TÜRKİYE YÜZYILI

TÜRKİYE CUMHURİYETİ'NİN YÜZÜNCÜ YILI

33rd International Scientific - Expert Conference of Agriculture and Food Industry

13-15 November 2023

Pine Bay Holiday Resort Hotel, **KUSADASI-AYDIN**

PROCEEDINGS BOOK

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33RD INTERNATIONAL SCIENTIFIC – EXPERT CONFERENCE OF AGRICULTURE AND FOOD INDUSTRY

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Dear Colleague,

We are delighted to extend our warmest invitation to you for the esteemed 33rd International Scientific-Expert Conference of Agriculture and Food Industry, scheduled to take place from 13 – 15 November 2023 in Kusadasi/İzmir, TÜRKİYE.

Your participation in the 33rd International Scientific - Expert Conference of Agriculture and Food Industry will not only provide significant value to the attendees but also offer you an exceptional platform to connect with fellow researchers and professionals, initiate collaborative projects, and broaden your academic and professional network.

We welcome you to "33rd International Scientific-Expert Conference of Agriculture and Food Industry" and hope you will have great time.

Warm regards,

On the behalf of Organization Comittee

Prof. Dr. Banu YÜCEL

President of the Conference

AGRIFOOD2023 CONFERENCE PROGRAM

13.11.2023

*Presentations will be 10 min + 3 min discussion

09.30 - 10.30	REGISTRATION	
10.30 - 12.00	OPENING CEREMONY **Prof. Dr. Banu Yücel** **Prof. Dr. Muhamed Brka**	
12.00 - 13.00	LUNCH BREAK	
13.00 – 14.00	**1st SESSION** **Chair: Prof. Dr. Jasmin Grahic**	
OP1	Determination of Volatile Chemicals from the Host Plants for Sesamia nonagrioides (Lef) (Lepidoptera Noctuidae)	**Erkan Yılmaz,** Oğuzhan Gürdal, Mustafa Hakan Balcı, Firdevs Ersin, Merve Çınar, Nergis İlayda Özkan, Uluç Yarkın Sipahi, Levent Pelit, Ferit Turanlı
OP2	Determination of Amplitude Potential in the Antenna of Sesamia nonagrioides (Lef) (Lepidoptera Noctuidae) in Electroantennography	**Erkan Yılmaz,** Mustafa Hakan Balcı, Firdevs Ersin, Ferit Turanlı
OP3	Amplitude Value of Bactrocera oleae (Rossi) (Diptera: Tephritidae) Antenna in Response in Electroantennography	**Mustafa Hakan Balcı,** Erkan Yılmaz, Firdevs Ersin, Ferit Turanlı
OP4	A New Approach to Control Vine Mealybug Planococcus ficus (Signoret, 1875) (Hemiptera: Pseudococcidae), in Aegean Region Vineyard Areas: Mating Disruption Method	**Neşe Keskin,** Ferit Turanlı
14.00 - 14.20	COFFEE BREAK	
14.20 – 15.00	**2nd SESSION** **Chair: Prof. Dr. Özer Hakan Bayraktar**	
OP5	DETERMINATION OF PVY RESISTANCE IN TOMATO PLANTS	**Nihan Güneş,** Mustafa Gümüş

OP6	Biological Identifiation of Cucumber mosaic virus (CMV) Isolated from Tomato and Pepper Fields in Izmir	**Nihan GÜNEŞ,** Sachin Sharma, Mustafa GÜMÜŞ
OP7	Investigation of the Effects of Beneficial Bacteria on Drought Stress and Clavibacter michiganensis subsp. michiganensis in Tomatoes	**Utku ŞANVER,** Barış Can ARDA, Hatice ÖZAKTAN
15.00 - 15.20	COFFEE BREAK	
15.20 – 16.00	**3rd SESSION Chair: Prof. Dr. Sezai Delibacak**	
OP8	Determination Of Population Dynamics of Sucking Insect Pests On Some Maize Genotypes	**SENA KOPARAN,** FERİT TURANLI, ERKAN YILMAZ, HÜLYA OKKAOĞLU, ERGÜL AY, MELEK AKÇA PELEN
OP9	Identification of Entomopathogenic Nematodes in Citrus Orchards in İzmir Province	**Esmeray Ayhan,** Galip KAŞKAVALCI
OP10	Current Situation of The Citrus Longhorned Beetle, Anoplophora chinensis Forster (Coleoptera: Cerambycidae) in Türkiye	**Ebru GÜMÜŞ MİNNETOĞLU,** Ferit TURANLI
14.11.2023		
*Presentations will be 10 min + 3 min discussion		
10.00 – 10.40	**4th SESSION Chair: Prof. Dr. Almir Toraman**	
OP11	Heat Resistant Microfungi Samples from Humulus lupulus L. (Hops) Agricultural Area	**Rasime DEMİREL**
OP12	Determination of Reactions of Pistachio Rootstocks to Some Important Soil Pathogens	**Mehmet Hadi AYDIN**, Tuba Uzun, Yusuf AYDIN, Behcet İNAL, Berrin KAYALAR
OP13	Determination of The Effectiveness of Some Fungicides Against Root Rot and Wilt Diseases In Pistachio.	**Mehmet Hadi AYDIN,** Tuba UZUN, Behcet İNAL,

		Yusuf AYDIN, Berrin KAYALAR
10.40 – 10.55	COFFEE BREAK	
10.55 – 11.35	**5th SESSION** **Chair: Doç. Dr. Hadi Aydın**	
OP14	Mutation Studies in Field Crops	**Özlem AKBAŞ,** Aliye YILDIRIM KESKİNOĞLU, Emre İLKER
OP15	Use of DNA-Based Molecular Markers in Plant Breeding	**Sabahat SHABBIR,** İsmail KARAKAŞ, Deniz İŞTİPLİLER, Fatma AYKUT TONK
OP16	Phenotypic Characterization of 130675/Avocet S Double Haploid Population of Wheat Against Yellow Rust at the Adult Plant Stage	**Sabahat Shabbir,** Özge Nur Zülfüağaoğlu, Fatma Aykut Tonk, Kumarse Nazari
11.35 – 11.50	COFFEE BREAK	
11.50 – 12.30	**6th SESSION** **Chair: Jasmina Tahmaz**	
OP17	Determination of Adaptation Abilities of Camelina (*Camelina sativa* L. Crantz) Genotypes of Different Origins in Ödemiş Ecological Conditions	**Hakan YILDIZ**
OP18	DETERMINATION OF FORAGE YIELD AND SOME YIELD CHARACTERISTICS IN DIFFERENT CEREAL-FORAGE PEA (Pisum sativum L.) MIXTURES	**Behçet Kır,** Dunya Isayeva, Şükrü Sezgi Özkan
OP19	Effect of Salt Stress on Stomatal Conductivity in 20 Different Cotton Genotypes	**Tülay EMREBAŞ**
OP29	HoeBot: Autonomous Hoeing for Sustainable Agriculture	**Omer Ertugrul,** Dilara Gerdan Koç, Emrah Saka, Caner Koç
12.40-14.30	LUNCH BREAK	
14.30 – 14.45	COMPANY PRESENTATION 1 (SYNGENTA)	
14.45 - 15.00	COMPANY PRESENTATION 2 (POLEN TOHUMCULUK)	

15.00 – 17.00	POSTER SESSION	
15.11.2023		
*Presentations will be 10 min + 3 min discussion		
10.00 – 10.50	**7th SESSION** **Chair: Munevera Begic**	
OP20	Blockchain-Based Livestock Management: Improving Efficiency and Accuracy	**Muamer Pekmez**, Sabahudin Tahmaz
OP21	OPPORTUNITIES OF USING PROPOLIS IN THE TREATMENT OF MASTITIS IN DAIRY ANIMALS	**Ekin VAROL,** Çağrı KANDEMİR, Turgay TAŞKIN, Banu YÜCEL
OP22	Greenhouse Gas Emissions Mitigation Strategies for Manure Management in Dairy Cattle Farms	**Esin Deri,** Halil Baki Ünal
OP30	Seasonal Impact of Harvesting on the Freshness and Quality of Gilthead Seabream Meat (Sparus aurata Linnaeus, 1758)	**Dino Lepera** **Samir** Muhamedagic
10.50 – 11.00	COFFEE BREAK	
11.00 – 11.40	**8th SESSION** **Chair: Emina Sijahovic**	
OP23	TESTING OF MICROBIOLOGICAL CONTAMINATION OF FRESH LETTUCE (Lactuca sativa L.)	**Enver Karahmet**, Senita Isaković, Muamer Bezdrob, Nermin Rakita, Saud Hamidović, Almir Toroman
OP24	Use of Citrus Fiber and Whey Protein Isolate Complex in Oleogel Fabrication and Application in Cookie Formulation as Palm Oil Alternative	**Ezgi Genç Yılmaz,** Salih Karasu, Alican Akçiçek, Ömer Said Toker

OP25	Determination of Plant Nutrient Element Composition of Olive Fruit According to Zeolite Doses	**Bihter Çolak Esetlili,** Neriman Tuba Barlas
11.40 – 11.50	COFFEE BREAK	
11.50 – 12.30	**9th SESSION** **Chair: Prof. Dr. Behçet Kır**	
OP26	Using Fuzzy Logic Applications in Land Reallocation	**Safiye Pınar TUNALI**, Selin AKÇAY, Necdet DAĞDELEN, Talih GÜRBÜZ
OP27	Industrial Plantations in Turkey and the Example of Poplar Trees (Populus)	**Ozlem Bozkurt**
OP28	Production Efficiency and Total Factor Productivity Growth in Turkish Agriculture	**Murside Cagla Ormeci Kart,** Görkem ÖRÜK, Sule ISIN
12.30	Closing Ceremony	

POSTER SESSION

Presentation Code	Title	Presenter
PP-01	Organic Food's Escalating Demand And Challenges For Public Health And Food Sustainability in Vietnam	Tai Diep
PP-02	Testing Preferences Of Fish And Fish Products Consummation Of Bosnia And Herzegovina Consumers	Enver Karahmet
PP-03	The Use Of Pyrophyllite And Zeolite For The Purpose Of Remediation Of Soil Contaminated With Heavy Metals in Maglaj	Emina Sijahović
PP-04	The Influence Of Natural Antioxidans On The Quality And Stability Of Animal Fats During Storage	Munevera Begić
PP-05	Determination Of The Effectiveness Of Alternative Control Methods To Vine Mealybug *Planococcus ficus* (Signoret, 1875) (Hemiptera: Pseudococcidae) in The Vineyard Areas Of Aegean Region	Neşe Keskin
PP-06	Determination Of The Effectiveness Of Traditional Control Methods To Vine Mealybug *Planococcus ficus* (Signoret, 1875) (Hemiptera: Pseudococcidae) in The Vineyard Areas Of Aegean Region	Neşe Keskin
PP-07	Physical Properties Of Experimentally Produced Tomato Sauces And Commercial Tomato Products	Jasmina Tahmaz
PP-08	Examination Of Lipolytic And Oxidative Changes During The Production Of Beef Prosciutto	Munevera Begić
PP-09	The Effect Of Antioxidants On The Quality And Stability Of Palm Oil	Selma Čorbo
PP-10	Development And Production Of Caffeine-Free Coffee Substitute: Date Seed Extract	Tuğba Bolluk

ABSTRACT PROCEEDINGS

CONTENTS

OP-01 Determination Of Volatile Chemicals From The Host Plants For *Sesamia nonagrioides* (Lef) (Lepidoptera Noctuidae)

Erkan Yılmaz[1], Oğuzhan Gürdal[2], Mustafa Hakan Balcı[1], Firdevs Ersin[3], Merve Çınar[2], Nergis İlayda Özkan[2], Uluç Yarkın Sipahi[2], Levent Pelit[2], Ferit Turanlı[3]
1 Directorate Of Plant Protection Research Institute Bornova-İzmir/Türkiye
2 Ege University, Faculty Of Science, Department Of Chemistry, İzmir/Türkiye
3 Ege University, Faculty Of Agriculture, Department Of Plant Protection, İzmir/Türkiye

A number of volatile organic compounds (VOCs) are emitted into the environment through specific biochemical processes in plants. *Sesamia nonagrioides* (Lef) (Lepidoptera: Noctuidae) is a major pest of corn cultivation in the Mediterranean and North African countries. The pest determines the location of its host plant by following the chemicals released by corn cultivation and pearl millet plants, which are common in the region. The aim of this study is to develop an environmentally friendly method of controlling the pest, starting with identifying the common chemicals released by corn and pearl millet plants that are preferred by the pest. VOCs sampling was performed using a dynamic thermal desorption sampling system consisting of glass and plastic oven bags operated by a vacuum pump. Tenax TA thermal desorption sampling tubes, connected to the system outlet at a fixed air flow of 600 mL/min, were used to collect VOCs emitted by the isolated system from the external environment. Air was drawn into the system by a vacuum from the outside atmosphere. Before entering the system, this air was passed through an activated carbon filter to remove volatile compounds. Blank experiments were performed in the absence of the plant to detect background chemicals. Following the background studies, the plant was placed in the system and sampling was carried out using another thermal desorption tube. The experiments were conducted with four replicates and the sampling tubes were transfered to the chemistry laboratory for compound identification analysis on the same day. The chemicals adsorbed in the Tenax TA thermal desorption tubes were analysed using gas chromatography-mass spectrometry (GC-MS) coupled to a Markes thermal desorption system. Pure standards that had been reported in various studies on corn plants were purchased and the detected VOCs were confirmed by means of pure standards. Common chemicals released by both host plants were identified as Alpha-pinene, Myrcene, Limonene, Methyl Salicylate and Benzaldehyde.

Keywords: *Sesamia nonagrioides*, Zea mays, *Pennisetum glaucum*, Volatile Organic Compounds, Gas Chromatography, Thermal Desorption Tube, Active Sampling

OP-02 Determination Of Amplitude Potential In The Antenna Of *Sesamia nonagrioides* (Lef) (Lepidoptera Noctuidae) In Electroantennography

Erkan Yılmaz[1], Mustafa Hakan Balcı[1], Firdevs Ersin[2], Ferit Turanlı[2]
1 Directorate Of Plant Protection Research Institute Bornova-İzmir/türkiye
2 Ege University, Faculty Of Science, Department Of Chemistry, İzmir/türkiye

Insects primarily rely on their chemical senses to locate their hosts within the complex web of living species in their habitats, particularly nocturnal insects. Chemical cues released into the environment by the host, in the form of odor proteins (semiochemicals), enter the antenna sensilla and interact with odor-binding proteins. Following the detection of these proteins, a series of chemical reactions stimulate receptors, transmitting electrical signals to the central nervous system through neurons. The amplitude values of these signals were determined through electroantennography, involving either the use of the entire flagellum or single sensillum measurements. Insect antenna amplitude depends on factors such as insect age, time elapsed after antenna excision, and the concentration of the stimulating chemical. This research is currently underway to control mated female individuals of *Sesamia nonagrioides* (Lef) (Lepidoptera: Noctuidae), important pest of maize, using volatile chemicals from host plants during their search for hosts and egg-laying. In this study, the voltage generated in the insect antenna in response to volatile chemicals from the host plant was determined using electroantennography. To obtain standard and healthy data at the beginning of the study, the electrical amplitude potential of the *S. nonagrioides* antenna was determined. For this purpose, heptanal, a known chemical that elicits an electrical response in the antenna, was applied to the antennae of mated female individuals of the pest. The stimulating chemical was diluted with n-hexane to create concentrations of 25%, 10%, 1%, and 0.1%. These different solutions were applied to the antennae obtained from adult females aged 1, 2, and 3 days. To assess the effect of time on electrical potential, the antennae were exposed to the stimulus at 5, 30, 45, 60, and 90 minutes after antennal excision. The study revealed that 2-day-old mated female individuals of S. nonagrioides exhibited the maximum response to a 10% stimulus solution. Additionally, it was observed that the electrical potential in the antenna had significantly decreased 45 minutes after excision, to a level that could not be evaluated in the study.

Keywords: *Sesamia nonagrioides*, Electroantennography, Potential Amplitude

OP-03 Amplitude Value Of *Bactrocera oleae* (Rossi) (Diptera: Tephritidae) Antenna In Response In Electroantennography

Mustafa Hakan Balcı[1], Erkan Yılmaz[1], Firdevs Ersin[2], Ferit Turanlı[2]
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Bactrocera oleae (Rossi) (Diptera: Tephritidae) is important pest of olives in many parts of the world. Despite the presence of numerous volatile compounds in their habitat, the mated female individuals of B. oleae locate their hosts by displaying behavioural responses to the volatile compounds released by the olive fruit in which they lay their eggs. There are many studies aimed at using volatile chemicals that facilitate interspecies communication for pest control. In semiochemical studies, after identifying the volatile chemicals released by the host, it is essential to determine the electrophysiological activity of these compounds in the pest individuals. When volatile chemicals reach the sensilla on the insect antenna, they stimulate olfactory receptors, generating electrical signals. *Bactrocera. oleae* has four types of sensilla in different regions of its antenna, each displaying different electrical amplitude values in response to stimuli. Therefore, the difference in the electrical potential between the antenna regions arises from this variation. It is crucial for the recording electrode used in electrophysiological studies to contact the region of the antenna with the highest amplitude. Moreover, the concentration of the stimulant also affects the amplitude of the response on the antenna. Therefore, the maximum amplitude region and optimum stimulus concentration were determined in the antenna of mated female *B. oleae* individuals. Preliminary studies have indicated that the insect antenna exhibits an electrophysiological response to α-Pinene released from olive fruits. Therefore, α-Pinene was chosen as the stimulating chemical. The flagellum of the antenna was horizontally divided into four virtual zones. After the recording electrode was placed on the area where the amplitude value would be measured, a 10% α-Pinene solution was applied to the antenna. The study revealed that the distal region of the antenna exhibited the highest amplitude To determine the optimum stimulus concentration, α-Pinene was diluted with n-hexane into four different doses. The recording electrode was brought into contact with the region that displayed the highest amplitude, and solutions with different concentrations were applied to the antenna. Among the comparison doses, the amplitude value measurements increased by up to 10%. Beyond this concentration, the amplitude value remained constant.

Keywords: *Bactrocera oleae*, α-Pinene, Electroantennography, Amplitude.

OP-04 A New Approach To Control Vine Mealybug *Planococcus ficus* (Signoret, 1875) (Hemiptera: Pseudococcidae), In Aegean Region Vineyard Areas: Mating Disruption Method

Neşe Keskin[1], Ferit Turanlı[2]
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In addition to having important growing areas, especially in the Aegean Region, vine is also important because it is an important export product. Vine mealybug, *Planococcus ficus* (Signoret, 1875) (Hemiptera: Pseudococcidae), which has become an increasing problem in the vineyard areas of the Aegean Region in recent years, feeds on roots, stems, wood tissues, leaves and clusters. Among the biotechnical methods, the mating disruption is used effectively to control many harmful species due to its species-specific nature and lack of negative effects on the environment and human health. This technique, which is used in species related to the Hemiptera order in a limited area around the world, has been tried for the first time in Türkiye with in this study and its effectiveness has been determined. The trial was conducted in Manisa province as a mating disruption and untreated control design of large plots in 2019-2021. Grape variety: 3 × 1.5 metre planting pattern and cultivar Sultani çekirdeksiz. Vine mealybug male flight was monitored from mid-April and mating disruption treatment were applicated when the first catch was detected in trial. Mating disruption plot were 1.5 hectare in size and untreated control plot were not as large (0.05 hectare), but had a comparable pest history. In 2019, the first year of the study, trap catch reduction was recorded in mating disruption plot compared to the untreated control plot was 84.09%, and in 2021 it was 95.39%. During the three-year application, it was observed that catch inhibition rate was in the total 89.82% mating disruption plot. This situation is indirectly related to rate of damage in clusters decreases due to population decline from year to year. Contamination rates were found to 12.6%, 3% and 2.3% in the mating disruption plot in 2019-2021, respectively, while 44%, 37% and 41% were found in the untreated control plot. As a result of this study, mating disruption could be applied to vine areas in the Aegean Region to control Planococcus ficus.

Keywords: biotechnical method, mating disruption, delta trap, pheromone

OP-05 Determination Of Pvy Resistance In Tomato Plants

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Tomato is a well-developed model system for molecular genetic studies and a natural host of Potato virus Y (PVY), which is a concern in Turkey. The resistance status of different tomato species and varieties against the PVYN:O strain has been evaluated. While *S. corneliomulleri* LA0444, *S. habrochaites* LA2106, *S. pimpinellifolium* LA0373 and LA0417 genotypes were found to be resistant, all other genotypes and commercial cultivars included in the study were tolerant. Polymorphism in the eIF4E1 mRNA sequence, which is an eukaryotic translation initiation factor, has been investigated, and amino acid changes at positions 54, 56, 71, and 72 of the *S. pimpinellifolium* LA0417 genotype have been associated with PVY resistance. Additionally, the efficiency of the dCAPS marker (eIF4E-SpeI) has been investigated in tomato plants. When the VPg region responsible for virulence of the isolate was sequenced, polymorphism was observed, but no amino acid changes were identified. During PVYN:O infection in *Solanum arcanum* LA2157, the most stable reference gene has been determined, and the expression status of the eIF4E1, eIF4E2, and eIF(iso)4E genes has been analyzed at different time points using RT-qPCR. On the 2nd day, the expression of the eIF4E1 gene was down regulated, while all genes were upregulated on the 7th day and remained steady on the 21st day.

Keywords: Potato virus Y (PVY), tomato, eIF4E

OP-07 Investigation Of The Effects Of Beneficial Bacteria On Drought Stress And *Clavibacter michiganensis* subsp. *michiganensis* In Tomatoes

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Tomatoes are an important crop for both global and Turkish vegetable production. The extreme temperatures brought about by the ongoing climate crisis, coupled with the resulting drought stress, lead to physiological problems in plants. The aim of this research is to minimize or eliminate the biochemical and physiological adverse effects of *Clavibacter michiganensis* subsp. *michiganensis* (Cmm) disease and drought stress through beneficial bacterial relationships. *In-vitro* experiments were initially conducted to investigate the effects of 30 bacterial isolates selected from the bacterial stocks of the Department of Plant Protection, Faculty of Agriculture, Ege University, on drought stress prevention and *Cmm*. The isolates that performed well in *in-vitro* experiments were 146 and 35E isolates. *In-vivo* experiments were conducted using these two bacterial isolates. *In-vivo* experiments revealed that the 35E isolate was the most successful in alleviating drought stress. The most successful result against both pathogen and drought stress was achieved with the 146+35E combination.

Keywords: Tomato, Drought Stress, *Clavibacter michiganensis* subsp. *michiganensis*, Biological Control

OP-08 Determination Of Population Dynamics Of Sucking Insect Pests On Some Maize Genotypes

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In this study, the population changes of the species belongs to Cicadellidae, Aphididae, Thripidae and Phlaeothripidae families were examined on different maize genotypes, suitable for use as a second crop. In order to determine whether the species of Cicadellidae, Thripidae and Phlaeothripidae families were present in the experimental field and to determine the population changes, yellow and blue sticky traps were used. The population of Aphididae family species were monitored with weekly observations on leaves, tassels and cob leaves. In addition, maize leaf samples taken from the experimental plots during the study period were analyzed by Imagej Analysis Program to determine the damage rates on leaf surface areas. According to the results most preferred maize genotypes by Cicadellidae species were M16S45 and KWS Kefieros, and the least preferred maize genotype was Capuzi genotypes. On the other hand the most preferred maize genotypes by Thripidae and Phlaeothripidae species were LG 31.545 and Bodega genotypes, and the least preferred maize genotype was DKC 6761. It was determined that *Zyginidia pullula* (Boherman, 1845), *Zyginidia sohrab* Zatchvakin, *Cicadulina bipunctella* (Matsumura), *Empoasca decipiens* Paoli, *Limothrips* spp., *Haplothrips* spp., *Aeolothrips* spp., *Rhopalosiphum maidis* (Fitch, 1856), *Rhopalosiphum padi* (L.) and *Aphis fabae* Scopoli were the dominant of sucking insect pest species of maize in Menemen (İzmir) district.

Keywords: Leafhoppers, thrips, aphids, population tracking, sticky traps, leaf surface area,

OP-09 Identification Of Entomopathogenic Nematodes In Citrus Orchards In İzmir Province

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The Mediterranean fruit fly *Ceratitis capitata* (Wiedemann, 1824) (Diptera: Tephritidae) is widely distributed in tropical and subtropical regions around the world. This insect, which has numerous host plants, is a major pest in citrus fruit production. Because of its quarantine status in many countries, the export of products infested with this pest is not possible. Because the insect directly damages the fruit, the product loses its market value. Therefore, intensive insecticide use is common in the control of this pest. Due to increased environmental awareness, environmentally friendly alternative control methods are preferred instead of chemical control around the world. One of these alternative methods is the use of entomopathogenic nematodes. These nematodes have become important as ideal biological control agents because of their active host searching, settling in the application area, and long-lasting effectiveness. EPNs are soil-dwelling, obligate insect parasites. The use of EPNs against pests that spend part of their life cycle underground has shown promising results. The last larval and pupal stages of the Mediterranean fruit fly are found in the soil. Entomopathogenic nematode species and/or isolates differ in their adaptability to the environment. The choice of entomopathogenic nematode species and/or isolate can influence the success of the application. Therefore, a survey was conducted in citrus orchards in İzmir province to determine the presence of EPNs, and 80 soil samples were collected. EPNs were isolated from % 5 of these soil samples by baiting late-stage larvae of *Galleria mellonella* (L.) (Lepidoptera: Pyralidae). Nematode isolates were identified through sequence analysis of ribosomal DNA (rDNA) ITS gene regions. Four different EPN species were isolated: *Heterorhabditis bacteriophora* (Poinar 1976), *Steinernema feltiae* (Filipjev 1934), *S. carpocapsae* (Weiser 1955), *Oscheius tipulae* (Lam & Webster, 1971). Soil samples were taken from the same orchards one year later, confirming the continuity of the population. This result indicates that EPNs are a permanent part of the ecosystem in these orchards.

Keywords: Entomopathogenic nematode, biological control, citrus, Mediterranean fruit fly (*Ceratitis capitata*)

OP-11 Heat Resistant Microfungi Samples From *Humulus lupulus* L. (Hops) Agricultural Area

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The heat resistant microfungi can be continue to their life after exposed of temperature at above or 75°C for 30 or more minutes thanks to their ascospores, clamydospore, thick walled hyphae, sclerotia. Aspergillus, Byssochlamys, Penicillium and Talaromyces are the most common types of heat resistant microfungi. In this study, we were investigated biodiversity of heat resistant microfungi in agricultural soils where *Humulus lupulus* L. (Hops) is grown in Bilecik Pazaryeri region in Turkey. This plant is endemic to the region and is used in beer making. The starting point of the study is; What is the existence and biodiversity of heat-resistant molds that do not die with heat treatments and that affect food quality and pose a health risk by producing mycotoxins? Could they pose a problem in the final product beer? For this aim, four different soil samples from per location were collected from agricultural soils at March and July 2023. Isolation process was performed by using heat treatment of soil samples and main soil dilution method. After purification step, isolates were diagnosed by using conventional methods. We were determined some members belong to Aspergillus, Paecilomyces, Penicillium and Taloromyces genera. As a result of this study, we were exhibeted that agricultural soil areas have high heat resistance microfungi biodiversity that commonly known as mycotoxigenic, pathogenic and saprophytic.

Keywords: Heat resistance fungi, *Humulus lupulus*, Pazaryeri, Aspergillus

OP-14 Mutation Studies In Field Crops

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Different breeding methods are used to achieve various goals in plants, such as increasing yield and quality, adaptation ability, and developing varieties resistant to abiotic and biotic stress factors. In these methods, the fundamental principle is for the researcher to select and breed plants that are suitable for their purpose from the existing pool of genetic diversity. In some cases, researchers create variations themselves. One of the methods used to generate variation is mutation. Mutations can be described as both a tool for creating variation and a breeding technique in plant breeding. Numerous studies demonstrate that naturally occurring or artificially induced mutations can affect different traits in plants. Furthermore, there are many varieties obtained through mutation breeding in Turkey, including approximately 16 varieties in different species such as lemon, cherry, sesame, barley, wheat, potatoes, soybeans, tobacco, and chickpeas. This review summarizes some of the physical and chemical mutation breeding studies conducted in the field of field crops with the aim of benefiting researchers who aspire to work in this area.

Keywords: Field crops, mutation, gamma ray, ethyl methane sulfonate (EMS), variation, plant breeding

OP-15 Use Of Dna-Based Molecular Markers In Plant Breeding

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Plant breeding, defined as the science of plant development, is the science and art of obtaining more productive, higher quality and more resistant varieties to adverse environmental conditions by changing the genetic structure of plants with the help of various breeding methods. The pace of yield increase in most traditional breeding programs is insufficient to meet the rising demand for food driven by a fast expanding global population. In plant breeding; the development of more productive, better quality and more resistant varieties to adverse environmental conditions is limited, especially because the plant growing period is very long. A new variety takes several years to create due to the various processes of hybridization, selection, and testing involved in the production of new plant species. However, the use of biotechnological tools in plant breeding, the rapid development of better plant varieties can help reduce food shortages and cope with the increasing food demand caused by the global population. In recent years, there have been astonishing and exciting advances in DNA marker technology. The advancement of molecular tools for genetic research to improve agronomic traits in plants associated with yield, quality, or resistance to biotic and abiotic stresses has resulted in a significant gain in our understanding of plant genetics and the structure and behaviour of plant genomes. Molecular markers have been shown to be useful tools in the development of qualitative and quantitative traits, selection, genetic and linkage mapping, variety identification and conservation, and a variety of plant breeding studies, including determination of genetic distance between genotypes. Furthermore, the application of molecular markers in variety registration and certification, stability, germplasm characterization/fingerprint studies, determining high-yielding and high-quality varieties, phylogenetic analysis, field trials, and laboratory testing is gaining popularity. In this phase, it is critical to revise present breeding procedures by incorporating molecular markers into breeding programs.

Keywords: Plant breeding, Molecular Markers, Molecular Breeding

OP-16 Phenotypic Characterization Of 130675/avocet S Double Haploid Population Of Wheat Against Yellow Rust At The Adult Plant Stage

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The *Puccinia striiformis* Westend f. sp*. tritici* (Pst) fungus poses a serious threat to the world's wheat production including the wheat production of Türkiye. A long-term solution to wheat stripe rust is the use of resistant cultivars with adult plant resistance to the disease. Genetic understanding of resistance to stripe rust is fundamental to breeding for rust resistance. To understand genetic basis of adult plant resistance of a resistant bread wheat line '130675' (Avd/Vee#1//1-27-6275/Cf 1770/3/MV171-C17466); from the International Winter Wheat Improvement Program (IWWIP), a doubled haploid (DH) population of 132 individuals developed from F1 progenies of '130675" resistance line crossed with the universally susceptible variety 'Avocet S'. The 132 doubled haploid lines were evaluated for adult-plant resistance to the PstS2 (virulence on Yr27) at adult-plant stage at the Regional Cereal Rust Resistance Center, Izmir, Türkiye (RCRRC) during the cropping season of 2021 and 2023 using artificial inoculation. Adult plant resistance responses were recorded when the disease severity in Avocet 'S' reached 100% following the Modified Cobb's scale for disease severity and infection types. The field scoring was carried out two times during the season at 10-day intervals. The coefficient of infection (CI) was calculated for the field scoring. During the year 2021, ninety DH lines (68%) showed resistance reaction response (CI=0 to 20); sixteen (12%) exhibited moderate resistance (CI=20 to 40); nine (7%) showed moderately susceptible reaction type (CI=40 to 60); the remaining seventeen (13%) genotypes were susceptible (CI=60 to 100). While in the year 2023, eight (6%) of the genotypes showed a susceptible response, five (4%) showed a moderate resistance response whereas, 114 (86%) of the genotypes were highly resistant. Over the two years, 83 genotypes displayed the same resistance response (CI = 0 to 20). The lines showing adult plant resistance can be utilized for further breeding and molecular studies.

Keywords: Wheat, Yellow Rust, Double Haploid Population, PstS2, Yr27, Adult Plant Resistance

OP-17 Determination Of Adaptation Abilities Of Camelina (*Camelina sativa* L. Crantz) Genotypes Of Different Origins In Ödemiş Ecological Conditions

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This research was conducted to observe the seed yields of 25 Camelina (*Camelina sativa* (L.) Crantz) genotypes with different characteristics under the ecological conditions of Ödemiş, Izmir. The research plan was designed with three repetitions following a randomized block trial design. Plant height, first lateral branch height, capsule count per plant, seed count per capsule, thousand seed weight, and yield performances were examined in the study. As a result of the examinations, genotypes suitable for the Ödemiş, Izmir location were determined

Keywords: Ketencik, Camelina, Yield

OP-18 Determination Of Forage Yield And Some Yield Characteristics In Different Cereal-Forage Pea (*Pisum sativum* L.) Mixtures

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In the global food economy, food demand has reached a critical point due to the increasing population, making products derived from livestock farming of utmost importance. Concurrently, the development of animal husbandry in parallel with population growth and the increasing need for animal products have led to a continuous rise in the demand for forage crops worldwide. One major challenge livestock farms face in Turkey is the shortage of quality forage feed. This situation can become a long-term issue, necessitating immediate exploration of solutions. It is well recognized that the further development of livestock farming, which holds a significant place in the country's agriculture, depends on the importance given to pasture-culture and forage crops within field agriculture in our country. This research was conducted during the winter second-crop vegetation period of 2014-2015 in Pancar village, Torbalı district, located 45 km from the center of Izmir Province, under Mediterrenean ecological conditions. The study aimed to determine the forage yield and some yield characteristics of different cereal+forage pea (*Pisum sativum* L.) mixtures. Italian ryegrass (*Lolium multiflorum* var. *westerwoldicum*) cv. *Pollanum, triticale* (×Triticosecale) cv. Tatlıcak-97, oat (*Avena sativa* L.) cv. Faikbey and forage pea (*Pisum sativum* L.) cv. Taşkent were used as plant materials in different cereal+forage pea mixtures. According to the randomized complete block design, the study was established in three replicates. In the research, vegetation height (cm), cereal plant height (cm), legume plant height (cm), green forage yield (kg/da), dry matter content (%), and dry matter yield (kg/da) were investigated. According to the results obtained, it can be suggested that in winter second-crop cultivation in the Aegean Region, triticale in monoculture and a mixture of forage pea+triticale in mixed cultivation should be preferred in terms of forage yield and some yield characteristics.

Keywords: Forage pea, cereal, mixture, yield

OP-19 Effect Of Salt Stress On Stomatal Conductance, Spad And Leaf Temperature In Some Cotton Genotypes

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In the study, stomatal conductance measurements were made under greenhouse conditions in terms of sensitivity and resistance to salinity of the varieties in the genetic stock of Nazilli Cotton Research Institute. The experiment was carried out in greenhouse conditions according to the random plots experimental design with 4 replications. In this study, 20 varieties (Tam- 01-E- 22 (Rey no:GP889, P1652865), Tam-04-WB-33-S (Rey no:GP-940, PI662041), Tam-87-G3-27, Tam-94-L-25-P1631441, Şahin 2000, Tam- A106-16-Els (Rey no:GP-895, PI54360), Tam-B139-17-Els (Rey no:GP-927,PI659699), Tam-B147-21-Els (Rey no:GP-896,PI654361), Tam-B182-33-Els (Rey no:GP-897,PI654362), Tam-C147-42-Els (Rey no:GP-900,PI654365), Tam-C155-22-Els (Rey no:GP-901,PI654366), SC 2079, SC 2009, ES 1, ES 2, Acala 1517 C, Acala 1517 D, Acala 1517 SR2– vert, Tropical 225, Acala 1517-70) 5 domestik and 15 foreign cultivars/lines were used. A control and 3 different salt doses (50mM, 100mM, 200mM NaCl2) were used to measure stomatal conductance. For this purpose, seeds sown in the field and harvested in the same year were used. Salt stress conditions were provided during the early period of the plants. Stomatal conductance was measured with a portable leaf porometer (Decagon Device inc.) on the 6th day after the stress conditions were provided. 20 cotton cultivars showed differences in stomatal conductance values. Cotton varieties are extremely sensitive to stress at the beginning of flowering. Salt stress was applied during this period and it was observed that they were affected by stress in the measurements. Stomatal conductance among the cultivars was generally in the form of 100mM NaCl, 50mM NaCl, 200mM NaCl and the lowest control, respectively, from highest to lowest, depending on the increasing salt concentrations. Different salt doses applied revealed differences among the genotypes in terms of stomatal conductance. These differences were observed as a result of the analysis. According to the genotypes used in the research in terms of stomatal conductance, Tam-B182-33-Els (Rey no: GP-897, PI654362) variety, Tropical 225 variety, Şahin 2000 variety, Tam-C155-22-Els (Rey no: GP-901, PI654366) varieties were at the top in terms of stomatal conductance. In terms of the lowest values, Acala 1517-70 cultivar, 17 Acala 1517 D cultivar and other cultivars were at average values.

Keywords: cotton, salt stress, stomatal conductance

OP-20 Blockchain-Based Livestock Management: Improving Efficiency And Accuracy

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The management of livestock has become increasingly complex in recent years, with growing demands for traceability, transparency, and efficiency in the supply chain. As a result, the use of blockchain technology has been proposed as a means to address these challenges in cattle production. This study aimed to conduct a comprehensive review of existing literature and case studies to evaluate the potential benefits and limitations of blockchain-based livestock management in the cattle industry. The review was conducted through a systematic analysis of the current state of research and practical applications of blockchain technology in livestock management. Our findings indicate that blockchain has the potential to significantly enhance the efficiency and accuracy of cattle tracking and record keeping, thereby improving supply chain management, animal welfare, food safety, and traceability. However, the implementation of blockchain technology in the cattle industry also faces certain challenges, such as the need for widespread adoption, technical difficulties, and the development of appropriate regulatory frameworks. In conclusion, our review highlights the potential of blockchain technology to transform the cattle industry by improving the efficiency and accuracy of livestock management. However, further research is necessary to fully understand the challenges and opportunities associated with the implementation of blockchain technology in cattle production and to develop strategies for promoting its widespread adoption.

Keywords: blockchain, livestock management, efficiency, accuracy, supply chain management

OP-21 Opportunities Of Using Propolis In The Treatment Of Mastitis In Dairy Animals

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Mastitis is an important health problem that adversely affects milk production in dairy animals, as well as animal health, welfare thus operating income. Mastitis in dairy animals is directly related to milk yield as well as manure management and udder hygiene. Approximately 20% of dairy cows and animals with high milk yield are affected by mastitis. The incidence of mastitis in herds may vary depending on many environmental factors such as udder hygiene before and after milking, manure management and stress. It is stated that more than 140 microorganisms have an effect on mastitis. The most common of these microorganisms are *Staphylococcus aureus*, *Streptococcus agalactiae*, *Escherichia coli* and *Streptococcus uberis*. Mastitis in dairy animals occurs in clinical and subclinical forms ranging from mild, moderate and severe forms. The particularly clinical form of mastitis is seen by visible changes in milk, as well as infection and mastitis, determined by visual inspection. On the other hand, the determination of subclinical mastitis is quite difficult since there is no significant change in udder and milk. However, the presence of bacteria related to the number of somatic cells and their determination in the laboratory environment are the two basic approaches used in determining the problem. The treatment of mastitis, especially in dairy cows, is still based on antibiotic administration. However, its effectiveness is decreasing due to increased drug resistance in bacteria, which is considered an important health problem. Bacterial resistance, as well as antibiotic residues in food and the environment, are increasingly affecting consumers' concerns, and the importance of reducing the use of antibiotics to treat bacterial infections in animals comes to the fore. For this reason, the tendency towards alternative products or approaches is increasing day by day. Bee products, each of which is very valuable, are widely used in the field of health, cosmetics and food. Propolis is a bee product whose antibacterial, antifungal, antivirus, anti-inflammatory, antiulcer, antitumor, anesthetic and wound healing properties have been proven by many studies. In this study; the possibilities and effects of using propolis as an alternative product to classical mastitis methods in dairy animals were examined.

Keywords: Propolis, mastitis, dairy animals, animal health, alternative treatment

OP-24 Use Of Citrus Fiber And Whey Protein Isolate Complex In Oleogel Fabrication And Application In Cookie Formulation As Palm Oil Alternative

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In recent years, a growing interest has been observed in oleogels formulated via emulsions, which are particularly interesting due to their structured networks and ability to replace saturated fats. In this study, oleogels were produced by the Pickering emulsion-based method using colloidal complexes produced with Citrus Fiber (CF) and Whey Protein Isolate (WPI). By keeping the WPI concentration (10%) constant in the oleogel formulation, production was carried out at different CF concentrations (1%, 2%, 3%, and 5%). Rheological properties and oil-holding capacities of the produced oleogels were determined. All oleogel samples showed shear thinning behavior. G' values for oleogel samples were higher than G'' values; this means that solid-like behavior prevails in all oleogel samples. An increase in the CF concentration in the oleogel formulation resulted in higher G' values and an increase in the pseudoplastic behavior of the oleogel. The oil holding capacity of all oleogel samples was over 90% and this capacity also increased with higher CF concentrations in the oleogels. The visual appearance of 3% CF-WPI oleogel and 5% CF-WPI oleogel showed that there was no oil on the surface and the more integrity structure could well retain the oil in a gel matrix. Increasing the CF% concentration led to a decrease in oil droplets and led to the formation of a more compact structure, especially for 3% and 5% CF-WPI oleogels. For this reason, oleogels containing 3% and 5% CF-WPI were added to the cookie formulation, and the cookies were compared with cookies produced with palm oil. Increasing the CF concentration from 3% to 5% caused an increase in the hardness value of the cookies, as the CF formed a 3-dimensional network structure binding the oil. Oxidative stability data showed no significant change between 3% CF WPI and palm cookies ($p<0.05$). Adding oleogels to the cookie recipe has proven to be an effective substitute for palm oil. CF-WPI oleogels offer the potential to replace saturated and trans fats in food products, showing promise for use in cookie preparation as a replacement for palm oil.

Keywords: Citrus Fiber, Emulsion Templated, Oleogel, Whey Protein Isolate, Palm Oil

OP-29 Hoebot: Autonomous Hoeing For Sustainable Agriculture

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The ongoing demand for sustainable and precision agriculture has led to the rise of innovative farming solutions. An international prominence effort continues in the field of development of robotic systems and their adaptation to agricultural production. One such innovation is the HoeBot, an autonomous hoeing robot designed to optimize weed management and crop cultivation. This study presents the conception, design, and practical applications of the HoeBot in various agricultural operations. Using sensing technology and machine learning algorithms, the HoeBot can differentiate between crops and weeds, ensuring precise hoeing without causing damage to the crops. Its design allows for seamless navigation across varied terrains, and its adaptability ensures reduced soil disruption, leading to healthier crop growth. The autonomous hoeing robot produced within the scope of the project is different from other hoeing tools and machines due to it does not require a separate power source such as a tractor. Compared to other hoeing equipment, human labor is used only for monitoring the operation. Another advantage is to increase work efficiency by reducing the rate of human error. Since it eliminates the use of physical strength in operation, it has a positive effect on occupational health and safety conditions. Use of electric powered robots contributes reducing negative aspects of using fossil fuels which is critical for climate change, and it contributes to the realization of agricultural production in accordance with the European Green Deal criteria. The robot chassis is manufactured by welding steel material. The autonomous robot is driven by four rubber wheels and a chain-gear system that transmits the movement from four 24 volt 250 W DC motors since total power requirement is calculated as 725 W. The vehicle was provided with autonomous driving feature by using the Pixhawk Control Card integrated with Ardunio Nano. Route data is created via the Mission Planer web application and transmitted to the Pixhawk module via rangefinders via wireless connection. The vehicle determines its location by GPS. The HoeBot represents a significant step forward in the integration of automation in agriculture and promises the adaptation of precision and sustainable applications.

Keywords: Robot, precision farming, digital agriculture, smart farming

OP-30 Seasonal Impact Of Harvesting On The Freshness And Quality Of Gilthead Seabream Meat (Sparus Aurata Linnaeus, 1758)

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In order to determine the impact of seasonal and stunning ways to maintain the freshness and quality of the gilthead seabream meat for consumption, 50 samples in two seasons (summer and winter) were randomly caught in the Bay of Neum using two stunning ways: using ice/sea water mixture (group I) and using anesthetic (group II). After stunning, number of muscle contractions, blood lactate concentration, temperature and pH of fish meat were measured. During laboratory analysis, trend values of pH and temperature were continued. The analysis also included the measurement of morphometric values, determination of the chemical composition of fish meat and carrying out the sensory analysis (QIM – Quality Index Method). The results showed that analyzed specimens were with uniform morphometric measures, without statistically significant differences between groups and seasons. According to a determined chemical composition, protein content was 17.7% (in summer period) and 18.5% (in winter period), moisture content was 70.2% (summer) and 78.0% (winter), and crude fat was 3.98% (summer) and 1.17% (winter). A statistically significant difference between seasons occurred at the moisture content, and especially for fat content. Temperatures are slightly down during the analysis with statistical difference between seasons every day, except day 11th. Readings of pH during analysis were 6.41 to 7.12 with a statistically significant difference between seasons at day 7 and 9. Based on the lactate content, it can be concluded that the fish group I (anesthetic) from the winter season survived stress levels higher than all other groups. Higher average number of muscle contraction after stunning was recorded in the fishes from group II (2.0) than in fish from group I (0.54). QIM values, as expected, had constant increase during testing (from 0.0 to 12.0), with significant differences between seasons for days 3, 7 and 11. Stunning methods, therefore, do not have an impact on maintaining the freshness and quality of gilthead seabream meat during storage, but the season of harvest has.

Keywords: gilthead seabream, freshness, meat quality, seasonal impact, stunning methods

PP-01 Organic Food's Escalating Demand And Challenges For Public Health And Food Sustainability In Vietnam

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Organic food mitigates public health risks and considers an alternative approach to enhancing sustainable food production, security, and safety. This study presented the current demand overview for organic food and the associated hurdles within Vietnam from 2012 to 2022. By analysing official, confidential databases, and amalgamating data from sources such as the World Bank, the Research Institute of Organic Agriculture, FAO, WHO, Vietnam's Ministry of Agriculture and Rural Development, and the Ministry of Industry and Trade, along with insights from local studies, the gathered information is categorized chronologically. Statistical analysis and interpretation are carried out using the SPSS software. The findings revealed a remarkable surge in organic food demand, surging from 63 million customers in 2012 to an impressive 70.5 million by 2022, encompassing 71% of the population. Correspondingly, the number of organic producers surged from none in 2012 to 338 in 2018, skyrocketing to 1065 by 2022, spanning 62 out of 63 provinces. However, despite the burgeoning demand and producer interest, only 42% of products were certified organic in 2022. While organic agriculture land increased to 174,000 hectares, marking a 479% growth from 2012 to 2022, this remained a modest fraction, accounting for merely 0.28% of the overall agricultural landscape. Additionally, organic food prices remained consistently 2.1 times higher than conventional counterparts. In conclusion, this study underscores both the escalating demand for organic food in Vietnam over the past decade and the challenges posed by limited investment. Strategic policies are needed to fully leverage the potential of organic agriculture, ensuring public health, sustainable development, and addressing food safety and security concerns.

Keywords: Organic food, Vietnam, Food safety and security, Public health.

PP-03 The Use Of Pyrophyllite And Zeolite For The Purpose Of Remediation Of Soil Contaminated With Heavy Metals In Maglaj

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Soil pollution with heavy metals is a growing problem both in Bosnia and Herzegovina and around the world, bearing in mind that the content of heavy metals above the limit values reduces the productivity of agricultural land, pollutes food and water sources, and consequently endangers human health and the environment. Soils contaminated with heavy metals can be restored to their original function, i.e. productivity, if appropriate remedial measures are implemented. Developed and environmentally conscious societies pay special attention to the improvement and development of those remedial measures that achieve the effect of removing or reducing the content of heavy metals in the soil without negative repercussions on any segment of the environment. In this work, alumosilicate materials zeolite and pyrophyllite were used in order to reduce the uptake of heavy metals from the soil into the plant. Pyrophyllite and zeolite particles with a size of 100 μm were added in the soil in amounts of 200, 400 and 600 kg ha-1, in three repetitions. Application of zeolite, regardless of the dose used, significantly reduced the availability of Cu, Zn, Cd, Pb and Ni in the tested soil. In the conditions of the experiment, the application of pyrophyllite in a dose of 200 kg/ha reduced the accessibility of Cu by 16.2%, Zn by 9.6%, Mn by 15.3%, Cd by 21.6%, Pb by 32.4% and Ni by 11.7% in the tested soil. pyrophyllite at a dose of 400 kg/ha reduced the accessibility of Cu by 24.5%, Zn by 28.3%, Cd by 27.0%, Pb by 48.2% and Ni by 11.7% in the tested soil, while the application of pyrophyllite at a dose of 600 kg/ha in the tested decreased the accessibility of Cu by 25.5%, Zn by 26.2%, Mn by 13.5%, Cd by 29.7%, Pb by 48.2% and Ni by 16.6%.

Keywords: heavy metals, pyrophyllite, zeolite, remediation

PP-04 The Influence Of Natural Antioxidants On The Quality And Stability Of Animal Fats During Storage

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Animal fats are obtained from the adipose tissue of warm-blooded animals. Given that fats are subject to spoilage and that consumer interest in natural antioxidants is on the rise, an experimental study of the effect of natural antioxidants (green tea and coriander extracts) on quality and stability of beef, goat and sheep fat, under conditions of storage in the refrigerator (4ºC), in the dark (20ºC), and in the light (20ºC). For the purpose of research, the content of moisture and insoluble impurities in the aforementioned fats, the value of the peroxide number and the content of free fatty acids, were determined. To test the quality and stability of animal fats, 0,2% of antioxidants (green tea and coriander extracts) were added to the melted fat. The content of free fatty acids in the base samples of beef fat was 0,67%, goat fat 0,77%, and sheep fat 0,71%. The values of the peroxide number of the base samples were 0,00 mmol O2/kg for beef and sheep fat, while the peroxide number of goat fat was 0,50 mmol O2/kg. The determined moisture content of beef fat was 0,27%, goat fat 0,18%, and sheep fat 0,29%. As part of this research, the percentage of insoluble impurities was determined, the lowest value of which was recorded in beef fat and amounted to 0,46%, followed by 0,91% in sheep fat, and the highest content of insoluble impurities was recorded in goat fat and amounted to 1,86%. The lowest oxidative changes in beef fat were recorded when the samples were stored in the refrigerator, where the added antioxidants showed the same antioxidant effect, while at the end of the test, the control sample and the sample with the addition of coriander had the same values (1,06%), and the highest changes were recorded in the sample with the addition of green tea (1,48%) under the same storage conditions. The greatest oxidative change in beef fat expressed through peroxide number, was recorded in the control sample stored in the light and is 1,88 mmol O2/kg, and the highest hydrolytic change, expressed through the content of free fatty acids, was recorded in the control sample stored in the dark and is 2,54%. In light-stored beef fat samples, added natural antioxidants accelerated hydrolytic spoilage. The smallest changes in the peroxide number of goat fat were recorded in the samples stored in the refrigerator, where the green tea extract showed better antioxidant properties compared to the coriander extract, while the smallest changes in the content of free fatty acids were recorded in the samples stored in the dark, and the largest in the light where added antioxidants even accelerated spoilage. Hydrolytic changes of sheep fat they are the least expressed in samples stored in the refrigerator, where the antioxidants exerted their positive effect.

Keywords: animal fats, oxidative changes, hydrolytic changes, natural antioxidants, storage.

PP-05 Determination Of The Effectiveness Of Alternative Control Methods To Vine Mealybug *Planococcus ficus* (Signoret, 1875) (Hemiptera: Pseudoccoccidae) In The Vineyard Areas Of Aegean Region

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In addition to having important cultivation areas, especially in the Aegean Region, vine is also important as it is an important export product. The vine mealybug, *Planococcus ficus* (Signoret, 1875) (Hemiptera: Pseudococcidae), which has become an increasing problem in the Aegean Region vineyard areas in recent years, feeds on roots, trunks, wood tissues, leaves and fruits. The fight against this pest is generally based on the use of chemical insecticides. However, there is no alternative method that can be applied against *Planococcus ficus* in organic vineyards which has large cultivation areas in the Aegean Region. For this reason, in order to demonstrate the effectiveness of cultural practices alternative to chemicals in organically grown vineyards, peeling of bark, peeling of bark + sticky trap (Tangle trap) and control applications were done in this study. The trials were carried out in 2021 in the vineyards where organic production was carried out in two different districts of Manisa province, according to the Randomized Blocks Trial Design, with 4 replications. In the trial conducted in first district, the repetitions in peeling of bark showed an effect of 91.43%, 93.75%, 100.00% and 95.00%, respectively. Peeling of bark showed an average effect of 95.04% when all repetitions were evaluated. Repetitions in peeling + sticky trap showed an effect of 94.29%, 100.00%, 95.38% and 98.33%, respectively. Peeling of bark + sticky trap showed an average effect of 97.00% when all repetitions were evaluated. In the trial conducted in second district, repetitions peeling of bark showed an effect of 97.14%, 100.00%, 95.45% and 89.58%, respectively. The average effect of all repetitions was calculated as 95.55%. Repetitions of peeling of bark + sticky trap showed an effect of 95.71%, 89.33%, 99.09% and 97.92%. Peeling of bark + sticky trap showed an average effect of 95.51% when all repetitions were evaluated. In line with the results obtained in the Aegean Region vineyard areas, it was concluded that peeling of bark and peeling of bark + sticky trap could be effectively applied to control *Planococcus ficus*.

Keywords: Aegean Region, cultural methods, organic vineyards, peeling of bark, sticky trap.

PP-06 Determination Of The Effectivenes Of Traditional Control Methods To Vine Mealybug *Planococcus ficus* (Signoret, 1875) (Hemiptera: Pseudococcidae) In The Vineyard Areas Of Aegean Region

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Aegean Region has approximately 30% of the vineyard areas in Türkiye. Sultani seedless (*Vitis vinifera* L.) is our registered variety, which is mostly grown and exported in this region. Vine mealybug, *Planococcus ficus* (Signoret, 1875) (Hemiptera: Pseudococcidae) is among the pests that have an increasing population in vineyard areas and negatively effect yield and market quality. Chemical and biopesticide treatments, which are widely and effectively used throughout the world to control vine mealybug, were tested in this study and their effectiveness was demonstrated. The trials were conducted in Manisa province, two different districts in 2021, according to the Randomized Blocks Trial Design, with 4 replications. The characters included in the trial were Spirotetramat (Movento ®), Orange oil (Prev-Am ®), Peeling of bark + orange oil and control in two districts. Applications were repeated intermittently, following the biology of *Planococcus ficus*. In the first trail area peeling of bark + orange oil, the repetitions showed an effect of 94.23%, 100%, 95.83% and 92.73%, respectively. Peeling of bark + orange oil application showed an average effect of 95.70% when all repetitions were evaluated. Repetitions in orange oil application showed an effect of 90%, 88.33%, 85.42% and 89.09%, respectively. Orange oil application showed an average effect of 88.21% when all repetitions were evaluated. Trials in Spirotetramat application showed an effect of 100.00%, 100.00%, 93.75% and 96.36%, respectively. Spirotetramat application showed an average effect of 97.53% when all repetitions were evaluated. In the second trial area repetitions in peeling of bark + orange oil application showed an effect of 95.38%, 98.08%, 100.00% and 92.59%. Peeling of bark + orange oil application showed an average effect of 96.51% when all repetitions were evaluated. Repetitions in orange oil application showed an effect of 93.88%, 92.31%, 94.00% and 98.15%. Orange oil application showed an average effect of 94.58% when all repetitions were evaluated. Repetitions in Spirotetramat application showed an effect of 96.92%, 98.08%, 100.00% and 100.00%. Spirotetramat application showed an average effect of 98.75% when all repetitions were evaluated.

Keywords: Aegean Region, biopesticide, Chemical, orange oil, peeling, spirotetramat, systemic.

PP-08 Examination Of Lipolytic And Oxidative Changes During The Production Of Beef Prosciutto

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Beef prosciutto is a traditional cured meat product that is produced on the territory of Bosnia and Herzegovina. It is produced from the highest quality parts of beef carcass. Various scientific studies have established that the flow of lipolytic and oxidative changes during processing depends on conditions, especially temperature, NaCl content, moisture, etc. The aim of this research was to determine the impact of production technology on the level of lipolytic and oxidative changes through the stages of production, from fresh meat to the finished product, and the impact of these changes on product quality. For research purposes, 10 samples were used, which were sampled 5 times, on fresh meat, after the salting phase, after smoking, and after 10 and 20 days of ripening. Accordingly, the total number of analyzed samples was 50. The samples were taken from different anatomical regions, round and back musculature. Sensory and physical-chemical studies were performed on the tested samples. Physical-chemical tests included the quantitative determination of moisture, fat, ash, NaCl, aw and pH values, acid and peroxide numbers, and the level of lipid oxidation (TBA number). The sensory evaluation and analysis of the obtained results established good quality, whereby all samples of beef prosciutto were classified as extra class. Based on the presented results of physical-chemical tests, observing the values of the analyzed parameters on the finished product, i.e. after the drying phase, a higher content of moisture (38.31%-47.08%) was, and then ash (9.22%- 10.27%), NaCl (8.64%-9.29%) and higher pH values (5.38-5.50). In the case of MLD samples, after the drying phase, higher fat content (16.17%-18.25%) and aw values (0.849-0.873) were registered. A higher intensity of oxidative changes was found in round samples (peroxide number 2.85 mmol O2/kg-4.00 mmol O2/kg; TBA number 0.83 mg MDA/kg-1.39 mg MDA/kg), which is explained by the higher content of phospholipids that cause greater oxidative changes. A higher intensity of lipolytic changes was also registered in round samples (acid number 3.24 mg KOH/fat-4.39 mg KOH/g fat). The reason for the above can be explained by the higher moisture content and lower fat content, which led to higher lipolytic activity.

Keywords: beef prosciutto, lipolytic changes, oxidative changes, production technology

PP-09 The Effect Of Antioxidants On The Quality And Stability Of Palm Oil

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The use of oil palm fruits (*Elaeis guineensis*) for the production of oil goes back several thousand years. At a temperature of 18–20 ℃, the oil is in a solid state, which is why it is also referred to as fat. Oil has a specific chemical composition and physical properties. By processing oil palm fruit, a high quality oil is obtained, which is used in various industries, with the largest application being in the food industry. However, the quality of palm oil is determined by the production method, storage and storage conditions. Storing the oil at high temperatures, exposed to light and oxygen leads to undesirable changes that affect the quality of the oil or the product containing it. In order to achieve a higher oxidation stability of palm oil, antioxidants are added in certain concentrations, which can be natural or synthetic. For this study, extracts of rosemary, smoke tree, ginger, immortelle, milk thistle, sage and extracts of medicinal plants were used as natural antioxidants at concentrations of 0.2%, while butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT) and propyl gallate (PG) were used as synthetic antioxidants at concentrations of 0.01%. First, analyses of the moisture content, free fatty acids and peroxide value were carried out on a control sample (without the addition of antioxidants). After the addition of antioxidants to the palm oil, a sustainability test was carried out in a drying oven at 63 ℃, and sampling and determination of the peroxide value and free fatty acid content were carried out every 24 hours up to a maximum of 120 hours. The tests carried out showed that from the group of synthetic antioxidants, butylated hydroxytoluene (BHT) made the greatest contribution to the stability of palm oil, while other synthetic antioxidants had a similar effect. In the group of natural antioxidants, immortelle extract had the best effect, while sage and milk thistle extracts accelerated the oxidative degradation of palm oil.

Keywords: palm oil, antioxidants, oxidative stability, fat quality

PP-10 Development And Production Of Caffeine-Free Coffee Substitute: Date Seed Extract

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Dates are an important agricultural product in many Middle Eastern countries and a staple food for the people in this region. The nutritional value of dates, consisting of 11-18% carbohydrates, dietary fiber, and protein, is of great significance in terms of nutrition. When examining consumer habits, it becomes evident that the growing preference for healthy options that still offer familiar flavors has brought forth the potential for the utilization of date seeds as a caffeine-free coffee alternative. Date seeds do not have a specific aroma and have a mild bitter taste. They are typically light and dark brown in color. Filter coffee is often intense in flavor, with a pronounced acidic profile and is often bitter. Date seed coffee, on the other hand, has a milder flavor profile. Date seeds can naturally possess a sweet characteristic, making date seed coffee offer a smoother and sweeter taste. While filter coffee is typically consumed for its caffeine content, date seed coffee can be preferred as a caffeine-free alternative. The aim of this study is to develop a new product as a caffeine-free coffee alternative by experimenting with different process parameters. We have developed processes similar to filter coffee by roasting and pre-processing date seeds at different temperatures. Our panelists have conducted taste tests and product recipe studies. By determining the process steps for date seeds that can serve as a coffee substitute both in taste and as a product, our research has been completed. On the other hand, this study aims to contribute to sustainability and waste reduction goals. This study can provide a healthy alternative to local consumers while also contributing to the country's economy.

Keywords: Date, Date Seed, Extract, Date Seed Powder, Date Seed Coffee, Caffeine, Filter Coffee.

FULL TEXT PROCEEDINGS

CONTENTS

OP-6

Full Text Proceeding

(Tam Metin Bildirisi)

Biological identification of cucumber mosaic virus (CMV) isolated from tomato and pepper fields in İzmir

Domates ve Biber Üretim Alanlarından İzole Edilen cucumber mosaic virus (Cmv)'nin Biyolojik Karakterizasyonu

It has been summarized from the first author's master dissertation

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Keywords: cucumber mosaic virus, CMV, biological indexing, DAS-ELISA, RT-PCR.

Anahtar sözcükler: cucumber mosaic virus, CMV, biyolojik indeksleme, DAS-ELISA, RT-PCR.

ABSTRACT

Objective: A study was conducted to identify cucumber mosaic virus (CMV) isolates present in tomato and pepper-growing areas of the İzmir province of Turkey, based on biological indexing and RT-PCR methods.

Material and Methods: Seventeen plant samples infected with CMV, previously obtained from the Aegean region, were used to carry out mechanical inoculation of virus into different test plants, consisting of *Solanum lycopersicum* 'SC-2121', *Nicotiana glutinosa*, *Nicotiana tabacum* cv. Xanthi and *Cucumis sativus* 'Beith Alpha'. The virus-inoculated plants were visually evaluated for symptom development, followed by the DAS-ELISA test with CMV-specific antibodies. CMV-positive tobacco plants were used to repeat the mechanical inoculation of the virus into newly grown test plants, followed by ELISA test and final PCR tests. **Results:** As a result, two isolates of CMV produced CMV-like symptoms in the test plants. However, only one isolate inoculated to plants consistently came out to be positive in the final ELISA and RT-PCR tests. Three weeks after inoculation, the isolate induced systemic mosaic in tobacco and cucumber, while it caused mosaic, stunting, and bushy appearance in tomato.

Conclusion: Samples from inoculated plants produced a spesific PCR amplicon (280 bp) in agarose gel, which indicates the presence of the virus.

ÖZ

Amaç: İzmir ilinin domates ve biber yetiştirilen bölgelerinde bulunan Cucumber mosaic virus (CMV) izolatlarının biyolojik indeksleme ve RT-PCR yöntemleri kullanılarak karakterize etmek için bir çalışma yürütülmüştür.

Materyal ve Yöntem: Önceden Ege Bölgesinden elde edilen CMV ile enfekte olmuş on yedi bitki örneği, *Solanum lycopersicum* 'SC-2121', *Nicotiana glutinosa, Nicotiana tabacum* cv. Xanthi ve *Cucumis sativus* 'Beit Alpha' gibi farklı test bitkilerine virüsün mekanik inokülasyonunu gerçekleştirmek için kullanılmıştır. Virüs inokule edilmiş bitkiler, belirti gelişimi açısından görsel olarak değerlendirilmiş olup CMV'ye özgü antikorlarla DAS-ELISA testine tabi tutulmuştur. CMV pozitif tütün bitkileri, virüsün yeniden yetiştirilen test bitkilerine virüsün mekanik inokulasyonu tekrarlamak için kullanılmış olup ardından ELISA ve PCR testleri yapılmıştır.

Araştırma Bulguları: Sonuç olarak, iki CMV izolatı test bitkilerinde CMV benzeri belirtilere neden olmuştur. Ancak bitkilere inokulasyon yapılan tek bir izolat, son

ELISA ve RT-PCR testlerinde tutarlı bir şekilde pozitif çıkmıştır. İnokulasyondan 3 hafta sonra izolat tütün ve hıyarda sistemik mozaik oluştururken domateste mozaik, bodurluk ve çalılaşma görünüme neden olmuştur.

Sonuç: 8 İnokule edilen bitki örnekleri, agaroz jelde virüsün varlığını gösteren virüse özgü spesifik PCR amplikonu (280 bç) oluşturmuştur.

INTRODUCTION

Tomato (*Solanum lycopersicum,* Solanaceae) and pepper (*Capsicum annuum,* Solanaceae) are major crops with significant economic and socio-cultural value worldwide (Diez and Nuez, 2008). They contain various beneficial compounds like fiber, protein, carbohydrates, vitamins, minerals, andantioxidants, which are essential for human health (USDA, 2021). Turkey is the third largest producer of tomatoes and peppers globally, with the Mediterranean, Aegean and Marmara regions (FAO, 2021). Cucumber mosaic virus (CMV) is a plant virus that can infect over 1200 plant species belonging to 101 families worldwide (Jacquemond, 2012). CMV is a major pathogen that affects various crops, including cucumber, tomato, pepper and melon. The virus is transmitted by nearly 75 aphid species in a non-circulative manner and can also be transmitted through mechanical means, seeds and Cuscuta species (Palukaitis et al., 1992; Roossinck, 2001; Jacquemond, 2012). The symptoms of CMV infection on tomato and pepper plants may vary from yellowing, mottling, or mosaic of leaves, leaf deformation, narrow leaves, bushy appearance, and stunted growth, with shoe-string being the most characteristic symptom (Palukaitis et al., 1992; Akhtar et al., 2008; Zitter and Murphy, 2009; Mahjabeen et al., 2012).

Tomato and pepper production in Turkey have been facing several challenges, one of them is the cases of frequent viral disease infections that possess a constant threat to the tomato industry. In Turkey, CMV has been reported as a significant disease-causing agent, leading to reduced yield and quality of affected crops. CMV is one of the common plant viruses identified in Turkey based on various serological and molecular detection techniques (Değirmenci and Uzunoğulları, 2007; Uzunoğulları and Gümüş, 2015; Güneş and Gümüş, 2019). CMV infection has been detected in tomato and pepper plants in Turkey since 2002-2003 in Samsun, using ELISA (Arli-Sokmen and Sevik, 2006). In 2013, Uzunoğulları and Gümüş (2015) detected CMV infection in tomato and pepper samples collected from Bursa, Yalova, Istanbul, Bilecik, and Sakarya provinces using DAS-ELISA and Real-Time PCR methods, with an infection rate of 87% and 69%, respectively. This work is an attempt to characterize CMV isolates obtained from tomato and pepper growing areas of the İzmir province of Turkey based on biological indexing and RT-PCR method. Virus-inoculated test plants were visually evaluated for symptom development for 3 weeks, followed by a DAS-ELISA test with CMV-specific antibodies for further confirmation.

MATERIAL and METHODS

Virus isolates and test plants

Plant samples (Table 1) having CMV infection that had been previously acquired from tomato and pepper growing areas of the İzmir province in 2019-2022 and preserved under appropriate temperatures (-20°C or -80°C) in the department of Plant Protection of Ege University were used to carry out mechanical inoculation of the virus into different test plants consisting of *Nicotiana glutinosa*, *Nicotiana tabacum* cv. Xanthi, *Solanum lycopersicum* 'SC-2121' and *Cucumis sativus* 'Beith Alpha. After test plants inoculated with CMV isolates, they were placed to growth chambers that set to 24-25°C with a 16-h photoperiod for their growth and evaluating their symptom development.

Table 1. CMV isolates used in mechanical inoculation.

Çizelge 1. *Mekanik inokulasyonda kullanılan cucumber mosaic virus CMV izolatları.*

Name of virus isolates	Source of virus infection	Sampling year
CMV-7	pepper	2019
CMV-14	pepper	2019
CMV-29	pepper	2019
CMV-32	pepper	2019
CMV-37	pepper	2019
CMV-39	pepper	2019
CMV-62	pepper	2019
CMV-72	pepper	2019
CMV-73	pepper	2019
CMV-75	pepper	2019
CMV-77	pepper	2019
CMV-82	pepper	2019
CMV-K	tobacco	2019
CMV+TSWV-03	tomato	2022
CMV-B1	pepper	2022
CMV-B2	pepper	2022
CMV-D	tomato	2022

Biological Identification

17 plant samples were separately ground with mortar and pestles in ice box. 5 ml, 0.05 M Potassium phosphate buffer having pH 7.2 and mixed with 1% Na_2SO_3 (Iqbal et al., 2011) was added to avoid oxidation of virus particles and to facilitate their establishment into plant cells. The solution containing virus particles and buffer was filtered through a double-layered muslin cloth. Test plants were mechanically inoculated at 3-4 true-leaf stage. Celite abrasive was sprinkled over the young leaves of test plants to create micro-wounds. The ear picks dipped in the filtered solution were lightly rubbed on the wounded leaves. Virus-inoculated plants were rinsed with tap water after 3-4 minutes and left for observation for 3 weeks. The mechanical inoculation was repeated for CMV isolates that found positive in the DAS-ELISA test. ELISA-positive *N. glutinosa* plants were used to repeat the mechanical inoculation of the virus isolates into newly grown test plants made up of the same species, followed by a second ELISA and a final RT-PCR test.

DAS-ELISA test

Test plants showing symptoms or suspected of CMV infection were tested for the virus using the DAS-ELISA procedure as per the guidelines of Clark and Adams (1977) and manufacturer's protocol (Bioreba, AG Switzerland). The procedure involved loading a 96-well ELISA plate with a mixture of coating buffer and coating antibody, followed by incubation and washing. Plant leaves were then ground in sterilized bags and added to

extraction buffer. The plate was loaded with extraction buffer, positive and negative controls, and plant samples, and kept overnight in a refrigerator. The plate was then incubated with a mixture of conjugate buffer and conjugate antibody, followed by washing and loading with substrate buffer and pNPP enzyme. Color formation was observed and absorbance values were measured at 405 nm wavelength. The DAS-ELISA test was repeated for new test plants after 3 weeks of second mechanical inoculation. Samples with an absorbance value equal to or more than 2 times the value of negative control were considered positive.

Reverse transcription polymerase chain reaction

The total nucleic acid was extracted from test plants, and cDNA was synthesized, followed by RT-PCR amplification and gel electrophoresis. Only plants showing symptoms of viral presence or testing positive in the DAS-ELISA test were included in the RT-PCR test, while asymptomatic and ELISA-negative plants were excluded. The silica-based extraction method outlined by Foissac et al., (2001) was used with minor modifications. First, a mixture grinding buffer and β-mercaptoethanol was used to grind 100 mg of leaves in sterilized plastic bags. First, Sarkosyl (10%) was added to each microcentrifuge tube and incubated. The tubes were then chilled on ice and centrifuged before being moved into new tubes containing sodium iodide and silica. Ethanol was added to each tube thereafter. The tubes were then vortexed, shaken, and centrifuged. The liquid portion of the samples was discarded, leaving nucleic acids attached to silica. The tubes were washed with a mixture of washing buffer and ethanol solution. Afterward, the tubes were dried at room temperature for a few minutes and supplied with RNA-free water. The tubes were centrifuged again and the resulting liquid portion was used for further analysis. At the end of the procedure, the total RNA concentration of each sample was measured using a spectrophotometer, and the samples were stored at -20 °C for future use.

The total nucleic acid samples were converted to complementary DNAs using the ABM Onescript Plus cDNA Synthesis Kit protocol. For each sample, 5 ml of the total nucleic acid was mixed with 7.5 µl nuclease-free water, 1 µl dNTPs (10 mM), and 1 µl random primer (mM), resulting in a total volume of 9.5 µl. The mixture was briefly centrifuged and heated at 65°C for 5 minutes. Then, 4 µl 5×RT buffer, 1 µl RTase enzyme (200 U/µl), and 0.5 µl RNAse OFF Ribonuclease Inhibitor (40 U/µl) were added to each tube. The tubes were placed in a thermal cycler and subjected to cDNA synthesis for 10 minutes at 25 °C, 50 minutes at 50°C, and 5 minutes at 85°C. The resulting cDNA samples were stored at -20°C until further use.

The cDNA samples were amplified with a CMV-specific primer set (Forward: 5'ACTCTTAACCACCCAACCTT3' and Reverse: 5'AACATAGCAGAGATGGCGG3') as previously described by Faggioli et al. (2005). Firstly, 2 µl of each cDNA sample was mixed with nuclease-free water, 12.5 µl PCR master mix, 1 µl forward, and 1 µl reverse primer, resulting in a total volume of 25 µl. The samples were then subjected to denaturation, extension, and annealing with a CMV-specific program using the PE Applied Biosystems Gene Amp PCR system 9700. The thermal cycling process consisted of 95 °C for 3 minutes, followed by 35 cycles of denaturation at 94 °C for 30 seconds, annealing at 55 °C for 45 seconds, and extension at 72 °C for 45 seconds. The final extension step was performed at 72 °C for 7 minutes.

To perform gel electrophoresis, RedSafe dye (iNtRON) was added to the mixture, which was then poured onto the machine and left for 30 minutes. TAE-buffer solution was added above the gel, and individual wells were loaded with samples following the horizontal line. The gel was loaded with a 100 bp ladder and a positive control mixture, and the remaining wells were loaded with samples. The gel was visualized and photographed under

a UV-transilluminator (DNR Bio Imaging System) to detect approximately 280 base pair nucleotide bands.

RESULTS and DİSCUSSİON

Biological Identification

The CMV isolates used in this study for mechanical inoculation were found to cause disease and produce symptoms in the test plants during 3 weeks post-inoculation period. However, symptom development slightly varied depending on the virus isolates tested and the plant species used for inoculation. Among the seventeen CMV isolates used for the virus inoculation, only CMV-D and CMV-B2 isolates consistently produced symptoms in the test plants when the mechanical inoculation was repeated after successful results in the first trial. Both of these isolates were from the tomato and pepper fields of Izmir. The tomato and pepper samples had leaf curling, leaf deformation, and mosaic-like symptoms, suggesting the possibility of CMV infection before confirming with DAS-ELISA and RT-PCR tests.

Tobacco plants inoculated with CMV-D and CMV-B2 isolates produced necrotic local lesions after 4 four days on the virus-inoculated leaves. Previous literature suggests that CMV induces systemic mosaic to vein clearing in *N. glutinosa*, depending on the virus strain involved in the infection. The necrotic local lesions on inoculated leaves of tobacco implied the possibility of mixed infection of tomato and pepper samples with more than one virus. CMV-D inoculated tobacco plants started to show signs of systemic infection in its young leaves after 14 days of virus inoculation. Mosaic pattern and vein banding were observed in tobacco plants after 3 weeks of CMV-D infection (Figures 1 and 2). CMV-B2 isolate inoculated tobaccos did not produce any distinct symptoms until the end of 3 week post-inoculation period.

Figure 1. CMV-D isolate inoculated *N. glutinosa* showing mosaic, yellowing, vein banding and necrotic lesions.

Şekil 1. *CMV-D izolatı inoküle edilmiş N. glutinosa mozaik, sararma, damar bantlaşması ve nekrotik lekeler göstermektedir.*

Figure 2. CMV-D isolate inoculated *N. tabacum* cv. Xanthi showing vein banding.

Şekil 2. *CMV-D izolatı inoküle edilmiş N. tabacum cv. Xanthi damar bantkaşması göstermektedir.*

CMV-D isolate inoculated tomatoes started to produce mosaic symptoms in their emerging leaves after 2 weeks of virus inoculation. The mosaic pattern was more pronounced after 3 weeks, accompanied by a mild form of leaf deformation (Figures 3 and 4). One of the plants was stunted with reduced leaf size and showed bushy appearance (Figure 5). Similarly, CMV-B2 inoculated tomatoes started to produce mosaic patterns in their young leaves after 2 weeks of virus inoculation. The mosaic pattern became more distinct after 3 weeks of virus inoculation with lower leaves showing yellowing symptoms (Figures 6 and 7). CMV-D inoculated cucumber plants produced mild mosaic at the end of 3 weeks of post-inoculation (Figures 8 and 9). CMV-B2, on the other hand, did not produce any distinct symptoms on inoculated cucumbers, and the plants appeared to be stunted at the end of 3-week virus inoculation period (Figures 10).

Figure 3. CMV-D isolate inoculated *S. lycopersicum* 'SC-2121' showing mosaic symptoms in emerging leaves.

Şekil 3. *CMV-D izolatı inoküle edilmiş S. lycopersicum 'SC-2121' yeni gelişen yapraklarda mozaik belirtisi göstermektedir.*

Figure 4. CMV-D isolate inoculated *S. lycopersicum* 'SC-2121' showing mosaic and leaf deformation.

Şekil 4. *CMV-D izolatı inoküle edilmiş S. lycopersicum 'SC-2121' mozaik ve yapraklarda şekil bozukluğu göstermektedir.*

Figure 5. CMV-D isolate inoculated *S. lycopersicum* 'SC-2121' showing stunting, narrow leaves with bushy appearance symptoms.

Şekil 5. *CMV-D izolatı inoküle edilmiş S. lycopersicum 'SC-2121' cücelik, iplik yapraklılık ve çalılaşma göstermektedir.*

Figure 6. CMV-B2 isolate inoculated *S. lycopersicum* 'SC-2121' showing mosaic symptoms.

Şekil 6. *CMV-B2 izolatı inokule edilmiş S. lycopersicum 'SC-2121' mozaik belirtisi göstermektedir.*

Figure 7. CMV-B2 isolate inoculated *S. lycopersicum* 'SC-2121' showing mosaic and leaf yellowing symptoms.

Şekil 7. *CMV-B2 izolatı inoküle edilmiş S. lycopersicum 'SC-2121' mozaik ve yapraklarda sararma göstermektedir.*

Figure 8. CMV-D isolate inoculated *C. sativus* showing mild form of mosaic symptom.

Şekil 8. *CMV-D izolatı inoküle edilmiş C. sativus hafif şiddette mozaik göstermektedir.*

Figure 9. CMV-D isolate inoculated *C. sativus* showing mosaic symptom.

Şekil 9. *CMV-D izolatı inoküle edilmiş C. sativus mozaik göstermektedir.*

Figure 10. Reaction (stunting) of *C. sativus* inoculated with CMV-B2 isolate.

Şekil 10. *CMV-B2 izolatı inoküle edilmiş C. sativus'un gösterdiği reaksiyon (cücelik).*

DAS-ELISA test

The DAS-ELISA test was conducted on CMV-suspected or symptomatic test plants after 3 weeks of the first mechanical inoculation. As a result, CMV-D and CMV-B2 inoculated test plants were found to be positive for the presence of CMV. The ELISA-positive tobacco plants inoculated with these two isolates were used to repeat the mechanical inoculation of the virus isolates into newly grown test plants of the same species as before. Symptom development was monitored for another 3 weeks. However, in the second DAS-ELISA test, only CMV-D inoculated test plants gave CMV-positive results. On the other hand, CMV-B2 inoculated test plants gave CMV-negative results, even though the virus-inoculated tomatoes were showing mosaic symptoms. Test plants inoculated with the rest of the isolates either failed to produce any distinct symptom in the test plants and/or failed to give CMV-positive results after the first mechanical inoculation and thus removed from the experiment.

One of the isolates, named CMV+TSWV-03, contained both CMV and tomato spotted wilt virus (TSWV). When inoculated into the test plants, it induced necrosis of leaves in tobacco and tomato. However, it did not produce any distinct symptoms in cucumber during 3-week evaluation period. The infected plants, when tested for the DAS-ELISA using specific antibodies of both CMV and TSWV, gave positive results for TSWV but negative results for the presence of CMV. Therefore, it was later removed from the experiment.

RT-PCR

Test plants inoculated with CMV-D that displayed symptoms and tested positive for CMV in the second DAS-ELISA test, as well as CMV-B2-inoculated tomatoes that exhibited symptoms of viral infection but had negative ELISA results for CMV, were selected for RT-PCR analysis. The process of RT-PCR involved the extraction of total nucleic acid, followed by cDNA synthesis, PCR amplification, and finally, gel electrophoresis. The measurement of total RNA concentration present in the samples was performed, and the results suggested that test plants inoculated with both of these isolates had enough concentration of RNA. When samples were converted to cDNA, they were subjected to RT-PCR amplification with a CMV-specific primer set. This was followed by gel electrophoresis to visualize the results. Out of all the test plants, only those inoculated with CMV-D showed positive PCR results, producing a 280 bp nucleotide band in the agarose gel upon visualization under a UV transilluminator. The PCR test yielded positive results for 5 test plants in total. CMV-B2 isolate inoculated tomato samples, on the other hand, failed to produce any bands as a result of gel electrophoresis and thus came out to be negative for the presence of CMV (Figure 11).

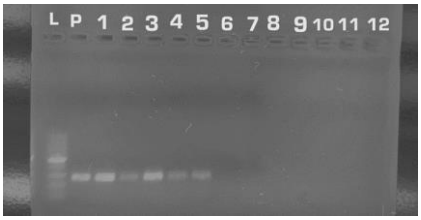

Figure 11. RT-PCR results of CMV-D and CMV-B2 inoculated test plants (L:DNA ladder; P:positive control; 1-12:samples).

Şekil 11. *CMV-D ve CMV-B2 inokule edilmiş test bitkilerinin RT-PCR sonuçları (L:DNA ladder; P:pozitif kontrol; 1-12:örnekler).*

The type and severity of symptom development induced by CMV in its host can vary depending on the sensitivity and age of the host plant, environmental factors such as temperature, and the viral strain involved in infection (Green and Kim, 1991; Palukaitis et al., 1992; Salánki et al., 2018). This study was carried out to characterize the isolates of CMV virus based on biological assaying and RT-PCR methods. When seventeen CMV plant samples were mechanically inoculated into different test plants (*N. glutinosa, N. tabacum* cv. Xanthi, *S. lycopersicum* 'SC-2121', and *C. sativus* 'Beith Alpha'), the results of biological characterization showed that both CMV-D and CMV-B2 isolates consistently induced CMV-like symptoms. This was observed upon repeated inoculation using a similar experimental setup. *N. glutinosa* has been extensively used as a propagative host for CMV in an experimental setting where the viral strains have caused systemic mosaic to vein yellowing with varied severities (Değirmenci and Uzunoğulları, 2007). CMV-D induced systemic mosaic in tobacco and cucumber, and it caused mosaic, stunting, and bushy appearance in tomato, during 3 weeks of the evaluation period. CMV-B2 induced mosaic and yellowing of leaves in tomato, stunting in cucumber, and no distinct symptom in tobacco. Tomato is a significant host for CMV, and the symptoms that appear can vary depending on factors such as the viral strain and the presence of other factors. These symptoms may include mosaic patterns, mottling, leaf deformation, reduced leaf size, a bushy appearance, stunting, and the appearance of shoe-string-like structures on the leaflets (Değirmenci and Uzunoğulları, 2007; Zitter and Murphy, 2009; Mahjabeen et al., 2012). Similarly, CMV infection in cucumber could result in mosaic, vein clearing, and leaf deformation (Değirmenci and Uzunoğulları, 2007). The PCR test is considered to be more sensitive than both biological indexing and serology-based tests for virus detection in plants. Researchers have emphasized the importance of using more than one method for better detection and reliable results for plant viruses (Legrand, 2015; Hou et al., 2020).

DAS-ELISA test with CMV-specific antibodies was conducted for virus-inoculated test plants, in which both CMV-D and CMV-B2 inoculated plants were found to be positive. However, only CMV-D inoculated test plants found to be positive in the second DAS-ELISA test, which was conducted after the second mechanical inoculation. Similarly, only CMV-D inoculated test plants were found to be CMV-positive by RT-PCR. The absence of positive results for CMV in the final ELISA and PCR test for the CMV-B2 inoculated test plants may indicate that this viral isolate was unable to establish itself in the test plants after the second mechanical inoculation. It is possible that the reason for this failure is the presence of another virus or some unforeseen factor, which may require further investigation to understand. A separate study might be needed to find out the underlying reason and mechanisms in more detail. Faggioli et al. (2005) used a primer set similar to the one used in this study to detect the presence of CMV in olive plants suspected of being infected. The primer set amplified the coat protein coding region of the viral genome, resulting in approximately 280 bp nucleotide bands, indicating the presence of the virus. In this study, CMV-D inoculated test plants consistently gave positive results for CMV based on biological assays, DAS-ELISA, and final RT-PCR tests. The results of biological

characterization of the CMV isolate used in this study align with the results of previous similar studies mentioned above. An additional study of CMV-D isolate could be achieved by performing its genome sequencing and phylogenetic analysis to better understand the viral strain involved in infection. However, further studies should be conducted.

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OP-10

Full Text Proceeding

(Tam Metin Bildirisi)

Current situation of the Citrus longhorned beetle, *Anoplophora chinensis* Forster (Coleoptera: Cerambycidae) in Türkiye

Turunçgil uzun antenli böceği, *Anoplophora chinensis* Forster (Coleoptera: Cerambycidae)'nin Türkiye'deki durumu

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Keywords: *Anoplophora chinensis*, eradication, invasive insects

Anahtar sözcükler: *Anoplophora chinensis*, eradikasyon, istilacı böcekler

ABSTRACT

Objective: The citrus longhorned beetle, *Anoplophora chinensis* Forster (Coleoptera: Cerambycidae) is considered to be one of the most destructive, wood-boring invasive pests. Since its first report in Türkiye, it has infested new areas and started to become an important pest in agricultural areas. In this study, the infested areas and the studies carried out are reviewed and the precautions to be taken are mentioned.

Material and Methods: Infestations of *Anoplophora chinensis* in Türkiye are listed according to the survey results conducted by the Ministry of Agriculture and Forestry in this paper.

Results: Following the first detection, this pest has been reported from seven provinces of Türkiye and eradication efforts are still continuing.

Conclusion: Since it is forbidden to grow host plants in infected areas until completely eradicated, it is of great importance to prevent new infections as they significantly affect agricultural production and economy.

ÖZ

Amaç: Turunçgil uzun antenli böceği, *Anoplophora chinensis* Forster (Coleoptera: Cerambycidae) en tahripkar, doku içi istilacı zararlılardan biri olduğu kabul edilmektedir. Türkiye'de ilk tespitinden bu yana yeni alanlara bulaşmış ve tarımsal alanlarda önemli bir zararlı haline gelmeye başlamıştır.Bu çalışmada bulaşma alanları ve yürütülen çalışmalar gözden geçirilerek alınması gereken önlemlere değinilmiştir.

Materyal ve Yöntem: Bu çalışmada Tarım ve Orman Bakanlığı tarafından yürütülen sürvey sonuçlarına göre *Anoplophora chinensis* bulaşmaları verilmiştir.

Araştırma Bulguları: İlk tespitinin ardından, bu zararlı Türkiye'de yedi ilde tespit edilmiştir ve eradikasyon çalışmaları devam etmektedir.

Sonuç: Bulaştığı alanlarda tamamen eradike edilene kadar konukçusu olan bitkilerin yetiştirilmesi yasak olduğu için tarımsal üretimi önemli şekilde etkilemesi nedeniyle yeni bulaşmaların önlenmesi büyük önem taşımaktadır.

INTRODUCTION

The Citrus longhorn beetle, *Anoplophora chinensis* Forster (Coleoptera: Cerambycidae), is recommended to be listed as a quarantine pest species by EPPO. While it is considered the most important wood boring pest of citrus in Japan (Adachi, 1989), it is also considered as one of the most destructive wood boring invasive species. Although the native habitat of *A. chinensis* is East Asia, it has been distributed in China, Japan, Korea, as well as in Malaysia, Myanmar, Taiwan, Vietnam, Indonesia and the Philippines. As an invasive species, it has also been reported in Denmark, Croatia, Finland, France, the United Kingdom, Switzerland and Italy. Eradication programs have been implemented in the USA, Denmark, the Netherlands and Germany to control this pest. Although adults can spread by flying over a distance of more than 2 km, they are carried longer distances by plant material (Adachi, 1990). Main contaminations occur especially with the import of *Acer* spp. and the other host plants from East Asia and other infested countries.

In Türkiye, it was first reported as an alien insect species in 2014 by Hızal et al. (2015). It was first recorded on *Acer palmatum, A. saccharum* and *Salix caprea* trees in a nursey in Istanbul and despite eradication efforts, it continued to spread. In 2016, it was reported on *A. negundo* L. trees in Antalya by Topakçı et al. (2017), later reported on *A. palmatum purperea*, *A. negundo flamingo* and *A. platanoides* plants imported from China in Bartın province by Yıldız et al. (2017). In the same year Eroğlu et al. (2017) reported *A. chinensis* on *A. palmatum* in Trabzon province. Authors state that the pest may have spread from Istanbul to Trabzon by ornamental plants used for landscaping near the constructions built for the European Youth Olympics Games 2011. After the detection on ornamental trees in Trabzon, *A. chinensis* began to spread in hazelnut orchards surrounding the first infested area. Till 2017, *A. chinensis* was an urban pest for Türkiye fauna, but in Trabzon it begun to be an important pest of hazelnut which is the most important export product for the agricultural economy of Türkiye. According to Cavagna et al. (2013) in Italy approximately 18.6% of the infested plants are *Corylus* spp. and the hazelnut trees are the second most infested plants in Lommbardy region. As seen from the Italy example hazelnut production is in the threat of this pest and spread of this pest should be restricted. In this study, the spread of the pest in Türkiye was revealed and the measures that should be taken to prevent new infestations were emphasized.

MATERIAL and METHODS

Surveys

Anoplophora chinensis surveys in the hazelnut production areas, given in Figure 1, were carried out between 2018 and 2022 years by the Provincial Directorates of Agriculture and Forestry in accordance with the *'Citrus longhorned beetle survey instructions*', determined by the Ministry of Agriculture and Forestry (Anonymus, 2021). Surveys were carried out at least once a year in areas where the pest was unknown. In the infested provinces, periodical surveys were conducted monthly during the year. Agricultural areas with known host plants, nurseries and the places where plant materials imported from abroad are located, distributed and stored were examined. Parks, gardens, private gardens and landscape plants where imported plants can be planted in urban areas were also examined. Visual signs of the presence of *Anoplophora chinensis*; a) larvae galleries and holes opened by first instar larvae by peeling off the bark, b) adult exit holes are generally 10-15 mm in diameter, although it varies between 6-20 mm, c) sawdust debris resulting from feeding and adult exit holes, d) swelling on the trunk, color change and deformation of the bark tissue in saplings, e) flying adults, adults feeding on the green parts of the plant and feeding scars, f) traces of adults laying their eggs on the tree were examined during

the surveys. Survey results were reported monthly to the Hazelnut Research Institute. In this study, only the locations where contamination was detected as a result of the surveys are given chronologically.

Figure 1. Hazelnut production and survey areas in Türkiye.

RESULTS and DİSCUSSİON

After the first detection of *Anoplophora chinensis* in Trabzon, monitoring surveys has been started in a 2 km radius area. In Trabzon, after the monitoring surveys 108.2 hectars of hazelnut orchard was found infested + buffer zone in Maçka in 2018 (Figure 2).

Figure 2. Infested and buffer zones according to a) 2018, b) 2019 surveys in Trabzon.

In order to limit the spread of *A. chinensis* in Maçka district of Trabzon, insecticide applications were carried out against adults, but the insect was detected in 250 ha in 2020 surveys. While eradication efforts were continuing in Trabzon, new contaminations has been detected in Sakarya and Kocaeli provinces. This has been the first report of *A. chinensis* from Sakarya and Kocaeli provinces. In July and September surveys totally 71.82 decars of hazelnut orchards were found to be infested in Arifiye district of Sakarya and all of the infested trees were removed immediately. Also it was detected in July and August surveys in Başiskele district of Kocaeli province. In 2020, totally 55 trees were found to be infested and all the infested plants were removed in Kocaeli. In addition to eradication of infested plants, insecticide application against adults in 5 decars of hazelnut orchards were carried out during the summer.

In 2021, the infested area in Trabzon enlarged to 409 ha and the pest was detected also in Ortahisar district (Figure 3). That year 400 hectars of hazelnut orchards were eradicated, insecticide applications were carried out against the adults in the infested arae. The government made a compensation payment of 2.6 dollars per kg in order to cover the income losses of hazelnut producers who cutted hazelnut trees in return for not re-establishing hazelnut orchards for 4 years of prohibition period (Turan and Erdoğan, 2022).

Figure 3. Infested and buffer zones according to 2021 surveys in Trabzon.

In July of 2021 new infested plants were detected in Başiskele district of Kocaeli. Infested 17 plants were removed and insecticide applications were carried out in 25 decars of hazelnut orchards in order to eliminate any adults of the pest which could be unobserved. Also the pest was detected again in Arifiye disrict of Sakarya province in that year. Totally 29.06 decars of hazelnut orchards were infested and the plants in these area had been eradicated in the same year. In 2021, out of hazelnut production areas, the pest was detected on ornamental trees in Diyarbakır province (unpublished) and it was stated that all the infested host plants were removed under the control of Directorate of Diyarbakır Agriculture and Forestry.

In 2022, *A. chinensis* was found on an alder tree in a hobby garden in the city center of Rize province, based on a sample came from producer to the Directorate of Rize Agriculture and Forestry. In the surveys carried out within a 2 km radius, feeding scars of adults were detected on *Acer* spp. trees near the infested plant and two *Acer* spp. plants were found with exit holes in a nursery. The infested plants in the nursery were eradicated under the control of Directorate. During the monitoring surveys, 120 infested and suspicious plants has been detected.

In 2023, *A. chinensis* was detected in Sakarya for the third time near the Hendek, Düzce border. Monitoring surveys are continuing around the infested trees. Since the first detection of *A. chinensis* in 2014 in Istanbul, within 9 years it has been reported from 7 provinces of Türkiye (Figure 4). Cavagna et al. (2013) states that the Lombardy Region of Italy has been engaged in survey and eradication efforts against the *A. chinensis* invasion since 2000 and studies have been carried out in 4 provinces and over 70 municipalities in an area of 400 km^2. Eradication efforts in Lombardy Region consisted of removing about 30.000 trees under the supervision of the Plant Protection Service. Since 2004, year of implementation of the contingency plan till 2015, 20 millions Euros have been spent by the local authorities for tree removal, stump grinding, replantation, survey and monitoring, public awareness campaigns, and scientific research (Maspero, 2015). Turan and Erdoğan (2022) states that by the end of 2021, 539 growers were paid of about 1.975,000 $ for compensation in Türkiye. Compensation payments will continue in 2024, according to Official Gazette dated 10/11/2023 and numbered 32365. In the Plant Quarantine Compensation Support Implementation Communiqué; the total amount for hazelnuts is stated as 555.5 $ /decare for the 4-year quarantine period (Anonymus, 2023).

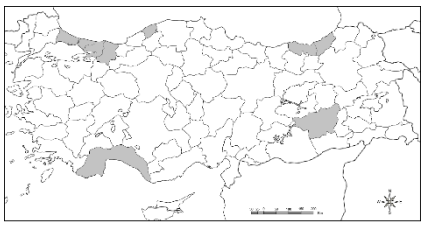

Figure 4. Infestation map of *Anoplophora chinensis* Forster in Türkiye as of 2023.

Since the active spread of *Anoplophora chinensis* is very restricted, most of the infestations has been due to transportation of living plant material. The fact that *A. chinensis* infestations have been detected in agricultural areas or urban areas in Türkiye except Trabzon (in nursery), indicates that the pest may have been spread by living plant materials bought from an infested nursey and because of that pest has emerged populations in that areas in previous years, so it is possible that new infestation points may be found in these provinces or in new provinces. Also this situation shows that nurseries in the infested provinces should be checked strictly by periodical surveys having been conducted by the Ministry of Agriculture and Forestry.

Infested plants are eradicated and nationwide surveys are conducted to detect new infestations in Türkiye. Insecticides are applied against adult beetles in quarantine and buffer zones to support the eradication of infested and host plants. Research is being conducted to understand its biology and behavior to limit its spread. In addition, quarantine measures should be carried out more carefully in the import and transportation of host plants from infected regions and countries.

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OP-12

Full Text Proceeding

(Tam Metin Bildirisi)

Determination of reactions of pistachio rootstocks to some important soil pathogens

Antepfıstığı anaçlarının bazı önemli toprak patojenlerine karşı reaksiyonlarının belirlenmesi

This article was supported by the Rectorate of Siirt University, Agriculture and Livestock Coordination Center, as project number 2021-SİÜİHT-ZİR-07

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Keywords: Disease reactions, pistachio rootstocks, soil athogens,.

Anahtar sözcükler: Hastalık reaksiyonları, Antepfıstığı anaçları, Toprak patojenleri,

ABSTRACT

Objective: Pistachio cannot be grown economically everywhere due to the special climatic requirements. Southeastern Anatolia is the only region in Turkey where pistachios are produced economically. Soil-borne fungal pathogens that cause root rot, wilting and dying are the most important problems in pistachio production. The aim of this study is to investigate how some rootstocks respond to significant soil pathogens.

Material and Methods: In this study, seven rootstocks *Pistacia khinjuk* L. (Buttum), *Pistacia terebinthus* L. (Menengiç), UCB1 (*Pistacia Atlantica* x *P. integerrima*), and four standard pistachio rootstocks from *Pistacia vera* L (Siirt, Halabi, Kırmızı, and Uzun) were evaluated against four pathogens (*Rhizoctonia solani* Rs2, *Fusarium solani* KY1, *Fusarium proliferatum* FÖY1-5, and *Macrophomina phaseolina* FÖY1-7). Following the preparation of pathogen inoculums, 25 g of each was contaminated into the root zone of 1-year-old saplings. Regular irrigation and cultural processes were implemented throughout the experiment, which was conducted in a greenhouse with four replications. The evaluation noted drying and defoliation of plants throughout the experiment. In the final stage, the saplings were carefully removed and assessed on a 0-5 scale, considering the symptoms observed in both the root and root collar.

Research Findings and Conclusion : The rootstocks exhibited varying degrees of disease reactions to pathogens. Generally, Menengiç, Buttum, and UCB1 demonstrated lower susceptibility to diseases caused by pathogens, whereas Kırmızı, Uzun, Halebi, and Siirt displayed the highest disease rates, respectively. Furthermore, the most pathogenic isolates on the rootstocks were identified as *F. solani* KY1, *R. solan*i Rs2, *M. phaseolina* FÖY1-7, and *F. proliferatum* FÖY1-5, respectively.

ÖZ

Amaç: Antepfıstığı özel iklim istekleri nedeniyle ekonomik olarak her yerde yetiştirilememektedir. Güneydoğu Anadolu, Türkiye'de antepfıstığının ekonomik olarak üretildiği tek bölgedir. Antepfıstığındaki en önemli problemlerden biri de kök çürüklüğü, solgunluk ve kurumaya neden olan toprak kökenli fungal patojenlerdir. Bu çalışmanın amacı antepfıstığında bazı anaçların önemli toprak patojenlerine karşı nasıl tepki verdiğini araştırmaktır.

Materyal ve Yöntem: Çalışmada *Pistacia khinjuk* L. (Buttum), *Pistacia terebinthus* L. (Menengiç), UCB1 (*Pistacia Atlantica* x *P. integerrima*) ve *Pistacia vera L* menşeli dört standart antep fıstığı anacı (Siirt, Halabi, Kırmızı ve Uzun) olmak üzere yedi anaç kullanılmıştır. Bu anaçların *Rhizoctonia solani* Rs2,

Fusarium solani KY1, *Fusarium proliferatum* FÖY1-5 ve *Macrophomina phaseolina* FÖY1-7 patojenlerine karşı reaksiyonları değerlendirilmiştir. Patojen inokulumları, 1 yaşındaki fidanların kök bölgesine her birinden 25 g bulaştırılmıştır. Deneme, sera koşullarında 4 tekerrürlü olarak yürütülmüştür. Değerlendirmede, Deneme süresince yaprak döken ve kuruyan bitkiler kayıt edilmiş, Son aşamada fidanların kök ve kök boğazında oluşan belirtiler dikkate alınarak 0-5 skalasına göre değerlendirilmiştir.

Araştırma Bulguları ve Sonuç: Anaçlar patojenlere karşı değişen oranlarda hastalık reaksiyonları göstermişlerdir. Genel olarak Menengiç, Buttum ve UCB1 patojenlerin neden olduğu hastalıklara karşı daha düşük duyarlılık gösterirken, sırasıyla Kırmızı, Uzun, Halebi ve Siirt en yüksek hastalık oranlarına yakalanmışlardır. Ayrıca anaçlar üzerinde en patojen izolatların sırasıyla *F. solani* KY1, *R. solani* Rs2, *M. Phaseolina* FÖY1-7 ve *F. proliferatum* FÖY1-5 olduğu belirlenmiştir.

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INTRODUCTION

Pistachio (*Pistacia vera* L.) has its origins in Asia Minor, Iran, Syria, Lebanon, the northern Caucasus, Turkmenistan, and Afghanistan. Wild or semi-wild forms of this tree have been cultivated in Afghanistan, Northwest India, Iran, Turkey, Syria, and other countries in the Near East and North Africa for many years (Eskalen et al., 2001). The top five pistachio-producing countries in the world include the United States, Iran, Turkey, China, and Syria, followed by India, Greece, and Pakistan. In Turkey, the total pistachio cultivation area spans approximately 370 thousand hectares, with an average annual production of 158,000 tons.

The economic cultivation of pistachio is confined to specific regions due to its distinct climatic requirements. In Turkey, intensive pistachio cultivation is carried out in the Southeastern Anatolia Region. Pistachio production faces various limiting factors, including periodicity, climatic conditions, fertilization, nutrition, diseases, and pests.

A significant limiting to pistachio production is plant diseases, with increasing complaints from producers in the Siirt province about the drying of some trees in pistachio orchards in recent years. Upon examination of the affected trees, infections in the roots leading to root rot were observed. Previous studies have reported that drying in pistachio trees causing by pathogens such as *Verticillium dahliae*, *Macrophomina phaseolina*, *Rhizoctonia solani*, and certain *Fusarium* species (Banihashemi, 1995; Aminaee and Ershad, 1999; Anonymous, 2008; Aydın, 2019; Crespo Palomo et al., 2019; Aydin and Ünal, 2021;Aydın et al.,2023).

The responses of varieties and rootstocks are crucial in controlling these significant pathogens. Developing or identifying resistant varieties has proven to be one of the effective methods for controlling soil-borne pathogens worldwide.

Pistachio varieties grown in Turkey include 'Uzun,' which is cultivated in the Antep and Urfa regions and has an oval or plump shape, and those cultivated in the Siirt region. The rootstocks comprise Buttum (*Pistacia khinjuk* L.), Menengiç (*Pistacia terebinthus* L.), and Atlantic mastic (*Pistacia atlantica* L.) (Tekin et al., 2001). The UCB-1 rootstock, of American origin, has seen an increase in planting areas in recent years. Various studies have reported different levels of tolerance to abiotic factors for these varieties and rootstocks (Epstein et al., 2005; Fani et al., 2006; Atlı et al., 2014; Yaşar et al., 2014). However, the reactions of these varieties and rootstocks against soil pathogens, significant biotic factors, have not been investigated in Turkey. One of the most significant studies globally is the development of the UCB-1 pistachio rootstock in California, USA as a against the *Verticillium dahliae* pathogen. (Epstein et al., 2004).

The objective of this study is to assess the responses of varieties and rootstocks to certain crucial soil pathogens previously identified in the Siirt region.

MATERIALS and METHODS

In this study, three rootstocks (*Pistacia khinjuk* L., *Pistacia terebinthus* L., and UCB-1) were employed, along with four standard pistachio rootstocks derived from *Pistacia vera* L (Siirt, Halebi, Kırmızı, and Uzun). Some of these materials were acquired from seeds, while others were procured as saplings from nurseries. The reaction experiment was conducted on one-year-old saplings. The inoculum was prepared by combining wheat grain, bran, and corn flour (100g wheat + 10g corn) with distilled water (200 ml). Subsequently, the mixture underwent sterilization twice in an autoclave at 121°C for 15 minutes. Aliquots were then taken from cultures of *Fusarium solani* KY1, *Rhizoctonia solani* Rs2, *Macrophomina phaseolina* FÖY1-7, and *Fusarium proliferatum* FÖY1-5, which had been grown on Potato Dextrose Agar (PDA) for a week. These aliquots were added to the sterile mixture in the bottle. After a three-week incubation period, 25g of the inoculum was applied to the root zone of each sapling. The experiment, conducted with four replications, involved maintenance operations such as periodic watering and weeding throughout the trial period.

Assessment

The evaluation of disease symptoms caused by pathogens on the rootstocks took place four months after establishing the experiment. The saplings were removed and assessed for root rot, crown rot, and wilt using a 0-5 scale. In this scale, 0 indicates no lesion, and the plants are considered healthy. Ratings progress as follows: 1 indicates damage to 20% of the roots or slight wilting of the upper parts; 2 indicates root damage ranging from 21 to 40% and the loss of some lateral roots or 1/3 wilting of the upper parts; 3 indicates root damage ranging from 41 to 60% and the loss of most lateral roots or half wilting of the upper parts; 4 indicates root damage ranging from 61 to 80%, and the loss of most lateral roots or 3/4 wilting of the upper parts, while 5 indicates root damage ranging from 81 to 100%, and the loss of all lateral roots or complete wilting of the upper parts.

The results were evaluated by rating the severity of disease symptoms for each replicate. The percent of disease severity was calculated using *Equation 1* (Towsend and Heuberger 1943).

$$\text{Severity of disease (\%)} = \Sigma\ (n \times V) \times 100 / Z \times N \qquad \text{(Eq.1)}$$

In the equation; n is the number of plants in different damage groups, V is degree of damage into groups, N is total number of plants subjected to control, and Z is the highest scale value.

Data were evaluated using analysis of variance; Differences between means were compared with the Least Significant Difference test. All statistical analyzes were performed using JMP 13 statistical software.

RESULTS and DISCUSSION

The experiment with 1-year-old seedlings in the greenhouse was evaluated four months after inoculum contamination. Drying and defoliation of plants were noted throughout the assessment. In the final stage, saplings were removed and assessed based on a 0-5 scale, considering symptoms in the root and root crown. The evaluation results are presented in Table 1 and Figure 1

Table 1. Disease reactions of pistachio rootstocks against some pathogens (%)

Tablo 1. Antep fıstığı anaçların bazı patojenlere karşı hastalık reaksiyonları (%)

	Pathogens			
Rootstock	*R.solani* Rs2	*F.solani* KY1	*F.proliferatum* FÖY1-5	*M.Phaseolina* FÖY1-7
Buttum (*Pistacia khinjuk* L.)	50,0^{defg*}	25,0^{h}	40,0^{efgh}	30,0^{gh}
Menengiç (*Pistacia terebinthus* L.)	60,0^{bcde}	35,0^{fgh}	30,0^{gh}	35,0^{fgh}
UCB-1	40,0^{efg}	60,0^{bcde}	35,0^{fgh}	40,0^{efgh}
Siirt (*Pistacia vera* L)	65,0^{abcd}	70,0^{abcd}	70,0^{abcd}	70,0^{abcd}
Halebi (*Pistacia vera* L)	80,0^{ab}	80,0^{ab}	80,0^{ab}	55,0^{cdef}
Kırmızı (*Pistacia vera* L)	65,0^{abcd}	70,0^{abcd}	70,0^{abcd}	85,0^{a}
Uzun (*Pistacia vera* L)	85,0^{a}	80,0^{ab}	80,0^{ab}	75,0^{abc}

* According to Duncan's multiple test, the difference between the same letters in the same column is insignificant with P < 0.01.

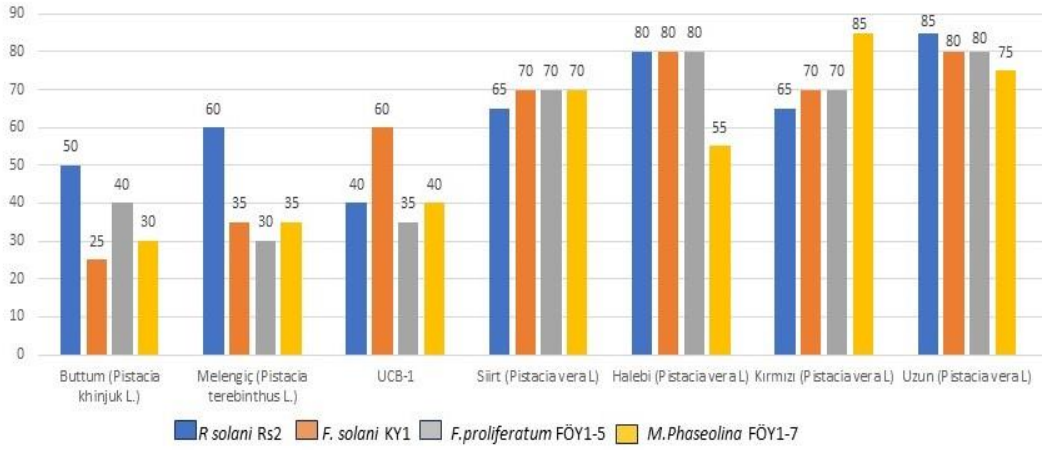

Figure 1. Disease reactions of pistachio rootstocks against some pathogens (%)

Şekil 1. Antep fıstığı anaçların bazı patojenlere karşı hastalık reaksiyonları (%)

Based on the data in Table 1 and Figure 1, different disease reactions are observed among rootstocks against pathogens. Kırmızı, Uzun, and Halebi appear to be the most sensitive rootstocks to *R solani* Rs2, *M. phaseolina* FÖY1-7, and *F. proliferatum* FÖY1-5. Conversely, Buttum and Melengiç emerge as the most tolerant varieties against *F. solani* KY1. Additionally, isolates *F. proliferatum* FÖY1-5 and *R solani* Rs2 exhibit lower effectiveness, causing only 40% disease on the UCB-1 rootstock. Uzun exhibited the highest susceptibility among the rootstocks to all pathogens, followed by Halebi, Kırmızı, and Siirt, respectively. In general, Buttum, Melengiç, and UCB-1 were the rootstocks least affected by all pathogens, respectively. While some rootstocks demonstrated a certain degree of tolerance to more than one pathogen, they also displayed greater sensitivity to other pathogens. For instance, Buttum, a significant rootstock in the Siirt region, showed a 25.5% infection rate by *F. solani* KY1 but was affected by *R. solani* Rs2 at a rate of 50%. Similarly, Melengiç was 60% more affected by *R. solani* Rs2 than by other pathogens. The appearance of some rootstocks is presented in Figure 2 during the trial evaluation phase.

Figure 2. Symptoms of pathogens on some rootstocks; (A) *R. Solani* Rs2 on Uzun, (B) *M. phaseolina* FÖY1.7 on Halebi, (C) *F. Solani* KY1 on UCB-1, (D) *F. proliferatum* FÖY1.5 on Uzun, (E) *M. phaseolina* FÖY1.7 on UCB-1, (F) *F. Solani* KY1on Uzun

Şekil 2. Bazı anaçlarda patojenlerin oluşturduğu belirtiler; A) Uzun üzerinde *R. Solani* Rs2, (B) Halebi üzerinde *M. phaseolina* FÖY1.7, (C) UCB-1 üzerinde *F. Solani* KY1, (D) Uzun üzerinde *F. proliferatum* FÖY1.5, (E) UCB-1 üzerinde *M. phaseolina* FÖY1.7, (F) Uzun üzerinde *F. Solani* KY1

Controlling the disease is particularly challenging due to the persistent nature of soil pathogens, such as *Rhizoctonia* and *Fusarium*. These pathogens can survive in the soil for extended periods, possess competitive abilities, exhibit rapid growth, and have a broad host range (Lewis and Papavizas, 1991; Åström and Gerhardson, 1988; Saremi et al., 2010). Therefore, it is imperative to explore alternative methods, such as tolerant varieties or biological control. Notably, in the California region of the United States, tens of thousands of pistachio trees were cut down in recent years due to *Verticillium dahliae* infections, a significant soil pathogen. Extensive research on resistant varieties has been conducted, leading to the development of the UCB-1 rootstock (Epstein et al., 2004). Based on the findings of this study, recommending Buttum and Menengiç as rootstocks would be more appropriate, especially in areas facing challenges in controlling soil pathogens.

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OP-13

Full Text Proceeding

(Tam Metin Bildirisi)

Determination of The Effectiveness of Some Fungicides Against Root Rot and Wilt Diseases in Pistachio

Antep Fıstığında Kök Çürüklüğü ve Solgunluk Hastalıklarına Karşı Bazı Fungisitlerin Etkinliğinin Belirlenmesi

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Keywords: Pistachio, fungicide application, *Phytophthora spp., Fusarium spp*,.

Anahtar sözcükler: Antepfıstığı, Fungisit uygulaması, *Phytophthora spp., Fusarium spp*,.

ABSTRACT

Objective: The most significant challenges in pistachio production arise from soil-borne fungal pathogens, leading to issues such as root rot, wilting, and plant mortality. Globally recognized as major threats to pistachio cultivation, Phytophthora species and Verticillium dahliae top the list of critical soil pathogens. However, under conditions of high temperature and low humidity, pathogens like *Rhizoctonia solani*, *Fusarium* spp., and *Macrophomina phaseolina* (Tassi) Goid. are anticipated to cause substantial economic damage. The objective of this study was to determine the effectiveness of certain fungicides [Bellis® (25.2% Boscalid + 12.8% Pyraclostrobin, 80 g/100 L) and Optix-R® (20% Fosetyl-Al + 15% Tribasic copper sulfate equivalent to metallic copper, 500 g/100 L)] against root rot and wilt pathogens (*Fusarium* spp. and *Phytophthora* spp.) in pistachio in southeastern Turkey.

Material and Methods: Fungicide applications were carried out in two pistachio orchards. The first orchard was identified as infected with *Phytophthora* spp., while the second was infected with *F. solani* and *Fusarium* spp. Four sprayings were conducted, twice for each fungicide, with two-week intervals. To achieve this, the soil around the roots and crown of the trees was stripped, and both this area and the trunk were thoroughly sprayed using a knapsack sprayer to ensure thorough wetting. The experiment was arranged with four replications, each consisting of three trees. In the evaluation phase, the roots and root collar of the trees were inspected for infection and categorized as non-infected or infected.

Research Findings and Conclusion: The effectiveness rate of fungicides in the orchard contaminated with *Phytophthora* spp. was 68.75%, while in the orchard contaminated with *Fusarium* spp., this rate was found to be 43.75%.

ÖZ

Amaç: Antepfıstığı üretimindeki önemli sorunlardan biri de toprak kökenli fungal patojenlerden kaynaklanmaktadır. Bu patojenler kök çürüklüğü, solgunluk ve bitki ölümlerine yol açmaktadır. Antepfıstığı yetiştiriciliğinde Dünya genelinde büyük tehdit olarak kabul edilen patojenler, *Phytophthora* türleri ve *Verticillium dahliae* dır. Ancak yüksek sıcaklık ve düşük nem koşulları altında *Rhizoctonia solani*, *Fusarium* spp. ve *Macrophomina Phaseolina* gibi patojenler öne çıkmakta ve büyük ekonomik zararlara yol açmaktadır. Bu çalışmanın amacı bazı fungisitlerin [Bellis® (%25,2 Boscalid + %12,8 Pyraclostrobin, 80 g/100 L) ve Optix-R® (%20 Fosetyl-Al + %15 Tribazik bakır sülfat eşdeğer metalik bakır, 500 g/100 L)] antepfıstığında kök çürüklüğü ve solgunluk patojenleri olan *Fusarium* spp. ve *Phytophthora* spp. karşı etkinliğini belirlemektir.

Materyal ve Yöntem: İki farklı antepfıstığı bahçesinde deneme kurulmuştur. Birinci bahçedeki ağaçların *Phytophthora* spp. ile, ikinci bahçenin ise *F. solani* ve *Fusarium* spp. ile daha önce enfekteli olduğu belirlenmiştir. Denemede her fungisit için iki hafta arayla ikişer kez olmak üzere dört ilaçlama yapılmıştır. Uygulamalarda ağaçların kök ve kök boğazının etrafındaki topraklar kaldırılmış ve bu kısımlar ile gövde kısmı sırt pülvirizatörü ile ıslatılmıştır. Denemede her parsel üç ağaçtan oluşmuş ve dört tekerrürlü olarak kurulmuştur. Değerlendirme

aşamasında ağaçların kökleri ve kök boğazı enfeksiyon açısından incelenmiş ve hasta-sağlam olarak kayıt edilmiştir.

Araştırma Bulguları ve Sonuç: *Phytophthora* spp. ile bulaşık bahçede fungisitlerin etkinlik oranı % 68,75 iken, *Fusarium* spp. ile bulaşık bahçede ise bu oran, %43,75 olarak bulunmuştur.

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INTRODUCTION

The leading pistachio producers globally are the United States of America, Iran, and Turkey, followed by India, Syria, Greece, and Pakistan. In Turkey, the total pistachio cultivation area is approximately 380,000 hectares, with an average annual production of 160,000 tons. The province of Siirt ranks third in Turkey, with a cultivation area of 36,000 hectares and a production of 31,000 tons (TurkStat 2020).

The incidence of various diseases and pests has risen with the expansion of the cultivation area. Tree mortality, attributed to soilborne pathogens, is notably widespread in orchards. During the initial phase, wilting and defoliation become evident in the upper parts of trees, accompanied by browning and darkening observed in the roots, along with crown rot on deceased trees. These soilborne pathogens can lead to the development of root rot, crown rot, and wilting, ultimately causing significant damage to pistachio trees. In the extensive literature, the following pathogens have been described as crucial causal agents: *Armillaria mellea* (Vahl) P. Kumm, *Phymatotrichopsis omnivore* (Shear) Hennebert, *Eutypa lata* (Persoon: Fries) Tulasne and C. Tulasne, *Cytospora terebinthi* Bres*., Phytophthora capsici* Leonian, *Phytophthora citricola* Sawada, *Phytophthora citrophthora* (Smith and Smith) Leonian, *Phytophthora cryptogea* Pethybr.& Laff., *Phytophthora nicotianae* Breda de Haan., *Scelerotinia sclerotiorum* (Lib) de Bary, *Rhizoctonia solani* Kühn., *Verticillium dahlia* Kleb., and *Fusarium* spp. Link. (Chitzanidis 1995; Michailides et al. 1995; Eskalen et al. 2001; Teviotdale et al. 2002; Türkölmez et al. 2015; Aydın and Ünal 2021;Aydın et al.,2023).

Currently, in Turkey, there are no licensed fungicides specifically targeting soil pathogens responsible for drying in pistachio trees. Nevertheless, in recent years, new formulations have been developed to control certain soil pathogens and have received licensing for application on specific plants. It has become imperative to research and test preparations with the potential to effectively control soil pathogens in pistachio trees. Notably, Fosetyl-Al has been licensed for use against brown and stem rot disease (*Phytophthora citrophthora*), significant diseases in citrus fruits (Anonymous, 2008). Some previous studies have reported success in applications against Phytophthora species on various plants. Fosetyl-Al, for instance, is licensed for combating brown rot and stem gummy disease (Phytophthora citrophthora), both of which are significant diseases in citrus fruits (Anonymous, 2008). Moreover, Turkölmez and Derviş (2017) conducted tests using the fungicides Fosetyl-Al and phosphorous acid against root and crown rot caused by Phytophthora palmivora on apricot and cherry trees in the Southeastern Anatolia Region. The study found that both Phosphorous acid and Fosetyl-Al significantly reduced root rot.

Fusarium species typically induce seed, seedling, root, crown rot, and wilt in plants. As a consequence of vascular bundle blockage, symptoms progress to wilting and drying in advanced stages (Arie, 2019). It has been reported that certain *Fusarium* species, such as *F. solani*, *F. equiseti*, and *F. proliferatum,* cause diseases in pistachio orchards and nurseries (Triki et al., 2011; Nouri et al., 2018; Cerespo et al., 2019; Aydın et al., 2023).

In this study, certain fungicides, although not licensed, were tested for their potential effectiveness against root rot and wilt disease in pistachio under field conditions.

MATERIALS and METHODS

The trials were conducted in the Kayabağlar and Dikilitaş locations in the Siirt province, which were found to be naturally contaminated. In surveys conducted a year ago, it was determined that the first garden was infected with *Phytophthora* spp, and the second garden was infected with other *Fusarium* spp., especially *Fusarium solani*. The fungicides used in the trials are listed in Table 1.

Table 1. Fungicides Used in the Experiment, Ingredient Substances, and Dosages

Tablo 1. Denemelerde kullanılan fungisitler, etkili maddeler ve dozları

Commercial name	Effective ingredient	Usage Dosage
Bellis®	%25,2 Boscalid + %12,8 Pyraclostrobin	80 g/100 L
Optix-R®	%20 Fosetyl-Al + %15 Tribasic copper sulfate equivalent to metallic copper	500g/100 L

The experiment was set up in orchards with rows measuring 6 m and 8 m, and tree ages ranging from 15 to 25 years. Four trees were selected in each plot. Spraying was conducted a total of four times, with a two-week interval between each application and twice for each fungicide (1st spraying: April 25, 2023; 2nd spraying: May 10, 2023; 3rd spraying: May 25, 2023; and 4th spraying: June 10, 2023). To achieve this, the soil around the roots and crown parts of the trees was scraped, and the root and trunk parts were moistened using a knapsack sprayer. The experiment was arranged with four replications following a randomized block trial design, with four trees identified in each plot.

Assessment

Evaluation took place in the second week of July. Treated trees in each plot were compared with untreated trees in the control plot and categorized as unhealthy/healthy. After counting the plants, the disease percentage of the trees, classified as healthy and diseased, was determined. The percentage effects of the fungicide were calculated by applying the Abbott formula

$$\text{Efficiency (\%)}: (X-Y) \times 100/X$$

X: Average disease severity in positive control plots (%)
Y: Average disease severity in treated plots (%)

The significance of differences between treatments was assessed through analysis of variance, and the LSD test was employed to compare treatment means at a significance level of $P < 0.05$.

RESULTS and DISCUSSION

Trial controls were conducted periodically, and the evaluation was carried out after a sufficient level of disease was observed in the untreated plots. The results of the evaluations are presented in Table 1 and Figure 1.

Table 2. Effectiveness of Fungicide in Orchard Contaminated with Pathogens

Tablo 2. Patojenlerle bulaşık bahçelerde fungisitlerin etkinliği

Bahçe No	Patojen	Average of Replications (%)	% Effect According to Abbott
1	The effectiveness of the fungicide in the orchard contaminated with *Phytophthora spp.*	31,25 c	68,75
1	Control	100,0 a	-
2	The effectiveness of the fungicide in the orchard contaminated with *F. solani* ve *Fusarium* spp.	56,25 b	43.75
2	Control	100,0 a	-

* According to Duncan's multiple test, the difference between the same letters in the same column is insignificant with $P < 0.05$.

Figure 1. Effectiveness of Fungicide in Orchard Contaminated with Pathogens

Şekil 1. Patojenlerle bulaşık bahçelerde fungisitlerin etkinliği

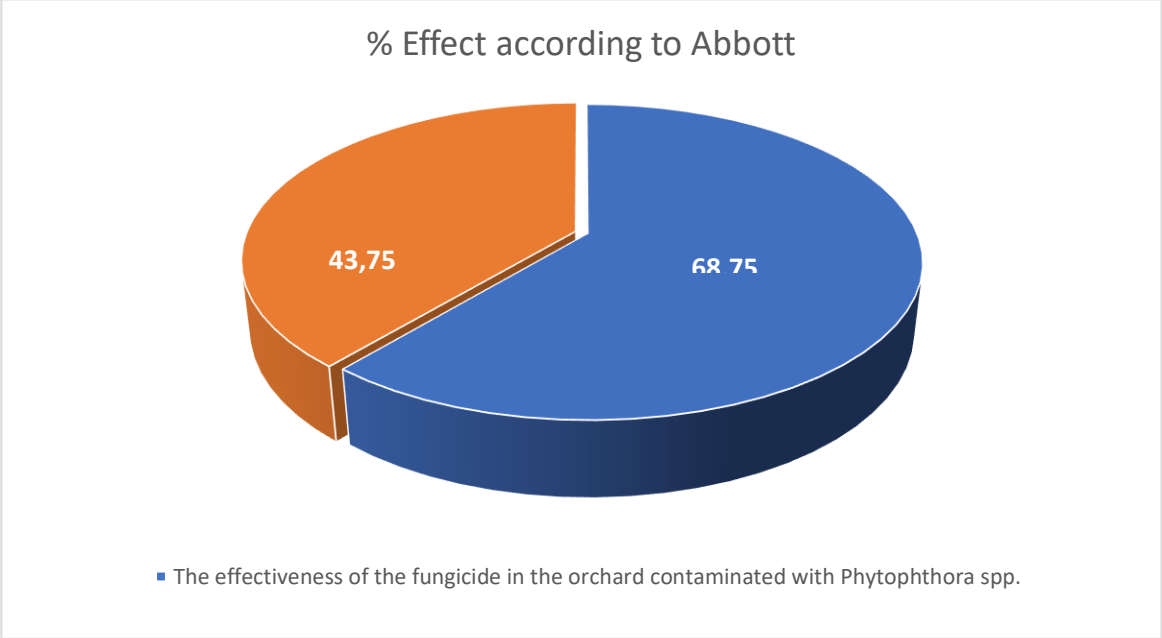

Table 1 and Figure 1 illustrate the effectiveness of the pesticides in both orchards. It is evident that the applications were effective to a certain extent in both cases. However, the effectiveness of the applications in the second orchard is notably lower than in the first. Specifically, the effectiveness rate of fungicides in the orchard infested with *Phytophthora* spp was 68.75%, while this rate was observed to be 43.75% in the orchard infested with *F.solani* and *Fusarium* spp.

Fosetyl-Al and metalaxyl-M are systemic fungicides commonly employed against Oomycetes members. Phosphorous acid, also systemic, is a degradation product of fosetyl-Al. It is transported from the shoots and sprouts of the plant to the roots, exerting both direct and indirect effects on Phytophthora species. Directly, it inhibits a specific process (oxidative phosphorylation) in the metabolism of oomycetes. Indirectly, it stimulates the plant's defense mechanism against pathogen attacks (McGrath, 2004; Smillie et al., 1989). Turkölmez and Derviş (2017) conducted tests on the fungicides Metalaxyl-M+Mancozeb, Fosetyl-Al, and Phosphorous acid against root and crown rot caused by *Phytophthora palmivora* on apricot and cherry in the Southeastern Anatolia Region. The study revealed that Phosphorous acid, Fosetyl-Al, and Metalaxyl-M+Mancozeb significantly reduced root rot. Notably, Fosetyl-Al (aluminum tris-O-ethyl phosphonate) and Metalaxyl-M+Mancozeb are employed to control various diseases caused by *Phytophthora* spp. in several fruit species (Gisi and Sierotzki, 2008).

The commercial preparation Bellis® exhibits both protective and preventive effects, being transported translaminarly and locally systemically. Pyraclostrobin, one of its active substances, belongs to the strobilurin group. This ingredient is naturally derived and is known to induce growth-promoting effects in certain plants (Vincelli, 2002). Nevertheless, the targeted level of effectiveness against *Fusarium* was not attained in the infested orchard.

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OP-22

Full Text Proceeding

(Tam Metin Bildirisi)

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Anahtar sözcükler: emisyon azaltma, gübre depolama, Metan, nitröz oksit, sürdürülebilir hayvancılık.

Greenhouse Gas Emission Mitigation Strategies for Manure Management in Dairy Cattle Farms

Süt Sığırcılığı Gübre Yönetiminde Sera Gazı Emisyonunu Azaltma Stratejileri

ABSTRACT

Objective: In developing animal husbandry, the share of greenhouse gases such as manure-derived methane (CH4) in global warming has increased and emission reduction efforts have been accelerated. CH4 released in ruminants accounts for 37% of global CH4 emissions. Manure management in dairy farming consists of manure collection, storage and evaluation stages. Each of these stages is seen as an emission source and different mitigation strategies are developed for each manure management stage.

Material and Methods: In this study, emission reduction strategies that can be applied at every stage of manure management (collection, storage and evaluation) in dairy cattle were examined.

Results: Increasing the frequency of manure collection during the manure collection stage reduces CH_4 emissions by up to 55%. In the manure storage stage, accumulating the manure in leak-proof tanks and covering the manure surface with natural or synthetic covering materials are very effective methods in reducing emissions. By reducing the storage time of manure, by 75% reduction in CH4 emissions can be achieved. In the manure evaluation stage, using manure in biogas production reduces CH_4 emissions by 41% -75% and completely prevents N_2O emissions. Similarly, composting manure is one of the most effective emission mitigation strategies.

Conclusion: In order to reduce manure-related emissions in dairy cattle farms in Turkey, it is necessary to develop the manure management infrastructure in accordance with the examined strategies and at the same time to determine strategies suitable for country conditions.

ÖZ

Amaç: Gelişen hayvancılıkta, gübre kaynaklı metan (CH_4) gibi sera gazlarının küresel ısınmadaki payı artmış ve emisyon azaltma çalışmalarına hız verilmiştir. Geviş getiren hayvanlarda ortaya çıkan CH_4, küresel CH_4 emisyonunun %37'sini oluşturmaktadır. Süt sığırcılığında gübre yönetimi gübre toplama, depolama ve değerlendime aşamalarından oluşmaktadır. Bu aşamaların her biri emisyon kaynağı olarak görülmekte ve her bir gübre yönetim aşaması için farklı emisyon azaltma stratejileri geliştirilmektedir.

Materyal ve Yöntem: Bu çalışmada, süt sığırcılığında gübre yönetiminin her aşamasında (toplama, depolama ve değerlendirme) uygulanabilecek emisyon azaltıcı stratejiler incelenmiştir.

Araştırma Bulguları: Gübrenin toplanmasında; toplama sıklığını arttırmak CH_4 emisyonlarında %55'e kadar azalma sağlamaktadır. Gübre depolamada ise gübreyi sızdırmaz depolarda biriktirmek ve doğal veya sentetik örtü materyalleri ile gübre yüzeyini örtmek emisyon azaltımında oldukça etkili yöntemlerdir. Gübre depolama süresini kısaltarak CH_4 emisyonlarında %75 oranında azalma sağlanabilmektedir. Gübre değerlendirme aşamasında ise gübreyi biyogaz üretiminde kullanmak CH_4 emisyonlarında %75 oranında azalma sağlarken, N_2O emisyonlarını ise tamanen önlemektedir. Benzer şekilde gübreyi kompostlaştırmak da emisyon azaltımında oldukça etkin stratejilerinden biridir.

Sonuç: Türkiye'deki süt sığırcılığı işletmelerinde gübre kaynaklı emisyonun azaltılabilmesi için gübre yönetim altyapısının incelenen strajilere uygun biçimde geliştirilmesi ve aynı zamanda ülke koşullarına uygun stratejilerin belirlenmesine ihtiyaç duyulmaktadır.

INTRODUCTION

GREENHOUSE GAS EMISSIONS AND EMISSION SOURCES IN DAIRY CATTLE MANURE MANAGEMENT

In animal barns, various gases are emitted into the environment resulting from feed, animal respiration and microbial decomposition in manure. Manures in different forms and other materials mixed with these manure (litter, feed, wastewater) are the main sources of gases formed in animal shelters. Methane (CH4), nitrogen monoxide (nitrous oxide) (N2O), carbon dioxide (CO2) and ammonia (NH3) have an important place among greenhouse gas emissions originating from animal production. Since the residence time of greenhouse gases in the atmosphere is quite long (N2O approximately 100 years, CH4 approximately 8.4 years), they have a global impact, causing ozone layer depletion and global warming (IPCC, 2001).

In the IPCC (2001) Climate Change Report, it was reported that the global warming potential of N2O is 296 times that of carbon dioxide and constitutes approximately 4% of the total global warming potential. It has been reported that the global warming potential of CH4 is 23 times greater than carbon dioxide. Again, in the said report, it was stated that CO2 emissions resulting from animal production do not contribute to atmospheric CO2 concentration in the long term, as they are part of the carbon cycle.

It is estimated that the intensification of livestock farming activities in the European Union (EU) causes increasing environmental impacts on soil, water and air, and that agriculture in the EU contributes 49% of CH4 gas emissions to the atmosphere and 63% of N2O gas emissions. In this context, in studies conducted on reducing greenhouse gas emissions caused by manure management, it has been reported that most of the CH4 gas emissions from manure come from the storage stage of manure management, and N2O emissions come from the application stage of animal manure to the field (Gebrezgabher et al., 2014).

Many studies show that animal production is the main source of some polluting factors such as particulate matter, odor, volatile organic compounds, especially pollutant gases, released into the atmosphere. For this reason, in accordance with the Kyoto Protocol, relevant institutions of many countries, especially EU countries, have created various regulations regarding emissions from animal shelters, keep animal production enterprises under control and have implemented various measures to reduce or control emission rates. Another of these measures, the EU nitrate directive, aims to reduce water pollution caused by nitrate from agriculture, while the EU air quality directive determines the limits of ammonia and nitrogen oxide gas emissions released into the atmosphere (Oenema, 2004).

When the total CH4 gas emissions resulting from manure management in Turkey are examined, it is understood that the largest share in this emission belongs to the cattle species, with a rate of 78% (TUIK, 2009). Due to the increase in capacity in dairy cattle farms, there is an increase in the amount of manure and, accordingly, the extent of environmental pollution increases. For this reason, it has become very important to use environmentally acceptable disposal methods of animal waste such as manure (Deri, 2022).

In studies conducted on the detection and reduction of manure-induced greenhouse gas emissions in dairy cattle enterprises; Storage areas such as slurry tanks and lagoons, where manure in different forms are accumulated for a long time, and hard manure piles stacked in the open, as well as hard surfaces such as shelter floors and animal crawl spaces, where urine and other materials mixed with manure (bedding, feed, wastewater, etc.) are located. It has been stated that open areas with ground floors and storage

structures where slurry and liquid manure are stored are important sources of manure-related greenhouse gas emissions (Figure 1). (Svensson and Ferm, 1993; Husted,1994; Svensson, 1994; Livingston and Hutchinson, 1995; Misselbrook et al., 1999; Kaharabata et al., 2000; Osada et al., 2001; Misselbrook et al., 2001; Hutchinson and Livingston, 2001; Ellis et al., 2001; IPCC, 2001; Brown et al., 2002; Sommer et al., 2004(a); Hensen et al., 2005; Livingston et al., 2006; Amon et al., 2006; IPCC, 2006; Sneath et al., 2006; Gupta et al., 2007; Padron vd., 2008; UNFCCC, 2008; Gao et al., 2011; Popita, 2012; Frunzeti and Baciu, 2012; Vac et al., 2013; Gallardo, 2013; Owen and Silver 2014; de Klein and Harvey, 2015; Won et al.,2020).

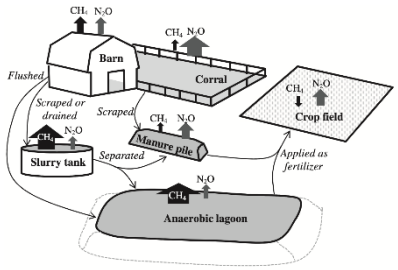

Figure 1. Greenhouse gas emissions resulting from manure management in dairy cattle farms (Owen and Silver, 2014).

Şekil 1. Sığır çiftliklerinde gübre yönetiminden kaynaklanan sera gazı emisyonları (Owen ve Silver, 2014).

Bacterial activities in animal manure increase depending on the ambient temperature, so ambient temperature is extremely effective in manure-induced greenhouse gas emissions. For this reason, greenhouse gas emissions from manure decrease in autumn and winter months and increase significantly in summer months. Similarly, in countries with high annual average temperatures, greenhouse gas emissions from manures increase significantly compared to countries in cold climate zones. (Misselbrook et al.,1999; Ellis vd., 2001; Rodhe et al., 2009; Cárdenas et al., 2021).

In the study conducted by Borhan et al (2011), greenhouse gas emissions were directly measured at various emission points in a 500-head, free-stall dairy cattle farm. Measured emission values varied according to each measurement point and season. The total CH4 and N2O gases released in the summer months were 5.3 and 2.2 times higher, respectively, compared to the winter months. It has been reported that the reason for this seasonal change is the increase in gas emissions as a result of the warming of the weather in the summer months, the increase in the temperature of the manure and the microbial activity in the manure. It has been emphasized that liquid and slurry manure tanks, in particular, contribute to 99% of the total CH4 emissions measured during the summer, and therefore CH4 reduction strategies should be directed to these emission sources.

In this study, emission reduction strategies that can be applied in manure management in dairy cattle are discussed separately for manure management stages (collection, storage and evaluation) and the targets achieved in the strategies developed at each stage are presented.

EMISSION REDUCTION STRATEGIES AND APPLICATION RESULTS IN MANURE MANAGEMENT

Dairy cattle manure management has three stages: removal of manure from shelters, storage of the removed manure and evaluation of the stored manure. Applications at each stage affect greenhouse gas emissions. It is possible to control emissions by applying emission-reducing strategies in the manure management stages.

In the studies examined, during the manure collection phase; increasing the frequency of manure collection by using scraper systems on slatted floors (Figure 2), at the manure storage stage; Emphasis was placed on covering the fertilizer tank surface with mulch, impermeable covers and geomembranes. The strategy of sealing the warehouse surface is based primarily on the principle of reducing emissions by preventing the operation of bacteria responsible for the production of greenhouse gases. In the evaluation of manure, measures such as composting the manure, using it in a biogas facility, and applying slurry and/or liquid manure by injection to the plant production area have been suggested (Figure 3) (Bicudo et al., 2004; Burns and Moody, 2014; Wei et al., 2021).

(a) (b)

Figure 2. Slatted floors and scraper system application in barn.

Şekil 2. Ahırda kullanılan ızgara zemin ve kazıyıcı sistem uygulaması.

(a) (b)

(c)

Figure 3. Emission-reducing practices in manure storage: (a) Covering the storage surface with mulch (Bicudo et al., 2004), (b) Covering the storage surface with an impermeable cover (Anonymous, 2022e), (c) Geomembrane for anaerobic digestion of the storage surface Closing with (Anonymous, 2022f).

Şekil 3. Gübre depolama alanındaki emisyon azaltma uygulamaları: (a) Depolama yüzeyini malç ile kaplama (Bicudo et al., 2004), (b) Depolama yüzeyini geçirimsiz bir örtü ile kaplama (Anonymous, 2022e), (c) Depolama yüzeyinin anaerobik sindirim için geomembran ile kapatılması (Anonymous, 2022f).

(a) (b)

(c)

Figure 4. Emission-reducing manure evalution practices: (a) Composting (Anonymous, 2022g) (b) Biogas production (Anonymous, 2022h) (c) deep injection (Anonymous, 2023).

Şekil 4. Emisyon azaltma gübre değerlendirme uygulamaları: (a) Kompostlama (Anonymous, 2022g), (b) Biyogaz üretimi (Anonymous, 2022h), (c) Derin enjeksiyon (Anonymous, 2023).

Strategies suggested in studies on reducing greenhouse gas emissions at each stage of manure management in dairy cattle enterprises and the goals of these strategies; They are summarized in Table 1 for the manure collection stage in the shelter, Table 2 for the manure storage stage and Table 3 for the manure evaluation stage.

Table 1. Emission reduction strategies and goals in barn.

Çizelge 1. Ahırda emisyon azaltma stratejileri ve hedefleri.

Strategies		Achieved Goals	Literature
1) Changing the frequency of manure collection	Increasing the frequency of manure collection	Provides about 50% reduction in CH_4 emissions	*Haeussermann et al., 2006*
		Provides about 55% reduction in CH_4 emissions Provides about 41% reduction in N_2O emissions	*Mohankumar et al., 2018*
		3% - 40% reduction in total greenhouse gas emissions	*Sommer et al. 2009*
		Provides total greenhouse gas emissions reduction	*Chadwick et al., 2020* *Philippe et al.,2007*
		23% to 80% reduction in NH_3 emissions is achieved	*Hamelin et al., 2010*
		Provides about 46% reduction in NH_3 emissions	*Lachance et al., 2005*

2) Changing the manure collection system	Using a manure scraper system	Provides reduction in CH_4 emissions	*Ross et al, 2021*
	Washing with pressurized water	Provides 15 % reduction in NH_3 emissions	*Misselbrook et al., 2006*
	Washing with pressurized water and formalin	Provides 50 % reduction in NH_3 emissions	*Misselbrook et al., 2006*
3) Changing the barn floor	Using Slatted floors in barns	Provides about 41% -%100 reduction in N_2O emissions	*Ellis et al., 2001* *Misselbrook et al., 2001*

Table 2. Emission reduction strategies and goals in manure storage.

Çizelge 2 Çiftlik gübresi depolama alanında emisyon azaltma stratejileri ve hedefleri.

Strategies			Achieved Goals	Literature
1) Covering manure tanks surfaces	a) use of permeable-floating covers	Allowing the manure surface to form a natural crust	Provides 38 % reduction in CH_4 emissions.	*Sommer et al., 2000*
			Provides 50 % reduction in NH_3 emissions	*Misselbrook et al.,2005*
			Provides 80 % reduction in NH_3 emissions	*Sommer et al. 1993*
		Covering the manure surface with straw mulch	Provides 13 % reduction in NH_3 emissions	*Wei et al., 2021*
			A 10cm layer of straw can reduce NH_3 emissions by 61%. A 20-30 cm layer of straw can reduce NH_3 emissions by 90 %.	*Bicudo et al., 2004*
		Covering the manure surface with wood mulch	In liquid manure, provides 2 % to 15 % reduction in CH_4 emissions	*Wei et al., 2021*

			In liquid manure, provides 37 % to %9 reduction in NH_3 emissions	
			It has been stated that the reduction in N_2O emissions varies seasonally.	
		Covering the manure surface with a mixture of wood and straw mulch	İn liquid manure provides 19 % - 8% reduction in CH_4 emissions.	*Wei et al., 2021*
			In liquid manure provides 21 % - 43% reduction in NH_3 emissions.	
	b) use of airproof covers	Covering the lagoon Surface with geomembrane	provides 54 % reduction in CH_4 emissions	*Rodhe et al., 2009*
		Suni filmler ile örtme	provides some reduction in NH_3 and CH_4 emissions	*Burbi,2015*
		Reducing the surface area of slurry ponds and lagoons	In liquid and slurry manure provides 4o% reduction in total greenhouse emissions.	*Chadwick et al., 2020*

Table 2. Emission reduction strategies and goals in manure storage (continue).

Çizelge 2 Çiftlik gübresi depolama alanında emisyon azaltma stratejileri ve hedefleri.(Devam)

Strategies		Achieved Goals	Literature
2) Improving Storage Technique	Reducing storage time	Provides 75% reduction in CH_4 emissions.	*Wei et al., 2021*
	Completely emptying the slurry manure tank	Provides %6 reduction in CH_4 emissions and %49 in total greenhouse gas emissions.	*Wood et al., 2014*
	Storage of manure by separation into solid and liquid forms	Provides 22% - 80% reduction in CH_4 emissions. 2% -72% reduction in NH_3 emissions. 22% reduction in CO_2 emissions.	*Burbi, 2014*
		Provides 30% reduction in CH_4 emissions and in total greenhouse gas emissions.	*Grossi et al., 2018*
	Reducing the temperature of the warehouse and fertilizer with a cooling system	Provides 30%-50% reduction in CH_4 emissions and in total greenhouse gas emissions.	*Borhan et al., 2012*

Table 3. Emission reduction strategies and goals in manure evaluation.

Çizelge 3. Çiftlik gübresi değerlendirme alanında emisyon azaltma stratejileri ve hedefleri.

Strategies	Achieved Goals	Literature
1) Anaerobic digestion	Provides about 75% reduction in CH_4 emissions.	*Burbi, 2014*
	40% in total greenhouse gas emissions reduction and reduce N_2O emissions by 100%.	*Wei et al., 2021*
2) Composting	In static composting, a 60% reduction in NH3 emissions can be achieved. Monthly rotational composting can reduce N2O emissions by 46% and CH4 emissions by 89.8%.	*Burbi, 2015*
	Increasing the frequency of rotation from 1 to 2 times per week in rotary composting can reduce CH4 emissions by 50%.	*Wei et al., 2021*
3) Acidification*	Reduction in CH4, N2O and NH3 emissions if pH < 5.0 40% reduction in CH4 emissions if pH 4.5-5.0 87% reduction in CH4 emissions, 83% reduction in NH3 emissions	*Burbi, 2014* *Houy, 2015*
	Provides emission reduction in CH_4, N_2O and NH_3	*Sommer et al. 2009*
4) Use of slurry and solıd manure ın biogas production	Provides total greenhouse gas emissions reduction.	*Chadwick et al., 2020*
5) Application of liquid manure to the land by injection	Shallow (surface) injection 70-73% and deep injection is provide 90% reduction in NH3 emissions. Both injection methods can reduce N2O emissions, but the rate of reduction varies depending on soil conditions.	*Wei et al., 2021*

* Acidification: %70 It is kept at pH 5.5 by adding 70% H_2SO_4 (Sulfuric acid). This option can be applied to both slurry manure and liquid manure formed after separation (Petersen et al., 2012 ; Chadwick et al.,2020; Sokolov, 2021)

RESULTS and DISCUSSION

Greenhouse gases originating from manure in animal production activities, especially in dairy cattle farming, pose a major environmental risk. For this reason, studies on the development of methods and strategies that can be applied at each stage of fertilizer management to reduce the emission of greenhouse gases continue intensively.

In this study, emission reduction strategies that can be applied in the collection, storage and evaluation stages of manure management in dairy cattle are discussed in detail and the strategies suggested at each stage are summarized in tables. Increasing the frequency of manure collection during the collection phase reduces CH4 emissions by up to 55%. During the storage phase, accumulating the manure in sealed warehouses and covering the manure surface with natural or synthetic cover materials are very effective methods in reducing emissions. Additionally, by reducing the storage time of manure, a 75% reduction in CH4 emissions can be achieved. In the evaluation phase, using manure in biogas production provides a 75% reduction in CH4 emissions and completely prevents N2O emissions. Similarly, composting manure is a very effective strategy in reducing emissions.

In our country's animal husbandry activities and especially in dairy cattle farms; There is no adequate manure management infrastructure (such as grid floor arrangement and scraper systems in shelters, leakage tanks, and biogas and compost facilities for manure utilization) that will reduce emissions. For this reason, in dairy cattle farms, it is necessary to first install grid-based manure scraper systems in the shelters, to build leak-proof manure storage tanks/lagoones with sufficient capacity, and to improve the storage conditions of open-surface manure tanks by covering them with natural crusting, mulch or permeable/impermeable materials. In addition, it is recommended to compost the stored manure or utilize it in biogas facilities, and to apply slurry and/or liquid manure by injection into the plant production area. In addition, in our country, which is in the process of harmonizing with the European Union Green Deal, there is a need for studies on the development of methods suitable for the climatic conditions of our country that will effectively reduce greenhouse gas emissions caused by manure.

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OP-23

Full Text Proceeding

(Tam Metin Bildirisi)

Testing of Microbiological Contamination of Fresh Lettuce (*Lactuca sativa* L.)

Taze Marulun (*Lactuca sativa* L.) Mikrobiyolojik Kontrolü

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Keywords: Baking soda, *Lactuca sativa* L. (letuce), microbiological safety, swabs

Anahtar sözcükler: Baking soda, *Lactuca sativa* L. (marul), mikrobiyolojik güvenlik, sürüntüler

ABSTRACT

Material and Methods: The microbiological saffety of 15 samples of fresh salad (Lactuca sativa L.) purchased at two different locations in the city of Sarajevo, Markale and Otoka were analysed. Sampling swabs were performed at the beginning of May 2021 to the total number of 160 swabs. Swabs for microbiological analysis were taken from samples of fresh salad in two independent repetitions before and after washing in tap water for 10 minutes. As a separate independent treatment, lettuce samples were immersed in a 2% solution of baking soda (NaHCO3) and after 15 minutes swabs were taken for microbiological examination as in other samples. Microbiological tests were performed on the total number of aerobic mesophilic bacteria, the total number of yeast and mold, enterobacteria, E. coli and Salmonella according to the Rulebook on performing microbiological analyzes (Official Gazette of Bosnia and Herzegovina No. 11/13) and according to the Rulebook on microbiological criteria for foodstuffs.

Results: The average value of total aerobic mesophilic bacteria in case of unwashed specimens ranged from 0.11 - 0.41 CFU/ml, in the case of washed samples of 0.07 - 0.35 CFU/ml, and soda treated samples 0.01 - 0.11 CFU/ml.

ÖZ

Materyal ve Yöntem: : Saraybosna şehrindeki Markale ve Otoka bölgelerinde satın alınan 15 adet taze marul örneğinin (*Lactuca sativa* L.) mikrobiyolojik güvenliği analiz edildi. Numune sürümleri Mayıs 2021'in başlarında gerçekleştirilmiş olup toplamda 160 sürüm yapılmıştır. Mikrobiyolojik analiz için örneklerden alınan sürüntüler, taze salata örneklerinin iki bağımsız tekrarında yıkama öncesi ve yıkama sonrasında 10 dakika boyunca musluk suyunda yıkanmasından sonra alınmıştır. Ayrı bağımsız bir işlem olarak marul örnekleri, %2'lik bir karbonat ($NaHCO_3$) çözeltisine batırıldı ve 15 dakika sonra diğer örneklerde olduğu gibi mikrobiyolojik inceleme için sürüntüler alındı. Mikrobiyolojik testler, toplam aerob mesofilik bakteri sayısı, toplam maya ve küf sayısı, enterobakteriler, *E. coli* ve Salmonella sayısı üzerinde gerçekleştirildi. (Bosna-Hersek Resmi Gazetesi No. 11/13'e göre mikrobiyolojik analizlerin gerçekleştirilmesi) ve gıdalara yönelik mikrobiyolojik kriterler hakkındaki Yönetmelik'e göre yapılmıştır.

Araştırma Bulguları: Yıkanmamış örneklerde toplam aerob mesofilik bakteri ortalama değeri 0.11 ile 0.41 CFU/ml arasında değişirken, yıkanmış örneklerde

0.07 ile 0.35 CFU/ml arasında ve karbonat işlem görmüş örneklerde 0.01 ile 0.11 CFU/ml arasında değişim göstermiştir.

INTRODUCTION:

The leaves of green vegetables are most often consumed raw, and thus can transmit pathogenic microorganisms and/or their toxins and are sometimes involved in the occurrence of food-borne illness caused by bacteria. Fresh fruits and vegetables are essential parts of healty diet because fresh products are a prominent source of nutrients, different types of vitamins and minerals (Slavin and Loyd 2012, Santareli et al 2017, Bhilwadikar et al., 2019). But unfortunately, a number of foodborne diseases have been noticed due to the consumption of raw and contaminated fruits and vegetables (Ifra Tun Nur, 2021). Since they are typically eaten raw and often without heat treatment or thorough washing, so they serve as vectors for the transmission of pathogenicmicro-organisms associated with human diseases. Lettuce (*Lactuca sativa* L.) is a vegetable available throughout the year and is always consumed minimally processed. Due to its low calorie content and pleasant refreshing taste, salad is recommended as a healthy food and is often the main ingredient in many diets. It contains vitamins, minerals, fibers and other valuable biological ingredients and makes this type of vegetable a high-quality choice and is consumed without heat treatment in order to preserve thermolabile nutritional components. Salad is considered a healthy food because it facilitates the cleansing of the body, improves digestion and increases appetite (Beart et al. 2011). In addition to its proven nutritional and medicinal properties, salad is considered one of the most contaminated products with pathogenic microorganisms.

Previous studies have shown worrying levels of potentially pathogenic microorganisms in green vegetables, including lettuce (Topalić-Trivunović et al. 2013). These potential pathogens include thermotolerant coliforms and intestinal parasites, especially in vegetables grown in traditional and organic farming systems. Poor sanitary conditions in rural and urban areas often lead to the transfer of pathogenic microorganisms to these vegetables, primarily through the use of irrigation water and fertilizers contaminated by animal and/or human faecal waste.

Presence of pathogenic microorganisms in salad

Lettuce (Lactuca sativa L.) can become contaminated with pathogenic microorganisms in contact with soil, manure, inadequately composted fertilizers, irrigation, post-harvest washing with contaminated water, contact with wild animals, as well as in contact with infected food workers. It is very important to study the procedures between sowing and harvesting crops in order to understand how certain microorganisms can be associated with plants in the pre-harvest period (Topalić-Trivunović et al. 2013, Agency for Food Safety B and H, 2012).

Salad must not contain pathogenic and potentially pathogenic microorganisms in quantities that adversely affect human health. These microorganisms act directly and can cause various forms of infections, or indirectly, through the toxins produced by the microorganism in food products. Microorganisms that can be detected most often in salad samples are *aerobic mesophilic bacteria,* yeasts and molds, *enterobacteria*, *E. coli* and *Salmonella* (Duraković, 1996).

Human pathogens such as *Shigella spp., Salmonella spp.,* enterohemorrhagic *Escherichia coli, Campylobacter spp., Listeria monocytogenes, Yersinia enterocolitica, Bacillus cereus* and *Clostridium botulinum* are most often present on fresh products, i.e. fresh vegetables and fruits that are mostly consumed fresh. *Enterobacteria*, that is, the *Enterobacteriaceae group*, or intestinal bacteria, represent a group of bacteria found in the digestive system of humans and animals. Some species are permanent residents, while others are found only in diseased organisms (Duraković, 1996, Sago et al. 2003). These bacteria, in part, form part of the normal, i.e., physiological intestinal flora. They include

both pathogenic and conditionally pathogenic bacteria. Some species cause only intestinal diseases, and some also cause diseases of the respiratory or urinary system (Bear et al, 2011, Berger et al, 2010).

MATERIAL AND METHODS:

In these studies, microbiological analyzes of 15 samples of fresh lettuce (*Lactuca sativa* L.) purchased at two different market locations in the city of Sarajevo were performed. Swab sampling was carried out at the beginning of May 2021. A total of 160 swabs were taken. Swabs for microbiological analyzes were taken from samples of fresh lettuce in two independent repetitions before and after washing with a jet of water for 10 minutes. Swabs were taken from the face and back of the lettuce leaves of the outer and central leaves using the system of the current and found conditions. Then the salad samples were washed under running water for 10 minutes and the same procedure was repeated.

At the end, as a special independent treatment, salad samples were immersed in a 2% solution of baking soda (NaHCO3) and after 15 min. were drained and dried on a paper towel and then swabs were made for microbiological examination. Microbiological tests were performed on the total number of: *aerobic mesophilic bacteria*, total yeasts and molds, *enterobacteria*, *E.coli* and *Salmonella* according to the Rulebook on performing microbiological analyzes (Official Gazette of BiH 11/13) and according to the Rulebook on microbiological criteria for food (Fig. Gazette BiH 11/13). The total number of aerobic mesophilic bacteria and yeasts and molds is expressed per 1g, i.e. per 1cm² of surface.

RESULTS AND DISCUSSION:

The microbiological quality of fresh lettuce depended on the type, sales facility and sampling time. The results indicate that bacteria, yeasts and molds are present in the tested samples. In all three research procedures of unwashed, washed and bicarbonate-treated samples, the number of bacteria was the highest in samples of the outer leaf of unwashed fresh lettuce compared to the other investigated fresh lettuce samples.

Salad samples from the market had the highest number of bacteria before washing the outer lettuce leaf ($288x10^3$ cfu/ml) and after washing the outer lettuce leaf ($190x10^3$ cfu/ml) compared to the values of other lettuce samples. In all samples, the number of bacteria is higher in unwashed and washed lettuce compared to soda treated. The number of yeasts and molds, similar to the number of bacteria, is the highest in unwashed lettuce samples compared to other samples. However, the abundance of this systematic group of microorganisms is the least in soda-treated samples compared to washed and unwashed samples of fresh lettuce.

The highest number of molds and yeasts is found in the unwashed outer leaves of fresh lettuce ($58x10^2$ cfu/ml). The number of yeasts and molds is significantly higher in unwashed and washed salad samples, while their number was lower in salad samples treated with 2% solution of baking soda. In all variants of the test, bacteria from the genus *Salmonella spp.* and were found in unwashed and washed salad samples, while their number decreases in samples treated with baking soda.

The total number of aerobic mesophilic bacteria on lettuce leaves before washing ranged from 45 cfu/cm^3 to 18.57 cfu/cm^3 was detected by Topalić-Trivunović et al. 2013, which was also proven in this research. It is clear that variations in the total number of aerobic mesophilic bacteria are related to manipulation during harvesting, storage and transport.

Table 1. Average values of microorganisms in tested samples of fresh lettuce (cfu/ml)

Çizelge 1. Taze marul örneklerinde test edilen mikroorganizmaların ortalama değerleri (cfu/ml)

Treatment	Swabs	Enterobact. (cfu/ml)	E.coli (cfu/ml)	Aerobic mesofilic bact (cfu/ml)	Yeats and molds (cfu/ml)	Salmonella spp
Unwashed	1.External leaf - inside	225	21	288	60	110; 129
	2. External leaf – revers side	169	25	139	58	119; 108
	3.Internal leaf - inside	257	12	194	56	112; 113
	4.Internal leaf – revers side	163	16	139	36	110; 161
Washed	1.External leaf - inside	229	18	267	30	107; 96
	2. External leaf – revers side	177	15	190	19	87;83
	3.Internal leaf - inside	123	16	51	11	75, 76
	4.Internal leaf – revers side	230	18	88	6	58; 86
2%NaHCO3	1.External leaf - inside	82	7	17	9	2;1
	2. External leaf – revers side	60	4	28	1	2;3
	3.Internal leaf - inside	39	2	37	3	2;1
	4.Internal leaf – revers side	15	1	22	6	1; 1

The highest presence of enterobacteria was found in the unwashed samples of the inner lettuce leaf (257, i.e. 163x103 cfu/ml), slightly less in the washed lettuce samples (229, i.e. 173x103 cfu/ml) and the least in the samples of the inner lettuce leaf treated with baking soda (39 , i.e. 15x103 cfu/ml). The number of Escherichia coli was also highest in the unwashed samples of the outer lettuce leaf (21 and 25x103 cfu/ml, respectively). The abundance of the examined type of bacteria was the lowest in the samples treated with baking soda. In all variants, the number of Escherichia coli bacteria is higher before washing compared to washed and soda-treated samples.

The number of yeasts and molds, similar to the number of bacteria, was the highest in unwashed lettuce samples compared to other samples. However, the abundance of this group of microorganisms is the lowest in soda-treated samples compared to washed and

unwashed samples of fresh lettuce (Berger et al, 2003). The largest number of molds and yeasts is in the unwashed outer leaves of fresh lettuce. The abundance of the examined type of bacteria was the lowest in the samples treated with baking soda. In all variants, the number of Escherichia coli bacteria is higher before washing compared to washed and soda-treated samples.

CONCLUSSIONS:

The conclusion was reached based on the results presented in the previous part of the paper that the number of bacteria significantly decreases in the samples of the inner lettuce leaf treated with baking soda, and the highest presence of microorganisms on which the testing was done is in the unwashed samples of the outer lettuce leaf. In addition to all of the above, systematic monitoring of microorganisms in raw materials is necessary, primarily when we are talking about green salad but also additives in production. Bosnia and Herzegovina institutions should take care of the potential danger to the health of consumers, and it is necessary to constantly find new methods in the prevention of microbiological and mycotoxicological hazards in these products, that is, to adopt the most modern methods of prevention used internationally.

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OP-26

Full Text Proceeding

(Tam Metin Bildirisi)

Using Fuzzy Logic Applications in Land Reallocation

Arazi Dağıtımında Bulanık Mantık Uygulamalarının Kullanımı

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Keywords: fuzzy logic, interview based reallocation, land consolidation

Anahtar sözcükler: Bulanık mantık, mülakat esaslı dağıtım, arazi toplulaştırma

ABSTRACT

Objective: One of the most essential stages of land consolidation projects is the reallocation of parcels. This study examined two different reallocation methods in three neighborhoods (Alhan, Çulhan, Dereköy) within the scope of the Aydın Yenipazar Plain Land Consolidation Project.

Material and Methods: One of the methods is the interview-based distribution model used in agricultural land consolidation studies throughout Turkey. The other method is the fuzzy logic-based distribution method, which has been mentioned extensively in recent years and has been the subject of many academic studies. The results obtained from the fuzzy logic method were compared with the project results made by the General Directorate of Agricultural Reform.

Results: The criteria used in comparing the results, especially in determining the success of the consolidation studies, were used. These criteria are the consolidation rate, the number of enterprises, the number of parcels per enterprise, the average parcel size, and the shareholding status of the parcels.

Conclusion: Considering the results obtained, it has emerged that the fuzzy logic-based distribution can be applied in land consolidation projects.

ÖZ

Amaç: Arazi toplulaştırma projelerinin en önemli aşamalarından biri parsellerin yeniden dağıtımı aşamasıdır. Bu çalışmada Aydın Yenipazar Ovası Arazi Toplulaştırma Projesi kapsamında üç mahallede (Alhan, Çulhan, Dereköy) iki farklı dağıtım yöntemi incelenmiştir.

Materyal ve Yöntem: Yöntemlerden biri Türkiye genelinde tarımsal arazi toplulaştırma çalışmalarında kullanılan mülakat esaslı dağıtım modelidir. Diğer yöntem ise son yıllarda adından sıkça söz edilen ve pek çok akademik çalışmaya konu olan bulanık mantık tabanlı dağıtım yöntemidir. Çalışmada, bulanık mantık yönteminden elde edilen sonuçlar Tarım Reformu Genel Müdürlüğü tarafından yapılan proje sonuçlarıyla karşılaştırılmıştır.

Araştırma Bulguları: Sonuçların karşılaştırılmasında, özellikle toplulaştırma çalışmalarının başarısının belirlenmesinde kullanılan kriterler kullanılmıştır. Bu

kriterler; toplulaştırma oranı, işletme sayısı, işletme başına düşen parsel sayısı, ortalama parsel büyüklüğü ve parsellerin hisselilik durumudur.

Sonuç: Elde edilen sonuçlar dikkate alındığında bulanık mantık tabanlı dağıtımın arazi toplulaştırma projelerinde uygulanabileceği ortaya çıkmıştır.

INTRODUCTION

An effective tool in sustainable rural development plans, agricultural land consolidation, has been carried out in many countries to ensure the sustainability of production. There are too many definitions or approaches in land consolidation studies; different countries apply different models and pursue different goals. However, comparing national regulatory frameworks allows for identifying key trends and practices.

Fragmentation has been a significant problem in many countries and Turkey since the 19th century. Since agricultural lands in Turkey are generally fragmented and scattered, land consolidation has become necessary, especially in recent years. This kind of agricultural enterprise can not achieve the targetted productivity increase. The scope of land consolidation includes measures such as arranging fragmented, scattered, and deformed land pieces appropriately, connecting road-irrigation-drainage systems to make management easy and economical, soil reclamation, land leveling, village renewal, and rural environment protection. Consolidation has significant benefits in the structure and development of agricultural enterprises, in the planning and construction of irrigation networks, in the provision of on-farm development services, in environmental protection, village renewal, and in the development of cooperation between public institutions and organizations (Polat et al., 2011).

In recent years, the fuzzy logic method, which can model the human mindset and be used when it is impossible to create mathematical models, has solved various engineering fields. There are some fuzzy logic based studies on agricultural land consolidation projects lately (Çay & İşcan, 2011; Uyan et al., 2015; Ertunç & Çay, 2016; Ertunç et al., 2018; Kilić et al., 2019; Kilić Pamuković et al., 2021; Tunalı & Dağdelen, 2023). Fuzzy logic or similar artificial intelligence applications will provide an incredible convenience in consolidation studies.

This study investigates the fuzzy logic method's application ability in the reallocation phase. The results from the fuzzy logic model are compared with those from the interview-based land reallocation model. The number of parcels, consolidation rate, average parcel size, average enterprise size, number of parcels per enterprise, and shareholding status of parcel values were examined.

MATERIAL and METHODS

Study area

In this study, three of the 9 villages in the consolidation project area completed in 2011 in Aydın - Yenipazar district were evaluated (Figure 1).

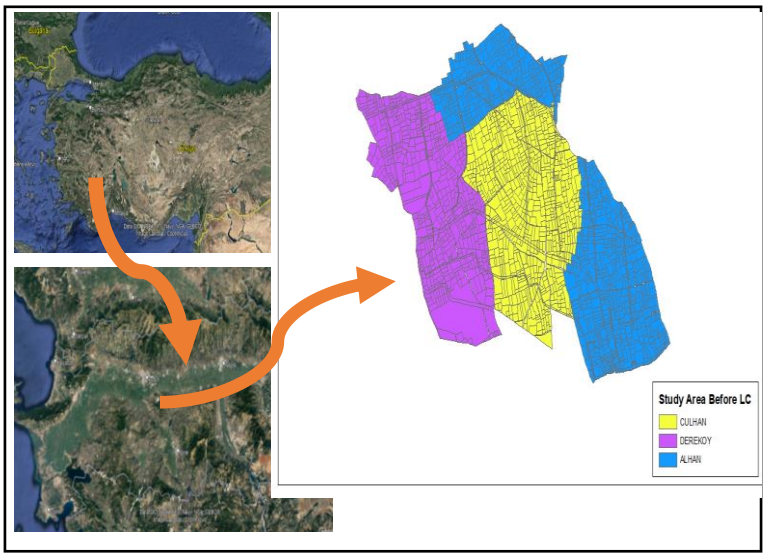

Figure 1. Study area before the consolidation project.

Şekil 1. *Toplulaştırma projesi öncesi çalışma alanı.*

Interview-based land reallocation method

The reallocation process in Turkey is carried out using an interview-based model. In the study, data for the interview-based distribution model was taken from the Directorate of Agriculture (Figure 2). The data obtained was edited by transferring it to the Microsoft Excel program.

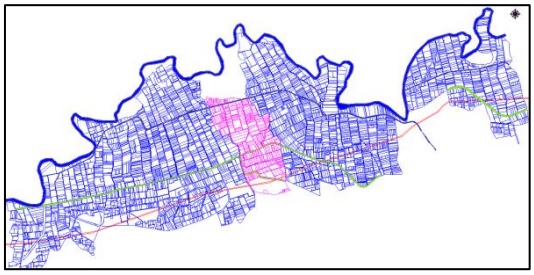

Figure 2. Aydın Merkez-Yenipazar Participatory Land Consolidation Project Area.

Şekil 2. *Aydın Merkez-Yenipazar Katılımcı Arazi Toplulaştırma Proje Alanı.*

Fuzzy logic based land reallocation method

In fuzzy systems, input data is first evaluated with the help of membership functions and then taken to the fuzzifier. Then, the obtained values are inferred with the help of the determined inference method and rule base. Finally, the fuzzy results obtained are clarified. At this stage, the outputs become classical numbers (Figure 3).

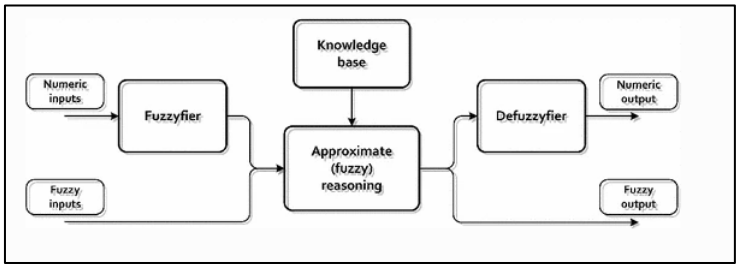

Figure 3. The typical structure of a fuzzy system (Czabanski et al., 2017).

Şekil 3. *Tipik bir bulanık sistemin yapısı (Czabanski et al., 2017).*

First of all, a survey was conducted with farmers in the project area to determine membership functions. When the survey studies were examined, it was seen that the most important criterion in all three villages was land fragmentation. The second important criterion was the proximity of the parcels to the road. However, today, in land consolidation projects carried out in Turkey, once the locations of the lands are determined, all of them are provided with roads. For this reason, only the first criterion was taken into account when determining the membership functions. In this study a fuzzy system with 4 inputs and 2 outputs was created (Figure 4).

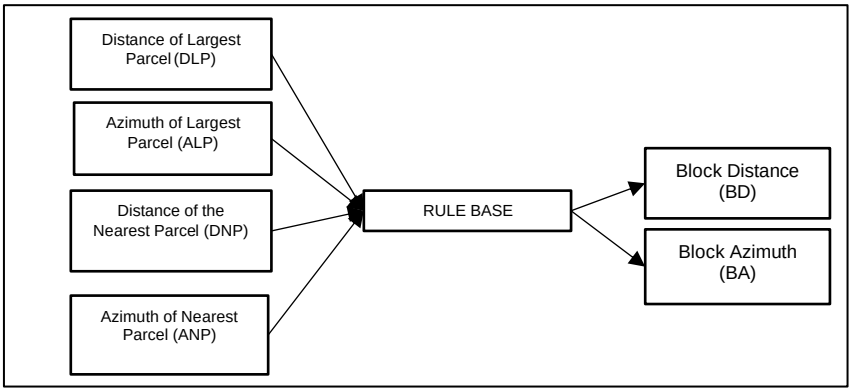

Figure 4. Fuzzy logic model structure.

Şekil 4. *Bulanık mantık model yapısı.*

Since the input and output variables will be entered as polar coordinate values, a starting point must be determined. For the starting point, a point was selected to cover the entire project area with the ArcGIS program's help, a software-based on Geographic Information System (GIS) (Figure 5) (ESRI, 2012).

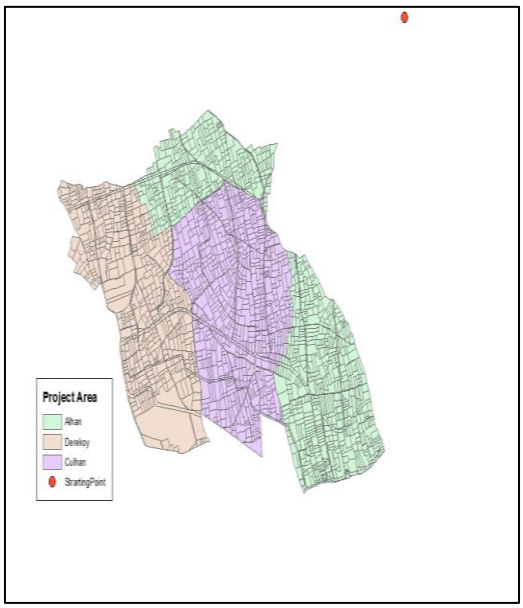

Figure 5. Selected starting point for the project area.

Şekil 5. *Proje alanı için seçilen başlangıç noktası.*

In this study, MATLAB Fuzzy Logic Toolbox was used (MATLAB, 2012). The parameters and methods used in reallocation using fuzzy logic are given in Table 1.

Table 1. The methods used in the fuzzy logic model.

Çizelge 1. *Bulanık mantık modelinde kullanılan yöntemler.*

MATERIAL	METHOD	OBTAINED DATA
Determination of membership functions	Taken x-y points of the parcels from ArcGIS. Trapezoidal and triangular membership functions were used for two different variables.	1. Distance Variable 2. Azimuth Variable
Creation of fuzzy logic rule base	Mamdani inference mechanism was used	144 rules have been created based on the number of membership functions.
Defuzification	The center of gravity (centroid) was used to defuzify the fuzzy output.	The priority here is the distance and azimuth value of the largest parcel owned by the enterprise.
Finding the block distance and block azimuth output values	The data was entered into the Simulink block of MATLAB	Obtained polar coordinate values calculated as distance and azimuth
Coordinate transformations	Polar coordinate values were later converted into the national coordinate system in Excel.	National coordinate values obtained
Initial land reallocation	Transformed coordinate values entered in ArcGIS	New blocks of the parcels are determined

After the initial reallocation, some parcels are concentrated in specific regions within the project area while others are outside the project area (Figure 6). This situation was especially due to the determination of a single starting point for all neighborhoods. Finally, parcels outside the consolidation area have been moved to appropriate locations within the area.

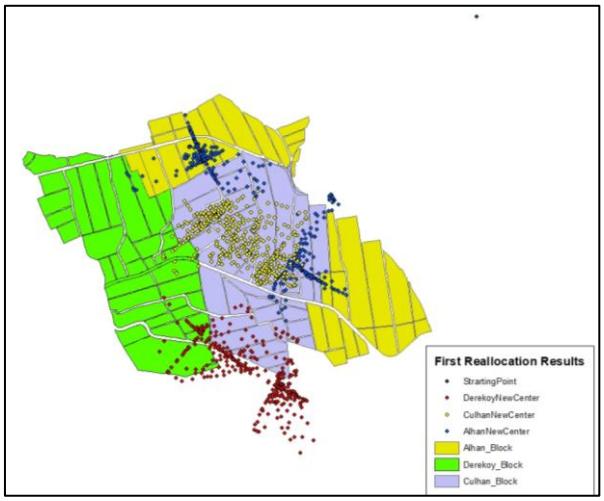

Figure 6. Initial reallocation results.

Şekil 6. *İlk dağıtım sonuçları.*

RESULTS and DISCUSSION

In this section, the results obtained from both methods are presented together for comparison. Some of the results obtained for both consolidation projects are given in Table 2.

Table 2. Results from two methods.

Çizelge 2. *İki yöntemden elde edilen sonuçlar.*

NEIGHBOURHOOD		ALHAN	ÇULHAN	DEREKÖY	TOTAL
TOTAL AREA (ha)		340	380	366	1086
NUMBER OF PARCELS (pcs)	Before	846	948	746	2540
	Interview	479	538	422	1439
	Fuzzy Logic	472	445	400	1317
	Interview_Decrease	177%	176%	177%	177%

	Fuzzy_Decrease	179%	213%	187%	193%
CONSOLIDATION RATE (%)	Interview	43.38	43.25	43.43	43.35
	Fuzzy Logic	44.21	53.06	46.38	48.15
NUMBER OF ENTERPRISES (pcs)	Before	573	638	482	1693
	Fuzzy Logic	472	473	475	1420

The number of parcels is decreased in the project area for both methods. The decrease in this number is greater in the fuzzy logic model. In the fuzzy logic based reallocation model, some shared parcels are combined. Some enterprises were also merged in the light of the information obtained from the interviews. The values in Table 2 showed similar results with the literature (Çay & İşcan, 2011; Tunalı & Dağdelen, 2018; Tunalı & Dağdelen, 2023). When the consolidation rate values, which is one of the most important evaluation criteria, are examined, it is seen that the fuzzy logic-based distribution model is more successful in all villages. Although the obtained consolidation rate values are above Turkey's average, they are seen to be lower compared to other countries (Arıcı & Akkaya Aslan, 2014). When other studies on the consolidation rate are examined (Peker & Dağdelen, 2016; Tunalı et al., 2016a; Tunalı et al., 2016b; Dağdelen et al., 2017; Kahramanoğlu & Dağdelen, 2018; Tunalı & Dağdelen, 2018; Lök and Değirmenci, 2019) has been observed that the reallocation made by this method gives very good results.

The change in enterprise and parcel size values according to reallocation methods is given in the Table 3, and shareholding status of parcel values are given in the Table 4.

Table 3. The change of the average parcel and enterprise sizes.

Çizelge 3. *Ortalama parsel ve işletme büyüklüklerindeki değişim.*

NEIGHBOURHOOD		ALHAN	ÇULHAN	DEREKÖY	TOTAL
Average Parcel Size (da)	Before	4.02	4.01	4.91	4.28
	Interview	7.10	7.06	8.67	7.55
	Fuzzy Logic	7.20	8.54	9.15	8.25
	Interview_Inc	177%	176%	177%	177%
	Fuzzy_Inc	179%	213%	187%	193%
Average Enterprise Size (da)	Interview	5.93	5.96	7.59	6.41
	Fuzzy Logic	7.20	8.03	7.71	7.65
Number of Parcel per Enterprise (pcs)	Before	1.48	1.49	1.55	1.50
	Interview	0.84	0.84	0.88	0.85
	Fuzzy Logic	1.00	0.94	0.84	0.93
	Interview_Decrease	177%	176%	177%	177%
	Fuzzy_Decrease	179%	213%	187%	193%

Table 4. Shareholding status of the parcels.

Çizelge 4. *Parsellerin hisselilik durumu.*

NEIGHBOURHOOD		ALHAN	ÇULHAN	DEREKÖY	TOTAL
Shareholding Status of Parcels (pcs)	Before	60	117	91	268
	Intervıew	24	43	37	104
	Fuzzy Logic	11	21	52	84
Shareholding Status of Parcels (%)	Before	7.09	12.34	12.20	10.55
	Intervıew	5.01	7.99	8.77	7.23
	Fuzzy Logic	2.33	4.72	13.00	6.38

Average parcel size and average enterprise size values in the project area were higher in fuzzy logic based distribution method. However, the value of the number of parcels per enterprise was higher in the interview-based distribution method for Dereköy. With the consolidation project, there has been a significant decrease in the shareholding status of the parcels. This decrease is more significant in the fuzzy logic method. However, it is observed that the number of shared lands in Dereköy is higher than the interview method. At this point, it is useful to evaluate the size distribution of shared lands. Tunalı and Dağdelen (2023) stated in their study in Aydın Yenipazar Hamzabali village that a significant change occurred in the presence of shared land in the fuzzy logic method.

Distribution of the parcels for two reallocation methods are given in Table 5 and 6. The area range values given in the table are the values accepted in ranking agricultural enterprises according to their size in Turkey.

Table 5. Distribution of the parcel numbers.

Çizelge 5. *Parsel sayılarının dağılımı.*

	Area Range	Alhan		Çulhan		Dereköy		TOTAL	
	(da)	Number (pcs)	Number (%)	Number (pcs)	Number (%)	Number (pcs)	Number (%)	Number (pcs)	Number (%)
BEFORE LC	0 – 4.99	618	71.36	679	71.62	517	69.21	1814	70.83
	5 – 9.99	193	22.29	202	21.31	158	21.15	553	21.59
	10 – 19.99	42	4.85	58	6.12	59	7.90	159	6.21
	20 +	13	1.50	9	0.95	13	1.74	35	1.37
	TOTAL	866	100.00	948	100.00	747	100.00	2561	100.00
INTERVIEW BASED REALLOCATION	0 – 4.99	231	48.63	255	47.75	196	46.89	682	47.79
	5 – 9.99	152	32.00	178	33.33	146	34.93	476	33.36
	10 – 19.99	77	16.21	82	15.36	54	12.92	213	14.93
	20.00 +	15	3.16	19	3.56	22	5.26	56	3.92
	TOTAL	475	100.00	534	100.00	418	100.00	1427	100.00
	0 – 4.99	248	52.54	244	54.83	241	60.55	733	55.74
	5 – 9.99	142	30.08	144	32.36	104	26.13	390	29.66

FUZZY LOGIC BASED REALLOCATION	10 – 19.99	64	13.56	49	11.01	43	10.80	156	11.86
	20 +	18	3.81	8	1.80	10	2.51	36	2.74
	TOTAL	472	100.00	445	100.00	398	100.00	1315	100.00

When the area distribution table of the number of parcels is examined, it is seen that the parcels in all three villages generally have a size of 0 - 5 da.

Table 6. Distribution of the parcel areas.

Çizelge 6. *Parsel alanlarının dağılımı.*

Distribution of Parcel Areas	Area Range (da)	Alhan		Çulhan		Dereköy		TOTAL	
		Area (da)	Ratio (%)	Area (da)	Ratio (%)	Area (da)	Ratio (%)	Area (da)	Ratio (%)
BEFORE LC	0 – 4.99	1390.00	38.50	1440.00	37.89	1081.00	29.56	3911.00	35.34
	5.00 – 9.99	1310.00	36.29	1389.00	36.55	1047.00	28.63	3746.00	33.85
	10.00 – 19.99	551.00	15.26	749.00	19.71	768.00	21.00	2068.00	18.69
	20.00 +	359.00	9.94	222.00	5.84	761.00	20.81	1342.00	12.13
	TOTAL	3610.00	100.00	3800.00	100.00	3657.00	100.00	11067.00	100.00
INTERVIEW BASED REALLOCATION	0 – 4.99	665.00	20.77	730.00	20.04	605.00	17.40	2000.00	19.37
	5.00 – 9.99	1055.00	32.95	1303.00	35.77	1039.00	29.87	3397.00	32.91
	10.00 – 19.99	1024.00	31.98	1097.00	30.11	736.00	21.16	2857.00	27.68
	20.00 +	458.00	14.30	513.00	14.08	1098.00	31.57	2069.00	20.04
	TOTAL	3202.00	100.00	3643.00	100.00	3478.00	100.00	10323.00	100.00
FUZZY LOGIC BASED REALLOCATION	0 – 4.99	633.61	21.38	678.01	25.73	555.65	25.19	1867.28	23.93
	5.00 – 9.99	973.55	32.85	1021.96	38.79	732.31	33.20	2727.83	34.95
	10.00 – 19.99	865.39	29.20	704.08	26.72	604.68	27.41	2174.16	27.86
	20.00 +	490.86	16.56	230.59	8.75	313.28	14.20	1034.73	13.26
	TOTAL	2963.42	100.00	2634.65	100.00	2205.92	100.00	7803.99	100.00

Before LC, the density of the parcels was between 0 - 5 da, depending on their size. In the interview-based distribution model, it was observed that there were more lands over 20 da in Dereköy. Although the number is small, some of the lands in this village are over 50 da, which has revealed this situation. However, in the total of three villages, the 0 – 5 da range is more intense. In the fuzzy logic method, parcels are generally in the range of 5 - 10 da.

Boyacıoğlu (1975), in his study on the economic analysis of agricultural enterprises in Erzincan Güllüce Village, stated that the increase in the average parcel size value has been reported to be 79%. Tunalı et al. (2016b) reported in their study in Yenipazar district of Aydın province that while 29% of the total number of parcels had an area of less than 0.5 ha before consolidation, this rate decreased to 12% after consolidation. Additionally, the area of parcels larger than 20 ha increased from 22% to 38%. Kahramanoğlu and Dağdelen (2018) reported in their study that the average parcel size increased from 4.81

da to 12.69 da. In their study examining the Şanlıurfa Türkeli Village land consolidation project, Kuzu et al. (2018) reported that while the average parcel size of 33 parcels belonging to 17 enterprises before consolidation was 12.61 ha, the average parcel size of 47 parcels formed due to the distribution of shares after consolidation decreased to 8.49 ha.

CONCLUSIONS

When the results obtained from the study are examined, it is possible to say that the fuzzy logic-based reallocation method is better than the interview-based reallocation method in many aspects (number of parcels, consolidation rate, average parcel size, average enterprise size, number of parcels per enterprise, shareholding status of parcels). However, it is very important to take farmers' opinions during the survey. In this way, farmer satisfaction will be ensured and the membership functions used in the fuzzy logic method will be easier to determine.

One of the aims of this study is to investigate the feasibility of reallocation the lands belonging to the entire project area at once. However, the first results obtained showed that parcel distribution in this way will increase the workforce in the later stage. For this reason, each village must be evaluated within itself in the parcel distribution process made with fuzzy logic.

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OP-27

Full Text Proceeding

(Tam Metin Bildirisi)

Industrial Plantations in Turkey and the Example of Poplar Trees

Türkiye'de Endüstriyel Ağaç Yetiştiriciliği ve Kavak Örneği

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Keywords: Construction materials, forestry, industrial plantation, poplar, timber

Anahtar sözcükler: Yapı malzemesi, ormancılık, endüstriyel plantasyon, kavak, ahşap

ABSTRACT

Objective: In this study is aimed to reveal the environmental and sectoral importance of industrial plantations and to investigate the usability of fast-growing industrial trees in the construction industry with the example of poplar trees, which have an important place in our traditional building culture.

Material and Methods: The state of industrial plantations in Turkey and the potential of poplar trees in terms of industrial forestry were investigated through literature review. Subsequently, the use of poplar wood in our traditional buildings was investigated by examining the civil architecture examples from Izmir, Malatya and Tekirdag.

Results: It has been observed that poplar wood is used in structural elements such as beams, lintels and masonry. Circular-shaped constructions that allow the use of heartwood layer were used in all of these building elements.

Conclusion: Industrial tree cultivation is perhaps the only raw material production method that does not burden the environment during the production process; instead, it offers solutions to various environmental issues such as carbon sequestration, erosion, and desertification. While it has become a popular concept with the increasing environmental concerns, industrial tree cultivation is, in fact, a part of our traditional culture. Tree species with low natural durability like the poplar wood can also be used in the construction industry if they are processed with the correct construction.

ÖZ

Amaç: Bu çalışmada endüstriyel plantasyonların çevresel ve sektörel açıdan öneminin ortaya konması ve hızlı büyüyen endüstriyel ağaçların yapı endüstrisinde kullanılabilirliğinin geleneksel yapı kültürümüzde önemli bir yeri olan kavak ağacı örneğinde araştırılması amaçlanmıştır.

Materyal ve Yöntem: Türkiye'de endüstriyel plantasyonların durumu ve kavak ağacının endüstriyel ormancılık açısından potansiyeli literatür taraması ile derlenmiştir. Ardından İzmir, Malatya ve Tekirdağ sivil mimari örnekleri incelenerek, kavak ağacının geleneksel yapılarımızdaki kullanımı araştırılmıştır.

Araştırma Bulguları: Kavak ağacının kiriş, lento, duvar örgüsü gibi yapı elemanlarında kullanıldığı görülmüştür. Bu yapı elemanlarının tümünde öz odunu tabakasının kullanılmasını sağlayan dairesel formlu konstrüksiyonlar kullanılmıştır.

Sonuç: Endüstriyel ağaç yetiştiriciliği üretim süreci esnasında doğaya yük getirmeyen aksine karbon emilimi, erozyon, çölleşme gibi pek çok çevresel soruna çözüm sunan belki de tek hammadde üretim yöntemidir. Çevresel kaygılarımızın artmasıyla birlikte popülerleşmiş bir kavram olsa da endüstriyel ağaç yetiştiriciliği aslında geleneksel kültürümüzün de bir parçasıdır. Doğru konstrüksiyonla işlendiğinde kavak gibi doğal dayanıklılığı düşük ağaçların da yapı endüstrisinde kullanılması mümkündür.

INTRODUCTION

With increasing environmental concerns, there is a growing recognition of the importance of natural, recyclable, and sustainable building materials, such as wood. Wood stands out as one of the most environmentally friendly materials, both in terms of its production methods and the comfort it offers in its applications. However, in modern construction, wooden materials are underutilized. This underutilization can be attributed to several key factors, including misconceptions about the durability of wood, the need for skilled labour for processing, the time-intensive nature of wood production, the limited availability of natural resources for wood, and the associated cost. Industrial plantations plays a vital role in addressing these challenges. Industrial tree cultivation not only ensures a consistent supply of wood materials but also contributes positively to the ecosystem during their growth.

The rapid increase in the world population and the continuous expansion of the global economy place increasing pressure on natural resources. Each year, 40-50 million hectares of forest are lost worldwide. Climate change, forest fires, and insect infestations pose serious threats to our forests (Yıldırım, 2011). Agroforestry and industrial plantation initiatives offer viable solutions to alleviate the strain on natural forest resources (Ayaz, 2019).

In Turkey, the term "industrial trees" is often associated with imported species like Paulownia. However, our country boasts fast-growing tree species that can serve this purpose and have been historically cultivated. The poplar tree stands out as a prime example. Beyond its value as a source of raw materials, the poplar tree holds a significant place in our folk culture and collective memory. Poplar wood, which is now a subject of extensive debate in terms of its utility as a building material, has a rich history of traditional use in our architecture. The poplar's fast growth and its ability to thrive in various geographical regions, thanks to its smooth, elongated trunk structure, make it an excellent choice for constructing.

MATERIAL and METHODS

In this study, firstly, the state of industrial plantations in Turkey and the potential of poplar trees in terms of industrial forestry were investigated through literature review. Subsequently, the use of poplar wood in our traditional buildings was investigated by examining the 19th and 20th century civil architecture examples of Izmir, Malatya and Tekirdağ, built with three different construction techniques. The structures were chosen among the ruined buildings so that the section can be observed easily.

STATE OF INDUSTRIAL PLANTATIONS IN TURKEY

Industrial plantations are afforestations specifically designed to cultivate fast-growing tree species, primarily to fulfill the demand for wood raw materials (Ürgenç, 1998). These fast-growing trees, including willow, poplar, paulownia, and eucalyptus, are commercially grown to support the forest products industry, the production of wood-based panels, building materials, and paper and cardboard (Taşdemir et al., 2015; Kaymakçı et al., 2011). Industrial afforestation holds a distinct advantage over traditional afforestation in terms of the wood yield achieved per unit area. This is because these plantations are strategically located in areas with high-quality soil, ideal for employing intensive afforestation techniques, such as deep soil cultivation and maintenance. Furthermore, these areas facilitate the use of improved tree species. (Erkan, 2021; Akgül et al., 2022).

The first official efforts for industrial afforestation in Turkey can be traced back to the 1950s (Eraslan, 1983). The establishment of the Poplar Research Institute in Izmit in 1962 further accelerated industrial plantation endeavours. Various tree species, including eucalyptus, pine, fir, and poplar, have been subject to industrial afforestation experiments through university-led scientific studies (Şen & Güngör, 2018). Today, nearly all industrial afforestation activities in Turkey are managed by the General Directorate of Forestry. These initiatives adhere to an action plan covering the 2013-2023 period and are guided by annual programs tailored to the specific needs of Regional Directorates of Forestry (Erkan, 2021).

Under the framework of this action plan, the General Directorate of Forestry has carried out industrial afforestation on a total of 62,324 hectares of land as of 2020. Notably, 94% of these afforestation efforts involved pine species, while the remaining 6% utilized ash, poplar, and eucalyptus. The regional directorates in Çanakkale, İzmir, Muğla, and Sakarya collectively accounted for approximately half of these afforestation activities (Gürlevik et al., 2022). This action plan has incentivized both individuals and legal entities to participate with interest-free loan support and specified grant, resulting in the establishment of private industrial afforestation initiatives that covered an area of around 2,000 hectares by 2020 (Görücü et al., 2020).

The industrial wood production managed by the General Directorate of Forestry amounted to 7,329,269 cubic meters (m^3) in 2000, which then increased to 15,521,622 m^3 in 2017 and further to 22,113,248 m^3 in 2019. On the other hand, the private sector contributed to the production of 3.3 million m^3 of industrial wood in 2014 (Akkaya et al., 2020). When assessing Turkey's forest resources' production capacity along with the growing demand for industrial wood raw materials, it becomes evident that the demand for wood raw materials cannot be met despite the increase in production. For this reason, imports continue to play a significant role in fulfilling the sector's need for wood raw materials (Velioğlu et al., 2022).

USE OF POPLAR TREE FOR INDUSTRIAL PURPOSES

Humanity's interest in the poplar tree dates back to ancient times. The Latin name for the poplar, "Populus," harks back to the ancient Roman Empire when it was referred to as "Arbor Populi," meaning "People's Tree." In our country, this enduring interest in the poplar tree is reflected in our folklore (Birler, 2010). The poplar tree has inspired idioms and poems. Traditions such as planting poplar trees to celebrate the birth of children and using them as boundary markers in gardens have made it an integral part of our culture.

Poplar (*Populus L.*) falls under the botanical classification of the *Salicaceae* family, which is part of the *Salicales* order. It is classified within the dicotyledons (*Dicotyledonae*) class, belonging to the *angiospermae* subphylum of the seed plants (*Spermatophyta*) group (Tunçtaner 2008). Worldwide, there are over a hundred species of poplar, with our country hosting 8 taxa (Aslan, 1994). In Turkey, the Aspen (*Populus tremula L.*) species, which holds particular significance in forestry, has established itself in nearly all regions. White Poplar (*Populus alba L.)* and Black Poplar (*Populus nigra ssp. nigra*) that are not as prominent in forestry but are cultivated for other purposes, along with Black Poplar hybrids (*Populus euroamericana*) that are grown in agricultural areas and their surroundings and have been contributing to poplar wood production in the last 20-25 years, are important varieties for Turkey (Öztan & Şahin, 2003). Since the inception of the studies conducted by the Poplar and Fast-Growing Forest Trees Research Institute in 1962, various foreign poplar species have been introduced and grown in Turkey. At present, over half of the poplar trees cultivated for industrial use in our country are foreign poplar clones (Birler, 2010; Ateşoğlu et al., 2022).

In industrial afforestation, the waiting period to obtain the final product is quite lengthy, typically around 60 to 100 years. However, in the case of poplar cultivation, the average time from the establishment of afforestation to the generation of final revenue is significantly shorter, averaging just 12 years (Birler, 2010). Poplar plantations, whether dispersed throughout agricultural lands or established in row formations, also play a crucial role as windbreaks. This positive function mitigates the adverse effects of strong winds and enhances the yield of surrounding agricultural products. Moreover, in addition to its capacity to absorb carbon dioxide from the atmosphere, poplar industrial plantations serve as valuable carbon storage units for long-lasting wood-based products (Marchi et al., 2022).

Table 1. Sectoral utilization quantities of poplar trees according to OGM 2022 data

Usage	Volume (m^3)
Planted trunk volume with bark	165.042
Lop	11.815
Industrial wood	1.542
Pulpwood	4.811
Fibre-chip wood	107.876

According to the 2022 data from the General Directorate of Forestry, the most commonly used trees for raw material production, in descending order, are red pine, other pine species, fir, beech, spruce, oak, cedar, alder, poplar, hornbeam, and juniper. Poplar occupies the 9th position in this list, considering both the planted bark trunk volume and log volume data (Anonymous, 2022). The annual usage quantities of poplar wood by sectors are outlined in Table 1. Notably, the primary utilization of poplar wood is for the production of wood-based boards, including fiberboards and chipboards, with limited usage in the construction industry.

Table 2. Mechanical Properties of Black Poplar Wood (Bozkurt and Erdin, 2000)

Properties	Value
Elastic Modulus in Bending	8.630 N/mm^2
Bending Resistance	63 N/mm^2
Tensile Strength	75 N/mm^2
Compressive Strength	34 N/mm^2
Dynamic Bending (Shock) Resistance	0.49 kN/cm
Shear Resistance	5–6 N/m^2
Brinell Hardness Resistance Parallel to Fibers	24–37 N/mm
Brinell Hardness Resistance Perpendicular to Fibers	10–15 N/mm^2
Fracture Resistance	0.6 N/mm^2

Poplar wood exhibits a light color and is devoid of any discernible odor. While there is no substantial color contrast between the spring and summer wood within the annual rings on its cross-section, these rings are readily visible. Due to its rapid growth, the annual rings in poplar wood tend to be wider compared to many other tree species, but the proportion of summer wood within the annual ring is relatively less (Bozkurt & Erdin, 1997).

On average, fully dry poplar wood possesses a density of 0.40 g/cm³, whereas the air-dry density averages 0.43 g/cm³ (Öner & Aslan, 2002; Aslan, 1994). The growth rate and density play a pivotal role in determining the material's mechanical strength. As a result, poplar wood tends to have lower mechanical resistance compared to other hardwoods (Table 2). Consequently, it is classified as a less durable tree species within the wood industry.

USABILITY OF POPLAR WOOD AS A BUILDING MATERIAL

Poplar is a species that has been cultivated in Anatolia for centuries. For this reason, it holds a significant role in Turkish housing culture, particularly in rural areas. The value of the poplar tree in this context goes beyond its widespread cultivation and fast growth. Contrary to some modern perceptions, poplar wood boasts a smooth and elongated trunk, making it easily moldable and lightweight. These qualities render it an excellent choice for building materials. In various regions of Anatolia, poplar wood was employed as beams in adobe or masonry structures (Figure 1).

a. **b.**

c.

Figure 1. a "Poplar beam detail from Birgi/İzmir houses (19th century)." **b "**Poplar branches used in wall masonry construction from Uçmakdere/Tekirdağ houses (19th century)". **c.** "Poplar beams and columns used in an adobe house in Hekimhan/Malatya (20th century)".

In our traditional architecture, poplar wood has been consistently utilized in its natural circular (log) form, primarily in load-bearing elements like beams. Thinner branches were employed in the beams that connected these main beams to the floor, as well as in wall fillings. Importantly, these branches were often used in their natural circular form, which ensured that the heartwood layer of the tree remained within the beam. This approach significantly contributed to the structure's durability and extended its lifespan. In fact, the natural durability of wood material depends not only on the type of tree but also on which

layer of the tree is used. The heartwood layer of a tree considered to have low natural durability may outperform the sapwood layer of a tree with higher natural durability (Bozkurt, 2011; Bokurt & Erdin, 1997). Therefore, through proper material selection and correct construction methods, fast-growing trees like poplar can indeed find valuable application in the construction industry.

In addition to its use as solid wood, poplar also finds application either independently or in combination with other tree species in the production of wood-based sheets, including OSB and plywood, which hold significant importance in the construction industry (Bal & Bektaş, 2012). Furthermore, poplar is exceptionally well-suited for the production of laminated panels such as LVL (Laminated Veneer Lumber) and CLT (Cross-Laminated Timber), two widely used building materials in contemporary architecture (Ceylan, 2021, Avlar, 2022, Caştur, 2021). LVL and CLT panels are created by pressing wooden boards with fibers oriented in opposite directions, resulting in increased durability compared to solid wood. This property enables the use of tree species with lower natural durability and mechanical strength, like poplar, as viable building materials.

RESULTS and DISCUSSION

The production of wood raw materials in our country struggles to keep up with the demands of wood-using sectors, especially given today's technological requirements. This also impacts material preferences within the construction industry. The constraints imposed by limited natural forest resources, coupled with the prolonged process of industrial wood material production, contribute to a gradual rise in raw material prices. To promote the more extensive use of natural materials like wood in the construction industry, it is imperative to enhance the supply of wood raw materials. Industrial plantations featuring fast-growing tree species offer a promising solution to address these challenges. Furthermore, apart from their economic significance and their role in satisfying the demand for wood raw materials, industrial plantations play a vital role in preserving natural resources, ensuring the continuity of forests, and maintaining ecosystem.

One of the most important species grown for industrial purposes in our country is the poplar tree. Poplar has an important place in social memory and our architectural heritage. However, the direct use of poplar wood in the construction industry is currently very limited. Negative prejudices regarding its natural durability cause it not to be preferred as a building material in the sector. In fact, when processed with the correct construction, it is possible to use it as solid wood in the construction industry. Our wooden construction heritage teaches us that tree species with low natural durability can also be used in the construction industry if they are processed with the correct construction. We can see an example of a structure built with poplar supports almost everywhere in Anatolia. Moreover, it can be converted into alternative building materials such as OSB, LVL, CLT, expanding its use in the modern construction industry.

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OP-28

Full Text Proceeding

(Tam Metin Bildirisi)

Production Efficiency and Total Factor Productivity Growth in Turkish Agriculture

Türk Tarımında Üretim Etkinliği ve Toplam Faktör Verimliliği Büyümesi

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Keywords: Agricultural Technical Efficiency, Data Envelopment Analysis (DEA), Input Parameters, Time-Series Data

Anahtar sözcükler: Tarımsal Teknik Etkinlik, Veri Zarflama Analizi (VZA), Girdi Parametreleri, Zaman Serisi Verisi

ABSTRACT

Objective: This study aims to estimate the technical efficiency of Turkish agriculture by employing Data Envelopment Analysis (DEA) method. The paper seeks to analyze the agricultural productivity of Turkiye and anticipates that this study will contribute to the existing literature.. Numerous prior studies have examined the technical efficiency of agricultural products in Türkiye, with many utilizing DEA for estimation.

Material and Methods: To compute the agricultural production efficiency of Türkiye, we utilized time-series data spanning from 1995 to 2019, sourced from FAOSTAT. The output variable is measured as agricultural gross production value (GPV). The selected input parameters encompass agricultural land, pesticide usage, fertilizer usage, labor, livestock and the presence of machinery.

Results: Analysis reveals that Turkish agriculture exhibits a negative technical efficiency score, representing a deficit of 2% over the study period. This indicates that the agricultural sector consistently falls short of achieving optimal productivity levels on an annual basis.

Conclusion: In this study, we compare Turkish agriculture with itself and conclude that there has been a notable increase in total factor productivity over the past 25 years.

ÖZ

Amaç: Bu çalışma, Veri Zarflama Analizi (VZA) yöntemini kullanarak Türk tarımının teknik etkinliğini tahmin etmeyi amaçlamaktadır. Çalışma, Türkiye'nin tarımsal verimliliğini analiz etmeyi amaçlamakta ve mevcut literatüre katkı sağlayacağı düşünülmektedir. Türkiye'de tarımsal ürünlerin teknik verimliliğini inceleyen çok sayıda çalışma bulunmaktadır ve bunların birçoğu tahmin için VZA'yı kullanmaktadır.

Materyal ve Yöntem: Türkiye'nin tarımsal üretim verimliliğini hesaplamak için FAOSTAT'tan elde edilen 1995-2019 yıllarını kapsayan zaman serisi verileri kullanılmıştır. Çıktı değişkeni tarımsal gayrisafi üretim değeri (GPV) olarak ölçülmüştür. Seçilen girdi parametreleri tarımsal arazi, pestisit kullanımı, gübre kullanımı, işgücü, hayvan ve makine varlığını kapsamaktadır.

Araştırma Bulguları: Analiz, Türk tarımının çalışma dönemi boyunca %2'lik bir açığı temsil eden negatif bir teknik etkinlik skoru sergilediğini ortaya koymaktadır. Bu da tarım sektörünün yıllık bazda optimum verimlilik seviyelerine ulaşmakta sürekli olarak yetersiz kaldığını göstermektedir.

Sonuç: Bu çalışmada Türk tarımını kendisiyle karşılaştırılmış ve son 25 yılda toplam faktör verimliliğinde gözle görülür bir artış olduğu sonucuna ulaşılmıştır.

INTRODUCTION

Agriculture is one of the most important sectors of Türkiye's economy, accounting for 6.5% of the gross domestic product in 2020. Türkiye is the world leader in the production and export of nuts, cherries, figs, and apricots. The country is placed among the top five in the world in terms of many other agricultural products. In 2020, agricultural land was estimated at 37.7 million hectares (TUIK 2021). Nevertheless, agricultural land has reached a maximum level and cannot be increased any further in Türkiye. To increase agricultural production; inputs should be used effectively (Akturk and Kıral 2002). Water, land, fertilizers, pesticides, agricultural technology, and agronomic management are increasingly important in facilitating the improvement of agricultural productivity and technical efficiency (Wang et al. 2017). Increasing agricultural productivity and technical efficiency is a very important policy objective in most developing countries because it is one of the main sources of overall growth (Zamanian et al. 2013). Since the pioneering work by Farrell in 1957, which drew upon the works of Debreu (1951) and Koopmans (1951), a considerable effort has been directed at refining the measurement of technical efficiency. The literature on efficiency analysis is broadly divided into deterministic and stochastic frontier methodologies. The deterministic, nonparametric approach that developed out of mathematical programming to measure efficiency is known as data envelopment analysis (DEA), while the parametric approach that uses a stochastic production, cost, or profit function to estimate efficiency is called the stochastic frontier approach (SFA) (Chakraborty et al. 2002). DEA is a non-parametric method and can easily handle multiple input and multiple output cases. Moreover, in DEA applications, inputs and outputs can have very different units of measurement without requiring any a priori trade-offs or any input and output prices (Gul et al. 2009).

Until the year 2000, the agricultural sector in Türkiye was supported by price-weighted policy tools (Abay et al. 2005). After the 2000s, radical changes occurred in the agricultural support system (Sahinoz et al. 2005). This study aims to evaluate agricultural technical efficiency over a 25-year period from 1995 to 2019 in Turkish agriculture by applying DEA methods. This paper aims to provide an analysis of the agricultural productivity and total factor productivity of Türkiye and is expected to provide a contribution to the literature and be used for preparing agricultural policies.

MATERIAL and METHODS

This study uses DEA and DEA-based Malmquist TFP index model to calculate technical efficiency and total factor productivity in Turkish agricultural sector from 1995-2019 periods. Therefore, firstly we provide a brief description of methods.

Data envelopment analysis

First proposed by Farrell (1957) and additionally contributed by Charnes, Cooper, and Rhodes (1978), DEA is a non-parametric technique based on Linear programming where the presence of multiple inputs and outputs makes comparison tough for measuring the relative performance of decision making units (DMU). Efficiency is defined as the ratio of the outputs produced by a production unit to the inputs it uses. It is known that there will be changes in productivity depending on the production technology, the efficiency of the production process, and the differences in the production environment (Gunden et al. 1999). By the efficiency of a production unit, is meant a comparison between observed and optimal values of its output and input. The comparison can take the form of the ratio of observed to maximum potential output obtainable from the given input, or the ratio of minimum potential to observed input required to produce the given output, or some combination of the two (Lovell 1993). For many years, the efficiency component was not considered in productivity studies. Efficiency is one of the components that ensure

productivity change (Gunden et al. 1999). Using DEA to estimate technical efficiency is achievable with output-oriented or input-oriented parameters. Separate units of efficiency values for by DEA for their technical efficiency calculate and a value of one indicates efficiency.

For each decision making unit, below weights of virtual input and output (v_i) and (u_r) are formed:

Virtual input = $\upsilon_{1k}X_{1k}$ +….+ $\upsilon_{ik}X_{ik}$

Virtual output = $u_{1k}Y_{1k}$ +….+ $u_{rk}Y_{rk}$

Now that the weights are been calculated, and for input and output oriented, adoption of linear programming to maximize the ratio virtual output/ virtual input for the former and minimize the ratio virtual input/virtual output for the latter. A desired weight may be different from each decision making unit. According to Cooper et al. (1999), individual decision making unit is given the most appropriate group of weights with units which might have different decision making units. Method of programming output oriented fraction to find the desired weights to estimate efficiency is formulated as:

min

$$f_k = \frac{\sum_{i=1}^{m} v_{ik} X_{ik}}{\sum_{r=1}^{s} u_{rk} X_{rk}}$$

s.t

$$\frac{\sum_{i=1}^{m} v_{ik} X_{ij}}{\sum_{r=1}^{s} u_{rk} Y_{rj}} \geq 1 \qquad i = 1, \dots, m$$

$$v_{ik} \geq 0, u_{rk} \geq 0 \qquad r = 1, \dots, s$$

$$j = 1, \dots, n$$

The restraints imply that virtual input versus virtual output ratio need to be equivalent or greater than 1 for each decision making unit (j=1,...,n). The aim is to achieve the input (v_i) (i=1,...,m) and the output weights values (u_r) (r=1,...,s) that decrease virtual input/virtual output ratio, decision making unit being estimated. The equation above produced unlimited results, therefore, the way of fractional programming can be transformed into linear programming method below.

min

$$g_k = \sum_{i=1}^{m} v_{ik} X_{ik}$$

s.t

$$-\sum_{r=1}^{s} u_{rk} Y_{rj} + \sum_{i=1}^{m} v_{ik} X_{ij} \geq 0 \qquad i = 1, \dots, m$$

$$\sum_{r=1}^{s} u_{rk} Y_{rk} = 1 \qquad r = 1, \dots, s$$

$$v_{ik} \geq 0, u_{rk} \geq 0 \qquad j = 1, \dots, n$$

The equation is considered as the multiplier form of the DEA approach. On the other hand, the DEA problem can be presented using duality. Measuring TE_{CRS} with k decision making unit, r outputs, and i inputs is done by envelopment form. The following model can be formulated as:

$$max\ Z_k$$

s.t

$$-\sum_{j=1}^{N} Y_{rj}\ \lambda_{jk} + Y_{rk} Z_k \leq 0 \qquad r = 1, \dots, s$$

$$\sum_{j=1}^{N} X_{ij}\ \lambda_{jk} \leq X_{ik} \qquad i = 1, \ldots, m$$

$$\lambda_{jk} \geq 0 \qquad j = 1, \ldots, n$$

here $1 \leq Z_k \leq \infty$ and Z_{k-1} analysis the relative gain in output shown through k-th decision making unit, input is at constant state while constant vector n×1 is λ. Thus, $1/Z_k$ calculates TE and measures would lie between 0 and 1. Utmost average of Z_k is resolves by linear program considering the restriction of the relatively gained vector of both input and output are in a realizable state and the magnitude variables are positive. Equal estimation of TE by output and input orientations is referred to as CRS in production frontier. Thus, this study adopted an output oriented estimation of TE thereby putting it into the consideration of how much output can be increased while maintaining the amount of inputs in the production.

In this paper, DEA and MPI are used to study the technical agricultural production efficiency in Türkiye. Parametric approaches make strict assumptions about the functional form, such as constant returns to scale and technological efficiency, which are difficult to justify in practice. In contrast, DEA is a nonparametric technique used to compute the efficiency of homogeneous DMUs and helps in improving the efficiency level by benchmarking a unit against the most efficient unit. The DEA method requires no initial assumptions about specifying the involved production functions as well as the standard errors (Takundwa et al. 2017).

Data envelopment applications can be classified into input-oriented and output-oriented. An input-oriented model minimizes the inputs for a desired level of output to be achieved, and an output-oriented model maximizes the outputs while the inputs are kept at a constant level. Both input and output-oriented models seek to maximize the outputs, minimize the inputs, and thus maximize the efficiency. In general, the input-oriented model closely focuses on operational and managerial issues, whereas the output-oriented model is more associated with planning and strategy (Rajasekar and Deo 2014). In this study, output-oriented DEAs have been selected. As a method, output-oriented CCR and BCC models were used. An output orientation has been selected because it would be fair to assume that, in agriculture, one usually attempts to maximize output from a given set of inputs rather than the converse (Coelli and Rao 2005).

Malmquist Total Factor Productivity Index

Malmquist (1953) uses the Malmquist index model to calculate the index employed in estimating input decomposition. Furthermore, Fare et al. (1992) integrated the ideas about efficiency from Caves et al. (1982). Additionally, it is done to create the input and output of the Malmquist TFP index using DEA. This model of the DEA-based Malmquist productivity index is considered one of the best methods for decision-making units in productivity. According to the literature on productivity growth, the Malmquist productivity index allows the evaluation of two data points in productivity growth, such as x for inputs and y for outputs. The Malmquist productivity model is estimated through multiplying units of individual distance data and corresponding technological change. According to Fare et al. (1994); the Malmquist productivity change index among the terms (s) and (t) is formulated below: (Tipi and Rehber, 2006)

$$m_o(x_s, y_s, x_t, y_t) = \left[\left(\frac{d_o^s(x_t, y_t)}{d_o^s(x_s, y_s)}\right) x \left(\frac{d_o^t(x_t, y_t)}{d_o^t(x_s, y_s)}\right)\right]^{1/2}$$

The concept d_o^s (x_t, y_t) stands for the distance between terms t and s technology. A score of more than 1 would represent positive total factor productivity growth from term s to term t. Another method of formulating the Malmquist productivity index is observed below:

$$m_o(x_s, y_s, x_t, y_t) = \left(\frac{d_o^t(x_t, y_t)}{d_o^s(x_s, y_s)}\right)\left[\left(\frac{d_o^s(x_t, y_t)}{d_o^t(x_t, y_t)}\right) x \left(\frac{d_o^s(x_s, y_s)}{d_o^t(x_s, y_s)}\right)\right]^{1/2}$$

Consequently, change in technical efficiency and technology change are the two elements that could decompose the Malmquist productivity index. Fare et al. (1994) described two ideas: outside and inside of a pair of brackets. The outside estimates efficiency change between terms s and t, while the inside brackets estimates technological change that translates into a measure of an average of a movement in the technology of the two terms.

Efficiency change = $\frac{d_o^t(x_t, y_t)}{d_o^s(x_s, y_s)}$

Technical change = $\left[\left(\frac{d_o^s(x_t, y_t)}{d_o^t(x_t, y_t)}\right) x \left(\frac{d_o^s(x_s, y_s)}{d_o^t(x_s, y_s)}\right)\right]^{1/2}$

In addition, Nin et al. (2003) described efficiency change as an estimated interval between actual production and the utmost prospective production between terms s and t, whereby the movement of technology between the two terms s and t indicates technical change. A positive is observed if the mean score is above 1, and regression or negative movement is considered if the average score is below 1. Also, when the average mean equals one, it shows no technological frontier movement. The Malmquist productivity index has the same scenario as the technical efficiency change integral. Furthermore, Malmquist four distance functions are needed in the calculations of the experimental approach. Thus, the data envelopment analysis-based linear programming method under constant return to scale assumption could be estimated by the distance function.

Data

To calculate the agricultural production efficiency of Türkiye, we used time-series data from 1995 to 2019. 25 years was considered to cover structural changes in the agriculture sector of Türkiye. Most of the data is gathered from FAOSTAT.

Determination of input variables and output variables is crucial in data envelopment analysis. The input and output variables are selected based on literature research and the availability of published data. The output is measured in agriculture GPV. The selected input parameters are agriculture land, chemical use, fertilizer use, the amount of labor employed, livestock and machine presence.

Y (agriculture GPV, constant 2014-2016 thousand US$)) =$X_1$, X_2, X_3, X_4, X_5, X_6, X_7, X_8

Agriculture land (X_1): It represents land used for the cultivation of crops and animal husbandry. The total area classified as "Cropland" and "Permanent meadows and pastures" is the total area classified as "Cropland."

X_2 variable describes total pesticide, covering insecticides, fungicides, and bactericides (including seed treatments), herbicides, plant growth regulators, rodenticides, mineral oils, disinfectants, and others.

Fertilizer use (X_3, X_4, X_5): These variables show the total amounts of nitrogen (N), phosphate (P_2O_5), and potash (K_2O) from all fertilizer products used in agriculture.

The labour employed (X_6): This variable indicates the share of people employed in agriculture. The indicator provides information on the relative importance of agriculture in employment. This variable can be defined as the percentage of all people seeking or working as employers, self-employed, salaried, or unpaid employees.

The livestock (X_7): This was created by aggregating animals using livestock unit equivalence.

The machine presence (X_8): This variable is the total number of tractors and harvesters used in agriculture.

In the study for the calculations, DEAP 2.1 and for plots deaR-shiny (https://rbensua.shinyapps.io/deaR/) was used which is an interactive web application used to evaluate efficiency and productivity.

RESULTS and DISCUSSION

This section shows the results of the analysis. Descriptive statistics about model variables are shown in Table 1.

Table 1. Descriptive statistics of variables (1995-2019)

Çizelge 1. *Değişkenlerin tanımlayıcı istatistikleri (1995-2019)*

Variable (1995-2019)	Mean	STD	Min.	Max.
Y- Agricultural GDP (billion TL, fixed prices)	61013750.00	10289525.11	46906006.00	79784624.93
X_1- Agricultural land (1000 ha)	39403.00	1138.22	37716.00	41223.00
X_2- Total pesticide used in agriculture (tonnes)	38009.80	9096.92	25539.00	60020.00
X_3- Nutrient nitrogen used in agriculture (tonnes)	1400483.24	204114.74	1053685.00	1896479.00
X_4- Nutrient phosphate used in agriculture (tonnes)	584617.32	94429.58	328791.00	792490.00
X_5- Nutrient potash used in agriculture (tonnes)	93312.92	20056.35	66300.00	131599.00
X_6- Share of employment in agriculture (% of total employment)	28.53	8.80	18.11	44.11
X_7- Livestock unit	17670568.57	2358729.57	15045277.55	23708528.50
X_8- Agricultural machinery	1078774.68	170978.64	776863.00	1372102.00

Technical efficiency measures over the period 1995-2019

The results of the technical efficiency values from 1995–2019 in Turkish agriculture are summarized and presented in Table 2. If the calculated TE value is equal to one, it means full technical efficiency in that year, and if it is less than one, it means ineffectiveness. The TE score also reflects the utilization performance of the factors of production. The fact that this index value is less than one means that the maximum output is not produced with the available inputs. It can be noticed that Turkish agriculture is efficient on average throughout the 1995–2019 years, except in 1997, 1998, 1999, 2000, 2003, 2004, 2005, 2007, 2009, 2014, and 2016 (Figure 1).

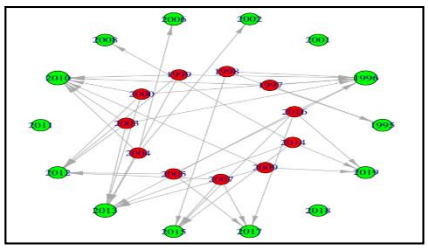

Figure 1: Inefficient years and targeted years

Şekil 1. *Verimsiz yıllar ve hedef yılları*

When the TE value is examined, it can be said that it was at its lowest level in 2007. According to the analysis, Turkish agriculture has a negative technical efficiency score, which is negative 2% over the study period. This shows that the Turkish agricultural sector is producing relatively less than the best frontier practice annually. In other words, Turkish agriculture is inefficient. The term "inefficient" is used to mean the distance between a given year and the best practice frontier. Inefficiency is not just a result of the input factors used in the model. This result means that agricultural efficiency improvements are needed. Tipi and Rehber (2006) also highlighted that technical efficiency in agriculture is influenced by

several factors that are not related to the technological choices made by the producers. Environmental conditions, location, transportation network, farm size distribution, and the size of local economies are the main elements explaining technical efficiency variation. Institutional factors such as extension and agricultural policies also need to be examined.

Table 2. Data envelopment analysis (DEA) technical efficiency (TEcrs) scores for Turkish agriculture from 1995 to 2019

Çizelge 2. *1995-2019 yılları arasında Türk tarımı için veri zarflama analizi (VZA) teknik etkinlik (TEcrs) skorları*

Year	TE_{crs}	Year	TE_{crs}	Year	TE_{crs}	Year	TE_{crs}	Year	TE_{crs}
1995	1.000	**2000**	0.958	**2005**	0.947	**2010**	1.000	**2015**	1.000
1996	1.000	**2001**	1.000	**2006**	1.000	**2011**	1.000	**2016**	0.987
1997	0.970	**2002**	1.000	**2007**	0.898	**2012**	1.000	**2017**	1.000
1998	0.997	**2003**	0.918	**2008**	1.000	**2013**	1.000	**2018**	1.000
1999	0.934	**2004**	0.959	**2009**	0.963	**2014**	0.976	**2019**	1.000
Mean									**0.980**

Years with an efficient TE score are the peers that determine the best production limit. Thus, Figure 1 is a graphical depiction of the reference sets of the inefficient years. In this plot, the inefficient years are represented as red nodes in the inner circle, while the efficient years correspond to the green nodes lying in the outer circle. From each inefficient year, there is an arrow joining it with each one of the efficient years in its corresponding reference set. Additionally, the size of each efficient year is proportional to the sum of the intensities obtained in the different reference sets to which it belongs.

Table 3. Malmquist TFP index summary of annual means for the DEA model, 1995–2019

Çizelge 3. *VZA modeli için yıllık ortalamaların Malmquist TFV endeksi özeti, 1995-2019*

Year	TFPC	TC	TEC	PEC	SEC
1996	1.019	1.019	1.000	1.000	1.000
1997	0.978	0.978	1.000	1.000	1.000
1998	1.011	1.011	1.000	1.000	1.000
1999	0.962	0.962	1.000	1.000	1.000
2000	1.087	1.087	1.000	1.000	1.000
2001	1.056	1.056	1.000	1.000	1.000
2002	1.065	1.065	1.000	1.000	1.000
2003	0.935	0.935	1.000	1.000	1.000
2004	1.055	1.055	1.000	1.000	1.000
2005	0.947	0.947	1.000	1.000	1.000
2006	1.206	1.206	1.000	1.000	1.000
2007	0.775	0.775	1.000	1.000	1.000
2008	1.296	1.296	1.000	1.000	1.000
2009	0.825	0.825	1.000	1.000	1.000
2010	1.080	1.080	1.000	1.000	1.000
2011	0.980	0.980	1.000	1.000	1.000
2012	1.013	1.013	1.000	1.000	1.000
2013	1.000	1.000	1.000	1.000	1.000
2014	0.975	0.975	1.000	1.000	1.000
2015	1.026	1.026	1.000	1.000	1.000
2016	0.899	0.899	1.000	1.000	1.000
2017	1.040	1.040	1.000	1.000	1.000
2018	1.123	1.123	1.000	1.000	1.000
2019	0.995	0.995	1.000	1.000	1.000
Mean	1.009	1.009	1.000	1.000	1.000

Note: 1996 refers to the change between 1995 and 1996, and so on

TFPC = (TEC) x (TC).

TEC = (pure efficiency change) x (scale efficiency change).

The Malmquist TFP index was obtained by applying the DEA technique to the model specification in the data set. The Malmquist TFP index represents the productivity of the production point (x_{t+1}, y_{t+1}) relative to the production point (x_t, y_t). A change in total factor productivity (TFP) index value greater than one indicates an increase in TFP, and lower than one indicates a decrease in TFP. Again, TEC (technical efficiency change) and TC (technology change) indices of TFP components greater than one indicate technical efficiency and technological progress, while those lower than one indicate regression. On the other hand, TEC is divided into two types: change in pure efficiency (PEC) and change in scale efficiency (SEC). Scale efficiency shows the success in producing at an appropriate scale (Deliktaş 2002). Table 3 shows the Malmquist TFP index summary of annual means for the model. It shows the annual means of TFPC, TC, TEC, pure efficiency change, and scale efficiency change over the study period (1995–2019). The mean TFPC of 1.009 indicates that, on average, over the sample period, there was a 0.9% productivity gain. There are fluctuations in technology change and total factor productivity indexes from year to year.

On average, the Turkish agricultural sector shows 0.9% positive productivity progress over the years 1995–2019. The reason for the growth in agricultural productivity is the increased adoption of technology change. The mean of TEC is 1.000 and the mean technology change is 1.009. Productivity gains were largely the result of technical change. This is because the mean TEC (1.000) is less than the mean technology change (1.009).

This study estimates agricultural technical efficiency in Turkish agriculture by applying output-oriented DEA and Malmquist index methods to one aggregated output and eight (8) inputs during the period 1995–2019. Study results show that Turkish agriculture has experienced a negative efficiency of 2%. In 2007, lowest technical efficiency score ever recorded was 0.898. The Malmquist TFP index decomposition has indicated that total factor productivity experienced a positive change of 0.09% in the study period. The analysis revealed that the year 2008 has the highest score of 1.296 (+29.6%) and the year 2007 has the lowest TFPC score 0.775 (-22.5%). According to DEA analysis, implemented Turkish agricultural reforms and policies have decreased efficiency by 2%, but increased Malmquist factor productivity index by 0.9% annually. The study suggests a few policies and recommendations. Policies and support should be selected more precisely to increase technical efficiency in agricultural production. Farmers should have easy access to extension services that affect efficiency in the sector. Also, both the public and private sectors should invest in infrastructure, access to credit, and trade policies that help in improving the sector.

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PP-02

Full Text Proceeding

(Tam Metin Bildirisi)

Testing Preferences of Fish And Fish Products Consummation of Bosnia And Herzegovina Consumers

Bosna-Hersek Tüketicilerinin Balık ve Balık Ürünleri Tüketim Tercihleri

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Keywords: Bosnia and Herzegovina, consumption, fish, fish consumers, preferences

Anahtar sözcükler: Bosna-Hersek, tüketim, balık, balık tüketicileri, tercihler

ABSTRACT

Objective: The market for fish and fishery products aims to provide an economic description of the entire fisheries and aquaculture industry. Fish consumption is subject to many influences, including the socioeconomic background of consumers, their general pattern of food consumption, their health status, and numerous dimensions. The aim of this study was to determine the level of fish and fish products consumption in Bosnia and Herzegovina..

Material and Methods: An appropriate sample of residents in larger cities in Bosnia and Herzegovina was examined.

Results: The largest percentage of respondents was from the group of qualified officials and senior management (26.2%), followed by almost the same officials of lower and middle management (23.8%). Respondents most often buy fish for frying about 45.1%, while 25.5% of respondents buy fish for storage, then about 21.6%. The supply of fish in our country is mediocre even about 62.0%, then 16% of respondents rated the supply of fish in our country as good with about 16%, about 14% of respondents could not assess what the supply of fish in our country.

Conclusion: It can make one conclusion that in Bosnia and Herzegovina fish eat relatively little in relation to the quantities produced.

ÖZ

Amaç: Balık ve su ürünleri pazarı, genel balıkçılık ve su ürünleri endüstrisinin ekonomik bir tanımını sunmayı amaçlamaktadır. Balık tüketimi, tüketicilerin sosyoekonomik arka planları, genel gıda tüketim düzenleri, sağlık durumları ve çeşitli boyutlar gibi birçok etkene bağlıdır. Bu çalışmanın amacı, Bosna-Hersek'te balık ve balık ürünleri tüketim düzeyini belirlemektir

Materyal ve Yöntem: Bosna-Hersek'in büyük şehirlerinde yaşayanlar arasında uygun bir örneklem incelenmiştir

Araştırma Bulguları: Katılımcıların en büyük yüzdesi, nitelikli yetkililer ve üst düzey yöneticiler grubundan (26.2%) gelmekte olup, neredeyse aynı oranda daha düşük ve orta düzey yöneticilerin olduğu bir grup (23.8%) takip etmektedir. Katılımcılar en çok balığı kızartmak için alır, yaklaşık %45.1, ardından katılımcıların %25.5'i balığı saklamak için alır, ardından yaklaşık %21.6. Ülkemizde balık arzı ortalama olarak kabul edilebilir, yaklaşık %62, ardından katılımcıların %16'sı ülkemizdeki balık arzını iyi olarak değerlendirdi, yaklaşık %16, katılımcıların yaklaşık %14'ü ülkemizdeki balık arzını değerlendirememiştir.

Sonuç: Bosna-Hersek'te üretilen miktarlara göre, insanların nispeten az balık tükettiği bir sonuca varılabilmektedir.

INTRODUCTION:

In Bosnia and Herzegovina, fish consumption is at a low level compared to other countries, estimates are in the range of 3-5 kilograms of fish per year per capita, in contrast to, for example, 15-20 kg of dried meat products and salami. "For most Bosnians, fish is not meat."

In this sense, we cite the example of Japan, where the average fish consumption per inhabitant is about 68 kg per year, so about 15 times more than in our country. Scientific data on the attitudes of the inhabitants of Bosnia and Herzegovina regarding the consumption of fish and other processed products are very limited. Therefore, examining the consumption habits and preferences of the Bosnian population towards fish and fish products is of inestimable value (Karahmet et al. 2020).

Fish is a suitable source of quality protein that is essential for health (Kim et al. 2000). Fish is usually cooked in different ways such as boiling, baking, frying and grilling. These cooking methods result in enhanced taste, flavor and improve digestibility and inactivate pathogenic microorganisms (Kocatepe et al. 2011). During the preparation of fish, some chemical and physical reactions take place, such as protein denaturation, which increases its digestibility and improves its nutritional value.

Fish consumption is subject to many influences, including consumers' socioeconomic background, their general food consumption patterns, their health status, and numerous dimensions. (Trondsen et al. 2004). A complex interrelationship can be expected among these factors. Consumers' attitude towards fish consumption, for example, may be based on personal experience with the availability of high-quality fish, fish preparation skills and feedback received from immediate family members (Myrland et al., 2000; Scholderer and Grunert, 2001; Turell, 1998).

Fish meat belongs to aromatic meats and is appreciated as very tasty. Fish meat is easily digestible, so it is often recommended in dietary and dietary diets. It contains small amounts of connective tissue. Its muscle fibers are delicate in structure. Fish meat contains many biologically valuable proteins that have a favorable ratio of amino acids. Due to the high content of mono- and polyunsaturated fatty acids, fish meat has a high nutritional value (Karahmet et al. 2020). This value is particularly pronounced due to the presence of long-chain essential fatty acids. Due to its nutritional value, fish meat occupies an important place in the human diet. The favorable content of proteins, minerals, vitamins, and especially essential fatty acids is beneficial in the prevention of numerous diseases (Sidhu, 2003). The human body uses an average of 95% of all the ingredients of fresh, frozen or smoked fish, 96% of protein and up to 91% of fat.

Knowledge of consumers and their decision-making processes help fish producers and processors make sound decisions about what to produce and market to ensure marketing effectiveness (Al-Mazrooei et al., 2001). It can be said that consumer behavior and habits of consuming fish and other fruits are important factors that influence the development of the fish production and processing sector. Therefore, consumer attitudes and habits are studied to determine these factors in many countries.

Consumer segmentation variables are developed to identify specific market opportunities and formulate a strategy to promote fish consumption in a specific area. Variables most often relate to five topics: fish consumption, attitudes and knowledge about the health benefits of fish, interest in potential information when purchasing fish, and individual socio-demographic characteristics, including weight and height. Fish consumption is measured as the sum of fish consumed at home and outside. A 9-point scale ranging from "never" to "every day or almost every day" is used (Wenaty 2018).

The aim of this study was to determine how past experiences influence consumer attitudes towards fish consumption, and how these attitudes are closely related to actual fish consumption patterns.

MATERIAL AND METHODS:

The research is oriented towards surveying the consumption of fish and other fish products as food items of that part of the population that consumes fish more often, i.e. that population that looks at, thinks about and buys fish in fish shops, supermarkets and other places.

The following techniques were used to survey consumers about the consumption of fish and fish products: surveys and interviews. Collected survey field research data on a selective sample of the population of Bosnia and Herzegovina that consumes fish more or less regularly were processed and presented in standard socio-demographic and other relevant variables. The data are presented in tables, and the most important results are thematically interpreted and discussed in the text.

RESULTS AND DISCUSSION:

This survey included 120 respondents, of which 70% were female and 30% male aged 22 to 70. Most of the respondents were from the continental part of the country (about 60%), followed by about 30% in Herzegovina, and the rest of the respondents were with temporary residence abroad. The work status of the respondents is shown in the following graph.

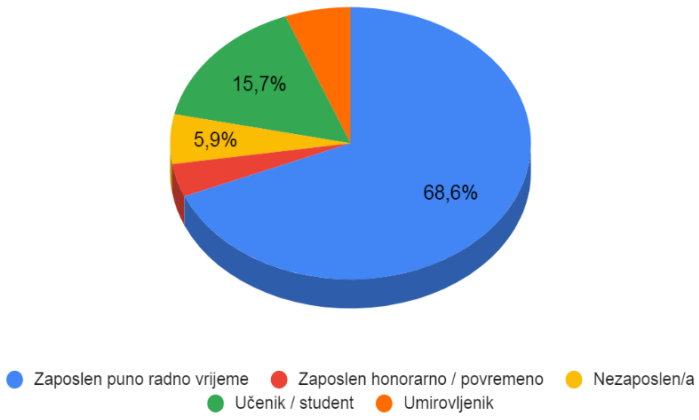

Figure 1. Employment status of the respondent

Şekil 1. Katılımcıların istihdam durumu

From Figure 1, we can see that the majority of respondents are employed full-time, 68.6%, while at the same time the number of students was 15.7%. This shows that fish is most often consumed in families that are employed. In addition to work status, the following chart shows a detailed description of the respondents' occupation.

The highest percentage of respondents was from the group of qualified employees and senior management (26.2%), followed by almost the same number of lower and middle

management employees (23.8%). They are followed by freelancers (16.7%), while business owners and freelancers are at the same level (11.9%). After the information related to the respondents of fish consumers, in the following text we will see what their habits are when it comes to fish consumption. When asked How often do they buy fish for food?, 58.8% of the respondents stated that they buy 2-3 times a month, while 23.5% once a week, and the entire structure of the respondents is shown in the following Figure.

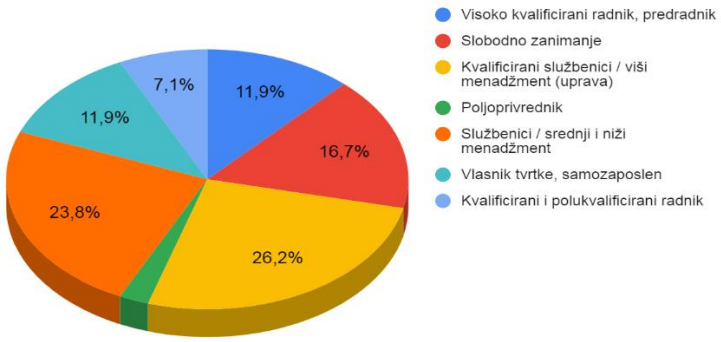

Figure 2. Percentage presentation of respondents' occupations

Şekil 2. Katılımcıların meslek gruplarının yüzde dağılımı

The surveyed respondents most often buy fish in stores (64%), then in fish shops (30%), and only 6% of them buy fish from friends or acquaintances and those respondents who catch fish themselves. Also, the overall structure of this Figure is shown below .

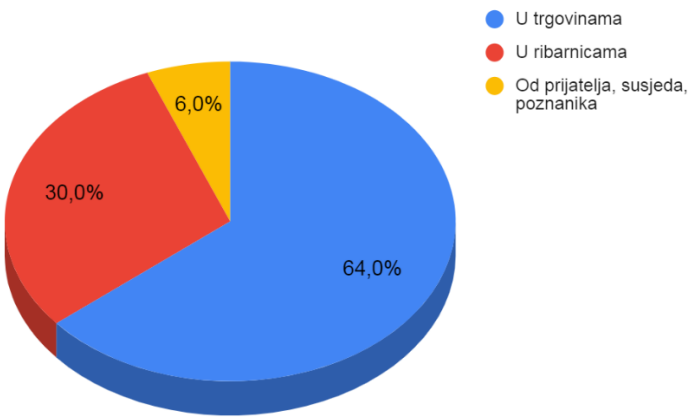

Figure 3. The most common places to buy fish

Şekil 3. Balık alışverişi için en yaygın tercih edilen yerler

The amount of fish that consumers buy varies considerably, so there are more of those who buy fish up to one and a half kilograms (39.2%), then those who buy from 0.5-1.5 kg (31.4%), 17% are of those consumers who buy up to 0.5 kg of fish. There are very few who buy up to 2 kg (9.8%) and the least number of consumers who buy more than two kilograms. The following chart shows us more information on this issue.

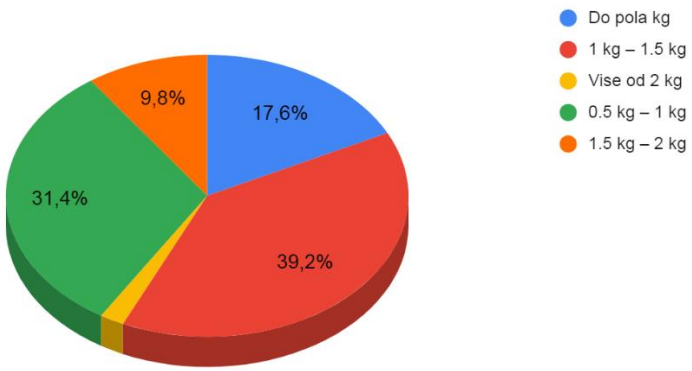

Figure 4. The amount of fish that respondents usually buy

Şekil 4. Katılımcıların genellikle ne kadar balık satın aldığının gösterimi

According to the analyzed data of the respondents, the most important segment is that the fish is fresh, in this case of the survey this was confirmed by 37.3% of the respondents, followed by domestic, fresh and cleaned fish with 17.6%, for cleaned fish there were 8%, while the percentages for fresh cleaned and frozen fish were the same with 3.9%, and the other choices of respondents were in the last places and with a small percentage of around 2%.

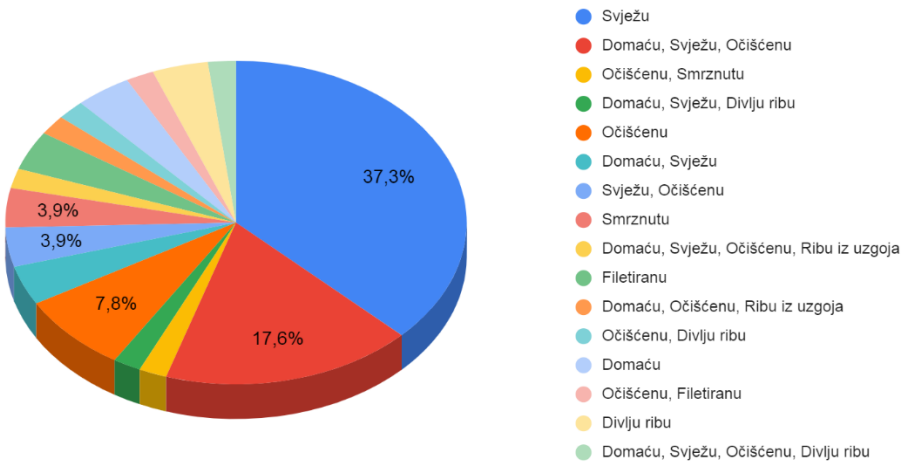

Figure 5. What type of fish do consumers buy?

Şekil 5. Tüketicilerin hangi tür balık satın aldığının gösterimi

Despite the research scientists have done before us, our understanding is still limited regarding the formation of consumer attitudes about fish consumption and how these attitudes influence actual consumer behavior. In particular, little attention has been paid to barriers to consumption related to different products. Understanding such barriers

is of crucial importance for marketers who want to differentiate their product offering, trying to meet the needs of certain market segments through improved product quality, distribution and communication, as well as health segments where they want to improve the status of their campaign.

The research results show a lack of knowledge about the safety of fishery products among customers, including processing, storage and monitoring systems - traceability. Consumer age, educational background, perceived certainty and average price are the main determinants of traceable fishery products. On average, consumers are willing to pay more than 6% for safe, traceable products over the price of unverified products and uncertain safety, which is in line with research by Wang et al. in 2009.

Scientific data on the attitudes of residents and tourists about the consumption of fish and other sea products are very limited. Therefore, the consumption habits in the examination of the preference of the Turkish population towards seafood were evaluated based on the example of Istanbul. Only 15.53% (151) of the 972 participants stated that they never consume fish or other seafood, but none of them consider seafood unhealthy. Their main reason for not consuming them is their smell and taste. A significant part of the participants (84.47%) was highly aware of the nutritional value of seafood. Previous negative experiences did not reduce the frequency of consumption. The rate of seafood consumers and the frequency of consumption increases proportionally with the age of the consumer. The majority of respondents (34.84%) eat seafood once a week and believe that they should consume seafood more often.

If seafood were more available, many participants (44.10%) stated that they would consume seafood. The first three preferred fish were oily species, while the most favorite seafood was mussel. Octopus was the most unfavorable, and most of the participants were not familiar with surimi. Respondents mostly (96.59%) preferred to consume fresh seafood, and canning was the favorite (37.64%) processing technology (Erdogan et al. 2011).

This study showed that fish as a meal is more suitable for the elderly. Education, income and family environment are other important factors. The usual frequency of fish consumption is 2-3 times a month. Also, the results revealed that most respondents are aware of the nutritional value of fish and fish products, although the essential content of amino acids in fish is the least known.

It is interesting that a significant percentage of the respondents believed that they would have to consume fish more often, while almost half of them stated that they could consume it more often if fish became easily available and cheaper. Another interesting result is that a very high percentage of respondents prefer to consume fresh fish over processed fish. The aforementioned discoveries about consumer preferences can be useful for the aquaculture sector in Bosnia and Herzegovina to increase fish consumption or to develop new products, such as more attractive products for young people. Likewise, various studies have also documented that high price, convenience, cooking, eating habits, availability, health, sensory properties such as smell and taste, consumer knowledge and socio-demographic characteristics are the main factors influencing fish consumption in Bosnia and Herzegovina.

Taking into account both food consumed by humans and seafood processed for food production, seafood consumption in EU member states is 27 kg per capita. The highest consumption at the EU level was observed in Portugal (61.5 kg per capita), and outside the EU, the top consumers were Korea (78.5 kg per capita), followed by Norway (66.6 kg per capita). (Alexander Raths 2018)

CONCLUSSION:

In accordance with the set goal of the work and the defined tasks, and based on the results obtained, it can be concluded that this survey included 120 respondents, of which 70% are female and 30% male, aged 22 to 70 years. The highest percentage of respondents was from the group of qualified employees and senior management (26.2%), followed by almost the same number of lower and middle management employees (23.8%). About 45.1% of respondents buy fish for frying, while 25.5% of respondents buy fish for storage, followed by about 21.6%. The supply of fish in Bosnia and Herzegovina is mediocre, even about 62.0% of them, then 16% of the respondents gave the assessment that the supply of fish in our country is good with about 16%, about 14% of the respondents could not assess what kind of fish supply it is in our country. The method of catching fish that the respondents chose most was with a net 42.9%, then with a hook 36.7%, 10.2% farming. The respondents were very interested in fish as a food item. In the end, one conclusion can be made that relatively little fish is eaten in Bosnia and Herzegovina compared to the quantities that are produced.

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PP-07

Full Text Proceeding

(Tam Metin Bildirisi)

Physical properties of experimentally produced tomato sauces and commercial tomato products

Deneysel olarak üretilen domates sosları ve ticari domates ürünlerinin fiziksel özellikleri

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Keywords: (physical properties, stability, starch, thermophysical properties, tomato sauce)

Anahtar sözcükler: (9 pt, bold, aliged to the left) At most 4-6 keywords (9 pt, justified, as in Keywords's order)

ABSTRACT

Objective: The aim of this paper was to analyze the physical properties of different tomato sauces and similar tomato products.

Material and Methods: The research was done on 3 tomato sauces produced from tomato concentrate, salt, vinegar, sugar, spices, and different starch concentrations (0, 2.5 and 4.5 %) and commercial tomato products (tomato puree, passata and ketchup).

Results: Experimentally produced sauces had the following values: moisture 77.18 – 84.00%, syneresis 14.54-42.62%, density 0.390 – 1.28 g/ml and dynamic viscosity 500 – 2200 mPas. Commercial samples of tomato puree and ketchup had lower moisture (65.88 and 68.74%), higher NaCl, and viscosity (2300 and 8150 mPas) and more stable consistency. Calculated thermal conductivity, specific heat capacity, and freezing point had higher values in samples with higher moisture content. Considering experimental produced samples the most stable consistency was noticed in samples with the highest starch concentration.

Conclusion: Experimental tomato sauces made with higher starch amounts had lower values of moisture content, pH value, thicker and more stable consistency, lower syneresis, and higher values of viscosity and density. Generally, samples with higher total solids content had higher viscosity, lower fluidity and spreadability, but more stable consistency due to lower syneresis.

ÖZ

Amaç: Bu makalenin amacı, farklı domates soslarının ve benzeri domates ürünlerinin fiziksel özelliklerini analiz etmektir.

Materyal ve Yöntem: Araştırma, domates konsantresi, tuz, sirke, şeker, baharatlar ve farklı nişasta konsantrasyonları (0, 2.5 ve 4.5 %) içeren 3 domates sosu ile ticari domates ürünleri (domates püresi, passata ve ketçap) üzerinde yapılmıştır.

Araştırma Bulguları: Deneysel olarak üretilen sosların değerleri elde edilmiştir: nem oranı %77.18 - %84.00, sinerezis %14.54 - %42.62, yoğunluk 0.390 - 1.28

g/ml ve dinamik viskozite 500 - 2200 mPas. Ticari domates püresi ve ketçap örnekleri daha düşük nem (sırasıyla %65.88 ve %68.74), daha yüksek NaCl ve viskozite (sırasıyla 2300 ve 8150 mPas) ve daha stabil kıvam değerlerine sahip olduğu görülmüştür. Hesaplanan termal iletkenlik, özgül ısı kapasitesi ve donma noktası, daha yüksek nem içeriğine sahip örneklerde daha yüksek değerlere sahip olduğu anlaşılmıştır. Deneysel olarak üretilen örnekler göz önüne alındığında, en stabil kıvamın en yüksek nişasta konsantrasyonuna sahip örneklerde görüldüğü gözlenmiştir.

Sonuç: Daha yüksek nişasta miktarları ile yapılan deneysel domates sosları, daha düşük nem içeriği, pH değeri, daha kalın ve daha stabil kıvam, daha düşük sinerezis ve daha yüksek viskozite ve yoğunluk değerlerine sahip olduğu görülmüştür. Genel olarak, daha yüksek toplam katı içeriğe sahip örnekler, daha yüksek viskozite, daha düşük akıcılık ve yayılabilirlik, ancak daha düşük sinerezis nedeniyle daha stabil bir kıvama sahiptir.

INTRODUCTION

Tomato (*Solanum lycopersicum*) is a vegetable species from *Solancea* family, originating from South America. Fresh tomato fruits have the following proximate composition: moisture 94%, total solids 6%, total soluble solids 5.2%, total carbohydrates 3.41%, reduced sugars 2.96%, proteins 0.30%, fats 0.70% and ash 0.55%. Fresh tomatoes also contain some nutritionally valuable bioactive compounds such as vitamin C 26.6 mg%, total carotenoids 37.7 mg%, lycopene 31.82 mg% and total flavonoids 18 mg/g. Lycopene is a very strong antioxidant, and the red color of tomato originates from lycopene (Ramadan et al. 2021; Ali et al. 2020). Tomatoes also contain pectin fiber, which is the most important ingredient that determines physical properties of tomato products. Rheological properties, texture and consistency of tomato products are influenced by pectins (Sharma et al., 1998).

Tomatoes are widely consumed in the world as fresh, canned or processed into various products. The most popular tomato products are sauce, ketchup, paste, puree and soups. Over 80% of the world's produced tomatoes are consumed in the form of processed products (Gould, 1992).

According to Codex Standard 13 (1981) tomato pulp is defined as skinless ground tomatoes. Whole or chopped tomatoes can be preserved in tomato pulp or tomato juice. Tomato concentrates can be classified into two groups (puree and pasta) depending on total solids content. The lowest required total solid content in tomato concentrates is 7%. Puree contains at least 7% of total natural tomato solids, while tomato pasta is double or multiple concentrated tomato puree with at least 24% of natural tomato solids (Codex Stan. 57, 1981). Ketchup is tomato-based sauce that is produced from concentrated tomato juice, e.g. single concentrate, diluted double or triple concentrate with the addition of sugar, starch milk, vinegar, salt and various spices. The total solids in ketchup are commonly 25-35%. Tomato concentrate is a product obtained by evaporation of mashed tomato pulp or tomato juice, and can be classified according to the amount of dry matter as single (14-16%), double (28-30%), triple (38-40%) and multiple concentrated (>50%). Pureed tomato is a product that is obtained by pureeing of chopped tomatoes, with separation of skin, seeds and rough parts of tomato tissue. Pureed tomatoes are commonly used as the basis for the production of tomato concentrate, juice, sauce and ketchup. Required total amount of tomato solids in puree and pulp should be 8-24% of solids, while in pasta at least 24% (Gould, 1992; Hankin, 1986, Codex stan. 13, 1981).

Pectins are plant polysaccharides soluble in water. Aqueous solutions of pectin have low values of dynamic viscosity and behave like Newtonian fluids at low concentrations. In higher concentrations, they take the properties of pseudoplastic non-Newtonian fluids. When heated in the presence of sugar and acids, they absorb water, swell and form gelatinous complexes (Wandrey, et al. 2010). Because of that, pectins are good food stabilizers and emulsifiers, and are widely used in the food industry as a thickener.

The most important physical properties of tomato products are density, dynamic viscosity, consistency, physical stability and syneresis. Density is defined as a ratio of mass and volume (ρ=m/V) and the commonly used units for density are kg/m^3, g/l and g/ml. Viscosity is a specific characteristic of each fluid material and it is defined as a measure of fluid resistance to flow. The unit for dynamic viscosity is Pas. Liquids with higher viscosity (more viscous fluids) values had higher resistance to flow. Viscosity and density of liquids depend on temperature. With increasing the temperature, viscosity and density of liquids decrease. Kinematic viscosity is the ratio of dynamic viscosity and density (Singh & Heldman 2009). Density and viscosity of tomato products depend on their composition, concentration and total solids content. Tomato products with higher solids content have

higher density and viscosity and thicker consistency. Kumbar et al. (2019) suggested mathematical models for prediction of tomato ketchup density and dynamic viscosity in dependence on sample temperature T. According to these models density (ρ) and viscosity (μ) of analysed samples were calculated using following formulas:

$$\rho = 0.6112 \bullet T(°C) + 1031.7 = [kg/m3] \quad (1)$$

$$\mu = 14.544 \bullet T(°C) + 632.11 = [mPas] \quad (2)$$

Thermophysical properties of are all physical properties that depend on change in temperature, chemical composition and structure of the material. The water content in the food has the most important influence on the thermophysical properties of the food. The most common thermophysical properties of food are: freezing point, thermal conductivity, specific heat capacity and thermal diffusion. These thermophysical properties can be predicted by using different mathematical models. In this study calculations of thermophysical properties were obtained by specific mathematical models specially established for tomato products and similar vegetable food products (Singh & Heldman, 2009).

MATERIAL and METHODS

Research was done on six samples of different tomato products: three samples of experimentally produced tomato sauces with different starch concentrations; and three samples of similar commercial tomato products such as tomato pasasata, ketchup and tomato concentrate purchased from the local market. The list of samples are given in Table 1.

Table 1. The list of samples

Çizelge 1. Örneklerin listesi

Sample name	Description	Producer
ETS – 0%	Experimental tomato sauce with 0% of added starch	Experimental
ETS – 2.5%	Experimental tomato sauce with 2.5% of added starch	Experimental
ETS – 4.5%	Experimental tomato sauce with 4.5& of added starch	Experimental
Passata	Commercial purred and canned tomato pulp	Podravka d.o.o., Koprivnica, Croatia
Ketchup	Commercial tomato ketchup	Polimark Omnico, Belgrade, Serbia
Concentrate	Commercial tomato puree duble concentrated	Podravka d.o.o., Koprivnica, Croatia

Experimentally produced tomato sauce samples were prepared from tomato concentrate with 28-30°Brix (Nectar, Serbia) 50 g, tap water 40 g, modified corn starch Thermophylo (TTC TM, Ingredios) with three concentrations 0, 2.5 and 4.50 g, salt 1,00 ±0.2 g, sugar 1 g and K-sorbate 0,6 g. Tomato concentrate was mixed with water, heated at 60°C and starch dissolved in water was added and uniformly mixed. Salt, sugar and K-

sorbate were added, mixture was additionally heated at 85°C and warm samples were poured into containers to avoid air bubbles.

Chemical properties

Moisture content was determined by drying at 105 °C until a constant weight was reached (AOAC, 1995). Total ash content was determined by burning at 550 °C for 8 h (AOAC, 2000). Water activity value was measured by digital aw meter (Nowasina Switzerland). Measurement of soluble solids was performed by digital refractometer (0-45 Brix, 952045 B.ATC Alla France) and pH value was measured by pH meter (Metler Toledio). Soluble solid fraction was calculated as a percentage of soluble solids in total solids content. Mohr titration with $AgNO_3$ using potassium chromate as an indicator was used for determination of NaCl content (E.K. 8045, JUS. 1993).

Physical properties

For physical properties all measurements were done at room temperature 20°C. Density of samples was determined by measuring the weight in a measuring cylinder and density was calculated as ratio of weight and volume (Singh & Heldman, 2009)::

$$\rho = m/V \; = \; [kg/m3] \tag{3}$$

Dynamic viscosity was measured using a rotational rheometer (Myr, VR 3000) with R2 spindle and rotation speed of 60 and 100 rpm. Kinematic viscosity was calculated as the ratio of dynamic viscosity and measured density of samples (Singh & Heldman, 2009):

$$\nu \; = \; \mu/\rho \; = \; [m2/s] \tag{4}$$

where v is kinematic viscosity [m^2/s], μ is dynamic viscosity [Pas] and ρ is density [kg/m^3]

Apparent fluidity was calculated as reciprocal value of dynamic viscosity (Hlavač et al. 2019; Sing & Heldman, 2009) according to equation:

$$\Phi = \; \mu - 1 \; = \; [Pas] - 1 \tag{5}$$

For dispersibility determination 5 g of seasoning powder were put in a 50 ml measuring cylinder and distilled water (t = 20 °C) was added to 50 ml. The mixture of powder and water was vigorously stirred and left to stay for 3 h without agitation for the solid phase to settle. The volume of the liquid phase was measured. Dispersibility was calculated as the ratio of liquid phase volume V_{liquid} and total volume V_{total} (50 ml) (Alawode et al., 2017; Asma et al., 2006; El-Gindy, 2018):

$$Dispersibility(\%) \; = \; V_{liquid} \; \cdot 100 \; / \; V_{total} \tag{6}$$

Amount of syneresis was measured according to the method described by Dzhivodereva-Zarcheva et al. (2021). 10 g of samples was put in a centrifuge tube and centrifuged (EBA 20 Heittich) at room temperature and 3000 rev/min for 15 minutes. After centrifugation, the supernatant was separated and weighted. Percentage of syneresis was calculated as a ratio of supernatant weight and initial sample weight by following equation:

$$Syneresis \; (\%) = m_{supernatant} \; 100 \; / \; m_{sample} \tag{7}$$

Precipitation ratio was determined after measuring syneresis by method described by Xu et al. (2018). After centrifugation of 10 g of sample at room temperature and 3000 rpm for 15 minutes, supernatant was decanted from the centrifuge tube and weighted. Precipitate

weight was calculated as a difference between initial sample mass (10 g) and mass of decanted supernatant. Precipitate ratio was calculated as ratio of precipitate and supernatant weight:

$$Precipitate\ ratio\ =\ m_{precipitate}/m_{\ sample} \tag{8}$$

Determination of adhesiveness was done by method described by Sihshobhon et al. (2013) with some modifications. 100 g of sauce samples was placed in laboratory glass, and wooden stick (15x1,7x0,1 cm) was imersed into samples, taking care that 10 cm of stick should be immersed in sample. Adhesiveness was calculated by following formula:

$$Adhesiveness\ (\%)\ =\ (m2 - m1)\ 100\ /\ m \tag{9}$$

Where m_2 is the weight of a wooden stick with sample, m_1- initial weight of wooden stick without sample and m – weight of sample in glass (100 g).

Spreadability was measured by planimeter according to the method described by Singh et al. (2014). 100 g of samples was poured out on a plain surface and left to stay for 2-5 minutes. The surface of poured samples was marked and measured by digital planimeter (Placom KP-92N). Speradibilty was presented as a measured area in cm^2/100 g.

Prediction of physical and thermophysical properties

Thermophysical properties and some physical properties were estimated and calculated by different mathematical models, which used previously determined moisture or total solids content in samples.

Freezing point was calculated by model suggested by *Guegov`s* model applicable for food with total solids content between 3.50 and 27% (Guegov, 1980):

$$T_f =\ 0.36 - 0.175 \bullet \%solids\ =\ [°C] \tag{10}$$

Specific heat capacity was calculated by model established by Dickerson for fruit and vegetable liquid or semi-liquid food with water content higher the 50% (Delgado et al., 2006):

$$Cp =\ 1674.7\ +\ 25.12\ \%water\ =\ [J/(kgK)] \tag{11}$$

Bowman`s model was used for prediction of thermal conductivity coefficient:

$$\lambda\ =\ 0{,}056\ +\ 0.567\ \bullet\ \%water\ =\ [W/(mK)] \tag{12}$$

Thermal difussion coeficient a was calculated by general definition equation, which assume density, thermal conductivity and specific heat capacity was used to calculate thermal difussion coeficient (Singh & Heldman, 2009):

$$\alpha =\ \lambda/(\rho Cp)\ =\ [m2/s] \tag{13}$$

where α is thermal difussion coeficient [m^s/s], λ is thermal conductivity calculated by *Browman*`s model [W/(mK)], ρ is measured denisity of samples [kg/m^3] and C_p is calculated specific heat capacity [J/(kgK)]

Statistic analysis

All analyses were done in triplicate and results are shown as mean value with standard deviation. Statistical analysis was performed using one-way ANOVA and post-hoc Tukey test ($p \leq 0.05$) using Data Analysis package, Excel 2010.

RESULTS and DİSCUSSİON

Chemical properties

Results of chemical characteristics are given in Table 2. Moisture content in samples ranged between 65.88% (concentrate) and 90.12% (commercial passata). Experimentally produced tomato sauces had 77.18-83.62% of moisture, and moisture content decreased significantly ($p \leq 0.05$) in samples with higher starch concentration. Total solids content ranged between 9.88% and 34.12%. Samples with higher total solids (lower moisture content) had higher soluble solids content. In samples with higher starch concentration, the amount of total solids slightly increased, while soluble solids slightly decreased. Total solids and soluble solids were significantly higher in tomato ketchup and concentrate samples in comparison to other samples. Amount of soluble solids fraction in total solid content varied between 67.08 and 96.15%. Tomato product samples (ETS-0, passata and concentrate) without addition of starch or other stabilizers had higher amounts of soluble solid fraction in total solids content. The fraction of soluble solids had significantly ($p \leq 0.05$) the lowest values in commercial tomato ketchup and experimental tomato sauce with 4.5% of added starch in comparison to other samples. Water activity ranged between 0.911 and 0.952, and there were no significant differences in values between samples. Sample with the highest moisture content (passata) had the highest aw value, and sample with the lowest moisture content (concentrate) had the lowest aw.

pH values varied between 3.72 (ketchup) and 4.30 (passata). Addition of starch in experimentally produced tomato sauces slightly decreased pH value without significant differences. Significantly the lowest pH value (the highest acidity) was noticed in commercial ketchup, probably because of the fact that standard recipe for ketchup production include addition of vinegar. From declared data, commercial samples contained vinegar as an ingredient. On the other hand, commercial passata had the lowest pH value (significantly $p \leq 0.05$), probably because of significantly the highest moisture content, and the well known fact that pH value of water is 7. It can be seen (Table 2) that samples with higher moisture content had higher pH value. Significantly the highest NaCl content was noticed in commercial ketchup, and the lowest in tomato passata.

Table 2. Results of chemical analysis

Çizelge 2 Kimyasal analize dair araştırma bulguları

	Experimental tomato sauce samples			Commercial tommato samples		
Chemical caracteristics	ETS-0	ETS-2.5	ETS-4.5	Passata	Ketchup	Concentrate
Moisture (%)	83.62±0.02b	81.39±0.18b	77.18±0.62c	90.12±0.27a	68.74±0.95d	65.88±1.61d
Total solids (%)	16.38±0.02c	18. 61±0.18c	22.82±0.62b	9.88±0.27d	31.27±0.95a	34.13±1.61a
Soluble solids (°Brix)	15.75±0.07c	14.30±0.00d	15.30±0.14c	9.50±0.14e	21.50±0.14b	28.5±1.06a

Soluble solids fraction (%)	96.15±0.54a	76.84±0.37c	67.04±2.44d	96.15±1.18a	68.76±1.65d	83.50±0.83b
Aw	0.925±0.000	0.938±0.001	0.943±0.001	0.952±0.00	0.938±0.011	0.911±0.021
pH	4.21±0.02b	4.15±0.01b	4.13±0.01b	4.30±0.03a	3.72±0.04c	4.13±0.03b
NaCl (%)	0.86±0.01b	0.87±0.01b	1.05±0.00b	0.48±0.30b	4.82±0.18a	0.79±0.27b

Results obtained for chemical properties were in agreement with literature data. Literature data confirm that tomato sauces and similar products with addition of starch had higher total solids content in comparison to samples without starch (Alqahtani et al., 2022, Suri et al., 2017; Kirse-Ozolina et al., 2019; Kumar et al., 2015). Suri et al. (2017) reported that tomato sauce with addition of corn, rice and potato starch had moisture content between 80.31 and 87.90%, which is very similar to obtained results for experimental tomato sauces. Kirse-Ozolina et al. (2019) reported that commercial tomato sauce produced with addition of starch had a higher amount of moisture (71-82%) in comparison to sauces without starch (87.91%). Literature data reported that tomato ketchup has lower moisture content and higher total solids in comparison to tomato sauce. Moisture content in tomato ketchup is commonly lower than in tomato sauce. Average moisture content reported from literature in ketchup ranged between 28.14 and 81% (Alam et al., 2008; Anandsynal et al., 2018; Bayod et al., 2018), in tomato sauce 68-91% (Kirse-Ozolina et al., 2019; Carini et al., 2014; Xu et al., 2018; Suri et al., 2017; Alqahtani et al., 2022), in tomato paste 63-94% (Shatta et al., 2012, Famurewa et al., 2013) and in tomato juice 64-94% (Youssef, 2009). According to literature, soluble solids in similar tomato products varied in a very huge range between 4.44 and 44 °Brix (Drusas & Saravacos,1985, Shatta et al., 2017; Alqahtani et al., 2022; Yousef, 2009; Hassan et al., 2019). It is important to mention that soluble solids amount depend on total solids content, and samples with higher total solids have higher soluble solids. Because of that, tomato juices and sauces have lower total soluble solid than ketchup and concentrated pastas, which can be shown from Table 2.

According to literature data, average soluble solids content in tomato sauces commonly had values 21.6-38°Brix (Avinash & Madav, 2014; Xu et al., 2017, Kumar et al., 2015; Alqahtami et al., 2022, Carini et al., 2014) in tomato juices depending on concentration 4.8-35.9 (Youssef, 2009; Razi et al., 2011) in ketchup 15-55°Brix (Alam et al., 2009; Anandsynal et al., 2018) and in tomato paste 13°Brix (Famureva et al., 2013: Shatta et al., 2017) and 14-22°Brix in tomato concentrate (Pandey & Kumar, 2016). These higher values in comparison to obtained results could be explained with differences in preparation methods mostly with higher total solids content (Alqahtani et al., 2022) and in some cases with lower starch content (Kumar et al., 2015).The most similar value for soluble solids (15.3°Brix and 81.6% of moisture) is reported by Carini et al. (2014) for experimentally produced tomato sauce with addition of rice flour and by Pandey and Kumar (2016) for slightly concentrated tomato puree (14-22°Brix).

Results obtained for aw values were in agreement with literature data for similar tomato products, where aw values ranged between 0.860- 0.990 (Apostol et al., 2020, Carini et al., 2014; Kirse-Ozolina et al., 2019). According to Carini et al. (2014) samples with added rice starch had slightly higher raw value in comparison to salted tomato pulp, while the highest value was in unsalted tomato pulp.

According to literature pH values of tomato paste and concentrate have values 3.76-5.70 in tomato paste and concentrate (Famurewa et al., 2013; Pandey & Kumar, 2016, Shatta et al., 2017; Hassan et al., 2019), 3.88-4.28 in tomato juice (Razi et al., 2011; Youssef, 2009), 3.2-4.22 in ketchup (Anansynal et al., 2018; Bayod et al., 2008; Alam et al., 2009; Kumar et al., 2015) and 3.4-4.5 in tomato sauce (Kirse-Ozoliona et al.,

2019; Suri et al., 2017; Avinash & Madav, 2014, Apostol et al, 2020). Kumar et al.(2015) reported that pH value of ketchup sligtly decrease with addition of starch, which is in agreement with results obtained for experimental sauces. Obtained results for ketchup are also in agreement to literature data, because the ketchup commonly has lower pH value then sauce and, juice and concentrate.

Results obtained for NaCl content in tomato products were in agreement with literature data, and indicated that ketchup had higher NaCl amount then tomato sauce. Commonly reported NaCl content in tomato sauces was 0.7-2.3 % (Di Cariano et al., 2023, Kirse-Ozolina et al., 2019), 0.5-0.7% in tomato pulp (Naing & Myint, 2020), while in tomato ketchup 1.2-7.0% (Kumbar et al., 2019, Nasir et al., 2014; Hankin, 1986). According to Hankin (1986) the most common NaCl concentration in tomato sauce is 1.20%, which is very similar to results obtained for experimentally produced tomato sauces. Ketchup samples had the highest NaCl which is in agreement with reported literature data. It can be seen (Table 2) that passata had the lowest NaCl content and the most similar to data for tomato pulp reported by Naing and Myint (2020), while tomato sauce had values between 0.86 and 1.05%, which are the most similar to data reported for tomato sauce reported by Di Cariano et al. (2023).

Physical and thermopysical properties

Results of measured physical properties and predicted thermophysical properties are given in Table 3 and 4.

Density of experimentally produced tomato sauces ranged between 1039.50 and 1280.00 kg/m^3 and increased significantly with higher starch concentration. Commercial passata and ketchup samples had the lowest density. Experimentally produced tomato sauce with added starch had significantly higher density than other samples. Considering the literature data (Kumbar et al., 2019; Halvač et al., 2019), density of similar tomato products commonly range between 1056 and 1165 kg/m^3 depending on composition and measuring temperature. The density of starch is about 1500 kg/m^3 (Singh and Heldman, 2009), while density of fresh tomato fruit is 470 kg/m^3 (Jahanbakshi et al., 2018). According to Razi et al. (2011) density of raw tomato juice was 1060 kg/m^3 which is the most similar product to tomato passata. Since starch has a higher density than water (as the main ingredient in tomato sauce) and raw tomato fruit or juice, obtained results were expected.

Dynamic viscosity in analysed samples had values from 500 mPas (sauce without starch) to 8150 (commercial tomato concentrate). Addition of starch to experimentally produced sauces significantly increased sauce viscosity. As it can be seen from Table 3, significantly the highest viscosity was measured in commercial tomato concentrate (duble concentrated), which could be explained by the highest concentration of total and soluble solids in tomato concentrate (Table 2). For that reason it can be concluded that the viscosity of tomato products is more influenced by the content of total solids than the amount of added starch. The sample of tomato concentrate had the highest viscosity, thickest consistency, but the lowest spreadability and adhesiveness. Significantly the highest kinematic viscosity was in tomato concentrate sample and the lowest in passata, although the lowest dynamic viscosity was noticed in sauce without added starch (ETS-0). This can be explained by the fact that passata had higher density than ETS-0.

Table 3. Measured physical properties of tomato samples

Çizelge 3 Domates örneklerinin ölçülebilir fiziksel özellikleri

	Experimental tomato sauce samples			Commercial tommato samples		
Physical property	ETS-0	ETS-2.5	ETS-4.5	Passata	Ketchup	Concentrate
Density (kg/m^3)	395.00±7.0.7d	1225±7.07b	1280±2.12a	1017±1.41c	1021±3.54c	1089±19.80b
Dynamic viscosity (mPas)	500.00±0..00e	1350±70.71c	2200±282.84b	1000±14.14c	2300±0.00b	8150±70.71a
Kinematic viscosity (mm^2/s)	1.27±0.02d	1..10±0.06d	1.72±0.22c	0.98±0.01e	2.26±0.01b	7.48±0.07a
Fluidity ($(Pas)^{-1}$)	2.00±0.00a	0.74±0.04c	0.46±0.06d	1.00±0.01b	0.44±0.00d	0.12±0.00e
Syneresis (%)	43.62±0.20b	26.55±0.78c	14.54±0.68d	58.48±1.32a	0.08±0.02f	3.09±0.01e
Precipitate ratio	1.29±0.01b	2.77±0.11b	5.88±0.04b	0.74±0.04b	1249.00±471.40a	31.41±0.07b
Dispersibility (%)	23.00±4.24c	37.00±1.41bc	38.00±2.83bc	33.00±4.24bc	67.00±4.24a	41.00±7.07b
Adhesiveness (%)	6.80±0.43bcd	9.12±0.04bc	10.15±0.02ab	5.65±1.35cd	13.76±2.07a	4.11±0.23d
Spreadibility ($cm^2/100g$)	303.00±21.21a	257.20±2.83ab	200.50±14.84b	293.00±7.07a	207.22±5.49b	94.50±33.20c

Obtained results were in agreement with literature data. According to literature data, tomato products commonly have viscosity 202 – 8298 mPas (Anandsynal et al., 2018, Pandey & Kumar, 2016, Hassan et al., 2019, Kumbar et al., 2019; Nasir et al., 2014, Razi et al., 2011, Hlavač et al., 2019, Shatta et al., 2017, Youssef, 2009) depending on product type, composition, solids concentration and temperature. Youssuf (2009) reported that viscosity of tomato juice increases with increasing of total solids concentration, while Xu et al. (2018) reported that viscosity of tomato sauce had higher values in samples with higher soluble solids concentration. According to Baeghbali et al. (2021) viscosity of experimental produced tomato ketchup rises with increased starch concentration. Additionally, considering the literature the most similar values to obtained results were reported by Nasir et al. (2014) and Kumbar et al. (2019) for ketchup (2316 and 2675 mPas). Fluidity ranged between 0.12 and 2.00 $(Pas)^{-1}$.

Sample with the lowest viscosity (ETS-0) had significantly the highest fluidity, while tomato concentrate sample with the lowest dynamic viscosity had significantly the lowest fluidity. Fluidity of tomato sauce samples decreased with increasing starch concentration. Ketchup sample and sauce sample with 4.5% of added starch had the most similar values for dynamic viscosity and fluidity. Higher values of fluidity indicates better flowability. Hlavač et al. (2019) reported that fluidity of commercial tomato ketchup samples ranged between 0.18 and 0.28 $(Pas)^{-1}$ at 20°C. These values are very similar to results obtained for tomato concentrate samples (Table 3). Results for fluidity of

commercial ketchup and tomato sauces analyzed in this study had pretty higher values in comparison to values reported by Hlavač et al. (2019), which can be explained by lower viscosity values (Table 3) in comparison to viscosity (3500-5250 mPas) reported by Hlavač et al. (2019).

Syneresis ranged between 0.08 and 58.48%. The lowest value was recorded in ketchup and concentrate samples, and the highest in passata and ETS-0 (tomato sauce without starch addition). All differences were significant. From this observation it could be concluded that total solid content, consistency and addition of stabilizers decrease the syneresis. Samples with lowest moisture content and lowest viscosity had the thickest consistency and the highest syneresis. Syneresis decreased significantly in experimentally produced tomato sauces with increased starch concentration and higher total solids (Table 2 and 3). As syneresis is defined as the amount of liquid phase separated from sample, it can be used as an indicator of physical stability of sauces. Lower syneresis indicates better stability against phase separation. Sample of commercial tomato ketchup had extremely the lowest syneresis value, which can be explained by addition of different stabilizers and emulsifiers during industrial production of ketchup. This is the main reason why these samples had negligible syneres value. Additionally, low moisture content in ketchup also contributed to the prevention of phase separation and syneresis in ketchup. Assuming that tomato concentrate don`t contain stabilizers, low value of syneresis in this sample can be explained by low moisture content and high viscosity (thicker consistency). These results are in agreement with literature data. According to Baeghbali et al. (2021) higher concentration of starch in tomato ketchup increased viscosity, decreased syneresis and improved physical stability of ketchup. Nasir et al. (2014) reported that addition of date pulp in tomato ketchup increased total solids content, made thicker consistency by increased viscosity, which resulted in decreased syneresis.

Precipitate ratio was calculated as mass ratio of precipitate and supernatant which were separated by syneresis during centrifugation. Sample with lowest syneresis had the highest peripitate ratio. Precipitation ratio ranged between 0.74 and 1249, and all differences between samples were significant. From presented results (Table 3), it can be seen that precipitate ratio was influenced by the combination of different factors such as viscosity (thicker consistency), moisture/total solids content and soluble solids content. The lowest precipitate ratio was recorded in tomato passata sample, which had the highest moisture and the lowest soluble solids content Observing the samples of experimentally produced tomato sauce, it can be observed that with the increase of soluble solids fraction, precipitate ratio decreased. On the other hand, precipitation ratio increased with the increase of starch concentration in sauce samples and decreased soluble solid/total solid ratio. Obtained results are in agreement with literature. Xu et al. (2018) reported that precipitate ratio in tomato products had values 0.14-0.20, which could be related to low soluble solids concentration (3.21-4.98°Brix).

Dispersibility increased with increasing starch concentration in tomato sauces and with increasing of soluble solids, but differences were not significant. Dispersibility ranged between 23 and 67%. Samples with higher moisture content had lower dispersibility, which can be explained by the fact that samples with higher moisture content had lower viscosity. Due to lower viscosity, the resistance of the liquid phase was lower, and because of this, solid particles settled more easily. Commercial ketchup samples had the highest dispersibility. This sample was the most stable, had the lowest syneresis and the highest precipitate ratio. Such results could be explained by taking into account the fact that commercial/industrial ketchup is produced with addition of additives (stabilizers and emulsifiers), which prevent its separation. In a similar way, the pretty high dispersibility of tomato concentrate (41%) could be explained. Considering

the fact that tomato concentrate does not contain emulsifiers or stabilizers, the pretty high dispersibility can be related to the high total solids amount, in which the high content of concentrated tomatoes dominates. It is known that tomato contains high amounts of pectin which can bind water, has good swelling power, emulsifying and stabilising properties, which lead to thicker consistency and higher viscosity. High viscosity of tomato concentrate (8150 mPas) created a great resistance to settling of solid particles. Because of that tomato concentrate had high dispersibility and precipitate ratio, but very low syneresis.

Adhesiveness has values between 4.11 and 13.76%, the lowest in tomato concentrate and the highest in ketchup. Low value also was observed in passata and tomato sauce without added starch. More liquid and thin consistency of passata and sauce ETS-0 caused lower ability of those samples to adhere on the wooden stick. Because of thin liquid consistency and low viscosity (higher fluidity and flowability), these samples could not adhere properly and stay on the stick. On the other hand, low adhesiveness of tomato concentrate could be explained by thich but rather incoherent consistency. Consistency of tomato concentrate was more incoherent (less cohesive) in comparison to other samples. Higher concentration of starch in experimentally produced tomato sauces led to higher adhesiveness (similarly as in ketchup), but the differences between adhesiveness in experimentally sauce samples were not significant. Alqahtani (2020) reported that decreasing soluble solids content slightly increased adhesiveness in tomato ketchup prepared with addition of date powder.

Spreadability of analysed samples ranged between 94.50 and 300 cm^2. Tomato concentrate had significantly the lowest, while passata and ETS-0 had the highest spreadability. This characteristics greatly depended on the viscosity and consistency. Addition of starch and increasing of its concentration resulted in lower spreadability in experimentally produced sauces. Samples with thicker consistency had lower spreadability. On the other hand, thicker consistency and lower viscosity resulted in higher spreadability. Samples with lower viscosity had lower resistance to flow, and easily spread on the plain surface. Because of that, the spreadability area of such samples is higher, while the thickness of spreaded layer is lower. It could also be concluded that lower density increased spreadability. The highest spreadability was noticed in samples with lowest viscosity and density (ETS-0), while the highest in concentrated samples with significantly the highest viscosity.

Table 4. **Estimated thermophysical properties of tomato samples**

Çizelge 4**. Domates örneklerini tahmini termofiziksel özellikleri**

	Experimental tomato sauce samples			Commercial tommato samples		
Physical property	ETS-0	ETS-2.5	ETS-4.5	Passata	Ketchup	Concentrate
Freezing point [°C]	-2.51±0.00b	-2.93±0.02b	-3.63±0.11c	-1.37±0.05a	-5.11±0.17d	-5.61±0.28e
Specific heat capacity [kJ/(kgK)]	3.78±0.00b	3.71±0.00b	3.61±0.0c	3.94±0.01a	3.40±0.02d	3.33±0.04d
Thermal conductivity [W/(mK)]	0.530±0.000ab	0.516±0.001b	0.494±0.004c	0.567±0.002a	0.446±0.005d	0.430±0.005d

Thermal difussion coeficient [mm^2/s]	0.356±0.00a	0.113±0.00 d	0.107±0.00e	0.142±0.00b	0.128±0.00c	0.118±0.00c

Results of thermophysical properties are shown in Table 4, Thermophysical properties were calculated from moisture or total solids content in analysed samples by using widely used mathematical models appropriate for similar food samples. It can be seen from Table 2 and 4 that samples with higher moisture content had predicticted higher values of freezing point, specific heat capacity and thermal conductivity. Thermal diffusion coefficient was calculated from predicted thermal conductivity coefficient, specific heat capacity and measured density of samples. Results showed that passata had significantly the highest predicted values of freezing point, specific heat capacity and thermal conductivity because of the highest moisture content. Predicted thermal diffusion coefficient was significantly the highest in the ETS-0 sample, which had high moisture content and the lowest density. On the other hand the lowest predicted value of thermal diffusion coefficient was ETS-4.5 sample (tomato sauce with starch concentration of 4.5%), which had the highest density. Higher values of thermal diffusion coefficient indicates faster temperature changes during product heating or cooling. All thermophysical properties were estimated at room temperature. Specific heat capacity had predicted values between 3.33 and 3.94 kJ/(kgK) and thermal conductivity 0.430 – 0.567 W/(mK).

Obtained results are in agreement to literature data for similar products. According to literature specific heat capacity for similar products have the following values: 4.02 kJ/(kgK) for fresh tomatoes with 93% of moisture and 3.676 kJ/(kg/K) for tomato concentrate with 81% of moisture. Thermal conductivity of fresh tomatoes was 0.528 W/(mK). Initial freezing point of fresh tomato with 93% of water content was -0.7 °C. Freezing point of water is 0°C. Thermal conductivity, specific heat capacity and thermal diffusion coefficient of water at 20°C the following values: 0.599 W/(mK), 4.18 kJ/(kgK) and 1.43 x 10^{-7} m^2/s (ASHRAE 2006; Singh and Heldman 2009, Toledo 1994). Estimated freezing point for tomato products (Table 4) calculated by *Guegov`s* model had lower values in comparison to reported. It should be considered that values reported from literature were related to fresh tomatoes with higher water content in comparison to analysed samples. It is also important to mention that *Guegov*`s model is usable for a very huge group of liquid food products with moisture content between 73 and 96.5%. Two samples (ketchup and concentrate) had lower moisture content and because of *Guegov`s* model probably is not precise enough for estimation of concentrate and ketchup freezing point. Results for specific heat capacity and thermal conductivity were more similar to literature data. Mathematical models used for prediction of specific heat capacity and thermal conductivity were more suitable for tomato products than models for freezing point calculation. Thermal conductivity was estimated by a model reported by *Dickerson* which is suitable for food products with water content higher than 50%. All samples had moisture over 50% (Table 2). According to literature, *Bowman`s* model is evaluated as suitable for thermal conductivity prediction for about 240 kinds of food products. Lower values obtained for specific heat capacity and thermal conductivity in comparison to literature could be explained by lower moisture content in samples. ETS-2.5 sample with moisture content of 81.3 had specific heat capacity 3.71 kJ/kgK which is a value very similar to value for tomato concentrate (83% of moisture) reported by literature (Heldman & Singh, 2006). According to Drusas & Saravacos (1985) thermal conductivity and thermal diffusion of tomato paste decreased with increasing soluble solids content. Tomato paste samples with soluble solids between 27 and 44°Brix had thermal conductivity coefficient between 0.460 and 0.600 W/(mK), while thermal diffusion of sample with the highest moisture content was 1.42x10^{-7} m^2/s. Thermal diffusion coeficient of passata sample was in agreemnt to literture. As it is shown in Table 4, thermal diffusion coefficient

of analysed samples increased with higher moisture content. Because of that, a passata sample with 90% of moisture had the highest thermal diffusion coefficient, which was very similar to thermal diffusion of water ($1.42 \times 10^{-7} m^2/s$ vs. $1.48 \times 10^{-7} m^2/s$).

CONCLUSION

Experimental tomato sauces made with higher starch amounts had lower values of moisture content, pH value, thicker and more stable consistency, lower syneresis, and higher values of viscosity and density.Commercial tomato ketchup had the most stable consistency with negligible syneresis, probably because of added stabilizers and emulsifiers during commercial ketchup production. Generally, samples with higher total solids content had higher viscosity, lower fluidity and spreadability, but more stable consistency due to lower syneresis. Addition of starch to experimental samples increased the total solids content, viscosity, density, adhesiveness and dispersibility,while decreased the soluble solids fraction and spreadability. Experimentally produced tomato sauce samples without starch addition had the most similar physical properties to commercial passata, while physical properties of sauce with 4.5% of added starch were the most similar to commercial ketchup. Moisture content in tomato product samples played the most important role in prediction of thermophysical properties. Mathematical models suitable for moist liquid and semi liquid food were used for prediction of thermophysical properties. Estimated thermophysical properties had higher values in samples with higher moisture content.

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