | 65.54 | 54.93 | 0.24 | 1.38 |
| **12** | 0.06 | 41.11 | 149.60 | 4646.00 | 327.40 | 19.38 | 12.11 | 0.22 | 0.95 |
| **13** | 0.08 | 16.90 | 263.80 | 8280.00 | 681.70 | 25.01 | 10.29 | 0.20 | 1.38 |
| **14** | 0.07 | 35.42 | 208.20 | 9325.00 | 795.90 | 13.66 | 7.90 | 0.21 | 1.02 |
| **15** | 0.09 | 9.59 | 253.90 | 4814.00 | 494.80 | 29.12 | 36.12 | 0.12 | 1.27 |
| **16** | 0.09 | 23.39 | 256.20 | 6332.00 | 653.00 | 31.21 | 20.89 | 0.19 | 1.25 |
| **17** | 0.04 | 9.29 | 195.10 | 3464.00 | 451.00 | 11.41 | 20.31 | 0.08 | 0.95 |
| **18** | 0.06 | 9.96 | 232.20 | 5631.00 | 603.00 | 26.49 | 9.13 | 0.32 | 2.15 |
| **19** | 0.07 | 27.74 | 274.60 | 3439.00 | 483.50 | 22.60 | 30.10 | 0.76 | 1.29 |
| **20** | 0.11 | 13.72 | 355.50 | 4157.00 | 495.10 | 24.39 | 52.16 | 0.39 | 1.65 |
| **21** | 0.04 | 7.23 | 200.20 | 5043.00 | 490.10 | 7.92 | 6.38 | 0.13 | 0.81 |
| **22** | 0.05 | 11.43 | 261.10 | 4460.00 | 819.50 | 12.39 | 13.39 | 0.21 | 1.18 |
| **23** | 0,05 | 11.22 | 259.50 | 4636.00 | 839.60 | 13.78 | 13.87 | 0.22 | 1.27 |
| **24** | 0,05 | 15.72 | 268.80 | 5201.00 | 440.50 | 9.84 | 5.27 | 0.30 | 0.87 |
| **25** | 0.06 | 14.39 | 365.20 | 4194.00 | 515.80 | 24.15 | 48.86 | 0.34 | 1.64 |
| **26** | 0.08 | 11.58 | 348.80 | 8217.00 | 389.20 | 10.84 | 11.64 | 1.27 | 1.21 |
| **Min.** | 0.04 | 2.81 | 149.60 | 2548.00 | 273.50 | 7.92 | 5.27 | 0.08 | 0.76 |
| **Maks.** | 0.11 | 89.22 | 419.60 | 9325.00 | 839.60 | 65.54 | 54.93 | 1.27 | 2.37 |
| **Average** | 0.06 | 18.35 | 252.72 | 5504.89 | 502.46 | 22.70 | 20.38 | 0.33 | 1.36 |

As seen in Table 7, the lowest pH value was determined to be 5.32 in sample 25, while the highest pH value was 7.74 in sample 4. The average pH value of the soils was found to be 6.75 (neutral). When examining the total salt values of the soils, it was observed that they contained salt in the range of 0.04% to 0.28%, indicating that the soils are within acceptable limits. In terms of organic matter, the highest value determined in the soils was 2.33% (soil sample 20), while the lowest value was 0.79% (soil sample 21). It is evident that the soils have low organic matter content. Ideally, the organic matter content should be around 4-5%, but it is significantly lower. This is a consequence of the excessive use of chemical fertilizers by farmers. To address this issue, it is recommended to reduce the use of chemical fertilizers and consider using organic fertilizers or vermicompost instead. Regarding calcium carbonate (CaCO3) content, the soils were found to have an average of 1.98% calcium carbonate, indicating that the soils in Hayrabolu are calcareous. The soils in terms of texture predominantly belong to the "silt" class, and it was determined that a total of 21 out of 21 soil samples fell into the "silt (L)" texture class. When the general physical and chemical properties of the soils are examined, it is observed that there has been a gradual decrease in organic matter content over the past 10 years. This decrease is believed to be due to conventional farming practices and the heavy use of chemical fertilizers in cultivation. Taking into account the parameters in Table 8, the soils are found to be "low" in terms of total N content, with an average value of 0.06%, indicating that they are deficient in nitrogen. In soils where nitrogen is insufficient, urea fertilizer can be used. Urea is a type of chemical fertilizer that contains the most nitrogen. The average contents of macro elements in the soil samples, specifically P, K, Ca, and Mg, were found to be 18.35%, 252.72 ppm, 5504.89 ppm, and 502.46 ppm, respectively. Accordingly, the soil samples are considered "sufficient" in terms of P and K and "excessive" in terms of Ca and Mg. When considering the average values of microelements, it was determined that the contents of Fe, Mn, Zn, and Cu were 22.70 ppm (excessive), 20.38 ppm (sufficient), 0.33 ppm (low), and 1.36 ppm (sufficient), respectively. Similar studies conducted in the region also emphasize the low organic matter content in the soils. To increase organic matter in the soil, it is necessary to increase the use of organic fertilizers. For this purpose, farmers can reduce the use of chemical fertilizers and replace them with alternatives rich in organic matter content, such as farmyard manure, vermicompost, compost, organic fertilizers made from municipal waste, liquid seaweed fertilizer, and biogas fertilizers. Implementing this fertilizer model will lead to a reduced demand for chemical fertilizers in the future, resulting in increased soil productivity, improved soil quality, and higher-quality crop yields.

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# THE IMPORTANCE AND MANAGEMENT OF BIOCHAR AND COMPOST FOR LAND DEGRADED AND ORGANIC MATTER-POOR SOILS

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## Abstract
The intensity of agricultural development and corresponding changes in environmental conditions have led to land degradation in many parts of the world. Land degradation occurs as a result of human actions aimed at obtaining more gains from the soil, which diminishes soil fertility and health. This study aims to explore the importance and sustainable productivity capabilities of using biochar and compost for the restoration of land that has suffered soil degradation and depleted organic matter levels. The increasingly rapid growth of the world's population contributes to the rise in agricultural production, but the intensive and careless use of soil reduces its organic matter levels and productivity. Materials that contribute to the restoration of soils, such as biochar and compost, are becoming increasingly used worldwide to increase crop yields per unit area. This study aims to explore the potential benefits of biochar and compost for the protection of soils in various agroecosystems. They have an important role to play in sustainable agriculture and environmentally friendly practices. Biochar and compost are among the most significant alternatives that can be used to protect soils, particularly in the face of climate change, drought stress, and toxic substances. The use of biochar and compost has been confirmed in numerous studies to have positive effects on soil-plant-atmosphere system harmony and improving soil quality and productivity in areas that have become impoverished and degraded in terms of organic matter.
**Keywords:** Land degradation, organic matter, compost, soil fertility, land management

## 1. Introduction

With the rise in environmental issues, land degradation has become a topic of great discussion and concern for various stakeholders involved in agricultural production in recent times. It is an essential global issue that impacts humanity (Müller et al., 2023). Land degradation leads to increasing and combined pressures on agricultural and livestock production including drought, soil pollution, deforestation, improper land use and management, erosion, soil salination, reduction in food production quantity and security, and damage to biodiversity. These factors have a negative impact on the production and distribution of ecosystem services (Hossain et al., 2020; Talukder et al., 2021). Land degradation poses a threat to the living standards and economies of 3.2 billion individuals worldwide. Furthermore, around 75% of the Earth's land surface is degraded (IPBES, 2018). The total arable land area across the world is estimated to be 7616 million acres; equivalent to only 24% of the total land mass, and roughly half of this land is currently in use (AbdelRahman, 2023).

Soil is a robust structure comprising inorganic, organic and microorganismal components in a constantly evolving and dynamic equilibrium formed over thousands or even millions of years (Nunes et al., 2023). The productivity of cultivable land hinges primarily on soil formation and management. Disrupting this balance due to intense human pressure and unconscious land management leads to rapid soil degradation (Lal et al., 2021). The exponential growth of the global population has heightened the demand on soil resources. The reduction in the area of land available for agricultural use has resulted in a need for greater productivity from each unit of land. The diminished productivity of soil represents one of the key issues in this regard. The decline in available land and soil quality, as well as other persistent agricultural issues, has resulted in a consistent rise in the use of inorganic fertilisers (Srivastava, 2009; Agegnehu et al., 2017; Çelik et al., 2019). However, the exclusive use of chemical fertilisers is not a sustainable solution for increasing soil fertility and yield increase in the long run. Several studies have recognised that the overuse of inorganic fertilisers, particularly nitrogen-based fertilisers, can lead to soil degradation and environmental issues. This is due to a quicker mineralisation of organic matter, resulting in a reduction in soil carbon stocks (Foley et al., 2005). There has been a marked rise in scientific investigations into soil degradation (Xie et al., 2020). Soil fertility is declining rapidly due to reduced levels of organic matter (SOM) and a lack of nutrients in the soil.

This results in decreased agricultural productivity and creates significant challenges in agricultural soils with varying properties (Lal, 2015; Gerke, 2022; Iderawumi and Kamal, 2022). The present study focuses on the impact of land degradation on agriculture and the environment, and the potential of environmentally and agriculturally friendly practices such as biochar and compost to prevent further degradation and manage soils with insufficient organic matter. The study adopts an objective approach, using clear and concise language with a logical flow of information. Technical terms are explained upon their first use, and the text adheres to conventional academic structure and formatting. The language is formal, value-neutral, and free from biased or ornamental language. The text is grammatically correct with consistent spelling, vocabulary, and citation style. Significant developments have occurred in research on biochar and compost fertilisers, which are currently the focus of researchers who are concerned with the decline in soil organic matter levels, as well as environmental and soil degradation issues. Key findings address sustainability in agricultural production, carbon sequestration, greenhouse gas emissions, soil quality, acidity, fertility, and salinity (Van Zwieten et al., 2014). Furthermore, amidst the accelerating process of drought and climatic changes, utilizing biochar-compost mixtures and composted-biochar-compost research in varying derivatives and ratios for soil improvements, as well as environmentally and agriculturally friendly fertiliser applications such as mulch, have been found to proficiently increase soil fertility. In tropical and arid climatic conditions, as observed in the studied areas, organic matter mineralises rapidly (Agegnehu et al., 2015a; Schulz et al., 2013).

Consequently, only a fraction of the applied organic matter is beneficial. Future research should focus on preserving organic matter in these regions. The aim of this study was to investigate the significance of using biochar and compost for rejuvenating depleted soils with diminishing organic matter levels. Moreover, the study explored how these techniques could contribute to enhancing sustainable productivity capacities.

## 2. Land Degradation and Soil Organic Matter Deficiency

Land degradation is the disruption of nature's sustainable production balance due to human impact. Finally, logical progression with clear causal connections between statements is necessary, and a balanced approach avoiding bias is essential. Land degradation is the disruption of nature's sustainable production balance due to human impact. The primary objectives of land degradation are to obtain maximum benefits from natural resources in the short term. Consistent formatting features and adhering to citation guidelines are also necessary.

Many scientific studies have revealed that the main causes of land degradation include loss of soil cover, deforestation, soil erosion, salinisation, acidification, and compaction. Technical terminology shall be explained in detail while avoiding ornamental language. Many scientific studies have revealed that the main causes of land degradation include loss of soil cover, deforestation, soil erosion, salinisation, acidification, and compaction. Factual and unambiguous titles must be employed, using formal language, objective and value-neutral vocabulary and hedging. When violating the laws of nature, it leads to additional predicaments. For instance, an attempt to achieve the highest output from a specific area by excessive usage of fertilisers and irrigation in agriculture not only causes nitrogen (N) pollution of groundwater but also destroys soil biodiversity, which poses a threat to agricultural procedures. Moreover, this method releases greenhouse gases into the atmosphere, which can be hazardous. (Akça et al., 2022).

Quantitative or qualitative changes in soil properties that lead to a reduction in soil productivity have significant implications for the sustainable future of the planet. Soil degradation has emerged as a critical issue in regions with intensive agriculture. In the last 20 years, various assessments indicate that between 15 to 80 per cent of the world's agricultural land is affected (Bindraban et al., 2012; Hurni et al., 2015; Gibbs and Salmon, 2015). Subsequent assessments indicate that a quarter of current agricultural land is severely degraded, with around 44% displaying slight to moderate levels of degradation, and roughly 10% recovering from damage. Gomiero (2016) stresses that land degradation has a significant connection to poverty and food security issues. Consequently, there is a need to make efforts to halt soil deterioration and implement measures to enhance its quality. Furthermore, extensive agricultural practices significantly decrease soil organic matter (SOM) and soil carbon stocks. The global distribution of degraded areas is presented in Figure 1.

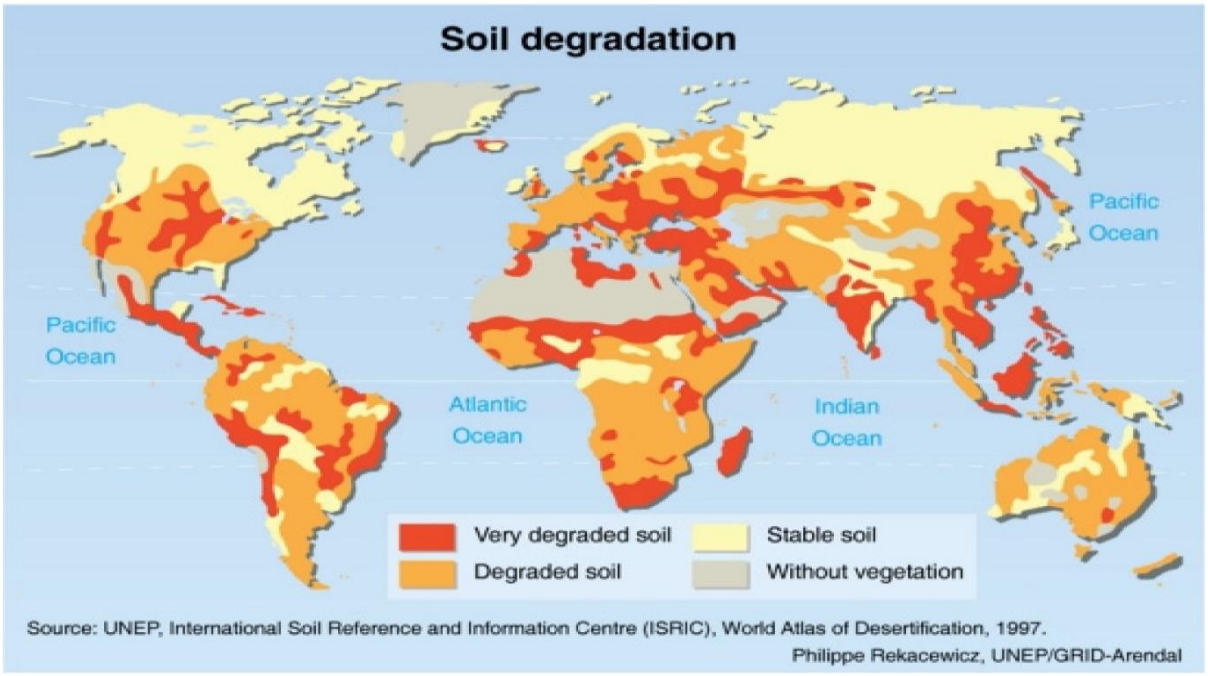


**Figure 1.** Estimates of the level of soil degradation at the global level (Gomiero, 2016).

A reduction in soil organic matter leads to decreased soil resistance against water and wind erosion, limits soil water holding capacity, and adversely impacts soil quality generally. Consequently, it exacerbates various issues, such as decreased crop yields, necessitating increased fertilisation and irrigation, and contributes to the soil releasing $CO_2$ emissions (Gurmu, 2019; Jangir et al., 2019; Ozlu et al., 2022). The organic carbon pool in the soil varies significantly up to a depth of 1m, ranging from 30 tonnes per hectare in arid climates to 800 tonnes per hectare in organic soils in cold regions. This range is mostly within 50 to 150 tonnes per hectare (Lal et al., 2004). Fertile soils usually contain 100 tonnes of organic matter per hectare, which constitutes about 4 to 5% of the total weight of the topsoil (Pimentel et al., 2005). Conventional farming methods commonly leave the soil exposed for extended periods, leading to topsoil erosion and a decrease in SOM levels. As decaying leaves and stems host the majority of soil organic matter near the soil surface, erosion dramatically diminishes it. Fine organic particles are selectively removed from the soil by both wind and water erosion, leaving behind the larger soil particles and stones. It has been demonstrated by numerous studies that soil removed by water or wind erosion is richer in organic matter by a factor of 1.3 to 5 times compared to the remaining soil (Lal and Stewart, 1990). For instance, reducing the soil's organic matter from 0.9% to 1.4% (assuming a soil organic content of 4 to 5%) could reduce agricultural productivity by up to 50%, depending on the crop type (Pimentel and Burgess, 2013). Therefore, the implementation of agronomic practices, such as no-tillage, minimum tillage, and

organic farming, aids in reducing soil loss, increasing soil organic matter, and restoring soil fertility and biodiversity (Carr et al., 2013; Domínguez and Bedano, 2016).

## 3. Properties of Biochar and Compost

Biochar is a carbonaceous substance created through slow or fast pyrolysis of biomass with minimal or no oxygen availability. Its applications include alleviating climate change and remediating environmental pollutants (Nkoh et al., 2022). Additionally, biochar can enhance soil and environmental quality, fertility, structure, nutrient accessibility, and water retention capacity, ultimately leading to increased carbon storage capacity (Bartocci et al., 2016). Furthermore, biochar possesses a negative charge due to its structure which includes phenolic and carboxyl groups thereby increasing the surface negative charge and cation exchange capacity (Tan et al., 2020). Consequently, plant-derived carbon-based substances, such as compost or biochar, can maintain the carbon within the soil while concurrently eliminating CO2 from the atmosphere. Although stability depends on various factors, such as the type of amendment, nutrient content, and physical soil structure, the inclusion of biochar through applications can cause the accumulation of C in the soil for many decades. Hence, biochar application is believed to yield affirmative outcomes in diminishing soil degradation and greenhouse gas emissions originating from soil, amplifying C sequestration and soil nutrient content, and, therefore, counteracting climate change predicaments (Stavi and Lal, 2013; Schmidt et al., 2021; Ozlu et al., 2022).

Compost is an organic fertilizer produced by the decomposition of animal and plant waste in a humid-oxygenated environment. Technical terms will be explained whenever used. Composting refers to intricate metabolic processes executed by diverse microorganisms that use nitrogen (N) and carbon (C) to create their own biomass in the presence of oxygen. Compost is a multi-nutrient fertiliser that contains essential plant nutrients. Its characterisation depends on the processing conditions and the type of raw material used. The release of plant-useful nutrients from organic matter through mineralisation is directly linked to soil fertility. The adequate quality of compost is responsible for stimulating mineralisation processes through different biological mechanisms (Paulin and Peter, 2008). Composting can be achieved through various methods and equipment. Generally, the raw material, degree of decomposition and composting conditions differ between composting processes (Azim et al., 2018). The quality of the final compost largely depends on the raw material used. Besides the natural waste

originating from households, like segregated organic waste, debris in parks could also be mixed with non-biodegradable substances such as plastic residuals, rendering them unsuitable for application in cultivable regions. Therefore, it is advisable to evaluate the compost's quality before utilising it in fields (Chen et al., 2013). The application of biochar and compost to soil depends chiefly on their physicochemical properties and can serve as a useful guide. Physical properties that are crucial include surface area, pore size distribution, and particle density, while the primary chemical properties of biochar and compost comprise total carbon, pH, nutrient concentration, and electrical conductivity (Zahra et al., 2021a). The characteristics of these amendments are largely influenced by the biomass material utilised in their production (Bird, 2015). Figure 2 illustrates the diverse mechanisms employed in the reclamation of deteriorated soil through biochar and compost.

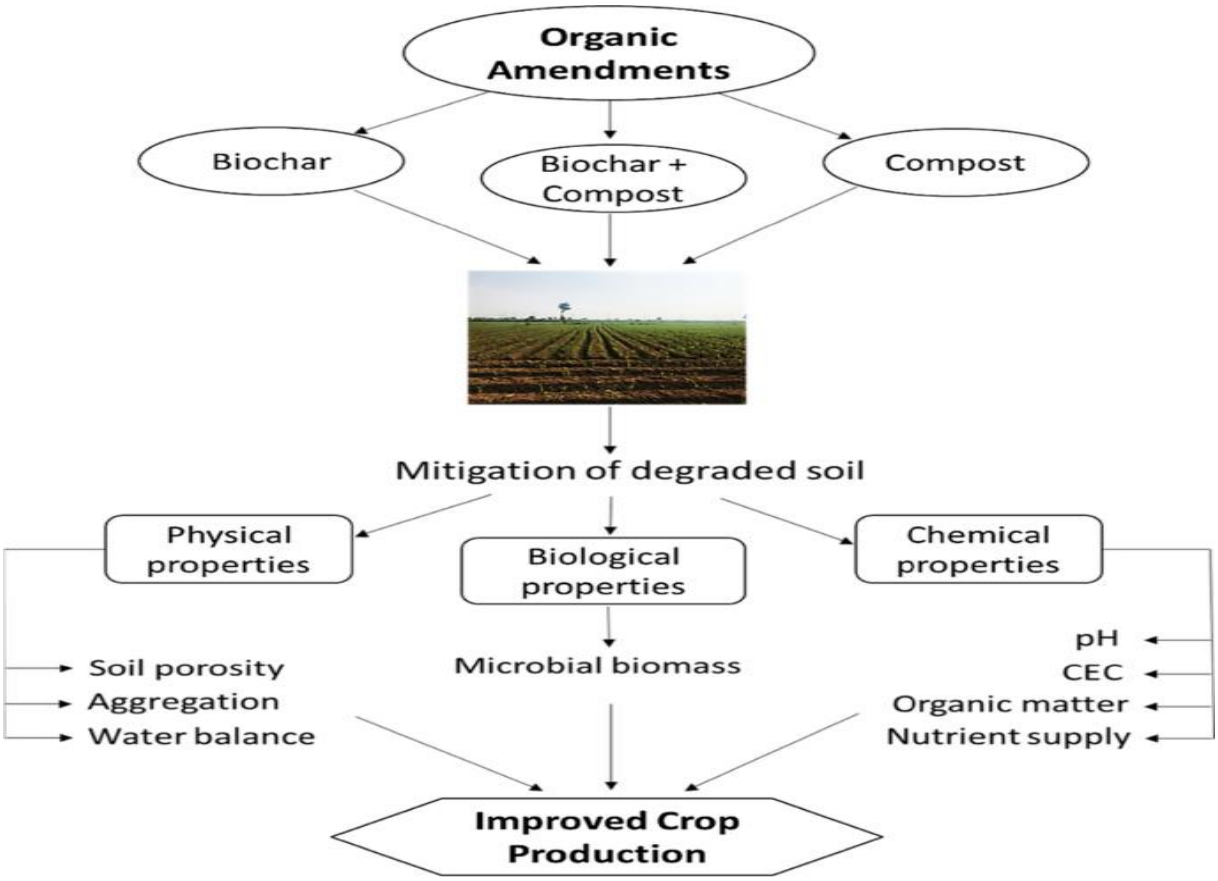


**Figure 2.** Mechanisms involved in the reduction of degraded soils following biochar/compost application (Zahra et al., 2021b)

## 4. Effect of Biochar and Compost on Soil Health

Soil health and continuity prove crucial on lands lacking organic matter and suffering from degradation. Soil health, which we describe as a soil's ability to perform a range of functions related to agriculture and the environment, proves crucial. These functions include productivity in both biomass and agronomy, management and input response, as well as resilience to biotic and abiotic strains (Doran and Zeiss, 2000; Srivastava and Ngullie, 2009). In the context of agricultural land use, soil health concerns the ability of soil to support animal growth and productivity whilst simultaneously maintaining or improving environmental quality (Doran and Zeiss, 2000). The interdependent cycle between soil and organic matter necessitates a close attention to both their management. Maintaining the biological cycling of soil organic matter and nutrients is crucial for strategic soil management and the sustainability of land management practices. The reduction in soil organic matter levels leads to diverse soil degradation processes, including erosion, compaction, salinisation, nutrient deficiency, loss of biodiversity, and desertification. This decline can lower soil fertility (Lal, 2015b) and ultimately impact soil quality. Therefore, it is vital to consider the interplay between these factors concerning the economic productivity of soil and environmental quality.

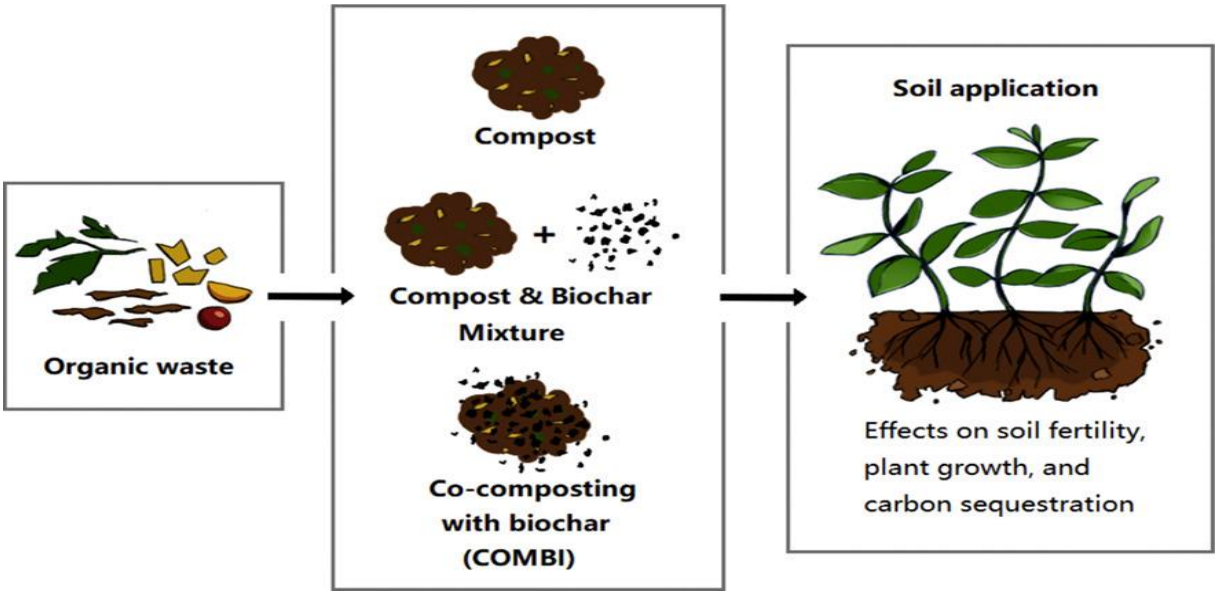


**Figure 3**. The role of composted biochar in plant growth (Wang et al., 2019)

Tillage and ploughing practices, along with soil management, have a direct impact on the sustainability of soil resources and their stability, resilience, and quality. Soil stability is the

term used to describe change under natural and anthropogenic disturbances, with soil resilience being the ability of the soil to recover under such circumstances (Lal, 2015a). Soil quality and resilience strongly affect soil fertility and environmental quality, but crop residue management and tillage practices can modify soil quality (Lal, 2008). Climate change and management practices can affect soil physicochemical and biological parameters, which serve as a set of composite soil quality indicators. Based on these soil properties, soil functionality and health can be evaluated (Allen et al., 2011; Zahra et al., 2021a). Various temporal and scale-based evaluations put forward numerous criterions for assessing soil quality. The deterioration of soil, particularly soil organic matter, has substantial implications for the electrical conductivity and quality of soil. Moreover, soil physics significantly impacts microbial activity in the soil. The deterioration of soil, particularly soil organic matter, has substantial implications for the electrical conductivity and quality of soil. Texture and structure of soil are yet another crucial factor in soil quality since it can potentially withstand soil erosion. The reduction in soil organic material is connected to the ground's water-holding capacity since soils that lack organic content diminish the water stability of soil aggregates (Allen et al., 2011).

**5. Effect of Biochar and Compost on Physical, Chemical and Biological Properties of Soil**

Despite the numerous studies on biochar and compost, innovative approaches to investigate their physical, chemical, and biological properties have led to an increase in research. One of the most prominent features of using biochar as a soil amendment is its effect on the physical properties of soil. The ability of biochar to hold water, increase soil porosity, and enhance surface functionality is a combination of its features (Suliman et al., 2017). Biochar increases porosity, particularly due to its porous structure, which enhances soil porosity, leading to improved water penetration. Previous research has shown that the application of biochar to infertile soils decreases soil bulk density and increases total pore volume and water holding capacity (Abel et al., 2013). Biochar application in soil has been found to result in higher infiltration rates and lower levels of erosion in the treated fields (Oguntunde et al., 2008). Soil physical properties, such as irrigation efficiency, aeration, and reduced flow, are related to soil infiltration rates (Fischer and Glaser, 2012). However, it has been observed that the application of compost has a significant effect on infiltration when applied to poorly drained, fine-textured, clayey soils. Thus, it was concluded that compost application increases water-holding capacity in coarse-textured soils and enhances infiltration rates in fine-textured soils (Brown and Cotton, 2011).

Studies have demonstrated that the application of biochar brings about considerable modifications in the chemical properties of soils, notably in relation to pH, organic carbon, cation exchange capacity, exchangeable cations, and soil quality, resulting in increased N fertiliser use efficiency (Chan et al., 2008; Bera et al., 2016). Additionally, biochar applications also lead to an enhancement in the nutrient uptake of plants, especially with regards to pH (soil reaction), which constitutes a critical factor for plant development and growth. In the conducted studies, it was found that composting of biochar, poultry manure, and pyrrolignose solution in soils with high salt content had led to notable decline in soil salinity, an increment of 0.3 in soil pH, and an increase in soil organic matter and P levels (Lashari et al., 2013).

Soil properties are influenced by various factors such as the raw material, the climatic environment and the activities of organisms. Soil organic matter is a significant factor affected by these differences. The presence of diverse organismal communities with varying levels of organic matter has distinct impacts on soil biological properties and biota (Lehman et al., 2011). The research findings illustrate that incorporating biochar and compost into soil results in increased soil porosity and altered biological activity via changes in enzyme activity, which creates a favourable habitat for microorganisms (Gomez et al., 2014). Biochar, characterized by a porous structure and high surface area, has the capability to adsorb soluble organic substances and inorganic nutrients, providing a favourable niche for microorganisms (Thies and Rillig, 2009). For instance, bacteria, actinomycetes, and arbuscular mycorrhizal fungi have a crucial function. Numerous studies have documented that microbial activities rise once biochar is added (Abujabhah et al., 2016; Murtaza et al., 2023). Additionally, high soil moisture content, along with improved aeration and soil aggregation, supports the growth of microbes in soil treated with biochar (Purakayastha et al., 2015).

## 6. Use of Biochar and Compost in Organic Matter Poor and Degraded Areas

It has been reported in many studies that biochar and compost application in degraded and organic matter-poor soils improves the physicochemical properties of the soil and thus the uptake of nutrients is made available to the plant (Zahra et al., 2021a; Shen et al., 2017). It has been determined that positive results are obtained with the addition of compost and biochar in increasing the amount of product obtained in crop production and improving soils. In particular, a significant change in plant growth, yield and root biomass has been reported by researchers (Agegnehu et al., 2015). Biochar can be an ideal bulking agent for composting nitrogen-rich

materials. Emissions from organic waste and crop residues can be avoided by preventing their natural decomposition in the soil.

Effective management and utilisation of crop residues on depleted land with low levels of organic matter can enhance the sustainability of integrated farming systems. Multi-purpose tree planting and allied activities may provide an alternative source of organic matter. Furthermore, biomass is suggested to be producible on abandoned and degraded agricultural land, resulting in positive impact on food security and biodiversity. The utilisation of biochar obtained from forage crops and legumes can substantially enhance land quality in such areas (Yuan and Xu, 2011). Meanwhile, the physical and chemical properties of soil can be influenced by the types of raw materials employed in biochar production, as well as the conditions and methods of pyrolysis (Alburquerque et al., 2014). Singh et al. (2010) found that wood biochar has greater total carbon but less ash, nitrogen, phosphorus, potassium, sulphur, calcium, magnesium, aluminium, sodium, and copper, as well as lower cation exchange capacity and exchangeable cations than manure-based biochar. Leaf biochar had intermediate levels. The study also identified variations in the reclamation effects of biochar produced from different crop residues in acidic soil. Biochar from legume crops generally results in a higher pH and liming effect on acid soils due to its greater alkalinity compared to biochar from non-legume crops (Yuan and Xu, 2011). Animal manure and crop residues are not typically recycled to maintain soil fertility, but rather utilised for energy purposes, particularly at home and as animal feed. This practice is commonplace in developing countries.

## 7. Conclusions

Biochar production, particularly its integration into agricultural soils formed in varied climatic conditions, presents a fresh avenue for developing soil health and creating a sustainable sink for atmospheric $CO_2$. Biochar exhibits remarkable potential in enhancing soil nutrient accessibility through the reduction of leaching and improvement of soil quality, besides the efficient usage of vital waste resources and avoidance of landfilling and environmental pollution. Biochar applications also hold significant potential for enhancing water retention and revitalising degraded lands, both of which are critical for improving agricultural productivity. It is imperative to increase and sustain land use efficiency to meet climate-induced transformations and provide sustenance for the burgeoning global population. Although the potential agricultural advantages of biochar and compost have been recognised in different climatic zones, their use in arid and semi-arid regions where the climate is fragile lacks

sufficient critical analysis. Certain studies indicate that the addition of biochar into soil affects physicochemical and biological properties of the soil. When biochar is applied with compost, it enhances soil porosity, providing a suitable environment for beneficial bacteria and mycorrhizal microorganisms. It can amplify soil quality by facilitating soil nitrification, which reduces greenhouse gas emissions. Using biochar has several advantages, including reducing environmental pollution, lowering fertilizer use and balancing water utilization. Biochar-compost application has a substantial impact on poor soil fertility when used on degraded land. The compost present in the biochar-compost mixture can offset nutrient deficiencies in the soil, resulting in an immediate economic advantage concerning crop yields. The application of biochar can also enhance nutrient and water retention, crop productivity, and carbon sequestration, specifically in soils with intermediate fertility. To better commercialise the use of biochar, it is necessary to optimise the feedstock properties and pyrolysis conditions suitable for farm conditions. It is imperative to conduct field investigations to determine the long-term potential of biochar as a sink for atmospheric CO2 sequestration. Furthermore, future studies could establish a framework by examining the influence of microorganisms on nutrient release, the surface properties of carbonized material in soil environments, comparing biochar-compost versus biochar-nutrient application methods, and evaluating the type and rate of biochar application.

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# LAMINITIS

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**Abstract**
Laminitis is a painful and destructive condition that mainly affects the nails of ruminant animals such as goats, sheep and cattle. This is categorized by damage and inflammation of the sensitive layers of the nails. This causes the animal to become lame. If left untreated, the situation will worsen and ultimately lead to major economic losses (Kaneps, 1996).
**Keywords:** Laminitis, animals, economic

## Introduction

According to Zhang et al. (2020), one of the three major illnesses commonly observed in dairy cows is hoof disease. Only mastitis has a greater effect on dairy farming than this illness (Nuss et al, 2019). According to Tian et al. (2021) laminitis is a widespread, aseptic, serous, non-purulent inflammation of the vascular layers and dermal papillae of the cow's hoof wall. Microanatomical and molecular abnormalities of the epidermal and dermal lamellae are linked to laminitis, a widespread and incapacitating foot disease in equids and other ungulates. The suspensory apparatus of the muscle may eventually structurally fail as a result of these damages (Galantino et al., 2020). Laminitis typically affects the laminae, or inside the hoof coat, in pastures (Zhang et al., 2018). On the surface, there are no lesions visible (Guo et al, 2021). Veterinarians are interested in laminitis because of this (Zeineldin et al, 2018). Laminitis is now a significant problem that negatively impacts the health and welfare of dairy cows and is a major cause of the cows' poor performance (Zhao et al., 2018). It has a significant negative impact on animal welfare and costs the dairy business a lot of money (Barcik et al., 2019).Thus, in order to improve dairy cow performance, study into the etiology, pathophysiology, diagnosis, and prevention of laminitis in cows is crucial (Lee et al., 2021). Laminitis's pathogenesis is unknown since its etiology is still up for debate (Liu et al., 2021). However, the prevailing theory of pathogenesis holds that when cows eat an excessive amount of concentrated feed, microbes in the rumen, particularly Streptococcus bovis, emerge.

Dairy farming in our country has been experiencing a significant structural change in recent years. While dairy cattle breeding, which was previously a small family business, was largely carried out in tied-stall and free-open barns and pastures, today a significant part of it is carried out on larger-scale farms with free-stall barns. Cows are exposed to better nutrition and management practices, and in parallel, productivity and performance are constantly increasing. As the herds grow, artificial structures and floor materials are widely used in enterprises. Dairy cattle, which are essentially a land animal; They are condemned to live in environments where materials such as iron, rubber and concrete, which are not suitable for their nature, are used predominantly. As a result of this; The incidence of hoof lesions and associated lameness has increased significantly in cows housed in freestall barns (Akköse and İzci, 2017).

In cattle breeding, foot diseases and deformed nails are of great importance in terms of productivity and economy (Yücel, 1982). Decrease in milk yield in cattle leads to problems such as failure in artificial insemination. As a result, it is inevitable to remove them from the herd and send them to compulsory slaughter (Alkan et al., 1992).

Laminitis is a painful and destructive condition that mainly affects the nails of ruminant animals such as goats, sheep and cattle. This is categorized by damage and inflammation of the sensitive layers of the nails. This causes the animal to become lame. If left untreated, the situation will worsen and ultimately lead to major economic losses (Kaneps, 1996).

Laminitis is considered the disease that leads to the formation of many foot diseases, especially sole lesions, that cause significant economic losses in cattle breeding. (Vermunt and Greenough, 1994). Laminitis; It is known as a diffuse and aseptic inflammation of corium ungulae with subacute, acute, chronic and subclinical courses (Weaver, 1988).

**Causes of Laminitis**

One of the most significant and financially difficult diseases affecting cattle nowadays is lameness. According to Langova et al. (2020), it presents as a shift in movement related to lesions, particularly in the pelvic extremities. The welfare of dairy cows is impacted by painful hoof diseases. Genetic and reproductive predispositions, stable technology, animal hygiene, and diet are all significant elements that impact the health of the limbs. One of the primary preventive variables influencing nail horn growth and quality, and consequently nail disease prevalence, is nutrition. The strength and structure of the hoof horn are affected by the composition of the feed ration (amino acids, minerals, vitamins and toxic substances that contaminate the feed ration or occur as fungal metabolites in the feed ration). Overweight animals are more prone to laminitis. In addition, animals with metabolic problems and conditions that disrupt blood flow in the body cause laminitis (Bell and Weary, 2000).

Nutrition and care conditions also play an important role in the formation of laminitis. It has been reported that subclinical laminitis lesions are more common in animals fed highly concentrated feeds than in animals fed low concentrated feeds, and that this condition is more observed in the postnatal period (Bargai and Levin, 1993).).

Injury or trauma on unhealthy ground can cause laminitis in cattle. Examples of trauma and injuries include not having the nails cut by experts, standing on hard ground for a long time, objects sinking into the nail base on gravel grounds, and the ground being constantly wet and humid (Vermunt and Greenough, 1994).

**Clinical Symptoms**

In general, animals are hunched over, reluctance to walk, inability to stand on all fours, in severe cases, fever, loss of appetite, weight loss, decrease in milk yield, problems in fertilization and of course lameness are known as general findings (Danscher et al., 2009).

When the sensitive area on the foot is touched, there is an increase in temperature and severe pain in the area. In some cases, excessive nail growth and breakage occur due to nail checks that are not performed on time. In this case, the animal feels the same feeling of pain (Goetz, 1989).

**The Link Between Laminitis and Acidosis**

Numerous studies have examined the connection between acidosis and laminitis in cattle (Thoefner et al., 2004; Danscher et al., 2009; Ding et al., 2020). By effectively reproducing the production of acute laminitis in cattle through oral administration of oligofructose, Thoefner et al. (2004) and Danscher et al. (2009) supported the conventional notion of laminitis pathogenesis by associating low ruminal pH with laminitis. The primary cause of rumen pH reduction is thought to be nutrition. In short, ruminal acidosis-induced initial systemic metabolic damage leads to vascular dysfunction in the nail, which subsequently results in dermoepidermal junction degeneration and loss of structural integrity in the laminar region of the nail. Due to the distal phalanx's displacement and subsequent compression of the sole chorion, lesions in the horn capsule occur, causing the sole and white line to become discolored (Ossent and Lischer, 1995). Subacute ruminal acidosis (SARA) is a common form of ruminal acidosis in cattle (Nocek, 1997; Greenough, 2007). When ruminal acidosis occurs, the release of lipopolysaccharide (LPS; endotoxin) and other inflammatory chemicals causes the rumen epithelium and blood circulation to express and synthesize more pro-inflammatory cytokines ( Zhao et al., 2018). Because endotoxins raise blood pressure, they can harm blood vessels, particularly the microcirculation in the nail. Bleeding and corium edema are anticipated outcomes. Compared to cows without laminitis, those with laminitis had higher levels of lactic acid and LPS (Guo et al., 2021). Acute, subacute, chronic, and subclinical laminitis have all been reported in cattle (Bradley et al., 1989).

**Genetics of Laminitis**

Endocrinopathies that result in hyperinsulinemia are known to be the most frequent cause of naturally occurring laminitis (Engiles et al, 2015). In experimental conditions, laminitis can be induced by administering exogenous insulin in sufficient amounts to cause abrupt hyperinsulinemia. This implies that insulin may play a role in the pathophysiology of laminitis (Gardner et al., 2017). Circulating insulin concentrations are especially elevated in response to a diet high in non-structural carbs (Karikoski et al., 2015). Additionally, it increases the quantity of insulin-receptor-bearing endothelial cells within the lamellae (Menzies et al, 2017). According to Tadros et al. (2019), each of these mechanisms has a role in the etiology of

laminitis. One recognized effect of IGF-1R stimulation is epithelial proliferation (Duan and Maki, 2016). It is assumed that IGF-1R mediates the action of insulin because epidermal lamellae do not express the insulin receptor (Kennedy and Lamming, 2016). Nonetheless, a study reveals that lamellar IGF-1R has a lesser affinity for insulin; as a result, insulin may affect lamellar epidermal cells directly or indirectly through another receptor (Hawkes et al, 2017). Increased activated ERK 1/2 and stress-activated protein kinase/Jun amino-terminal kinase (SAPK/JNK) after experimental laminitis induction using the CHO model suggest that the mitogen-activated protein kinase (MAPK) pathway may be a viable choice (Norton et al., 2019). Cell stress triggers a variety of interrelated stress response pathways, including autophagy, apoptosis, ER stress/UPR, and antioxidant response, regardless of the initiator (Lewis et al., 2017). Determining the remaining molecular links between these two signaling pathways will be crucial for comprehending the initial causes of lamellar degradation, as there is evidence to support a role for mTORC1 and IGF-1R in both experimental and naturally occurring laminitis (Nanayakkara et al., 2019).

**Conclusion and Recommendations**

Successful results have been obtained in many laminitis treatments. However, the expenses incurred during this period, productivity losses and whether the animal loses its breeding properties should also be taken into consideration. We can reduce the incidence of laminitis if we pay attention to the following preventive measures rather than treatment.

Considering the research, it is important to prevent laminitis by not giving excessive carbohydrate foods and preparing a balanced ration according to the animal's season. Animals should be housed in areas where they can roam freely and should never be kept in a permanent tethered system. Since more laminitis occurs in nails exposed to excessive moisture, the ground conditions must be dry and suitable. Animals should be given plenty of exercise. In addition, animals should be given vitamins and minerals that will strengthen the nail structure.

Researching genetic propensity could lead to early, focused treatments via nutrition, care, and possibly even medication in the future to avoid the challenging-to-treat ailment. It is theoretically possible to incorporate these loci into genomic selection schemes in order to lower the disease's incidence in subsequent generations. This is a promising field of study, but in order to reap the rewards, substantial monetary commitments and sample sizes will be needed.

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# A STUDY OF THE EFFECTS OF TECHNOLOGICAL CHANGES ON SOCIETY AND THE ENVIRONMENT

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**Abstract**
Simply said, technology is a tool created via the application of scientific knowledge to help produce goods and services and aid in problem-solving for humans. Examples of technology include the Internet, phones, automobiles, airplanes, children's toys, and other devices. The society has been tremendously touched by these pieces of technology. They have speed up and simplified the flow of people and products. People may now connect and share information more easily thanks to the Internet and mobile devices. It is impossible to survive without technology in the modern world. Today, technology is ingrained in daily life. The effects of technology on society and the environment will be thoroughly covered in this review paper.
**Keywords:** Technology, Society, Environment

**Objectives**:

1. To study about the present technological advancement
2. To study the effect of technology on society
3. To study the negative and positive effect of technology on environment.

**Introduction:**

Technology is the term refers to the actual application of scientific knowledge, as well as the apparatus and instruments that follow. We are now living in an era of fast transition, in which technology advancements are revolutionizing the way we live while also driving us deeper into disaster in the form of climate change and resource shortages.

Technology nowadays has significantly impacted into changed society. People used to live in temporary homes in rural areas before the development of advanced technology; the majority of these rural residents were based on hunters and gatherers. Major economic activity was non-existent at the period. Agriculture technology brought forth some of the major developments. This happens when people first discovered knowhow to cultivate and get their fields ready to grow food. Because there was more food available, more people began to live in cities and companies that produced vast quantities of products, leaving their rural dwellings.

Technology development has been essential in the production of more wholesome food, improving people's health. Nowadays, people eat cheaper, healthier food that is also easy to farm. Some individuals no longer go to hotels to eat their favourite foods since they can order them over the phone or via the Internet. Food has now started delivered to consumes homes or workplaces once they place an order. All individuals have a selection to choose from since goods like clothing, footwear, and bedding are manufactured in big quantities and at a range of prices.

**Environmental Impact of Technology:**

The industrial revolution gave birth to new technologies with enormous power. From roughly 1760 to 1840, this was the shift to new industrial methods in Europe and the United States. This has been followed by increased industrialisation and technical breakthroughs in industrialized nations across the world, with the environmental consequence of this technology including the exploitation and devastation of our natural planet.

This type of technological advancement may have harmed our planet in two ways: pollution and natural resource depletion.

**Pollution of the air and water:**

When dangerous or excessive amounts of gases such as carbon dioxide, carbon monoxide, sulfur dioxide, nitric oxide, and methane are injected into the earth's atmosphere, air pollution develops. The primary sources are all related to technology that arose during the industrial revolution, such as the use of fossil fuels, industries, power plants, mass agriculture, and automobiles. Air pollution has a significant influence on human and animal health, as well as global warming, because rising levels of greenhouse gases in the atmosphere trap thermal energy and cause the global temperature to rise.

**Technologies affect our life:**

In 2023, technology will have an impact on practically every area of daily living, including productivity, socializing, food and healthcare availability, and the safety and efficiency of transportation. It has facilitated learning, made knowledge more accessible, and allowed for the emergence of worldwide online communities.

**Positive Effects of Technology on Society:**

The following are some of the good consequences of technology that have helped society considerably as a result of technological growth.

- Increasing the human lifetime. People were treated with herbal remedies created from untamed plants before modern technology was developed. Because there were no equipment and it was difficult to identify illnesses, many people died as a result. Major tools like microscopes and scanners have been important in saving lives and detecting diseases since the advent of technology. Cancers, typhoid, malaria, and other illnesses that put people's lives in danger are treated by well-researched medications, medical facilities, and pharmacies. The use of technology in the treatment of diseases has extended life expectancy and expanded global population.
- Time savings. People place a lot of value on time. A life can be saved, as well as money. Before the invention of locomotives, transporting people and commodities was challenging and painfully slow. The means of transport were both people and animals. The roads would become muddy and inaccessible during wet seasons. People would frequently come under attack from wild animals and other adversaries. The technology of locomotives was used to resolve these issues. Since that time, it has been simpler to move big things across vast distances. The development of automobiles, aircraft, motorcycles, and ships has sped up and improved travel.

- An increase in output. Productivity gains are yet another advantage of technology. This was first seen during the Industrial Revolution, when devices like the spinning jenny were developed, increasing the output of clothing. Other tools and machines have since been developed. Computers can swiftly do complicated computations, transmit emails, and preserve data. People are readily and pleasantly transported to their workstations by vehicles, which improves their focus and productivity.
- Showing improved informational accessibility. The ease of access to computers, phones, and the Internet benefits society. People have access to and can learn a lot of knowledge through the Internet. Online distance learning makes it possible to learn and obtain a degree today. As evidenced by the coronavirus outbreak, people may now work from home.

**Negative Impact of Technology on Society & Environment:**

Although technology provides many benefits for society, it also has drawbacks. Few negative impacts are listed below. The development of technology causes quicker fossil fuel use, resource pollution, and deforestation. Humans now need to dig deeper to get additional resources because it is easier to abuse minerals.

**Discussion:**

Technology may have both good and bad effects on the environment. Recycling garbage, lowering carbon dioxide emissions, and generating renewable energy are all beneficial impacts. Natural resource depletion, air pollution, and trash build-up are some of the detrimental outcomes.

**Conclusion:**

Even while technology may not be able to solve every environmental problem, when used properly, it may always help to make things better. The improper use and use of technology is to blame for the state of the environment. The mishandling of technology, rather than the use of it, is what influences climate changes, global warming, and pollution. Conclusion: Unauthorized and out-of-control use of technology has a harmful influence on the environment, but it also has the potential to improve it if it is properly focused. Therefore, the application of technology affects whether it has a good or bad influence, therefore the goal should be to place technology in a way that will effectively treat the present state of the world around us.

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# THE ROLE AND IMPORTANCE OF COVER CROPS IN ORGANIC FARMING

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## Abstract
In addition to reducing and effective use of agricultural inputs, cover crops, which play a major role in improving product quality, have become the basic component of organic agriculture with their contributions to the ecological environment. Considering the increasingly deteriorating human health, the ecological environment that is under great threat by being polluted with chemicals, the worsening climatic conditions and economic conditions, the importance of cover crops is increasing day by day and is understood by people. Cover crops, which are effective in preventing erosion, one of today's major problems, also play an active role in combating drought by preserving soil moisture. In addition, cover crops, which have an important place in the control of plant pests as well as plant diseases and weed control with their various features, also reduce agricultural inputs by contributing to the enrichment of the soil with the organic and inorganic matters they provide. It also contributes positively to the structure of the soil by increasing biological activity. In this study, not only organic farming but also today's agricultural problems will be touched upon. By examining cover crops in detail, it also aims to combat drought, which is one of today's major problems, to obtain soils rich in mineral and organic matter, and to prevent unnecessary expenses by reducing inputs in agricultural areas and soils with the desired structure. Cover crops will be examined in detail by examining worldwide studies that synthesize cover crops and organic agriculture for a healthy life and ecological environment away from chemicals.
**Keywords:** organic farming, cover crops, drought, legumes, grasses, forage crops

## Introduction

**Organic Agriculture** is widely practiced in the world and its popularity is increasing over the years. The importance of Organic Agriculture is emerging. Organic farming principles, which emphasize sustainability, protecting the environment and focusing on natural processes, are very important among consumers and farmers around the World (Schmid, 2007).

As a result of this widespread adoption of organic agriculture, it has experienced significant growth worldwide. According to the data of the United Nations Food and Agriculture Organization (FAO), organic agriculture is practiced in more than 100 countries. In many European countries, especially within the EU, a significant amount of agricultural land is devoted to organic farming. Countries such as Germany, France and Italy are among the leaders in organic agriculture. Organic agriculture is generally regulated by certification programs and standards. Different countries have their own organic certification standards, and some comply with international standards such as those set by the International Federation of Organic Agriculture Movements (IFOAM). Increasing consumer awareness on environmental and health-related issues increases the demand for organic products (Geier,2007).

Consumers often choose organic products due to their known health benefits, reduced exposure to synthetic chemicals, and support for sustainable agricultural practices. While organic farming offers numerous benefits, it also faces challenges. These challenges include the transition to organic farming, potential yield fluctuations, and the high costs associated with organic production. Many governments around the world have implemented policies and initiatives to support organic agriculture. Although organic agriculture has gained momentum worldwide, its share of total agricultural land is still relatively small compared to conventional agriculture. The movement towards organic practices reflects a broader interest in sustainable and environmentally friendly approaches to food production.

Organic farming is an approach to agriculture that emphasizes the use of natural and sustainable practices while avoiding synthetic inputs such as pesticides, herbicides, and genetically modified organisms. The principles of organic farming aim to promote ecological balance, preserve biodiversity and improve soil health. Organic farmers prioritize soil health, recognizing that healthy soil is crucial to producing nutritious products. In organic agriculture, practices such as crop rotation, cover crops, compost and organic matter use are widely applied to increase and maintain soil fertility.

The necessity of systematically changing the plant species grown in a certain area over time emerges. Crop rotation helps break pest and disease cycles, improve soil structure and increase nutrient availability.

Organic growers use natural methods to control pests and diseases rather than relying on synthetic pesticides. This may include introducing beneficial insects, implementing companion plantings (where some plants are grown together to deter pests), and using biological controls. Organic farming prohibits the use of synthetic pesticides, herbicides and fertilizers. Instead, farmers use organic alternatives such as neem oil, copper sulphate and natural fertilizers such as compost. Organic agricultural producers prefer traditional growing methods to develop new crop varieties that are better adapted to organic conditions.

**Cover Crops** play a vital role in organic farming, contributing to the overall sustainability, soil health, and productivity of the agricultural system. In agricultural systems, cover crops have various positive effects on soil (Roberts et al.,2018).

The impact of cover crops on soil health is multifaceted, affecting physical, chemical and biological aspects. Cover crops create a protective cover on the soil, reducing the impact of raindrops and preventing soil erosion.

This is especially important during heavy rains or sloping terrain. The root systems of cover crops help improve soil structure by creating channels for water movement and increasing aeration. This can lead to better water infiltration, less compaction and better drainage.

Some cover crops, particularly legumes, have the ability to fix atmospheric nitrogen through a symbiotic relationship with nitrogen-fixing bacteria. When cover crops are incorporated into the soil, they release nitrogen and contribute to increased soil fertility. Decomposition of cover crops also increases nutrient cycling by releasing other essential nutrients (Wszelaki and Broughton,2012).

Cover crops help suppress weed growth by competing with weeds for sunlight, water, and nutrients, and some cover crops release allelopathic compounds that inhibit the germination and growth of certain weed species.

The root systems of cover crops help improve soil water retention. This is beneficial in both reducing water runoff and increasing water availability for subsequent crops.

As cover crops decompose, they add organic matter to the soil. Increased organic matter improves the soil structure, water retention capacity and provides a food source for beneficial soil microorganisms. They also contribute to a more diverse and active microbial community

in the soil. This microbial activity is crucial for nutrient cycling, organic matter decomposition, and other soil processes. The cover provided by cover crops helps moderate soil temperatures, protecting the soil from extreme heat and cold. This is especially important to maintain microbial activity and nutrient availability. Some cover crops can disrupt pest and disease cycles. For example, biofumigants coat plants such as mustard, releasing compounds that suppress soil-borne pests and diseases. Some cover crops can affect soil pH. For example, some legumes can slightly increase soil acidity over time, which can be beneficial in soils that are too alkaline (Kaspar and Singer, 2008).

Cover crops encourage soil biodiversity, creating a more diverse and habitat-rich environment. This diversity is necessary for a healthy soil ecosystem. Cover crops contribute to overall soil health by eliminating erosion, improving nutrient cycling, improving soil structure, and supporting a diverse and active soil ecosystem. Specific impacts may vary depending on the type of cover crops used, their management, and the characteristics of the farming system. One important benefit of some cover crops is their ability to fix atmospheric nitrogen through a symbiotic relationship with nitrogen-fixing bacteria. This process is especially common in legume cover crops. Many legume cover crops, such as clover, vetch, peas and clover, form a symbiotic relationship with nitrogen-fixing bacteria known as rhizobia (Giller et al., 2016).

As the legume cover crop grows, the roots release compounds that attract and infect the rhizobia. In response, the plant creates special structures called nodules on its roots to host bacteria.

Within root nodules, rhizobia convert atmospheric nitrogen (N2) to ammonia (NH3) through a process called nitrogen fixation. This ammonia can then be converted into forms of nitrogen, such as ammonium and nitrate, that plants can use for growth. The legume cover crop absorbs the fixed nitrogen compounds in the nodules and uses them for its own growth. This additional nitrogen improves the nutritional quality of the plant by contributing to its overall nitrogen content (Fageria et al., 2005).

When a legume cover crop is terminated and incorporated into the soil, the nitrogen-rich plant material decomposes, releasing nitrogen into the soil. This process is often called "green manure".

Nitrogen released into the soil from the decomposed legume cover crop provides an organic nitrogen source for subsequent crops (Yang et al., 2019). This can reduce the need for synthetic nitrogen fertilizers and contribute to increased soil fertility.

Incorporating legume cover crops into a crop rotation plan can effectively manage soil nitrogen levels. For example, a legume cover crop may precede a nitrogen-requiring plant and help meet the nutrient needs of the next plant. Nitrogen fixation by legume cover crops has environmental benefits as it reduces reliance on synthetic nitrogen fertilizers that can contribute to water pollution and greenhouse gas emissions.

It is important to note that the effectiveness of nitrogen fixation by cover crops can be affected by a variety of factors, including the specific cover crop species, the presence of compatible rhizobia in the soil, and environmental conditions. Proper management practices, such as inoculating cover crop seeds with appropriate rhizobia species, can improve nitrogen fixation abilities. Additionally, selecting cover crops based on the nitrogen needs of subsequent crops in rotation is an important consideration for optimizing the nitrogen cycle in organic farming systems (Camarotto et al., 2018). Cover crops used in organic farming include legumes such as clover and vetch, grasses such as rye and oats, and a variety of cover crop mixtures tailored to specific goals and environmental conditions. The choice of cover crop depends on factors such as climate, soil type, and the goals of the organic farming system.

In organic farming, cover crops are considered a key component of a holistic and sustainable agriculture approach and contribute to the overall health and productivity of the farm ecosystem.

The adaptability of cover crops depends on several factors, including climate, soil type, and specific farming goals. Different cover crops have different adaptations, making them suitable for certain conditions and purposes. Rye, oats and some types of clover are well suited to cool climates and can be planted in autumn or early spring. Buckwheat and sunflowers are examples of warm-season cover crops. They thrive in warmer temperatures and are usually planted in late spring or early summer. Cover crops such as clover and vetch can adapt to a variety of soil types and increase soil fertility by fixing nitrogen. They are generally suitable for well-drained soils. Radishes and some cover crops of the grass family have deep tap roots that can help break up compacted soils and improve drainage (Gruver et al. 2014). Grasses forage crops, including rye and oats, are widely used in erosion control due to their root systems.

Choosing between legumes and grasses as cover crops depends on the specific goals, soil conditions, and desired benefits for the farming system. Both legumes and grasses offer unique advantages, and in many cases a combination of both can be used for a more comprehensive cover crop strategy. Including legumes in a crop rotation plan can break pest and disease cycles and diversify the types of plants grown over time.

Grasses cover crops can be used to diversify rotations and provide different benefits, such as nutrient cycling and weed suppression (Işık et al., 2009). Some legumes thrive in well-drained and well-aerated soils. They can be especially useful in regions with moderate temperatures. Grains, which include cold season and warm season varieties, can be selected according to climatic conditions and are generally more resistant in different climates.

Some legumes, such as clover species, can serve as nutritious fodder for livestock. Additionally, some grasses, such as annual ryegrass, can be used as feed for livestock.

In many cases, cover crop mixtures, or legumes and grasses, can provide the benefits of both types of plants. Cover crop selection should be compatible with specific farm goals, soil conditions, and crop rotation plan. Consulting local agricultural extension services or experts can provide specific recommendations based on regional conditions and specific needs. Cover crop installation is an integral part of sustainable and regenerative agriculture practices. By carefully planning and implementing cover crop strategies, farmers can improve soil health, reduce erosion, improve nutrient cycling, and contribute to more resilient and sustainable agricultural systems (Clark, 2008).

Cover crops encompass a wide variety of plant species that are grown primarily to cover and protect the soil rather than for harvest. The selection of cover crops depends on specific goals, climate, and soil conditions (Demiroğlu Topçu et al., 2020). Some common types of cover crops (Wilke and Snapp, 2008) Trifolium spp.: Various species of clover, such as red clover and white clover, are commonly used as cover crops. They are known for their nitrogen-fixing ability. Vicia spp.: Vetch is another leguminous cover crop that fixes nitrogen and provides ground cover. Secale cereale: Winter rye is a popular cover crop that is hardy and provides excellent soil coverage. It is often used to prevent erosion and scavenge excess nutrients. Avena sativa: Oats are quick-growing and are often used in cooler seasons as a cover crop. Lolium multiflorum: A fast-growing grass that is commonly used for erosion control and weed suppression. Brassica spp.: Mustard cover crops, such as oilseed radish, have biofumigant properties that can suppress soil-borne pests and diseases. Brassica napus: Rapeseed is another brassica that is used as a cover crop (Mutch and Martin, 1998). Legume-Grass Mixtures: Trifolium incarnatum and Lolium multiflorum: This combination provides the benefits of both legumes and grasses, with nitrogen fixation and good soil coverage. Pisum sativum: Winter peas are a cool-season legume cover crop that can fix nitrogen and provide ground cover. Fagopyrum esculentum: Buckwheat is a warm-season cover crop that grows quickly and is effective in suppressing weeds. Vicia villosa: Hairy vetch is a winter cover crop that fixes

nitrogen and provides excellent soil coverage. Phacelia tanacetifolia: Phacelia is often used as a cover crop to attract pollinators and beneficial insects while improving soil structure. Helianthus spp.: Certain varieties of sunflowers are used as cover crops to break up compacted soil and scavenge nutrients. Crotalaria juncea: Sunn hemp is a warm-season legume cover crop that is well-suited for tropical and subtropical regions (Wang et al., 2002).

The choice of cover crops depends on factors such as climate, soil type, specific goals (e.g., nitrogen fixation, weed suppression), and the subsequent cash crops in the rotation. Crop rotation and the inclusion of diverse cover crops play a crucial role in sustainable agriculture, contributing to soil health and overall ecosystem resilience.

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# POSSIBILITIES OF USING SOME THORN SPECIES AS FEEDING

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**Abstract**
Nowadays, the problem of adequate and balanced nutrition emerges as an increasing problem day by day. Roughages are indispensable feed sources in animal husbandry and it is a fact that there is a serious shortage of quality roughage in our country's animal husbandry. As in many parts of the world, roughage problems arise from time to time in our country due to drought or other reasons, and animal production is damaged. To solve the feed problem, roughage is generally imported from abroad. In this regard, quality forages that are relatively cheap and have a positive effect on the digestive activities of ruminants, meadows and pastures, which are the main source of these forages, and alternative roughage sources that can be included in crop rotation plans come to the fore. In our country, as a result of irregular grazing regimes, misuse of agricultural lands and mechanization in agriculture, our pasture areas have shrunk and the productivity obtained from existing pastures has fallen far behind developed countries. Although there are many roughage feeds that can be used as alternatives in our country, the types of roughage used are limited. As the main roughage source in Türkiye; meadow-pastures, legume-grasses forage crops, stalks and straw of cereals are used. The use of thorns in animal feeding is not very common and a limited number of studies have been found in the literature. In order for farmers to include any plant in the production system, it is necessary to know some features of that plant. Many of the thorny weeds in pastures have high nutritional value. Thorns are generally known as famine forage. In this study; It is aimed to evaluate the usage possibilities of some thorn species in animal feeding and their use as roughage by examining the thorn species in detail.
**Keywords:** Roughage, forage crops, thorn, alternative crops

## Introductıon

With the rapidly increasing population and difficult economic conditions, human nutrition is becoming less productive throughout the day. Animal perishables are of great importance for the balanced and adequate nutrition of human beings (Özkan and Demirbağ, 2016).

Pastures are natural resources where quality and cheapest forage is provided (Altın et al., 2011). Roughage plays an important role in ruminant rations because it provides fillers as well as nutrients such as energy, protein and minerals. As in many parts of the world, roughage problems arise from time to time in our country due to drought or other reasons, and animal production is damaged. However, preliminary studies have shown that thorns, which grow in marginal areas in many regions of our country and where animals cannot graze directly, can be used to meet the roughage needs of ruminant animals. Thorns are generally known as famine food. The use of thorns in animal feeding is not very common and a limited number of studies have been found in the literatüre (Giray, 2019)

In order for farmers to include any plant in the production system, it is necessary to know some features of that plant.

Roughages have an important place in animal nutrition because they meet both the nutritional and filler needs of ruminants. The degree of digestibility of roughage depends on plant-specific characteristics (Budak and Budak, 2014). It may not be possible to reach the potential digestibility level and potential feed consumption of the feed due to the interaction between the nutrients in the feed and other feeds in the ration or due to the animal itself. It is also obtained from individually grown plants such as corn, alfalfa, sainfoin and oats. In addition, by-products such as stalks and straw remaining after the grain feed is obtained are used as roughage to meet the needs of ruminant animals (Giray, 2019). There are significant differences between the composition and nutritional values of roughage used in the feeding of ruminant animals (Atalay and Kamalak, 2021). One of the richest families in Turkey is the Asteraceae family with 447 species. It is a family representing 1100 genera and around 2500 species worldwide.

**Cirsium arvense (L.) Scop.** Cirsium arvense, a perennial plant, is a plant from the Asteraceae family and is naturally distributed in Europe, Asia and northern Africa. In our country, in Istranca, Çatalca-Kocaeli, Ergene, Southern Marmara, Western, Central and Eastern Black Sea, Inner Western Anatolia, Upper Sakarya, Middle Kızılırmak, Upper Kızılırmak, Upper Fırat, Erzurum-Kars, Upper Murat-Van, Antalya, Adana sub-regions. It has a natural distribution (Figure 1).

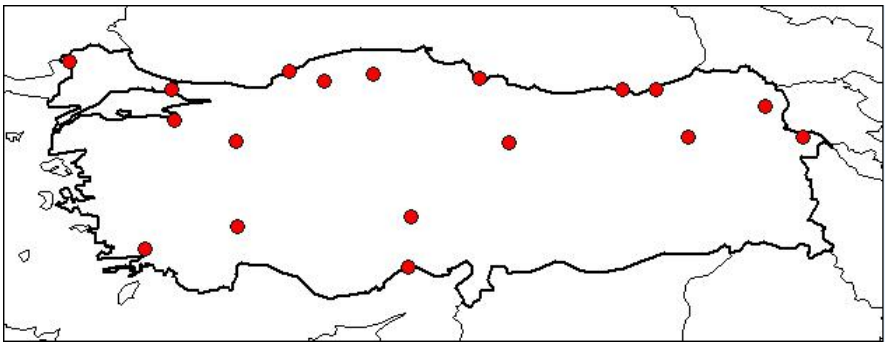

Figure 1: Distribution of Köygöçüren thistle in Türkiye (Anonymous, 2023a)

The genus name comes from Ancient Greek meaning swollen vein. It indicates that some species of the genus are used for treatment in cases of vascular swelling. The species name comes from Latin meaning cultivated area. It indicates that the species is commonly seen on field edges. Cirsium arvense, which can be observed at altitudes up to 1600 meters above sea level, is an invasive species and has spread over large areas. They usually grow on roadsides, along streams, in fruit and vegetable gardens, ditches, pastures, agricultural lands, steppes, thuja oak and chestnut forests. Cirsium arvense is a perennial herbaceous plant. It can grow up to two meters tall. The plant is green and abundantly branched, erect, smooth and hairless. The stems are hollow. It forms large colonies with thick roots.

The leaves are dark green, lanceolate or oblong-lanceolate, alternately arranged and sessile. They are spiny, lobed, 15 to 20 cm long, 2 to 3 cm wide. While the top of the leaves are hairless, short white hairs appear underneath. (Doğan, 2023).



Figure 2: Cirsium arvense Pre-Flower Period (Original)

Cirsium arvense, which begins to bloom in June, continues to bloom until September (Dirmenci et al.,2020, Anonymous, 2023b).



Figure 3 : Cirsium arvense Flowering Period (Original)

The flower heads are 10-22 mm in diameter and lilac or rose pink in color. Flowers are mostly bisexual. The plant is bisexual and the seeds of the plant are long, flattened, dark brown in color, 3-4 mm long and have pappus.

Başbağ and Sayar (2023) reported that the crude protein ratio of the dry grass samples of the Cirsium arvense plant was 14.99%, the ADF ratio was 30.28%, the NDF ratio was 35.27%, the RFV ratio was 178.



Figure 4: Cirsium arvense Post-Flower Period (Original)

**Scolymus hispanicus L. :**Scolymus hispanicus, a member of the Asteraceae family, is native to Southern Europe and Western Asia. This plant is generally found widely in the Mediterranean regions and coasts. It also grows in countries such as Italy, France, Greece and Spain. In our country, it is widely found in the Marmara, Central Anatolia, Aegean, Mediterranean and Black Sea regions. Scolymus hispanicus L. is known by names such as

golden thorn, yellow diken, akkiz, saricakiz, akdiken in our country (Sarı et al., 2019). It is a wild plant that grows easily.

It is an annual, biennial or perennial, herbaceous, thorny plant that can grow up to 1 meter tall and is therefore not afvevefected much by drought.



Figure 5: Scolymus hispanicus (Original)

The leaves are generally curly, thorny at the edges and tips, green, with white spots on them.



Figure 6: Scolymus hispanicus (Original)

In the Aegean and Mediterranean regions, it begins to bloom in June and continues until September. The flowering period gets delayed as you move towards the inner regions and the north (Güllüdağ and Yoldaş, 2015).

Flowers bloom at the leaf axils and tips of the side branches on the developing crown. Usually one flower forms in each leaf axil. The flower heads are 2 to 3 cm in diameter, bright yellow and orange-yellow. The outer surface is sparsely white hairy (Sarı et al 2011). Its flowers are herbal. Seeds ripen in August-September. The edges of the seeds have a winged, flat, scaly structure.

Gülümser et al., (2022) showed that the crude protein ratio of the dry grass samples of the hop plant was 15.76-20.8%, the ADF ratio was 35.76-44.09%, the NDF ratio was 48.63-59.80%, the K ratio was 2.12-2.20%, the P ratio was 0.30%. They reported that the Ca ratio varied between 0.37%, the Ca ratio between 0.87-1.16%, and the Mg ratio between 0.46-0.54%.

**Carduus nutans L. :**Although it is generally called Musk Thistle in Turkish literature, in some regions it is known as Kerbeş, Kangal, Eğri Eş Dikeni, Camel Thorn or Yıldırgöz Thorn. Carduus nutans L., a member of the Asteraceae family, is an annual, biennial and perennial herbaceous plant. It naturally spreads in Europe and Asia. The plant, an invasive species, is distributed throughout much of the world.

In our country, Çatalca-Kocaeli, Ergene, Southern Marmara, Western and Eastern Black Sea, Main Aegean, Inner Western Anatolia, Upper Sakarya, Middle Kızılırmak, Upper Kızılırmak, Konya, Upper Fırat, Erzurum-Kars, Upper Murat-Van, Antalya, Adana lower It has a natural distribution in the regions (Figure 7).

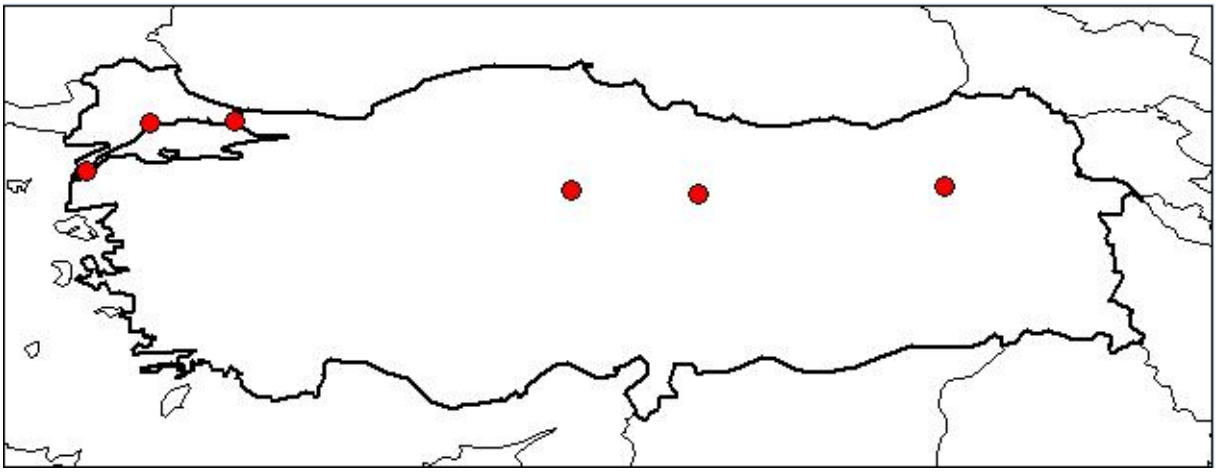

Figure 7: Distribution of Musk Thistle in Türkiye (Anonymous, 2023c)

The plant, which can be observed at altitudes up to 1600 meters above sea level, can grow up to 1 to 1.5 meters and is very branched. The leaves of the plant, whose stems and leaves are spiny, are dark green and have a two-lobed, slightly hairy surface. It has sharp thorns at the tip of the leaves (Tan and Temel 2012).



Figure 8: Carduus nutans (Orijinal)

Carduus nutans begins to bloom in July and produces red-purple flowers (Doğan, 2023). Flower head diameters are between 3.8 and 7.6 centimeters, and are magnificent and fragrant.



Figure 9: Carduus nutans (Original)

It is difficult to distinguish it from other thistle species until the flowers appear. Mature flowers hang 90-120 degrees from the stem. They produce thousands of straw-colored and hairy seeds. They start to spread seeds one month after the flower form (Doğan, 2023). Because it is a thorny plant, only donkeys, camels, and goats partially graze it when the plant is edible fresh.

Carduus nutans (Anonymous, 2023d)



Carduus nutans (Original)



**Lycium anatolicum A. Baytop & R. Mill:** Lycium anatolicum, which has a different family compared to the other described thorns, is an endemic species from the Solanaceae family. In Turkey, it spreads in Ankara, Erzincan, Eskişehir, Kayseri, Kırşehir, Nevşehir, Şanlıurfa, Van and Yozgat (Figure 10).

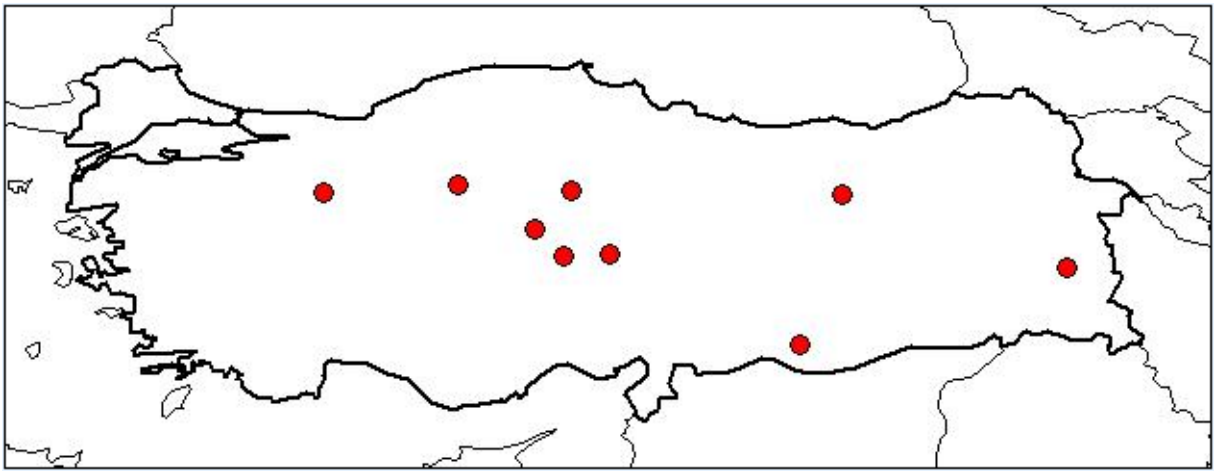

Figure 10: Spread of Lycium anatolicum in Türkiye (Anonymous, 2023e)

Scientists examining the anatomical structure of the Lycium anatolicum, identified and named by Asuman Baytop (Selvi et al., 2009) They reported that there are 70 species of the Lycium genus in the world, 7 of which are in Turkey.

Lycium anatolicum It is a bushy species that can grow up to 1-2 meters. Its branches are gray in color and have a hard texture. It has sparse strong thorns. Its leaves are narrow, elliptic-

reverse-lanceolate, pointed at the tips, and measure -5 x0.1-0.5 cm. The edges are convex but become concave at the base towards the petiole (Floranatolica, 2023).

Figure 11: Lycium anatolicum (Anonymous, 2023f)




Flowering occurs between April and November. Flower board consists of 1-5 flowers (Acar et al., 2022). The flower cluster consists of 1 to 5 flowers. Flower stalks are 2-18 millimeters. The calyx is bell-shaped, two-lobed, and measures between 2.5-30.5 millimeters.

The entire crown part is 9-12 mm long, the tube part is cylindrical, 5 mm in diameter and 6-8 mm in length. Lobes diffuse or bent backwards, 3-4 mm, and margins sparsely or densely ciliated; Petioles are hairy at the base and at the end of the tube of the free part (Floranatolica, 2023). The fruit is dark red brown, spherical and 3-4 millimeters long and is stated to bloom generally in April and November (Fırat and Aksoy, 2014)

It has been determined in field observations that the Lycium anatolicum , a common endemic species, is loved and eaten with appetite by small ruminants (Acar et al.,2022). In the study, in leaves of the plant was found to be the crude protein ratio 27.52% /DM, the ADF and NDF ratios were 26.05%/ DM and 31.03%/DM, respectively, and TDN was 58.10%/DM. The results showed that the Konya location (64.70%) had a higher TDN value than the Ankara location ( 51.10%).

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# FARKLI İNCİR ÇEŞİTLERİNE AİT SOĞUK PRESS ÇEKİRDEK YAĞLARININ KİMYASAL ÖZELLİKLERİ VE ANTİFUNGAL ETKİLERİ

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**Özet**
Moraceae familyasına ait olan incir 800 farklı türü bulunan bir meyvedir. Eski zamanlardan beri Ficus türünün meyveleri (Ficus spp.) gıda olarak ve halk hekimliğinde birçok hastalığın tedavisinde kullanılmaktadır. Günümüzde meyveleri kadar yaprak ve çekirdeklerinin potansiyel sağlık faydaları üzerine araştırmalar yapılmaktadır. Soğuk press ile elde edilen incir çekirdeği yağları doymamış yağ asitlerince zengindir. Bu çalışmanın amacı soğuk press yöntemi ile elde edilen iki farklı çeşit incir çekirdeği (Ficus carica L. cv 'Bursa Siyahı' ve Ficus carica L. cv 'Sarılop') yağının kimyasal özelliklerinin ve antifungal etkilerinin belirlenmesidir. Bu çalışmada Ficus carica L. cv 'Bursa Siyahı' ve Ficus carica L. cv 'Sarılop' çekirdek yağlarının sırasıyla özellikle linolenik (% 42.17 ve % 39.48) ve linoleik (% 31.07 ve % 31.62) asitlerce zengin olduğu tespit edilmiştir. Antifungal etki için 5 farklı küfe (Aspergillus flavus, Penicillium expansum, Mucor racemosus, Rhizopus nigricans, Cladosporium cladosporioides) karşı etkileri disk difüzyon yöntemi ile belirlenmiştir. Ayrıca minimum inhibitör konsantrasyon (MIC) ve minimum fungusidal konsantrasyon (MFC) değerleri tespit edilmiştir. Ficus carica L. cv 'Bursa Siyahı' çekirdek yağı P. expansum için güçlü antifungal etki (27.87 mm zon çapı) gösterirken Ficus carica L. cv 'Sarılop' çekirdek yağı A. flavus için güçlü antifungal etki (18.35 mm zon çapı) göstermiştir. Hem Ficus carica L. cv 'Bursa Siyahı' hem de Ficus carica L. cv 'Sarılop' çekirdek yağlarının düşük konsanstrasyonlarının A. flavus inhibisyonu için yeterli olduğu belirlenmiştir. Ficus carica L. cv 'Bursa Siyahı' çekirdek yağının A. flavus için MIC ve MFC değerleri sırasıyla 0.018 ve 0.006 mg/L'dir. Ficus carica L. cv 'Sarılop' çekirdek yağının A. flavus için MIC ve MFC değerleri sırasıyla 0.047 ve 0.031 mg/L'dir. Elde edilen veriler doğrultusunda incir çekirdeği yağının antifungal etkisinden teknolojik anlamda faydalanılabileceği düşünülmektedir.
**Anahtar kelimeler:** Ficus carica, çekirdek yağı, soğuk pres, antifungal

# CHEMICAL PROPERTIES AND ANTIFUNGAL EFFECTS OF COLD PRESS SEED OILS OF DIFFERENT FIG VARIETIES

**Abstract**

Fig, belonging to the Moraceae family, is a fruit with 800 different species. Since ancient times, the fruits of the Ficus species (Ficus spp.) have been used as food and in folk medicine to treat many diseases. Nowadays, research is being done on the potential health benefits of its leaves, seeds, and fruits. Fig seed oils obtained by cold pressing are rich in unsaturated fatty acids. This study aims to determine the chemical properties and antifungal effects of two different types of fig seed (Ficus carica L. cv 'Bursa Siyahı' and Ficus carica L. cv 'Sarılop') oil obtained by cold press method. In this study, it was determined that Ficus carica L. cv 'Bursa Siyahı' and Ficus carica L. cv 'Sarılop' seed oils were rich in linolenic (42.17% and 39.48%) and linoleic (31.07% and 31.62%) acids, respectively. For its antifungal effect, its effects against five different molds (Aspergillus flavus, Penicillium expansum, Mucor racemosus, Rhizopus nigricans, and Cladosporium cladosporioides) were determined by the disk diffusion method. Additionally, minimum inhibitory concentration (MIC) and minimum fungicidal concentration (MFC) values were determined. Ficus carica L. cv 'Bursa Siyahı' seed oil showed a strong antifungal effect (27.87 mm zone diameter) for P. expansum, while Ficus carica L. cv 'Sarılop' seed oil showed a strong antifungal effect (18.35 mm zone diameter) for A. flavus. It was determined that low concentrations of both Ficus carica L. cv 'Bursa Siyahı' and Ficus carica L. cv 'Sarılop' seed oils were sufficient for A. flavus inhibition. The MIC and MFC values of Ficus carica L. cv 'Bursa Siyahı' seed oil for A. flavus are 0.018 and 0.006 mg/L, respectively. The MIC and MFC values of Ficus carica L. cv 'Sarılop' seed oil for A. flavus are 0.047 and 0.031 mg/L, respectively. In line with the data obtained, it is thought that the antifungal effect of fig seed oil can be beneficial technologically.

**Keywords:** Ficus carica, seed oil, cold press, antifungal

## Giriş

Bitkiler eski çağlardan günümüze insan yaşamını iyileştirmek için kullanılmıştır. Bitkilerin besinsel rolleri ve sağlık yararları dünya çapındaki pek çok araştırmanın konusu olmuştur ve olmaya devam etmektedir (Barolo ve ark., 2014). Özellikle bazı egzotik meyveler, antioksidan özellikleri ve esas olarak fenolik asitler, flavonoidler, proantosiyanidinler, iridoidler, kumarinler, hidrolize edilebilir tanenler, karotenoidler ve antosiyaninlere dayanan fitokimyasal bileşimleri nedeniyle umut verici sağlık yararları olan fonksiyonel gıdaların değerli bir kaynağı olarak kabul edilir (dos Anjos Cruz ve ark., 2022). Moraceae, tüm parankimatöz dokudaki sütlü lateks, tek cinsiyetli çiçekler, anatropöz ovüller ve toplanmış sert çekirdekli meyveler veya akenlerle karakterize edilen yenilebilir türler açısından çok zengin bir kapalı tohumlu bitki ailesidir (Barolo ve ark., 2014). Ficus, dünya çapında 800'den fazla türün bulunduğu kapalı tohumluların en büyük cinslerinden biridir. Bu cins, sütlü lateks ve meyve olarak toplanmış sert çekirdekli meyveler veya akenler içeren yenilebilir türler açısından zengin olan Moraceae familyasına aittir. Ficus carica, çiçek salkımının içi boş, etli bir hazneyle çevrelenmiş meyveleri nedeniyle cins içindeki en önemli ticari türdür (Ayuso ve ark., 2022).

İncir meyvesinin taze ve kurutularak tüketimi yaygındır. İnciri hem besin değerleri hem de sağlık açısından önemli kılan kısımlardan biri de çekirdekleridir (Ergun & Bozkurt, 2020). İncir, meyveye karakteristik fındıksı tadı veren çok sayıda küçük tohum içerir. Tohum sayısı 1600 adete kadar çıkabilmekte olup meyvenin büyüklüğüne ve olgunluğuna göre değişiklik göstermektedir. İncir tohumlarının iyi bir karbonhidrat (%52,62-53,66), protein (%14,74-15,07), kül (%2,99) ve yağ (%23,06 %23,67) kaynağı olduğu gösterilmiştir. Ayrıca tohumlar Mg, Mn, Zn, Fe, Ca, Cu, Na, K ve P gibi önemli mineraller açısından zengindir (Vardin ve ark., 2023).

Başta meyve işleme endüstrisinin bir yan ürünü olarak açığa çıkan incir çekirdeği yağ eldesinde değerlendirilmektedir. İncir çekirdeği yağının farmakolojik, fitokimyasal ve antioksidan özellikleri üzerine yapılmış çalışmalar mevcuttur (Tarlacı, 2021). Fakat incir çekirdeği yağının antimikrobiyal özellikle de antifungal etkileri üzerine çalışma oldukça azdır. Bu çalışmada Sarılop ve Bursa Siyahı iki farklı çeşit incir çekirdeğinden soğuk press ile elde edilen yağların kimyasal kompozisyonu belirlenerek antifungal etkileri incelenmiştir.

## Materyal ve Metot

### 1. Soğuk Pres Yağ Eldesi

Sarılop ve Bursa Siyahı incir çekirdekleri Aydın ve Bursa illerinden temin edilmiştir. Yağ eldesi için soğuk pres sıkım makinesi (Tokul Tarım Ürün. San. Ve Tic. Ltd. Şti., İzmir) kullanılmıştır.

Sıcaklık 50°C'yi geçmeyecek şekilde makineden çekirdekler geçirilmiştir. Elde edilen yağ renkli şişelerde analizleri yapılan dek +4°C'de muhafaza edilmiştir.

**2. Yağ Asidi Kompozisyonunun Belirlenmesi**

Atik ve ark. (2022) yöntemi ile incir çekirdek yağlarının kimyasal kompozisyonu FID detektörlü GC (Agilent 6890N) yardımıyla belirlenmiştir.

**3. Antifungal Aktivitenin Belirlenmesi**

Antifungal etkinin belirlenmesi için et ürünlerinden izole edilen 5 farklı küf türü (Aspergillus flavus, Penicillium expansum, Mucor racemosus, Rhizopus nigricans ve Cladosporium cladosporioides) kullanılmıştır. Antifungal etkinin belirlenmesinde disk difüzyon yöntemi kullanılmıştır (Sevik ve ark., 2021).

**4. MIC, MFC ve MIC/MFC Değerlerinin Belirlenmesi**

Minimum inhibitör konsantrasyon (MIC), minimum fungisidal konsantrasyon (MFC) ve MIC/MFC değerleri Sevik ve ark. (2021)'ın belirtmiş olduğu yönteme göre belirlenmiştir.

**Bulgular ve Tartışma**

Bursa Siyahı ve Sarılop incir çekirdeği yağlarının yağ asidi oranları Tablo 1'de verilmiştir.

**Tablo 1.** Bursa Siyahı ve Sarılop incir çekirdeği yağlarının yağ asidi dağılımları

| Yağ Asitleri Çeşidi (%) | Bursa Siyahı Çekirdek Yağı | Sarılop Çekirdek Yağı |
|---|---|---|
| Doymuş Yağ Asitleri | 8.48 | 10.92 |
| Doymamış Yağ Asitleri | 89.8 | 88.53 |
| Tekli Doymamış Yağ Asitleri | 16.56 | 17.43 |
| Çoklu Doymamış Yağ Asitleri | 73.24 | 71.7 |

Bursa Siyahı çekirdek yağında doymamış yağ asitlerinin oranı % 85.58, Sarılop çekirdek yağında ise % 88.47 olarak bulunmuştur. Her iki çeşit incir çekirdeği yağında doymuş yağ asitlerinin oranı sırasıyla % 14.42 ve % 11.53'tür. Doymamış yağ asitlerinden çoklu doymamış yağ asitlerinin oranı Bursa Siyahı çeşidi incir çekirdeği yağında % 73.24, tekli doymamış yağ asitlerinin oranı ise % 16.56 olarak tespit edilmiştir. Sarılop çekirdek yağında çoklu doymamış yağ asitlerinin oranı % 71.7, tekli doymamış yağ asitlerinin oranı ise % 17.43 olarak bulunmuştur. İncir çekirdeği yağı doymamış yağ asitlerince zengin bir yağdır.

İncir çekirdeği yağlarının yağ asidi kompozisyonları Tablo 2'de verilmiştir.

**Tablo 2.** Bursa Siyahı ve Sarılop incir çekirdeği yağlarının yağ asidi kompozisyonları

| **Bursa Siyahı Çekirdek Yağı** | | | | **Sarılop Çekirdek Yağı** | | | |
|---|---|---|---|---|---|---|---|
| Doymuş Yağ Asitleri (%) | | Doymamış Yağ Asitleri (%) | | Doymuş Yağ Asitleri (%) | | Doymamış Yağ Asitleri (%) | |
| Palmitik Asit (C16:0) | 5.88 | Palmitoleik Acit(C16:1) | 0.06 | Palmitik Asit (C16:0) | 7.71 | Palmitoleik Asit (C16:1) | 0.06 |
| Stearik Asit (C18:0) | 2.19 | Oleik Asit (C18:1) | 16.46 | Margarik Asit (17:0) | 0.04 | Oleik Asit (C18:1) | 17.37 |
| Araşidik Asit (C20:0) | 0.31 | Linoleik Asit (C18:2) | 31.07 | Stearik Asit (C18:0) | 3.01 | Linoleik Asit (C18:2) | 31.62 |
| Behenik Asit (C22:0) | 0.06 | Linolenik Asit (C18:3) | 42.17 | Araşidik Asit (C20:0) | 0.16 | Linolenik Asit (C18:3) | 39.48 |
| Lignoserik Asit (C24:0) | 0.04 | Eikosenoik Asit (C20:1) | 0.04 | | | | |

Ölçüm Limiti (LOQ): %0.05

Yağ asidi komposizyonu incelendiğinde Bursa Siyahı incir çekirdeği yağında doymuş yağ asidi olarak en fazla % 5.88 oranında Palmitik asit, en az ise % 0.04 oranında Lignoserik asit bulunmuştur. Sarılop incir çekirdeği yağında ise doymuş yağ asidi olarak en fazla Palmitik asit (% 7.71), en az Margarik asit (% 0.04) belirlenmiştir. Doymamış yağ asidi profili incelendiğinde her iki yağ içinde en fazla Linoliek asit (% 42.17 ve % 39.48), en az Palmitoleik asit ( % 0.06) tespit edilmiştir.

İncir çekirdeği yağlarının gıda kaynaklı küfler üzerindeki antifungal etkisi Tablo 3'te gösterilmiştir.

**Tablo 3.** Bursa Siyahı ve Sarılop incir çekirdeği yağlarının antifungal aktivitesi

| Küfler | Bursa Siyahı Çekirdek Yağı | | Sarılop Çekirdek Yağı | |
|---|---|---|---|---|
| | Antifungal Etki (mm zon çapı) | Antifungal Etki | Antifungal Etki (mm zon çapı) | Antifungal Etki |
| Aspergillus flavus | 25.84±1.85[a] | +++ | 18,35±1.56[a] | +++ |
| Penicillium expansum | 27.87±2.18[a] | +++ | 14.29±1.78[b] | +++ |
| Mucor racemosus | 14.59±0.69[b] | +++ | 9.85±0.44[c] | ++ |
| Rhizopus nigricans | 14.04±1.03[b] | +++ | 10.21±0.95[c] | ++ |
| Cladosporium cladosporioides | 17.69±1.56[b] | +++ | 11.12±0.88[c] | +++ |

a - c (↓): Values with the same capital letters in the same column for each analysis differ significantly (P< 0.05), 6-8(-): Resistant. 8-9(+): Moderately Sensitive. 9-11(++): Sensitive. 11≥ (+++): Ultra-sensitive

İncir çekirdeği yağlarının seçili küf türleri üzerindeki antifungal aktivitesi incelendiğinde en yüksek antifungal aktiviteyi Penicillium expansum (27.87 mm zon çapı) ve Aspergillus flavus (18.35 mm zon çapı) üzerinde gösterdiği belirlenmiştir. Özellikle Bursa Siyahı incir çekirdeği yağının antifungal etkisi daha fazladır. İncir türü, küf türü, incir türü X küf türü etkileşimlerinin antifungal aktivite üzerine etkilerine yönelik varyasyon ve korelasyon sonuçları Tablo 4'te verilmiştir.

**Tablo 4.** Bursa Siyahı ve Sarılop incir çekirdeği yağlarının antifungal aktivitesi üzerine varyasyon ve korelasyon analizi

| Etkileşimler | P value | r |
|---|---|---|
| İncir Türü (İ) | 0.003 | -0.629** |
| Küf Türü (K) | 0.470 | 0.558 |
| İ X K | 0.376 | -- |

r: korelasyon katsayısı, p<0,0001: İstatistiksel olarak çok fazla anlamlı, p<0,01: İstatistiksel olarak fazla anlamlı, p<0,05: İstatistiksel olarak anlamlı, p>0,05: İstatistiksel olarak anlamlı değil, ns: İstatistiksel olarak anlamlı değil, *: p<0,05 ; **: p<0,01

Anti fungal etkide kullanılan incir türü çok fazla etkili olmuştur (P<0,0001). İncir türü yağın antifungal aktivitesi üzerinde negatif yönlü korelatif etki göstermiştir.

İncir çekirdeği yağlarının MIC, MFC ve MIC/MFC değerleri Tablo 5'te gösterilmiştir.

**Tablo 5.** Bursa siyahı ve Sarılop incir çekirdeği yağlarının MIC, MFC ve MIC/MFC değerleri

| Küfler | Bursa Siyahı Çekirdek Yağı | | | Sarılop Çekirdek Yağı | | |
|---|---|---|---|---|---|---|
| | MIC | MFC | MIC/MFC | MIC | MFC | MIC/MFC |
| Aspergillus flavus | 0.018±0.01$^{b}$ | 0.006±0.01$^{b}$ | 3.00 | 0.047±0.00$^{a}$ | 0.031±0.00$^{c}$ | 1.49 |
| Penicillium expansum | 0.035±0.01$^{ab}$ | 0.012±0.01$^{ab}$ | 2.99 | 0.136±0.07$^{a}$ | 0.125±0.00$^{bc}$ | 1.08 |
| Mucor racemosus | 0.070±0.03$^{ab}$ | 0.047±0.02$^{ab}$ | 1.49 | 0.117±0.09$^{a}$ | 0.094±0.04$^{bc}$ | 1.24 |
| Rhizopus nigricans | 0.094±0.00$^{a}$ | 0.094±0.04$^{a}$ | 1.00 | 0.188±0.00$^{a}$ | 0.188±0.09$^{ab}$ | 1.00 |
| Cladosporium cladosporioides | 0.070±0.03$^{ab}$ | 0.047±0.02$^{ab}$ | 1.49 | 0.141±0.07$^{a}$ | 0.250±0.00$^{a}$ | 0.56 |

a - c (↓): Values with the same capital letters in the same column for each analysis differ significantly (P< 0.05)

Bursa Siyahı ve Sarılop incir çekirdeği yağları için en düşük MIC ve MFC değerleri Aspergillus flavus (0.018, 0.006 ve 0.047, 0.031) türü için belirlenmiştir. En yüksek MIC/MFC değeri Bursa siyahı çekirdek yağında A. flavus için 3.00 olarak tespit edilmiştir. Çekirdek yağlarının MIC ve MFC üzerine incir ve küf türünün etkisine yönelik varyasyon ve korelasyon analizleri Tablo 6'da verilmiştir.

**Tablo 6.** Bursa Siyahı ve Sarılop incir çekirdeği yağlarının MIC, MFC üzerine varyasyon ve korelasyon analizi

| Etkileşimler | MIC üzerindeki etki | | MFC üzerindeki etki | |
|---|---|---|---|---|
| | P value | r | P value | r |
| İncir Türü (İ) | 0.027 | 0.490* | 0.015 | 0.537* |
| Küf Türü (K) | 0.319 | 0.028 | 0.346 | 0.015 |
| İ X K | 0.685 | -- | 0.532 | -- |

r: korelasyon katsayısı, p<0,0001: İstatistiksel olarak çok fazla anlamlı, p<0,01: İstatistiksel olarak fazla anlamlı, p<0,05: İstatistiksel olarak anlamlı, p>0,05: İstatistiksel olarak anlamlı değil, ns: İstatistiksel olarak anlamlı değil, *: p<0,05 ; **: p<0,01

İncir çekirdeği yağlarının MIC ve MFC değerleri üzerine kullanılan incir türü etkili olmuştur (P<0.01). Ayrıca incir türü MIC ve MFC üzerinde pozitif yönlü korelatif etkide bulunmuştur.

**Sonuç ve Öneriler**

İncir meyvesi hem taze hem de kurutularak tüketimi yaygın bir meyvedir. İncir ağacının meyvesi, yaprakları ve kökü geleneksel tıpta çeşitli hastalıkların tedavisinde eski çağlardan bu yana kullanılmaktadır. İncir çekirdeği yağı kimyasal kompozisyonu ile oldukça değerli bir yağdır. Çalışma kapsamında soğuk press ile elde edilen çekirdek yağlarının Aspergillus flavus, Penicillium expansum üzerine antifungal etkisi olduğu belirlenmiştir. İncir çekirdeği yağının doğal antifungal olarak kullanımına yönelik yapılacak yeni çalışmalar ile kimyasal antifungal ajanlara alternatif olabileceği düşünülmektedir.

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# BUĞDAY RUŞEYM YAĞININ ANTİFUNGAL VE ANTİBAKTERİYEL ÖZELLİKLERİ

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**Abstract**
Buğday ruşeymi, buğday üretiminde yan ürün olarak oluşmaktadır. Vitamin E, folik asit, fosfor, tiamin, çinko ve magnezyum gibi birçok besin elementinin potansiyel kaynağıdır. Bu çalışmanın amacı soğuk pres yöntemi ile elde edilen buğday ruşeym yağının antibakteriyel ve antifungal etkisinin belirlenmesidir. Elde edilen yağın kompozisyonu % 86.91 oranında doymamış yağ asitlerinden oluşmaktadır. Yağın kimyasal kompozisyonu incelendiğinde en fazla doymamış yağ asitlerinden % 54.35 oranında linoleik asit bulunurken, en az doymuş yağ asitlerinden % 0.01 oranında kaprilik asit bulunmuştur. Yağın antimikrobiyal etkisi 4 farklı küfe (Aspergillus flavus, Penicillium expansum, Candida tropicalis, Debaromyces hansenii) ve 4 farklı bakteriye (Escherichia coli, Salmonella Tyhimurium, Staphylococcus aureus, Listeria monocytogenes) karşı disk difüzyon metodu ile belirlenmiştir. Ayrıca minimum inhibitör konsantrasyon (MIC), minimum bakterisidal konsantrasyon (MBC) ve minimum fungusidal konsantrasyon (MFC) değerleri tespit edilmiştir. En güçlü antifungal etki A. flavus için (16.85 mm zon çapı) ve en güçlü antibakteriyel etki S. aureus için (11.62 mm zon çapı) tespit edilmiştir. Ruşeym yağının düşük konsanstrasyonlarda A. flavus ve S. aureus için inhibe edici etkisi olduğu belirlenmiştir. A. flavus için MIC ve MFC değerleri sırasıyla 0.070 ve 0.063 mg/L'dir. S. aureus için MIC ve MBC değerleri sırasıyla 0.140 ve 0.125 mg/L'dir. Çalışma sonuçlarına göre ruşeym yağının antimikrobiyal ve antifungal niteliğe sahip olduğu tespit edilmiştir. Gıda muhafazada ruşeym yağının antimikrobiyal özelliklerinden faydalanabileceği düşünülmektedir.
**Anahtar kelimeler:** Buğday ruşeymi, yağ, antifungal, antibakteriyel

# ANTIFUNGAL AND ANTIBACTERIAL PROPERTIES OF WHEAT GERM OIL

**Abstract**
Wheat germ is formed as a by-product in wheat production. It is a potential source of many nutritional elements such as vitamin E, folic acid, phosphorus, thiamine, zinc and magnesium. The aim of this study is to determine the antibacterial and antifungal effects of wheat germ oil obtained by cold press method. The composition of the oil obtained consists of 86.91% unsaturated fatty acids. When the chemical composition of the oil was examined, 54.35% of linoleic acid was found to be the most unsaturated fatty acid, while caprylic acid was found to be 0.01% of the least saturated fatty acids. The antimicrobial effect of the oil was determined by the disk diffusion method against 4 different molds (Aspergillus flavus, Penicillium expansum, Candida tropicalis, Debaromyces hansenii) and 4 different bacteria (Escherichia coli, Salmonella Tyhimurium, Staphylococcus aureus, Listeria monocytogenes). Additionally, minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC), and minimum fungicidal concentration (MFC) values were determined. The strongest antifungal effect was detected for A. flavus (16.85 mm zone diameter), and the strongest antibacterial effect was detected for S. aureus (11.62 mm zone diameter). It has been determined that germ oil has an inhibitory effect on A. flavus and S. aureus at low concentrations. The MIC and MFC values for A. flavus are 0.070 and 0.063 mg/L, respectively. The MIC and MBC values for S. aureus are 0.140 and 0.125 mg/L, respectively. According to the study results, it was determined that wheat germ oil has antimicrobial and antifungal properties. It is thought that wheat germ oil can benefit from its antimicrobial properties in food preservation.
**Keywords:** Wheat germ, oil, antifungal, antibacterial

## Giriş

Antik çağlardan beri, yenilebilir katı ve sıvı yağlar, insan beslenme alışkanlıklarının önemli bir bölümünü oluşturmuştur; çünkü bu yağlar, esansiyel yağ asitlerini, yağda çözünen vitaminleri ve diğer biyoaktif bileşenleri sağlar (Sıraj, 2022). Meyve çekirdekleri, yağlı tohumlar ve tahıllar yağ eldesinde kullanılabilmektedir. Tahıllar beslenmenin vazgeçilmez bir öğesidir. Tahıllar lif ve fitokimyasallarca zengin olmaları nedeniyle sağlık açısından insan beslenmesine en uygun gıdalar arasındadır (Çetinyürek, 2012). En fazla üretim ve tüketim oranına sahip olan tahıl ise buğdaydır. Başta ekmek, makarna, bisküvi vb. birçok ürün eldesinde buğday unu kullanılmaktadır. Buğday (Triticum aestivum L.), dünya çapında 652 milyon ton üretimiyle antik çağlardan beri insanlar için bilinen en eski ve yaygın temel gıdalardan biridir (Sıraj, 2022). "Caryopsis" olarak bilinen tek bir tam buğday meyvesi, üç parçaya bölünmüş tek bir tane içerir; endosperm (%80-84), kepek (%14-15) ve embriyodan (%2-3) oluşur (Kutlu, 2021; Sıraj, 2022). Buğday ruşeymi, değirmencilik endüstrisinin bir yan ürünüdür. Aynı zamanda yüksek biyolojik değere sahip proteinler, çoklu doymamış yağ asitleri ve steroller, tokoferoller, tokotrienoller, fenoller ve karotenoidler gibi biyoaktif moleküller olmak üzere konsantre bir besin kaynağıdır (Meriles ve ark. 2022). Buğday ruşeym yağı, çok sayıda çoklu doymamış yağ asitleri ve E vitamini içerdiğinden sağlık yararları ile yaygın olarak bilinir. Bu yağ asitleri, yenilebilir yağları oksidasyona karşı çok hassas hale getirir ve bu da onların besinsel ve organoleptik özelliklerini etkileyebilir (Abu-el Khair ve ark. 2023). Buğday ruşeym yağı esas olarak doymamış yağ asitlerinden, özellikle oleik (%14-25), linoleik (%49-60) ve linolenik (%4-10) asitlerden oluşur. Tokoferoller, fitosteroller ve karotenoidler gibi oldukça değerli başka biyoaktif bileşikleri de içermektedir. Bu eşsiz bileşim nedeniyle buğday ruşeym yağı, insan sağlığında yaşlanma karşıtı, serum kolesterol seviyelerini düşürücü, kardiyovasküler koruma, kanser önleyici, iltihap önleyici ve ülser önleyici etkiler gibi çeşitli biyolojik aktivitelere sahiptir (Aslan ve ark. 2021). Buğdayın öğütülmesi sırasında bir yan ürün olarak açığa çıkan ruşeymden soğuk sıkım ile elde edilen yağın genellikle antioksidatif niteliği üzerinde durulmaktadır. Ruşeym yağının antibakteriyel ve antifungal niteliği üzerine yapılmış araştırmalar oldukça sınırlıdır. Bu çalışmada buğday ruşeyminden soğuk press ile elde edilen yağın yağ asidi kompozisyonu ile birlikte antibakteriyel ve antifungal nitelikleri incelenmiştir.

## Materyal ve Metot

### 1. Soğuk Pres Yağ Eldesi

Buğday ruşeymi Afyonkarahisar'daki yerel bir marketten temin edilmiştir. Soğuk sıkım makinesi (Tokul Tarım Ürün. San. ve Tic. Ltd. Şti., İzmir) kullanılarak yağ elde edilmiştir. Elde edilen yağ renkli şişelerde analizleri yapılan dek +4°C'de muhafaza edilmiştir.

### 2. Yağ Asidi Kompozisyonunun Belirlenmesi

Buğday ruşeym yağının kimyasal kompozisyonu FID detektörlü GC (Agilent 6890N) ile Atik ve ark. (2022) yöntemine göre belirlenmiştir.

### 3. Antifungal Aktivitenin Belirlenmesi

Antifungal etkinin belirlenmesi için çeşitli gıda ürünlerinden izole edilen 4 farklı küf türü (Aspergillus flavus, Penicillium expansum, Candida tropicalis, Debaromyces hansenii) kullanılmıştır. Antifungal etkinin belirlenmesinde disk difüzyon yöntemi kullanılmıştır (Sevik ve ark. 2022).

### 4. Antibakteriyel Aktivitenin Belirlenmesi

Antibakteriyel etkinin belirlenmesinde 4 farklı bakteri türü (Escherichia coli (ATCC 25922), Salmonella Typhimurium (ATCC 14028), Listeria monocytogenes (ATCC 51774), Staphylococcus aureus (ATCC 19615) ) üzerinde disk difüzyon metodu kullanılmıştır (Akarca, 2019).

### 5. MIC, MFC ve MIC/MFC Değerlerinin Belirlenmesi

Minimum inhibitör konsantrasyon (MIC), minimum fungisidal konsantrasyon (MFC) ve MIC/MFC değerleri Sevik ve ark. (2021)'ın belirtmiş olduğu yönteme göre belirlenmiştir.

### 6. MIC, MBC ve MIC/MBC Değerlerinin Belirlenmesi

Minimum inhibitör konsantrasyon (MIC), minimum bakterisidal konsantrasyon (MBC) ve MIC/MBC değerleri Oulkheir ve ark. (2017)'ın yöntemi kullanılarak belirlenmiştir.

## Bulgular ve Tartışma

Buğday ruşeym yağının yağ asidi oranları Tablo 1'de verilmiştir.

**Tablo 1.** Buğday ruşeym yağının yağ asidi dağılımları

| Yağ Asitleri Çeşidi | % |
|---|---|
| Doymuş Yağ Asitleri | 10.9 |
| Doymamış Yağ Asitleri | 86.91 |
| Tekli Doymamış Yağ Asitleri | 32.24 |
| Çoklu Doymamış Yağ Asitleri | 54.67 |

Buğday ruşeym yağında doymamış yağ asitlerinin oranı % 86.91, doymuş yağ asitlerinin oranı % 10.9 olarak bulunmuştur. Doymamış yağ asitlerinden çoklu doymamış yağ asitlerinin oranı % 54.67, tekli doymamış yağ asitlerinin oranı ise % 32.24 olarak tespit edilmiştir.

Buğday ruşeym yağının yağ asidi kompozisyonları Tablo 2'de verilmiştir.

**Tablo 2.** Buğday ruşeym yağının yağ asidi kompozisyonları

| **Doymuş Yağ Asitleri (%)** | | **Doymamış Yağ Asitleri (%)** | |
|---|---|---|---|
| Kaprilik Asit (C8:0) | 0.01 | Palmitoleik Acit(C16:1) | 0.10 |
| Miristik Asit (C14:0) | 0.07 | Oleik Asit (C18:1) | 31.56 |
| Palmitik Asit (C16:0) | 6.67 | Linoleik Asit (C18:2) | 54.35 |
| Margarik Asit (C17:0) | 0.04 | Linolenik Asit (C18:3) | 0.26 |
| Stearik Asit (C18:0) | 3.59 | Eikosenoik Asit (C20:1) | 0.58 |
| Araşidik Asit (C20:0) | 0.29 | Eikosedienoik Asit (C20:2) | 0.06 |
| Lignoserik Asit (24:0) | 0.23 | | |

Ölçüm Limiti (LOQ): %0.05

Yağ asidi komposizyonu incelendiğinde ruşeym yağında doymuş yağ asidi olarak en fazla % 6.67 oranında Palmitik asit, en az ise % 0.01 oranında Kaprilik asit bulunmuştur. Doymamış yağ asidi profili incelendiğinde en fazla Linoleik asit (% 54.35), en az Eikosedienoik asit ( % 0.06) tespit edilmiştir.

Buğday ruşeym yağının antifungal ve antibakteriyel etkisi etkisi Tablo 3'te gösterilmiştir.

**Tablo 3.** Buğday ruşeym yağının antifungal aktivitesi

| **Küfler** | **Antifungal Etki (mm zon çapı)** | **Antifungal Etki** |
|---|---|---|
| Aspergillus flavus | 16.85±1.69$^{a}$ | +++ |
| Penicillium expansum | 15.82±0.80$^{a}$ | +++ |
| Candida tropicalis | 9.83±0.88$^{b}$ | ++ |
| Debaromyces hansenii | 8.25±1.15$^{b}$ | + |
| **Bakteriler** | **Antibakteriyel Etki (mm zon çapı)** | **Antibakteriyel Etki** |
| Escherichia coli | 6.97±0.12$^{b}$ | - |
| Salmonella Typhimurium | 6.33±0.31$^{b}$ | - |
| Staphylococcus aureus | 11.62±0.60$^{a}$ | +++ |
| Listeria monocytogenes | 10.77±0.35$^{a}$ | ++ |

a - b (↓): Values with the same capital letters in the same column for each analysis differ significantly (P< 0.05), 6-8(-): Resistant. 8-9(+): Moderately Sensitive. 9-11(++): Sensitive. 11≥ (+++): Ultra-sensitive

Buğday ruşeym yağının seçili küf türleri üzerindeki antifungal aktivitesi incelendiğinde en yüksek antifungal aktiviteyi Aspergillus flavus (16.85 mm zon çapı) üzerinde gösterdiği belirlenmiştir. En düşük antifungal etki ise Debaromyces hansenii (8.25 mm zon çapı) üzerinde olduğu tespit edilmiştir. Antibakteriyel aktivite incelendiğinde en yüksek etkinin Staphlococcus aureus (11.62 mm zon çapı) üzerinde olduğu, en düşük etkinin ise Salmonella Tyhimurium (6.33 mm zon çapı) üzerinde olduğu görülmüştür.

Buğday ruşeym yağının gıda kaynaklı fungus ve patojen bakteriler üzerindeki MIC **(mg/L)**, MBC**(mg/L),** MFC **(mg/L)** MIC/MBC ve MIC/MFC değerleri Tablo 4'te gösterilmiştir.

**Tablo 4.** Buğday ruşeym yağının gıda kaynaklı fungus ve patojen bakteriler üzerindeki MIC **(mg/L)**, MBC **(mg/L),** MFC **(mg/L)** MIC/MBC ve MIC/MFC değerleri

| **Küfler** | **MIC** | **MFC** | **MIC/MFC** |
|---|---|---|---|
| Aspergillus flavus | 0.070±0.03$^{b}$ | 0.063±0.00$^{a}$ | 1.13 |
| Penicillium expansum | 0.094±0.00$^{ab}$ | 0.094±0.04$^{a}$ | 1 |
| Candida tropicalis | 0.141±0.07$^{ab}$ | 0.094±0.04$^{a}$ | 1.5 |
| Debaromyces hansenii | 0.188±0.00$^{a}$ | 0.125±0.00$^{a}$ | 1.5 |
| **Bakteriler** | **MIC** | **MBC** | **MIC/MBC** |
| Escherichia coli | 0.750±0.00$^{a}$ | 0.500±0.00$^{ab}$ | 1.5 |
| Salmonella Typhimurium | 0.875±0.18$^{a}$ | 0.750±0.35$^{a}$ | 1.17 |
| Staphylococcus aureus | 0.140±0.07$^{b}$ | 0.125±0.00$^{b}$ | 1.12 |
| Listeria monocytogenes | 0.281±0.13$^{b}$ | 0.188±0.09$^{b}$ | 1.49 |

a - b (↓): Values with the same capital letters in the same column for each analysis differ significantly (P< 0.05)

Buğday ruşeym yağı için en düşük MIC ve MFC değerleri Aspergillus flavus (0.070 ve 0.063) türü için belirlenmiştir. En yüksek MIC/MFC değeri Candida tropicalis ve Debaromyces hansenii küfleri için 1.50 olarak tespit edilmiştir. Bakteriler için en düşük MIC ve MBC değeri Staphlococcus aureus (0.140 ve 0.125) için belirlenmiştir. En yüksek MIC/MBC oranı ise Escherichia coli için 1.50 olarak bulunmuştur.

## Sonuç ve Öneriler

Tahıllar günlük beslenmenin önemli unsurlarından biridir. Genellikle un şeklinde bir çok üretimin ana maddesini oluşturan buğday en çok tüketilen tahıl ürünüdür. Ruşeym buğdayın öğütülmesi sırasında açığa çıkan bir yan üründür. Buğday ruşeymi yüksek biyolojik değere sahip proteinler, çoklu doymamış yağ asitleri ve steroller, tokoferoller, tokotrienoller, fenoller

ve karotenoidler gibi biyoaktif moleküller içermektedir. Son zamanlarda ruşeymin doğrudan kullanımı yanında ruşeym yağının kullanımı üzerinde durulmaktadır. Çalışma kapsamında soğuk press ile elde edilen ruşeym yağının Aspergillus flavus üzerine antifungal, Staphlococcus aureus üzerine ise antibakteriyel etkisi olduğu belirlenmiştir. Buğday ruşeym yağının doğal antimikrobiyal olarak kullanımına yönelik yapılacak yeni çalışmalarla birlikte kimyasal koruyuculara alternatif olabileceği düşünülmektedir.

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# USE OF BIOCHAR FOR REMEDIATION OF HEAVY METAL-CONTAMINATED ALFISOLS GROWN TO Corchorus olitorious

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## ABSTRACT

Heavy metals contamination of Agricultural soils is a major plant growth, yield and quality performance constraint, affecting the quality and safety of food when their uptake by crops is substantially increased. In this respect, extreme concerns are gradually being focused on vegetables because of their high consumption by man, possess huge ability to bioaccumulate heavy metals and as a result threatening human health. Two types of biochar; Poultry Litter Biochar (PLB) and Maize Cob Biochar (MCB) each applied at 0, 1, 2.5 and 5% to a dumpsite soil contaminated with Pb and Cd, in a 5kg pot. Corchorus olitorious was then planted into the pots arranged in Completely Randomised Design. Growth and yield parameters of Corchorus olitorious were determined while Pb and Cd concentration in soil and crop were analyzed, using standard laboratory techniques. Data were analysed using descriptive statistics, polynomial regression and ANOVA at $\alpha_{0.05}$. The growth, biomass yield, Pb and Cd concentration in soil and accumulation (PB and Cd) by Corchorus olitorious were highest with PLB and MCB at 5%. Application of PLB at 5% resulted into the highest significant Pb and Cd remediation (48.9% and 55.7%), respectively while for MCB treatment it was 45.8 and 51.5%. Also, at 5% application of PLB and MCB reduction of bioaccumulation Pb in Corchorus olitorious was by 89.4 and 88.8% while for Cd, it was decreased by 81.2 and 72.7% respectively. Thus, the useage of biochar for soil amendment in heavy metal-contaminated soils has outstanding potential for metal-immobilization if the suitable rate for crop growth and yield performance is applied.

## INTRODUCTION

In a study conducted by Amusan et al. (2005), it was observed that soil found at refuse dumpsites contains varying concentrations of heavy metals (HMs). Despite this knowledge, in Nigeria, many refuse dumpsites have been extensively used for cultivating various edible vegetables and plant-based foodstuffs, even though there is existing data on the potential for these vegetables to accumulate heavy metals from contaminated and polluted soils (Cobb et al., 2000; Benson and Ebong, 2005). The presence of heavy metal contamination (HMs) in soil poses a significant constraint to plant growth, yield, and food quality, impacting both the quality and safety of food. This concern is especially critical for vegetables, as they are abundantly consumed, have a high capacity to accumulate HMs (Oluwatosin et al., 2010; Fernando et al., 2012), and pose a threat to human health (Nirmal et al., 2007). In response to these challenges, there is a growing interest in exploring environmentally beneficial alternatives for remediation.This study focuses on the use of biochar as a potential solution for remediating heavy metal-contaminated soils where Corchorus olitorius is grown.

## MATERIALS AND METHODS

The study assessed the impact of two forms of biochar, namely Poultry Litter Biochar (PLB) and Maize Cob Biochar (MCB), applied at concentrations of 0, 1, 2.5, and 5% w/w, on the bioavailability of lead (Pb) and cadmium (Cd) in a dumpsite soil and their accumulation in Corchorus olitorious. The research was conducted in the greenhouse of the Department of Crop & Horticultural Sciences at the University of Ibadan, Nigeria, using soil collected from a heavy metal-contaminated dumpsite. The soil in this area is classified as an Alfisol, locally identified as the Egbeda soil series. The experiments involved the application of four different rates of two biochar sources. These treatments were replicated three times, resulting in a total of 24 experimental units, arranged in a completely randomized design (CRD).

Soil collected from a dumpsite was air-dried, sieved through a 2 mm sieve, and 5 kg of soil was weighed into planting bags. Each type of biochar from the two sources was mixed thoroughly with the soil according to the treatment combinations and watered to 60% field capacity. Seeds (0.2 g) were sown per pot, with subsequent thinning to four seedlings per pot after one week of growth. Frequent hand weeding was conducted throughout the experiment. The fresh and dry biomass weights were measured (g/pot) after harvesting at 6 weeks after sowing (6WAS). The biomass was oven-dried at 60°C for two days to determine the dry weights (g/pot). The concentrations of Pb and Cd in both the soil and the crops were analyzed using standard laboratory techniques

**Calculations**

Remediated Metal Concentration (mg/kg) = Initial metal concentration in soil before cropping minus final metal concentration in soil after cropping

First Planting Remediation (%) = (remediated metal concentration divided by initial metal concentration in soil before cropping) × 100

Bioaccumulation Factor "BAF" = Concentration of metal in plant parts (root or shoot) divided by concentration of metal in soil (Nizam et al., 2016; Shehata et al., 2019)

## RESULTS AND DISCUSSION

The chemical and physical characteristics of the soil used in this study are revealed in Table 1. The pH levels of both soils were slightly acidic. Organic carbon content was low, measuring less than 15 g/kg, and total nitrogen fell below the critical limit. Available phosphorus (Bray 1) was insufficient, registering less than 15 mg/kg, indicating a deficiency. However, the exchangeable bases were slightly below the critical range. Exchangeable acidity was 0.5, while the concentrations of lead and cadmium were 368.5 and 9.9 mg/kg, respectively, exceeding the critical levels as defined by WHO (1996).

Table 2 presents the selected chemical properties of the biochars employed in the study. Poultry Litter Biochar (PLB) and Maize Cob Biochar (MCB) contained 16.4 and 14.3 g/kg of $P_2O_5$, respectively, with nitrogen content in PLB and MCB measured at 0.38 and 0.27, respectively. The lead content was 0.1 mg/kg in PLB and undetectable in MCB, with no presence of cadmium in any of the treatments.

Table 1. Pre-cropping properties of the experimental soil

| Parameters | Dumpsite soil |
|---|---|
| pH (1:1 soil/$H_2O$) | 6.7 |
| Organic C (g/kg) | 2.4 |
| Nitrogen (g/kg) | 0.4 |
| Available P (mg/kg) | 4 |
| Exchangeable base (cmol/kg) | |
| K | 0.1 |
| Ca | 1.8 |
| Mg | 0.2 |
| Na | 0.2 |
| Extractible micronutrient (mg/kg) | |
| Mn | 5133 |
| Fe | 152 |
| Zn | 3150 |
| Cu | 1 |
| Heavy metals | |
| Pb | 368.5 |
| Cd | 9.9 |
| Particle size distribution (g/kg) | |
| Sand | 751 |
| Silt | 139 |
| Clay | 110 |
| Textural class | Sandy loam |

Table 2. Selected Chemical composition of Biochar used in the Study

| N | $P_2O_5$ | $K_2O$ | Pb | Cd |
|---|---|---|---|---|
| $gkg^{-1}$ | | $mgkg^{-1}$ | | |
| MCB | | 2.70 | 14.3 | 5.0 | 0.0 | 0.0 |
| PLB | | 3.80 | 16.0 | 5.6 | 0.1 | 0.0 |

MCB - Maize cob biochar, PLB - Poultry litter biochar

Table 3 Effects of biochar application levels on fresh and dry Biomass of Corchorus olitorious in a Screen house environment

| **Treatments** | **Rate** | **Yield (g/pot)** | |
|---|---|---|---|
| | (%) | **fresh** | **dry** |
| Control | - | 13.60f | 2.99b |
| Maize Cob Biochar | 1 | 34.03de | 5.13a |
| Poultry Litter Biochar | 1 | 33.145e | 5.00a |
| Maize Cob Biochar | 2.5 | 34.84de | 4.96a |
| Poultry Litter Biochar | 2.5 | 36.77cde | 5.07a |
| Maize Cob Biochar | 5 | 54.21ab | 5.65a |
| Poultry Litter Biochar | 5 | 44.65bcd | 5.14a |
| **Standard Error of Mean** | - | 2.33 | 0.19 |

As indicated in Table 3, the control pots produced the smallest biomass (13.6 g). Application of Maize Cob Biochar and Poultry Litter Biochar at 5% significantly increased biomass production. In Figure 1, the use of PLB (5%) and Maize Cob Biochar (5%) reduced lead and cadmium levels in the soil, with control having the highest concentrations (349.12 mg/kg for lead and 7.68 mg/kg for cadmium). Additionally, the lead and cadmium levels in Corchorus olitorious varied with different levels of Biochar, where control plants accumulated more lead (18.15 mg/kg) and cadmium (1.34 mg/kg), while those grown with PLB (5%) had the lowest concentrations (8.7 mg/kg for lead and 0.26 mg/kg for cadmium), as shown in Figure 2. The study also found that Pb remediation was more effective compared to a study by Ahmad et al. (2012), where Pb in soils decreased by 75.8% using biochar.

In Table 4, the soil remediated lead concentration ranged from 18.9 mg/kg (control) to 179.8 mg/kg (PLB 5%), with the ranking as follows: PLB 5% > MCB 5% > PLB 2.5% > MCB 2.5% > PLB 1% > MCB 1% > Control. Poultry Litter Biochar (PLB) at 5% resulted in the highest lead remediation (48.9%), while the control had the lowest (5.1%). Moreover, the application of PLB or MCB at 5% and PLB at 2.5% resulted in the lowest lead Bioaccumulation Factor (BCF) of 0.04, whereas the control accumulated more with a BCF of 0.06. The remediated

cadmium in the contaminated soil ranged from 2.2 mg/kg to 5.5 mg/kg, representing a remediation percentage of 22.4% to 55.7%. The use of PLB at 5% produced Corchorus olitorious with the lowest Cadmium BCF (0.06), while the control had a higher BCF of 0.17. This result aligns with a study by Zhou et al. (2008), where biochar application increased the levels of Cd, Zn, and Pb as mine tailings decreased.

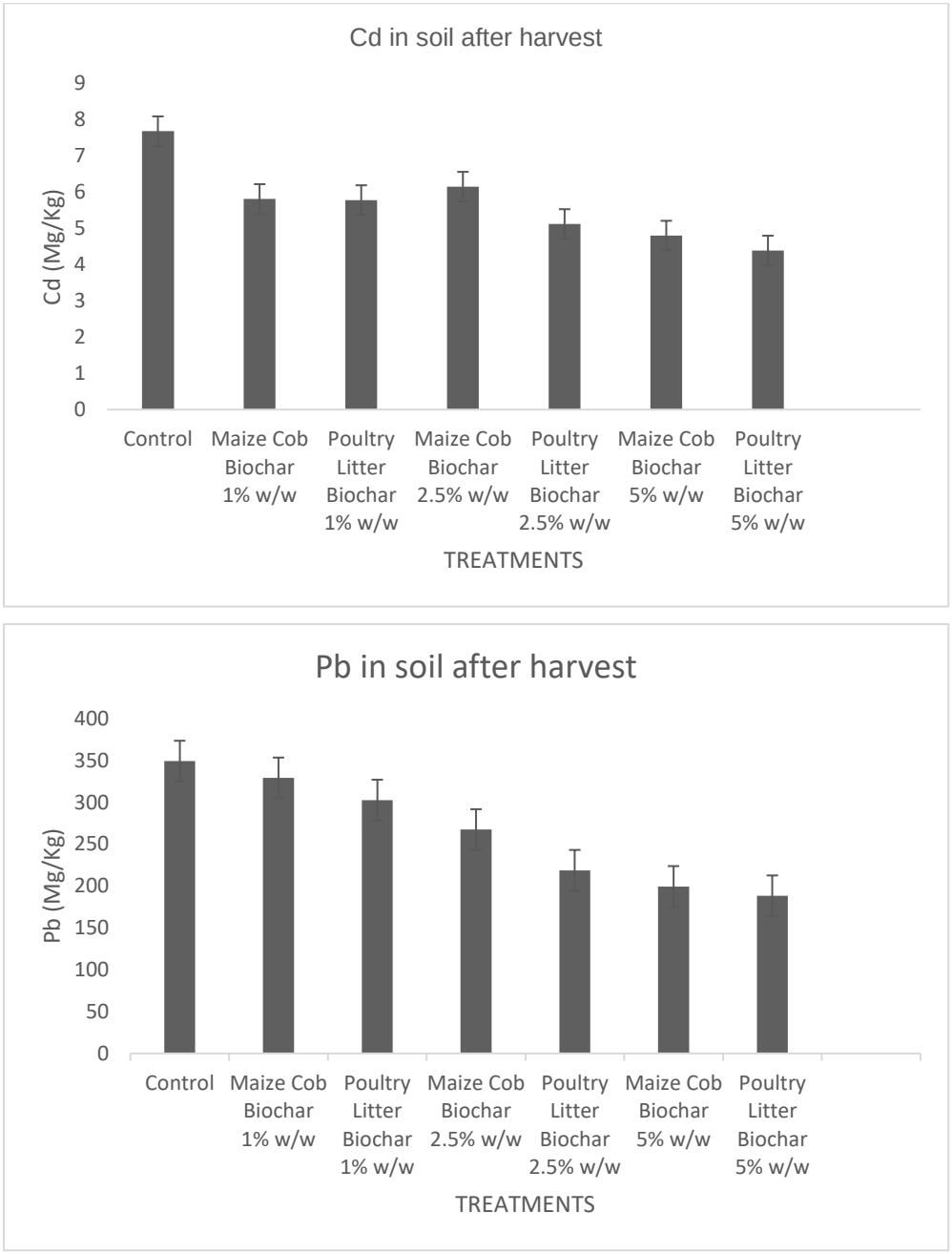


**Figure 1. Effects of different levels of Biochars on Lead and Cadmium concentration in soil after harvest of Corchorus olitorious**

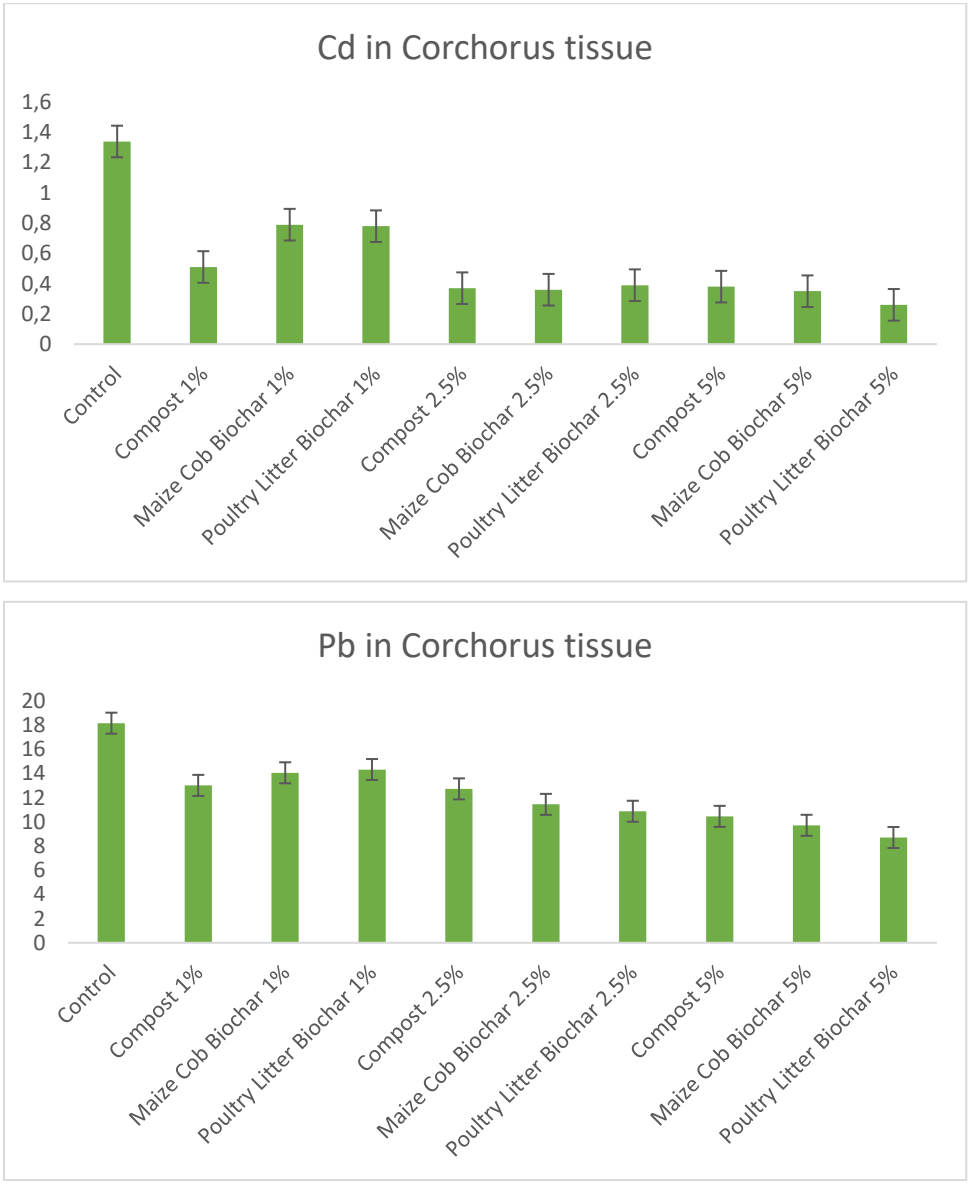


**Figure 2. Effects of different levels of Biochars on Lead and cadmium content in Corchorus olitorious**

Table 4. Effects of different levels of Biochars on Remediated Metal Concentration (RMC)- mg/kg, First Season Remediation (FSR)- % and Bio-accumulation Factor (BAF) of Corchorus olitorious

| | Pb (mg/kg) | | | Cd (mg/kg) | | |
|---|---|---|---|---|---|---|
| **Treatments** | **RMC** | **FSR** | **BAF** | **RMC** | **FSR** | **BAF** |
| Control | 18.88f | 5.13f | 0.06b | 2.22f | 22.42f | 0.17a |
| Maize Cob Biochar 1% w/w | 39.00e | 10.60e | 0.04a | 4.09d | 41.31d | 0.14b |
| Poultry Litter Biochar 1% w/w | 65.46d | 17.79d | 0.05b | 4.12d | 41.61d | 0.14b |
| Maize Cob Biochar 2.5% w/w | 100.65c | 27.35c | 0.04a | 3.75e | 37.88e | 0.06d |
| Poultry Litter Biochar 2.5% w/w | 149.31b | 40.57b | 0.05b | 4.78c | 48.28c | 0.08c |
| Maize Cob Biochar 5% w/w | 168.62a | 45.82a | 0.04a | 5.10b | 51.52b | 0.07c |
| Poultry Litter Biochar 5% w/w | 179.79a | 48.86a | 0.04a | 5.51a | 55.66a | 0.06d |
| **Standard Error of Mean** | 10.2 | 2.76 | 0.001 | 0.17 | 1.7 | 0.01 |

## CONCLUSIONS

This study demonstrated the promising potential of biochar as an effective tool for addressing heavy metal contamination in soils, particularly in the cultivation of Corchorus olitorious. The use of Poultry Litter Biochar (PLB) and Maize Cob Biochar (MCB) at a 5% application rate showed the most positive results in terms of biomass production and heavy metal remediation.

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# THE EFFECTS OF DIFFERENT LEVELS OF BLACK SEED (NIGELLA SATIVA) IN THE DIET OF LAYING HENS ON THE DURABILITY OF EGGS STORED IN DIFFERENT CONDITIONS

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## Abstract
This experiment was conducted to evaluate the effects of feeding different levels of black seed powder on the durability of eggs stored in different conditions using 160 hyline-w36 hens. The experiment was conducted in the form of a CRD with 4 treatments and 5 repetitions (8 layer for each repetition). The experimental diets were: 1- control treatment 2- treatment containing 1% black seed 3- treatment containing 2% black seed 4- treatment containing 3%, black seed. Eggs were collected after feeding the diet for 8 weeks and stored for 7 or 30 days at 4 or 25°C. The results of this experiment showed that the pH of egg yolk and egg white increased and the height of egg yolk, egg white and egg unit decreased with increasing the storage of eggs from 7 days to 30 days. The effect of temperature on egg quality was significant and keeping eggs at a temperature of 25 degrees Celsius instead of 4 degrees Celsius increased the effect of time. The interaction effect of time and temperature was significant in this relationship and the highest quality loss was observed in eggs stored at 25°C for 30 days. The effect of black seed on preventing the decline of egg quality was significant. The interaction effect of storage temperature and black seeds on the internal quality of eggs was significant, and keeping eggs obtained from chickens fed with black seeds at high temperature had less quality loss than the control group, and the most quality loss was in the eggs of the control group that were kept at a temperature of 25 degrees. Celsius were stored occurred. In general, the results of this experiment showed that the use of at least one percent black seed in the diet of laying hens increases the shelf life of eggs
**Keywords:** Black Seed, Egg, layer hen, quality.

## INTRODUCTION

Today, the use of growth-promoting antibiotics has been limited due to the possibility of bacterial resistance and also transmission to consumers through manufactured products (Abdelhady et al., 2009). Medicinal plants with antimicrobial effects have been proposed as suitable alternatives for antibiotics. In recent years, a lot of research has been done to maximize the production and quality of products and to prevent or treat some diseases (Abdelhady et al., 2009). Global poultry industries, especially in developing countries, are faced with food shortages every year. The continuous use of common feed additives from plant or animal sources in poultry diets has become a critical issue due to the high competition between livestock species and industrial purposes. This has led to an increase in the price of this feed and livestock products. There is a global trend towards finding healthier natural alternatives to synthetic drugs and therapeutic drugs in poultry farms (Alagawany et al., 2021). Therefore, the discovery of alternative feed additives is necessary for the sustainability of the poultry industry, especially in developing countries. Black seed or (Nigella Sativa L.), which is sometimes called black seed, is an annual plant that has been grown as a car since the past, but because of its seeds and flowers, its cultivation has become common in some places (Abdel-Magged et al., 2002). Among its discovered properties, it can be mentioned that it helps the body's immunity, antihistaminic properties, antimicrobial effects, anti-blood pressure and anti-inflammatory effects, most of which are attributed to the Quinone compounds found in black seeds. Research has shown that the consumption of black seed in the amount of 1-3% has been able to have a positive effect on the growth factors of broiler chickens (Abu-Dieyeh et al., 2008). Research in broiler chickens that were under heat stress conditions has shown that adding a percentage of black seeds to the diet has increased production and digestibility (Liu et al., 2014). Recent studies have shown that addition of black seed to diets of laying hens enhanced all egg quality characteristics such as : egg shell weight, albumin weight and yolk weight (Al-Hamied et al., 2011). The object of this experiment is to investigate different levels of black seed as a supplement in the diets of laying hens on the durability of eggs stored in different conditions in corn-soybean based diets.

## MATERIALS AND METHODS

The black seed required for this project was obtained from the local market; And after determining its chemical composition, experimental diets were formulated with UFFDA software according to the recommendation of the feeding guide for Hyline w36 strains at the

age of 60 weeks. The experimental diets was as follows: treatment 1 control diet (based on corn-soybean meal) without adding black seed, treatment 2 basal diet and 1% black seed, treatment 3 basal diet and 2% black seed, and treatment 4 basal diet and 3% black seed.

In the experimental diets, black seeds replaced wheat bran in the basal diet. Laying hens were placed in cages 45 cm long, 35.5 cm wide and 39 cm high. The cages are equipped with trough feeding system and nipple drinking system. Four chickens were placed in each cage and both adjacent cages were considered as an experimental unit. The lighting schedule was lighting regimen of L: D of 17:7 h. The experiment was conducted in the form of a CRD with 4 treatments and 5 repetitions (8 layer for each repetition). A week before the start of the experiment was considered for the habituation period. Eggs were collected after feeding the diet for 8 weeks and stored for 7 or 30 days at 4 or 25°C. Chickens were fed twice a day (9:30 am and 5:30 pm) and had free access to drinking water throughout the experiment. The yolk was separated and weighed, and the albumen was collected into a recalibrated graduated beaker. The albumen collected in the beaker was weighed, and the pH was measured with an Accumet 950 pH/ion meter. After sampling, each egg were weighed and broken on a flat surface. The weight of the albumen was determined by the difference between the egg weight and the yolk. The height of the thick whites was measured in three points and the Haugh unit was calculated through the following formula:

$$HU = 100 * log(h - 1.7w^{0.37} + 7.6)$$

Where:

HU = Haugh unit

h = observed height of the albumen in millimeters

w = weight of egg in grams

**FINDINGS and DISCUSSION**

The results of the main effects of black seed, storage period and temperature, interaction effects between black seed and storage time, as well as the interaction between time, storage time and temperature on internal quality traits of eggs are shown in Tables 2, 3, 4 and 5.

The results show that the effects of black seed, storage time and temperature, as well as the interaction effects between them, on the internal quality traits of eggs were significant ($p>0.05$).

Table 1. The effect of storage time on egg quality

| Storage time | Yolk height | Yolk pH | Albumin pH | Haugh unit | Yolk index |
|---|---|---|---|---|---|
| **7 day** | 12.25 | 9.01b | 9.6 b | 72.35a | **28.23** |
| **30 day** | 11.79 | 9.28a | 9.93a | 66.80b | **27.16** |
| **SEM** | 0.237 | 0.065 | 0.072 | 1.323 | **0.545** |
| **Pvalue** | 0.169 | <0.01 | 0.014 | <0.01 | **0.168** |

Means denoted by a different letter indicate significant differences between treatments ($p < 0.05$).

By increasing the storage time of eggs in, the pH of egg white increases to 9.93 or even higher values, and this increase in pH is due to the release of carbon dioxide gas from the holes in the egg shell. While the pH of egg yolk decreases with time.

Table 2 The effect of storage temperature on egg quality

| Temperature | Yolk height | Yolk pH | Albumin pH | Haugh unit | Yolk index |
|---|---|---|---|---|---|
| **4** | 15.12a | 9.08 | 9.55b | 86.21a | **34.83a** |
| **25** | 8.92b | 9.21 | 10.06a | 52.95b | **20.56b** |
| **SEM** | 0.237 | 0.065 | 0.072 | 1.323 | **0.545** |
| **P-value** | <0.01 | 0.185 | <0.01 | <0.01 | **<0.01** |

Means denoted by a different letter indicate significant differences between treatments ($p < 0.05$).

Also, the results show that with the increase in storage temperature from 4°C to 25°C, the amount of internal quality traits of eggs (white pH, yolk index, yolk height and Haw unit) decreased significantly ($p>0.05$); While it did not show any significant effect on the pH of egg yolk ($p < 0.05$). Jin et al. (2011) showed that a significant increase in the pH values of egg white and yolk was observed with increasing temperature and storage time. A rapid increase in albumin pH was observed, even after only 2 days of storage, regardless of storage temperature. The results of which were consistent with the present study. In the present study, the pH of egg white increased with increasing storage time. But it decreased with increasing temperature. A very significant interaction between storage time and temperature was observed for the pH of the yolk and the Haugh unit ($p < 0.05$). Most of the increase occurred during the first 7 days of

storage at 4 °C. These findings are consistent with the results reported by other researchers (Akyurel and Okur, 2009).

Our results showed that the interaction effects of storage temperature and time on egg white pH were not significant ($p<0.05$). In line with the results of our study, Walsh et al. (1995) reported that neither storage time nor temperature affected the pH of egg whites. The increase in the pH of the yolk was not as high as the increase in the pH of the white. Yolk pH did not differ during 7 and 30 days of storage at 4°C. In contrast, Semli et al. (2005) showed that yolk pH varied from 5.75 to 6.08 during 10 days of storage at 29°C. The present results are consistent with the results of other researchers (Samli et al., 2005; Akyurel and Okur, 2009). They also found that the increase in yolk pH was significantly affected by storage time. Albumin pH varied even at 5°C storage temperature**.**

Table 3. The interaction effects of black seed and storage period on internal quality traits of eggs

| **Black seed × storage time** | **Yolk height** | **Yolk pH** | **Albumin pH** | **Haugh unit** | **Yolk index** |
|---|---|---|---|---|---|
| **0 × 7** | 12.84a | 9.37 | 10.02 | 68.59 | **26.06b** |
| **0 × 30** | 10.90b | 9.35 | 10.33 | 66.88 | **24.84b** |
| **1 × 7** | 12.87a | 9.20 | 9.41 | 71.58 | **29.10ab** |
| **1 × 30** | 11.36b | 8.84 | 9.60 | 69.39 | **26.09b** |
| **2 × 7** | 12.52ab | 9.37 | 9.68 | 70.01 | **29.51a** |
| **2 × 30** | 11.23b | 8.97 | 9.86 | 64.92 | **28.19ab** |
| **3 × 7** | 12.30ab | 9.17 | 9.60 | 69.22 | **29.26ab** |
| **3 × 30** | 12.17ab | 8.90 | 9.93 | 66.04 | **28.51ab** |
| **SEM** | 0.474 | 0.131 | 0.144 | 2.647 | **1.091** |
| **P-value** | <0.01 | 0.479 | 0.943 | 0.382 | **<0.01** |

Means denoted by a different letter indicate significant differences between treatments ($p < 0.05$).

The results show that Storage eggs for 30 days at 25 °C decreased the Haugh unit, but this reduction was not significant. This reduction shows the effect of time on the proteolysis of ovomucin and the breaking of some disulfide bonds between egg white proteins, which has caused the decrease in the height of the yolk and the Haugh unit. Contrary to the present study,

Kirunda and McKee (2000) and also Silversides et al. (2001) showed that keeping eggs for two weeks at room temperature resulted in a significant decrease in Haugh unit.

Table 4. The interaction effects of black seed and storage temperature on internal quality traits of eggs

| Black seed × Storage temp. | Yolk height | Yolk pH | Albumin pH | Haugh unit | Yolk index |
|---|---|---|---|---|---|
| **0 × 4** | 14.91 | 9.07b | 10.14a | 83.99 | **33.98** |
| **0 × 25** | 8.83 | 9.65a | 10.21a | 48.49 | **20.12** |
| **1 × 4** | 15.15 | 8.92b | 9.50b | 85.84 | **34.73** |
| **1 × 25** | 9.08 | 9.12b | 10.12a | 54.09 | **20.83** |
| **2 × 4** | 15.19 | 9.14b | 9.42b | 86.77 | **35.30** |
| **2 × 25** | 8.56 | 9.19b | 10.02a | 51.48 | **19.90** |
| **3 × 4** | 15.25 | 9.00b | 9.09b | 88.24 | **35.33** |
| **3 × 25** | 9.22 | 9.06b | 9.95a | 57.73 | **21.38** |
| **SEM** | 0.474 | 0.131 | 0.144 | 2.647 | **1.091** |
| **P-value** | 0.908 | 0.033 | 0.010 | 0.472 | **0.871** |

Means denoted by a different letter indicate significant differences between treatments ($p < 0.05$).

The interaction effects of black seed and storage time on the yolk index were significant, so that the maximum yolk index was observed in the treatment of one percent of black seed and 7 days of storage. (Table 4) The amount of yolk index is one of the freshness indicators of eggs. The more yolk height and the smaller the diameter of the yolk, the better the quality of the yolk index. Based on the value of Indonesian national standard (SNI) for consumption eggs, egg yolk index is divided into three, that is, grade I with egg yolk index value of 0.521-0.458, grade II between 0.457-0.394 0 and grade III between 0.33-0.393 (Widyantara et al., 2017). The yolk index decreased during the storage period along with the decrease in egg white quality, and as a result, water was transferred from the white to the yolk. Jin et al. (2011) reported that the dilution factor of egg white is caused by an increase in pH, which leads to damage to protein fibers (ommosin). In the present study, due to its antioxidant compounds, black seed prevents the separation of water from egg white to egg yolk. As a result, water is removed from the egg white protein and the dilution process occurs. According to Khan et al. (2013), the decrease in

egg yolk index can be influenced by the duration of storage, storage location, temperature, vitelline membrane quality and feed nutrition. There is a difference in osmotic pressure between egg yolk and egg white, where the osmotic pressure in egg yolk is higher than in egg white. This leads to the movement of water from the egg white to the yolk through the vitelline membrane, thereby reducing the viscosity of the yolk and damaging the protein fibers that make up the vitelline membrane. This process reduces the height of the yolk and increases the diameter of the yolk so that the value of the yolk index decreases.

## CONCLUSION and RECOMMENDATIONS

In general, the results of this experiment showed that the use of at least one percent black seed in the diet of laying hens increases the shelf life of eggs

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# THE IMPORTANCE OF LOCAL GOVERNMENT SUPPORTS IN RURAL DEVELOPMENT: A CASE OF IZMIR PROVINCE

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**Abstract**
Izmir is a vibrant and culturally rich city located on the country's western coast along the Aegean Sea. With a population of approximately 4.5 million, the city has industrialized in sectors such as textiles, agriculture and services due to its role as a port city. Over its 8,000-year history, agriculture, including farming, livestock husbandry, and fishing, has played a central role. Rural development is vital to stop the migration from rural to urban areas. To degrease the migration trend, rural areas needs to improve their production qualities to benefit from the urban consumers. Local governments are increasingly important for the continuation of this production, ensuring rural development, enabling equal and fair access to food resources for citizen. Since its establishment, the Agricultural Services Department of Izmir Metropolitan Municipality has been providing agricultural machinery and facility support to agricultural development, aquaculture, and irrigation cooperatives. There are 289 units of agricultural cooperatives with a staggering 36.000 members, which makes a reliable partner for the local government in the rural areas. To transform an agricultural crop into a final product, the rural development cooperatives are among the best candidates for a healthy and a sustainable diet. Local government of Izmir aims to align all the rural development projects into United Nations SDG's (Sustainable Development Goals). In the vision of the future aspects of the climate change, the rural cooperatives have a key role to unite the farmers. The aim of this study is to analyse the status, conduct a needs assessment, and examine the outlook of cooperatives contributing to agricultural production from an integrated management approach.
**Keywords:** Integrated Management, Agriculture, Aquaculture, Agro Ecologic Economy, Rural Development, Animal Husbandry.

## Introduction

Governments have traditionally intervened heavily in the agricultural sector, probably more so than in any other productive sector of the economy. Historically, governments have done so because they were concerned about ensuring an adequate level of farmer income and sufficient and affordable food supplies for their populations. While these objectives are still important today, many governments have broadened the scope of their policies to achieve other goals, including contributing to more competitive and innovative industries and environmentally sustainable production systems that are more resilient to climate change and other risks (OECD, 2021).

Started in 2020, The Farm to Fork Strategy is at the heart of the Green Deal. It addresses comprehensively the challenges of sustainable food systems and recognises the inextricable links between healthy people, healthy societies and a healthy planet (FAO, 2020)

Central and local government play a role in agricultural development through multi-stakeholder processes, policy development, facilitation of land protection and allocation, and agricultural supports. (Halloran and Magid, 2013).

As the national government in Turkey, the Ministry of Agriculture and Forestry provides agricultural supports. Today, agricultural supports; area based agricultural support payments, difference payment supports, livestock support payments, agricultural insurance services, other agricultural purposes supports, compensatory payments and rural. It consists of payments for development purposes (TOB, 2022a).

Izmir is a vibrant and culturally rich city located on the country's western coast along the Aegean Sea. With a population of approximately 4.5 million, the city has industrialized in sectors such as textiles, agriculture and services due to its role as a port city. Over its 8,000-year history, agriculture, including farming, livestock husbandry and fishing has played a central role. When the agricultural production of Izmir Province has examined, on the agricultural land of 343,309 hectares of the total production is produced 42% by field crops, 28% by olives, and 11% by vegetables (TUİK, 2021).

For the sustainability of agricultural production in Izmir and increasing resilience against climate change and food crisis The current Mayor M. Tunç SOYER, who served between of 2019-2023, keep the agricultural policies and supports with the "Another Agriculture is Possible" program. In this regard, studies have carried out to improve production processes on climate change and drought, agricultural education, animal nutrition, indigenous seeds, product purchase guarantee, food safety, machinery and facility supports. (YŞEP, 2020)

The aim of this study is to evaluate the agricultural support provided by Izmir Metropolitan Municipality and its contributions to production, producers, and consumers. The primary approach of this study involves scrutinizing the agricultural support initiatives across Turkey. It begins by conducting a needs analysis based on studies conducted in Izmir, subsequently correlating these findings with impact assessments.

**Materials and Methods**

In Turkey, alongside the Ministry of Agriculture and Forestry, several institutions once supported rural areas. The Village Services Institution closed in 2005, followed by the Special Provincial Administration in 2012, which transferred its duties as per Law No. 6360 on Municipalities. The Izmir Metropolitan Municipality, established in 2014, operates the Agricultural Services Directorate to foster production and support producers across 30 districts. The current administration, spanning 2019 to 2024, includes the Mayor, Council Members, Commissions, and Protocols. Under the General Secretariat, there are sub-units like Deputy General Secretaries, Department Heads, and Branch Directorates.

The organizational structure of local governments is particularly crucial for streamlining bureaucratic processes, enabling swift decision-making, and efficient implementation, especially in agricultural support services. Since 2019, the Agricultural Services Department Presidency within the Izmir Metropolitan Municipality has been providing services through its Branch Directorates for Agricultural Projects, Rural Development, Irrigation, Agricultural Education and R&D, Vegetable Market, Aquaculture Market, and Abattoirs. Through the efforts of these branch directorates, it is evident that every stage of production is represented, encompassing crop production, animal husbandry, aquaculture, facilities-equipment, and educational support.

When agricultural production has considered from a basin-based management perspective, there are four main basins in the province: Bakırçay, Gediz, Küçük Menderes, and Peninsula. In these basins, local authorities carry out integrated management practices. In these basins, local authorities carry out integrated management practices. Within this context, collaborations are established with various stakeholders in agricultural production, including ministry directorates, universities, cooperatives, agricultural chambers, professional organizations, and relevant non-governmental organizations (İktisat Kongresi Sonuç Raporu, 2023).

Integrated management strategies encompassing production planning, processing methodologies, marketing tactics, and sales protocols garner significant focus within pastoral livelihoods. These comprehensive approaches intricately orchestrate the entire production

continuum, from field to table, optimizing agricultural output while emphasizing the interconnection among diverse operational facets. Producer cooperatives, similar to other collective associations, enable farmers and breeders to consolidate their strengths, facilitating the implementation of this integrated management approach. This collaboration empowers them to develop more effective marketing strategies, enhance production planning, and establish more efficient sales networks within pastoral practices. The focus is centered around producer cooperatives and similar collective associations in providing support within these domains.

"In this study, the correlation between the support provided directly to producers by the Izmir Metropolitan Municipality and the process of cooperativization is examined. This examination evaluates its effects on production data, income of producers, and market strength through a case study. Data for the study were gathered through individual interviews with producers. These data were then subjected to regression analysis and impact assessment.

**Findings and Discussion**

When examining the support process, it involves a sequence starting with a request made by a producer or their affiliated cooperative, followed by the municipality's assessment of the request. This is succeeded by the signing of a protocol between the cooperative and the municipality, the procurement and installation processes, the initiation of support implementation, and the continuity of the cooperative-municipality relationship through regular inspections conducted by the municipality. Within the legal framework, the support process has initiated when the producer's needs has conveyed to the Metropolitan Municipality with cooperative demands (Fig. 1).

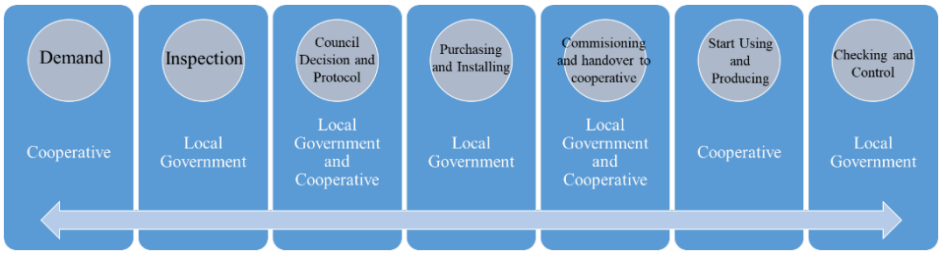


Figure 1. Flowchart of the Support Process

There are 289 units of agricultural cooperatives in the city of Izmir. 160 units are rural development cooperatives while 85 units are irrigation cooperatives, and 42 units are aquaculture cooperatives, with almost 36.000 members in total. (TOB,2022)

An exemplary case under scrutiny among the agricultural supports provided between 2019 and 2023 is the Dereköy Case. The cooperative management applied to the municipality in 2018 for a honey production facility, and following investigations, the council decision granted them the right to benefit from the support. Dereköy-Gökyaka Rural Development Cooperative founded in 1998 and with its 90 members it serves in the villages of Dereköy and Gökyaka in Kemalpaşa District. In this region beekeeping activities are popular due to low use of pesticides.

In 2018 the cooperative demanded a honey production and packaging facility from the local municipality to compete with its natural products in the market. Honey production is possible with the presence of rich vegetation in that region. However, the work to be done to protect and develop this vegetation is extremely important. These should be handled in a planned manner and the situation of flora and fauna should be made suitable over the years with the development plans. Agricultural land classification should be developed and evaluated in accordance with honey production.

The Honey Processing, Packaging and Labeling facility, which started production with Agricultural Support in 2019, has 90 cooperative partners. A total of 694,400 tons of production has been made since the day it started operating. The parameters used in the impact analysis are the number of businesses in the region, cooperative income, input costs, and production amount. (Table.1)

Table 1. Parameters of Production

| Year | Number of Business (Cooperative, Enterprise etc.) | Coop. Payment to Outsource the Filling and Labelling Task | Coop. Operating Costs | Number of Member | Number of Beeheves | Aprx. Annual Production (Kg) |
|---|---|---|---|---|---|---|
| 2017 | 300 | 280.000 ₺ | - ₺ | 90 | 8.500 | 119.000 |
| 2018 | 310 | 320.000 ₺ | - ₺ | 90 | 8.500 | 119.000 |
| 2019 | 315 | - ₺ | 50.000 | 90 | 8.500 | 119.000 |
| 2020 | 208 | - ₺ | - ₺ | 90 | 8.300 | 116.200 |
| 2021 | 279 | - ₺ | - ₺ | 90 | 8.000 | 112.000 |
| 2022 | 400 | - ₺ | - ₺ | 90 | 7.800 | 109.200 |

When analyzing data over a five-year period, the Municipality's support for the honey processing and packaging facility showcased an 84% reduction in mitigating production costs. The surge in private enterprises within the Kemalpaşa district significantly influenced the

production metrics of the Dereköy Agricultural Development Cooperative. This decline can be attributed to multiple factors, including climate change, drought conditions, and the impact of the 2020 pandemic.

Honey production data in Turkey for 5 years is as follows; in 2017, 114471 tons of honey were produced in approximately 8 million hives in 83,210 enterprises across Turkey. (TUIK,2017). Turkey's average honey yield per hive it is 14.3 kg, which is well below the world average (20 kg) (FAO, 2017). In 2022, the number of businesses and hives increased and 118,297 tons of honey were produced. The production amount decreased by 4.8% compared to the previous year (Beekeping Product Report, 2022).

As of 2017, the number of hives in Izmir is 215.743 in the province in the same year, 2836 tons of honey and 114 tons of wax were produced. In Kemalpaşa district of Izmir province, In the same year, 450 tons of honey were produced with 25,000 hives. A yield of 18 kg was obtained per hive (TUIK, 2017).

Despite regional variations, the analysis of the annual production quantity reveals an average yield of 15 kilograms, slightly surpassing the nationwide average in Turkey by approximately 0.4%.

Table 2. Financial Structure of Honey

| Years | Cooperative Purchasing | Merchant Purchasing |
|---|---|---|
| | Price of 1 unit of honey tin | Price of 1 unit of honey tin |
| 2019 | 500 ₺ | 280 ₺ |
| 2020 | 1.000 ₺ | 475 ₺ |
| 2021 | 1.500 ₺ | 675 ₺ |

Table. 2 shows that this grant or support has been beneficial for both the cooperative and the beekeepers collectively. Following this assistance, the cooperative reduced their expenses related to outsourcing services and procured honey at a more favorable price from its members. Consequently, the final products became available for sale in diverse markets and cities.

**Conclusion and Recommendations**

Regression analysis aimed to determine production costs as independent variables and cooperative incomes as dependent variables, yet this information could not obtained from the cooperative. This situation signifies the need for significant changes in the cooperative's modern

production processes in honey production. By examining annual yield calculations, the significance of production supports can be determined.

A considerable portion of the produced quantity goes to waste due to erroneous practices. Thus, the adoption of modern mechanization techniques, as previously mentioned, holds the potential for generating profitable projects.

Regional capacity significantly surpasses current honey production levels. Advancement necessitates the implementation of basin-oriented integrated project models. Furthermore, the prudent approach involves addressing these issues within a meticulously designed plan and program.

The study underscores the importance of evaluating the impact of agricultural production support across three distinct dimensions and aligning analyses accordingly. Within this evaluation of environmental, economic, and social impacts, the study suggests that supporting cooperatives by local administrations has the potential to enhance productivity, resulting in economic profitability. Ecologically, basin-oriented approaches are deemed crucial for agricultural development. Socially, these approaches have the potential to fortify relationships between rural and urban areas. This Support by itself serves several SDGs. Aligning a project with the United Nations Sustainable Development Goals (SDGs) is a powerful way to contribute to global efforts to address critical social, economic, and environmental challenges.

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# ASSESSING THE EFFICACY OF IOT-BASED ANIMAL HEALTH MONITORING SYSTEM: A SURVEY FOR PRECISE AGRICULTURAL PRACTICES

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**Abstract**
The use on internet technology in the fields of agriculture cannot be undermined. The term 'Internet of Things' (IoT) refers to the interconnectivity of devices or systems with embedded sensors that could send or receive data among them using the internet. In recent years, Internet of Things (IoT) has played very important role in enhancing automated agricultural practices. IoT-based systems have the capacity that could be useful to help gather real-time data on numerous parameters on animal's health including heart rate, blood pressure, body temperature and many more. This information can be very helpful to farmers, veterinarians and researchers in the identification and treatment of various health issues in animals. According to Aliku, et al. (2020), reveals that various programs have being developed for tracking and monitoring of animal health and effectiveness. This paper is a descriptive survey on IoT based animal health monitoring system. The paper described the major application of automated health monitoring system and also highlighted some of the key benefits of IoT-enabled animal health monitoring system. Conclusively, the paper affirmed that farmers' are now able to monitor the health conditions of their animals from anywhere using IoT based mobile devices.
**Keywords:** Internet Technology, Internet of Things, Animal Health Monitoring System.

## INTRODUCTION



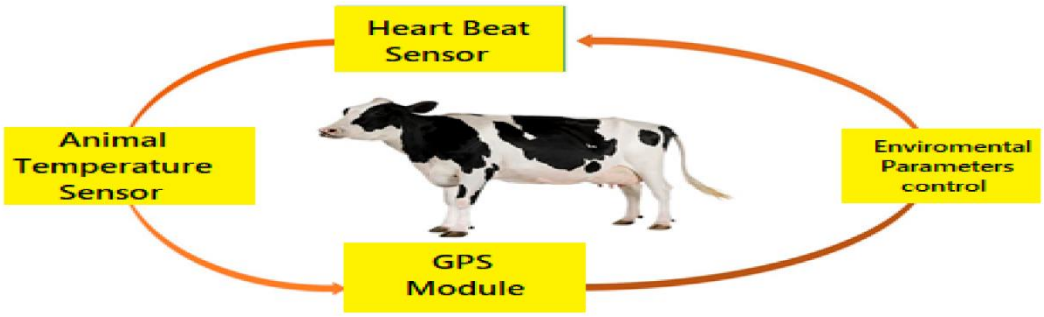

The use of Internet of Things (IoT) technology in the field of agriculture, especially in dairy livestock farming is growingly becoming popular as the secret to increasing dairy production is the fitness of the animal. IoT-based systems provide real-time data on various parameters on animal's health including body temperature, heart rate, and activity level. The data gathered are essentially useful to farmers, veterinarians and researchers for identifying and addressing numerous health issues in animals thereby lowering the minimum health and long-term costs of animal health inspections. The proposed system has several components such as temperature sensors, heart rate sensors, activity sensors and microcontroller module which are attached to the body of animal to help collect data on various health parameters.

## RELATED LITERATURE

The study of Pei & Wu (2013) reveals that Internet of Things (IoT) is increasingly being incorporated into many industries including agriculture to help improve productivity. Ghosh, et al. (2016) state that the implementation of IoT based technologies is considered useful for successful and sustainable agricultural practices and operations. Nwanakwere & Oyedokun (2018) emphasized that monitoring early emerging disease problems in animal is considered

very tasking. Oliveira (2016) inferred that veterinary laboratories are the principal sources of animal health surveillance information but only a little information are provided on animal welfare/ conditions and only a small proportion of animal illness are evaluated. Santana (2017) noted that embedded application tools are currently being developed for diagnosing and reporting disease. According to Aliku, et al. (2020), numerous programs are also being developed for tracking and monitoring of animal health and effectiveness. Palowei, et al. (2017) mentioned that Australian project have currently implemented Bovine Syndrome Surveillance System (BOSSS) which helps to collects information on particular diseased animals in farm fields. Campus (2019) noted that the collected is later used to identify and potentially predict new diseases based on the available database of diseases.

**Application of Automated Health Monitoring System**




1. Body temperature:

One major sensor based devices used for quantifying the body temperature of livestock is a tympanic thermometer device. This device is tied around the ear around the lower ear canal. Alert is triggered whenever the temperature is above 103.6°F.

2. Environmental humidity:

The strength of signals is weakened by humidity thereby causing loss of data while communicating between wireless components. The data on the level of humidity obtained on the farm provides a baseline for the temperature of livestock during the whole day.

3. Heart rate:

CorTemp bolus is commonly used to measure heart pulse using a microphone to ascertain and convert the time between consecutive pulses into a pulse rate.

4. Respiration:

Thermistor is used to quantify the respiration of livestock. This is determined by the number of times/minute the temperature falls and rises.

**Benefits of IoT-Enabled Health Monitoring System**

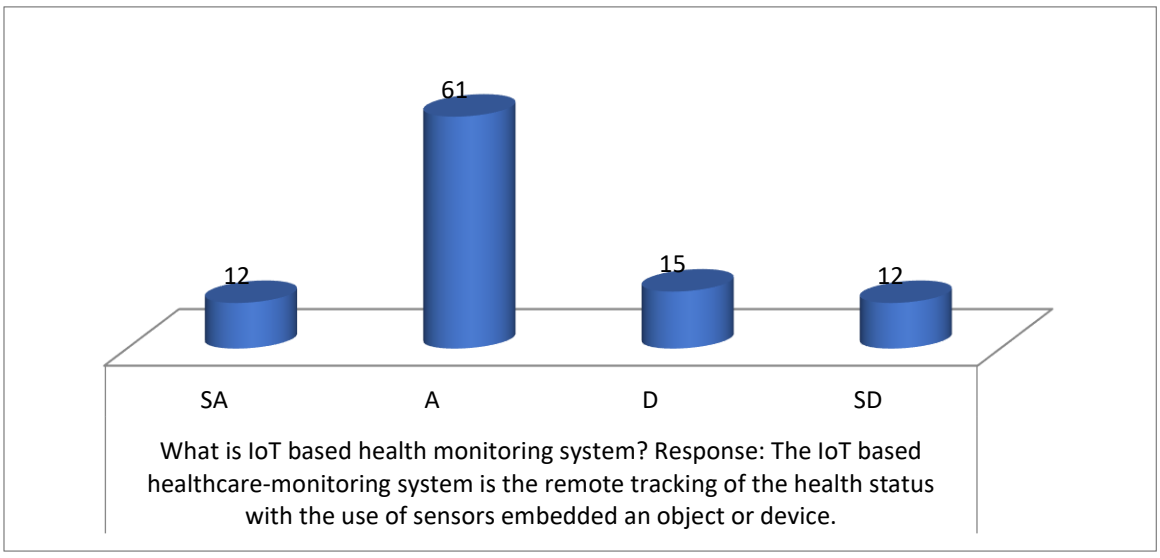
1. The health and vitality of livestock is monitored in real-time. This enables farmers to prevent the spread of illness or disease as they are able to quickly administer treatment to animals.
2. Grazing animals are effectively tracked. This helps to prevent losses and potentially identify grazing patterns.
3. Analysis of historical data. This enables farmers to identify trends in livestock health thereby preventing the spread of illness.
4. Monitoring of tendency for mating child birth. This enables farmers to prevent the possibility of losing new calves thereby optimizing breeding practices.

## MATERIALS AND METHODS

This paper is a descriptive survey design. The popular for the study involves 5 selected livestock farms in Lagos State, Nigeria. The researcher adopts simple random technique. Relevant and reliable information was gathered through validated questionnaire. In order to collect the information considered useful, the questionnaires were administered by experts to respondents using online Google form questionnaire instrument. The responses gathered were subjected to Cronbach's alpha reliability analysis. The result of 0.89 gave a good reliability index of the instrument. The entire exercise took place within the space of 43 days before completion.

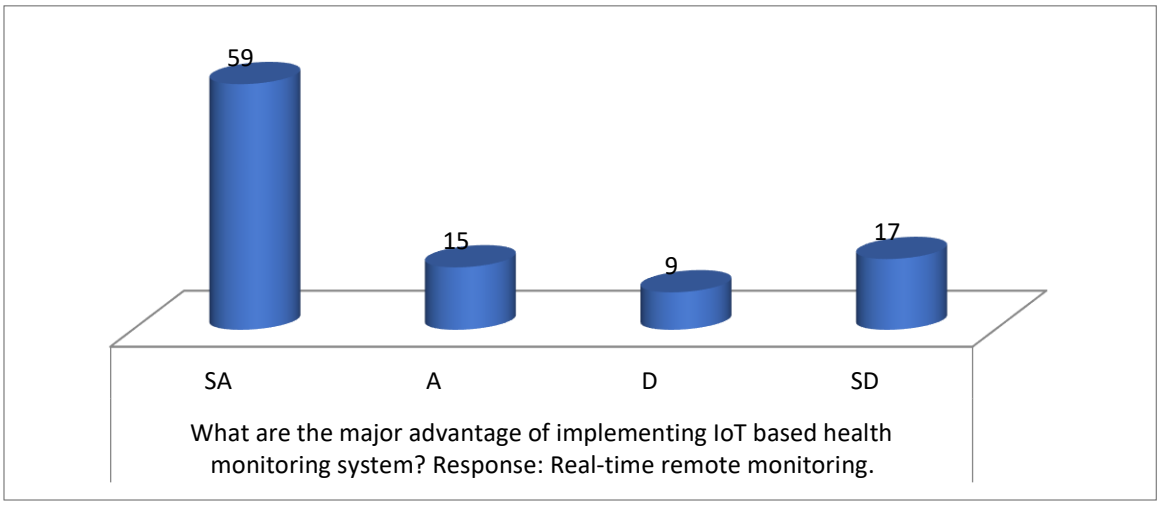
## RESULT AND DISCUSSION

**Fig.1: Chat Analysis**



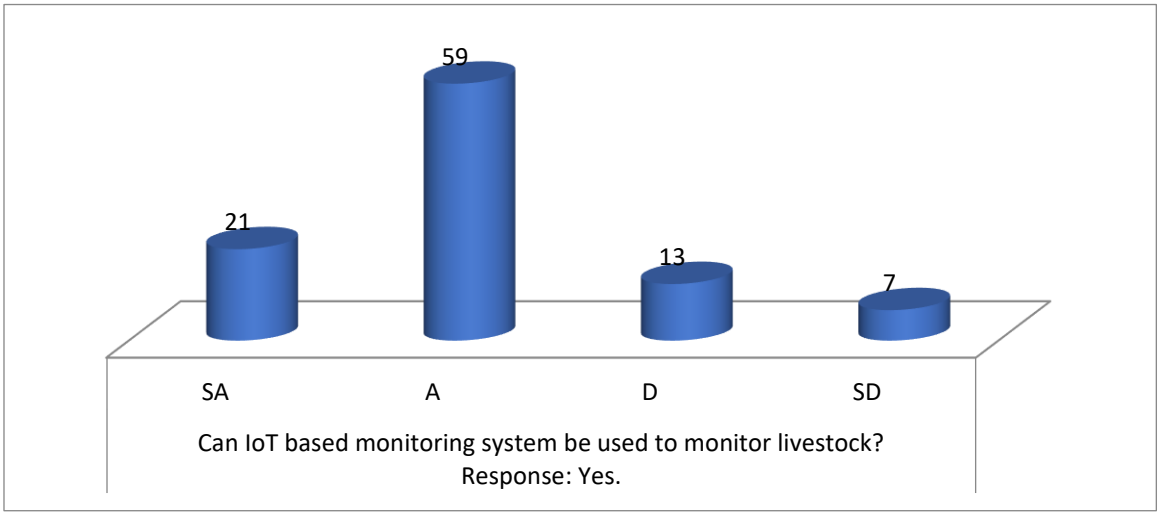
The graph plotted in figure 1 signifies that the respondents are knowledgeable abount sensor technology. Most of the respondents inferred that IoT based healthcare-monitoring system is the remote tracking of the health status with the use of sensors embedded an object or device. According to the respondents, the technology is aimed to enable the accurate tracking of things and connect various services with the use of embedded sensors in objects that have internet connectivity.

**Fig.2: Chat Analysis**



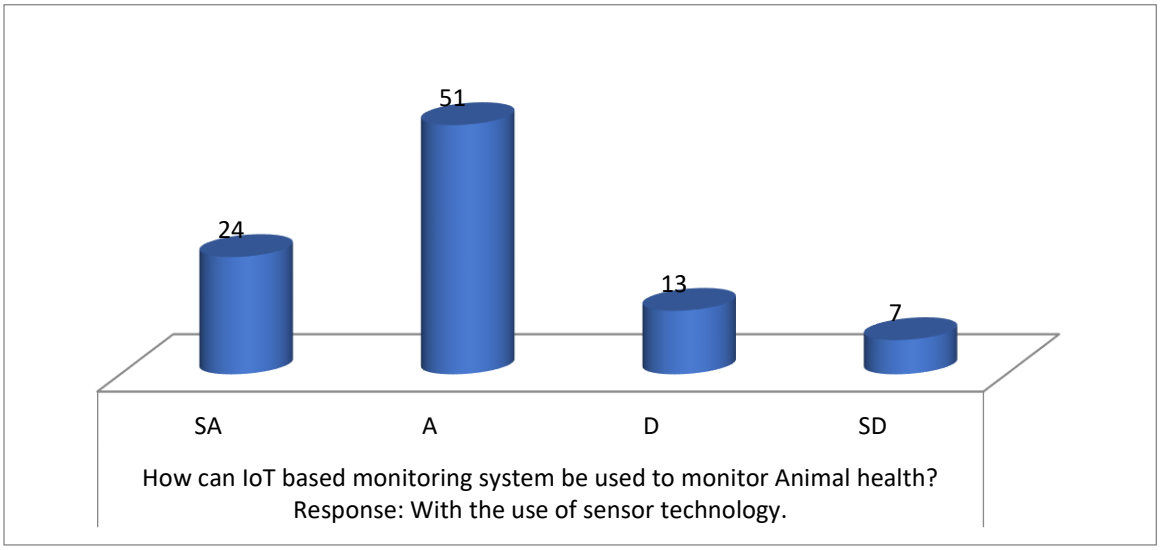

The chat analysis shown in figure 2 clearly indicate that a huge number of the respondents agree that the benefits of implementing IoT based health monitoring system cannot be undermined. According to the respondents, the major advantage of implementing IoT based health monitoring system is real-time remote monitoring. The respondents further explain that real-time remote monitoring is enabled via internet connectivity of IoT devices.

**Fig.3: Chat Analysis**




The chat analysis seen in figure 3 suggests that IoT based monitoring system can indeed be used to monitor livestock. A greater number of the respondents concur that IoT based monitoring system is essentially used to track the activity of livestock including health the fitness. The respondents noted that the technology helps to take care of the animal well-being and health. In addition, IoT-based systems can be used to track the location of a animal and identify the sick ones in order to curb the spread of disease.

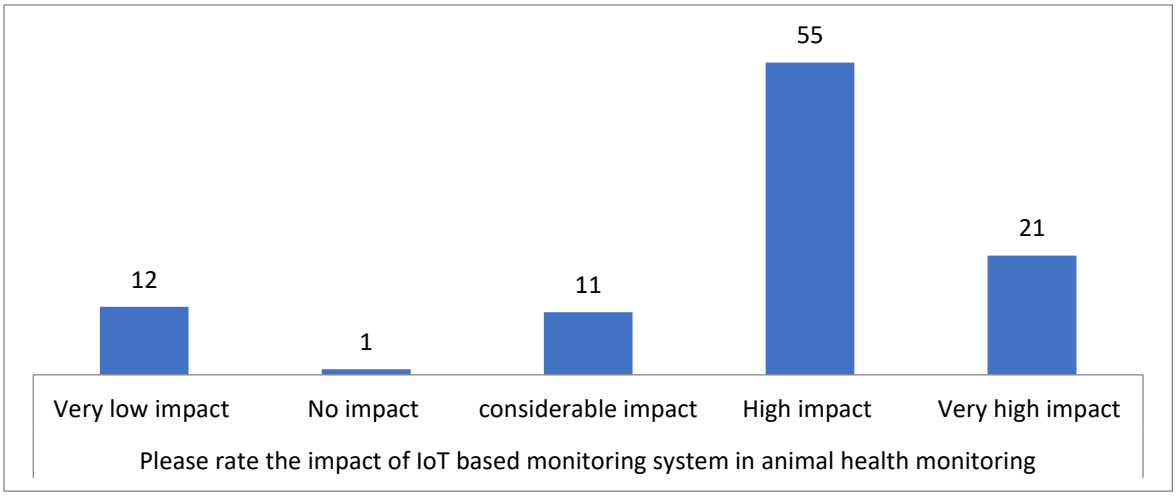
**Fig.4: Chat Analysis**




The graph plotted in figure 4 shows that a larger number of the respondents agree that sensor technology is essentially use to enable the monitoring of farm animals. The respondents explain further that sensors are used for automatic follow up on the various health factors. The

respondents stated that sensors are mounted on the body of animals which help to continuously observe their health parameters such as body temperature, heartbeat rate, etc.

**Fig.5: Chat Analysis**




The table plotted in figure 5 shows the rating of the respondents on the impact of IoT-based monitoring system in animal health monitoring. From the chat, it can be deduced that a significantly huge number of the respondents indicated that IoT-based health monitoring system have a high impact on the health inspection on animals. According to the respondents, the incorporation and use of IoT-based monitoring system is increasingly growing worldwide in agriculture domain.

## CONCLUSION

This paper discussion is focused on IoT based animal health monitoring system. In the paper work, we described the major application of IoT-enabled animal health monitoring system. Some of the key benefits of IoT-enabled animal health monitoring were also highlighted in the paper write-up. The paper asserts that the demand for high production of livestock is on the high side and therefore there is a crucial need to continuously monitor the wellbeing of the animal as this will determine their optimal fitness (health) for maximum productivity. In conclusion, the paper affirmed that IoT based mobile devices are used by farmers to monitor the health conditions of their animals from anywhere.

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# USES OF DEHYDRATED FOOD WASTE AS HALAL ENERGY SOURCE IN VILLAGE CHICKEN LAYERS DIET FOR WEIGHT GAIN AND IMPROVEMENT OF EGG QUALITY TRAITS

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## Abstract
This study was conducted to utilized dehydrated food waste (DFW) as halal feed ingredient for energy and source in village chicken layers' diets for weight gain and improvement of egg quality traits. One hundred and twenty (120) village chicken layers (Arabian strain) were randomly assigned to four dietary treatments. Commercial layers feed was used as control treatment ($T_1$), other dietary treatments contained formulated feed ingredients with processed dehydrated food (DFW) waste collected from different halal restaurants and used as energy and source in dietary treatments ($T_2$, $T_3$ and $T_4$). Each treatment was replicated 3 times with 10 birds per replicate. The feeding trial lasted for 7 weeks, in which initial weight of the birds were taken at day one of the study and subsequent weight reading were taken at every week for the determination of body weight gain (BWG). Feed were measured and given to the birds daily and the left over was measured subsequent day for determination of daily feed intake (DFI). Feed conversion ratio (FCR) was calculated by dividing feed intake with weight gain. At 3$^{rd}$, 5$^{th}$, and 7$^{th}$ weeks, egg laid were analyzed for egg quality traits (Egg weight, albumen weight, yolk weight, yolk weight, eggshell thickness and egg grade). All data taken were subjected to one-way ANOVA, treatments mean comparism were done using Duncan multiple range test at $P<0.05$. Results showed that, dietary feed treatments had no significant effect on BWG, DFI and FCR. However, there was a significant effect of dietary feed on egg quality traits. $T_2$ containing 56% DFW produced the highest result on egg weight (49.71g), albumen weight (26.70g) yolk weight (16.77g) eggshell weight (5.67g), and egg grade (letter A). Findings of this study, demonstrated that, DFW is of adequate quality as certified halal poultry feed ingredient, and is economical, cheap and readily available with easy processing method. Therefore, DFW can be offered to farmers as halal feed ingredient in large quantity as energy and other nutrients sources in village chicken layers' diet for growth improvement and quality egg traits.

**Keywords**: Body weight gain, dehydrated food waste, egg quality traits, halal feed ingredient, village chicken layers

## Introduction

Rapid increase in Muslim population growths worldwide and awareness on fulfilment of their religious obligation, creates a greater challenge for the demand of halal food and products for their quality, direct impact to food, fulfilment of their obligation and "Halal food security". This creates an opportunities or potentialities to manufacturers across the globe to come up with a qualitative halal food that will cater for the need of Muslim worldwide. (Anonim, 2006; Nazar, et al., 2014). Actually, the word halal is derived from an Arabic phrase which signifies the meaning allowed (lawful) or permitted (Authorized) by the Islamic Law with an opposite meaning "Haram" (forbidden or unlawful) in Islamic Law. For all Muslim, as far as food is concerned, its trading or commerce process is only allowed or permissible by the Islamic law to be consumed by Muslims when its fulfil the Halal certification (Halal Malaysia, 2006). One of the main concerns that plays a major role in the consumption of halal products for both Muslim and non- Muslim consumers is the cleanness and hygiene that comes with the Halal principles (Bonne, et al., 2007; Agri-Food Trade Service, 2008). Thus, increasing demand for halal food in the international market, which gave a golden opportunity for many countries to compete and participate in the lucrative global halal market (Zakaria and Abul–Talib, 2010). The size of the global halal food industry is estimated to be worth USD 1.292 billion in 2013 and is expected to become as high as USD 2.537 billion by 2019 (Thomson Reuters, 2014).

However, regarding the demand for halal food security by Muslim worldwide, there has been a controversy surrounding the issue of animal feed, Some Muslim scholars believe in concept that the animal feed made from haram products lead to category of unclean animal and thus to be avoided for consumption. On the other hand, some believe that the animal that lives in un-lawful products and survive by eating un-lawful products all the time meet the condition of unfit for the Muslim consumption (Jabar, et al., 2011). These days, most of the major supply of feedstuff for livestock feeding were mainly from the western nations and also from far east, which are not Muslim countries and really made from halal source (Amir and Mona, 2013). These brought about a sensitive issue within Islamic countries worldwide that led in stressing for, feed for animal feeding must be from plant origin or from Halal source (Jabar, et al., 2011). One of the cheapest and available source is to harness the value of food waste from halal sources. They are precious supplies, which can be reutilized as new valuable foodstuffs for animal production and also help in reducing the importation of costly feed ingredients and lessening environmental pollution (Hossein and Dahlan, 2015). However, this study was carried out with the objectives of utilizing dehydrated food waste (DFW) from halal source as halal

feed ingredient for energy and other nutrients sources in village chicken layers' diet for weight gain and improvement of egg quality.

## Materials and Methods

The experiment was conducted at Ladang 2 poultry unit, Universiti Putra Malaysia, (UPM). One hundred and twenty (120) village chicken layers (Arabian strain) at the age of 50 weeks' old were randomly distributed at indoor pen housing system, with 12 units (10 birds/unit replicate) under same environmental condition. The birds were assigned to four dietary feed treatments in which commercial layers feed was purchased and used as control dietary treatment ($T_1$), other dietary treatments were formulated using processed dehydrated food waste (DFW) from different halal restaurant and used as energy and other nutrients source in dietary treatments ($T_2$, $T_3$ and $T_4$). The study covered the duration of seven weeks. One-week feeding was used as an adaptation period, subsequent feeding continued for six weeks, in which feed and water were served ad libitum.

## Preparation and Processing of dehydrated food waste

Restaurant food waste was collected every morning and afternoon from 14 different halal restaurants within the premises of Universiti Putra Malaysia (UPM), then processed and used as an energy feed ingredient and other nutrients sources in experimental dietary treatment ($T_2$, $T_3$, and $T_4$). The food-waste were mainly uneaten rice from halal sources. Preprocessing commence by removal of unwanted materials (straw, tissue papers, meat, bones, tooth picks etc.) manually with covered hand glove from the food waste. After removing the unwanted materials, the waste was packed into a 0.2 mm nets strainer and soaked in hot water at $<100^{O}C$ for 10 minutes, which was gradually agitated for the removal of oil and killing of pathogens. The food waste was then washed with clean running tap water, spread on a protected wooden net and allowed to dry in the sun for 3 days. The sun dried food waste was later transferred to oven for drying under 40°C to < 10% moisture. The dried food waste was grounded into fine particle sizes using grinding machine (Retsch, Type SM100, 1500W) through 1-mm screen, then packed in a clean dry airtight containers and stored in a dry place which was later used as halal feed ingredient for energy and other nutrients source in the experimental diets ($T_2$, $T_3$ and $T_4$). Three samples of DFW were taken to laboratories for the determination of their nutritional contents through proximate analysis by AOAC (1990) methods. Gross Energy (GE), Crude

protein (CP), Crude Fiber (CF), C. Fat (C. Ft), Phosphorus (P), Salt (NaCl), Dry matter (DM) and ash were determined (Table 1).

**Table 1.** Nutritional contents of dehydrated food waste**.**

| **SAMPLES OF DEHYDRATED FOOD WASTE** | | | | |
|---|---|---|---|---|
| **NUTRIENTS** | **1st Sample** | **2nd Sample** | **3rd Sample** | **Mean. St. Dev.** |
| Gross Energy Kcal/k**g** (GE**)** | 3400 | 3404 | 3402 | 3402 ±1.63 |
| Crude protein (CP%) | 15.12 | 15.46 | 15.22 | 15.27 ±0.14 |
| Crude Fiber (CF%) | 3.20 | 3.09 | 3.17 | 3.15 ±0.05 |
| C. Fat (C. Ft%) | 6.40 | 6.47 | 6.34 | 6.40 ±0.05 |
| Calcium (Ca%) | 3.20 | 3.27 | 3.21 | 3.23 ±0.03 |
| Phosphorus (P%) | 0.06 | 0.09 | 0.07 | 0.07 ±0.01 |
| Salt (NaCl%) | 2.70 | 2.67 | 2.48 | 2.62 ±0.10 |
| Dry matter (DM%) | 90.10 | 89.98 | 89.93 | 90.00 ±0.07 |
| Ash (%) | 2.94 | 2.89 | 2.91 | 2.91 ±0.03 |

**Note: -** St. Dev.: - Standard deviation

The composition of commercial layers feed according to the feed label tag, was; - Corn, soybeans meal, other grain and grain by-product, Animal protein, vegetable oil, molasses, calcium carbonate, Di-calcium phosphate, amino acid, vitamin, trace minerals and enzymes, approved anti-microbial and additives (Corn based energy source). Other dietary feed treatments ($T_2$, $T_3$ and $T_4$) were mixed and formulated using percentage of DWF ranging between 50% to 56% as energy and other nutrients source (Table 2). Proximate analysis of the experimental diets was carried out for the determination of the experimental feed nutritional contents (Table 3).

**Table 2.** Percentages composition of experimental dietary feed treatments**.**

| **DIETARY FEED TREATMENT PERCENTAGES** | | | | |
|---|---|---|---|---|
| **INGREDIENTS** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** |
| Dehydrated food waste | - | 56 | 51 | 50 |
| Rice bran | - | 29 | 32 | 33 |
| Fish meal | - | 2 | 3 | 3 |
| Refine oil | - | 3 | 4 | 4 |
| Bone meal | - | 4 | - | - |
| Eggshell powder | - | - | 2.5 | - |
| Limestone powder | - | - | - | 2.5 |
| Soybeans meal | - | 5 | 6.5 | 6.5 |
| Vitamin premix | - | 0.3 | 0.3 | 0.3 |
| Mineral premix | - | 0.3 | 0.3 | 0.3 |
| Salt | - | 0.4 | 0.4 | 0.4 |
| **TOTAL** | **-** | **100** | **100** | **100** |

-

**Table 3:** Calculated and analyzed experimental dietary feed treatments**.**

| **DIETARY FEED TREATMENT PERCENTAGES** | | | | |
|---|---|---|---|---|
| **Calculated** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** |
| ME (Kcal/Kg) | 2800 | 2836 | 2832 | 2830 |
| Crude protein (%) | 16 | 16 | 16.4 | 16.4 |
| Calcium (%) | 3.0 | 3.0 | 3.0 | 3.0 |
| Total Phosphorus (%) | 0.4 | 0.52 | 0.4 | 0.4 |
| **Determined (Proximate analysis)** | | | | |
| ME (Kcal/Kg) | 2830 | 2839 | 2835 | 2832 |
| Crude protein (%) | 18.2 | 18.2 | 18.23 | 18.2 |
| Calcium (%) | 3.52 | 3.52 | 3.52 | 3.53 |
| Total Phosphorus (%) | 0.53 | 0.56 | 0.52 | 0.52 |
| Ether Extract (%) | 4.53 | 4.52 | 4.57 | 4.50 |
| Crude fiber (%) | 5.65 | 5.74 | 5.66 | 5.71 |
| Moisture (%) | 9.8 | 10.7 | 10.2 | 10.4 |

All experimental diets met the NRC (1994) nutrient recommendations for laying hens at older age All experimental diets are isocaloric and isonitrogenous.

**Experimental procedure and data collection**

Experimental feed was measured and served to the birds every morning. Daily feed intake was determined by measuring the feed left over in the subsequent mornings and the values obtained were recorded. Feed conversion ratio (FCR) was determined by dividing feed intake with weight gain. At 3$^{rd}$, 5$^{th}$, and 7$^{th}$ weeks, eggs laid within 24 hours were collected from each replicate per dietary treatment, and analyzed for egg quality traits (Egg weight, eggshell weight, eggshell thickness, albumen weight, yolk weight, haugh units and egg grade) in the laboratory. The weight of an egg was determining by placing each egg on the electric precision scale (Mettler Toledo), and the obtained measured values were recorded as egg weight. Data on egg grade was obtained by breaking and dropping the egg internal content on the plate of the egg analyzer, and the readings were given automatically and recorded. Both albumen and yolk weight were measured, after getting the total weight of the contents and plate (plate + albumen + yolk). The yolk was sucked from the content with the use of plastic bottle, and measured the weight of plate and albumen, then subtract from the total weight (plate + albumen + yolk) to get the weight of the yolk. Albumen weight was obtained by subtracting weight of the plate from both weight of plate + albumen. The eggshell thickness was determined after cleaning with soft tissue paper and allowed to dry for 6 hours, then three portion part (apex, equator and bottom side) of the eggshell were measured with digital micrometer calipha. The average was determined to get the values of shell thickness. All the data obtained was subjected to one-way ANOVA using (SAS Institute software, 2010) 9.4 version. Statistical test was performed on replicates averages and comparison between dietary feed treatments were done using Duncan multiple range test at $P< 0.05$.

**Results and Discussions**

The effect of dietary treatments on daily feed intake (DFI), body weight gain (BWG) and feed conversion ratio (FCR) of village chicken layers are shown in Table 4. There was no significant difference statistically ($P<0.05$) among treatments on DFI. The highest DFI (70.64g) was observed on group of birds fed with dietary treatment three ($T_3$). While the lowest DFI was observed on both group of birds fed treatment two ($T_2$) and treatment four ($T_4$) (70.60g). Birds fed with control treatment ($T_1$) shows higher DFI than birds fed with $T_2$ and $T_4$.

**Table 4**: Effect of treatments on production performance

| **DIETARY FEED TREATMENTS** | | | | | |
|---|---|---|---|---|---|
| **Egg Traits** | **$T_1$ STD.DEV)** | **($T_2$ STD.DEV)** | **($T_3$ STD.DEV)** | **($T_4$ STD.DEV.)** | **CV.** |
| DFI (g feed/g hen/day) | $70.63^a \pm 0.27$ | $70.60^a \pm 0.21$ | $70.64^a \pm 0.38$ | $70.60^a \pm 0.23$ | 0.39 |
| BWG (g feed/g gain-hen) | $15.44^a \pm 0.73$ | $15.78^a \pm 0.78$ | $15.80^a \pm 1.19$ | $15.62^a \pm 0.83$ | 18.38 |
| FCR (g feed/g-weight) | $2.21^a \pm 0.11$ | $2.25^a \pm 0.11$ | $2.27^a \pm 0.17$ | $2.23^a \pm 0.12$ | 5.78 |

**Note;** - $^{a, ab, b, and\ c}$: - Values within a row with different superscription are significantly different ($P< 0.05$), DFI: - Daily feed intake, BWG: - Body weight gain FCR: - Feed conversion ratio, STD.DEV: - Standard deviation.

On the result of BWG, there was no significant difference statistically ($P<0.05$) when the treatments were applied. However, despite that, all the dietary treatments administered performed better than the $T_1$ (control), but the performance was not significant. Slight higher gained (15.80g) was observed on birds group under $T_3$ and the lowest (15.44g) was observed in $T_1$ (control). Similarly, the applied treatments had no significant effect on FCR to body weight gained (Table 4). However, despite that, the performance in the control treatment was lowest FCR (2.21g) among all the administered treatments. $T_3$ has the highest (2.27g) FCR than other treatments. The result obtained is in agreement with the findings of other researchers in the field of Animal nutrition. Safaa, et al., (2008), Elsayed, et al., (2014), and Tunc and Cufader, (2015) reported non-significant effect of dietary feed treatments with corn as energy and other nutrients source on DFI, BWG and FCR. Contrary to this findings, Khalil and Anwar, (2009) and Ahmed, et al., (2013) however, reported a significant increase on DFI, BWG and FCR to body weight gain after serving layers with dietary feed treatments containing corn as an energy and other nutrients sources. On the other hand, some researchers used DWF as source energy and other nutrients source in chicken layers' diets but found significant effect on DFI, BWG and FCR. Hossein and Dahlan, (2015) fed diet to village chicken containing DFW as energy and other nutrients source, but in different ratio inclusion and found a significant effect on DFI, BWG and FCR. Though in their finding, the performance of experimental diet containing 20% inclusion of DFW was highly significant than other higher level >50% DFW inclusion. Diet with level inclusion above 50% DFW shows lower performance on DFI, BWG and FCR when compared to other diet containing lower inclusion level <40% DFW. Also, in result of Kojima, (2005) a significant effect of dietary feed treatments containing dried kitchen leftover as energy and other nutrients occurs on DFI, BWG and FCR. Probably, a significant effect observed by

these researcher's findings might be due to the nature and method of processing the food waste. Processing method in dehydrating food waste did affect the nutritional contents and palatability of the DFW. In our study, the nature of the DFW was mainly rice only from the restaurant, unlike the nature of food waste and processing method in Kojima, (2005) and Hossein Dahlan, (2015) study. In our study, high fat or oil content were reduced and oven dried was carried out after sun drying to reduce the moisture content of DFW. According to Kwak, et al., (2002), the values of food waste varies depending upon the origin of the food waste. Also, method of processing the food waste did affect the nutritional content of the dried food waste. In kojima, (2005) study, kitchen food waste was used, unlike restaurant food waste used in our study. In another view, the differences might be due to the effect of housing system used in conducting the research. Comparing our study with that of Kojima, (2005) and Hossein and Dahlan, (2015), the types of housing system used in conducting the study were different. Indoor pen housing system was used in conducting our research, contrary to cage and free range system of housing they used in their study. This was supported by other researcher's view. Van Niekerk, (2014) reported that, layers in non-cage systems spend more of their energy on movement; this resulted in either production of small eggs or decreased yolk content.

The result of egg weight, albumen weight, yolk weight, eggshell thickness and egg grade was presented (Table 5). It shows that, the experimental dietary feed treatments had significant effect statistical ($P<0.05$) on egg weight. $T_2$ with 56% DFW recorded the highest mean value of egg weight (49.71g), while, the lowest mean value (42.80g) was observed in $T_4$ with 50% DFW. The mean egg weight of $T_1$ (corn base) (control) was significantly higher than that of $T_4$ with 50% DFW (Table 5). The result is in agreement with the findings of Kojima, (2005) that used Dehydrate kitchen waste as source energy and other nutrients in layers' diet and found significant effect on egg weight. Likewise, Bozkurt, et al., (2004) noticed a significant effect of dietary treatments, but containing corn as an energy and other nutrient source on egg weight after serving to layers in their diet.

**Table 5**: Effect of treatments on egg quality traits

| **Dietary feed treatments** | | | | | |
|---|---|---|---|---|---|
| **Egg Traits** | **($T_1$ STD.DEV)** | **($T_2$ STD.DEV)** | **($T_3$ STD.DEV)** | **($T_4$ STD.DEV.)** | **CV.** |
| Egg weight (g) | $44.20^{c}$ ±3.39 | $49.71^{a}$ ±3.97 | $45.41^{b}$ ±3.50 | $42.80^{d}$ ±1.04 | 6.46 |
| Albumen weight (g) | $24.56^{c}$ ±1.97 | $26.70^{a}$ ±2.51 | $25.37^{b}$ ±1.57 | $24.14^{c}$ ±0.59 | 7.15 |
| Yolk weight (g) | $14.64^{b}$±1.46 | $16.77^{a}$ ±1.07 | $14.95^{b}$ ±0.68 | $13.73^{c}$±0.09 | 6.43 |
| Eggshell weight (g) | $4.45^{c}$ ±0.60 | $5.67^{a}$ ±0.32 | $4.83^{b}$ ±0.10 | $4.44^{c}$ ±0.08 | 7.49 |
| Egg grade (Grade) | B | A | A | A | |

**Note;** - $^{a, ab, b, and\ c}$; - Values within a row with different superscription are significantly different (P< 0.05)

EST: - Eggshell thickness,

Likewise, Catli, et al., (2012) and Tunc and Cufadar, (2015) observed a significant effect on egg weight when they offered diet to layers containing corn as source energy and other nutrients. But in other research findings, no significant effect was observed on egg weight. Safaa et al., (2008) and Safamehr, et al., (2012) did not find any significant effect statistically (P<0.05) among dietary treatments containing corn as source of energy and other nutrients on egg weight.

On albumen weight result, it pinpointed out that, the treatments had significant effect statistically (P<0.05) on this trait. The heaviest (26.70g) and lightest (24.14g) mean albumen weight values were obtained with $T_2$ (56% DFW) and $T_4$ (50% DFW) respectively. The mean values of $T_1$ (corn based) and $T_4$ (50% DFW) were however at per statistically (P<0.05) (Table 5). The result is in agreement with Houndonougbo, et al., (2014), who observed a significant effect of dietary treatments with corn as energy and other nutrients source on albumen weight. But disagreed with the findings of Gongruttananun, (2011) and Ahmed, et al., (2013) who did not observe significant effect of experimental diet containing corn and other nutrients sources on albumen weight. In case of yolk weight result, significant difference was observed when the treatments were administered. $T_2$ (56% DFW) and $T_4$ (50 % DFW) had the highest (16.77mm) and lowest (13.73mm) mean yolk weight respectively. There was however no significant different between the mean yolk weight of $T_3$ containing 50% DFW and the control treatments (corn energy based treatment) (Table 5). The result coincided with findings of Garba, et al., (2006), who observed significant effect (P<0.05) of dietary treatments on yolk weight after providing layer with diet containing pearl millet as energy and other nutrients source. However,

the result of Gongruttananun, (2011) and Ahmed, et al., (2013) does not agreed with present finding. They found no significant effect ($P<0.05$) among treatments on yolk weight after offering diet to layers containing corn as energy and other nutrient source. Probably, the disharmony between our result and other researcher's findings on albumen and yolk weight, might be due to breed type used in conducting the research. Heavier breeds were used in other research finding and lighter breed of Ayam Kampong was used in our study. This was supported by Monira, et al., (2003) who stated that, given qualitative diet to white leghorn layers (heavy breed), leads to superior production of heavy albumen and yolk eggs over other breeds of chicken layers.

The eggshell weight was also significant influence by the treatments administered. The highest (5.67g) and the lowest (4.44g) were obtained from $T_2$ and $T_4$ treatments respectively. There exist with no significant difference statistical ($P<0.05$) between the mean values of $T_1$ and $T_4$ (Table 5). The result coincided with earlier findings of Brister Jr, et al., (1981) and Lichovnikova, (2007), who observed a significant difference in eggshell weight, eggshell percentage and eggshell thickness when they provide dietary feed treatment containing DFW as energy feed ingredient source in layers' diet. Also in the result of Sultana, et al., (2007) a significant ($P<0.05$) effect of dietary treatments occurs on eggshell weight, eggshell thickness and eggshell percentages when DFW was serve as energy in layers in diet. In the study of Ahammad, et al., (2005) and Safaa, et al., (2008) do not observed any significant difference statistically ($P<0.05$) on eggshell weight, shell percentages and eggshell thickness after offering different dietary calcium sources to layer birds in their diet. On egg grade result, significant effect ($P<0.05$) was observed with the administration of the dietary treatments. The best egg grades with letter A was obtained with $T_2$, $T_3$ and $T_4$, both containing DFW as energy and other nutrients sources. Whereas the control treatment $T_1$ (corn base) was with the letter grade B at lower and differ significantly with the other treatments (Table 5). With these, the result pinpointing to the fact that DFW improves egg grades, and these were primarily determined by the profile of pigmenting carotenoids and can simply be adapted through feed ingredients (Hernandez, et al. 2005). Therefore, it could be assumed based on this study that, $T_2$, $T_3$ and $T_4$ had the highest profile of pigmenting carotenoids that effectively enhanced the production of internal egg quality. However, the study confirms that DFW does contain quality nutritional values as indicated by its overall nutrient profile and performance in village chicken layers' diet as halal feed ingredients for energy and other nutrients sources. Both dietary feed treatments (2, 3 and 4) containing high level of DFW (56%, 50% and 50% respectively) exhibit qualitative

result on growth performance of village chicken layers. $T_2$ exhibit superior result on egg quality traits (Egg weight (49.71g), albumen weight (26.70g), yolk weight (16.77g), eggshell weight (5.67g) and egg grade (letter A)) over other dietary feed treatments. Therefore, DFW can be offered to farmers as satisfactory halal feed ingredients in village chicken layers' diet for growth improvement and egg quality traits.

**Conclusion and Recommendation**

Findings of this study demonstrated that, DFW is of adequate quality as certified Halal poultry feed ingredient that can improve growth performance and egg quality of village chicken layers. It can be a substitute to higher amount (50 - 56%) in poultry nutrition contrary to other research findings that indicate only 20 – 25% of DFW was economical to be used in poultry nutrition. Thus, since this by-product is purely halal in its composition, economical, cheap and readily available with easy processing method, it can be offered to farmers as halal feed ingredient for growth improvement and quality egg in village chicken layers. Therefore, DFW can be offered to farmers as halal feed ingredient in large quantity as energy and other nutrients sources in village chicken layers' diet for growth improvement and quality egg traits.

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# DEVELOPMENT OF METHODS AND TECHNOLOGIES FOR IN VITRO PROPAGATION AND STORAGE OF WILD PLANT SPECIES

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**Abstract**
Clonal micropropagation finds wide application, provoked by the main advantages compared to conventional methods for the production of planting material - virus-free plants, accelerated propagation of newly selected, promising or marketed material and vegetative offspring of the species. Several factors determine the success of microvegetative propagation - the genotype and condition of the starting plant, the type of starting explant, the method of introducing the explants into culture, the cultivation conditions. The Bulgarian flora is a source of plant species rich in a large set of chemical components - specific substances or groups of compounds that are in limited populations. Insufficient amounts of plant material cannot be the basis for satisfying the demand and production of their metabolites by traditional technologies. In the last years of our century, scientists are alarming that the loss of biodiversity is increasing. This necessitates the collection and preservation of plant species. Plant genetic resources bring together plant species that provide humanity with everything necessary for life: food, raw materials, and energy. Their preservation is a priority task on a global scale.
**Keywords:** micropropagation, in vitro storage, in vitro collections, nutrient media, growth regulators, proliferation

## INTRODUCTION

The Bulgarian flora is a source of plant species, rich in a large set of chemical components, which are in limited populations. In recent years, thanks to the artificial increase in the productivity of cultivated plants, there has been a loss of plant biodiversity, which is essentially the starting material for selection (Desheva et. al., 2016). This necessitates the collection and preservation of plant species. Their conservation is a priority task on a global scale (Krasteva et.al.2008).

The Institute of Plant Genetic Resources "Konstantin Malkov" was established in 1902 - as an experimental agricultural station, which in 1977 grew into the Institute of Plant Genetic Resources. The National Seed Gene Bank is located on the territory of the Institute, which stores 57,684 seed samples out of the total of 62,131 registered as a gene pool in the country (Desheva et. al., 2016; Uzundzhalieva et. al., 2017). The Institute is the national coordinator of the Program on Plant Genetic Resources, which is part of the European Program on Plant Genetic Resources (ECPGR).

The application of storage under controlled conditions of development is one of the approaches to the conservation of plant diversity. The long-term storage of the seed samples is carried out at minus temperatures (-18°C) in a specially designated chamber. Vegetatively propagating species of cultivated and wild flora are cultivated under in vitro conditions (Dimitrova et al., 2011; Engelmann F., 2011; Ruseva, 2011). The accelerated development of plant biotechnologies worldwide has turned developed in vitro techniques from an ideal into a practical necessity (Rout et al. 2000; Uzundzhalieva et. al., 2016; Varbanova et. al., 2014).

In the tissue culture laboratory, research work is aimed at studying the behavior of valuable medicinal species under in vitro cultivation. The reason for emphasizing these plant species is that they are much more difficult to reproduce in vitro, which requires a more detailed study of the conditions and factors for their introduction into culture and successful micropropagation. For this purpose, it was necessary to test different variants of nutritional environments with variation in the field of mineral elements (Ruseva R., 2011)

Factors influencing the growth of Ruta graveolens L. under controlled conditions and storage were studied by Massot et al (2000). Murashige & Skoog (1962) found that the main nutrient medium for the development of the species under controlled conditions. Protocols for micropropagation of the species were developed by John Steal, (1997) and Castro and Barros, 1997 shoot tip, between nodal and leaf segments and evaluated different culture media for optimal micropropagation.

Studies on the development of the species Atropa belladonna L. in vitro under Murashige & Skoog nutrient medium were carried out by Taha (2003). It has been found that the amount of sugar and agar depends on the plant species and the purpose of the experiment (Gamborg, 1976). According to Hank et al. (2003) very good results in the cultivation of the species Atropa belladonna L. were observed in medium ½ MS containing 3% sucrose. Possibilities for in vitro propagation and study of the reaction of Atropa belladonna L., developing under controlled conditions, on Murashige & Skoog nutrient medium with the participation of BAP at a concentration of 0.5 mg/l and IAA- 1.0 mg/l, were studied by Dimitrova et al. . (1996).

The aim of the present study is to answer the questions related to the study and optimization of the factors affecting the long-term storage of Ruta graveolens and Atropa belladonnaL.

## MATERIAL AND METHODS

The research was carried out in the Tissue Culture Laboratory at the Constantin Malkov Research Institute - Sadovo.

To introduce Ruta graveolens into in vitro culture, seeds originating near a deposit in the "Kaliakra" reserve and Atropa belladonna from Beglika in the Rhodopes were used as starting material.

Disinfection of seeds from the starting plant material was carried out with 50% C2H5OH for 3 min followed by 20% bleach (containing 5% active chlorine). This is the most important moment on which obtaining a culture free of bacteria and viruses depends. The sterilizing agent used is in maximally low concentrations, for minimal damage to the plant genetic material.

The culture medium used was Murashige & Skoog (1962). The plant material is placed in individual test tubes with a capacity of 20 ml. As a control variant, nutrient medium MS (1962) (Table 1) was used, without added growth regulators. Side and top buds are used for reproduction.

The growth regulators used for Ruta graveolens are TDZ and BAP in concentrations of 0.2, 0.5, 0.7 and 1.0 mg/l TDZ was added after sterilization of the culture medium in a laminar box.

The growth regulators used for the species Atropa belladonna are IBA and IAA with applied concentrations of 0.1, 0.3 and 0.7 mg/l.

| | **Murashige & Skoog** (1962) |
|---|---|
| **macronutrients** | mg/L |
| MgSO4. 7 H2O | 370 |
| CaCl2. 2 H2O | 440 |
| KNO3 | 1900 |
| NH4NO3 | 1650 |
| KH2PO4 | 170 |
| **trace elements** | |
| Mn SO4. 4H2O | 22.3 |
| KJ | 0.83 |
| CoCL2. 7 H2O | 0.025 |
| ZnSO4. 7H2O | 8.60 |
| CuSO4. 5H2O | 0.025 |
| H3BO3 | 6.2 |
| NaMoO4. 2H2O | 0.25 |
| | |
| **vitamins** | |
| Thiamine vit. B1 | 2.0 |
| Pyridoxine HCl vit. B6 | 0.5 |
| Nicotinic Acid | 0.5 |
| Kinetin | 0.4 |
| **Fe chelate** | |
| Fe NaEDTA | 36.7 |

Table.1 Composition of nutrient media for in vitro culture

Cultivation takes place under low intensity light of 2000 lx. with a temperature regime of 20–22ºC. Sucrose (30 g/l) was used as a carbohydrate source, and agar (7.0 g/l) with a medium pH of 5.6 was used as a hardener, and its adjustment was made with 1N KOH before autoclaving. Sterilization is carried out for 20 min at 120º C and a pressure of 0.9 atm.

RESULTS AND DISCUSSION

Taking into account the biometric indicators, the measurement of the effect of the action of BAP on the multiplication process in the medicinal species Ruta graveolens was observed one month after placing the plants on the nutrient medium. The BAP action is accounted for by eliminating apical dominance, thereby inducing the development of lateral buds and initiating the proliferation process of new explants. The number of sprouts formed depends on the type and concentration of cytokine administered. A very good response of the species was observed in the variant with the participation of 0.5 mg/l BAP with 85% shoots (pic.1). Number of shoots per explant was 3.49 compared to the control 1.44. The data show that the frequency of multiplication does not subside over the studied period. Application of low concentrations of BAP lead to maximum multiplication of the species with values exceeding the control variant.



Picture 1. Variant involving 0.5 mg/l BAP

Compared to BAP, the influence of TDZ does not give an optimal opportunity for the Ruta graveolens species to realize its maximum development potential under controlled conditions. As the concentration increased from 1.0 mg/l TDZ, the least number of shoots formed per explant was observed, but the highest shoot height of 3.03 cm was reported here, compared to the control of 2.81 cm. It is reported that with the increase in the concentration of TDZ, the number of shoots from one explant decreases, but there is an increase in the height of the shoots. The results of the influence of the nutrient medium with added BAP and TDZ on the degree of development of the explants are presented in Table 2.

| food environment | formed shoots in % | number of shoots per explant | shoot height |
|---|---|---|---|
| контрола | 43 | 1.44±0.10 a | 2.81± 0.07 a |
| 0.2 mg/l BAP | 82 | 3.00±0.21 b, c | 2.89±0.09 a |
| 0.5 mg/l BAP | 85 | 3.49±0.27 c | 2.70±0.06 a |
| 0.7 mg/l BAP | 71 | 2.80±0.24 b, c | 3.19±0.12 b |
| 1.0 mg/l BAP | 65 | 2.70±0.30 b,c | 2.85±0.11 b |
| 0.2 mg/l TDZ | 16 | 1.21±0.06 b | 3.0±0.13 a, b |
| 0.5 mg/l TDZ | 13 | 1.10±0.05 a,b | 2.80±0.11 a |
| 0.7 mg/l TDZ | 7 | 1.00±0.03 a | 3.1±0.11 b |
| 1.0 mg/l TDZ | 5 | 1.00±0.04 b | 3.03±0.11 a, b |

Table 2 Influence of BAP and TDZ in the nutrient medium Murashige and Skoog (1962) in Ruta graveolens

After obtaining virus- and bacteria-free in vitro plant genetic material for Atropa belladonna, we moved on to the next stage of the preservation of the species - determination of the best nutrient medium for development pic. 2.



Picture 2. pure plant material of the species Atropa belladonna

Comparing the development of microplants in nutrient media containing 0.1, 0.3 and 0.7 mg/l IBA and IAA. The growth of the stem in the medicinal species in controlled conditions, with the addition of 0.1 mg/l IBA, on the 10th day of planting the experiment reached $\bar{x}$ =0.6 cm, and for the control variant $\bar{x}$ = 0.5 cm, a value exceeding the other variants of the experiment. The results we obtained regarding leaf formation on the 10th day of microplant development in 0.1 mg/l IBA was $\bar{x}$ = 2.8 units, a value exceeding the control variant and the other auxin

concentrations. As the observation period increases, the measured indicators also increase, and on the 30th day of betting the experience reaches a maximum value of $\bar{x}$ =5.0 pcs.

In a concentration of 0.3 mg/l IBA, development of the root system was observed on the 20th day of planting the experiment, with low indicators compared to the other variants. On the 30th day, maximum indicators of root formation were recorded in this variant with an average value of $\bar{x}$ = 1.0 units, and for the control variant with $\bar{x}$ = 4.0 units of roots.

Comparing the three variants with the participation of auxin with the control variant, a concentration of 0.1 mg/l IBA stood out with the highest indicator of development on the 20th day of planting the experiment.

In order to determine the requirements of A. belladonna L. to the cultivation conditions in vitro, the influence of the auxin IAA at a concentration of 0.1, 0.3 and 0.7 mg/l was investigated.

From the comparative analysis performed in an auxin concentration of 0.7 mg/l IAA on the 10th day of planting the experiment, it can be seen that the results are the same as the control variant – $\bar{x}$ = 0.4 cm. After this period, the control variant has higher stem growth values compared to the variant with the participation of cytokinin. Maximum height growth in 1.0 mg/l IAA was observed on day 30 of the trial. The proliferation ratio for this variant is 1:3.

## CONCLUSIONS

To obtain an effective multiplication factor associated with normal morphological development and good life status of the explants in the species Ruta graveolens L., low concentrations of BAP lead to maximum multiplication of the species with values exceeding the control variant. A certain dependence is observed: with an increase in the period of development of the explants, leaf formation in Atropa belladonna also increases. The presence of a smaller number of roots with a less developed root system was observed in the variants with the participation of the auxin IAA compared to the control variant, where there is a very well developed root system.

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# RESTORATION OF SEMI-NATURAL GRASSLANDS - SHOULD I STAY OR SHOULD I GO?

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## Abstract
Grasslands offer significant ecosystem services. However, because to invasive species, urbanization, agriculture, climate change, and other human-caused factors, grasslands have seen widespread degradation. The possibility for restoration in grasslands is negatively impacted by an extended amount of time between abandonment and restoration. Common species frequently relocate to restored grasslands. Prescribed burns, grazing management, the grazing of wild animals, tree pruning, shrub removal, and the control of invasive species are important challenges in restoring the biodiversity of these grasslands.
**Keywords:** Grassland, recover, recolonise, semi-natural, management

## 1. Introduction

Among the biggest terrestrial biomes, grasslands are hotspots for biodiversity in many different parts of the world. More than 25% of the surface of the terrestrial globe is covered by these ecosystems; 9.3 million km2 of grasslands are found in Eurasia alone (Török & Dengler, 2018). Broadly distributed, grasslands offer significant ecosystem services such as food and fodder, water regulation and freshwater supply, erosion control, pollinator encouragement, and carbon sequestration, in addition to having a very high conservation value (Bengtsson et al. 2019). However, because to invasive species, urbanization, agriculture, climate change, and other human-caused factors, grasslands have seen widespread degradation (Steffen et al. 2015). There have been reports of alarming losses in biodiversity and grassland space. For instance, during the previous 30 years, 50–70% of Europe's former grassland acreage has been devastated (Habel et al. 2013; Dixon et al. 2014). Despite this, compared to forests or freshwater ecosystems, grassland restoration research and management have received less attention from conservation agencies, the media, and the scientific community (Temperton et al. 2019).

In addition to protecting the surviving natural ecosystems, ecological restoration of degraded areas is thought to be essential in the fight against land degradation (Strassburg et al. 2020). In order to meet these goals, ecological restoration must be improved and larger landscapes must be restored. This entails prioritizing restoration efforts globally and usually taking into account broader geographical and temporal dimensions in restoration (Gann et al. 2019).

Patch area, perimeter, and proximity to propagule sources are the most often measured landscape parameters when considering the surrounding environment (Alsfeld et al. 2010; Guido et al. 2016). An further significant aspect influencing the outcome of restoration is the species that are present in a landscape. Restoring habitat is a crucial addition to habitat protection in order to preserve biodiversity. In temperate Europe, semi-natural grasslands are the ideal sites for ecological restoration. Restoring abandoned semi-natural grasslands frequently depends on plant species from the surrounding environment or the soil seed bank spontaneously colonizing new areas. While numerous studies demonstrate the significance of the regional species pool in maintaining local diversity (Waldén et al. 2017).

While the establishment of new grasslands on formerly arable land frequently involves the human spreading of specific seed mixes, the restoration of semi-natural grasslands that have been abandoned typically depends on the spontaneous recolonization of plants from the surrounding landscape or the soil seed bank. This restoration technique may be less expensive than others, but in order for the targeted species to be able to recolonize the restored habitat,

they must continue to occur locally inside the site or regionally throughout the landscape. According to Bagaria et al. (2015), several grassland species show a delay in going extinct after grassland abandonment; they can continue as perennial adults or as seeds in the seed bank (Auffret and Cousins, 2011). The extinction debt is this gap in the extinction process' timeliness (Kuussaari et al., 2009), enables populations to recover rapidly when habitat conditions within restored grasslands have become suitable again (Havrdová et al., 2015). However, the possibility for restoration in grasslands is negatively impacted by an extended amount of time between abandonment and restoration. The long-term effects of abandonment, particularly if the grassland has been fertilised, frequently lead to the domination of a small number of competing plant species while grassland specialists vanish (Fagan et al., 2008). The amount of time that has passed following restoration is another temporal component that affects restoration outcome. Typically, after restoration, there is an increase in the total species richness of plants (Piqueray et al., 2011), although this does not always mean that the species that make up the habitat are becoming more numerous (Helm et al., 2015). Common species frequently relocate to restored grasslands, but uncommon and specialist species frequently exhibit little to no recovery (Helsen et al., 2013).

Even after three decades of restoration, Gijbels et al. (2012) demonstrated that barely half of the projected appropriate habitats supported the target species. Reference sites often feature a higher share of grassland specialists than restored sites because grassland specialists species have a low potential for colonisation (Waldén et al., 2007). According to Cousins (2006), species dispersal ability and landscape structure both influence a species' propensity to recolonize restored habitats from the landscape species pool. The surviving species-rich grasslands in contemporary European agricultural landscapes are frequently small and isolated, which reduces the opportunity for species to disperse between grassland fragments. However, populations of typical grassland species can also thrive in other types of habitats, such as road verges, gardens, middle islets, and abandoned former grasslands (Plue and Cousins, 2013), aside from regularly managed semi-natural grasslands. These types of habitats could serve as stepping stones for species dispersal into regenerated grasslands (Lindborg et al., 2014). Therefore, when surveying plant species, excluding these potentially suitable areas could lead to an underestimation of the pool of species accessible. Few studies have built on field surveys of the actual species pool and its possible impact on restoration outcomes in restored semi-natural grasslands, despite the fact that dispersal from neighbouring habitats is a prevalent assumption in both restoration practise and research. Recreated grasslands on formerly arable

fields were the subject of a recent study, which found a significant correlation between the number of target plant species present there and their prevalence in the surrounding area. When remnant grasslands are closely linked to restored grasslands, they can also serve as source communities. This suggests that target species from a species pool are able to recolonize spontaneously, even though the abiotic and biotic pre-conditions in recreated grasslands are fundamentally different from restored abandoned semi-natural grasslands (Horrocks et al., 2016).

It is still unclear how much of the total species pool in the landscape is represented by the various kinds of restored semi-natural grasslands. Certain species may remain absent from the local restored habitat (i.e., they belong to the dark diversity) even while the surrounding landscape may support a sizable habitat-specific species pool (Pärtel et al., 2011). This may be the result of factors like their poor capacity for dispersal and/or competition, as well as temporal and/or spatial problems such inadequate biotic or abiotic conditions (Helsen et al., 2016) or absence of useful connectivity (Auffret et al., 2017). A number of researchers stress the significance of taking time scale into account when working on restoration projects, and they show that the amount of time that has passed since the restoration's inception and the diversity of target species at experimental sites are positively correlated (Waldén et al. 2017). To fully comprehend the restoration process, monitoring over a longer period of time would be necessary (Reis et al. 2021). It could take a few years for the management effects to become apparent in a restored system, and initial success might turn out to be unfounded in the long run (Herrick et al. 2006). Long-term monitoring enables us to accurately assess the progress of the restoration and, if necessary, modify the restoration trajectory through adaptive management (Zahawi et al. 2015). In the past, the majority of restoration projects had monitoring periods of fewer than five years; however, more recently, monitoring periods have generally increased (Wortley et al. 2013). However, it varies depending on the types of restored ecosystems and the creatures under study. Forests have the largest time spans (11 years), while plants generally have 6.5 years. Studies lasting longer than 20 years are still rare (Reis et al., 2022).

The dispersal from the surrounding landscape can have a positive or negative impact on the restoration process. The colonisation of the target species is one of the positive factors (Prach et al. 2015); the lack of natural fragments in the landscape (Török et al. 2018a) combined with the low dispersal ability of species (Deák et al. 2018) and the spread of invasive alien species (Guido et al. 2016) are examples of the negative factors. According to Yelenik and D'Antonio (2013), invasive species have the power to alter ecological processes, community structure, and

function. They can also hinder the growth of native plants, endangering the integrity of the ecosystem (Corbin and D'Antonio 2012).



**Fig. 1.** Reduced competition and shade from goat pasturing increased ground light availability and stimulated highly species-rich calcareous dry grasslands that support target plants like Carex humilis Euphorbia cyparissias, Anthericum ramosum, Helianthemum canum, Hippocrepis comosa, H. nummularium, Inula hirta, Salvia pratensis, Ophrys sphegodes, Stipa pennata, T. montanum and Teucrium chamaedrys (Photo: M. Köhler, 2020).

According to Dudley et al. (2020), the majority of global restoration initiatives concentrate on forest ecosystems; yet, restoring all types of ecosystems is required to achieve the global restoration goals. Furthermore, restoration of grasslands and dry lands becomes significant when attempts to prioritise global restoration incorporate the objective of reducing project costs (Strassburg et al. 2020). Approximately one-third of the area is made up of savannahs and grassy biomes, which are home to a wide variety of species (Habel et al. 2013). In addition, they offer a wide range of other ecosystem services, like as pollination, carbon storage, erosion control, water supply and flow regulation, and climate mitigation (Bengtsson et al. 2019). Since grasslands in Eastern Europe have historically been managed by customary practises like grazing and mowing (Janišova et al., 2011), they are also seen as landscapes of cultural significance (Bengtsson et al., 2019). The primary factors contributing to the degradation of

grasslands in the area include changes in land use, such as conversion to arable land, afforestation, abandonment of land, and improper management (Török et al. 2018b).

**2. Wet grasslands**

Important wet grasslands for nature conservation have been preserved for generations by agricultural practises including grazing and hay-making mowing, but despite recent restoration efforts, they are currently in threat of being abandoned. Wet grasslands are biologically diverse parts of agricultural landscapes that have been farmed for generations, but the loss of traditional farming practises is threatening them presently. Flood attenuation, groundwater recharge, sediment storage, nutrient removal, erosion control, and aesthetic value are just a few of the many ecosystem services they offer. The majority of wet grasslands are semi-natural, formed by the drainage of other types of wetland (such as fens or marshes) or by clearing forests on floodplains. They are kept in place by human activity, most frequently through substantial livestock grazing on pastures or cutting for hay. They have a high water table for at least part of the year, a profusion of grasses (or sedges), or sporadic floods with fresh or brackish water, all of which are sufficient to affect the flora and related ecological diversity (Joyce, 2014). In Europe, there are various types of wet grasslands, such as polders, fen meadows, sea-shore meadows, floodplain or alluvial grasslands, and wet meadows and pastures. Though they have different evolutionary and management histories, sedge-dominated meadows, fen grasslands, floodplains, alluvial or riparian grasslands, and wet prairies are comparable in North America. It is likely that the wet grassland resource suffered losses of at least 80% during the 20th century, primarily due to drainage and agricultural changes. The extent and status of wet grasslands are not well known beyond the regional or occasionally national level, in part because of inconsistencies with defining the various types. It is estimated that less than 1% of the traditional area of wet grassland exists in various nations or areas, including Finland, eastern England, and the mid- and western United States (Clark and Wilson, 2001).

Since agricultural management has been a crucial component of the farm economy in Europe's wet grasslands for hundreds or thousands of years, it has resulted in highly valued and protected cultural landscapes with few to no trees and distinctive biodiversity. Because cutting and grazing remove aboveground biomass to allow a range of less strong plants to coexist and to maintain an open landscape ideal for large numbers of wading birds and wildfowl, regular management is seen as advantageous or even vital for nature conservation. For example, estimates place the number of wading birds that breed in wet grasslands in the European Union at over 50%. Outside of Europe, opinions on managing grasslands are frequently less favourable

or unclear, in part because grazing is sometimes viewed as an extreme or unnatural disturbance that favours weedy or foreign plants (Joyce, 2014). Examples are the flooding Pampean grasslands of South America, which formed with low numbers of herbivores but are now primarily grazed by cattle, and the riparian wetlands of the western United States, which have evolved with vast grazing communities. However, there is growing acknowledgment in North America that the hay cutting, burning, and grazing management practises used to wet grasslands there have been in place for generations, and that these practises may be comparable to those in Europe (Scanga and Leopold, 2012). In addition, after disturbances like fire, cutting, and grazing were suppressed, there was a rise in anxiety throughout North and South America over the spread of woody species, extinction of endangered species, and invasion of aggressive or non-native plant species (Cabral et al., 2003). These issues could get worse due to climate change, since rising carbon dioxide levels, prolonged droughts, and variations in the weather could encourage the spread of woody plants into moist grasslands (Joyce, 2014).

There is a good description of the general process of secondary succession in grasslands. When there is no management at first, grasses grow larger leaves, biomass builds up as dead matter and litter, and tall, vigorous, competitive grasses or forbs predominate because they can outcompete smaller plants for resources, particularly light. As a result of relatively few species predominating, species variety tends to decrease. Although the exact timing varies, succession usually begins with the invasion and establishment of woody species (trees and shrubs) (Rosenthal, 2010). However, a large portion of this general successional template is taken from mesic or dry grassland sites and is related to vegetation structure; there aren't many specific descriptors for the wet grassland successional range that follows abandonment (Joyce, 2014).

Grasslands have been widely impacted by agricultural intensification to increase productivity, particularly in the second half of the 20th century. Wet grasslands are typically treated with inorganic fertilisers, insecticides, herbicides, and land drainage techniques, with regular ploughing causing the last devastation. The termination of management has drawn far less attention than intensification, but given that wet grasslands depend on regular vegetation management to preserve their biological features and biodiversity, abandonment or neglect could pose a serious threat. At its most severe, abandonment entails the desertion of land. Typically, it relates to the end of customary farming methods like hay meadow management or grazing. The effects of wet grassland abandonment for nature conservation are frequently likely to be highly detrimental, even while it may present a chance for more naturally functioning wetlands and certain wildlife, such as forest or reed bed species, may eventually benefit. For

instance, it's projected that the abandonment of fen meadows in northwest Germany would result in the loss of approximately 10% of the region's fen flora, while the abandonment of coastal grasslands puts endangered species like the Natterjack toad and wading birds like the Baltic Dunlin and Ruff in danger. The USA's Trollius laxus herb, which is worldwide rare, is in danger due to haying and grazing being abandoned in Madison County fens (Scanga and Leopold, 2012).

**3. Guiding grassland restoration**

Synthesis plays a vital role in the research process by arranging existing knowledge, pointing out research gaps, and suggesting new study avenues. This has never been more important in restoration than it is now, as practitioners and scientists working in the field are asked to address environmental problems on a variety of sizes. In addition to maintaining natural migration and dispersal networks throughout the landscape, restoration efforts must combat localised habitat deterioration (Suding et al. 2015). Restoration efforts are becoming more sophisticated on even greater dimensions as natural solutions to lessen the consequences of climate change. At times, this can lead to a conflict between the restoration objectives on several levels. For instance, regional or local-scale conservation efforts or demands may not be well served by global-scale agendas, which frequently place a strong emphasis on planting trees (Temperton et al. 2019). If site-level objectives are aligned with global and regional restoration agendas, these tensions may be lessened (Brudvig 2011). In order to guide grassland restoration across scales and promote the next generation of research, synthesises of current knowledge and research gaps are required. Research gaps and problems facing grasslands in the next decades include: 1) the necessity for "climate-adaptive" restoration and cautious target vegetation selection; and 2) a lack of understanding regarding the dynamics and restoration of various locations or types of grasslands.; 3) increased importance of the species arrival sequence and high likeliness of stochasticity of species establishment; and, finally, 4) issues of long-term sustainability of restored sites/ habitats in the form of post-restoration management (Török et al., 2021).

The scientific community is particularly ignorant about the restoration of biodiverse grasslands in tropical and subtropical areas, which can even give rise to myths. Prescribed burns, grazing management, the grazing of wild animals, tree pruning, shrub removal, and the control of invasive species are important challenges in restoring the biodiversity of these grasslands. For grasslands and savannas to function, have a desirable structure, composition, resilience, and stability, monitoring should be evidence-based. It is not practical to set the restoration of pre-industrial vegetation as our goal. This is due to various factors: 1) changed landscapes, land

uses, and site circumstances that have a significant impact on establishment and dissemination in most regions; 2) biological invasions and other dangers brought on by climate change; and 3) Growing stochasticity implies that the effectiveness of restoration could be contingent upon years with specific patterns or amounts of rainfall, or upon variations in the reproductive and establishment performance of specific target plant species from year to year. This emphasises the significance of plant species arrival sequence, or the "priority effect," in restoration (Weidlich et al. 2021; Wilsey 2021).

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# IDENTIFICATION OF A NEW PLANT VIRUS AGENCY USING MOLECULAR METHODS

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## Abstract
Plant viruses cause significant economic losses in terms of quality and quantity in many plant species (cereals, garden plants, ornamental plants, etc.), and therefore their diagnosis is very important. Today, it is known that there are more than 1000 viruses in plants and that they directly or indirectly affect important criteria such as development in plants, product formation, quality and marketing value of the resulting product. Identification of a new plant virus; It is of great importance for control and disease management, grouping of viruses, epidemiological studies, quarantine studies, seed-seedling and sapling certification, research/surveys and breeding studies. Since the use of one technique is generally not sufficient for the identification and diagnosis of plant viruses, it is necessary to use more than one technique together to reach a definitive result. It is important that the methods used are safe, specific, sensitive, fast and economical. Firstly, for the diagnosis and diagnosis of plant virus diseases; A preliminary/general diagnosis can be made using symptomatology, biological indexing, host environment studies and electron microscopy methods. Molecular and new technological methods are needed for specific virus diagnosis. Identification of a new plant virus is also very important in terms of introducing new and unique control methods in the fight against viruses. For this purpose, to diagnose a viral agent, preliminary diagnostic studies (such as symptomatology, biological indexing and host environment) are followed by gene sequencing and molecular studies. Today, Next gene sequencing (NGS) is a fast, reliable and specific method used in the diagnosis of a new viral agent. Finally, identification, bioinformatic analysis and nomenclature studies that reveal its relationship with other viruses are carried out.
**Keywords:** Plant virus, Identıfıcatıon, NGS

## 1. Introduction

Plant viruses cause significant economic losses in terms of quality and quantity in many plant species (cereals, garden plants, ornamental plants, etc.). In addition, it is known that there are nearly 1000 viruses in plants today and that they directly or indirectly affect important criteria such as development in plants, product formation, quality and marketing value of the resulting product (Hull et al., 2009). Depending on the host-virus combination, viruses are reported to cause millions of plant deaths or billions of dollars of crop loss annually in different countries (Hull et al., 2009). Unlike other pathogens that cause diseases in plants, there are no direct control methods or chemical control used to control viruses.

In general, against viral diseases in plants; To prevent viruses from infecting plants, precautions are taken such as eliminating the source of infection, reducing the spread of disease by combating vectors, using virus-free plant material, and using virus-resistant varieties. When we look at the studies carried out, the methods indirectly used in the fight against viruses that cause diseases in plants are discussed and the aim is to protect plants from virus infection. Therefore, detection and diagnosis of a new virus in plants and vectors has an important role in the management of plant virus diseases. Recently, diagnosis and identification of a new plant virus agent is more frequently done with molecular methods, and the issue of diagnosing the virus is important. Diagnostic techniques used for plant viruses are generally grouped under two headings (Naidu et al. 2003). These;

-Biological features related to the interaction between the virus and its host and/or vector (e.g. symptomatology, biological indexing and transport tests)

-It is performed according to the properties of the virus's own components (protein and nucleic acid) through methods such as precipitation, agglutination tests, Enzyme-Linked Immunosorbent Assays (ELISA), immunoblotting test, hybridization test, polymerase chain reaction (PCR) and electron microscopy. In light of this information; It is possible to express the techniques used in the detection or diagnosis of viruses in plants under main headings such as symptomatology, biological indexing, transport tests, serology, nucleic acid-based methods and electron microscopy.

## 2. The Importance of Identification of Plant Viruses

The importance of identifying plant viruses; control and disease management, research/surveys, epidemiological studies, breeding studies, quarantine studies, seed-seedling and sapling certification, virus grouping, etc. It means a lot in these matters (Tonukari et al., 2003). The

desired features of the methods and techniques used are that they are safe, specific, sensitive, fast and economical. Since the use of a method or technique depending on the viruses is not generally sufficient in the identification and diagnosis of plant viruses, it may be necessary to use more than one method or technique together to reach a definitive result. When we look at the studies carried out for this purpose, while preliminary diagnosis is made with symptomatology, biological indexing and transport studies, specific diagnosis and diagnosis are made by analyzes using serological and molecular tests together.

**3. Methods Used to Identify Plant Viruses**

Techniques used to identify plant viruses are divided into groups according to their biological, serological and molecular characteristics. According to their biological characteristics; While they are grouped as symptomatology, biological indexing and transport tests, electron microscopy studies can be performed according to their morphological features. When looked at according to their serological properties (Protein); precipitation test, agglutination tests, Enzyme-Linked Immunosorbent Assays (ELISA), immunoblotting test, etc. Diagnosis and diagnosis can be made with tests. Many methods can be applied according to their molecular properties (Nucleic acid-DNA/RNA), but the most preferred ones are; hybridization techniques (Southern-Blot, Northern-Blot), Polymerase Chain Reaction (RT-PCR), Immunocapture–Reversetranscription–Polymerasechain Reaction (IC-T-PCR), which is a combination of molecular and serological-molecular properties (nucleic acid and protein). . After all these studies, DNA sequencing can be performed. Recently, Next gene sequencing (NGS) technology has been preferred in sequencing studies.

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### 3.1. Serological Methods Used in the Identification of Plant Viruses

In addition to the identification and diagnosis of plant viruses, serological methods have been used successfully for many years in research for various purposes. For the definitive diagnosis and diagnosis of viral diseases, it is difficult and not always possible to identify, produce and reveal the agent, as in other pathogens. Serological methods are based on the sheath or membrane proteins surrounding the nucleic acids of viruses and their properties. Serological methods are based on the relationships between antigen and antibody in immunology.

Serological methods have been used for a long time in determining virus infections in plants and continue to be used today with some modifications (Hull et al., 2009, Naidu et al. 2003). With these methods, if an antiserum containing known specific antibodies is available, unknown antigens (viruses) can be identified, or if known antigens are available, it can be understood whether there are specific antibodies against this antigen in the antiserum.

### 3.2. Identification of a New Plant Virus Disease with Molecular Methods

There are many methods according to their molecular properties (Nucleic acid-DNA/RNA and protein). The most frequently used among these are; hybridization techniques (Southern-Blot and Northern-Blot), Reverse Transcriptase Polymerase Chain Reaction (RT-PCR), Immunocapture–Reversetranscription–Polymerasechain Reaction (IC-T-PCR), which is a combination of molecular and serological-molecular properties (nucleic acid and protein relationship). ) analysis and many other molecular analyses.

Plant virus genome analysis in general; First, nucleic acid isolation and then cloning of the isolated genes is the creation of a library using the available data. Following these analyses, sequencing is performed. Sequencing (DNA sequencing) has been known for a long time, but today it is done more quickly and easily by technological methods and devices. The history of DNA sequencing and its development until today are briefly mentioned below.

### 3.2.1. DNA Sequencing (Sequencing)

The most important stages of sequencing were the sequencing of a gene belonging to Bacteriophage MS2 by Walter Fiers and his colleagues from Ghent University (Ghent, Belgium) in 1972, and then the sequencing of the entire genome of the same bacteriophage in 1976. Various laborious methods were used for DNA sequencing until rapid DNA sequencing methods were developed in the early 1970s.

For example, in 1973, Gilbert and Maxam published the sequence of 24 nucleotides using a method called wandering-spot analysis. The chain termination method developed by Sanger and his friends in 1975 became the most preferred method in a short time, and because it is relatively easier and more reliable, it has become a frequently preferred method today and forms the working principle of technological devices.

**A) Maxam-Gilbert sequencing**

In 1976-1977, Allan Maxam and Walter Gilbert from Harvard University developed a DNA sequencing method based on chemical modification of DNA and subsequent cutting of it at specific bases. Although the Maxam and Gilbert paper on chemical sequencing was published two years later than Sanger and Coulson's paper on plus-minus sequencing, Maxam-Gilbert sequencing has been more popular. The reason for this is that in the Maxam-Gilbert method, purified DNA can be sequenced directly, whereas in the first Sanger method, each DNA to be read must be separately cloned in order to produce single-stranded DNA.

This method requires radiolabeling the 5' end of the DNA (this is typically a kinase reaction using gamma-32P ATP) and then purifying the DNA fragment to be sequenced. With the chemical processes applied in four different chemical reactions (G, A+G, C, C+T), cuts occur in one or two of the four nucleotide bases that make up DNA in a small portion of the molecules (Gilbert et al., 2007). For example, purines are depurinated with formic acid, guanines (and some adenines as well) are methylated with dimethyl sulfate, pyrimidines (C+T) are methylated with hydrazine. In the C-only reaction, the addition of salt (sodium chloride) to the hydrazine reaction inhibits methylation of thymine. The modified DNAs are then cut with hot piperidine at the position of the modified bases. By adjusting the concentration of the modifying chemicals, an average modification per DNA molecule is achieved. Thus, a series of labeled DNA fragments is obtained, with the radioactive label at one end and the first "cut" site at the other end. The fragments resulting from the four reactions are separated by electrophoresis side

by side in a denaturing acrylamide gel. To visualize the fragments, the gel is placed on x-ray film so that the photographic film darkens at the point corresponding to the location of each radioactive DNA fragment. DNA sequence can be extracted from the series of bands occurring in the film (Gilbert et al., 2007).

**B) Sanger method (Chain termination method)**

The chain termination method (or Sanger method, after Frederick Sanger, who developed it) became widespread in a short time because it was more efficient and required less toxic chemicals and radioactivity compared to the Maxam and Gilbert method. The main principle of the Sanger method is the use of dideoxynucleotide triphosphates (ddNTPs) as chain terminators (Sanger et al., 1977). For the classical chain termination method, a single-stranded DNA template, a DNA primer, a DNA polymerase, normal deoxynucleotidephosphates (dNTPs) and modified nucleotides that terminate DNA chain growth (dideoxyNTPs, or ddNTPs for short) are used. These ddNTPs are labeled radioactively or fluorescently for automatic detection in automated sequencing machines. The DNA sample is aliquoted for four separate sequencing reactions, which have in common standard deoxynucleotides (dATP, dGTP, dCTP, and dTTP) and DNA polymerase. One of four dideoxynucleotides (ddATP, ddGTP, ddCTP, or ddTTP) is added to each reaction. Since 3'-OH, which is necessary for the formation of a phosphodiester bond between two nucleotides, is not present in dideoxynucleotides, a DNA chain containing them cannot extend any further. Therefore, the reaction ends with the formation of DNA chains of various lengths. Newly synthesized and labeled DNA fragments are denatured by heating and separated according to their size by gel electrophoresis. DNA fragments in each of the four reactions (A, C, G and T) are separated by moving through separate paths parallel to each other (these paths are called stripes or lines) in the gel under the influence of the electric field (Sanger et al., 1977).

DNA fragments of the same length move at the same speed and appear as a band when visualized (by autoradiography or ultraviolet). In the picture on the right, an x-ray film has been placed on the gel, and the black bands correspond to DNA fragments of a certain length. The dark band in a given strand is a piece of DNA terminated by the addition of a dideoxynucleotide (ddATP, ddGTP, ddCTP, or ddTTP) into the chain. The DNA sequence can be read (from bottom to top) by looking at the relative positions of the different bands in the four strands.

To mark a piece of DNA; labeled primer, labeled dNTP, or a labeled ddNTP can be used. Technical variations of chain termination sequencing exist. Radiolabeling can be done using

nucleotides containing radioactive phosphorus, or a primer labeled with a fluorescent dye at the 5' end can be used. Thanks to dye-primer sequencing performed in an optical system, reading can be done faster and more economically, and automation of the system is possible. These systems, developed by Leroy Hood and colleagues, enable automatic and high-volume DNA sequencing.

Chain termination has made DNA sequencing extremely easy. For example, commercially available chain termination kits contain the reactants required for sequencing, divided and ready for use. Situations where the method may be limited are when the primer binds to DNA non-specifically, causing the DNA sequence not to be read correctly, and when secondary structures in the DNA affect the sequence.

### 3.3 Next Generation Sequencing (NGS)

New generation DNA sequencing is known as the method that uses the latest technology due to the use of fluorescently labeled nucleotides in the Sanger sequencing technique, the necessity of agarose gel or polymer in the separation of DNA fragments that differ in length by only one nucleotide, the ability to analyze a relatively low number of samples, difficulties in sample preparation and limitations in automation. . Efforts to overcome these limitations have initiated the development of new generation sequencing techniques that do not use gel and can be performed simultaneously with nucleotide sequencing.

New generation DNA sequencing techniques provide speed and efficiency. While genome sequencing projects take a long time with the Sanger sequencing technique, they can be completed in a short time (one week) with today's sequencing approaches. When looking at next-generation sequencing approaches in terms of biochemical reactions, they have different biochemical bases than Sanger sequencing. The biochemical approach of second-generation sequencing technology includes sequencing of DNA sequences by synthesis and sequencing by ligation (Fuller et al., 2009, Liu et al., 2012). Due to the high cost, there are limitations in genome sequencing and de novo sequencing of new species. Second generation sequencing technologies have taken part in molecular applications with their fast, high efficiency and low cost features. However, since second-generation sequencing is based on PCR amplification, misreadings in sequencing constitute the main problem of the technology. Despite the increasing use and new modifications of second-generation sequencing, third-generation sequencing brings a new approach. Third generation sequencing has two basic features; i-

sequencing is done in a short time by eliminating the need for PCR process before sequencing, ii- simultaneous detection of signals (electric current).

New generation DNA sequencing technology developed in recent years has become an important tool that provides information about genetic/epigenetic regulatory networks, chromatin structure, nuclear structure and genome variations (diversity). With new generation DNA sequencing systems, sequencing can be done with high accuracy and ultra-fast. A microbial genome sequence obtained with this method provides researchers with rich and unique information that cannot be obtained with any other experimental method. For example, the 4.6 Mb E. coli genome can be completed with a single read. In a study, the E. coli genome was sequenced de novo four times, with 400,000 reads in each run, and it was determined that the sequencing was done with an accuracy of 99.997% to 99.999% (Margulies et al., 2005). By using new generation DNA sequencing technology, it is possible to sequence the genomes of different organisms such as plants, bacteria, yeast, fungi, viruses, and bacterial artificial chromosomes (Bacterial Artificial Chromosomes (BACs)) ultra-fast and with high accuracy with the de novo sequencing method. De novo sequencing, shotgun and paired-end sequencing methods. Sequencing with the Whole Genome Sequencing System is based on the principle of sequencing small DNA fragments and adapter sequences in picoliter volumes by massive parallel sequencing (Margulies et al., 2005).

Shotgun Sequencing method is used to sequence long DNA fragments. In this method, large-sized genomic DNA or bacterial artificial chromosomes are physically fragmented into randomly small sizes (300-800 bp). These DNA fragments are captured by DNA capture beads from adapters added to their ends, creating a DNA library. Then, the DNA fragment captured by each bead is sequenced separately and all the read fragments are combined with Bioinformatics software. The Shotgun Sequencing technique has been used by many important groups. With this method, the entire genome map of many species, ranging from complex genomes such as humans (Venter et al., 1998) to the genome of Drosophila melanogaster and genomes of bacteria and viruses such as Haemophilus influenzae, has been revealed.

After the de novo sequence reads are turned into contigs, these pieces are combined with paired-end reads by aligning them in the correct direction. These paired-end reads contain two 20-mer DNA fragments on each side, approximately 2.5 kb apart. Thanks to bioinformatics software, these 20-mer particles are mapped to the created contigs, and thus these contigs are aligned in the correct direction and combined. Thanks to these spliced sequences, high quality and accurate genome sequence is obtained. Next-generation sequencing systems used today are

Roche 454 genome analyzer, Illumina Genome Analyzer, Applied BioSystem SOLiD, Complete Genomics, Helios, Pacific Biosciences and IonTorrent. Next-generation DNA sequencing technology provides unimaginable amounts of information and new approaches. However, there are great difficulties in storing, analyzing and evaluating this much information. Advanced bioinformatics analysis tools are needed for the successful use of next-generation DNA sequencing technology. In addition, obtaining a large number of short readings is also an important problem. The issue of reading length and error rate is still being developed.

### 3.3.1 Sanger (Dideoxy) and Next Generation Sequencing Methods

#### 3.3.1.1 Sanger Method

The most commonly used method for determining the genome sequence is the shotgun technique and the Sanger (dideoxy) method. The Sanger method is also called the chain termination method. Shotgun Sequencing method is used to sequence long DNA fragments. With the Sanger method, DNAs that are too long to be sequenced at once are first divided into small pieces. Each resulting fragment is cloned into a plasmid. Cloned plasmids are sequenced one by one. By combining these sequences with bioinformatic analysis, the sequence of the long DNA fragment is obtained.

Many copies of the DNA sequences to be sequenced primer normal deoxy nucleotides (dNTP) dATP, dCTP, dGTP, dTTP, dideoxy nucleotides: ddNTP; ddATP, ddCTP, ddGTP, ddTTP and DNA are mixed with the Polymerase I enzyme. DNA is a polymer formed by bonding four deoxyribonucleotide triphosphate (dATP, dCTP, dGTP, dTTP) molecules together. Each new nucleotide is added to the 3' OH end of the previous nucleotide. Dideoxynucleotide triphosphate (ddNTP), on the other hand, does not contain a 3' OH end. Therefore, such a molecule stops chain elongation and forms the last nucleotide of the chain (Sanger et al., 1977). These DNA sequences are read using capillary gel electrophoresis.

#### 3.3.1.2 Pyrosequencing Method

Cloning and colony selection, which are required to be performed before sequencing to sequence long DNA regions with the Sanger method, are laborious processes that take a very long time, and this has led scientists to search for alternative sequencing methods. Significant technological innovations in recent years have enabled the sequencing of complex samples at unprecedented speed and scale. In this direction, the development of the "Pyrosequencing" method based on the principle of "Sequencing by Synthesis" by Ronaghi and his colleagues in

1996 emerged as a result of these searches (Ronaghi et al., 1999). Pyrosequencing has replaced traditional Sanger sequencing thanks to its high throughput and low cost.

The basis of pyrosequencing is the detection of DNA polymerase activity through a luminescent enzyme. The sequencing reaction consists of synthesizing the complementary strand (complementary DNA / cDNA) on the single strand (ssDNA) of the DNA to be sequenced. First of all, nebulization (separation into small fragments of 400-800 bp) of double-stranded DNA is performed. Adapters carrying sequencing primers are added to these fragments. Emulsion-based clonal amplification (em-PCR) of DNA fragments carrying adapters is performed in microreactor. As a result of this stage, the DNA fragments, which were increased to approximately 10 million copies, were sequenced in a plate containing approximately 3.6 million wells by the synthesis sequencing method.

The basis of pyrosequencing is the detection of DNA polymerase activity through a luminescent enzyme. The sequencing reaction consists of synthesizing the complementary strand (complementary DNA / cDNA) on the single strand (ssDNA) of the DNA to be sequenced. First of all, nebulization (separation into small fragments of 400-800 bp) of double-stranded DNA is performed. Adapters carrying sequencing primers are added to these fragments. Emulsion-based clonal amplification (em-PCR) of DNA fragments carrying adapters is performed in microreactors. As a result of this stage, the DNA fragments, which have been increased to approximately 10 million copies, are sequenced in a plate containing approximately 3.6 million wells by the synthesis method. A light appears in the environment. It is determined which nucleotide binds to the chemiluminescent signal that creates this light. The immobilized ssDNA is incubated with DNA polymerase, ATP sulfurylase, luciferase, apyrase, APS and luciferin. DNA polymerase releases pyrophosphate (PPi) when a complementary nucleotide arrives during nucleotide flow. The enzyme ATP sulfurylase quantitatively converts this PPi into ATP. ATP enables the conversion of luciferin to oxyluciferin via the enzyme luciferase. Oxyluciferin creates visible light. The intensity of this light is directly proportional to the amount of ATP, and thus single nucleotide repeats (homopolymers) on the same sequence are detected. This resulting light is recorded by the CCD camera and converted into sequence data (phlogram) with the help of a computer program.

Using the pyrosequencing method, it is possible to sequence 100-500 million bases in 7.5 hours without cloning. This system has made it possible to complete sequencing projects that previously took years in a matter of weeks. Nobel Prize-winning researcher Dr. who discovered

the double-helical structure of DNA. James Watson's genome was sequenced using this method. Again, the Neanderthal genome and the genome of the extinct mammoth species could be completely sequenced in a short time with these methods. This method allows the entire genome of simpler genomes such as bacteria and viruses to be sequenced within one day, as well as such complex genomes.

#### 3.3.1.3 Sequencing with cyclic reversible termination

DNA molecules are first bound to the primers on the slide and amplified (bridge amplification). Four types of ddNTPs are added and ddNTPs that do not enter the structure of the newly synthesized strand are washed away. Unlike pyrosequencing, the DNA is lengthened by one nucleotide after each wash. After the fluorescently labeled nucleotides are detected by the camera, the terminator at the 3' end is chemically removed and the next cycle begins.

#### 3.3.1.4 Sequencing by ligation

In this method, emulsion PCR is performed as in pyrosequencing. As in pyrosequencing, primers hybridize to the template strand with the help of adapter sequences. In this method, unlike others, DNA ligase enzyme is used instead of DNA polymerase. Fluorescently labeled oligonucleotide probes are used, the probes hybridize to the template DNA and ligate with the primer. After fluorescence detection, the 5' phosphate end of the oligonucleotide probes is cut and a new ligation cycle is started. The DNA sequence is determined by repeating the ligation, detection and separation cycles.

#### 3.3.1.5 Ion semiconductor sequencing

This method is based on the detection of Hydrogen ions formed during the polymerization of DNA. A uniform flow of nucleotides is applied to the microwell containing a single sequence of Template DNA. When the given nucleotide is complementary to the template strand, it joins the structure of the newly formed strand and hydrogen ion is released. Hydrogen ions are detected by hypersensitive ion sensors. In the presence of homopolymer repeats in the template DNA, more than one nucleotide will enter the structure of the new strand in a single cycle and the DNA sequence is determined by obtaining more electronic signals according to the number of hydrogen ions released.

#### 3.3.1.6 Nanosequencing

This method is also based on sequencing through synthesis. A different bioengineered polymerase and dNTPs are used as direct molecular sensors. The synthesis of a single DNA molecule in each nanomachine can be monitored in real time.

As a result, NGS technology enables high-volume parallel sequencing to sequence millions of DNA fragments simultaneously. In this way, it is possible to sequence the entire genome in less than a day. Different NGS platforms have been developed. Some of the prominent platforms commonly used today for the sequencing stage are; Roche 454, Illumina (Miseq, Hiseq), Ion-torrent, Nanopores etc. It is known as

### 3.3.2. Next Generation Sequencing (NGS) Data Analysis

Raw gene sequences are obtained after Next Gene Sequencing (NGS). This data covers some stages after bioinformatic analysis is performed. After bioinformatic analysis, it is possible to obtain the sequence of the entire genome. After this stage, the primer design phase begins. Primer design is now done through computer programs. Examples of these programs are Primer 3, PrimerZ, PerlPrimer, Vector NTI Advantage 10, etc. web programs are provided. After primer design, the disease must be controlled by RT-PCR with the primer obtained. Thus, diagnosis and diagnosis of the new virus agent can be made.

## 4. Discussion and Conclusion

Known control methods against plant viruses are generally vector control to minimize losses due to the virus as much as possible. Identification of a new plant virus is also a very important issue in terms of introducing new and unique control methods in the fight against viruses. For this purpose, to diagnose a viral agent, preliminary diagnostic studies (such as symptomatology, biological indexing and host environment) are followed by gene sequencing and molecular studies. Today, Next gene sequencing (NGS) is a fast, reliable and specific method used in the diagnosis of a new viral agent. Future studies will show which NGS method will be preferred and used routinely in the laboratory environment in the future.

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# FARKLI BİTKİ SIKLIĞININ KIŞLIK ARA ÜRÜN OLARAK YETİŞTİRİLEN GAP PEMBESİ YEM BEZELYE (*Pisum arvense* L.) ÇEŞİDİNDE BAZI VERİM DEĞERLERİNE ETKİSİNİN BELİRLENMESİ

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**Özet**
Bu araştırmada; Şanlıurfa ekolojik koşullarında kışlık ara ürün olarak farklı sıklıkta yetiştirilen Gap Pembesi yem bezelyesi (*Pisum arvense* L.) çeşidinin bazı verim özelliklerinin bitki boyu (cm), çiçeklenme gün süresi (gün), olgunlaşma gün süresi (gün), bitkide bakla sayısı (adet/bitki), yeşil ve kuru ot verimleri (kg/da) incelenmiştir. Deneme 2021-2022 yetiştirme sezonunda Harran Üniversitesi Osmanbey kampüsünde yer alan Ziraat Fakültesi Tarla Bitkileri Bölümü arazisinde, tesadüf blokları deneme desenine göre, 5 bitki sıklığında (10-15-20-25-30) cm ve 4 tekerrürlü olarak yürütülmüştür. Araştırmada, bitki boyu 29.16-32.81 cm, yeşil ot verimi 161.79-224.31 kg/da, kuru ot verimi 34.88-49.30 kg/da, bitkide bakla sayısı 6.03-8.86 (adet/bakla), çiçeklenme gün süresi 87.50-90.25 (gün), olgunlaşma gün süresi 121.25-123-75 (gün) arasında değişim göstermiştir. Araştırma sonunda yapılan analiz sonuçlarına göre, kışlık ara ürün olarak yetiştirilen Gap Pembesi yem bezelye çeşidindeki en yüksek verim değerleri 30x15 cm bitki sıklığı uygulamasında gözlemlenmiştir.
**Anahtar Kelimeler:** Yem bezelyesi, yeşil ot, çiçeklenme ve olgunlaşma süresi, kuru madde oranı

# DETERMINATION OF THE EFFECT OF DIFFERENT PLANT DENSITY ON SOME YIELD VALUES IN GAP PEMBESI FODDER PEA (*Pisum arvense* L.) VARIETY GROWN AS WINTER INTERCROP

**Abstract**

In this study; Some yield characteristics of Gap Pink forage pea (*Pisum arvense* L.), which is grown as a winter intermediate in Şanlıurfa ecological conditions at different frequencies, is plant height (cm), flowering day time (day), maturation day time (day), number of pods per plant (piece/unit). plant), green and dry grass yields (kg/da) were investigated. The experiment was carried out in the field of Field Crops Department of the Faculty of Agriculture, located in Harran University Osmanbey campus, in the 2021-2022 growing season, according to the randomized blocks trial design, at a density of 5 (10-15-20-25-30) cm and with 4 replications. In the study, plant height was 29.16-32.81 cm, green grass yield was 161.79-224.31 kg $da^{-1}$, hay yield was 34.88-49.30 kg $da^{-1}$, number of pods per plant was 6.03-8.86 (pieces/pod), flowering day duration was 87.50-90.25 (days), maturation day duration varied between 121.25-123-75 (days). According to the results of the analysis made at the end of the research, the highest yield values in the Gap Pink forage pea variety grown as a winter intermediate product were observed in the application of 30x15 cm plant density.

**Keywords**: Forage peas, green grass, flowering and ripening time, dry matter content

## GİRİŞ

Ülkemizdeki hayvansal ürün talebi sürekli artmaktadır. Ancak yem bitkileri üretiminin yetersizliği, hayvancılık işletmelerinin girdi maliyetlerini yükseltmekte ve bu da et ve süt ürünlerinin fiyatlarını artırmaktadır. İşte bu sorunun üstesinden gelmek ve insanların protein ihtiyacını karşılamak için ülkemizin coğrafi çeşitliliği sayesinde birçok farklı yem bitkisi türü yetiştirilebilir. hayvan otlatma alanlarında rotasyon, sulama, gübreleme gibi uygulamalarla bu alanların sürdürülebilirliği sağlanabilir. Yem bitkilerinin verimliliğini artırmak için modern tarım teknikleri kullanılarak daha verimli ürün elde edilmesi, maliyetleri düşürebilir. Bezelye (*Pisum sativum* L.), hayvanların ihtiyaç duyduğu proteinin karşılanmasında önemli bir kaynak olan, dünyadaki en değerli baklagillerden biridir. Bu bitki, tarihsel olarak Güney-Batı Asya'ya özgüdür ve tarımın erken dönemlerinde yetiştirilmeye başlanmıştır. Bezelye, hem insanlar için hem de hayvanlar için yüksek besin değerine sahip olmasıyla bilinir (Ghafoor ve Arshad, 2008).

Yem bezelyesi (*Pisum sativum*), otu, sapı ve taneleri için üretimi yapılan tek yıllık bir baklagil yem bitkisidir. Bu bitki, çiftlik hayvanlarının beslenmesinde önemli bir rol oynamakta olup, otunun besleme değeri yüksektir ve tanelerinde yüksek oranda protein bulunur.

Yem bezelyesi otu, çiftlik hayvanları için değerli bir yem kaynağıdır. Yüksek besin değeri ve lezzeti sayesinde hayvanlar tarafından istekle tüketilir. Ayrıca tanelerinin yüksek protein içeriği, hayvanların büyüme, et veya süt üretimi için gerekli protein ihtiyacını karşılamada etkilidir. Taneleri kırıldıktan sonra kaba yemlerle karıştırılabilir, böylece hayvanların beslenmesi zenginleştirilebilir. Ayrıca yem bezelyesi, tahıl karışımları içinde kullanılarak dengeli bir yem sunabilir. Yem bezelyesi, çiftlik hayvanlarının sağlıklı beslenmesini sağlayan değerli bir yem bitkisidir ve bu özellikleriyle çiftçilerin hayvanlarının ihtiyaçlarını karşılamasına katkıda bulunabileceğini Açıkgöz (2001) bildirmektedir. Ülkemizin elverişli ekolojik koşullarına rağmen yetersiz bezelye üretiminin temel nedenleri arasında çeşit geliştirme eksikliği, yetersiz üretim alanları ve pazarlama sorunları yer almaktadır. Bu sorunları aşarak bezelye üretimini artırmanın ve bu ürünün münavebe kullanılmasını teşvik etmenin yolu farklı ekolojik koşullarına uygun çeşitlerin geliştirilerek ve yetiştirme tekniklerinin iyileştirilerek bezelyeden yüksek verimi elde edilmesi hedeflenmelidir.

Bu çalışma; Şanlıurfa İli ekolojik koşullarında ot üretimi amacıyla bu bölgeye adapte olmuş sertifikalı Gap Pembesi yem bezelye çeşidinin farklı sıklıkta verim ve besleme değerindeki değişimi incelemek ve otunun ülkemizde yapılan hayvancılık faaliyetlerinde alternatif bir kaliteli kaba yem kaynağı olarak kullanılabilirliğini belirlemek amacıyla ele alınmıştır.

## MATERYAL ve YÖNTEM

Araştırmada materyal olarak Diyarbakır ilinde bulunan GAP Uluslararası Tarımsal Araştırma ve Eğitim Merkezi Müdürlüğü tarafından 2015 yılında Diyarbakır ilinde ıslah edilen Gap Pembesi yem bezelyesi (*Pisum arvense* L.) sertifikalı çeşidi kullanılmıştır.

### Araştırma alanına ait toprak ve iklim özellikleri

Deneme yerinin toprak bünyesi killi-tınlı olup, toplam tuz %071, pH 7.78, kireç %29.2, organik madde %0.28 dekara 1.30 kg yarayışlı fosfor ($P_2O_5$) ve 30.3 kg potasyum ($K_2O$) olarak belirlenmiştir. Harran Üniversitesi Ziraat Fakültesi deneme alanı toprağı; killi-tınlı bünyeli, pH hafif alkali ve çok fazla kireçli bir yapısı vardır. Potasyum bakımından yeterli, azot ve fosfor bakımında fakir, organik maddece yetersizdir (Şahin, 2021). Şanlıurfa ilinde yer alan araştırma alanının Kasım 2021 ve Nisan 2022 arası ve uzun yıllar ortalamasına ait bazı iklim değerleri Çizelge 1'de verilmiştir.

**Çizelge 1.** Şanlıurfa ili bazı iklim verilerinin araştırma yılı ve uzun yıllar ortalama değerleri *

| Yıllar | Kasım | Aralık | Ocak | Şubat | Mart | Nisan |
|---|---|---|---|---|---|---|
| **Şanlıurfa** | | | | | | |
| **Ortalama sıcaklık (°C)** | | | | | | |
| 2021-22 | 19.4 | 11.6 | 6.8 | 11.7 | 19.7 | 21.0 |
| Uzun yıllar** | 13.1 | 7.6 | 5.6 | 7.1 | 10.9 | 16.2 |
| **Ortalama nispi nem (%)** | | | | | | |
| 2021-22 | 53.5 | 45.2 | 35.8 | 36.3 | 45.4 | 31.1 |
| Uzun yıllar** | 59.9 | 69.9 | 70.3 | 66.9 | 60.4 | 56.2 |
| **Toplam yağış miktarı (kg/m²)** | | | | | | |
| 2021-22 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 |
| Uzun yıllar** | 44.7 | 80.2 | 87.4 | 68.3 | 62.8 | 49.5 |

* Mgm, (2021-2022) ** Mgm, (1929-2021)

Çizelge 1'de belirtildiği gibi araştırmanın yapıldığı dönemde, en düşük ve en yüksek ortalama sıcaklık değerleri sırasıyla 6.8°C ile Ocak Ay'ında ve 21.0°C ile Nisan Ay'ında görülmüş olup, uzun yıllar ortalamalarına ait en düşük ve en yüksek ortalama sıcaklık değerleri ise sırasıyla 5.6°C ile Ocak Ay'ında ve 16.2°C ile Nisan Ay'ında gözlemlenmiştir. Araştırma dönemindeki yağış miktarlarına bakıldığında, ekim zamanından bitkilerdeki çiçek ve bakla oluşumu dönemine kadar (Nisan Ay'ı dahil) yağış ölçülmemiş olup, kış ve ilkbahar mevsimleri kurak geçmiştir. Bu da bitkilerin yeterli miktarda yağış alamadıklarını göstermektedir.

Araştırma; tesadüf blokları deneme desenine göre 5 bitki sıklığında (10-15-20- 25- 30) cm olup 4 tekerrürlü olarak oluşturulmuştur. Toplam parsel sayısı 20 (5 bitki sıklığı x 4 tekerrür) olup her bir parsel 4 sıradan teşekkül etmiştir. Parsel alanları; (10cm sıra üzerinde 5x0.10x4=2.0 $m^2$), (15 cm sıra üzerinde 5x0.15x4=3.0 $m^2$), (20 cm sıra üzerinde 5x0.20x4=4.0 $m^2$), (25 cm sıra üzerinde 5x0.25x4=5.0 $m^2$) ve (30 cm sıra üzerinde 5x0.30x4=6.0 $m^2$) olarak belirlenmiştir.

Her bir parsel aralarında 50 cm, tekerrürler arasında ise 1.5 metre mesafe bırakılmış, ekimde dekara 15 kg hesabıyla tohumluk kullanılmıştır (Bozkurt, 2018). Sıra aralığı 30 cm olarak ayarlanmıştır. Kasım Ay'ının ikinci haftası elle ekimi yapılmıştır. Denemede standart olarak toprak analizleri dikkate alınarak 3.5 kg/da azot, 10 kg/da $P_2O_5$ tamamlanacak şekilde (18:46 DAP) gübre uygulanmıştır (Sayar, 2007). Bitkilerin ilk çıkış dönemlerinde el ile, 30 cm yüksekliğe ulaştığında ise çapa ile yabancı ot mücadelesi yapılmıştır. Bitkiler kurak koşullarda sulama yapılmaksızın yetiştirilmiştir. Deneme parselinin tamamı bakla bağlamaya başladığı döneminde ot verimi ile ilgili gözlemleri almak için elle biçilmiştir (Sayar, 2007). Toplam deneme alanı ise 24.5m x 8m = 196 $m^2$ olarak planlanmıştır.

Araştırmada; Bitki boyu (cm): Her parselin orta 2 sırasından tesadüfî olarak alınan 10 bitkide bakla bağlama başlangıcı döneminde toprak yüzeyi ile bitkinin en uç noktası arasındaki uzunluk ölçülerek bitki boyu ortalamaları (cm) olarak belirlenmiştir (Sümerli ve Ark., 2002).

Çiçeklenme gün süresi (gün): Ekim zamanı ile bitkilerin %50 çiçeklenme zamanı arasındaki geçen gün sayısı olarak hesaplanmıştır.

Olgunlaşma gün süresi (gün): Çeşitlerin ekim zamanı ile tohum hasat olgunluğuna kadar geçen gün sayısı olgunlaşma süresi olarak hesaplanmıştır.

Bitkide bakla sayısı (adet/bitki): Her bir parselden tesadüfi olarak alınan 10'ar bitkinin baklaları sayılıp ortalamaları alınarak bitkide bakla sayısı saptanmıştır.

Yeşil ot verimi (kg/da): Her parselde, kenar tesirleri atıldıktan sonra geriye kalan kısım 8-10 cm yükseklikten biçilerek tartılmış ve parsel verimleri belirlenip, hasat alanı dikkate alınarak, dekara yeşil ot verimleri hesap edilmiştir.

Kuru ot verimi (kg/da): Hasat edilen bitkilerden en fazla 0.5 kg'lık örnekler 78°C'ye ayarlanmış etüvde 24 saat süreyle kurutulduktan sonra tartılıp ve belirlenen kuru ağırlıklarda gerekli dönüşümler yapılarak dekara kuru ot verimi hesaplanmıştır.

Araştırmadan elde edilen verilerin varyans analizi, uygun paket programı yardımıyla tesadüf blokları deneme deseni düzenine göre yapılmış ve çoklu karşılaştırma testi ile ise F testi sonuçlarına göre gruplar arasındaki farklılıklar Lsd (%5) tespit edilmiştir (Yurtseven, 2011).

## BULGULAR VE TARTIŞMA

### Bitki boyu (cm)

Farklı bitki sıklıklarında Gap Pembesi yem bezelyesinde tespit edilen bitki boyu ortalamaları Çizelge 3'de verilmiştir. Çizelge 3. incelendiğinde farklı ekim sıklıklarına ait bitki boyu değerleri 29.16-32.81 cm arasında değişim göstermiştir. en yüksek bitki boyu 32.81 cm ile 30x10 bitki sıklığından elde edilirken, en düşük bitki boyu değeri ise 29.16 cm ile 30x30 bitki sıklığındaki parsellerde ölçülmüştür. Çeşidin bitki boyu ortalaması 30.95 cm olarak tespit edilmiştir. Yapılan LSD testi sonuçlarına göre üç farklı grubun oluştuğu görülmektedir. Deneme sezonunda uzun yıllar ortalaması altında yağış düşmesinin, bitkilerde su stresini tetiklediğinden bitkilerdaha kısa boylu olmuşlardır. Su stresi büyümeyi kısıtlayıp generatif devreye geçişi teşvik etmiş, böylece bitki boyları kısa kalmıştır (Özel ve ark. 2016). Denemenin yürütüldüğü kış yetiştirme döneminde, özellikle kış aylarının çok soğuk ve kurak geçmesi, oluşan soğuk ve kurak zararı olduğu düşünülmektedir (Çizelge 1.).

Bu çalışmada elde edilen bitki boyuna ait değerler, Açıkgöz ve ark. (2001) Bursa'da 30-189 cm, Guy (2002), ABD'da 60-75 cm, Sümerli ve ark. (2002), Diyarbakır'da 43–70 cm, Sayar ve ark. (2009), Diyarbakır ekolojik koşullarında39.22- 79.33 cm, Seydoşoğlu (2013), Güneydoğu ekolojik koşullarında 67.6-87.9 cm, Kavut ve ark. (2016), İzmir'de 155.89-144.56 cm, Mart ve ark. (2017), Çukurova'da 47.2-93.8 cm, Ömeroğlu (2016), Isparta'da 74.40-92.60 cm, Çınar (2017), Çanakkale'de 125.17-127.84 cm, Kılınç (2017), Giresun ilinde 50-145 cm, Halil (2020), Bursa'da bitki boyu 5-190 cm ve Özeroğlu (2021), Aydın'da 85.7-103.2 cm olarak bulmuşlardır.Dar sıraya ekimde ışık rekabeti, bitkilerde boylanmayı teşvik etmiştir. Bitki boyuna ait elde edilen bulguların diğer araştırmacıların elde ettikleri bulgulardan farklılık arz etmesi, söz konusu araştırmaların yürütüldüğü çevre koşulları, sulama vegübreleme gibi kültürel uygulamalardan kaynaklanmış olabilir.

**Çizelge 3.** Farklı sıklıktaki Gap Pembesi yem bezelyesinin bazı verim özelliklerine ait ortalamalar ve oluşan gruplar*

| Bitki sıklıkları (cm) | Bitki boyu (cm) | Çiçeklenme gün süresi (gün) | Olgunlaşma gün süresi (gün) | Bitkide bakla sayısı (adet/bitki) | Yeşil ot verimi (kg/da) | Kuru ot verimi (kg/da)[1] |
|---|---|---|---|---|---|---|
| 30x10 cm | 32.81 a | 90.25 a | 123.75 | 6.03 c | 224.31 a | 49.30 a |
| 30x15 cm | 30.92 b | 89.50 ab | 123.75 | 6.50 c | 195.38 b | 37.96 b |
| 30x20 cm | 30.81 b | 87.75 bc | 121.25 | 7.68 b | 196.70 b | 39.57 b |
| 30x25 cm | 31.06 b | 87.50 c | 121.25 | 8.18 b | 199.15 b | 34.88 b |
| 30x30 cm | 29.16 c | 87.75 bc | 122.25 | 8.86 a | 161.79 c | 39.35 b |
| Ortalama | 30.95 | 88.55 | 122.25 | 7.45 | 195.46 | 40.21 |
| Lsd (%5) | 1.63 | 1.95 | ö.d. | 0.65 | 18.08 | 5.89 |

*) Aynı sütunda benzer harf grubu ile belirtilen ortalamalar, Lsd (%5) değerine göre farklı değildir.

[1)] Kuru ot verimine ait değerler, Cengiz ve ark. (2022)'ye ait makaleden alınmıştır.

## Çiçeklenme gün süresi (gün)

Çiçeklenmeye kadar geçen süre bakımından; incelenen çeşidin farklı sıklıklarıarasında istatistikî olarak %5 seviyesinde önemli farklılıklar bulunmuştur. Yem bezelyesi farklı sıklıklardaki çiçeklenme süresi ortalama değerleri ve oluşan gruplar Çizelge 3'de verilmiştir. Çizelge 3'de görüldüğü gibi, çiçeklenme süresi 87.50 gün ile 90.25 gün arasında değişim göstermiştir. En uzun çiçeklenmeye kadar geçen süre 90.25 gün ile 30x10 cm bitki sıklığında, en kısa çiçeklenmeye kadar geçen süre 87.50 gün ile 30x25 bitki sıklığında gözlenmiştir. Çiçeklenme süresi; bitkilerin erken veya geç olgunlaşmalarının bir göstergesidir. Daha önce yapılan çalışmalarda farklı sıklıktaki GP yem bezelyesinin çiçeklenme gün süresi ile ilgili farklı değerler elde edilmiştir. Sümerli ve ark., (2002), Diyarbakır'da 126.00-132.44 gün, Çeçen ve ark. (2005), Antalya ekolojik koşullarında 122 gün, Sayar ve ark. (2009), Diyarbakır'da 156-169 gün, Gündüz (2013) Erzurum'da 59-77 gün, Seydoşoğlu (2013), Diyarbakır'da 157.8-175.5 gün, Mart ve ark. (2017), Çukurova'da 51-39.3 gün, Varol (2016), Sivas'ta 271.0-295.0 gün, ve Kılınç (2017), Giresun'da 65-145 gün olarak tespit etmişlerdir. Bunun nedeni, Çizelge 1'de belirtilen sıcaklık ve yağış değerlerinden anlaşılacağı üzere çalışmamızın yürütüldüğü kış yetiştirme döneminde, özellikle kış aylarının çok soğukve kurak geçmesi sebebiyle oluşan soğuk ve kurak zararı yanında ilkbahar aylarının daha yağışlı ve serin geçmesinden, araştırmamızın ekim tarihinin daha erken olmasından kaynaklanmış olabilir.

**Olgunlaşma gün süresi (gün)**

Çizelge 3. incelendiğinde Gap yem bezelyesinin farklı sıklıktaki en uzun olgunlaşma gün sayısı değerinin önemsiz olmasına rağmen rakamsal olarak en uzun olgunlaşma gün sayısı 123.75 gün ile 30x10-30x15 bitki sıklıklarında gözlenmiştir. Bütün sıklıklarda olgunlaşma gün sayısı ortalaması 122.55 olarak tespit edilmiştir.

Bu araştırmada elde edilen olgunlaşma gün süresine ilişkin değerlerim, Sümerli ve ark. (2002), Diyarbakır koşullarında 166.33–170.11 gün, Sayar (2007), Diyarbakır'da 195.66-209.00 gün, Sayar ve Anlarsal (2008), Diyarbakır'da 201 gün, Varol (2016), Sivas'ta 282.6-316.6 gün ve Çınar (2017), Çanakkale'de 211-218 gün, sayısından daha düşüktür. Bunun nedeni Çizelge 1'de sıcaklık ve yağış bakıldığında denemenin yürütüldüğü kış yetiştirme sezonunda uzun yıllar ortalamasına göre kışın daha soğuk geçmesiyle oluşan soğuk zararı yanında, ilkbahar aylarının daha az yağışlı geçmesinden kaynaklanmış olabilir. Zira kuraklığın; bitkilerde su kaybını artırarak erken olgunlaşmayı teşvik edebileceğini Özel ve ark. (2016) bildirmektedirler.

**Bitkide bakla sayısı (adet/bitki)**

Farklı sıklıkta yem bezelyesinin tespit edilen bitkide bakla sayısı ortalamaları Çizelge 3'de verilmiştir. Çizelge 3. incelendiğinde farklı sıklıklardaki Gap yem bezelyesi çeşidinin, bitkide bakla sayısı 6.03 adet ile 8.86 adet arasında değişmekte olup, en yüksek değer 30x30 cm, en düşüğü 30x10 cm ile 30x15 cm'deki sıklıklardan elde edilmiştir. Bunun sebebi; bitki sıklığın yüksek olduğu parsellerde bitkinin daha az besine ulaşabilip daha az bakla oluşumuna sebebiyet verdiğini söyleyebiliriz, Farklı sıklıktaki bitkide bakla sayısı ortalaması ise 7.45 adet olarak tespit edilmiştir. Bu çalışmada elde edilen sonuç; Kılınç (2017), Giresun'da 7-35 adet/bitki, Gündüz (2013), Erzurum'da 2.67-39.50 adet/bitki, Yörük (2015), Sivas'ta 1.3-12.3 adet/bitki, Timurağaoğlu ve Altınok (2004), Ankara'da 5-13 adet/bitki, Sayar (2007),Diyarbakır'da 5.63-9.00 adet/bitki, Tamkoç (2007), Konya'da 6.8-9.4 adet/bitki, Sayarve ark. (2009), Diyarbakır'da 6.49-10.0 adet/bitki ve Ömeroğlu (2016), Isparta'da 7.50-8.80 adet/bitki, Varol (2016), Sivas'ta 2.6-13.7 adet/bitki, Bozkurt (2018), Bingöl'de 10.33-28.33 adet/bitki, olarak bildirdikleri değerlerden farklılık arz etmektedir. Bitkide bakla sayısına ilişkin elde edilen sonuçların araştırmacıların elde ettikleri değerlerden farklı olmasının nedeni, söz konusu araştırmaların yürütüldüğü farklı alan ekolojilerinin, kışlık ekim ve farklı ekim normunun bitkide bakla sayısındaki farklılıklara sebebiyet vermiş olabileceği düşünülmektedir.

**Yeşil ot verimi (kg/da)**

Farklı sıklıklardaki Gap Pembesi yem bezelyesinin yeşil ot verimi karakter ortalamaları ve oluşan gruplar Çizelge 3.'de verilmiştir. Çizelge 3. incelendiğinde farklı bitki sıklıklarının ait ortalama yeşil ot verimi değerleri 161.79 kg/da ile 224.31 kg/da arasında değişim göstermiştir. En yüksek yeşil ot verimi30x10 cm sıklıktaki parsellerden, en düşük değeri ise 30x30 cm'deki parsellerden tespit edildiği görülmektedir. Bunun sebebi olarak; sıklığın yüksek olduğu parsellerdebitkinin diğer bitkilerle rekabet edebilmek amacıyla kısa sürede boylanmasından, yanitür içi rekabetten dolayı yeşil ot veriminin artabileceğini (Okant , 1992;Tansı veUçar,1996; Karadağ ve Büyükburç, 2003;Bilgen ve Özyiğit, 2005) bildirmektedirler. Ayrıca, denemedeki yeşil ot veriminin oldukça düşük olası bitki gelişim döneminin kısalması ve vejetasyon döneminin çok kurak geçmesi çok düşük ot veriminin elde edilmesine sebep olmuştur (Çizelge 1.). Değişik ekolojilerde farklı genotiplerle yapılan çalışmalarda yeşil ot veriminin Timurağaoğlu ve Altınok (2004), Ankara koşullarında 1.525-2.022 kg/da, Çeçen ve ark. (2005), Antalya'da 1219 kg/da, Çil ve ark., (2007), Şanlıurfa'da 2178 kg/da, Sayar(2007), Diyarbakır'da 884.58-1648.06 kg/da, Sayar ve ark. (2009),Diyarbakır ekolojikkoşullarında 1156-1658 kg/da, Seydoşoğlu (2013), Diyarbakır'da 1143.1-2417.6 kg/da, Kavut ve Ark. (2016), İzmir'de 4360-3398 kg/da, Ömeroğlu (2016), Isparta'da 907.00-1109.00 kg/da, Karaköse (2018), Bingöl'de 853.6-2442.0 kg/da, Erkovan ve ark. (2020), Eskişehir'de 1679.16- 1812.74kg/da, Tankuş (2020), Şanlıurfa koşullarında 2462.78 kg/da ve Özeroğlu (2021), Aydın'da 1449.2-3452.8 kg/da olarak bildirdikleri değerlerden farklılık arz etmektedir.

Yeşil ot verimine ait elde edilen sonuçların diğer araştırmacıların tespit ettikleri değerlerden farklı olmasının sebebi, araştırmaların yürütüldüğü alanın ekolojik koşulları, özellikle ortalama sıcaklık ve toplam yağış miktarındaki farklılık ve farklı ekim zamanından kaynaklandığını söyleyebiliriz.

**Kuru Ot Verimi (kg/da)**

Farklı sıklıklardaki Gap Pembesi yem bezelyesinin kuru ot verimine ait karakter ortalamaları ve oluşan gruplara ait veriler Çizelge 3.'de belirtilmiştir. Çizelge 3. incelendiğinde, farklı sıklıktaki Gap yem bezelyesinde iki farklı grubun oluştuğu, kuru ot verimi en yüksek dekara 39.30 kg ile 30x10 bitki sıklığında, en düşüğü ise dekara 34.88- 39.57 kg degerleriyle 30x15, 30x20, 30x25 ve 30x30 cm'den elde edilmiştir. Bitki sıklığının yoğun olduğu 30x10 cm uygulamasından elde edilmesi, tür içi rekabetle açıklanabilir (Galal ve ark. 1974;Tansı. 1987;Okant, 1992). Bütün farklı sıklıklardaki kuru ot veriminin ortalama değeri ise dekara

40.21 kg olarak tespit edilmiştir. Denemede, 2021 yılı vejetasyon döneminde yeterli nemin olmayıp çok kurak geçmesi, tüm uygulamalarda kuru ot veriminin oldukça düşük çıkmasına sebep olmuştur (Çizelge 3.). Dekara kuru ot verimi ile ilgili diğer araştırmacıların değerlerine bakıldığında; Tekeli ve Ateş (2003), Tekirdağ ekolojik koşullarında 731,9 kg, Timurağaoğlu ve ark. (2004), Ankara'da 404-542 kg, Çeçen ve ark. (2005), Antalya'da 317 kg, Çil ve ark. (2007), Şanlıurfa'da 457 kg, Sayar ve ark. (2009), Diyarbakır'da 279-410 kg, Yörük (2015), Sivas'ta 198,2-466,3 kg, Ömeroğlu (2016), Isparta'da 221-281 kg, Çınar (2017), Çanakkale'de 430,65 kg, Karaköse (2018), Bingöl'de 264.0-580.8 kg, Temel ve Yazıcı (2021), Ağrı-Eleşkirt koşullarında 204.4–398.2 kg olarak tespit edilmiş olup, bildirdikleri değerlerden farklılık arz etmektedir.

Araştırma sonuçlarının diğer araştırmacıların bulgularıyla benzerlik göstermemesinin sebebi; belirtilen sıcaklık ve yağış değerlerinden görülebileceği gibi çalışmanın yürütüldüğü 2021 kış yetiştirme sezonu esnasında, düşük yağış ve düşük sıcaklıkların uzun yıllar ortalamasına göre daha soğuk geçmesi, diğer araştırıcıların sulu arazi koşullarında denemelerini yürütmüş olma ihtimali ile kuru ot verimlerinin daha yüksek çıkmasına sebebiyet verdiği düşünülmektedir (Çizelge 1.).

## SONUÇ

Bu çalışmada; Şanlıurfa İli ekolojik koşullarında kışlık ürün olarak farklı sıklıkta yetiştirilen Gap Pembesi yem bezelye (*Pisum arvense* L.) çeşidinin benzer ekolojik koşullar için yüksek yeşil ve kuru ot verim özellikleri birlikte değerlendirildiğinde 30x15 cm bitki sıklığı tavsiye edilmektedir.

## AÇIKLAMA

Bu tezde kullanılan veriler, ilk yazarın yüksek lisans tezi olup, HÜBAP tarafından desteklenen 21250 nolu projeden alınmıştır. Ayrıca, makale yazarları aralarında herhangi bir çıkar çatışması olmadığını beyan ederler.

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# TÜKETİCİLERİN SOSYO-EKONOMİK STATÜLERİNE GÖRE DONDURMA TÜKETİM TERCİHLERİ

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**Özet**
Çalışmada Bingöl İlinde dondurma tüketicilerinin dondurma tüketim alışkanları incelenmiştir. Çalışmada birincil veriler kullanılmıştır. Buna göre dondurma tüketicileriyle yüz yüze anket yapılmıştır. Örnek hacmi "Ana kitle Oranlarına Dayalı Kümelendirilmemiş Tek Aşamalı Tesadüfi Olasılık Örneklemesi" yöntemiyle örnekleme için yeterli örnek sayısı 385 adet olarak belirlenmiştir. Verilerin analizinde Cluster analizi kullanılmıştır. Çalışmada tüketiciler kendilerini hissettikleri sosyoekonomik sınıflara göre kümelere ayrılmıştır. Buna göre tüketicilerin %24,15'i yüksek düzey sosyoekonomik statüye sahip oldukları (93 tüketici), %38,18'i orta sınıf sosyoekonomik statüye (147 tüketici) ve son olarak %37,66'sı ise düşük düzey sosyoekonomik statüye (145 tüketici) sahip oldukları belirlenmiştir. Tüketicilerin sosyoekonomik statüleri arttıkça buna paralel olarak gelirlerinin de arttığı söylenebilir. Tüketicilerin sosyo-ekonomik statüleri yükseldikçe dondurma harcamalarının da arttığı söylenebilir. Buna göre yüksek düzey sosyo-ekonomik grubunda yer alan tüketicilerin aylık dondurma harcamaları 24,59 TL iken, orta düzey sosyo-ekonomik grubunda yer alan tüketicilerin 2,55 TL olarak hesaplanmıştır. Söz konusu harcama türü düşük düzey sosyo-ekonomik grubunda 22,90 TL olarak gerçekleşmiştir. Tüketiciler büyük oranda ambalajsız yani açık dondurma tüketmeyi tercih etmişlerdir. Üst düzey sosyo-ekonomik grubundan düşük düzey sosyo-ekonomik grubuna doğru gidildikçe ambalajsız dondurma tüketenlerin oranları gittikçe azalmıştır. Buna göre ambalajsız dondurma tüketmeyi tercih eden tüketicilerin yüksek düzey sosyo-ekonomik grubundaki oranı %64,5 iken bu oran orta düzey sosyo-ekonomik grubunda %53,7 ve düşük düzey sosyo-ekonomik grubunda ise %50,30 olarak gerçekleşmiştir.
**Anahtar Kelimeler:** Dondurma Tüketimi, Cluster Analizi, Tüketim davranışları, Bingöl

# ICE CREAM CONSUMPTION PREFERENCES OF CONSUMERS ACCORDING TO THEIR SOCIO-ECONOMIC STATUS

**Abstract**

In the study, ice cream consumption habits of ice cream consumers in Bingöl Province were examined. Primary data was used in the study. Accordingly, a face-to-face survey was conducted with ice cream consumers. Sample volume: The sufficient number of samples for sampling was determined as 385 with the "Non-Clustered Single-Stage Random Probability Sampling Based on Population Proportions" method. Cluster analysis was used to analyze the data. In the study, consumers were divided into clusters according to the socioeconomic classes they felt themselves in. Accordingly, 24.15% of the consumers have a high level socio-economic status (93 consumers), 38.18% have a medium level socio-economic status (147 consumers) and finally 37.66% have a low level socio-economic status. It was determined that they had socioeconomic status (145 consumers). It can be said that as the socioeconomic status of consumers increases, their incomes increase accordingly. It can be said that as the socio-economic status of consumers increases, their ice cream expenditures also increase. Accordingly, monthly ice cream expenditures of consumers in the high socio-economic group were calculated as 24.59 TL, while consumers in the middle socio-economic group were calculated as 2.55 TL. This type of expenditure was 22.90 TL in the low socio-economic group. Consumers largely preferred to consume unpackaged, that is, open ice cream. As we move from the upper socio-economic group to the lower socio-economic group, the proportion of people consuming unpackaged ice cream gradually decreases. Accordingly, while the rate of consumers who prefer to consume unpackaged ice cream in the high socio-economic group is 64.5%, this rate is 53.7% in the middle socio-economic group and 50.30% in the low socio-economic group.

**Keywords:** Ice Cream Consumption, Cluster Analysis, Consumption Behaviors, Bingöl

## GİRİŞ

Dondurma, geçmişte buza ilave edilen şarap, ezilmiş meyveler, bal, şerbet gibi katkı maddeleri ile mevsimlik zevk veren bir besin olarak üretilmiştir. Ancak zamanla farklı şekilde ve içerikte geliştirilmiştir. Dondurma; çeşitlerine krema, süt, süt tozu, harç, aroma maddeleri ve şeker ile elde edilen karışımın öncelikli olarak pastörize hale getirilmesi veya bu maddelerden elde edilen karışımın pişirilmesi ve ardından ısı derecesinin düşürülerek dondurulması ile elde edilen bir ürün olduğu söylenebilir (Uludağ, 2010; Özel ve Ceylan, 2016).

Dondurma pazarında hızlı bir küresel büyüme yaşanmakta ve şirketlere yatırım için yeni fırsatlar sunulmaktadır (Özel ve Ceylan, 2016). Dünya dondurma sektöründeki ilk beş ülke, ABD, Avustralya, Norveç, İsveç, Danimarka'dır. Dondurma pazarının tüm dünyadaki büyüklüğü 160 milyar lira civarındadır. İlk iki sırada ABD ve Avustralya'nın bulunduğu tüketim sıralamasında üçüncü olarak Norveç, dördüncü İsveç ve beşinci sırada Danimarka yer alıyor. Dünyanın en büyük dondurma üreticisi konumunun sahibi ise yılda ortalama olarak 6 milyar litre ile yine ABD'dir. Dünya üretiminin 17 milyar litre olduğu düşünülürse ABD'nin bu pazardaki yeri daha net ortaya çıkıyor (Yapraklı ve Kara, 2011).

ABD'de kişi başına düşen dondurma tüketimi 26 litre, Avrupa ülkelerinde ortalama 11 litre olarak gerçekleşirken, bu miktar ülkeler bazında incelendiğinde; İtalya'da 12 litre, İngiltere'de 25 litre, İsveç'te 14 litre, Yunanistan'da 7 litre ve Japonya'da 15 litre olarak gerçekleşmiştir. Bu rakam Türkiye'de 1991 yılında 0.3 litreyken 2003 yılında 1.5 litre olarak hesaplanmıştır (Türkel, 2004; Tiryaki ve Akbay, 2009;). 2005 yılında bu rakam yine 1,5 litreyken, 2010 yılında 2,5 litreye çıkmış ve 2015 yılında ise kişi başına tüketim 4,2 litreye çıkmıştır (Anonim, 2016). 2003 yılında markalı ve ambalajlı ürünlerin pazardaki toplam payı %65'e yükselmiştir. Açık dondurmaların pazardaki payı ise yaklaşık %35'dir (Ulusu, 2005, Aktaran, Tiryaki ve Akbay, 2009;).

Türkiye'de dondurma sektörü, tüketicilerin beklentilerini karşılama yolunda hızla gelişen bir sektördür. Dondurma pazarındaki hedef gruplar, toplumun önemli bir bölümünü oluşturan tatlıya düşkün bireyler, sağlıklı insanlar, gençler ve çocuklardır. Bu durum, bu pazara giriş için firmaları teşvik ettiği söylenebilir. Dondurma genç nüfusu, jeopolitik konumunun firmalara sunduğu istihdam olanakları yanı sıra büyük bir pazar için yatırım üssü olması açısından Türkiye için büyük önem taşımaktadır. Türkiye'de dondurma piyasasını açık ve ambalajlı dondurma olarak iki kısımda incelenebilir. Ambalajlı dondurmalar pazar payı gittikçe artan bir eğilim göstermektedir (Tiryaki ve Akbay, 2009). Kişi başına dondurma tüketiminin gelişmiş ülkelere oranla oldukça düşük olması ve özellikle de Türkiye'nin genç bir nüfusa sahip olması,

dondurma piyasasındaki firmaları ve piyasaya girmek isteyen diğer yerli ve yabancı firmaları oldukça cesaretlendirmiştir.(Özel ve Ceylan, 2016; Büyük ve ark., 2014).

Bu çalışmanın amacı, Bingöl ilinde tüketicilerin dondurma tüketim alışkanlarını ve tercihlerini ortaya koymaktır.

## 2.MATERYAL VE YÖNTEM

Çalışmanın ana kaynağını anketlerle toplanan birincil veriler oluşturmaktadır. Bunun yanında daha önce yapılmış olan çalışmalardan yararlanılmıştır.

Bu çalışmada örnek hacmi " Anakitle Oranlarına Dayalı Kümelendirilmemiş Tek Aşamalı Tesadüfi Olasılık Örneklemesi" yöntemiyle örnekleme için yeterli örnek sayısı, aşağıda belirtilen formül uyarınca 385 adet olarak belirlenmiştir (Collins, 1986).

$$n=t^2\,[1+(0,02)*(b-1)]*p*q/e^2$$

| | | |
|---|---|---|
| n | : | Örnek hacmi |
| t | : | %95 (tablo değeri:1,96) |
| b | : | Örnekleme aşaması ( çalışma tek aşamalı olduğundan 1 olarak alınmıştır) |
| p | : | İncelenen birimin ana kitle içinde gerçekleşme olasılığı (0,50 alınmıştır) |
| q | : | (q=1-p) |
| e | : | Çalışmada %5,00'lik hata kabul edilecektir |

b=1 alındığında eşitlik aşağıdaki şekle dönüşmektedir:

$$n=(t^2/e^2)*p*q$$

Bu formül excel paket programına girildiğinde ise;

$$n=(1,96/5,00)^2*(0,50*0,50)$$

**n=385** olarak bulunmuştur.

Anketlerin farklı sosyal ve ekonomik sınıflara dağılımında kullanılmak üzere, kent merkezini oluşturan mahalleler nüfuslarıyla birlikte TUİK'ten temin edilmiştir. Mahallelerin kent merkezinin toplam nüfusu içindeki payları bulunarak, her mahallenin sahip olduğu oran, tek tek toplam örnek anket hacmi sayısıyla çarpılarak söz konusu mahallede yapılacak anket sayısı bulunmuştur.

**Çizelge 1. Bingöl Merkez İlçe'de ve Mahalle Nüfuslarına Göre Anket Dağılımı**

| | Mahalle Nüfusu | % | Anket Sayısı |
|---|---|---|---|
| Kültür Mahallesi | 14890 | 17,36 | 67 |
| Recep Tayyip Erdoğan M. | 12908 | 15,05 | 58 |
| Şehit Mustafa Gündoğdu M. | 10035 | 11,70 | 45 |
| Yenişehir Mah. | 8449 | 9,85 | 38 |
| Yeni Mahalle | 7536 | 8,78 | 34 |
| Simani Mahallesi | 7247 | 8,45 | 33 |
| Saray Mahallesi | 7013 | 8,17 | 31 |
| Bahçelievler Mahallesi | 6998 | 8,16 | 31 |
| Yeşilyurt Mahallesi | 5641 | 6,58 | 25 |
| Karşıyaka Mahallesi. | 5070 | 5,91 | 23 |
| **Toplam** | **85787** | **100,00** | **385** |

Anketlerden elde edilen verilerin analizinde, pazarlama literatüründe önemli yer tutan ve pazarlama çalışmalarında çokça kullanılan çok değişkenli analiz tekniklerinden Kümeleme analizi yöntemi kullanılmıştır.

Cluster kümeleme analizi, bireylerin veya uyarıcıların benzerliklerine göre kümelerde toplanmasını amaçlayan çok değişkenli bir istatistiki analizdir. K-means yöntemi ise, bir dizi input değerini baz alarak verideki benzerlikleri bulmaya çalışır. Aynı özellik gösterenler bir kümede yer alacak şekilde gruplara atanır (Kurtuluş, 1985). K-Mean tekniğinde, işletme büyüklükleri veya bireyler, kümeler içi kareler toplamı en küçük olacak şekilde k kümeye bölünmektedir. Yani, $X_1$, $X_2$……$X_n$ gibi P değişkenli gözlem vektörleri, çok boyutlu X uzayında birer nokta olarak düşünüldüğünde ve uzayda $a_{1n}$……$n_{kn}$ her grup işletme veya kişiler için küme merkezleri seçildiğinde (Tatlıdil, 1996);

$$W_n = \frac{1}{n}\sum_{i=1}^{n} \min_{1\le j\le k} \left\| x_i - a_{jn} \right\|^2$$

Prensibince tüketiciler gelir düzeylerine göre en yakın kümeye atanmaktadır. Dolayısıyla çalışma düzeyinde değişkenler arasındaki karşılıklı ilişkinin nedenini ortaya koyan faktör analizinin başlıca varsayımları, veri matrisinin analiz öncesi kriter ve tahmin değişkenleri alt matrislerine bölüştürülmemesi ve değişkenler arasındaki ilişkinin doğrusal olduğudur. Tüketici davranışlarının kodlanması ve ifade edilmesi için giderek bilimsel pazarlama konularında kullanılan bir analiz türüdür. Bundan dolayıdır ki faktör analizi özellikle tüketicilerin davranışsal eğilim ve tercihlerinde olmak üzere çeşitli pazarlama problemlerinde sık sık kullanılan birçok değişkenli analiz tekniğidir (Koç, 2011, Kurtuluş, 1985). Çalışmada

tüketiciler kendilerini hissettikleri sosyoekonomik sınıflara göre kümelere ayrılmıştır. Buna göre tüketicilerin %24,15'i yüksek düzey sosyoekonomik statüye sahip oldukları (93 tüketici), %38,18'i orta sınıf sosyoekonomik statüye (147 tüketici) ve son olarak %37,66'sı ise düşük düzey sosyoekonomik statüye (145 tüketici) sahip oldukları belirlenmiştir. Tüketicilerin sosyoekonomik statüleri arttıkça buna paralel olarak gelirlerinin de arttığı söylenebilir.

## 3.ARAŞTIRMA BULGULARI

### 3.1.Bingöl'de Dondurma Tüketicilerinin Profili

Genel ortalamaya göre dondurma tüketicilerinin önemli bir kısmının erkek tüketicilerden oluştuğu söylenebilir. Buna göre dondurma tüketicilerinin %57,4'nün erkeklerden, %42,6'sının ise kadınlardan meydana geldiği belirlenmiştir. Konu gruplar bazında incelendiğinde, üst ve orta sosyoekonomik statüde yer alan tüketicilerin çoğunlukla erkeklerden oluştuğu ancak alt sosyoekonomik statü grubunda ise çoğunlukla kadın tüketicilerin yer aldığı söylenebilir.

Genel ortalamaya göre, dondurma tüketicileri yaş gruplarına göre incelendiğinde, 25-34 yaş grubunun en yüksek orana sahip olduğu belirlenmiştir. Bu yaş grubunu eşit oranla (%23,4) 18-24 ve 35-50 yaş gruplarının izlediği söylenebilir. Gruplar bazında konu incelendiğinde 25-34 yaş grubundaki tüketicilerin daha çok üst ve orta sosyoekonomik statü grubunda yer aldıkları buna karşın 18 yaş altı ve 18-24 yaş grubundaki tüketicilerin ise daha yüksek oranlarda alt sosyoekonomik statüde yer aldıkları söylenebilir. Eğitim durumunun dondurma tüketicileri üzerindeki etkisi incelendiğinde genel ortalama bazında en çok üniversite mezunu ve lise mezunlarının dondurma tükettikleri belirlenmiştir. En az dondurma tüketenlerin ise okuryazar olmayan kitle olduğu saptanmıştır. Buna göre üst ekonomik statüde bu oran %41,9 iken orta ekonomik statüde %58,5 olarak belirlenmiştir. Dondurma tüketicilerinin meslek gruplarıyla olan ilişkisi incelendiğinde genel ortalamaya göre en fazla dondurma tüketenlerin öğrenciler ve memurlardan meydana geldiği belirlenmiştir. Dağılımda öğrencilerin oranı %30,9 iken memurların oranı %26,5'tir. En az oran ise %0,3 ile çiftçilerden oluşmaktadır. Dondurma tüketiminin aile nüfusu üzerindeki etkileri incelendiğinde genel ortalama verilerine göre en fazla (2-4) kişiden oluşan aileler oluştururken ikinci sırayı (4-6) kişiden oluşan aileler oluşturmaktadır. En az oran ise (0-2) kişilik ailelerden oluşmaktadır. Çoğunluğu oluşturan (2-4) kişilik ailelerin oranı %39,5 iken azınlıktaki (0-2) kişilik ailelerin oranı 10,9 olarak belirlenmiştir. Genel ortalamaya göre dondurma tüketicilerinin ortalama aylık gelirleri incelendiğinde elde edilen bulgular neticesinde aylık gelirleri 2500-5000 TL aralığında olan tüketicilerin mutlak çoğunluğu oluşturduğu belirlenmiştir (Çizelge 2).

## Çizelge 2. Dondurma Tüketicilerinin Sosyoekonomik Statülerine Göre Profili

| | Sosyoekonomik statüler | | | Ortalama % |
|---|---|---|---|---|
| | Yüksek % | Orta-% | Düşük % | |
| **Cinsiyet Durumu** | | | | |
| Erkek | 58,1 | 68,7 | 45,5 | 57,4 |
| Kadın | 41,9 | 31,3 | 54,5 | 42,6 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **Yaş Durumu** | | | | |
| 18 yaş altı | 11,8 | 3,4 | 26,2 | 14,0 |
| 18—24 | 29,0 | 17,0 | 26,2 | 23,4 |
| 25-34 | 35,5 | 43,5 | 20,7 | 33,0 |
| 35-50 | 17,2 | 31,3 | 19,3 | 23,4 |
| 50+ | 6,5 | 4,1 | 7,6 | 6,0 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **Eğitim Durumu** | | | | |
| Okuryazar | 9,7 | 0,0 | 15,9 | 8,3 |
| Okuryazar değil | 2,2 | 0,0 | 6,9 | 3,1 |
| İlkokul mezunu | 4,3 | 6,8 | 15,2 | 9,4 |
| Ortaokul mezunu | 11,8 | 10,9 | 37,2 | 21,0 |
| Lise mezunu | 30,1 | 23,8 | 20,0 | 23,9 |
| Üniversite mezunu | 41,9 | 58,5 | 4,8 | 34,3 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **Meslek** | | | | |
| Memur | 30,1 | 46,9 | 3,4 | 26,5 |
| Çiftçi | 1,1 | 0,0 | 0,0 | 0,3 |
| İşçi | 4,3 | 5,4 | 3,4 | 4,4 |
| Öğrenci | 31,2 | 36,7 | 24,8 | 30,9 |
| Serbest meslek | 6,5 | 2,7 | 28,3 | 13,2 |
| Ev hanımı | 24,7 | 8,2 | 36,6 | 22,9 |
| Emekli | 2,2 | 0,0 | 3,4 | 1,8 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **Toplam Aile nüfusu** | | | | |
| 0-2 | 7,5 | 12,9 | 11,0 | 10,9 |
| 2-4 | 38,7 | 45,6 | 33,8 | 39,5 |
| 4-6 | 40,9 | 29,9 | 40,0 | 36,4 |
| 6 ve üstü | 12,9 | 11,6 | 15,2 | 13,2 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **Ortalama aylık gelir** | | | | |
| 0-2500 | 18,3 | 14,3 | 37,2 | 23,9 |
| 2500-5000 | 49,5 | 44,2 | 55,2 | 49,6 |
| 5000 ve üstü+ | 31,2 | 40,8 | 7,6 | 26,0 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |
| **Ortalama Değerler** | | | | |
| Hanehalkı Büyüklüğü (Kişi adet) | 4,97 | 4,31 | 4,66 | 4,60 |
| Aylık Ort. Gelir TL | 17.424,73 | 6.525,64 | 4.115,51 | 8.250,70 |
| Aylık Ort. Gıda Harc. TL | 1.516,12 | 1.599,67 | 1.315,86 | 1.472,60 |
| Aylık Ort. Dondurma Harc. TL | 24,59 | 24,55 | 22,90 | 23,94 |
| **%** | | | | |
| Aylık Ort. Gıda Harc./Aylık Ort. Gelir | 8,7 | 24,5 | 31,9 | 17,8 |
| Aylık Ort. Dondurma Harc./Aylık Ort.Gıda Harc. | 1,6 | 1,5 | 1,7 | 16 |

### 3.2. Tüketicilerin İzlediği TV Programları ve Gıda Etiketlerini Okuma Davranışları

Genel ortalamaya göre, dondurma tüketicileri en yüksek oranla film ve dizileri, ardından spor programlarını ve haberleri izlemeyi tercih etmiştir. Buna göre film ve dizileri izleyen tüketicilerin oranı %27,5 iken bun oranı %21,3 oranıyla spor programları ve %18,2 oranı ile de haber programları takip etmiştir. Bununla birlikte en az izlenen programlar kadın ve aile programları ile açık oturum ve tartışma programları olmuştur. Konu sosyoekonomik statüler düzeyinde incelendiğinde, üst ve alt sosyoekonomik statüye sahip dondurma tüketicileri en çok film ve dizileri izlerken, orta sosyoekonomik statüye sahip tüketiciler ise daha çok haber programlarını izlemeyi tercih etmişlerdir (Çizelge 3).

**Çizelge 3. Dondurma Tüketicilerinin Sosyoekonomik Statülerine Göre En çok İzlediği TV Programları**

| | Sosyoekonomik Statüler | | | Ortalama % |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | |
| Müzik, eğlence, yarışma prog. | 6,5 | 20,4 | 10,3 | 13,2 |
| Haberler | 5,4 | 28,6 | 15,9 | 18,2 |
| Spor programları | 14,0 | 21,8 | 25,5 | 21,3 |
| Açık oturum ve tartışmalar | 6,5 | 8,2 | 4,1 | 6,2 |
| Belgesel ve araştırma prog. | 14,0 | 9,5 | 2,1 | 7,8 |
| Film ve diziler | 46,2 | 9,5 | 33,8 | 27,5 |
| Kadın ve aile programları | 7,5 | 2,0 | 8,3 | 5,7 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Pazarlama sektöründeki önemli sorunlardan biri girilecek pazardaki tüketicilerin yeni ürünlere karşı tavırlarıdır. Yeni ürün deneme konusunda kapalı olan bir pazara farklı ürün çeşitleri sürmek hem zor hem de risklidir. Tüketicilerin yeni bir gıda ürününü deneme konusundaki tutumları incelendiğinde bütün sosyoekonomik statülerde yer alan tüketicilerin yeni gıda ürünlerini deneme konusunda istekli oldukları söylenebilir (Çizelge 4).

**Çizelge 4.Dondurma Tüketicilerinin Sosyoekonomik Statülerine Göre Yeni Gıda Ürünlerini Deneme Durumları**

| | Sosyoekonomik Statüler | | | Ortalama |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | % |
| Evet Denerim | 82,8 | 81,0 | 78,6 | 80,5 |
| Hayır denemem | 17,2 | 19,0 | 21,4 | 19,5 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

### 3.3. Ürün Etiketi Okuma

Dondurma tüketicilerinin ürün satın alırken ürün etiketinin okunması durumu incelendiğinde üst sosyoekonomik statüdeki tüketicilerin en fazla %41,9 oranında bazen okudukları, en az ise %10,8 oranında nadiren okudukları belirlenmiştir. Orta sosyoekonomik statüdeki tüketicilerin en fazla %45,6 oranında her zaman okudukları, en az ise %6,8 oranında ise hiç okumadıkları görülmektedir. Alt sosyoekonomik statüdeki tüketicilerin en fazla %38,6 oranında her zaman okudukları, en az ise %9,0 oranında nadiren okudukları belirlenmiştir. Bu üç grubun ortalaması alındığında; ürün satın alırken ürün etiketinin en fazla %39,7 oranında her zaman okunduğu ve en az %10,1 oranında nadiren okunduğu sonucuna varılmıştır (Çizelge 5).

**Çizelge 5. Tüketicilerin Sosyoekonomik Statülerine Göre Ürün Satın Alırken Etiket Okuma Durumu**

| | Sosyoekonomik statüler | | | Ortalama |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | % |
| Her zaman okurum | 32,3 | 45,6 | 38,6 | 39,7 |
| Bazen okurum | 41,9 | 36,7 | 31,7 | 36,1 |
| Nadiren okurum | 10,8 | 10,9 | 9,0 | 10,1 |
| Hiç okumam | 15,1 | 6,8 | 20,7 | 14,0 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

### 3.4. Tüketicilerin Dondurma Tüketim Tercihleri ve Davranışları

#### 3.4.1. Dondurma Tüketim Tercihleri

Bingöl ili dondurma tüketicilerinin dondurma tüketim çeşitleri incelendiğinde bütün sosyoekonomik statüdeki tüketicilerin ambalajsız dondurmayı tercih ettikleri belirlenmiştir. Genel ortalamaya göre bu oran %55,1 olarak hesaplanmıştır. Konuyu gruplar bazında ele alırsak üst sosyoekonomik grubun ambalajsız(açık ) dondurma tercihi %64,5 iken ambalajlı (kapalı) dondurma tercihi %35,5 oranındadır. Orta sosyoekonomik grubun ambalajsız (açık) dondurma tercihi %53,7 iken ambalajlı (kapalı) dondurma tercih oranı %46,3 olarak belirlenmiştir. Son olarak ise alt sosyoekonomik grubun ambalajsız(açık) dondurma tercihi %50,3 iken ambalajlı (kapalı) dondurma tercihi %49,7 olarak saptanmıştır ( Çizelge 6).

**Çizelge 6. Tüketicilerin Sosyoekonomik Statülerine Göre Dondurma Tüketim Tercihleri**

| | **Sosyoekonomik statüler** | | | **Ortalama %** |
|---|---|---|---|---|
| | **Üst %** | **Orta %** | **Alt %** | |
| Ambalajsız (Açık) | 64,5 | 53,7 | 50,3 | 55,1 |
| Ambalajlı (Kapalı) | 35,5 | 46,3 | 49,7 | 44,9 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

#### 3.4.2. Tüketicilerin Dondurma Tüketim Şekli

Tüketicilerin dondurma tüketim tercihleri gruplar bazında incelendiğinde, üst sosyoekonomik statüdeki tüketicilerin dondurmayı sade olarak tüketim oranı %74,2 olarak belirlenirken, dondurmayı tatlının yanında tüketen tüketicilerin oranı ise %19,4 olarak hesaplanmıştır. Orta düzey sosyoekonomik statü grubunda yer alan tüketicilerin %72,8'i dondurmayı sade olarak tüketirken, tatlının yanında tüketenlerin oranı %21,1 olarak saptanmıştır. Son olarak ise alt düzey sosyoekonomik statüdeki tüketiciler için dondurmayı sade dondurma olarak tüketim oranı %64,1 olarak hesaplanmıştır. Bu oran tatlı ile birlikte dondurma tüketen tüketiciler için %25,5 ortaya konulmuştur. Meyvenin yanında dondurma

tüketim oranı en çok alt düzey sosyoekonomik statüde yer alan tüketiciler tarafından tercih edilmektedir (Çizelge 7).

**Çizelge 7. Tüketicilerin Sosyoekonomik Statülerine Göre Dondurma Tüketim Şekilleri**

| | Sosyoekonomik statüler | | | Ortalama % |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | |
| Sade dondurma olarak | 74,2 | 72,8 | 64,1 | 69,9 |
| Tatlının yanında | 19,4 | 21,1 | 25,5 | 22,3 |
| Meyvenin yanında | 6,5 | 6,1 | 10,3 | 7,8 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

### 3.4.3. Dondurma Tüketim Amacı

Genel ortalama sonuçlarına göre dondurma tüketicilerinin dondurma tüketim amaçları incelendiğinde üst sosyoekonomik statüdeki tüketicilerin en fazla %62,4 oranıyla dondurmayı sevdikleri için, daha sonra ise %21,5 oranıyla dondurmayı serinlemek için tükettikleri sonucuna ulaşılmıştır. Dondurmayı sağlıklı bulduğu için tüketen tüketicilerin oranı ise en düşük payı alarak %3,2 bulunmuştur. Buna göre dondurmayı sevdiği için tüketen tüketicilerin %62,4'ü üst sosyoekonomik statü grubunda yer alırken, orta sosyoekonomik statüde yer alan tüketicilerin oranı ise %64,6 olarak gerçekleşmiştir. Söz konusu bu oran alt sosyoekonomik statüde ise %54,5 olarak hesaplanmıştır (Çizelge 8).

**Çizelge 8. Sosyoekonomik Statülerine Göre Tüketicilerin Dondurma Tüketim Amacı**

| | Sosyoekonomik statüler | | | Ortalama % |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | |
| Serinlemek için | 21,5 | 28,6 | 42,8 | 32,2 |
| Sevdiğim için | 62,4 | 64,6 | 54,5 | 60,3 |
| Sağlıklı bulduğum için | 3,2 | 1,4 | 1,4 | 1,8 |
| Çocuklar istediği için | 8,6 | 3,4 | 0,7 | 3,6 |
| Diğer | 4,3 | 2,0 | 0,7 | 2,1 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Tüketicilerin en sık tercih ettikleri dondurma çeşitleri incelenmiştir. Üst sosyoekonomik statüdeki grubun en çok tercih ettiği dondurma çeşidi %31,2 oranında karışık dondurma olurken en az tercih ettikleri dondurma çeşidi ise %10,6 oranı ile meyveli dondurma olmuştur. Orta sosyoekonomik statüdeki grubun en çok tercih ettiği dondurma çeşidi %30,6 oranıyla sade dondurma iken en az tercih ettikleri dondurma çeşidi ise %9,5 oranıyla çikolatalı dondurma olarak belirlenmiştir. Son olarak alt sosyoekonomik statüdeki grubun dondurma tüketim tercihlerini incelersek en çok %26,9 oranında çikolatalı dondurma tercih edilirken en az %13,8 oranında sade dondurma tükettikleri sonucuna ulaşılmıştır. Genel ortalamaya göre, ençok karışık dondurma, ardından sade dondurma tercih edildiği söylenebilir (Çizelge 9).

**Çizelge 9. Sosyoekonomik Statülerine Göre Tüketicilerin En Çok Tercih Edilen Dondurma Çeşitleri**

| | **Sosyoekonomik statüler** | | | **Ortalama %** |
|---|---|---|---|---|
| | **Üst %** | **Orta %** | **Alt %** | |
| Sade olarak | 19,4 | 30,6 | 13,8 | 21,6 |
| Karışık | 31,2 | 22,4 | 16,6 | 22,3 |
| Sütlü | 22,6 | 22,4 | 21,4 | 22,1 |
| Meyveli | 10,8 | 15,0 | 21,4 | 16,4 |
| Çikolatalı | 16,1 | 9,5 | 26,9 | 17,7 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Tüketicilerin hangi süt çeşidinden yapılan dondurmayı tercih ettiklerini incelediğimizde; her üç statüdeki tüketicilerin en fazla keçi sütünden yapılan dondurmayı tercih ettikleri belirlenmiştir. Oransal olarak ise üst sosyoekonomik statüdeki tüketicilerin en yüksek %68,8'i keçi sütünden yapılan dondurmayı tercih ettikleri gözlemlenirken bu oran orta sosyoekonomik statüdeki grupta ise %76,2 olarak hesaplanmıştır. Alt sosyoekonomik statü grubunda yer alan tüketicilerin %72,4'de yine aynı şekilde keçi sütünden yapılan dondurma tercih ettikleri belirlenmiştir. Bu üç grubun ortalaması alındığında ise tüketicilerin %73'ü keçi sütünü ve %5,7'si ise manda sütündün yapılan dondurmayı tercih ettikleri sonucuna varılmıştır (Çizelge 10).

**Çizelge 10. Sosyoekonomik Statülerine Göre Tüketicilerin Sütün Türü Bakımından Dondurma Tercihleri**

| | Sosyoekonomik statüler | | | Ortalama % |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | |
| Keçi sütü | 68,8 | 76,2 | 72,4 | 73,0 |
| İnek sütü | 18,3 | 15,6 | 13,1 | 15,3 |
| Manda | 3,2 | 5,4 | 7,6 | 5,7 |
| Diğer… | 9,7 | 2,7 | 6,9 | 6,0 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Bingöl ili dondurma tüketicilerinin dondurmayı genelde nereden temin ettikleri incelendiğinde, üst sosyoekonomik statüdeki tüketicilerin dondurmayı en fazla %59,1 oranında marketlerden en az ise %5,4 oranında kafelerden temin ettikleri bulgusuna ulaşılmıştır. Orta sosyoekonomik statüdeki tüketicilerin en fazla %57,1 oranında marketlerden en az ise %8,2 oranında kafelerden temin ettikleri tespit edilmiştir. Alt sosyoekonomik statüdeki tüketicilerin en fazla %72,4 oranında marketlerden en az ise %3,4 oranında kafelerden temin ettikleri belirlenmiştir. Bu üç grubun ortalaması alındığında ise Bingöl ilinde dondurmanın en fazla %63,4 oranında marketlerden ve en az olarak da %5,7 oranında kafelerden temin edildiği sonucuna varılmıştır (Çizelge 11).

**Çizelge 11. Tüketicilerin Sosyoekonomik Statülerine Göre Dondurma Temin Noktaları**

| | Sosyoekonomik statüler | | | Ortalama % |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | |
| Sokak satıcısı | 14,0 | 8,8 | 10,3 | 10,6 |
| Market | 59,1 | 57,1 | 72,4 | 63,4 |
| Kafe | 5,4 | 8,2 | 3,4 | 5,7 |
| Pastane | 21,5 | 25,9 | 13,8 | 20,3 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Yapılan çalışmada dondurma tüketicilerinin dondurma servisi tercihleri incelendiğinde, üst sosyoekonomik statüdeki tüketicilerin ilk tercihi %51,6 oranında külahta servis olurken, orta sosyoekonomik statüdeki tüketicilerin ilk tercihi %38,8 oranında tabakta servis olarak belirlenmiştir. Alt sosyoekonomik statüdeki tüketicilerin ilk tercihine bakıldığında ise %51,0 oranında külahta servis edilen dondurma olarak belirlenmiştir. Genel ortalamaya göre en fazla külahta, daha sonra da tabakta servis edilen dondurma tercih edilmiştir. Diğer şekillerde servis edilen dondurmanın en az tercih edilen seçenek olduğu sonucuna varılmıştır (Çizelge 12).

**Çizelge 12. Sosyoekonomik Statülerine Göre Tüketicilerin Tercih Ettikleri Dondurma Servisi**

| | **Sosyoekonomik statüler** | | | **Ortalama %** |
|---|---|---|---|---|
| | **Üst %** | **Orta %** | **Alt %** | |
| Tabakta | 20,4 | 38,8 | 31,7 | 31,7 |
| Külahta | 51,6 | 34,0 | 51,0 | 44,7 |
| Ufak kapta | 8,6 | 18,4 | 13,1 | 14,0 |
| Diğer… | 19,4 | 8,8 | 4,1 | 9,6 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Ambalajsız dondurmanın satış yerlerinde ne gibi eksikliklerin söz konusu olduğu incelendiğinde üst sosyoekonomik statüdeki tüketicilerin şikâyetlerinde ilk sırayı %62,4 oranında hijyene dikkat edilmemesi konusu oluşturmuştur. Hijyene dikkat edilmemesi noktasındaki eksiklik, orta ve alt sosyoekonomik statüdeki tüketicilerin de en çok dikkat ettikleri konu olarak belirlenmiştir. Buna göre hijyene dikkat edilmediğini ifade eden orta sosyoekonomik statüdeki tüketicilerin oranı %70,7 iken bu oran alt sosyoekonomik statüdeki tüketicilerin bulunduğu grupta ise %67,6 olarak saptanmıştır. Buna göre genel ortalama sonuçları neticesinde, tüketicilerin en fazla %67,5 oranında hijyene dikkat edilmediği, en az olarak ise %9,6 oranında diğer sebeplerin eksikliğinin söz konusu olduğu belirlenmiştir (Çizelge 13).

**Çizelge 13. Tüketicilerin Sosyoekonomik Statülerine Göre Açık Dondurma Satış Noktalarında Gözlemledikleri Eksiklikler**

| | Sosyoekonomik statüler | | | Ortalama % |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | |
| Çeşitlilik az | 21,5 | 19,0 | 27,6 | 22,9 |
| Hijyene dikkat edilmemesi | 62,4 | 70,7 | 67,6 | 67,5 |
| Diğer… | 16,1 | 10,2 | 4,8 | 9,6 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Bütün sosyoekonomik statü düzeylerinde dondurma tüketiminin çoğunlukla yaz aylarında gerçekleştiği söylenebilir. Buna göre gruplar bazında dondurmanın genellikle hangi mevsimde tercih edildiği incelendiğinde, üst sosyoekonomik statüdeki tüketicilerin dondurmayı en fazla yaz aylarında (%93,5), tüketildiği ancak sonbahar aylarında ise hiç tüketilmediği bilgisine ulaşılmıştır. Orta sosyoekonomik statüdeki tüketicilerin dondurmayı en fazla %92,5 oranı ile yaz aylarında, en az %1,4 oranı ile ilkbahar aylarında tükettikleri belirlenmiştir. Son olarak alt sosyoekonomik statüdeki tüketicilerin en fazla %86,2 oranında yaz aylarında, en az %1,4 oranında sonbahar aylarında dondurma tükettikleri sonucuna varılmıştır. Elde edilen veriler doğrultusunda genel ortalama sonuçlarına bakıldığında, dondurmanın %90,4 oranında en fazla oranla yaz aylarında tüketildiği saptanmıştır (Çizelge 14).

**Çizelge 14. Tüketicilerin Sosyoekonomik Statülerine Göre Mevsimsel Dondurma Tüketimi**

| | Sosyoekonomik statüler | | | Ortalama % |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | |
| İlkbahar | 3,2 | 1,4 | 2,8 | 2,3 |
| Yaz | 93,5 | 92,5 | 86,2 | 90,4 |
| Sonbahar | 0,0 | 4,1 | 1,4 | 2,1 |
| Kış | 3,2 | 2,0 | 9,0 | 4,9 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Dondurmanın en çok hangi zamanlarda ve hangi ortamlarda tüketildiği konusu sosyoekonomik statüler bazında incelendiğinde; üst sosyoekonomik sınıfın en çok %24,7 oranıyla parkta otururken, Orta ve alt sosyoekonomik sınıfın ise en çok arkadaşlarla olan sohbet ortamlarında dondurma tükettikleri belirlenmiştir. Genel ortalamaya göre dondurma tüketicileri en yüksek oranla arkadaşlarla olan sohbet ortamlarında, ardından ise TV izlerken dondurma tükettiklerini belirtmişlerdir. Buna göre arkadaşlarla olan sohbet ortamlarının oranı %41,3 iken TV izlerken dondurma tüketiminin oranı %25,7 olarak belirlenmiştir. Dondurma tüketiminin en az tercih edildiği ortam ise %5 oranıyla toplantılar olmuştur (Çizelge 15).

**Çizelge 15. Sosyoekonomik Statülerine Göre Tüketicilerin Dondurma Tüketim Ortamları**

| | **Sosyoekonomik statüler** | | | **Ortalama** |
|---|---|---|---|---|
| | **Üst %** | **Orta %** | **Alt %** | **%** |
| Toplantılarda | 0,0 | 0,7 | 0,7 | 0,5 |
| Arkadaşlarla olan sohbet ortamlarında | 15,1 | 53,7 | 45,5 | 41,3 |
| Sinemada | 1,1 | 0,7 | 1,4 | 1,0 |
| TV izlerken | 19,4 | 23,8 | 31,7 | 25,7 |
| İş yerinde | 3,2 | 2,7 | 1,4 | 2,3 |
| Yürürken | 14,0 | 8,8 | 9,7 | 10,4 |
| Parkta otururken | 24,7 | 5,4 | 9,7 | 11,7 |
| Diğer | 22,6 | 4,1 | 0,0 | 7,0 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Dondurmanın tüketim sıklığını incelediğimizde elde edilen verileri sosyoekonomik statülere göre değerlendirecek olursak üst sosyoekonomik statüdeki tüketicilerin en fazla %31,2 oranında haftada bir kez, en az ise %5,4 oranında ayda üç dört kez dondurma tükettikleri saptanmıştır. Ayrıca orta sosyoekonomik statüdeki tüketicilerin en fazla %28,6 oranında haftada üç dört kez ve alt sosyoekonomik statüdeki tüketicilerin ise en fazla %35,9 oranında haftada üç dört kez dondurma tükettikleri belirlenmiştir. Genel ortalama sonucu neticesinde ise en fazla %30,1 oranı ile en fazla haftada bir kez tüketildiği sonucuna ulaşılmıştır (Çizelge 16).

**Çizelge 16. Tüketicilerin Sosyoekonomik Statülerine Göre dondurma Tüketim Sıklığı**

| | Sosyoekonomik statüler | | | Ortalama % |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | |
| Her zaman | 25,8 | 9,5 | 28,3 | 20,5 |
| Haftada bir kez | 31,2 | 23,8 | 35,9 | 30,1 |
| Haftada üç dört kez | 24,7 | 28,6 | 27,6 | 27,3 |
| Ayda bir kez | 12,9 | 25,2 | 5,5 | 14,8 |
| Ayda üç dört kez | 5,4 | 12,2 | 2,8 | 7,0 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Dondurmanın yalnızca çocuklara yönelik bir ürün olup olmadığını incelediğimizde üst sosyoekonomik statüdeki tüketicilerin %37,6 oranında hayır cevabını verirken, %29,0 oranında kısmen cevabını verdikleri gözlemlenmiştir. Orta ve alt sosyoekonomik statüdeki tüketicilerin %49,0 oranında büyük çoğunluğun fikrinin dondurmanın yalnızca çocuklara yönelik bir ürün olmadığı yönündedir. Bu üç grubun genel ortalama sonuçları neticesinde, en fazla %46,2 oranında hayır cevabı verilmiştir. Sonuç olarak ise dondurmanın yalnızca çocuklara yönelik bir ürün olmadığı, her yaş grubuna yönelik bir ürün olduğu bilgisine ulaşılmıştır (Çizelge 17).

**Çizelge 17. Tüketicilere Göre Dondurma Çocuklara Yönelik Bir Ürün Müdür?**

| | Sosyoekonomik statüler | | | Ortalama % |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | |
| Evet | 33,3 | 19,7 | 28,3 | 26,2 |
| Hayır | 37,6 | 49,0 | 49,0 | 46,2 |
| Kısmen | 29,0 | 31,3 | 22,8 | 27,5 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Dondurma tüketicilerinin ürün satın alırken en çok neyden ve kimden etkilendiklerini incelediğimizde konuyu sosyoekonomik statüler bazında ele alacak olursak üst sosyoekonomik statüdeki tüketicilerin dondurma satın alırken en çok %40,9 oranında arkadaş, komşu, iş

çevresinden ve bununla yine aynı orana (%40,9) sahip diğer seçeneğinden etkilendikleri belirlenmiştir. Orta sosyoekonomik statüdeki tüketicilerde en fazla %38,8 oranında TV reklamları ve alt sosyoekonomik statüdeki tüketicilerde en fazla %69,0 oranıyla yine TV reklamlarından etkilenildiği bilgisine ulaşılmıştır. Genel ortalamaya sonuçlarına göre tüketiciler dondurma satın alırken en çok TV reklamlarından, en az ise radyo reklamlarından etkilenmektedirler. Elde edilen bulgular doğrultusunda bu oran TV reklamlarında %41,8 iken radyo reklamlarında %1,0 olarak belirlenmiştir (Çizelge 18).

**Çizelge 18. Tüketicilerin Sosyoekonomik Statülerine Göre Dondurma Seçiminde En çok Etkilendiği Faktörler**

| | Sosyoekonomik statüler | | | Ortalama |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | % |
| TV reklamlarından | 4,3 | 38,8 | 69,0 | 41,8 |
| Radyo reklamlarından | 0,0 | 0,7 | 2,1 | 1,0 |
| Gazete ve dergi reklamlarından | 1,1 | 3,4 | 2,8 | 2,6 |
| Duvar afişleri ve el broşürlerinden | 0,0 | 3,4 | 2,8 | 2,3 |
| Promosyonlu satışlar ve fiyat indirimlerinden | 12,9 | 8,8 | 4,8 | 8,3 |
| Arkadaş, komşu, iş çevresinden | 40,9 | 28,6 | 15,9 | 26,8 |
| Diğer | 40,9 | 16,3 | 2,8 | 17,1 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Yapılan çalışmada marka bağımlılık düzeyi araştırılmıştır. Konu sosyoekonomik statüler bazında ele alındığında üst sosyoekonomik statüdeki tüketicilerin en fazla %36,6 oranında her zaman aynı markayı satın aldıkları belirlenirken en az %11,8 oranında belirli sürelerde belirli markaları tercih ettikleri sonucuna ulaşılmıştır. Orta sosyoekonomik statüdeki tüketicilerin en çok %38,8 oranında 2 veya 3 markayı satın aldıklarını en az ise %14,3 oranında belirli sürelerde belirli markaları tercih ettikleri belirlenmiştir. Son olarak alt sosyoekonomik statüdeki tüketicilerin en fazla %33,1 oranında her zaman aynı markayı tercih ettikleri, en az olarak %13,8 oranında belirli sürelerde belirli markaları tercih ettikleri bilgisine ulaşılmıştır. Konuyu

genel ortalama sonuçları neticesinde incelersek; tüketicilerin çoğunluğunun sürekli olarak en fazla %33,2 oranında 2 veya 3 marka arasında tercih yaptıkları saptanmıştır Çizelge 19).

**Çizelge 19. Tüketicilerin Sosyoekonomik Statülerine Göre Dondurma Satın Almada Marka Bağımlılık Düzeyleri**

| | Sosyoekonomik statüler | | | Ortalama |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | % |
| Her zaman aynı markayı satın alıyorum | 36,6 | 28,6 | 33,1 | 32,2 |
| 2 veya 3 marka satın alıyorum | 34,4 | 38,8 | 26,9 | 33,2 |
| Belirli sürelerde belirli markaları tercih | 11,8 | 14,3 | 13,8 | 13,5 |
| Belirli bir marka tercihim yok, sık sık | 17,2 | 18,4 | 26,2 | 21,0 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Genel ortalamaya göre tüketicilerin çoğunluğu fiyat bakımından birbirine eşdeğer ürünleri tercih ederken, kalite bakımından çoğundan kaliteli olduğunu düşündükleri ürünleri tercih etmektedirler. Buna göre konu oran bakımından ele alınacak olursa fiyat durumu karşılaştırmasının genel ortalama oranı %41,8 iken kalite durumu karşılaştırmasının genel ortalama oranı ise %41,0 olarak saptanmıştır (Çizelge 20).

**Çizelge 20. Sosyoekonomik Statülerine Göre Tüketiciler Tarafından sürekli satın alınan dondurma markasının pazardaki diğer markalara göre kalite ve fiyat durumu karşılaştırması**

| | Sosyoekonomik statüler | | | Ortalama % |
|---|---|---|---|---|
| | Üst % | Orta % | Alt % | |
| En pahalı | 19,4 | 13,6 | 11,0 | 14,0 |
| Çoğundan pahalı | 34,4 | 40,1 | 21,4 | 31,7 |
| Eşdeğer | 33,3 | 39,5 | 49,7 | 41,8 |
| Çoğundan ucuz | 12,9 | 5,4 | 14,5 | 10,6 |
| En ucuz | 0,0 | 1,4 | 3,4 | 1,8 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |
| | **Sosyoekonomik statüler** | | | **Ortalama %** |
| | **Üst %** | **Orta %** | **Alt %** | |
| En kaliteli | 35,5 | 29,3 | 31,7 | 31,7 |
| Çoğundan kaliteli | 47,3 | 42,2 | 35,9 | 41,0 |
| Eşdeğer | 15,1 | 25,9 | 26,9 | 23,6 |
| Çoğundan kötü | 1,1 | 1,4 | 2,8 | 1,8 |
| En kötü | 1,1 | 1,4 | 2,8 | 1,8 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

Yapılan çalışmada tüketicilerin dondurma satın alınırken hangi durumlarda ürünün markasını veya satış noktasını değiştirecekleri konusu incelendiğinde genel çoğunluğun ürünün kalitesinin düşmesi sonucunda bu değişikliğe gidileceği sonucuna ulaşılmıştır. Sosyoekonomik statülere göre bu oran üst sosyoekonomik statüdeki tüketicilerde %58,1 iken orta sosyoekonomik statüdeki tüketicilerde %67,3 olarak belirlenmiştir. Alt sosyoekonomik statüde ise bu oran %57,7 olarak görülmektedir (Çizelge 21).

**Çizelge 21. Tüketicilerin Sosyoekonomik Statülerine Göre Satın Aldıkları Dondurma Markasını/ Dondurma Satış Noktasını Değiştirme Koşulları**

| | Sosyoekonomik statüler | | | Ort. % |
|---|---|---|---|---|
| | Üst % | Orta % | Düşük % | |
| Kalite düşmesi | 58,1 | 67,3 | 47,6 | 57,7 |
| Fiyat yükselmesi | 11,8 | 15,0, | 27,6 | 19,0 |
| Ürün bulunama durumu | 15,1 | 8,8 | 14,5 | 12,5 |
| Yeni ürün çıkması | 10,8 | 4,8 | 5,5 | 6,5 |
| Diğer markaların yaptığı promosyon ve fiyat indirimleri | 1,1 | 3,4 | 3,4 | 2,9 |
| Reklam | 3,2 | 0,7 | 1,4 | 1,6 |
| **Toplam** | **100,0** | **100,0** | **100,0** | **100,0** |
| **N** | **93** | **147** | **145** | **385** |

## 4. SONUÇLAR

Tüketicilerin yaşam ve tüketim davranışlarının gittikçe değişmesiyle birlikte eskiden sadece yaz aylarında tüketilen bir gıda olan dondurma, son yıllarda özellikle ambalajlı dondurma sektörünün gelişmesiyle kış aylarında da tüketilen bir besin kaynağı olduğu söylenebilir.

Araştırma sonuçlarına göre hanehalkı başına düşen ortalama nüfus 4.60 kişi olarak hesaplanmıştır. Tüketicilerin sosyo ekonomik statüleri yükseldikçe gelirlerinin de arttığı gözlemlenmiştir. Ancak dondurma tüketimine ayrılan bütçe bütün gruplarda birbirine yakın rakamlar hesaplanmıştır. Bu durum geyin arttığı halde tüketicilerin dondurma tüketimlerinde ancak çok az miktarda bir değişimin olduğu belirlenmiştir.

Tüketicilerin daha çok ambalajsız ve keçi sütünden yapılan dondurmaları tercih ettiği söylenebilir. Ayrıca dondurmayı açık dondurma satılan dondurmacılardan, yine açık dondurma

satışı yapan normal marketlerden satın aldıkları belirlenmiştir. Buna ek olarak tüketicilerin yeni dondurma türlerini deneyimlemeye açık oldukları belirlenmiştir.

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# İŞLENMİŞ YÖRESEL GIDA ÜRÜNLERİ PAZARININ ANALİZİ: BİNGÖL SOĞUK ÇEŞME KAVURMASI ÖRNEĞİ

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## ÖZET
Araştırmanın kaynağını birincil veriler oluşturmaktadır. Bu anlamda Bingöl ilinin Merkez ilçesinde yer alan iki adet kavurma işletmesinin yöneticisiyle anket yapmak suretiyle veriler elde edilmiştir. Bu çalışmada Bingöl ilinde kavurma sektörünün iki önemli ana firmasıyla görüşülmüştür. Dolayısıyla tam sayım yöntemiyle anket çalışmaları tamamlanmıştır. Ankette firma kimliği, soğuk çeşme Kavurmasının tarihçesi, et tedarik yöntemleri, kavurmanın hazırlanma aşamaları, firmaların pazarlama stratejileri ele alınmıştır. Dolayısıyla anket ve görüşmelerden elde edilen bilgiler harmanlanarak yorumlanmıştır. Çalışmada ayrıca konu ile ilgili olan bilimsel çalışmalar, kitaplar, dergiler ve diğer basın yayın organlarından da yararlanılmıştır. Soğuk Çeşme Kavurması üreten iki adet firma bulunmaktadır. Firmaların Bingöl merkez ve ilçelerinde olmak üzere toplamda 6 adet şubede faaliyet gösterdikleri söylenebilir. Firmaların web siteleri bulunmakla birlikte etkin bir şekilde kullanmadıkları belirlenmiştir. Soğuk çeşme kavurması üreten her iki firma toplamda 85 adet daimi istihdam sağladıkları belirlenmiştir. Her iki firmanın üye olduğu kuruluşlar, Ticaret ve Sanayi Odası, TOBB ve Esnaf ve Sanatkârlar Odası olarak sıralanabilir. Her iki firmanın yıllık toplam kavurma üretimi 816 ton ve günlük ciro ise 85.000 TL olarak hesaplanmıştır. İşletmeler et tedarikini, sözleşmeli çiftçilerden ve işletmelerin kendi çiftliğinde yetiştirdikleri hayvanlardan sağladıkları belirlenmiştir. Kavurma için kesilen hayvanlar bölgede özellikle meşe ağacıyla beslenen hayvanlardan seçilmiştir. Seçilen hayvanların hem cinslerinin uyumu hem de yaşları oldukça önem arz etmektedir. Kavurma için tercih edilen hayvanlar; oğlak (2-2,5 yaş), Çepiç (1 yaşına kadar), dana (1-2,5 yaş), kuzu (1-2 yaş), sığır (5-6 yaş) olarak sıralanabilir.
**Anahtar Kelimeler**: Soğuk çeşme, kavurma, Bingöl

# ANALYSIS OF THE PROCESSED LOCAL FOOD PRODUCTS MARKET: THE EXAMPLE OF BINGÖL SOGUK ÇESME ROAST

**Abstract**

The source of the research is primary data. In this sense, data was obtained by conducting a survey with the managers of two roasting businesses located in the Central district of Bingöl province. In this study, two important main companies of the roasting industry in Bingöl province were interviewed. Therefore, the survey studies were completed with the full count method. In the survey, company identity, history of Cold Fountain Roasting, meat supply methods, roasting preparation stages, and marketing strategies of the companies were discussed. Therefore, the information obtained from the survey and interviews was blended and interpreted. In the study, scientific studies, books, magazines and other media related to the subject were also used. There are two companies producing Cold Fountain Roast. It can be said that the companies operate in a total of 6 branches in Bingöl center and districts. It has been determined that although companies have websites, they do not use them effectively. It has been determined that both companies producing cold fountain roasting provide a total of 85 permanent jobs. The organizations of which both companies are members include the Chamber of Commerce and Industry, TOBB and the Chamber of Tradesmen and Craftsmen. The total annual roasting production of both companies is calculated as 816 tons and the daily turnover is 85,000 TL. It has been determined that businesses supply meat from contracted farmers and from animals raised on their own farms. Animals slaughtered for roasting were selected from animals that feed on oak trees in the region. Both the breed compatibility and the age of the selected animals are very important. Preferred animals for roasting are; They can be listed as kid (2-2.5 years old), Çepiç (up to 1 year old), calf (1-2.5 years old), lamb (1-2 years old), cattle (5-6 years old).

**Keywords**: Cold fountain, roasting, Bingöl

## GİRİŞ

İnsanoğlunun yaşamını idame ettirebilmesi için temel besin ihtiyacı olan yeme ihtiyacını karşılayabilmesi gerekmektedir. Bu yüzdendir ki gıda uygulamaları insanoğlu için vazgeçilmez bir unsurdur. Yemek geleneği ile toplumun sosyo-kültürel ve ekonomik durumunu, tarihsel kimliğini, yeme-içme alışkanlıklarını, damak zevkini, tarım üretimine göre şekillenmiş mutfağını da içine alan kendine özgü kültürel bir yapıyı ifade etmektedir (Irmak, 2019; Uzel, 2018).

Birçok medeniyete ev sahipliği yapmış olan Anadolu oldukça zengin ve kendine özgün bir gıda çeşitliliğine sahiptir. Böylelikle Anadolu yemek kültürünü yansıtan geleneksel gıdalar içerisinde yer alan et ve et ürünleri bu çeşitliliğe önemli bir katkı sağlamaktadır. Bu da Anadolu toplumlarının mutfak kültürüne ne kadar önem verdiğini bize göstermektedir. Sucuk, pastırma, döner, kokoreç ve kavurma gibi ürünler ekonomik öneme sahip Anadolu et ürünleridir. (Kaynakçı ve Kılıç, 2009). Söz konusu bu yeme içme kültüründen dolayı Türkiye'de kırmızı ete olan rağbet gün geçtikçe arttığı söylenebilir.

Geleneksel gıdalar veya yerel gıdalar, üretildiği bölgenin tanıtılmasında ve kalkınmasında büyük bir önem arz etmektedir. Dünyada son zamanlarda kırsal kalkınma ve yerel kalkınma için işlenmiş yöresel ürünlerin markalaştırılarak üretilmesi ile yatırım olanakları yaratılabilmektedir (Koç ve Ark., 2012). Dolayısıyla yöresel gıdalar normal sıradan gıdalar değil katma değeri yüksek olan ve istihdam yaratan, kendisiyle birlikte diğer farklı örneğin ambalaj, turizm gibi sektörleri harekete geçiren ürünlerdir.

Gıdalardaki yenilikler veya mevcut gıda ürünlerindeki değişiklikler gıda pazarlarında kendini gösterdiği söylenebilir. Buna göre bu yenilik ve değişiklikler, kendini gıda maddelerinin yeni kombinasyonları, yeni üretim yöntemleri veya yeni ambalaj olarak göstermektedir. Yeniliğin böyle güçlü bir merkez olduğu bir dönemde, geleneksel gıda ürünleri (GGÜ) "garip adam" olarak görülebilir (koç, 2012; Vanhonacker ve ark., 2010). Ancak işlenmiş yöresel gıdalar yerel kalkınmanın birer itici gücü olduğu söylenebilir.

Tüketiciler yerel gıdaların tüketimi ve bu gıdaların üretimi konusunda özellikle iç turizm faaliyetlerinde giderek daha fazla ilgi duydukları söylenebilir (Pearson and at all, 2011). Son yıllarda tüketicilerin artık gıda tüketimi konusunda daha seçici davrandıkları belirlenmiştir. Bu durum bireylerin sağlıklı ve doğal beslenmeye ilişkin bilgi düzeylerinin artması ve yerelleşme eğilimindeki artış ile açıklanabilir (Taşdan vd., 2014). Tüketiciler yerel işlenmiş gıdaları hem daha lezzetli, hem de daha taze yüksek gıda güvenliği ve ayrıca azaltılmış çevresel etkiler gibi

ürün ve süreç kalitesi açısından faydaları nedeniyle genellikle olumlu bir şekilde algılamaktadır (Jensen et al., 2019). Tüketiciler gıda satın alma tercihlerinde bulunurken gıda ürünleri etiketlerinde en çok pişirme, yapılış tarifi, saklama ve muhafaza koşulları bilgilerine önem verdikleri (Koç ve Ceylan, 2012) ve sadece kalite garantisi olan gıda ürünlerini yani tanınan ve markalaşmış ürünleri tercih ettikleri belirlenmiştir (Koç ve Ceylan, 2009). Uluslararası pazarlarda olduğu gibi, yerli tüketicilerin de yeni tatlar, ürün çeşitliliği, güvenli gıda, daha az işlenmiş ve daha az katkı içeren gıdalar talep ettikleri (Demirbaş vd., 2006) düşünüldüğünde, bu alt sektörün ve geleneksel gıda ürünlerinin önemi ortaya çıkmaktadır. Yerel yemek, ulusal, bölgesel ve kişisel kimliği ifade eder ve bir destinasyonun imajını geliştirebilme potansiyeline sahip olduğu düşünülebilir (Choe ve Kim, 2018).

Bu noktada yerel ürünler, kırsal ekonomiyi canlandırmanın bir aracı olarak görülmeye başlanmış ve aynı zamanda kırsal kalkınma stratejilerinin önemli bir parçası olmaya başlamıştır (Neill, 2014). Bu nedenle, yerel gıda sistemlerine odaklanmak, yerel ekonomiye katkıları arttırırken aynı zamanda sürdürülebilir bir yaklaşım olarak kabul edilmektedir. Yerel gıda sistemleri ve sürdürülebilirlik arasındaki ilişkilerin niteliği, yerel olarak büyümenin kimyasal, enerji ve tarım uygulamaları açısından daha sürdürülebilir sonuçlar doğurması olasıdır. Daha iyi bir çevre ve daha sağlıklı yiyecek 'yerel' ürünlere atfedilen birçok fayda bulunduğunu öne sürmektedir (Roy et al., 2017).

Bölgesel kalkınma politikaları aracılığıyla yöresel gıda ürünlerinin ön plana çıkarılmasında bölgelerarası ekonomik dengelerin korunması amacı güdülmektedir. Bu doğrultuda hem üreticiyi hem tüketiciyi düşünen “coğrafi işaret” kavramı ortaya çıkmıştır. Coğrafi işaret; Belirgin bir niteliği, diğerlerinden ayırt edici özelliği, ünü veya herhangi bir spesifik özelliği itibariyle kökenin bulunduğu bir yöre, alan, bölge veya ülke ile bütünleşmiş bir ürünü gösteren benzerlerinden farklı olarak sahip olduğu kalite, tanınırlık ve diğer karakteristik özelliklerini ait olduğu coğrafi bölgeye atfeden, ürünün menşei bölge ile ilişkisini ve standartlarını ortaya koyan genel bir tanımlamadır. Başka bir ifadeyle yöreye özgü yiyecekleri koruyan bir tescil sistemidir. (TPE, 2022).

Yöresel ürünlerde Coğrafi ortam özelliklerinin ortaya çıkardığı ürün zenginliğinin coğrafi işaret yoluyla korunması, dünya ticaretinde yaşanan gelişmelere bağlı olarak giderek önem kazanmıştır. Özellikle bu ürünler, yöre halkının geliştirdiği mutfak teknikleri, kültürel gelenekleri ve bölgenin sahip olduğu tarımsal ürün çeşitliliği içerisinde inşa edilen kalitesiyle, yerel kaynakların kullanılarak üretildiği, sosyal ve ekonomik etkileşimlerin bir sonucu olarak ortaya çıkmıştır (Sgroi, 2021: 2). Ürünlerin coğrafi işaret ile korunmasının sağladığı avantajlar;

üreticilere koruma sağlaması, pazarlama olanaklarını arttırması ve ekonomik getiri sağlayarak kırsal kalkınmayı desteklemesi şeklindedir (Gökovalı, 2007).

Türkiye geleneksel ürün adedi ve çeşitliliği açısından zengin bir potansiyele sahiptir. Türkiye'deki coğrafi tescille korunmaya alınmış yöresel gıda ürünleri ve yöresel ürün zenginliği birlikte değerlendirildiğinde, ülke ekonomisi için önemli bir üretim potansiyelinin varlığı ortaya çıkmaktadır. 2 bin 500'ün üzerinde tescil alabilecek ürün bulunduğu halde sadece 932 ürünün coğrafi işareti bulunmaktadır. Coğrafi işaretli ürünlerden beklenen ekonomik ve sosyal katkıların sağlanması için uluslararası geçerliliği olan coğrafi işaretli ürün sayısının artırılması gerekmektedir. Potansiyel ürünlerin coğrafi işaret alması istihdam ve katma değer yaratmasının yanı sıra üretim bölgelerinde üretimin sürdürülebilirliğine de katkılar sağlayabilmektedir. (Demirbaş vd., 2018) Yaratılan katma değer ise kır ve kent arasındaki gelir farkının kapanması ve bölgeler arasındaki gelir dağılımı üzerinde olumlu etkileri nedeniyle önemlidir. Bizim üzerinde duracağımız konu olan kavurma çok eski tarihten beri yapılan bir Anadolu kültürüdür. Eskiden beri süregelen kavurma geleneği, Orta Asya'da sonbaharda kesilen hayvan eti küçük parçalar halinde doğranarak yağı ile birlikte pişirildikten sonra küplere doldurulup kış için saklanırdı. Bu uygulamaya kavurma denmektedir (Baysal, 1990: 28).Osmanlı sarayında yemeklerin hemen hepsinin kavurma ile yapıldığı kaynaklarda yer almaktadır.(Sarı, 1982).Kavurma Anadolu'da uzun yıllardır tanınmakta ve hala önemli bir yer tutmaktadır.

Anadolu'da hala devam eden bu gelenek kıyma veya kuşbaşı olarak hazırlanan et kızartıldıktan sonra yağı ile birlikte kaplara dökülüp, dondurulur. Siirt yöresinde kavurmaya tuz da eklenir. Isparta yöresinde et makinesinden çekilen et, tuzlanır ve tavada kızartılır. İçerisine eritilmiş iç yağı (donyağı) katılarak sahan veya tencerelere dökülerek dondurulur. Bu şekilde elde edilen kavurmaya "sızma" denir. Isparta Uluborlu'da kap içerisinde dondurulmuş olan kavurma una gömülerek saklanır.(Koşay ve Ülkücan, 1961: 23-24). Bingöl yöresinde kar yağmadan hemen önce kış için hazırlanan kavurma, etin kemikleriyle birlikte kendi yağı ayırt edilmeden içine sadece çok az su ilave edilerek ek olarak kuyruk yağı eklenip, pişmeden hemen önce tuz konulup büyük toprak çanaklarda muhafaza edilip daha sonra bir kısmı kış mevsimi için ahşaptan yapılan ambar denilen güneş ışığının etki etmediği ve soğukluk hissi uyandırılan kapalı ortamlarda muhafaza edilen kavurma türü olarak ifade edilir. Anadolu'da gıda teknolojisi ve muhafazası eskisi kadar gelişmiş değilken et ürünü daha çok kış aylarında et ürünleri ihtiyacını karşılamak için üretilmiştir. Et ve et ürünlerinin korunmasına yönelik yöntemler,

ürünler bozulmadan veya minimum kalite kaybıyla daha uzun süre saklanabildiği ortaya konulmuştur.

İnsanlar yaşadıkları coğrafik şartlara ve ekonomik yapılarına göre mutfak kültürlerini oluşturmaktadırlar. Öyle ki Soğuk Çeşme Kavurmanın yapıldığı bu bölge özellikle kendi hayvan türlerine has yetişme alanı olan özellikle meşe ağaçlarından beslenen hayvanların bu coğrafyaya uygun olması münasebetiyle burada yetiştirilmesi etin kalitesi açısından oldukça mühimdir. Coğrafi işaret alan bu bölgeye-yöreye has olan ve bu yörenin kalkınmasında büyük bir ekonomik rol alan Çobantaşı Soğuk Çeşme Kavurma ile ilgili daha önceden yapılmış herhangi bir akademik çalışma bulunmadığından dolayı bu konu üzerinde durulmak istenmiştir.

Çobantaşı Soğuk Çeşme Kavurma: Sadece kırmızı et olması yeterli olmayan özel hayvan türlerinden yapılan (oğlak/çepiç, dana, sığır, kuzu) ve bu hayvanların özel yetişme bölgesi olan Doğu Anadolu Bölgesinde yer alan meşe ağaçlarından beslenen hayvan etleri olması sebebiyle çok nadir yetişen ve hayvanların doğduktan hemen sonraki yaşam alanından başlanıp yeme içmelerine kadar özel beslenen hayvanların, mezbahadaki kesiminden pişirilip paketlenmesine kadar geçen tüm süreci kapsamaktadır. Bu yüzden Soğuk Çeşme Kavurma Bingöl için önemli bir yere sahiptir. Ancak Bingöl için bu kadar önemli olan bu gelenek üzerinde daha önceden herhangi bir çalışma yapılmaması bu konuya oldukça ehemmiyet verilmesi gerektiğini tekrar gözler önüne sermiştir Günümüze kadar kavurma üzerinde yapılan çalışmalarda hemen hemen tamamının sığır ve koyun eti kullanılmış olduğunu görmekteyiz. Fakat bizim yaptığımız bu çalışmada ise özellikle bilinmesi gereken Soğuk Çeşme Kavurmanın farklı hayvan türlerinden nasıl elde edildiği ile ilgili bir çalışma olmasıdır. Bu çalışmanın ana amacı, coğrafi işareti olan yöresel gıda ürünlerinin yerel kalkınmaya (kırsal kalkınmaya) katkısını, Bingöl'ün ekonomisine ve kalkınmasına kayda değer etkileri ve yerel yansımaları olacağını düşündüğümüz bu çalışmanın ne gibi yankılar uyandıracağını, geleneksel bilgileri ve kültürel değerleri korumak adına bu akademik çalışma nihayetinde yapılan anketlerimiz sayesinde rahatlıkla varabileceğimiz bir argüman olması açısından önem arz etmektedir.

## 2.MATERYAL VE YÖNTEM

Araştırmanın kaynağını birincil veriler oluşturmaktadır. Bu anlamda Bingöl ilinin Merkez ilçesinde yer alan iki adet kavurma işletmesinin yöneticisiyle anket yapmak suretiyle veriler elde edilmiştir. Bu çalışmada Bingöl ilinde kavurma sektörünün iki önemli ana firmasıyla görüşülmüştür. Dolayısıyla tam sayım yöntemiyle anket çalışmaları tamamlanmıştır. Ankette

firma kimliği, soğuk çeşme Kavurmasının tarihçesi, et tedarik yöntemleri, kavurmanın hazırlanma aşamaları, firmaların pazarlama stratejileri ele alınmıştır. Dolayısıyla anket ve görüşmelerden elde edilen bilgiler harmanlanarak yorumlanmıştır. Çalışmada ayrıca konu ile ilgili olan bilimsel çalışmalar, kitaplar, dergiler ve diğer basın yayın organlarından da yararlanılmıştır.

## 3.ARAŞTIRMA BULGULARI

### 3.1. Soğuk Çeşme Kavurması Üreten İşletmelerin Kimliği

Soğuk Çeşme Kavurması üreten iki adet firma bulunmaktadır. Firmaların Bingöl merkez ve ilçelerinde olmak üzere toplamda 6 adet şubede faaliyet gösterdikleri söylenebilir. Firmaların web siteleri bulunmakla birlikte etkin bir şekilde kullanmadıkları belirlenmiştir. Soğuk çeşme kavurması üreten her iki firma toplamda 85 adet daimi istihdam sağladıkları belirlenmiştir. Her iki firmanın üye olduğu kuruluşlar, Ticaret ve Sanayi Odası, TOBB ve Esnaf ve Sanatkârlar Odası olarak sıralanabilir. Her iki firmanın yıllık toplam kavurma üretimi 816 ton ve günlük ciro ise 85.000 TL olarak hesaplanmıştır.

### 3.2. Soğuk Çeşme Kavurma İşletmesinin Tarihçesi

Soğuk Çeşme Kavurma firması 1963 yılında gayri resmi olarak kurulmuş olup, 1967 yılında ise ruhsatı alınmıştır. Cuma Kutan Soğuk Çeşme Kavurma ise 1965 yılında kurulmuştur.

#### 3.2.1.Çobantaşı Soğuk Çeşme Kavurma İşletmesinin Kuruluş Yeri Seçimi

1963 yılında Doğan Koç'un babası olan Aziz Koç tarafından Bingöl-Erzurum yolu üzeri 29. km'de alt katı lokanta üst katı ise dinlenmek için otel olarak restore edilmiştir. Aziz Koç işletmesini Diyarbakır-Bingöl-Erzurum yollarının kesiştiği yer olan Karlıova yolunun şehirlerarası önemli bir güzergâhı üzerinde kurmuştur. Yol güzergâhında uzun yol şoförlerinin hem dinlenip yatabileceği bir otel hem de alt katının yemek için lokanta olarak restore etmiştir. 1978 yılında yaşanan sel felaketinden dolayı sadece taştan ve topraktan yapılan eski iki katlı yeri yıkıp yerine şuan hala mevcut olan Karlıova yolu üzerindeki Soğuk Çeşme Kavurma işletmesi yeniden inşa edilmiştir. İşletmenin ilk kurulan yerinde sadece Tepsi Tava menüsü yer almıştır. Daha sonra menüye; kuru fasulye, fırın ağzı, tas kebabı, kaburga tava gibi yemekler

menüye dâhil edilmiştir. İlk etaplarda kavurma menüde yer almamıştır. 1963-1983 dönemine kadar kurucu yönetici olarak Aziz Koç tarafından firmanın işletmeciliği sürdürülmüştür. 1983'ten sonra Doğan Koç 12 yaşındayken mücbir sebeplerden dolayı işletmenin başına geçmek durumunda kalmıştır. İşletme, 1983 yılından sonra kavurma ile ilgili ilk adımını atmıştır. Bölgenin yapısından dolayı (Hacılar- Çan- Bingöl) meşe ağaçlarının çokluğundan dolayı hayvan türlerinden daha çok keçi yetiştiriciliği yapılmıştır. İşletme de ilk defa oğlak etinden kavurma yapılmıştır. Bölgede oğlak etinden ilk defa kavurma yapılması eleştirilere neden olmuşsa da işletme bunlara göğüs germiştir. Dolayısıyla çepiç etinden yapılmış kavurma, diğer kavurmalardan lezzet ve kıvam bakımından farkını zamanla ortaya koymuştur. Böylece söz konusu lezzet günümüze kadar ününü sürdürmüştür. 2006 yılından itibaren yoğun talepten dolayı paketlemeye başlanıp kargolama sistemine geçilmiştir. 2014'ten günümüze kadar kavurma paketleme işinde 50 kişinin istihdamı sağlanmıştır. 1990-2002 döneminde bölgedeki güvenlik problemleri nedeniyle işletme yarım kapasite ile çalışmıştır. 2018 yılında ise "Çobantaşı Soğuk Çeşme Kavurma" adı altında Coğrafi işaret alınmıştır.

### 3.2.2. Cuma Kutan Soğuk Çeşme Kavurma İşletmesinin Kuruluş Yeri Seçimi

1960 yılında Cuma Kutan tarafından Karlıova yolu üzerinde kurulmuştur. 1965 yılında ise resmi olarak kuruluşu sağlanmıştır. 1994 yılında ise oğlu olan şimdiki firma yöneticisi Serhat Kutan tarafından devralınmıştır. İşletme ilk olarak Karlıova yolu üzerinde toprak damlı bir esnaf lokantası olarak kurulmuştur. Karlıova yolu üzerinde kurulmasının sebebi önemli şehirlerin yol güzergâhı olmasıdır. Daha sonra işletme burayla sınırlı kalmayıp yeni şubeler açmıştır. Bingöl merkezde 1 adet şube daha açılmıştır. Merkezde şubeler açılmasının en önemli sebebi ise Karlıova yolu uzak geldiğinden müşteri kayıpları en aza indirgemeye çalışılmıştır. Daha sonra açılan şube ihtiyaca cevap vermediğinden 2020 yılında Binkap Otel Şubesi açılmıştır.

### 3.3. Soğuk Çeşme Kavurma İşletmelerinin Et Tedarik Durumu

İşletmeler et tedarikini, sözleşmeli çiftçilerden ve işletmelerin kendi çiftliğinde yetiştirdikleri hayvanlardan sağladıkları belirlenmiştir. Kavurma için kesilen hayvanlar bölgede özellikle meşe ağacıyla beslenen hayvanlardan seçilmiştir. Seçilen hayvanların hem cinslerinin

uyumu hem de yaşları oldukça önem arz etmektedir. Tercih edilen hayvanların yaşları iki işletme için de şu şekilde sıralanabilir:

Çobantaşı Soğuk Çeşme Kavurma İşletmesinde Tercih edilen hayvan özellikleri;

Oğlak:2-2,5 yaş aralığı,

Çepiç 1 yaşına kadar

Dana:1- 2,5 yaş aralığı

Kuzu:1-2 yaş aralığı

Sığır: 5-6 yaş aralığı

Cuma Kutan Soğuk Çeşme Kavurma İşletmesinde ise 1,5 yaşına kadar olan Oğlaklar ve 2 yaşındaki Sığırlar tercih edildiği belirlenmiştir.

Ayrıca işletmelerin kendi bünyelerinde barındırdıkları hayvanları da mevcuttur. Yıl içerisinde anlaştıkları tüccar tarafından hayvan tedarik edilememesi durumunda işletmeler kendilerini garantiye almak için bu hayvanlardan da faydalanmaktadırlar. İşletmelerin kavurma için hayvan tercihleri Bingöl'den başka Diyarbakır, Muş, Erzurum ve Tunceli illerinden de temin edilmektedir.

### 3.3.1. Soğuk Çeşme Kavurma İşletmelerinin Günlük Et Talebi

Bingöl merkez ilçesinde faaliyet gösteren soğuk çeşme kavurma işletmelerinin günlük et talepleri toplamda 1.200 kg'lık ette tekabül ettiği söylenebilir. Dolayısıyla günlük olarak 15 kuzu, 22 oğlak ve 3 dana olmak üzere canlı hayvan kesimi yapıldığı söylenebilir.

### 3.4.Soğuk Çeşme Kavurmasının Hazırlanma Aşaması

Soğuk Çeşme Kavurma işletmeleri kavurmalarını hazırlarken özellikle kendileri için olmazsa olmaz kriterlerine dikkat çekmişlerdir. Belki de bu yüzden soğuk çeşme kavurma adını diğer kavurma isimlerden ayırt etmek oldukça önem arz etmektedir. Et kesimleri taze olmakla birlikte pişirme esnasında ise günaşırı olmadan kullanılan etlerden kavurma yapımı için hazırlıklarını yapmışlardır. Özel hayvan türlerinden seçilen etlerin özel pişirme yöntemleriyle kendilerine has bir şekilde kendi markalarını oluşturdukları gözler önüne serilmiştir.

Soğuk Çeşme Kavurma işletmelerinde iki günde bir hayvan kesimleri yapılmaktadır. Kesilen bu etlerin soğuk depolarda 1 gün boyunca muhafaza edilip dinlendirildikten sonra doğranmaya başlanıp pişirilme işlemi gerçekleşmektedir. İşletme çalışanları etlerini doğrarken etin en ince

detaylarına kadar inip eti sinirlerinden ayırma işlemi yapmaktadırlar. Böylece Soğuk çeşme kavurmasının etinin yumuşak olması sağlanmaktadır. Bel kemiği ve kaburga kemiği dışında hiçbir kemik kavurmaya dâhil edilmemektedir. Hayvanın doğal yaşam alanı ve kesilen etin özel işlenişi soğuk çeşme kavurmasının olmazsa olmazları arasında olduğu söylenebilir. Hafta boyunca sürekli olarak taze et kesimleri sağlanmaktadır. Gündelik olarak bir gün önceden ham olan et dinlendirilerek pişirilip servis edilmektedir.

### 3.4.1. Soğuk Çeşme Kavurma İşletmelerinde Etlerin Muhafaza Yöntemleri

İşletme sahipleri etlerini muhafaza ederken soğuk depoları kullanmışlardır. Özellikle kavurma hazırlık aşamasında et kesildikten sonra en az 24 saat kavurma etinin dinlendirilmesi gerektiğinden muhafaza yöntemleri önem teşkil etmiştir. Çobantaşı Soğuk Çeşme Kavurma İşletmesinin 5 adet soğuk depoları olduğu tespit edilmiştir. Bu soğuk depolar 250 $m^2$ kapalı alana sahip oldukları belirlenmiştir. Cuma Kutan Soğuk Çeşme Kavurma İşletmesinin ise 3 şubesinin ayrı ayrı soğuk depoları mevcuttur. İşletmelerin soğuk depolarında et maksimum 1 hafta kalmaktadır. Doğrama, işleme, pişirme, paketleme dâhil en fazla tüm işlemler 1 hafta sürmektedir.

### 3.5.Soğuk Çeşme Kavurmasının Pazarlanma Stratejisi

Soğuk Çeşme Kavurma işletmelerinin yemek çeşitliliği farklılık göstermekle birlikte ayrıntılı bir şekilde şöyle sıralanabilir; Çobantaşı Soğuk Çeşme Kavurma İşletmesinin yemek çeşitliliği şu şekildedir; Kavurma, tepsi tava, paket kavurma ve Ilıcalar şubelerinde ise kendin pişir kendin ye şeklinde sıralanabilir. Cuma Kutan Soğuk Çeşme Kavurma İşletmesinin yemek çeşitliliği ise; kavurma dışında meşe odununda pişirilen sebzeli tepsi, kilo işi mangal, çorba, paket kavurma, kaburga pirzola gibi yemekler menülerinde yer almaktadır.

Soğuk Çeşme Kavurma işletmelerinin yöneticileri müşteri kitlelerine daha yakın ve daha güzel ortamlarda hizmet sunabilmek adına Bingöl merkez ilçede yeni şubeler açmışlardır. Ancak daha doğal ortamlarda ve şehir gürültüsünden uzak yerleri tercih eden müşterileri içinde farklı bir konseptle kendin pişir kendin ye sistemiyle çalışan mekân açmışlardır.

Ayrıca kavurma işletmeleri il dışından da sipariş almaktadırlar. Ancak il dışına dondurulmuş ve paketlenmiş kavurmalar müşterilerine ulaştırılmaktadır. Çobantaşı Soğuk Çeşme Kavurma işletmesinin 25 noktaya yakın bayii tipinde yerleri mevcuttur. Türkiye'nin 81 iline sipariş

göndermektedirler. 25 bayilik bulunan şehirler ise şu şekildedir: Batman, Van, Ankara, İstanbul, Bursa, Şanlıurfa, Erzurum, Diyarbakır, Elazığ, Malatya, Konya, Denizli, İzmir, Yalova, Muş, Siirt, Eskişehir ve Tekirdağ olarak sıralanabilir.

Soğuk Çeşme Kavurma İşletmeler toplu kavurma için hem kamu kurumları hem de özel sektöre toplu kavurma yemekleri verebilmektedirler. İşletmelerin müşterileriyle iletişime geçme yöntemleri arasında, yüz yüze görüşme yöntemiyle ve telefonla iletişim olarak sıralanabilir. Soğuk Çeşme Kavurma işletmelerinin yöneticilerine göre Soğuk Çeşme Kavurmasını farklı kılan faktörler arasında hizmetlerde yüksek kalite, profesyonel ekibe sahip olma, azami hijyen, kaliteli servis, zengin yemek menüsü, hijyen ve standartlara uygun yemek üretimi olarak ifade etmişlerdir. İşletme yöneticileri ayrıca işletmelerinin pazar ve pazarlama sıkıntısı çekmediğini belirtmişlerdir. İşletme yöneticileri işletmede bir yeniliğe karar verdiklerinde işletme çalışanlarının da görüşlerine başvurduklarını belirtmişlerdir.

İşletme yöneticileri gıda güvenliğine önem verdiklerini ve İşletmelerin depolarının bu anlamda güvenli ve hijyenik olduğunu ve sürekli denetim altında olduklarını söylemişlerdir. İşletmeleri için kontrol noktalarının satın alma ve teslim, depolama, hazırlık, pişirme, soğutma, sıcak tutma gibi aşamaların büyük önem taşıdığını ifade etmişlerdir. İşletme yöneticileri müşteri geri bildirimlerine çok önem verdiklerini müşterilerinin genelde dostlara–aile bireylerine söylemek, yönetime sözlü şikâyet şeklinde kendini gösterdiğini belirtmişlerdir. İşletme yöneticileri mutfağın havalandırmasını merkezi havalandırma, aspiratör veya fan ile sağladıklarını, hijyen denetimlerinin de Bingöl il Tarım ve Orman Müdürlüğü ekipleri tarafından ayda bir yapıldığını ifade etmişlerdir.

### 3.6. Soğuk Çeşme Kavurmasının Vizyonu

İşletmelerin geçen yıllardan bu yana müşteri beklentilerine uygun olarak yemek menülerinde değişiklikler yapılmış olup yemek içerikleri iyileştirilip aynı zamanda yemeklerin zamanında teslimatına önem verilmiştir. İşletme yöneticilerinin gelecekte büyümek için yapmayı düşündükleri faaliyetleri hem kaliteye daha çok önem vermek hem de web sitelerini geliştirerek Türkiye geneline aynı kalitede hizmet sağlamayı amaçlamışlardır. İşletme sahipleri gelecekte piyasada tutunmak ve güven teşkil eden bir firma olmak için internet kullanma sıklığını artırmak istemişlerdir. Mevcut bir web siteleri olmakla birlikte daha da geliştirmek istediklerini ifade etmişlerdir. İşletmelerin ihtiyaç duyulan ve gelecekte alınması planlanan eğitimleri; Sanitasyon, hijyen, Haccp, ve ISO- 9001 kalite yönetim sistemi olarak ifade edilmiştir.

## 4.SONUÇ VE ÖNERİLER

Türkiye'de son yıllarda kırsal kalkınma, yerel ekonomik kalkınma çalışmaları hız kazanmış olsa da yöresel ürünler açısından zengin olan ülkemizde ürünlere ayrıcalık sağlanmasında ve böylece ürünlerin kırsal ekonomiye katkılarının artırılmasında coğrafi işaretlerden yeterince faydalanılmadığı ortadadır. Coğrafi işaret sistemi yerel değerlerin sürdürülebilir korunmasında ve değerlendirilmesinde önemli bir sistemdir. (Kan ve Ark., 2012). Coğrafi işaretin bölgede en önemli etkisinin bölgenin ve ürünün tanıtım ve reklam konusunda olduğu belirtilmiştir. Fakat söz konusu olan Soğuk Çeşme Kavurması adlı yöresel ürünün ne yazık ki reklam ve tanıtım konusunda yeterli çalışmaları olmadığı görülmektedir. Yöresel gıdaların; pazarda daha fazla yer bulması ile istihdama, üretici ve satıcı gelirlerinde artışa katkıda bulunabileceği ortadadır. Günümüzde tüketiciler satın aldıkları ürün ve yiyeceklerin kültürel ve sağlık boyutlarına da ilgi göstermeye başlamışlar ve yöresel ürünlere olan ilgi artmaya başlamıştır. (Polat, 2017)

Türkiye gerek jeopolitik konumu gerek eski çağlardan beri çok sayıda medeniyete ev sahipliği yapmasından dolayı zengin bir kültürel mirasa sahiptir. Bu zengin kültürel miras ülkemizde birçok ilin mutfağının ve yöresel değerlerin çeşitlenmesini sağlamıştır (Doğan, 2015). Ülkemizin ılıman iklime sahip olması, bitkisel çeşitliliği sağladığı gibi hayvansal çeşitliliği de sağlamaktadır. Ülkenin doğusunda bulunan Bingöl ili geniş meraları ile hayvan otlatmak için önemli bir stratejik konuma sahiptir. Geniş alanlar sayesinde hayvan çeşitliliği de oldukça fazladır. Hayvansal üretimde özellikle yerel ırkların tercih edilmesi bölgede yetişen bitki çeşitliliği ile ilgili olup aynı zamanda yöredeki meşe ağaçlarının bolluğu ile alakalıdır.

Toplumların sahip olduğu kültürel miras içinde, yöresel yiyecek ve içecekler önemli yer tutmaktadır (Durlu-Özyaka ve diğerleri, 2013; Polat, 2017). Bingöl ili de yöresel yemek çeşitliliği bakımından önemli bir yere sahiptir. Bu coğrafyadaki mutfak kültürüyle bağlantılı olarak pişirilen et ve türevleri gün geçtikçe daha yerel şekillerde karşımıza çıkabilmektedir. Yerel olan hayvan ırklarının doğal beslenmesi sonucunda Soğuk Çeşme Kavurmasının lezzeti ve kendine has özellikleri ön plana çıkmaktadır. Coğrafi işaret alınarak korunan bu yöresel ürünün kırsal kalkınmadaki önemli ekonomik katkısı düşünülerek devamlılığı sürdürülmektedir. Geleneksel gıda yöntemlerinden biri olan Bingöl Soğuk Çeşme Kavurmasının şimdiye kadar üzerinde herhangi bir çalışma olmaması, bu konunun ehemmiyeti üzerinde durulması gerektiğini göstermektedir. Bu konunun araştırılarak Bingöl ekonomisine kayda değer yankılar uyandıracağını düşündüğümüz Soğuk Çeşme Kavurmasının orta ve uzun vadede insanımızın faydasına olacak sonuçlar getirmesini temenni ediyoruz. Böylece bu

çalışma sonucunda geleneksel gıdaların yeniliğin güçlü olduğu bu dönemde 'garip adam' olarak görünmekten çıkıp aksine daha çok değer verilmesi ve üzerinde yoğunlaşması gerekilen bir sonuç ortaya çıkarmıştır.

Bingöl ilinin sahip olduğu bu, coğrafi işaretli Soğuk Çeşme Kavurma ürününün bölgeye tanıtılmasında etkin rol oynayabilmesi için kamu, özel sektör ve yerel yönetimler için geliştirilen öneriler şöyle ifade edilecek olursa;

- Basın yayın organları ve sosyal medya kullanılarak coğrafi işaret almış bu yemeklerin tanıtımları gerçekleştirilebilir.
- Coğrafi işarete sahip olan Soğuk Çeşme Kavurmasının, üzerinde bu ürünün geleneksel özeliklerini anlatan tanıtımların bulunduğu özel ambalajlar ile paketlenmelidir. Ayrıca bu ambalajların üzerinde Bingöl ilindeki diğer kültürel çekiciliklerin de resimlerine yer verilebilir.
- Bölgeye gelenler seyahatlerinde o bölgeyi kendisine anımsatacak, yöreyle özdeşlemiş ürünleri satın almak isteyeceklerinden, coğrafi işarete sahip olan Soğuk Çeşme Kavurmasının küçük minyatürleri ve magnetleri yapılarak, hediyelik eşya satan dükkânlarda satışları gerçekleştirilebilir.
- Bingöl'de ili ziyaret edenlerin Soğuk Çeşme Kavurma ürününü kolaylıkla satın almasını sağlamak için satış ofisleri açılabilir.
- Bingöl tanıtım günlerinde coğrafi işaret almış Soğuk Çeşme Kavurmayı ön plana çıkartacak afişlere ve reklam panolarına yer verilmelidir.
- Soğuk Çeşme Kavurma yapımında kullanılan et için köyde hayvancılıkla geçinenlerin sıkıntıları dinlenip hayvancılıkla uğraşanlara hayvan yetiştirmeleri için gerekli destekler sağlanabilir. Bu şekilde Soğuk Çeşme Kavurmasının kendine has özellikleriyle sürekliliği sağlanabilir. Günümüzdeki kırsal nüfusun azalmasına bağlı olarak gün geçtikçe azalan hayvan yetiştiriciliğinin artırılması sağlanabilir, böylelikle gelecek kuşaklara da Soğuk Çeşme Kavurmasının geleneksel ve orijinal hali aktarılabilir.

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