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SİDAS MEDYA

Invited Speakers

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"Minimally processed cereal grains have health-promoting phytochemicals"

University of Manitoba,

Canada

Hilal Elver

"Right to Food, Food Security and Sustainability"

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Portable Food Testing Technologies to Combat Food Fraud

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INVITED SPEAKERS

141 - Food Chemistry and Technology – Invited Speakers

Hidden hunger and Biofortification: High zinc content genotypes among synthetic hexaploid and spring bread wheats under conditions of Western Siberia

V. Shamanin[1], S. Shepelev[1], P. Flis[2], I. Pototskaya[1], V. Pozherukova[1], A. Chursin[1], O. Kuzmin[1], H. Koksel[1,3], A. Morgounov[4]
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Hidden hunger is chronic lack of vitamins and minerals and cause mental impairment, poor health and death. Deficiencies of certain vitamins and minerals are quite common around the world and might lead to hidden hunger. In recent years, biofortification seems to be a critical tool in the battle against hidden hunger. It is defined as the process by which the nutritional quality of food crops is improved through agronomic practices, conventional plant breeding or modern biotechnology. Bread is a staple food in Russia, neighboring countries, Western Asia and North Africa. Thanks to the achievements in breeding and agricultural technologies, wheat production in the world has reached over 780 million tons. Hence, more attention should be paid to ensuring nutritional quality of wheat grain. The objective of this study was to identify sources with high grain zinc content among the synthetic hexaploids and spring wheat varieties and reveal the relationship between grain Zn content and plant productivity components for wheat breeding in Western Siberia.

Field experiments were performed at Omsk State Agrarian University in 2017–2018 on four groups of samples: 1) CIMMYT synthetic wheat lines with *Ae. tauschii* genome; 2) synthetic lines from Kyoto University; 3) spring bread wheat varieties from the USA and Canada; 4) wheat varieties from Russia/Kazakhstan. The Zn content of wheat grain was determined at the University of Nottingham. The year conditions influenced grain Zn content. In 2017, the highest and the lowest Zn content in grain was 120 and 34 mg/kg; while in 2018, the highest and the lowest Zn content was 90 and 23 mg/kg. On average for two years, the samples resistant to leaf and stem rust, powdery mildew, and also samples with a longer growing season were characterized with high Zn content in grain. The maximum grain Zn content was noted in synthetic hexaploid wheat varieties from the USA, and some varieties from Russia. In 2017–2018, strong correlation was found between grain Zn content and protein and gluten content in grain. A negative relationship was revealed between grain Zn content and yield, as well as with the main traits of plant productivity – grain weight, number of grains per plant, number of shoots per plant. Among the varieties developed by Omsk SAU the highest Zn content, on average for two years, observed in the varieties Lutescens 87-12, OmGAU 100 and Pamyati Leontyeva were 57.7, 56.1 and 50.2 mg/kg, respectively. The spring bread wheat varieties and synthetic wheat lines with high Zn content are recommended for using in breeding program of Western Siberia.

Conclusions: There is sufficient information and germplasm diversity to initiate a biofortification breeding program. KASIB network represents an excellent tool to establish such a program in a well-coordinated and targeted manner. KASIB research activities are expected to make the grain in this region more beneficial for the domestic and international consumers.

Key words: variety; grain of wheat; zinc, breeding

Acknowledgments: KASIB activities at Omsk State Agrarian University have been supported by the Ministry of Science and Higher Education of the Russian Federation (Agreement No. 075-15-2021-534 of May 28, 2021).

142 - Food Packaging Materials and Technologies - Invited Speakers

Novel approaches for the preservation of food quality

Shlomo Navarro*, Hagit Navarro
Green Storage Ltd., Argaman St. 5, Rishon Letsion, 7570905, Israel

There is an increasing demand for quality food uncontaminated by insects, insecticidal residues and mycotoxins. Whereas, the food industry is facing serious problems of insects and mite contamination due to the restrictions placed on the use of chemical pesticides. The adverse effects of pesticide residues in food and the environment resulted in strict limitations on pesticide registration by regulatory agencies. In addition, insects have been developing resistance to contact insecticides and to the conventionally used phosphine. This paper reviews the emerging novel technological approaches for the preservation of food quality. . Among the newly considered fumigants are sulfuryl fluoride, propylene oxide, ethyl formate, and ozone. Sulfuryl fluoride has emerged as a promising candidate fumigant for disinfesting stored food commodities, but has not been registered as widely as phosphine. Other registered fumigants suffer from the limitation that they may be useful for application using special equipment or under specific conditions. A recent development is thermal disinfestation of empty spaces to prevent insect contamination. Field trials have demonstrated the efficacy of thermal disinfestation in flourmills. A new approach to the use of pheromones is the monitoring of insects based on remote sensing electronic transmitters that are progressively integrated into control programs. Those sensors enabled development of algorithms for the advance warning systems of insect contamination and also to guide the quality control personnel on the most appropriate method of food protection. An integrated pest management (IPM) program that might integrate insect monitoring and control of food quality by remote sensing to enable use of algorithms is being developed. Such IPM program should integrate aeration in winter, chilling with refrigerated air in summer in grain silos, biogenerated MAs, for insect control and for quality preservation of food, and assisted MAs during storage of food and at the final stages gas tight protected food.

Keywords: postharvest systems, non-chemical alternatives, refrigeration, thermal disinfestation, hermetic storage, modified atmospheres, pheromones, insect monitoring, IPM.

143 - Food Chemistry and Technology - Invited Speakers

Portable Food Testing Technologies to Combat Food Fraud

Bert Pöpping*, Carmen Diaz-Amigo
FOCOS – Food Consulting Services, Germany

Major challenges of testing for food fraud are the number of known adulterants per commodity, not considering the number of unknown adulterant that are likely being used. In the case of cows milk, more than 200 common adulterants are known, including, but not limited to melamine, urea, formalin, vegetable fat, starch. Sampling, for example, an incoming shipment of dried milk powder for all known adulterants is economically challenging. And also sampling often happens randomly, selecting only a few of the bags containing dried milk powder from the delivery.

What if a smart sampling could take place at the food manufacturing site with a portable instrument screening for multiple adulterants at the same time with little or no sample preparation.
Such devices are already available, saving time and money and allowing manufacturers to quickly identify raw materials that are not within the specification.

The presentation will highlight the principles of these screenings, available tools, requirements for methods and existing gaps.

Additional information on portable devices can be found at
https://www.focos-food.com/portable-food-safety-devices-j-aoac/

149 - Food Chemistry and Technology - Invited Speakers

Material science approaches to cereal foods structuring and destructuring

Guy Della Valle
INRAE, UR 1268 Biopolymers Interactions & Assemblies (BIA), BP 71627, 44316 Nantes, France

The structure of cereals and snack foods during processing is developed according to various changes at different levels of matter organization. These changes can be captured by different methods, including quantitative imaging and rheology. In addition, state diagrams that represent the variations of material properties with the composition, can be enriched with the hydrothermal conditions followed by the food during processing. Several results obtained through these methods will be illustrated, in this talk, by tackling the effect of the addition of dietary fibers, an essential factor in nutritional quality. Indeed, the use of whole grain rather than refined flour allows delivering a healthier diet, whilst coping with the stakes of sustainable development.

These results make it possible to ascertain the mechanisms of cellular structure creation during dough mixing and fermentation. Simple models can be derived by integrating the different structural scales, in order to simulate structural changes and predict final food properties, texture for instance. Then, by extending the approach to food oral processing, some nutritional properties can also be foreseen, and all together define product performances. Finally, we will also strive to present the recent prospects opened by this approach to address some challenges such as protein transition – from animal to plant - and the supply of peculiar populations with specific diets.

Acknowledgements: This talk will cover several years of activity that have benefited from enriching exchanges with many colleagues from BIA and, more broadly, at INRAE and other establishments, in the framework of various multidisciplinary, national and European collaborative projects. The author is also indebted to several PhD students, whose doctoral thesis was pleasant to supervise.

150 - Food Chemistry and Technology - Invited Speakers

Minimally processed cereal grains have health-promoting phytochemicals

Trust Beta
Department of Food and Human Nutritional Sciences at the University of Manitoba

Postharvest processing of grains include dehulling, milling, germination, fermentation, extrusion, baking, flaking, and puffing to produce a wide array of cereal-based foods. Foods prepared from whole, dehulled and milled grains may be considered as minimallly processed. Cereals consumed as dehulled or milled grains serve as important sources of nutrients and phytochemicals. Dehulled foxtail millets, as an example, contain unique hydroxycinnamic acid spermidines that we recently reported for the first time. The diverse phenolic compounds found in minimally processed millets and other grains provide an impetus for the development of functional foods with unique antioxidant properties.

151 - Food Safety, Security and Sovereignty - Invited Speakers

Digital tools for food product design

Francesco Marra
Department of Industrial Engineering, University of Salerno, Fisciano, SA, Italy

In the digital life we live in today, how digital is the food world? When we think about “digital tools” and “food” together, what comes to our minds? An app to follow a healthier diet? A platform for order food home delivery? A blog for learning culinary techniques? Or the spreadsheet to calculate the ingredients’ mass of a old-fashion apple pie? And what about the role of the (another trendy word) artificial intelligence in digital tools for food product innovation?
This talk is aimed to stimulate (well before to answer) these and similar questions and then to follow a journey landing on how to faster innovation, leading to product development timed to meet surging consumer demands and sustainability needs.
During the journey, we will have an quick overview of digital tools for exploring social media data and understanding consumers' perception, for choosing food products in an informed way, for reducing domestic food waste. To avoid a too large perspective, the talk will deep dive on two main aspects of usefulness of digital tools for the food production: food product design and food process design.
Thus, multiscale and hybrid approaches are presented, to show that digital tools (based on science) for the food world exist – apart the inflated world of food delivering apps (not revolutionary digital tools anymore) – and they are mature to be used for reinventing food products.

ORAL PRESENTATION

16 - Food Chemistry and Technology - Oral Presentation

Determination of Quality Changes of Sultaniye Grapes Dried by Vacuum Microwave Dryer

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In the food industry, the drying process is applied to prevent microbiological, physical, and chemical deterioration of foods and increase their shelf life. Sun drying is a traditional drying method commonly used for drying fruits and vegetables. However, this method has disadvantages such as a long drying time and the inability to obtain standard products. For this reason, losses occur in the quality and economic value of the product. Nowadays, it is aimed to shorten the drying time and produce high-quality dry products with the pre-treatment application. For this purpose, potash solution (a mixture of potassium carbonate and olive oil) is used as a pre-treatment to dry Sultanas. In recent years, interest in new technologies has increased to obtain short drying times and high-quality dry products. The vacuum Microwave (VMW) drying method, which is among the new technologies, has higher drying speed, shorter drying time, lower energy consumption, and higher food quality. In this study, the effects of sun and VMW on the pretreated (potash solution) quality and untreated Sultaniye grapes were compared. The working temperature of the VMW dryer was determined as 70°C by preliminary experiments. At the end of the drying process, physical (color, water activity, pH, rehydration rate, moisture, water-soluble dry matter), chemical (titration acidity, total phenolic substance, antioxidant activity), and sensory analyses of raisins were performed. As a result of the study, it is thought that VMW technology can be an alternative to the sun drying method for drying Sultanas.

Keywords: vacuum Microwave , drying , grape

39 - Food Chemistry and Technology - Oral Presentation

Modeling Of Drying Rates Based On Variable Diffusion Coefficient

Burak Selçuk*, Deniz Çekmecelioğlu, Mecit Öztop
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Drying process is one of the most widely used methods for food preservation.. The purpose of the drying is to reduce water content and water activity. Thus, the shelf life of the food is extended without use of any food preservatives. During the drying process, heat and mass transfer occur simultaneously. In previous studies, diffusion constant was calculated using moisture versus time data collected during drying and considered constant with the spatial position. The purpose of this study is to determine the change of diffusion coefficient with position and time during drying of apple, banana, and eggplant, as to understand the drying mechanism in vegetables and fruits with high and low water contents. The drying experiments were carried out at temperatures of 60 ℃, 70 ℃, and 80 ℃. The time-domain nuclear magnetic resonance (TD-NMR) relaxometry was used to measure (longitudinal relaxation time) and (transverse relaxation time) times, which were then related to diffusivity and moisture change at different drying conditions. Mono-exponential($M=M_0e^{-t/\lambda_2}$) and bi-exponential($M=M_{01}e^{-t/\lambda_2}+M_{02}e^{-t/\lambda_2}$)functions were used to determine the water content. M is defined as the magnitude of the signal. For the corner sample of apple, positive correlation between relaxation time and moisture content was observed (r=0.911). Besides this, the correlation between drying time and relaxation time was also significant (r=-0.935). The results were modeled according to TD-NMR and regional moisture data and compared with other models.

Keywords: Drying , Variable Diffusion Coefficient

43 - Food Chemistry and Technology - Oral Presentation

Determination of Some Bioactive Polyphenolic Compounds of Ocimum Basilicum L. by HPLC

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Ocimum basilicum L. which has known as sweet basil is an important crop in food and pharmaceutical industries. *Ocimum basilicum* was originally grown in warm tropical climates, however is now cultivated worldwide. It has been used traditionally due to the its culinary and medicinal properties. Some of the medicinal properties have been known as antibacterial, antiviral, antiinflammatory, antiallergic, antioxidant, anticonvulsant and anticarcinogenic properties. Basil contains wide variety of compounds with human health benefits such as polyphenols, especially phenolic acids that contribute to its strong antioxidant capacity. In this study, the phenolic profile (protocatechuic acid, caftaric acid, caffeic acid, p-coumaric acid, rosmarinic acid and rutin) of *Ocimum bacilicum* (collected from Sivas/Turkey) was analyzed by HPLC-PDA, and the separation was achieved using a RP-ODS4 column.

The method comprised of a mobile gradient phase consisting of A solution (trifloroacetic acid in water, 0.1 %) and a mixture of the solution B (trifloroacetic acid in acetonitrile, 0.1 %), at a flow rate of 1.0 ml/min, and PDA detection was carried out at between 190-550 nm. According to the results, it can be said that the program indicated good linearity over the range of 0.1-1500 mg L^{-1} of phenolics with R^2>0.998. The recovery of the polyhenolics ranges from 85.47% to 105.45% at *Ocimum basilicum* L. extract. The method is well precise, with the relative standard deviation (RSD) of the average concentration of the phenolic compounds are ranges from 0.92% to 2.79%. As a result, a highly specific, sensitive, and simple chromatographic method has been presented and validated.

Keywords: *Ocimum basilicum* L., HPLC, polyphenols, validation.

57 - Food Chemistry and Technology - Oral Presentation

Encapsulation of β-Carotene Loaded Sunflower Oil Droplets in Alginate Beads

Keziban Kübra Güngör * **, Mehmet Torun**
Akdeniz University, Turkey

The value-added product development from food processing wastes is one of the main fields of the multiple disciplines such as food and environment in recent years. If we could produce valuable products from food industry by-products through new scientific, technological and eco-friendly methods, these by-products could be converted into products with a higher economic value than the main products. For a good waste management, it is necessary to conversion the by-product into the economy with environmentally friendly methods. In this study, β-carotene extraction from pumpkin peel was performed using sunflower oil instead of petroleum-based solvents and encapsulation was carried out by alginate beads method to increase the storage stability of the obtained β-carotene rich oil. Optimum conditions of the alginate concentration (1-2%), feed ratio (20-50%), height of feeding (1-10 cm) and flow rate (5-100 µL/min) were determined using Response-Surface Methodology (Optimal Custom Design) according to shape factor (maximum), sphericity value (minimum) and β-carotene content (maximum) responses. The results showed that alginate concentration was the limiting factor and desired capsules could not be obtained at maximum concentration. Optimum conditions of the alginate beads encapsulation process were determined as 1% alginate concentration, 50% (alginate:oil) feed ratio, 1.5 cm height and 74 µL/min flow rate. Shape factor, sphericity value and β-carotene content of the alginate beads obtained at optimum conditions were found as 0.878, 0.002 and 0.527 mg/100 g capsule, respectively. The β-carotene-enriched alginate beads produced under optimum conditions and the free-form β-carotene-rich sunflower oil extract were stored at 55 °C for 15 days. The β-carotene content of the beads was monitored at 0, 6, 9, 12, and 15 days of storage. At the end of the storage period, the β-carotene loss of encapsulated oil and free-form β-carotene-rich sunflower oil was calculated as 14.42% and 25.81%, respectively.

67 - Food Chemistry and Technology - Oral Presentation

Application of A New Root Cause Approach for Foaming Problem in Refined Sunflower Oil Production

Kübra Sümer, Ebru Karacan, Onur Özdikicierler, Fahri Yemişçioğlu*
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Quality systems are important constituents of production facilities due to their benefits in term of maintaining standardization and providing reliable records. Hence in case of doubt or complaints about the quality of a specified goods; quality systems act as a solution provider as well as a precaution activity for better quality goods. Therefore, building a reasonable quality system is beneficial to prevent problems, to satisfy customers with better quality goods.
Root cause analysis is a very important tool for determining the reason for the occurrence of a problem, or a persistent situation leading into undesired results. Although root cause analysis is varied depending on good production facility; most popular use if technique consists of consequent WHY questions to find the real causes for the problem.
Sunflower oil is among the most popular vegetable oils in Turkey especially used for frying or cooking purposes. Due to temperature resistance; foaming is the major complaint either on B2C or B2B sides. Therefore, root cause analysis may act as a solution provider to identify the problems to foaming complaints of customers.
This study is mainly focused on application of root cause analysis to foaming problem for refined sunflower oil as a tool for maintaining customer happiness.
These possible causes are analyzed for segments to reach the root cause. Mistakes by end user, which are one of the causes of foaming problem, can be prevented by effective customer relations, informative fliers, technical sales activities, etc. Properties of crude oil and production technology both are dependent on quality documentation system, research and development facilities, communication efficiency between production, quality and research and development departments, performance on joint projects with universities, etc. In this study, a specific root cause analysis model is established by considering the above listed segments.

Keywords: edible oil , sunflower oil , foaming problem , Root Cause Approach

68 - Food Chemistry and Technology - Oral Presentation

An Efficient Ultrasound Assisted Fat Extraction Method from Different Food Matrices for 3-MCPDE and GE Analysis

Onur Özdikicierler[1,*] , Sercan Karadağ[2] , Fahri Yemişçioğlu[1]
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Purpose: 3-monochloropropan 1-2 diol esters (3-MCPDE) and glycidyl esters (GE) has been well noted issue for last 10 years for food industry. The concerns and new findings on the subject, lead significant legal regulations for 3-MCPDE and GE and some limits were set. It became challenging when it comes to extract the oil phase from different food matrices using right techniques to clearly reflect the amount of these contaminants. Studies show that the oil extraction step from food before 3-MCPDE and GE analysis is usually performed by cold extraction and solvent mixtures such as hexane or hexane/diethyl ether were used. However, it was observed that there is no detailed study on the possible effects of cold extraction duration and compositional differences in the solvent mixtures used on the results of analysis.
Methods: In this study, 3-MCPDE and GE extraction was performed by cold extraction in different hexane/tert butyl methyl ether (TBME) compositions from potato chips, which is a fried product, and sponge cake, which is a bakery product, and the most suitable solvent composition was determined. In the second stage of the study, the extraction process was carried out with ultrasound application at different amplitude and time parameters using the most suitable solvent composition.
Results: The results of the study revealed that the use of TBME as a solvent plays an important role in the extraction of 3-MCPDE and GE from the food matrix. In addition, it has been found that sample extraction, which takes considerably long time when cold extraction applied, can be performed much faster under ultrasound conditions.
Conclusion: The results of the study showed that the preparation of samples from the oil phase in different food matrix structures before 3-MCPDE and GE analysis can be done effectively with the ultrasound technique using the appropriate solvent composition.

Keywords: 3-MCPDE , GE , Edible oils , Ultrasound , Extraction Method

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Decontamination of Frozen Cherries by Commercial Disinfectant and High-intensity Pulsed Light Treatment

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Innovative light-based technologies for the decontamination of fruits have been taking more attention in recent years. IQF fruit processing plants have a possible risk for pathogens that may contaminate fruits, especially Listeria monocytogenes, which is extremely difficult to control this pathogen effectively for the food industry.
In this study, for the first time, the decontamination efficiency of L. monocytogenes on frozen cherries by pulsed light (HIPL) was investigated. Frozen cherry surfaces inoculated with Listeria innocua were exposed to HIPL treatment at various fluences (3, 6, 9, 12 J/cm2) and distance between sample and lamp (10 and 20 cm). As a control, inoculated cherries were washed with chlorine solution (300 ppm) for 60 s. In addition, the effectiveness of decontamination treatments on the natural microbial load and quality of frozen cherries were examined. Moreover, the surface temperature rise of the samples was measured in HIPL treatment.
The highest Listeria reduction (~3 logs) was achieved when HIPL was applied at 9 J/cm2 (20 cm). For chlorine-washed samples, the reduction was not significantly different when compared to light treatment. Changes in pH, TTA, and TSS values of washed and/or HIPL-treated samples did not exceed 5% compared to the untreated samples. Furthermore, no significant differences in total anthocyanin and total phenolic contents were obtained between washed and untreated frozen cherries after treatment. Nevertheless, HIPL treatment increased TAC and TPC levels depending on the process parameters. HIPL included short treatment times (2.3-28.6 s) and prevented high-temperature rises on the product.
Finally, HIPL treatment showed higher inactivation of microbial load without any adverse effect on the quality of samples. HIPL can be used as a promising and alternative decontamination method for the frozen fruit industry compared to the use of commercial disinfectants.

Keywords: Frozen cherries , decontamination , high-intensity pulsed light (HIPL) , commercial disinfectant , quality

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Applications of Multiple Emulsions in Food Industry: Structure, Characterization, and Determination of Stability

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The development of healthy food formulations in line with the demands of customers has attracted attention in recent years. The encapsulation methods used for this purpose are a relatively new technology for the preservation, stabilization, and controlled release of food bioactive compounds. Methods such as spray-drying, freeze-drying, extrusion, and emulsification are used to encapsulate food ingredients. Multiple emulsions, one of the emulsification techniques, are widely used in the food industry. These methods are applied in foods for many purposes, such as increasing the shelf life, improving the nutritional value, and enhancing bioavailability. Multi-emulsions, known to be used in many different industrial areas of emulsion systems, are complex polydisperse systems formed by stabilizing two different immiscible liquids using hydrophilic or lipophilic surfactants. There are two different types: oil-in-water (W/O/W) and water-in-oil (O/W/O), and it is known that oil-in-water emulsions have an extensive use in the food applications. The stability of thermodynamically unstable multiple emulsions can be affected by many factors, especially the balance between water, oil, and emulsifier. However, it has been demonstrated by several studies that rheological properties, droplet size, and distribution of the emulsion, except stability, directly affect the quality of the food formulations included. For this reason, this review highlights recently published results of research reported in the preparation of multiple emulsions in foods as encapsulation application, structural properties, characterization, and stability evaluation. Furthermore, future studies on multiple emulsion systems should focus on the production of stable multiple emulsions used in functional food preparation and evaluate their effects on the interaction with food compounds and quality during storage.

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Pilot-Scale Production of Dietary Fiber from Sugar Beet Pulp

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Dietary fibers have a variety of health benefits as well as technological advantages in food processing. Therefore, the usage of dietary fiber in the food sector is expanding. Sugar beet pulp is a byproduct of the sugar factory and is used for animal feed. The goal of this research was to figure out how to improve the method for producing dietary fiber from sugar beet pulp at a pilot scale. First of all, production studies were carried out in a laboratory environment. Within the process driven by laboratory-scale studies, pilot-scale dietary fiber production studies were conducted. The pilot-scale manufactured dietary fibers were analyzed when the best manufacturing parameters were identified. The results of the analysis were compared with the properties of imported sugar beet fiber and the data in the literature. The starch content of both dietary fibers was less than 0.12%. The ash, crude protein, L* value of the color properties, the water holding capacity (g/g), and oil holding capacity (g/g) of pilot-scale produced sugar beet dietary fiber were 3.75 %, 8.38 %, 73.35, 7.42 g/g and 2.67 g/g, respectively. The ash content, protein, L* value, the water holding and oil holding capacity of imported sugar beet fiber were determined to be 3.79 %, 7.79 %, 78.62, 5.31 g/g, and 2.01 g/g, respectively. It has been observed that the sugar beet fiber produced on the pilot-scale has similar properties compared to the equivalent beet fiber available on the market. It has been observed that the water holding capacity, which is the most important of the technological properties, has a better result in the sugar beet fiber produced on the pilot-scale.

Keywords: dietary fiber , sugar beet fiber , sugar beet pulp , pilot scale production

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Pilot-Scale Production of Pectin from Sugar Beet Pulp

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Sugar beet pulp is a byproduct of the sugar industry and one of the raw materials used to produce pectin. Pectin is a natural food additive that is commonly used as a thickening, gelling agent, stabilizer, or emulsifier in the food, pharmaceutical, and cosmetic industries. The goal of this project was to produce pectin at a pilot scale from sugar beet pulp. At the pilot scale, the optimum extraction (pH, temperature, time) and drying conditions of sugar beet pectin were determined. Physicochemical (pH, ash, protein, color) and rheological analyses were performed on pectins produced at the pilot scale and he imported sugar beet pectin obtained from the market. The analysis results were compared with both sugar beet pectin and the data in the literature. The ash content, degree of esterification and galacturonic acid content of pilot-scale produced sugar beet pectin were determined to be 4.87%, 59.67% and 303.68mg/g, respectively. The ash content, degree of esterification and galacturonic acid content of imported sugar beet pectin were 2.55%, 35.71% and 694.17mg/g, respectively. Also, rheological properties of pilot-scale produced sugar beet pectin consistency coefficients, flow behavior indexes, the apparent viscosity values, storage modulus, loss modulus and tangent delta were determined to be 0.047 Pasn, 0.98, 0.042 Pas, 0.975 Pa, 1.628 Pa and 1.678, respectively. Consistency coefficients, flow behavior indexes, the apparent viscosity values, storage modulus, loss modulus and tangent delta of imported sugar beet pectin were determined to be 0.93 Pasn, 0.84, 0.52 Pas, 4.35 Pa, 6.34 Pa and 1.46, respectively.

Keywords: pectin , sugar beet pectin , sugar beet pulp , pilot scale production

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Prevention Sedimentation with Gellan Gum in Cocoa Milk

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Recently, there has been an expansion investigation to prevent sedimentation in cocoa milk. The aim of this study is to prevent sedimentation in cocoa milk. Possible solutions for reducing sedimentation in such products have taken into consideration. Gellan gum creates a fluid gel network with excellent particle suspension properties. Homogenization process reduces risk of creaming, marbling, cocoa sedimentation and top separation. Homogenization and gellan gum amount have a very important effect on preventing sedimentation in cocoa milk. In this study, the effects of gellan gum concentration (0.01% to 0.04%) and homogenization pressure (100 bar to 300 bar) were evaluated using a response surface methodology with 11 trials in cocoa milk. Results demonstrated that increasing gellan gum concentration decreased the sedimentation ($p<0.01$) and increased the water holding capacity (WHC) ($p<0.01$). Both of pressure level and gellan gum concentration had a considerably impact on creaming value. In all conditions, pH and viscosity were measured as well. There was no significant difference between pH values (from 6.83 to 6.87). As the gellan gum value increased, viscosity values increased (from 31.44 mPas to 75.94 mPas). As a result of RSM, optimum conditions were selected as 0.04% gellan gum concentration and 218.59 bar homogenization pressure. In this conditions sedimentation, WHC, creaming value, pH, viscosity, sensory analysis were carried out. It was compared with the cocoa milk obtained from the market.

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Determination of Quality Characteristics of Naturally Debittered Olive Varieties in Turkey

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Olive fruit (*Olea europea* l.), consumed as table olive or by processing to olive oil, has an important place in our country and in the world. Oleuropein, the dominant phenolic component in olive fruit, causes bitterness. While there is no need to remove oleuropein in olive oil production, it is removed in table olive production by brine or dry salting method. However, some special olive varieties in Turkey can be consumed as table olives without any pre-treatment (brine or dry salting). Attun, Kilis Yağlık olives is debittered by falling on the soil in Kilis region, Butko is debittered on the tree in Yusufeli district of Artvin, Hurma is debittered on the trees in the Izmir region, and Nizip Yaglik olives are debittered by falling on the soil in Nizip district of Gaziantep. These four olive varieties of which their bitterness decreased naturally, are special olives for Turkey. The aim of this study was to determine the moisture, protein and oil content, antioxidant activity, total phenolic content and fatty acid composition of Attun, Butko, Hurma and Nizip Yağlık olive varieties, which can be consumed as table olives without any pre-treatment. The moisture content of Attun, Butko, Hurma and Nizip Yağlık were determined as 6.84, 50.01, 38.61 and 27.92%, respectively. The protein content of the olive samples varied between 0.19-18.13%, and the oil content were between, 16.66-68.46%. DPPH radical scavenging capacity of Attun, Butko, Hurma and Nizip Yağlık were determined as 87.83, 77.56, 79.87, 83.46%, respectively. ABTS (mM trolox/g olive) values of Attun, Butko, Hurma and Nizip Yağlık were determined as 77.67, 26.00, 34.90, 51.62 and total phenolic content (mgGAE/100g) as 458.87, 152.09, 109.73, 234.33, respectively. The unsaturated fatty acid content of the olive samples were determined between 16.00-21.10%, whereas saturated fatty acid content of the olive samples were determined between 78.90-84.08%.

Keywords: olive, table olives, natural debittering

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Effect of Ozone Micro/Nano Bubble Application on Yoghurt Viscosity and Whey Syneresis

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In this study combine effect of ozone and micro/bubbles were investigated. Ozone is known as highly oxidizing gas and its use in dairy sector has already been extensively investigated (Varga and Szigeti, 2016; Khanashyam et al. 2021; Suprapto et al., 2021).
Micro/nano bubble treatments is an emerging technology for food industry (Phan et al., 2021). It is already shown that the bubbles behave differently as its size decreases. Gas bubbles with a diameter over milimetres raise to liquid surface and burst on the air liquid interface. However, at micro scale, gas bubbles movements up to the liquid surface dramatically reduces according to Stoke's law. At nano scale, bubbles do not show any raising tendency towards liquid surface. Instead, nano bubbles floats in the liquid.Reduction in the bubble size results in an enourmous increase in the surface area of the bubbles leading to increased mass transfer from gas to liquid or incerease in chemical reactions occuring gas liquid interface.
This study aimed at revealing how incorporation of ozone micro/nano bubbles on yoghurt milk would affect the viscosity and whey syneresis of final product, set yoghurt.
Ozon micro/nano bubble application is an emerging technology that is yet to be explotited in food industry. As for yoghurt production, the preliminary results has shown that micro/nano scale bubbles were likely to be stable in milk system once entrapped. In addition, inclusions of bubbles at micro/nano scale reduced the viscosity of yoghurt with no major effect on whey syneresis. Using micro/nano scale bubbles yoghurt with weak matrix could be designed for babies or those having difficulties to eat or swallow. The effect of different foodgrade gases should also be exploited at micro and nano scale in dairy products.

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Formation of Starch-Lipid Complexes between Buckwheat Starch and Fatty Acids

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The aim of this study was to investigate the effect of fatty acids (capric acid or stearic acid) and various reaction pH values (5, 6.5 and 8) on the buckwheat starch-lipid complex formation. The reaction between buckwheat starch and capric acid or stearic acid was conducted at pH 5, 6.5 and 8. The complex formation degree between starch and fatty acids was measured with complex index analysis. Some physicochemical properties (swelling power and pasting properties) of starch-lipid complexes were also determined.
The complex index value of the starch-lipid complexes produced using long-chain fatty acid (stearic acid) increased with an increase in pH. On the other hand, in case of the samples produced using short-chain fatty acid (capric acid), the decrease in pH caused a decrease in the complex formation. Besides, complex formation significantly affected the swelling power (SP) and pasting behavior of buckwheat starch. Complex formation decreased SP of starch, since starch-lipid complexes inhibit the water uptake and swelling of starch granule. In addition, pasting properties showed that the formation of starch-lipid complexes resulted in lower viscosity value compared to the native buckwheat starch. The viscosity values of the starch-lipid complex produced using capric acid were higher than those of the ones prepared using stearic acid due to the difference in solubility of fatty acids. These results proved that the fatty acid chain length and reaction pH value were important parameters affecting the complex formation.

Keywords: Buckwheat starch , starch-lipid complex , stearic acid , capric acid

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Determination of hydroxymethylfurfural (HMF) Content in Different Types of Coffee Drinks Using by HPLC-DAD Method

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Hydroxymethylfurfural (HMF) is formed by the dehydration of sugars in the final step of the Maillard reaction which is a non-enzymatic browning reaction. HMF has become a substance of interest since recent results showed a possible carcinogenic potential in consequence of a metabolic activation by sulfotransferases. The HMF content is an index of quality product and the severity of the heating processing. Coffee, as a source of HMF needs to be investigated to understand the contribution of different precursors. In this study, the analysis of HMF in different roasted (medium, very) Turkish coffee powder and drink, instant coffee powder (classic, gold) and drink were determined. The HMF content in powder and coffee were analysed by high performance liquid chromatography (HPLC) coupled to diod array detector (DAD). In this study, we reported the HMF content of instant coffee was 200-300 mg/L, Turkish coffee drinks varies between 1000-1500 mg/L. The highest HMF value was found in the 800-2000 mg/L range of instant coffee powders. HMF is formed during the roasting process in high amounts at 240°C. However, the degradation is rather quick and commercially roasted coffee contains less HMF than expected. Statistical analysis was performed using SPSS 22.0 version. The differences of mean values among samples was determined using One-way analysis of variance (ANOVA) followed by Duncan. The differences in the HMF content of the types of coffee and powder were significant ($P<0.05$).

Keywords: Coffee, HMF, HPLC-DAD

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Optimization of Bleaching Process Conditions of Palm Oil by RSM

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Crude vegetable oils contain mono-, di-, triacylglycerols and some undesirable minor components. Undesirable minor components are generally free fatty acids, phospholipids, trace metals (e.g.iron, copper) pesticide residues, gums, waxes, some pigments such as chlorophylls, carotenoids and oxidized compounds. Also, oxidised compounds increase off-flavors and decrease thermal and oxidative stability of oils and fats. So, many vegetable crude fats and oils need to be refined to provide to the levels in the regulations, to increase their shelf life and consumer acceptance. By refining, the amount of undesirable compounds are reduced to acceptable and harmless levels in terms of quality and health. Chemical refining process contains several steps. These steps are neutralization, bleaching and deodorization processes. However, these refining processes needs to be tailored as the composition of crude oil is highly variable.
In this study, optimum bleaching conditions of palm oil were determined. Some factors were kept constant, such as the type of bleaching earth, stirrer speed, vacuum level. Using three variables such as bleaching time, bleaching temperature and amount of bleaching earth was used in Response Surface Methodology (RSM). Bleaching trials were carried out according to the determined RSM experimental design at the Multipurpose Pilot Plant in Besler R&D Center. All bleached oil samples were analyzed as 3 parallels. The analyses of Peroxide value (PV), anisidine value (AV), totox value (Tx), free fatty acids (FFA), Lovibond colour (red), Glycidyl esters (GE), and fatty acid compositions were determined according to the official methods. Significant factors were determined using the results of PV, AV, Lovibond colour (red), fatty acid composition and GE by ANOVA statistical method. At the end of the study with these significant factors, optimum bleaching condition of palm oil was obtained with 74% desirability, and the mathematical model was obtained using significant bleaching factors in ANOVA statistical analysis.

Keywords: optimization , bleaching , ANOVA , refining , vegetable oil

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Production of Sulfated Glycosaminoglycans from Bovine Tendon by Enzymatic Hydrolysis and Optimization of Process Parameters

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Glycosaminoglycan (GAGs) is one kind of unbranched homopolysaccharide, this natural bio compound can be extracted from the cartilage of animals. It is covalently attached to the core protein. The entire branched macromolecule is called proteoglycan. Chondroitin-4-sulfate which is at the highest proportion in GAGs of poultry cartilage is using as a supplement of functional food for preventing and supporting the treatment of arthritis. The bovine tendon is a waste that remains after the slaughter of bovine, which has no significant economic value but will constitute a potential source for the production of glycosaminoglycans. The aim of this study is to obtain sulfated glycosaminoglycan by enzymatic hydrolysis and optimize a suitable hydrolysis condition by statistical experimental design using RSM. A central composite design was chosen to explain the combined effects of the four extraction parameters namely, enzyme amount, pH value, extraction temperature, and time on glycosaminoglycan yield. The optimum process condition for the extraction process in the sulfated glycosaminoglycan extraction was determined as 0.8% enzyme amount, 7.02 pH value, 63.20°C extraction temperature, and 10.89 hours extraction time. At this optimum condition, the obtained extraction yield value was found to be 1.72% and the validation of the optimum condition was provided experimentally. Afterward, some properties of the optimized glycosaminoglycan were determined by performing SEM analysis, FTIR, molecular weight determination, total amino acid analysis, and rheological measurements on sulfated glycosaminoglycans to characterize. Results show that sulfated glycosaminoglycan was obtained successfully by enzymatic extraction from the bovine tendon.

Keywords: Bovine Tendon , Food Waste , GAG , Extraction

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The Effect of Tarragon on Lipid Oxidation and Heterocyclic Aromatic Amine Formation in Meatball

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Herein, the effects of the use (0.5, 1 and 1.5%) of tarragon in the meatball preparation on the lipid oxidation (TBARS) and heterocyclic aromatic amine (HAA) formation of meatballs cooked at 150, 200 and 250°C were determined. The usage of tarragon at the rate of 0.5% significantly decreased TBARS, whereas the usage of tarragon at the rate of 1 and 1.5% significantly increased TBARS value compared to the control group meatballs. Only IQx (up to 0.05 ng/g) and MeIQ (up to 0.26 ng/g) from the analyzed nine HAAs were determined in the meatballs. The use of tarragon had both an inhibitory and enhancing effect on the formation of HAAs, depending on the rate of use and the temperature of cooking. It could be recommended to use 0.5% tarragon in meatball production as it completely inhibits the HAA formation and reduces TBARS value compared to the control group meatballs

Keywords: Meatballs, heterocyclic aromatic amine, tarragon, lipid oxidation, cooking

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GABA Metabolism Pathway Genes Response to Heat Stress in Saccharomyces Cerevisiae

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A wide range of traditional foods produced by microbial fermentation contain GABA(γ-aminobutyric acid) and also has the possibility of providing new health-benefited products. The major factors affecting the production of GABA by microbial fermentation are temperature, pH, fermentation time and different media additives, therefore, these factors are under research to provide information for effective GABA synthesis. Persistent fluctuations temperature inhibits microorganism's growth and development during fermentation, that's why responses against various stress conditions have great importance in technological and economical manners.
The aim of this study was to investigate the effects of heat stresses on the expression profiles of GABA metabolism pathway genes and to identify GABA genes for heat stress response in commercial baker's yeast (*Saccharomyces cerevisiae*) using microarray technology and comparative statistical data analysis. The value 2.0 was chosen as the cut-off value in order to detect GABA genes included in the yeast.
S.cerevisiae(Izmit,Turkey) used in this study was cultured in YPD broth medium at 30°C. To ensure heat stress conditions, the pellet was resuspended in 10 mL of YPD medium and then each 1mL from this stock culture was inoculated in YPD broth (40mLx3) as 3 groups and incubated for 6h. These groups are; Control group(30°C), 25 to 37°C Heat-Shock-group and 37 to 25°C Temperature-Downshift-group. Total RNA-Isolation, cRNA synthesis, biotin labeling, hybridization and screening, Affymetrix GeneChip Expression Analysis were performed. The gene expression profile in yeast was monitored using the GeneChip methodology developed by Affymetrix. Transcriptional response was monitored using high density oligonucleotide arrays with 6x2 hybridizations with RNA. Data from all hybridizations and sequence normalization in the study were analyzed using GeneSpringGX 12.1(Agilent).
As a result, we identified GABA genes expression profile responses to heat stress, including heat shock and temperature shift, for yeast from our local company.

Keywords: GABA metabolism , Heat stress , Saccharomyces cerevisiae

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DNA-based Nanobiosensor for Visual Detection of a GMO Content in Soybean Event MON87701

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More than 25 years, genetically modified organisms (GMO) and their products have been in the food and feed sector. There is almost 32 crops approved in 44 countries. Every country has a different legislation regarding the threshold values and allowed GM events. In case of Turkey, here isn't any GMOs have been given approval for food use except three microbial food enzymes. In order to determine GMO levels in the specified limits, rapid and sensitive GMO detection is required.

The aim of this study is to propose a new method that make critical decision regarding GMO and to develop a PCR-free, DNA-based nanobiosensor that will allow rapid qualitative determination of Cry1Ac gene in soybean event MON87701. New methodology with gold nanoparticles (AuNPs) offers an excellent platform based on the genomic DNA (gDNA) sequence of interest's hybridization with complementary sequence. gDNA isolated from the Certified Reference Materials (CRM) AOCS0809-A2 was prepared with high purity. The probes used were the exact complementary of the gene of interest. Also AuNPs were synthesized through the citrate reduction method. Firstly, heat treatment applied to unamplified gDNA and the complementary probe to allow hybridization, later addition of AuNPs. Detection was accomplished through aggregation of AuNPs which was associated with color changes of the reaction after addition of NaCl. The aggregation levels were evaluated using UV–vis absorption at 400-700 nm, or by visual observation immediately. The nanobiosensor was also applied to CRM maize and soybean flour purchased from market, as well as controls.

Under the optimum conditions, a correlation was obtained between the GMO level according to Cry1Ac gene with colorimetric change of red to purple. The detection limit is as low as 30 nM, and detection time estimated as 10 min. The method proposed here has a potential to be an alternative methods available in food.

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Survival of Microencapsulated Probiotics in Simulated Gastrointestinal System

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Probiotics have many positive effects on human health. For these effects to be observed in humans, a certain amount of living probiotics should reach and colonize in the gut. Therefore, it is important for probiotics, which are sensitive to environmental conditions, to be protected from gastric and intestinal fluids. Microencapsulation is an effective method that can be used for that aim.
In this study, *Lactobacillus rhamnosus* GG and *Escherichia coli* Nissle were used as the probiotic strains. For the polymer solutions, sodium alginate (ALG) is used as the gelling agent and cellulose acetate phthalate (CAP) is used because of its acid-tolerant features. Microencapsulation of probiotic bacteria was performed by emulsion method with polymer solutions prepared with different concentrations of ALG and CAP. In addition to that, symbiotic microencapsulation was held by adding inulin (INU) to the polymer solution. Encapsulation efficiencies were calculated and ESEM images were captured for morphological characterization of the formed microcapsules. The effect of the microencapsulation process and polymer concentrations on the viability of the probiotics in simulated gastrointestinal conditions was determined for both probiotic strains.
As a result, encapsulation efficiency was above 80%. The capsules were in micron size, irregular shape, and different sizes. Although, microcapsules from different polymer concentrations showed different survival rate, the number of living probiotics were always higher in the microencapsulated forms than the free forms during the gastrointestinal system simulation. The viability of probiotics was positively affected by the encapsulation method, the increase in the CAP concentration, and the addition of inulin to the polymer solution.
It is shown in the study that microencapsulation with acid-tolerant polymers and prebiotics is an effective approach to protect probiotics from simulated gastrointestinal conditions. In addition, food applications with probiotic microcapsules can be held in further studies.

Keywords: Probiotic bacteria , Lactobacillus rhamnosus GG , Escherichia coli Nissle , Microencapsulation , Simulated gastrointestinal system

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Antimicrobial Effects of Different Extracts from Red Pepper (Capsicum Annuum) on Various Pathogens and Probiotics

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Spices are the natural ingredients included in the Turkish Food Codex, which are used for taste, smell or color in food. When the different definitions about spices are examined, they are used to increase appetite, to make the taste, color and smell of the food pleasant and to facilitate digestion. Furthermore, some spices are reported to have bactericidal or bacteriostatic activities. The inhibitory effects of spices are mostly due to the volatile oils present in their composition. The main factors that determine the antimicrobial activity are the type and composition of the spice, amount used, type of microorganism, composition of the food, pH value, temperature of the environment, and proteins, lipids, salts, and phenolic substances present in the food environment

It is accepted that the spice entered Turkish cuisine after the 15th century. The most consumed spice in Turkey is red pepper with 25%.

In this study, antimicrobial activities of methanol, ethanol, cloroform and PBS extracts of three different red pepper (Capsicum annuum) were investigated on pathogens (Staphylococcus aureus, Bacillus cereus, Escherichia coli, Enterococcus fecalis, Listeria monocytogenes, Salmonella typhi) and lactobacilli known as probiotic (Lactobacillus plantarum, Lactobacillus rhamnosus, Lactobacillus casei, Lactobacillus gasseri, Lactobacillus acidophilus). Agar well diffusion method and MİC method were used as research methods. Varying degrees of antimicrobial effects of the ethanol and the methanol extracts were observed on the used strains. As a result, while the highest antimicrobial effect was observed in the methanol extract, almost no effect was observed in theeh PBS and the chloroform extracts.

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Inactivation of Pseudomonas Syringae Spp. And Other Microorganisms on Cherry Surfaces by Uv-C and Led Light

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In Turkey, cherry production is approximately 438.6 thousand tons, and nearly 10% of the product is exported. Microbial spoilage is the main source of loss of quality during post-harvest storage and causes an enormous decrease in exports. This study was aimed to extend the shelf life of fruits by inactivating the main spoilage microorganism *Pseudomonas syringae* spp., fungi, and natural microflora on sweet (*Prunus avium* L.) and sour (*Prunus serasus* L.) cherry surfaces by intense UV-C and pulsed LED light. Various treatment parameters were evaluated and later microbial activities and some quality aspects on the fruit surfaces were measured. Total aerobic mesophilic, total mold and yeast count, *Pseudomonas syringae* spp. and fruit mold were followed. Quality analysis was repeated at intervals on cherries stored at room conditions (25-28˚C, 40-60% humidity) or refrigerated (+4˚C). According to our results, while both light treatments reduced microbial load on the fruit surface; it is observed that pulsed LED light is more effective than UV-C light. Under the treatment conditions tested in this study fruit shelf life extended nearly 30% compared to untreated samples. This extension can have a critical role in export durations and distances and is expected to have enormous improvement for export quantity.

Keywords: Sweet and Sour Cherry, UV-C and LED Light, Pseudomonas syringae spp., Fungi, Shelf life

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Development of a Colorimetric pH-Sensitive CO2 Indicator for Use in Food Packaging

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CO_2 is one of the key metabolites that determine the spoilage of poultry and meat products. The microbial growth results in a gradual increase in CO_2 concentration in the headspace of the package, leading to a change in the pH. In this study, pH sensitive dyes were used to fabricate a color changing label that can be used to detect CO2. A three-layer structured label was obtained by entrapping the color changing pH sensitive dye solution containing either phenol red (PR) or bromothymol blue (BTB) encapsulated within cellulose based matrix between two plastic layers. The dye solution was doped with sodium hydroxide (NaOH) to achieve a more distinct color change. The labels were exposed to different CO_2 concentrations (0-30 %) at 25°C for 24 hours. The colorimetric response of the labels was observed using a portable colorimeter, and the digital images were used to calculate the ΔRGB patterns. The obtained ΔE and ΔRGB results showed that the color change of the pH-sensitive indicators correlates with different CO_2 concentrations. According to these results, the highest total color change (ΔRGB) was observed in PR-based labels which a had more distinct color change in the range of 15-20% CO_2 at which the spoilage starts in meat products in comparison to BTB labels. In conclusion, the developed pH-sensitive CO_2 indicators are promising to use as an intelligent indicators in the food packaging sector.

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Designed Biocompatible Hybrid Electrospun Nanofibers for Antimicrobial Food Packaging Application

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Nanotechnology is focused on innovative approaches in food packaging applications, as there is a growing demand for the extension of fresh food shelf life as well as protection against foodborne diseases. Thus it unveils the invention of antimicrobial food packaging is utilizing biopolymer embedded nanoparticles that are synthesized by the green route. In this study, the stable metal nanoparticles were synthesized using agro-food waste, characterized, and assessed for their antimicrobial activity against Listeria monocytogenes, Staphylococcus aureus, Escherichia coli O157:H7, Salmonella typhimurium, and Salmonella enteritidis. The production of nanoparticles was illustrated by UV-vis. An environmentally sustainable hybrid electrospun nanofibers were advanced via the electrospinning technique. The morphology, physicochemical and thermal properties of the developed mats were analyzed by Scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR) and X-ray diffraction (XRD), and Differential Scanning Calorimetry (DSC) respectively. These nanofibers had range from 100 to 200 nm average diameter. The diameter of the nanofiber decreases as the concentration of nanoparticles increased. These nanoparticles and electrospun mats showed good antimicrobial activity against both Gram negative and Gram positive bacteria. These findings suggested that hybrid electrospun mats could be possible to use as antimicrobial packaging for food preservation especially could enhance the shelf life of perishable foodstuffs.Acknowledgements: This research was supported by Mersin University Project Research Unit (Project number: 2021-1-TP2-4325).

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Plant Based Green Synthesis of Silver Nanoparticles and their Applications in Food Packaging

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Silver nanoparticles (AgNP) are used in many different fields due to their ability to pass through the cell membrane quickly and their antibacterial, antiviral and antifungal effects. However, the possible environmental effects associated with the production of these nanoparticles are also a matter of increasing interest. The reason is because the production of nanoparticles often uses chemical and physical methods that could potentially be harmful to the environment. In recent years, biological synthesis, also called "green" production, has come to the fore as an alternative to traditional methods, which is efficient, inexpensive and environmentally safe. This method is made using plant, algae, bacteria, fungi and even human cells. Inorganic silver ions are converted into silver nanoparticles by reducing protein and metabolic substances in living organisms with these method. The fact that plants and plant products are cheap and renewable resources has increased the plant extract-mediated synthesis of silver nanoparticles.

Nanotechnology is a new application area emerging in antimicrobial and environmentally friendly food packaging. Silver nanoparticles have been used in food packaging applications due to their antimicrobial properties. Nano silver causes the formation of reactive oxidative species even in resistant bacteria, causing membrane damage, inactivation of proteins such as respiratory enzymes and DNA damage in microorganisms. It is known that the use of silver nanoparticles in the production of food packaging materials improves the properties of the packaging material and thus has positive effects on the shelf life of foods.

In this review, the potential uses of the plant extract-mediated synthesis of silver nanoparticles in the production of food packaging materials are tried to be explained.

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The Effect of Different Drying Methods on Tarragon (Artemisia dracunculus) Essential Oil Components

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One of the applications used in terms of preventing food-borne poisoning and extending the shelf life of food; It is the use of natural or synthetic origin antimicrobial agents in foods. Consciousness of consumers about healthy nutrition has increased the tendency for foods containing natural origin preservatives instead of foods containing synthetic substances.
Tarragon (Artemisia dracunculuis) essential oil can be used as a natural antimicrobial agent in foods. The aim of this research is to determine the effect of different drying methods on the essential oil content and essential oil composition of Tarragon (Artemisia dracunculus). Drying methods used in the research; radio frequency drying and conventional drying.
To determine the effect of different drying methods on tarragon essential oil content and oil components; The essential oil from fresh tarragon grass was obtained using the Clevenger device.
The components of essential oils were determined by GC/MS device in Mersin University Advanced Technology Education Research and Application Center Laboratory.
Estragol , Cis-Ocimene, Beta (β) Ocimene, Limonene, Alpha (α) Pinene are given below respectively.
Fresh Sample-Ethanol; % 89,55, % 4,8, % 3,98, % 1,08, %0,31
Fresh Sample-Hexane; %89,5, %4,87, %3,98, %1,09, %0,31
Sample Dried at Room Temperature for 3 Days – Ethanol; %85,62, %6,5, %5,05, %1,87, %0,61
Sample Dried at Room Temperature for 3 Days-Hexane; %84,8, %6,83, %5,34, % 1,87, % 0,61
RF Drying-Ethanol; %85,15, %6,65, %5,23, %2,04, %0,57
RF Drying-Hexane; %83,91, %7,11, %5,61, %2,27, %0,65
Sample Dried at Room Temperature for 7 Days-Ethanol; %85,85, %6,48, %4,84, %1,78, %0,61
Sample Dried at Room Temperature for 7 Days- Hexane; %83,62, %7,39, %5,59, %2,12, %0,72
The difference in the drying methods is that it definitely increases the amount of essential oil of the plant, but does not cause a proportional change on the essential oil components.
This study was supported by Mersin University Scientific Research Projects Unit as project numbered 2020-1-TP2-4019. (BAP)

Keywords: essential oil , antimicrobial agent , tarragon

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Enhancing Storage Stability of Fresh Eggs with Ultrasonication

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Fresh eggs as a valuable source of protein and nutrients have a limited shelf life.
The aim of this research is to investigate the effectiveness of ultrasonication processes (80W, 160W and 360W) on quality qualities (albumin and egg yolk pH, Haugh unit, egg yolk index, dry matter, RWC) in extending the storage stability of fresh eggs.
The yolk index (YI) of fresh eggs decreased from 0.42 to 0.27 for control during storage, while 360W, 160W and 80W decreased by 0.32, 0.33 and 0.33, respectively.
Haugh units (HU) decreased from 79.30 to 40.66 (control), while 47.39HU(360W), 46.73(160W) and 47.07(80W) after 4 weeks of storage. Stability decreased from the initial value 31(control) 25-18(ultrasonication) to 6.5(control) 13-14(ultrasonication) at the end of storage.
Albumin pH values increased from 8.67-8.84(initial) to 9.54(control) 9.43-9.41(ultrasonication) at the end of storage. The pH values of egg yolk increased to 6.07- (initial)- 6.35 (control) 6.27 (80W), 6.25 (160W) and 6.23 (360W) at the end of storage. The dry matter of albumin increased from 14.23 (initial) to 16.43(control) -16.5(360W), 16.62(160W) and 16.90(80W) at the end of storage. Dry matter values of egg yolk decreased from 48.75(initial) to 44.78(control) -46.48(360W), 46.26(160W) and 45.92(80W) at the end of storage.
RWC values (initial 932-845) were decreased to 725(control), 860(360W), 847(160W) and 855(80W) at the end of storage. The lowest shell strength, due to ultrasonic cavitation 360W-in ultrasonication eggs (4.1(kgf)-top) has been observed. From this study, it was reveal that the functional properties of fresh eggs were preserved depending on the ultrasonication power used. High ultrasound caused micro cracks.
This study showed that the storage stability of fresh eggs, especially 80W and 160W, was extended for at least 1 week without any adverse effect on shell strength. Ultrasonication can be a feasible and effective process for increasing the long-term storage stability of fresh eggs.

Keywords: EGG , ultrasonication , stability , quality criteria

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The Effect of Cold Press Oil Extraction Method on Ochratoxin A Levels in Contaminated Olives

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Ochratoxin A (OTA) is a highly toxic and carcinogenic mycotoxin which is synthesized by some Aspergillus and Penicillium species as secondary metabolites. OTA causes nephrotoxic, genotoxic, neurotoxic, immunotoxic, embryotoxic, teratogenic and carcinogenic effects in the human body. OTA contamination is frequently reported in foods such as cereals, grapes and olives. Fungal contamination can observe to natural or processed olives. The transfer of OTA to olive oils results from the processing of OTA-contaminated olive fruits. The aim of this study is to investigate the presence and amount of OTA in the final product as a result of olive oil extraction by cold press from olives contaminated with OTA which are both naturally (NC) and spikeded with 15 µg kg-1 (SC). Cold press method was used for oil extraction from olives. OTA was extracted to samples via methanol, than it was purified with the immunoaffinity column and quantified in HPLC using a fluorescence detector. The recoveries and detection limits are 92% and 0.15 µg kg-1, respectively. SC samples processed into olive oil, and finally OTA was detected in olive oil between 4.32-6.29 µg kg-1. Mean concentration was 5.42 µg kg-1 (36.13%). OTA concentrations in NC samples were between 0.589 and 12,005 µg kg-1. Olive oils obtained from these were contaminated with OTA in the range of 0.241 to 3.891 µg kg-1 (34.34%). As a result, similar results were obtained from both NC and SC experiments. It was determined that in the cold pressing process, 35.23% of OTA in olive was transferred to olive oil.

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Effects of Autochthonous Lactic Acid Bacteria Strains on Growth of Staphylococcus Aureus in Heat Treated Sucuk

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The aim of the study was to investigate the effects of autochthonous lactic acid bacteria strains (*Lactobacillus plantarum* S91, *Lactobacillus sakei* S15, *Pediococcus acidilactici* S147b) on the growth of *Staphylococcus aureus* during fermentation in heat-treated sucuk.

Five different heat-treated sucuk batters were prepared using autochthonous strains (Control, *L. plantarum* S91, *L.sakei* S15, *P. acidilactici* S147b or *L. plantarum* S91 + *L. sakei* S15 + *P. acidilactici* S147b). Sucuk batters were contaminated with *S.aureus* at the level of 10^5 cfu/g. After fermentation (22°C) and heat treatment (68°C internal temperature), the heat-treated sucuk groups were dried at 18°C. Samples taken during fermentation (0, 24, 48 and 72 hours) were analyzed. The samples taken after heat treatment and drying stages were also analyzed.

In the control group without starter culture, a significant increase in the count of *S. aureus* was determined during the fermentation stage. There were no significant changes in the count of *S. aureus* in the presence of autochthonous strains. The strains showed a good growth during fermentation and caused a significant decrease in pH value. After heat treatment, the counts of *S. aureus*, lactic acid bacteria, *Micrococcus*/*Staphylococcus*, yeast and mold were found below the detectable limit (<100 cfu/g) in all heat-treated sucuk groups. At the end of drying, the a_w value varied between 0.927 and 0.935 in heat-treated sucuk groups. In addition, enterotoxin was not detected in the final products.

The autochthonous strains used decrease the pH value during fermentation in heat-treated sucuk, which is a semi-dry fermented sausage type, and thus the growth of *S. aureus* can be inhibited. On the other hand, even at the level of 10^6 cfu/g *S.aureus*, no enterotoxin is formed in the control group without starter culture.

Keywords: S.aureus , Heat treated sucuk , Autochthonous strains , L. sakei , Staphylococcal enterotoxin

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Methanol Content of Illegally Produced Alcoholic Beverages in Black Market of Turkey

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Methanol is a substance that accounts for many health risks (i.e. blindness, death) because of its toxicity. In recent years, many deaths have been registered in Turkey due to methanol poisoning. The chemical composition of illegal or unrecorded alcoholic beverages that containing methanol was clarified in this study. A total of 66 samples with lethal doses of methanol were analysed between 2019-2021. The content of methanol and major volatile compounds (aldehydes, esters and higher alcohols) in samples were determined by direct injection with gas chromatography-flame ionization detector (GC-FID) according to the European Commission Reference Method. The results showed that the samples mainly consisted of ethanol, methanol and water. The total alcohol content of samples ranged from 11% (v/v) to 97.9% (v/v). The methanol levels of the samples changed between 35,5-616,2 g/L. Results showed that methanol levels of samples were much above than maximum acceptable limits of Turkish Alcoholic Beverage Regulation (2016/55) and Regulation (EC) No 110/2008 of the European Parliament of spirit drinks and repealing Council Regulation (EEC) No 1576/89. As a result, alcoholic beverages which are produced in black market of Turkey are not safe and these samples should not reach to the consumers due to serious health risks.

Keywords: Methanol, Alcoholic beverages, GC-FID

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Modeling Inactivation of E. coli O157:H7 on Sucuk Slices by Pulsed UV Light

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Objective: The surface of sucuk is susceptible to contamination especially after processing. Pulsed UV (PUV) light technology is a non-chemical and non-thermal (for short treatment times) alternative to decontaminate food surfaces. PUV light consists of electromagnetic radiation ranging from ultraviolet to infrared that is emitted by an inert gas lamp as light pulses. Escherichia coli O157:H7 is a pathogen associated with the consumption of contaminated meat products. In this study, the effect of PUV light on E. coli O157:H7 on sucuk slices was investigated, and the inactivation was described by mathematical models.

Method: Sucuk slices inoculated with E. coli O157:H7 were treated at varying distances from the xenon lamp in a PUV-light system. In order to limit the confounding effect of temperature on the inactivation, only the following treatments were included: 5 cm (≤15 s), 8 cm (≤30 s) and 13 cm (≤45 s). The first-order, Membre, and Weibull models were used to describe the inactivation curves. Non-linear regression in MINITAB 17 was performed to determine the model parameters. The goodness-of-fit of models was determined using root mean square error (RMSE), regression coefficient (R2), and slope of 'observed vs. predicted reductions'.

Results: Among the treatments included, the maximum reduction of 2.18 log cfu/cm2 was obtained after the 13 cm-45 s treatment. Weibull model yielded the highest goodness-of-fit at 5 cm (RMSE: 0.0045, R2: 1, Slope: 1) and 8 cm (RMSE: 0.1595, R2: 0.966, Slope: 0.987), while Membre model provided the best fit at 13 cm (RMSE: 0.2785, R2: 0.904, Slope: 0.949). According to these models, the decimal reduction dose was about 12.8, 13.3, and 23.8 J/cm2 at 5, 8, and 13 cm, respectively.

Conclusion: PUV light may be used for effective postprocessing decontamination of meat products. PUV-light inactivation of E. coli O157:H7 on sucuk slices follows a nonlinear trend.

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Electrosprayed Food Grade Particles for Food Safety Applications

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Electrospraying technique as a novel emerging technology has been proposed for obtaining the micro-, sub-micro- and nanoparticles for innovative food applications. This study used the electrospray technique to produce whey protein concentrate-lauric arginate particles to generate the micro–nanoparticles for food safety applications. The effect of lauric arginate (LAE) concentrations (2, 1, 0.5 % w/v) on the formation of whey protein concentrate (WPC) particles morphology, structure, and functional properties were examined. The optical and scanning electron microscopy (SEM) and, FT-IR analysis was applied to characterize the obtained particles. The SEM results demonstrated that the WPC particles could be obtained with different concentrations of LAE with spherical morphology and smooth surface. FT-IR analysis confirmed the interactions between whey protein concentrate and lauric arginate. The presence of LAE enhanced the electrospraying of WPC particles. The WPC-LAE particles were obtained under the applied voltage of 22 kV, a flow rate of 0.3 mL h-1 and a distance of 10 cm between the nozzle and collector. The obtained WPC-LAE particles antimicrobial activity tested against bacteria including Bacillus cereus, Listeria innocua, Escherichia coli, and Salmonella enterica subsp enterica serovar. The WPC-LAE particles possessed significant antimicrobial activity, and the activity was concentration-dependent. The antimicrobial food-grade WPC-LAE particles can respond to food industry demand for food safety applications with simple and low-cost novel electrospraying technique.

Keywords: Whey protein, food-grade particles, lauric arginate, antimicrobial

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12 - Food and Sustainability - Oral Presentation

A discussion on Green Deal and Sustainable Development Goals –Exemplary Optimization Problem on Agriculture Industry

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United Nations and European Commission state in their respective call for action documents Sustainable Development Goals 2030 (SDG2030) and the Green Deal that the World is no longer sustainable and research-driven change is required, and they call for a transformation. Applied research has a strategic position in this research-driven transformation where policy engagement is crucial. As the world population rises Nature's critical resources of land, water and air becomes more constrained and Nature's balance and defense capacity has already been degraded resulting in a higher number of biotic hazard occurrences including floods, epidemics, extreme climate occurrences and droughts with an aggravated impact.

Main target of European Green Deal is to relieve the stress on the natural resources and to solve climate and environmental-related challenges whereas main target of SDG30 is to preserve social equality and social welfare of everyone. The indispensable and interlinked five elements of SDG30 and Green Deal, i.e. people, planet, prosperity, peace and partnership also alter main perceptions of the scientific research including but not limited to:

• The impact of any research and innovation initiative shall no longer be assessed by its economic feasibility but its overall impact on societal, environmental and economic dimensions.
• The whole value chain must be carefully considered, thereof policy making has a crucial role in defining the right incentives to reach the intended targets[2].
• Sustaining sustainability requires improvement in resilience capacity of the planet which might have been more severely compromised when compared to sustainability.

This paper focuses on how operations research discipline is affected from this transformation and potential research topics related to agricultural industry are illustrated. An exemplary multi-criteria optimization problem on SDG12-Ensure sustainable consumption and production patterns will also be presented.

Keywords: green deal, sdg30

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49 - Food and Sustainability - Oral Presentation

Exergy Analysis of Apple Juice Concentrate Production

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Exergy analysis plays an important role in the sustainability of the industrial food processing systems. Considering the second law of thermodynamics, the exergy analysis method has become a useful tool to indicate the inefficiencies of the system of interest. There is an intense use of energy in the food industry, hence it is important to make energy and exergy analysis of the systems for sustainable development in the food industry. The object of this study is to perform exergy analysis of an apple juice concentrate production line and to define the energy and exergy destruction rates to assess the system performance. The mass and energy amounts of the inputs and outputs at each step in the apple juice concentrate production process were determined. Within the limits of this system, exergy destruction and exergy efficiency were calculated separately for each step. While the exergy destruction in the whole system was calculated as 6376.64 kW, the highest exergy destruction rate was found as 3560.60 kW and 2159.04 kW in the evaporation and first press steps, respectively. In addition to these results, the exergy efficiency of the evaporation and first press steps were calculated as 23% and 68%, respectively. The exergy efficiency of the total system was found as 14%.

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17 - Food Loss and Waste - Oral Presentation

Development of Protein Rich Pre-gelatinized Flour Mix by Twin-screw Extrusion of Food Processing by-products

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Pregelatinized flour (PF) is widely used as a thickener agent in the formulation of many food products such as bakery products, baby foods, instant soups and desserts.PF can easily absorb water even at low ambient temperatures and can also quickly increase the viscosity of the mixture by providing cold viscosity.Twin screw extruders are preferred for the production PF because of their advantages such as low energy cost, easy process control, high efficiency and better product quality. In this study, nutritious PF mix was developed from the broken chickpea kernel, which is the by-product of legume processing, and the whey protein concentrate (WPC).The aim of the study is investigating extrusion processing conditions to obtain PF formula with acceptable physicochemical properties.The ground chickpea flour (20-40%), WPC (5-15%), corn starch were blended, extruded using a twin screw extruder under feed moisture contents(25-35%), barrel temperature profiles(30/50/70/80/95-30/50/80/100/110).The screw speed was kept constant at 225 rpm.The obtained samples were dried, ground and sieved.The PF samples were analyzed for water absorption, solubility indices, oil absorption capacity, Hunter *L, a, b* and *ΔE* values, grinding efficiency (percent of the amount of PF under sieve in the total PF mass)(%).Physicochemical properties of the PF were significantly affected by both of high feed moisture content and temperature profile.The acceptable PF sample included 5% of WPC and 20% of broken chickpea kernel flour.The physicochemical characteristics covers water absorption of 6.36%, water solubility of 10.60%, oil absorption capacity of 1.80%, and grinding efficiency of 47.82%.Hunter *L, a*, *b* and *ΔE* values were 87.78, -1,18, 11.77 and 6.24, respectively.This work was supported by TUBITAK (Project No. 219O341).

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Optimization of Extrusion Pretreatment Process for the Extraction of Hemicellulose from Lentil Bran

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Legumes, an important source of protein in human nutrition, are produced at approximately 70 million tons per year in the world. Huge amounts of industrial by-products are produced during the processing of legumes. The great majority of them is used for livestock feed. The conversion of the bran fraction, one of the main side streams of legume processing, into high value-added products has a great economic importance. Bran is a lignocellulosic biomass and consists of app. 20-35% hemicellulose. In this study, it was aimed to efficiently extract the hemicellulose fraction of lentil bran to obtain high value-added products. For this aim, extrusion was used as the pretreatment process. Extrusion pretreatment was carried out using a computer-controlled twin-screw extruder with five heating zones. Statistical optimization of the extrusion process was performed using Response Surface Methodology (RSM) and Box-Behnken experimental design, and the obtained data were analyzed with Design Expert (7.0) software. Moisture content, screw speed and barrel temperature were chosen as independent variables for design of the experiments. In accordance with the experimental design, 17 sets of extrusion were performed and hemicellulose extraction from processed bran samples by alkaline extraction technique was performed. Optimal process conditions to obtain the highest hemicellulose yield from processed bran samples were determined as 40% (w/w) moisture content, 200 rpm screw speed and 110ºC barrel temperature. As a result of the statistical analysis, the correlation coefficient (R2) of the mathematical model was determined as 0.9969. This result showed that the experimental data were compatable with the full quadratic model. This work was supported by TUBITAK (Project No: 219O341).

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Green Production of Bacterial Polygalacturonase Enzyme Using Apple Pomace to Minimize Waste Disposal

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Apple pomace is a residue of apple processing industry, which is generally under-utilized. Turkey is the third largest apple producer, accounting for 3.6% of total worldwide production. Despite large amounts of worldwide-generated apple pomace, only a small fraction of this waste is reused. Bioprocessing of apple pomace with bacteria for producing enzyme can greatly reduce the disposed amount of apple pomace, thus providing a green approach to enzyme production.

Bacterial enzyme production using apple pomace is generally carried out by saccharifying the dried apple pomace and fermenting the resulting sugar mix using bacteria, especially *Bacillus* spp. One major advantage of this technique is its simplicity and relatively less error prone nature. In this study, *Bacillus subtilis* was used as polygalacturonase (PGase) producer by growing in the fermentation medium prepared by hydrolyzing the dried and ground apple pomace with dilute acid with initial solid mass amount of 10 g/L. All fermentation experiments were conducted with 100 mL fermentation medium in 500 mL Erlenmeyer flasks at 30 ^{o}C, 130 rpm, and initial pH of 5.0. The PGase production and reducing sugar consumption were monitored every 24 hours for 1-3 days using DNS method for optimization of fermentation period. The obtained enzymes were then tested on media containing different amounts of substrate (pectin) by incubating the enzyme-substrate mix at 50^{o}C, 165 rpm, and 24 hours. The results indicate that apple pomace has the potential for use at a larger scale for bacterial polygalacturonase enzyme production and thus for minimization of waste disposal.

Keywords: Waste management , Apple pomace , Bacillus subtilis

44 - Food Loss and Waste - Oral Presentation

Production of Natural Colorant from Peach Pomace by Eco-friendly Methods

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The interest in natural-based products might even be more motivating if the selected sources correspond to industrial by products, avoiding the need to deprive natural resources. Although being typically considered as waste, these remaining materials are commonly rich in valuable compounds, such as polyphenols, vitamins or carotenoids. These bio-residues deserve special attention when originated from products with high production levels, such as in the case of peach. A considerable part of harvested peaches are processed to obtain juice, originating great volumes of residues. Curiously, since phenolic compounds are mainly located in peels, peach pomace retains most of these compounds, thereby raising its interest as a high potential ingredient for many applications. It is considered as an important source of natural carotenoids.
The aim of this study is that optimization of carotenoid extraction conditions with enzymatic (pectin lyase) and ultrasound assisted extraction using eco-friendly methods from peach pomace, which is a food industrial waste.
The peach pomace used in the study was obtained from Dimes Food Corp (Tokat-Turkey). Ultrasound-assisted extractions were carried out using an ultrasound bath operating at 37 kHz frequency. The carotenoid extraction conditions of the samples were optimized using the Response Surface Method (RSM) using the Box-Behnken design. The effects of sample amount (1-3g), enzyme ratio (0-10%), temperature (20-60°C) and time (10-60 minute) (independent variables) were investigated on the total carotenoid content (response) of peach pomace carotenoid extract. Response selection was determined according to maximum total carotenoid content.
For the optimization of the extraction conditions, a statistical design consisting of 29 experimental points and four variables was used. In the experimental studies reached with the theoretically calculated amount of carotenoid in the optimization of enzymatic and ultrasonic assisted extraction conditions using RSM, a compatibility between 53.90% and 60.99% was determined.

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Freeze Drying of Aquafaba: A Case Study on the Valorization of Food Wastewater

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Food industry is one of the world's largest and most important businesses. Food production systems causes considerable amount of environmental effects since it has been consumed natural resources such as raw materials, water and energy, and generated wastes. For this reason, the importance of sustainability in food life cycle has been increasing day by day all over the world. In that concept, energy efficiency, waste minimization and water management play significant roles in the production processes.

Drying has been widely used for reducing the moisture of foods since ancient times. Freeze drying is one of the best drying technique in terms of final product quality. This drying method is used in many fields and for different purposes. One of them is the situations in which the nutritional values of the products are desired to be preserved. In some cases, a very valuable by-product can be obtained from a substance that is thrown away as food waste.

Chickpea boiling water, also known as aquafaba is a good example of valuable food wastewater. Aquafaba is viscous and flow; and it has approximately 95% moisture content. It can be used as a thickener, foaming agent and emulsifier in food industry. It is also a good egg-white replacement in the vegetarian food production.

In this study, energy consumption of freeze drying process of aquafaba at 3 different temperatures (40, 50 and 60 oC) was investigated. In this context, MER (Moisture removal rate), SMER (Specific moisture removal rate) and SEC (Specific energy consumption) values were calculated. MER (0.098 kg/h), SMER (0.051 kg/kWh) and SEC (91.48 kWh/kg) values show that the lowest energy consumption was achieved for the condition of aquafaba was freeze-dried at 40°C.

Keywords: Freeze drying , Aquafaba , Wastewater , Energy analysis

40 - Functional Foods - Oral Presentation

Determination of Phenolic Compound Profiles and Antioxidant Effect of Plant Extracts on Late-Release Soft Lozenge”

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Medicinal plants contain different bioactive compounds that have immune system stimulant, anti-inflammatory, antibacterial, antiviral, antifungal, anticancer and wound healing effects. *Echinacea purpurea* L., *Sambucus nigra* L. and *Cetraria islandica* L. are known with their high antioxidant content and health promoting properties. The main objective of the study was to determine the total phenolic content, total flavonoid content and antioxidant capacity of each plant extract with water and 75 % ethanol as solvents.
The extraction efficiency was significantly higher in ethanol extracts according to total phenolic content, total flavonoid content, 1-diphenyl-2-picryl-hydrazyl (DPPH) and copper reducing antioxidant capacity (CUPRAC) analysis ($p<0.05$). Among all extracts, the highest result of radical scavenging capacity was found in ethanol extract of Sambucus nigra L. as 901.62±24.53 mg TEAC/ g dry extract. Total flavonoid and total phenolic contents of the same extract were determined as 840.54±13.46 mg RE/ g dry extract and 339.68±1.47 mg GAE/ g dry extract, respectively.
The selected phenolic compounds were quantified and phenolic profiles were determined by HPLC analysis for all extracts. By using the selected plant powders, the late-release soft lozenge product was formulated. Loss of bioactive compounds was examined by using spectrophotometric and chromatographic techniques. In lozenge product, the highest phenolic content was obtained with *Sambucus nigra* L. (2.33±0.11 mg GAE/ g dry extract. Results confirmed that the lozenge application caused a significant loss in antioxidant amount for all plant extracts. In order to obtain optimum antioxidant effectiveness from the lozenge products with functional properties, it is needed to provide a suitable recipe with optimized usage of plant extracts.

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Keywords: Antioxidant Capacity , Medicinal Plant , Soft Lozenge , Phenolic Content

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Determination of Maximum Functional Capacity in Infused Linden Flowers by Response Surface Method

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Objective
To achieve maximum antioxidant activity and maximum phenolic capacity in linden tea using response surface method.

Method
Linden tea samples were prepared by infusing 1 g of linden flowers in 100 mL of water in a glass beaker. Antioxidant activity (DPPH) and total phenolic compound analyzes were performed on 13 linden tea samples prepared at different temperatures (65-95 °C) and time (1-4 minutes) combinations determined using the response surface method. The antioxidant activity was expressed as a percentage, while the total phenolic compound was expressed as milligram catechin equivalent/mL.

Results
While the effect of infusion temperature on the antioxidant capacity of linden tea was found to be very significant ($p \leq 0.001$), the effect of infusion time was found to be significant ($p < 0.05$). The effect of temperature on the total phenolic compound of linden tea was found to be very significant ($p \leq 0.001$), but there was no statistically significant influence of time ($p > 0.05$).

Conclusions
For the highest antioxidant capacity and total phenolic compound, the optimal infusion time and temperature are 1 minute and 95°C. Using these optimal experimental conditions, 33.38 mg/L total phenolic compound and 87.78% antioxidant capacity were determined. These new findings will enable us to benefit from linden tea with maximum functional capacity within the specified temperature and time.

Keywords: antioxidant activity, linden, total phenolic compound

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Production of Iced Tea from Microencapsulated *Papaver rhoeas* L. Flowers Extract and Determination of Bioactive Properties

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Today, depending on the increase in demand for hot or cold beverages, the food industry has sought different alternatives. Among these alternative beverages, iced teas are among the popular ones. However, with the limited selection of iced teas and the preference of healthier alternatives to these beverages, products with natural ingredients stands out. Poppy plant (Papaver rhoaes L.) is an annual edible flower species belonging to the Papaveraceae family and its flowers are red in color due to the anthocyanin components it contains. Especially in folk medicine, the flowers of the plant are used in the treatment of various diseases such as cough, pneumonia, bronchitis, sleep disorders. However, it is stated that the bioactive compounds of the poppy plant have positive effects on health such as antioxidant, antiinflammatory, antimicrobial and antiproliperative.
In this study, leaf extracts of poppy plant were microencapsulated with maltodextrin in a spray dryer. The obtained microencapsulated extracts were used as components in the production of iced tea, and the total phenolic content, total flavonoid, anthocyanin, antioxidant activity (DPPH method), color (L*, a*, b*), turbidity, titration acidity and sensory properties of the produced teas were investigated. Total anthocyanin and total phenolic content values of cold tea samples were determined as 37.96 mg cyn-3-O-glu/100mL and 6.20 mg GAE/100mL, respectively. It has been concluded that the production of iced teas, which received high sensory appreciation by the panelists, can be a better and healthier alternative to limited varieties of iced teas.

Keywords: Poppy , Iced tea , Bioactive compounds , Spray drying

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Fruit Juices with Pea Protein as an Extra Vegan Protein Source

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Protein has 20 different amino acids in its structure. Some of these amino acids are called essential amino acids and cannot be synthesized by the body and must be obtained from the diet. In the daily rush, protein-rich food consumption cannot always be made as much as the body needs. Extra protein to be added to a product that is easier to consume during the day, such as fruit juice, will prevent this problem. Protein sources can be animal or plant- based origin. In recent years, more people tend to change their eating habits from animal sources to plant sources. Pea protein can be used as an effective and novel alternative since it is easier to obtain, gluten free and more sustainable. Amino acid profile of pea protein is well balanced compared to other proteins. Different amounts of protein (%3, %5, %7, %10) were added to the juice. It was seen that increased added protein caused increased pH value which is not acceptable for fruit juices in terms of microbial safety. The higher the protein content, the shorter the shelf life. It is not possible to use high amounts of protein unless additives and preservatives are used. Consequently, additional protein in the final product determined as 5%. Also added protein caused undesired sandy texture and unfavourable after-taste. To overcome this issues, heat pre-treatment and mechanical forces were applied. In addition, low pH fruit juices were used to decrease pH under 4.2 and obtain desirable mouth feel. Within the scope of this study, brix, pH, total acidity and total protein values, shelf life and sensory tests were examined. The product with suitable values has become both a vegan alternative and a candidate to become a new trend in the market with its functionality.

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Techniques For Increase the Stability of Natural Pigments in Foods

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Color is one of the most important sensory attributes of food, as it contributes to providing the consumers with a first impression of the food quality, but it is also associated with flavor, safety, and nutritional value. Pigments are the natural colorant compound, abundantly present in both animal and plant tissue. Natural pigments are becoming very attractive for consumers mainly health safety and some trends like clean labels. Unfortunately, their uses are limited by their lower stability and high cost compared to their synthetic counterparts. Most of the natural pigments are unstable compounds and their composition or color may be changed in some environmental and chemical conditions such as pH, presence of metal ions, exposure to light, high temperatures, and oxygen, but it is also significantly influenced by the product enzymatic activities. So, the food industry is focused on protecting the natural pigment's properties, as in artificial, throughout the process and storage. Nano and micro technologies are very useful tools for eliminating such problems. Micro/nano encapsulation has defined a technology used to obtain capsules (microcapsules) with sizes ranging from micrometre to millimetre by wrapping an active substance (core material) with one or more coating materials (wall material). The main purpose of encapsulation is to create a barrier or matrix with the coating materials around the sensitive components. So that it is ensured that the minimizing of interaction between the components and the environment. Thanks to modern encapsulation technology methods, natural pigments such as carotenoids can be stabilized as well as significantly improved solubility and bioavailability. This study is about the modern technologies for the enhancement of natural pigments stability.

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Development of Meat-Added Expanded Snacks Using Extrusion Technology

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Snack foods is one of the largest food industries in the world. Todays, consumer interest into the ready-to-eat snack foods is constantly growing mainly due to their convenience, wide availability, appearance, taste and texture. Many manufactured snacks are rich in calories and fat but low in protein, vitamins, and other nutrients. Snack foods could be re-designed to be nutritious, to contain ingredients which are attractive to consumers, and to meet regulatory requirements. Addition of animal proteins in such snack type food products can improve the nutritional quality especially with respect to amino acid composition; and also sensory properties like flavor and taste. Incorporation of meat to snacks type product is a good alteration in its nutritional value with particularly high value animal protein. In this study it was intended to develop meat-added expanded snacks using extrusion technology. Different type of meats (chicken and rainbow trout) were incorporated into the cereal-based mixture. The expanded snack products were analyzed for the proximate composition, physical and functional characteristics and also microbiological quality. The extruded meat-added snacks included 6.36-7.44% of moisture; 2.21-2.87% of ash; 0.24-0.68% of fat. The total titratable acidity of the samples ranged from 0.0061% to 0.0080% in terms of citric acid. Water absorption index and water solubility index of samples were 4.72-6.22 g/g and 37.5-53.9%, respectively. Color parameters were measured as lightness (L*), redness (a*) and yellowness (b*) and recorded as 67.11-71.35; 2.54-6.14; 19.91-23.91, respectively. The snack samples were well expanded at the die, so they have moderately low hardness values. The expansion ratios were ranged between 3.05 to 3.22 and the hardness of the extrudates were in the range of 130.362 to 237.621 (N), respectively. Changing meat content generally affected the texture, color and functional properties of produced extrudates. Physical and functional properties were influenced from extrusion process conditions.

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Interactions between Curcumin and Dietary Mixed Micelles Explored by Molecular Dynamics Simulations

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Curcumin is a natural phenolic bioactive compound with many health benefits. However, it has limited bioavailability due to its low solubility and stability. It has been asserted that enhanced bioaccesibility of curcumin results in enhanced absorption by intestinal cells. So far, many experimental studies have been directed towards revealing the poorly understood molecular-scale mechanisms by which curcumin is taken up by dietary mixed-micelles(MMs), but there are still major gaps. In this study, solubilization of curcumins in MMs was investigated by coarse-grained(CG) molecular-dynamics(MD) simulations. MD calculates the time dependent macroscopic properties of a system using a microscopic model via an algorithm applying Newton's equations of motion on the atoms constructing the system. The model used was the Martini force field, which defines the potential energy function formed by bonded and non-bonded types of interactions and restraints between the CG atoms. In this work, the interactions between three curcumin molecules and representative duodenal fed state MMs incorporating different fatty acids(FA) (lauric, stearic and linoleic) were explored. The simulations showed that curcumins joined MMs by adsorption on the micelle surface. Their incorporation showed a highly dynamic behavior as they kept departing from and joining the MMs continuously. Radial distribution functions revealed the internal morphology of the MMs. The cores were occupied by POPC and FA tails, while cholates were positioned on the surface mostly adopting a flat alignment, thereby shielding the hydrophobic core. Curcumin adsorbed on the surface located around the charged head groups with a preferably parallel alignment in a bent conformation(~126^{o}). Although not conclusive, our results indicate no direct link between curcumin bioaccessibility and FA type on the basis of a single MM analysis. The literature reported effects of FA type on curcumin bioaccesibility might be related to the interplay of dynamics of lipid digestion and curcumin degradation.

Keywords: Mixed micelle , Curcumin , Bioaccessibility , Fatty acids

8 - New Technologies and New Risks - Oral Presentation

Extraction of Phenolic Compounds from Cranberrybush (*Viburnum opulus* L.) Fruit by Ultrasound-Microwave Combination

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Minimal processing is one of the major developing category in food industry due to energy saving and high nutritional product advantages. *Viburnum opulus* L. is known as "gilaburu" in Turkey and "Guelder rose" and Cranberrybush in Europe. European Cranberrybush fruits contain high amount of phenolic compounds. The aim of this research is to extract high value phenolic compounds from Cranberrybush (Viburnum opulus L.) fruit by combining ultrasound and microwave technologies. Water was used as the solvent. Solid-to-solvent ratio was kept constant at 5:100 g:mL. The effects of extraction time, microwave power (90 and 180 W) and ultrasound power (14 and 35 W) on total phenolic content (TPC) and color values (L*, a*, b*, ΔE) were determined. In addition, antioxidant capacities of the extracts with highest phenolic content were determined. The process conditions which resulted in the highest TPC (72.03±0.90 mg GAE/ g dry material) were 30 min ultrasound extraction at 35 W and 10 min microwave extraction at 180 W, and it is comparable to maceration results. On the other hand, the highest AA (21.28±0.60 mg DPPH/ g dry material) was obtained for 10 min ultrasound extraction at 35 W and 10 min microwave extraction at 180 W and it is found to be 12 times greater than maceration results. In addition, the combination extracts, which provide 94.4 % time saving compared to maceration, had acceptable color values.

Keywords: Extraction, cranberrybush, ultrasound-microwave combination, phenolic compounds, minimal processing

51 - New Technologies and New Risks - Oral Presentation

Cold Plasma Technology in Food Industry: Current Applications and Future Perspectives

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Nowadays, there is an increasing trend for the consumption of nutritious and safe food products as the awareness of consumers increased. To preserve or improve food quality and extend the shelf life by non-thermal technologies have become an important issue for the food industry. It is well-known that thermal treatments have adverse impacts on the nutritional, physicochemical, and sensory quality of heat-sensitive food products. Cold plasma, a non-thermal technology, has been used for microbial decontamination, inactivation of undesirable enzymes, degradation of mycotoxins, removal of pesticides, reduction of allergens, and structural modifications of food compounds while maintaining the food quality. The shorter process time and decreasing the thermal effect during processing have driven scientists to investigate this technology for different applications in the field of food. Besides, atmospheric cold plasma is generally preferred for ease of use and no need to control pressure, and it can be applied directly to the food surface and liquid products such as juices and water. Cold plasma can be used in combination with other novel technologies, which shows a synergistic effect. In recent studies, it has been demonstrated that cold plasma is an effective and promising technology with various advantages in terms of food safety and quality, however, many question marks need to be explained. This review aims at highlighting the potential use of cold plasma technology in food applications, the process parameters and system configurations, and the effects of food quality and safety, advantages, limitations, and future remarks.
There is an important issue to introduce non-thermal food processing technologies to manufacturers and consumers since they are interested in food safety and quality and the applied technologies. Future studies should be carried out to investigate the uncertainties of cold plasma technology and the implementation of this environmentally friendly technology in the food industry.

Keywords: non-thermal technologies , microbial inactivation , cold plasma , food quality , environmentally friendly

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Testing of Nanoparticles and Microplastics in Food and Beverages

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Nanoparticles normally do exist in nature, and humans are exposed to these particles in their daily lives. Beside this, technically it is also possible to intentionally create engineered nanomaterials with the help of nanotechnology which can improve the desired properties of food and feed and packaging materials at the nanoscale. However, there are also some substances that are produced in classical processes with a minor content of nanoparticles that are produced unintentionally during the process. In order to understand the occurrence, size distribution, type (natural/engineered or intentional/unintentional), characterization and identification, and quantification and risk assessment of nanoparticles in food, standardized testing protocols are needed. This is a challenging work due to the interferences between the nanoparticles and food matrix constituents, heterogeneity, generally low concentrations, alteration of the target analyte during sample preparation, and the difficulty in the quantification of the amount of nanoparticles.
On the other hand, microplastics that are plastics that are smaller than 5 mm are another growing concern in the food supply chain. There is a need for standardized testing methods for the characterization and identification of microplastics in different food matrices.
This presentation will cover the development of a multi-step testing protocol for nanoparticles based on a tiered approach and the development of a microplastics testing approach that can be used in food matrices and beverages.

Keywords: nanoparticles , microplastics , nanotechnology , engineered nanoparticles

Poster Presentations

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Nutritional Properties of Organic Eggs and Cage Eggs

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Egg is a source of animal protein and a valuable food. Chicken eggs are understood as eggs because they are widely produced and consumed. The weight of an egg varies between 50 and 60 g. An egg consists of a shell, egg white and yolk. Egg protein, which has high quality protein content, has a chemical score of 100%, a digestibility rate of 97% and a biological value of 94%. In the Turkish Food Codex, eggs are classified according to the method of rearing: organic, free-range, non-cage rearing in hen house and cage rearing. There is a code for each rearing method. This code has to be stamped on the eggshell by the manufacturer. In recent years, interest in organic foods has increased. Egg is one of them. The rearing method can be effective on the physical, sensory and nutritional properties of eggs. It is reported that organic eggs contain higher amount of protein than obtained with cage system. The cholesterol content is also higher in organic egg yolks. Similarly, it is stated that the ratio of palmitic and stearic fatty acids and total saturated fatty acids is higher in organic egg yolk oil than in cage egg yolk, however, there is no significant difference in monounsaturated and polyunsaturated fatty acid composition. When compared in terms of mineral content, the amount of potassium and copper in organic egg yolk is higher than cage egg yolk. Organic egg white has more potassium, copper, sodium and iron than cage egg white. As a result, the nutritional properties of organic eggs and cage eggs may differ.

Keywords: egg, egg protein, organic egg, cage egg

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Wheat Grass Juice Rich in Functional Components (*Triticum Aestivum* L.)

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Foods that provide a healthy and balanced diet at any stage of life include a diverse selection of goods with different origins and processing methods. With the increasing world population, the demand for alternative grain products is also increasing. Wheat has an important place among these grains. Wheat (*Triticum aestivum L.*) is a major source of human food, which is consumed either raw or processed. Wheat has a wide range of adaptability, is cost-effective, and is simple to cultivate and produce. Wheatgrass, a cereal crop from the Graminae (or Poaceae) family, has been a popular addition to people's diets in recent years, particularly in developing countries. The meeting of wheatgrass with the consumer has come to the fore today with wheatgrass juice. Wheatgrass; It is an extract squeezed from the mature sprouts of wheat seeds .(*Triticum aestivum L.*) It is beneficial in preventing anemia with the liquid oxygen and chlorophyll content in wheatgrass.
The chlorophyll in wheatgrass juice, also called green blood, exhibits the same molecular properties as the hemoglobin in our blood. In the consumption of wheatgrass juice, the chlorophyll in its content also helps to support the production of chlorophyll oxygen because our tissues need oxygen. Wheatgrass content; iron, zinc, iodine, phosphorus, selenium, potassium, copper, from group A, B; It contains vitamins B_1, B_2, B_5, B_6 and B_{12}, C, D, E, F, H, K and enzymes. At the same time, it has been stated in studies that it is a very useful product for health by strengthening the immune system because it contains flavonoids, choline, indoles, minerals and many amino acids. Wheatgrass juice is an effective and inexpensive source as it contains most of the components required in people's lives, and it has great health effects.

Keywords: *Triticum aestivum*, Wheatgrass juice, Green blood

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Rapid Method Development for Consistency Stability of Filling Cream Against Baking Applications Based on Rheological Measurements

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One of the features sought in fat-based filling creams, which are used in the pastry sector commonly, is that they can maintain fluidity and do not burn after baking process. This property can be achieved by the type of oil and the concentration of emulsifier used.
For analyzing the resistance of filling creams against heat treatment, doughs are prepared, cream is deposited and baking process is applied. These steps are requied long time. In this study, rheological methods were developed to rapid measure of stability of the creams against heating process. Rheological properties of creams were studied by rotation and oscillation tests. Temperature-dependent viscosity change of cream was examined by rotation tests. Regarding products that cannot maintain fluidity after heating process, viscosity increased and fluctuated during heating and cooling, while in products that can maintain fluidity, viscosity decreased or remained the same with the initial value. Viscoelastic parameters (storage modulus, loss modulus, loss factor and complex modulus) were also measured with respect to temperature during heating and cooling of the product on rheometer. As a result of the analysis, it was decided that the method that should be used to get accurate data is to observe the change in viscosity, which is consistent with the conventional baking process. The findings of the study indicated that rheometer can be used as an effetctive tool for determining baking stability of the creams with minimal effort, labor, sample requirement and time.

Keywords: Baking, fluidity stability, filling cream, viscosity, viscoelastic parameters

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Texture and Sensory Properties of Sugar-Free Soft Candy Products

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In recent years, the confectionery industry has been improved and the sector of marketing is obviously growing. The marketing trend has increasing for the healthy snack products. Hence in this study; the texture and sensory properties of the sugar free soft candy products had been examined.
Generally, as a production procedure of the standard soft candy products contain gelling agent(s), glucose syrup, sugar and water. While in the standard recipes of the soft candy products, glucose syrup and sugar are used, maltitol syrup, sorbitol and sweeteners can be used in the sugar-free products.
In the studies had been performed for standard soft candy and sugar-free product samples in terms of hardness, elasticity, chewiness and gumminess parameters had been tested. As the sensory analysis; taste, appearance and color parameters had been investigated.
The hardness parameter values of the soft candy products had ranged from 340(g) to 150(g) so it can be said that the standard soft candy product sample has hard. While the elasticity value of the standard product was 0.144(g),it was observed that it had a more elastic structure with a value of 0.476(g) in the sugar-free product. The adhesiveness values of the standard and sugar-free products had been recorded between 0.145(g) and 0.210(g); this indicates that they have similar structure for this parameter. For the gumminess feature, the standard soft candy value was 6.3(g) and sugar-free product data has been reached to 16.1(g).When all the texture values had been evaluated, the results have indicated that the sugar-free product was softer, chewable and more elastic while comparing the standard product.
For the sensory evaluations which have been performed with panelists for sugar-free and standard soft candy product samples; sugar-free samples have been preferred in terms of taste. Although there is no difference in the appearance of the products by panelists, it is noted that the sugar-free product is brighter.

Keywords: Sugar-free, Soft Candy, Texture, Sensory, Sugar-Free Soft Candy

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Mitigation of 3-MCPDE and GE via Enzymatic Interesterification

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Purpose: Mitigation of 3-monochloropropane 1-2 diol esters (3-MCPD) and glycidyl esters (GE) has been discussed in the last decade because of their health effects. Nevertheless current methods are based on ensuring that these contaminants are not formed during production of edible oils and food supply chain by increasing the quality of raw materials with good farming practices and good manufacturing practices which are still non-effective methods for elimination of these contaminants that already formed in production processes. In this study enzymatic interesterification which is an edible oil modification method has been applied; based on the suggestions of previous studies on mitigation of 3-MCPD and GE via enzymatic methods.
Methods: In this study, 3-MCPDE and GE mitigation was performed by enzymatic interesterification in different composition of enzymes and the most suitable enzyme composition was determined. In the second stage of the study, the enzymatic interesterification was carried out with different time parameters using the most suitable enzyme composition.
Results: The results of the study revealed that the use of enzymes plays an important role in the production of high quality edible oils with considerable reduction of 3-MCPDE and GE. In addition, it has been found that use of enzymes in interesterification process decreased energy requirements due to the mild reaction conditions in comparison with chemical method of interesterification.
Conclusion: The results of the study showed that the mitigation of 3-MCPDE and GE during the production of different edible oils via enzymatic interesterification can be done effectively with the optimized reaction conditions using the appropriate enzyme composition.

Keywords: mitigation of 3-MCPDE and GE, enzymes, interesterification, edible oils

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Enriched Milk

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Vitamins; are chemicals that must exist in our body and are important for vital functions. They are not sources of energy on their own, but play an important role as catalysts and regulators in the body. Some vitamins cannot be synthesized in the body, so they must be taken with food.
The word vitamin was first used by the Polish biochemist Casimir Funk in 1912 and comes from the word "vita". Vita means "life" in Latin.
Vitamins are the most important chemicals for the protection of human health. When their general properties are considered, they are divided into two groups as fat-soluble and water-soluble vitamins.
Fat-Soluble Vitamins: A,D,E,K group vitamins.
Water-Soluble Vitamins: C and B group vitamins.
They are the simplest organic substances that are absolutely necessary for our body and act as a catalyst in our body. Vitamins are essential for the healthy development of the body, digestive functions and immunity against infections.
One of the substances necessary for the functions in the human body to perform properly is minerals. There are different macro and micro minerals in the human body and they have different functions. Minerals are substances that the body cannot produce on its own but stores through food and drink. Minerals are indispensable for the human body in order for our body to be healthy and for enzymes and functions to work fully.
With the current pandemic period, immunity has gained more importance than ever before. Vitamins and minerals are essential for a healthy immune system. The most associated with the immune system are vitamins A, C, D, E, and the minerals selenium and zinc.
In the light of this information, we combined a healthy product with a vitamin supplement by launching milk enriched with vitamin D under the brand of İçim.

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Diabetic Cold Brewing Tea - Pending Author Update

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The food product known as soluble tea, tea powder or instant tea has an increasing consumption potential, especially in developed countries.

In addition to meeting the needs of essential nutrients, foods that have a positive effect on health are known as functional foods. In recent years, as scientific studies on the effects of foods on health have increased, functional foods have also begun to gain increasing importance.

Today, human interest in natural functional foods is increasing in order to avoid some of the side effects of many artificial foods and medicine. Both naturally functional and having useful nutrients, many functional food products attract the attention of the consumers, the functional food market is growing and the product range is expanding.

One of the main goals of the food industry is to carry out studies to meet the changing and developing conscious consumer demands around the world.

In this context, for example, food industry experts try to reduce the amount of sugar in foods in order to prevent chronic diseases such as diabetes, obesity, etc. in parallel with changing social trends.

Today, the dizzying advances in developing technology, communication and transportation cause people to adopt a more practical and faster lifestyle. For this reason, it has become necessary to produce practical products that are suitable for the ever-accelerating lifestyle. The fact that people are ready to use and adopt all kinds of improvements to save time also makes it easier to adopt these products.

In line with this information, we have developed a functional tea that can be safely consumed by the consumer group with diabetes and/or obesity disorders, since fruit and plant particles have a positive effect on health.

The stevian cold brew cup sachet formulation we developed has become a healthy beverage alternative to the products on the market.

Keywords: Tea, Cold Brew, Diabetic cold brewing tea

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History of Cheese

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Cheese was firstly produced due to coincidences and obligations. Cheese has several kinds and everyone finds favorite one. However, there are some questions which are not considered such as what its origin is, how long ago it was produced, how many kinds of it has and the amazing one is that why cheese is loved too much in Turkey. It is unlikely to know the first time of milk consumption or the actual time of cheese production, but some archeological findings helps to make some assumptions. These findings show that cheese was produced more than 7000 years ago [1]. Also, it is certain that human beings found ways to store milk before the invention of writings.

Both beneficial and harmful bacteria are present in the milk, lactic acid bacteria (LAB) are the most needed one since it can make desirable change. For example, LAB prevents growth of harmful bacteria and it makes milk more consuming due to its capability to decrease lactic acid amount. Without this knowledge, cheese production has been made successfully for thousands years. Lactose may not be broken by some people due to lack of lactase, which is the enzyme responsible for lactose breakage into its monomers. This situation causes some disorders since several microorganisms consume unbroken lactose and produce CO2. The consumption of cheese can have an effect on increasing importance of milk since cheese has less amount of lactose [2]. Thus, people can consume milk derived food without having critical disorders. Thanks to cheese, adaptation of milk consumption became easier. People found critical points of preserving cheese, so they has stored cheese safely before even invention of fridge. For example, fermentation, removal of water as much as possible, salting and storing at chilled places must be done for proper preserving of cheese.

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Preparation of Brine with Brine Mix and Its Effect on Shelf Life of Round Cheese

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Known as the most worldwide consumed milk derivatives, cheeses are defined both on their textures additionally to their cultural identities allowing them to be labelled as matured or unripened. The present study assessed the effect of brine mix and salt on physicochemical and sensorial features of round or stick-shaped full-fat fresh or melted cheeses. Cheeses falling into previously cited features were purchased from local market. Generally, these cheeses were preserved in brine for about 4 months. Qualities such as taste and texture of these cheeses were also investigated. At the end of the investigation, qualities planned to be developed were determined to be especially texture.In this context, various studies were carried out and the brine mixture was commercially developed by Maysa Gıda. In order to demonstrate the functionality of the product, the facility of a company that currently produces in this lane was used. During production, the brine prepared by Maysa Gıda and the standard brine prepared by the company were added to the cheeses samples before being stored in closed packages used subsequently at day 15, Day 45, Day 60, Day 90 and Day 120. Dry matter, fat, pH, and salt analyses were carried out in both cheeses at the specified intervals throughout the study. Similarly, changes in cheese-brine amount were also examined. Sensory qualities (appearance and colour, taste, smell and texture) were evaluated by an educated panel team. At the end of the study, there were significant differences between the standard product and the product prepared with Maysa Gıda in terms of changes in dry matter, pH, salt and cheese-brine amounts. However, no significant effect on the fat content of cheese samples were observed. The standard product produced by the company was found to be behind Maysa Gıda product in all the sensory evaluations conducted during shelf life.

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Evaluation of The Physical and Chemical Properties of The Developed Stabilizer&Emulsifier Mix for Soft Ice Cream

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There are emulsifier and stabilizer mixtures developed for different purposes in the ice cream process in the production of soft ice cream mix, to increase the quality of the final product by providing the emulsion and homogeneity of the recipe inputs. Stabilizer&Emulsifier mixtures used in soft ice cream recipes are expected to maintain their structure and effectiveness in the UHT process. The final product is required to stand upright in the cone, to melt slowly, controls ice crystal formation, to have a homogeneous structure and standard structure. Various Stabilizer&Emulsifier raw materials were examined within the scope of this study. Mixture prototypes showing the targeted soft ice cream properties were created. The mixture content in which the expected results were obtained in the final product was determined as polysorbate80, guar gum, carrageenan, locust bean gum and glycerin monostearate. When the soft ice cream made using mixture prototype were examined, the variability of the water became stable with the effect of guar gum and carrageenan, the viscosity gave results expected and facilitated the penetration of air. With the presence of polysorbate80 in the powder mix, it was ensured that the milk proteins completely covered the fat droplets in the ice cream mix and the melting was delayed by increasing the resistance of the air bound with glycerin monostearate. The quality of the final product has been increased by improving the whisking ability of the mix which is an important parameter in the freezing process with the presence of carrageenan. Mixture prototype also provided an important advantage in UHT processes reducing the filling temperature to the maximum extent due to its low viscosity, allowing 18-20°C filling. In line with the successful results obtained, a commercial stabilizer&emulsifier mixture was created under the brand name Texturole 206 SI SP.

Keywords: Soft Ice Cream, UHT process, air penetration, Stabilizer, Emulsifier

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Nutrient Composition of Triticale and Its Usage in Bakery Products

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Cereals are one of the oldest products in the human diet. It makes up the bulk of plant production and has been the main source of carbohydrates in the human diet for many years. Cereal grains cover 40% of all arable land and constitute more than 50% of the food energy and 50% of the protein consumed on Earth. Grains such as wheat, rice, barley, maize, rye, oats and triticale make up the bulk of crop production and are the most important food source for humans. Cereal grain contains many nutrients such as protein, carbohydrates, fat, phospholipids, vitamins and minerals. All grains are considered a good source of energy. In this study, information is given about the nutritional values of triticale, wheat, rye and oats and the use of triticale in bakery products. When the studies were examined, it was found that naked oats had the highest protein content. The highest values of the crude oil analysis performed in cereals were defined for naked oats and the lowest values for triticale. The content and composition of dietary fiber are among the factors that determine the quality of cereals and cereal products. The content of different fiber fractions also differed for wheat, triticale, rye and oats. Cereal grains are a source of many minerals. Consumption of whole-grain cereal products is closely associated with higher dietary quality and nutrient-dense foods. Given its higher lysine content, better protein digestibility, better mineral balance and improvements in cooking potential, triticale is also considered to have enough properties to become an important grain for humans in the future. So far, studies have been carried out in bakery products such as cakes, crackers and biscuits, and the positive effects of triticale have been examined in the final product.

Keywords: Cereals, Triticale, Nutritional value, Bakery products

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Artificial Mouth Study on Mint Oil Volatile Release in Chewing Gum

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The aim of this study is to investigate the release of mint oil components in vitro experiment, which applied in sugar free chewing gum (CG).
Artificial Mouth (AM) was developed by IFF Inc. to be used as a screening tool for ingredients and formulation effects in CG. 1,5 % of mint oil was dosed in sugar free CG matrix, samples aged for 2 weeks. Pure water was introduced in device to mimic the saliva at 15mL/min flow rate, aqueous fraction was collected every minute of 20 minutes mastication. Concentrated flavor extracts were analyzed with GC/FID and GC/MS. GC/MS analysis were run for the flavors and aqueous solutions (AS) (5ml) for every samples of defined minutes collected from AM.
We measured 58% volatile loss during the process of mint oil application in CG. 21,69% of active release was calculated in AS and considered as flavor release in sitimulated saliva. Total release (mg) for each compound over 20 minutes of mastication was analysed. The release of menthol and mentone increased constantly till minute 5, had peak at minute 8. They were still present in AS collected at minute 20. Menthyl acetate releasing dynamic was slower and lower during 20 minutes. 24,8% and 11,9% of total release was calculated in AS for menthol and mentone respectively, whereas menthyl acetate was 1,5%.
The release of volatiles were affected by their physical and chemical properties including the volatility (vapor pressure) and hydrophobicity. Hydrophilic compounds with lower LogP values tend to release faster in water. LogP values of menthol, menthone and menthyl acetate are 3,4; 2,9 and 4,9 respectively. This study shows that varying structure of volatile compounds and log P values are correlated with the release of menthol, menthone and menthyl acetate which are main volatile compounds of mint oil effective in profile.

Keywords: flavor release, artificial mouth, chewing gum, mint oil, flavor

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Method for The Analysis of Amino Acids in Milk by Lc -Ms/Ms

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Milk has high nutritional benefits and is therefore one of the most important food in the human diet. Since the primary function of milk is the healthy growth of the newborn, it contains all the essential bioactive components. Determination of the amino acid profile in milk is important for the qualitative evaluation of peptides and proteins that may affect the chemical and nutritional properties of milk. The purpose of the present study was to apply a method for the assay of amino acids in milk by LC-MS/MS after hydrolysis. The advantage of LC–MS technique over other known methods is that amino acids can be analyzed without derivatization steps.

A simple, fast and low-cost method for measurement of amino acids without derivatization in milk by LC-MS/MS was applied. Both acidic and alkaline hydrolysis were performed to analyze 18 amino acids (Aspartic acid, Glutamic acid, Alanine, Arginine, Glycine, Leucine, Histidine, Tyrosine, Isoleucine, Lysine, Methionine, Cystine, Phenylalanine, Proline, Serine, Threonine, Tryptophan, Valine). After acid hydrolysis the sample supernatant filtered and dried at 40 °C in Nitrogen Turbo Evaporator. The residue was reconstituted with 1 mL of 80:20 Water: MeOH containing 0.1% formic acid and injected into the LC-MS/MS.

The analytical separation was performed on a InertSustain AQ-C18 analytical column (4.0 × 150 mm, 3 µm) for 12 min with a flow rate of 0.5 mL/min. The calculated coefficients of determination (R2) were above 0.995 for all amino acids over the range of linearity. The precision of the method (repeatability and within-laboratory reproducibility) was evaluated using relative standard deviation(RSD) of replicated measurements (n = 6) of milk samples and acceptable results were obtain with RSD values less than 20%.

Keywords: amino acid, milk, LC-MS/MS

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The Effect of Cold Stress on RNA Quality Extracted from Wheat Leaf in Tillering Stage

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Wheat is one of the major components of nutrients for the human diet. Recent studies on the health advantages of bioactive compounds from wheat, have become crucial. In addition, studies involving the characterization of bioactive compounds in wheat and transcriptomic analysis of the expression level of enzyme genes responsible for bioactive compounds are gaining popularity. RT-PCR is one of the methods used in gene expression analysis. The application of this method begins with RNA isolation and RNA quality-quantity are important factors for ensuring the accuracy of gene expression analysis.
Here, we aimed to present the effect of cold stress on RNA Quality Extracted from Wheat Leaf at tillering stage which is one of the early growth stages of wheat. To achieve this purpose, phenol-chloroform based RNA-Extraction method was used to compare the quantity-quality of RNA extracted from wheat samples.
In the study, selected 11 Turkish wheat varieties such as Triticum monococcum (4),Triticum dicoccum(3), Triticum spelta(1),Triticum durum(3) were germinated as two groups after sterilization. All of the local wheat varieties selected in the group called "cold stress group" were germinated at 6°C, but the ambient temperature was reduced to 0°C 5 days before they reached the tillering stage. In the group called “control group”, the growing environment temperature of the wheat samples was kept constant at 6°C. From all wheat samples RNA extraction was performed at tillering stage. NanoDrop was used to determine RNA quantity-quality.
When the cold stress was removed, a 2-to12-fold increase in the amount of nucleotides obtained as a result of RNA isolation was observed. The results show the importance of ambient temperatures for the amount of RNAs isolated from wheat leaves. This, preliminary study provides the basis for the data obtained from gene-expression studies in wheat to be meaningful.

Keywords: Wheat, RNA isolation, RNA quality, RNA quantification, Wheat leaf

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Phenol-Based Method for Isolation of High-Quality RNA from MON810 and MIR604 Maize Events

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Obtaining high-quality RNA is the most critical step to understand the genome functionality of eukaryotic tissues. For plant materials such as maize rich in polysaccharides, it is crucial to produce biologically relevant results when performing many molecular techniques. Although there're several protocols to extract total RNA including TRIzol Reagent, CTAB-LiCl, RNeasy-Plant Mini-Kit, there's a need to use different methods that can inhibit the presence of the RNase enzyme and protect the integrity of the RNA.

This study aims to test a robust and reliable isolation method to obtain high-quality RNA from different genetically modified (GM) maize crops. To achieve this purpose, European approved RNA-Extracol method was used to compare the quantity and quality of RNA extracted from MON810 and MIR604 maize varieties that approved for animal feed usage in Turkey. In this study, 5% MON810, 75% MIR604 and non-GM maize varieties were used as certified reference materials. RNA Extracol method was applied to each material. All the experiments were carried out with two replicates. Concentrations and purity values were measured by Nanodrop spectrophotometer and detected average A260/A280 close to 1.7 and 1.8 for MON810 and MIR604, respectively. After RNA-isolation step, cDNA synthesis was performed for obtained RNA's. At this stage, no significant difference was observed in the purity values, but it was observed that the average nucleic acid concentrations ~5-fold changes for 5% MON810 and 3-fold for non-GM; 10-fold changes for 75% MIR604, and 8-fold for non-GM. Lastly, qPCR analyses were performed for the alcohol dehydrogenase (ADH1) to all obtained cDNA samples in order to assess the RNA quality.

The results were appropriate for downstream applications demonstrating the effectiveness of the RNA-Extracol protocol on GM maize events. Besides, this preliminary study can form a basis for further studies in terms of food biosafety and biotechnology fields.

Keywords: RNA Isolation, Genetically Modified Crops, Maize, MON810, MIR604

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Development of qPCR Method to Detect Probiotic Bacteria in Fruit Juice Samples

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Probiotic bacteria have critical importance on obtaining a healthy gut and thus are related to many aspects of human well-being. Therefore, the presence of a wide variety of probiotic foods is crucial. Probiotic fruit juices hold an important place that can be a new face of the probiotic food industry in Turkey. For probiotic foods, the number of living probiotic microorganisms should be preserved to be at least $1.0x10^6$ cfu/g. Cultural methods can be used to count the bacteria in probiotic fruit juice samples. But the downside of this method is having the results at least in 24 hours. In the mass production of these foods, having results in a shorter time is important. Therefore, an alternative that gives faster results, can be qPCR that is a molecular method to count bacteria.
In this study, *Lactobacillus rhamnosus* GG (LGG) and *Escherichia coli* Nissle (EcN) probiotic strains were used. First, DNA isolations from fresh cultures were held by using a commercial DNA isolation kit with some modifications. For the qPCR step, specific primer and probe sequences for each bacterium were designed from 16S rRNA sequences. Real-time qPCR analyses were run with the DNA isolates of the bacteria to draw a standard curve. With the help of Cq values, standard curves were obtained for each bacterium. After that, LGG and EcN were added into commercial orange juice and apple-peach juice samples. DNA is isolated from probiotic fruit juice samples and the same real-time PCR program is used on these samples. As a result, the Cq values showed 0-3 log CFU/ml difference from the living bacteria counts from the cultural method.
The results show the possibility of the use of a different counting method of bacteria which is qPCR for the industrial process of the foods.

Keywords: Probiotic bacteria, Lactobacillus rhamnosus GG, Escherichia coli Nissle, Real-Time qPCR, Probiotic fruit juice

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Models in Predictive Microbiology and Food Safety

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The number and type of microorganisms in the food flora is critical to the quality of the food. There are many factors (water activity, pH, temperature, relative humidity, gases, and their concentrations etc.) that affect the growth of microorganisms in foods. Mathematical models are used to predict the impact of these factors on microbial growth in food and the variation in behaviour of microbial populations over time. Mathematical models allow predicting microbial behaviour under different conditions and evaluating changes in microbial numbers in foods from harvest to final product. They are used to quantitatively predict the characteristics of microbial populations such as growth, survival, and toxin production.
This discipline, called predictive microbiology, was developed in the 1980s and, in summary, is the study of microbial behaviour with mathematical and statistical models in relation to certain conditions that affect food quality and food safety. It can be used in Hazard Analysis and Critical Control Point (HACCP) programs, hurdle technology and for microbial risk assessment purposes. It can also be applied to determine food shelf life or optimize food formulations. Predictive microbiology deals almost exclusively with the growth of bacteria and fungi in food. Viruses and protozoa do not reproduce in food, but it is possible to inactivate them. Therefore, the survival and inactivation of viruses and protozoans in food has also begun to be modelled.
Predictive models are very useful and valuable methods in both industrial and scientific research. The application of predictive models has become easy to implement largely after the development of information technology. This article summarizes types of mathematical models, suggested uses, future predictions and expected results for predictive microbiology in food safety.

Keywords: Predictive microbiology, mathematical models, food safety

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Effect of Organic Acid Mixtures on Food Pathogens in Foods with Different Chemical Properties

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Today, although the process technologies are developed, the preservation of foods and extending the shelf life are not only a problem in underdeveloped countries, but also in developed countries. Studies on the use of food preservatives have gained momentum with the fact that food spoilage causes great financial losses and food safety has gained international importance today. This situation encourages the use of food preservatives in the industry. Organic acids, as food additives, play a critical role in stopping or inhibiting microbial growth. Preservative organic acid mixture prototypes have been created for commercialization. Preservative prototype applications were made by selecting two different food groups (Dairy and Meat products) and bacteria (*B. cereus*, *E. coli*, *L. monocytogenes*, Salmonella Enteritidis, *S. aureus*) that are the most subject to food poisoning. The target is determined as inhibiting the maximum number of selected food pathogens at the rate of use that will not change the flavor of the food to which it is added. As a result of the data obtained, the closest prototype to the target was determined as the mixture made with sodium diacetate and potassium lactate. While it was determined that the use of preservatives between 0.05% and 0.1% in foods with high water activity was quite effective, it was observed that the use of preservatives between 0.1% and 0.8% was more effective in foods with low water activity. It was observed that the mixture of sodium diacetate and potassium lactate prevented the growth of bacteria in an environment with a low microorganism load (approx.10^2-10^3) and reduced the number below <10 CFU ml/g. It was determined that there was no development in the target bacteria during the shelf life of the food. In line with these results, it can be clearly said that the mixture is effective in target microorganisms.

Keywords: food spoilage, organic acids, Food preservatives, food pathogens, dairy and meat products

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Evaluation of dough and bread performances of fungal xylanase enzymes

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INTRODUCTION-OBJECTIVE: Xylanase enzymes make bread with better properties by breaking down arabinoxylans in wheat flour. In this study, fungal xylanase enzyme produced within the scope of TÜBİTAK (UN-EN, 115O052) project in Ege University Bioengineering Department and commercial fungal xylanase were compared in terms of their effects on dough and bread properties.
MATERIALS-METHODS: Xylanase was not added to the control bread, commercial and project xylanases were dosed at 20 ppm (on flour basis) each, then the dosage of the project xylanase decreased to 12 ppm. Farinograph and extensograph analyzes were used to determine the effect of xylanases on dough qualities. TexVol device was used for the effect on bread volume, and Texture Analyzer device for crumb texture. Analyzes were performed in 3 parallel.
RESULTS: The stability (min.) values of the doughs of control, commercial xylanase, and project xylanase were 9.52±1.01, 6.86±0.06, and 4.51±1.28, respectively. The resistance to extension (BU) values of the doughs at the end of the extensograph analysis of the same experimental group were 1189±64, 1062±52, and 952±108, respectively. Bread volume (cm3) and crumb hardness (N) values were 1549±97, 1603±96, 1653±135 and 1.42±0.049, 1.31±0.049, 1.12±0.056, respectively. When 12 ppm of project xylanase is used; dough stability (min.), dough resistance to extension (BU), bread volume (cm3), and crumb hardness (N) values were found to be 8.60±1.07, 943±69, 1592±112, and 1.23±0.053, respectively.
CONCLUSION: Results of the experiments showed that project xylanase increased bread volume at 20 ppm using, but decreased dough stability and strength. The same enzyme increased the bread volume as much as 20 ppm commercial enzyme in the use of 12 ppm, and an improvement was observed in the stability and resistance values. The fact that project xylanase reduces dough stability and strength at the same dosage as commercial xylanase (20 ppm), suggests that it may have side activity.

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Environmental monitoring for beverage manufacturing

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Food processing areas are suitable environments for the growth and spread of microorganisms. There are some risks at every point, from raw materials to personnel, from the production line to the ambient air.
In order to ensure food safety and prevent food-borne diseases, it is necessary to perform hygiene and sanitation practices correctly, to review them periodically, to make trend analyzes and to take action to prevent possible risks at the right time. This is only possible with an effective environmental monitoring program.
Benefits of environmental monitoring;

- It is important to protect consumer and public health.
- It provides the determination of the factors affecting the product quality microbiologically.
- It shows the effectiveness of the process steps and hygiene and sanitation practices aimed at protecting the product microbiologically, it determines its frequency and ensures its continuity.
- It ensures elimination of possible risks and is an important preventive action.
- Protects brand value with company and product reliability.
- It prevents economic losses by preventing possible customer complaints and recalls with timely measures.

Beverage production is done in a closed system and the product has no contact with the outside environment. The risk of contamination from raw materials, environment and personnel is low compared to other types of food (meat processing, milk, fruit processing, etc.). However, it is important to apply an environmental monitoring plan together with the heat treatment process in ensuring food safety, verifying sanitation activities, monitoring personnel and environment-based contaminations, and producing beverages without preservatives, due to the healthy consumption trend and developing technology.
This review includes information on establishing and carrying out an effective environmental monitoring system in beverage production.

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Vejetable Juice Production by Lactoferment Method

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Codex Alimentarius defines vegetable juice as "Vegetable juice is the liquid unfermented but fermentable product or lactic acid fermented product intended for direct consumption obtained from the edible part of one or more sound vegetables and preserved exclusively by physical means". Fermentation is a very old method among preservation methods of vegetable juice, and it allows the products to be stored for a long time without the need for the addition of any chemical preservatives. Increasing consumer concern about the use of chemical preservatives in foods has prompted researches on healthy, delicious and natural beverages produced by fermentation. Within the scope of these studies, lactoferment method is used.
The lactoferment method is literally lactic acid fermentation, and lactic acid fermentation is a biochemical event in which carbohydrates are converted into lactic acid by some bacteria. In the lactoferment method, which means providing quick and controlled fermentation by using starter culture in the production of vegetable mashes or vegetable juices, the process is the conversion of sugar-containing compounds, which are originally in the raw material or added from outside, into lactic acid or other compounds by the inoculated bacteria.
Production of vegetable juice by lactoferment is a research area which has been studied for years. For this purpose, different studies have been carried out on the production of lactoferment vegetable juice using red carrot, turnip, cabbage and many more local vegetables. Although as it knows, vegetable juices are a very good environment for growing of lactic acid bacteria, many factors, such as fat content, protein and sugar concentration of the medium as internal, pH temperature, exc. as external factors could affect survival of microorganisms. Therefore, new research topics are tend towards manipulation of product formulation and selection of microorganisms that can show maximum performance under the conditions of the product.

Keywords: vegetable juice, lactoferment method

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130 - Food Microbiology and Biotechnology - Poster Presentation

Evaluation of Multiplex Selective Enrichment Broth for Simultaneous Detection of Salmonella spp.,E.coli O157:H7 and Listeria monocytogenes

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Foodborne diseases continue to be an important public health problem. *Salmonella spp*., L. monocytogenes and E. coli O157:H7 are considered to be the most important foodborne pathogens. Although many rapid and high-throughput molecular methods have been developed in recent years for the detection of foodborne pathogens, the recovery and enrichment of non-fatally injured, stressed and low numbers of cells is still a problem to be considered. It is important to identify the presence of injured microorganisms to ensure that safe foods are produced. FDA/BAM and ISO recommend LAC, Fraser broth, TSB or BPW as pre-enrichment. In these methods, different enrichment media are used for each bacterial group and 2-stage enrichment is carried out. Simultaneous recovery of cells and co-enrichment broth for three bacterial species were evaluated in our studies. With reference to the "ISO 16140-3:2021" method validation guide, the food groups with high competitive flora were contaminated at 18, 6 and 3 cfu and incubated for 24 hours. It was carried out by the classical culture method according to the reference validation guide and studied in artificially contaminated cheese, sausage and fruit juice products. All three pathogens were seeded on selective agars without discrimination in the enrichment broth and could be detected individually. The detection limit was determined at the level of 1-3 cfu at 25g/225ml. Comparatively, the same detection was also performed with the VIDAS procedure. The detection rates for the three developed pre-enrichment pathogens were higher than with conventional pre-enrichment methods compared to other media. It has been observed that selective enrichment for L. monocytogenes in food samples with high lactic flora increases the success in classical cultivation. In this study, traditional culture protocols were compared with multiplex selective media, and a significant workload time advantage for users was presented by confirming suitability.

Keywords: Multiplex Detection, Foodborne Pathogen, Food Matrices

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9 - Food Packaging Materials and Technologies - Poster Presentation

Effects of Map Application on Pickle Quality

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The aim of this study is to prevent fungal growth and to improve the quality and sensory properties of pickled Jalapeno peppers by application of modified atmosphere packaging (MAP). For this purpose, the effects of 2 different MAP atmospheres (100% N_2 or 30% CO_2-70% N_2) on chemical parameters (salt, acidity, pH), total yeast and mold counts, and sensory properties (color, texture, smell and taste) of pickles were compared with those of controls packed at atmospheric or vacuum conditions.

The O_2 concentrations within the packages were also analyzed to monitor suitability of storage conditions for fungal growth. The results of storage tests clearly showed that MAP at 30% CO_2-70% N_2 gave the highest smell and taste scores while the same scores of the other samples in descending order were followed by MAP at 100 % N_2, vacuum packaging, and atmospheric packages. Although no yeast and mold growth was detected in samples during 12 months of storage at ambient temperature, after 5 months in control samples, undesirable properties began to be seen in terms of sensory characteristics, while in both of MAP-applied packages, sensory criteria were observed to maintain the desired levels for up to 8 months. According to these results shelf life can be given as 8 months with MAP technology for Jalapeno pickles stored in flexible packages. However, an increase observed in the O_2 concentration of packages after 6 months suggested that the barrier properties of packaging should be better than that of PA/EVOH/PE film (5kg package with a film thickness of 90 microns).The OTR and WVTR values of the package used are respectively: ≤ 0,5 cm3/m2.day.atm and ≤ 2,6 g/m2.day. The 8-month period can also be extended with the use of higher barrier package.
This work clearly showed the possibility of improving sensory properties of pickled peppers by combination of MAP with barrier packaging.

Keywords: Pickle, Jalapeno, Modified Atmosphere Packaging, Nitrogen, Carbon Dioxide

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60 - Food Packaging Materials and Technologies - Poster Presentation

Development of Eco-Friendly Packaging Materials for Use in Packaging Market

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The environmentally friendly packaging project was initiated with the aim of reducing packaging waste in nature by developing packaging solutions that can be compostable or recycled, because of petroleum-derived packaging materials non-biodegradable in nature.
The current structures were redesigned as suitable for recycling and composting. In addition to, it is designed to be able to work on current machine line and protect the product placed inside packaging.
In the recyclable packaging consept BOPE-Film/PE-Film and MDO PE-Film/PE-Film structures are designed. These are alternative for BOPP-Film/PE-Film or PET-Film/PE-Film structures. It is expected that BOPE and BOPP have similar features because both films are bi-oriented. And it is aim to provision expected similar performance. Since, PET film is not suitable for recycling with PE Films, BOPE is used instead of it.
In the compostable packaging concept, Kraft Paper/PLA structure including all compostable raw material is designed. The material spec specifically limited the use of chemicals as extrusion coating to 5% of the packaging weight in accordance with EN 13432 norm.
It has been observed that the machine performance and shelf life tests for sachet types packaging.
Although it is known that the raw materials used for both spesification are recyclable and compostable, the certification process has been initiated for the produced packages.
At the end of the project, alternative compostable or recyclable packaging materials were produced as an alternative to existing petroleum derivative products. In this way, it is aimed to reduce plastic waste rates. The developed materials are suggested for the product groups that do not require high barrier properties (gas, moisture, oxygen and etc), and the future studies are planned to develop the compostable/recyclable materials with high barrier properties.

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A Novel Biodegradable Food Packaging Film from Pea Hull and Gelatin

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For a sustainable food industry, there are two significant strategies. One of them is to reduce plastic consumption and the second one is to valorize food byproducts/waste. Sweet pea is one of the most-grown grains in the world; thus, it causes huge waste generation due to its main byproduct hull [1]. In this research, we focused on both of these strategies, and successfully produced low-cost sustainable food packaging material by valorizing sweet pea hull (PH). The main goal of this research is production of an eco-friendly food packaging material from green pea waste. Composite packaging films having gelatin matrix filled with sweet pea hull powder (PH) were produced by cast film method. PH packaging films were processed at 0, 20, 30, 40, 50 w % PH compositions by using glycerin as a plasticizer. Dried mint was added into the polymer blend as an antimicrobial agent. The films were used to package white cheese, ground meat, strawberry, and banana; then, the changes in the sensory properties of these food samples were observed during 11 days. On the other hand, soil biodegradation of the packaging films was followed for 15 days.

PH agglomerates were successfully dispersed in the gelatin matrix. During the food packaging studies, films containing pea hull powder showed similar effect on the foods with those of gelatin packaging (control) without PH. It was observed that the food spoilage rate reduced when the foods were packaged with the PH film with dried mint. Moreover, at the end of 15 days of biodegradation studies, the films were firmly attached to the soil, hardened and shrunk. In conclusion, the PH packaging films produced by cast film are candidates in the food packaging industry as low-cost, biodegradable and environmentally friendly materials.

Keywords: Biodegradable Packaging, Sustainability, Edible Packaging, Pea Hull, Shelf Life

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103 - Food Engineering Education - Poster Presentation

Determination of Processing Parameters of Pulses and Cereals for Gun Puffing Processing

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Cereal and cereal products especially contain carbohydrates, vitamins, minerals and other nutrients. An important part of this group of nutrients is carbohydrates. Therefore, cereals are the main source of energy of the body. 55-65% of the daily energy needs in the world are provided from cereal products. In addition, legumes are a food group believed to be one of the first crops grown in agriculture and have become a staple food for many cultures all over the world. Although these foods are considered as an alternative protein source worldwide, they are the most produced food group in agriculture after grains. Legumes are a good source of plant protein. It also contains valuable micronutrients, high concentrations of certain carbohydrates, antioxidants and dietary fibers. In addition, the amount of fat and calories are low. The principle of the puffing system is based on time, temperature and pressure parameters. It mainly utilizes the principle of phase-change and the thermal pressure effect of gas. The water in the raw materials is heated and instantaneously vaporized with the sudden decompression, that results in a dramatic volume increase of raw materials and the phenomenon of "blowing-up", meanwhile a porous structure of the materials is formed. Explosion puffing by sudden release and expansion of water vapour is a relatively well known and widely used process. In this study, the processing parameters were determined for cereals and legumes during the gun puffing processing. Optimum operating parametre were determined. It was observed that cereals and pulses began to swell as the parameters of pressure and water vapor increased.

95 - Food Safety, Security and Sovereignty - Poster Presentation

A Multiclass Method for The Analysis of Antibiotic Residues in Milk by Lc -Ms/Ms

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Consumption of foods containing antibitiotic residues poses many risks to public health, particularly development of antibiotic resistance, hypersensitivity reaction, carcinogenicity, mutagenicity, teratogenicity, and disruption of intestinal normal flora. Because of these risks monitoring animal origin foods in terms of antibiotic residues is very important for public health. Although sensitive and reliable analytical methods for the determination of veterinary drugs in food of animal origin are strongly required to ensure food safety, multiclass methods for veterinary drugs are still limited. Today LC-MS/MS (liquid chromatography–tandem mass spectrometry), which has high selectivity and sensitivity, is the most common technique used in the detection and quantification of veterinary drug residues and the current trend in drug residue analysis is the development of multi residue methods that can monitor a wide variety of compounds belonging to different classes. In this study, it was aimed to develop and validate a multi residue method that can detect veterinary drugs in milk.
A multi-class method was developed and validated for the determination of 49 antibiotic residues from nine classes (macrolides, sulfonamids, amphenicols, nitroimidazoles, quinolones, lincosamides, tetracyclines, anthelmentics, penicillins) in milk by LC-MS/MS. The validation of the method was performed following the requirements outlined in the European Commission Decision 2002/657/EC, which is required procedure for the methods used in analysis of official audits samples in Europe and Turkey. The LOQ values ranging from 0.14 ppb to 47.76 ppb were all below the MRLs set by the European Commission (EC).
Matrix effect and uncertainties related with sample preparation and instrumental analysis were minimised by using matrix-matched calibration. Acceptable validation results were obtained for the method which meets the expected characteristics of multi residue methods with simple, inexpensive and fast sample preparation.

Keywords: antibiotic, residue, LC-MS/MS, validation, multi-class

54 - Food and Sustainability - Poster Presentation

A Critical Role of Life Cycle Assessment in Food Production Process

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Sustainability, which is used in economic fields such as production, consumption, trade and growth, and in cultural, political, social and environmental fields, in brief, means the transfer of present resources to future generations without loss. Today, with the destruction of natural resources, main problems such as external dependence in agricultural products with conventional agriculture, immigration from rural areas to cities, the disappearance of rural society characteristics, and the increase in rural and urban population imbalance have come to the fore. Sustainable agriculture understanding has emerged, which conservation of natural resources for future generations and uses environmentally friendly agricultural production techniques. The application of sustainability principles to food chains in terms of management inputs and resources more effectively is important for small farmers and food premises to be more productive and innovative. Sustainable food production involves food safety, more efficient and renewable energy and zero waste approach. Life Cycle Assessment (LCA) is one of the key tools for the evaluation of the environmental sustainability of the agricultural sector, food processing and food waste management. In recent years, it has been observed that there has been a significant increase in the number of studies investigating the environmental effects of both agricultural and industrial production processes of food. The carbon footprint is the expression of the total greenhouse gas emissions in terms of CO2 caused by the products throughout their life cycle. In this review, the development of LCA in relation to sustainable agriculture and food implementation in the world and their reflections in Turkey are involved.

Keywords: sustainability, life cycle assessment, carbon footprint

92 - Food and Sustainability - Poster Presentation

Applications of Plant-Based Cheese Alternatives

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Cheese is a widely consumed dairy product all over the world and a great source of calcium, fat and protein. Recently, consumers have tended to reduce animal-based food consumption due to environmental effects, health and ethical reasons. Establishing livestock farms and producing animal feed causes the destruction of forests, biodiversity reduction, and climate change. Therefore, greenhouse gas emissions and carbon footprints are being continued to increase drastically. Antibiotic and hormone issues also raise concerns about dairy products. Alternative dairy products are preferred by individuals with milk allergy, lactose intolerance, phenylketonuria, MSUD, and consumers who do not prefer animal products and seek new tastes [1,2]. While the consumption of cow's milk in the USA declined by 15% between 2012 and 2017, the consumption of milk alternative products grew by 61% and valued at USD 2.11 billion in 2017 [3]. The global plant-based cheese market was reached 1.01 billion US dollars in 2019. With this potential, the plant-based cheese market is expected to grow at a compound annual growth rate (CAGR) of 12.8% from 2020 to 2027 [4]. Due to the GMO perception in soy products, consumers are moving away from products containing soy and turn to prefer other protein sources [5]. This study includes cheese alternative types in the market, protein types in the recipes, structure problems arising from the difficulties encountered and solution methods to prevent these problems. Moreover, the protein contents and protein types of cheese alternatives in the market were examined in this study.

Keywords: plant-based, sustainability, cheese, dairy alternatives, protein

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Bisphenol A Migration in Polycarbonate Water Bottles

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Nowadays, the water taken into the body for consumption is significantly by packaged water. Factors such as pollution of city mains water and demand for access to safe water lead people to packaged water.
As in the whole world, 19 L carboys are widely used in the packaging/distribution of drinking water in Turkey. BPA-based polycarbonate and preferred to transparent, low weight, resistant to heat and impacts. Like many environmental pollutants, BPA has an endocrine disruptor effect by mimicking body hormones and by imitating the hormone system, it impairs body development, fertility and cell metabolism.
The long-term storage of packaged water, the use of water carboys many times, the conditions during storage cause many questions. Because, many studies were about negative effects of using containers containing organic compounds in water packaging on human health.
With the emergence of the negative effects of BPA on human health, the maximum amount of BPA to protect public health was determined 50 µg/kg in 2006 by EFSA. The value revised as 5 µg/kg in 2014, rearranged as 4 µg/kg/day body weight(TDI)in 2015.
According to these values calculated in terms of the maximum BPA levels that can be taken into the body daily, it has been stated in the studies that the BPA levels taken from polycarbonate carboys with water don't pose risk for human health.
However, "Directive on Water Quality for Human Consumption" No.2020/2184 adopted on 16 December 2020, a direct limit value has been determined for BPA in waters. By 2026, the maximum BPA value is going to be 2.5 µg/L.
Considering these new limit values, new studies should be carried out, safer materials should be researched instead of polycarbonate materials and the water flowing from the tap should be made reliable and consumers should be encouraged to use tap water.

Keywords: Bisphenol A, packaged water

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Probiotic Foods and Obesity

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The effects of nutrition on health are among the most researched topics nowadays. Adequate and balanced diet is necessary for our health. While consuming foods, beneficial bacteria should also be included. It is known that beneficial microorganisms in these foods have positive effects on health when adequate amounts of probiotic foods are taken in the daily diet. There are probiotic bacteria in naturally fermented foods such as yogurt, kumiss, kefir, pickles and tarhana. It is predicted that the consumption of probiotic food will benefit the problem of obesity because it balances the intestinal flora and helps weight loss. Obesity is seen as a health problem with sociological, physiological and economic effects that concern the society. Many food companies around the world have noticed this and are exploring ways to add probiotics to more foods and drinks.
The most commonly used microorganisms in probiotic foods are Lactobacilli and Bifidobacteria. These produce propionic acid, acetic acid and lactic acid and reduce the pH in the intestine, preventing the growth of harmful bacteria and maintaining the balance in the intestinal flora. The differences in the intestinal flora of obese and normal weight individuals were investigated and the effect of probiotics on weight management was examined. As a result of the researches, it is thought that the intestinal flora (microbiota) will take place in the treatment of obesity in the future, as in many diseases. In this study, it was investigated how probiotic-containing foods have an effect on the intestinal microflora and how they can be beneficial in preventing obesity directly or indirectly.

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Synbiotic Ice Cream Production with Probiotic and Prebiotic

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Along with the increasing pace of life, the benefits that consumers want to get from the foods they consume are also increasing. In this direction, the importance of functional foods comes to the fore day by day. This increasing need has caused the functional food deficiency on the shelves to be noticed. It is known that R&D studies have gained importance as a result of the market search for this field in the FMCG (Fast-Moving Consumer Goods) sector, which is growing rapidly throughout the world and in our country. The changes in dietary habits brought about by the Covid-19 pandemic have also contributed to the orientation towards functional foods.
In this study, it was aimed to produce synbiotic ice cream with improved functional properties by adding prebiotics and probiotics. In the production of ice cream, *Lactobacillus rhamnosus* GG strain was used as a probiotic and inulin was used as a prebiotic. In the study, 3 groups of ice creams (control, containing *Lactobacillus rhamnosus* GG strain and containing both *Lactobacillus rhamnosus* GG strain and inulin) were produced and the microorganism growth, chemical properties (pH, brix, overrun) and sensory properties were analyzed.
As a result of the study, it has been proven that the sensory and rheological properties of ice cream are improved with prebiotic inulin, and additionally, it supports the development of probiotic microorganisms in ice cream production. An ice cream product containing a higher number of probiotic microorganisms was obtained with the sample of ice cream containing prebiotics and probiotics together. In future studies, it was aimed to produce synbiotic ice cream by improving the physical and sensory properties of ice cream with Antifreeze proteins (AFP) and High Intensity Ultrasound Technology (HUI).

Keywords: Functional Food, Synbiotic Ice Cream, *Lactobacillus rhamnosus* GG, Probiotic, Prebiotic

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Microbial and Sensory Properties of Rice Kefir

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Consumers are recently tend to reduce consuming animal-based products, due to health, environmental, and ethical reasons. Therefore, the food industry produces plant-based milks such as almond milk, coconut milk, rice milk in recent years. Kefir is a well-known fermented dairy product that contain probiotics, prebiotics and other bioactive substances. Water kefir is also an important probiotic source for vegans/allergic consumers. In this study, microbiological and sensorial properties of rice kefir were investigated. Water kefir grains may have effect on the microbiological content of plant-based milks as well as their sensorial properties. Moreover, fermentation is a crucial process to increase functionality of foodstuffs as well as increasing in their shelf-life. Lactobacillus spp., Lactococcus spp., and yeast contents, and sensory properties of rice milk kefir were determined. At the beginning, the pH score of rice milk was 6,89, and this value was changed as 4,57 at the end of the fermentation. Lactobacillus spp., Lactococcus spp., and yeast contents of rice kefir were 7 Log cfu/mL 8 Log cfu/mL and 7 Log cfu/mL, respectively. Rice kefir samples had high sensory scores.
Based on the research results; water kefir grain microbiota were able to grow in rice milk. Fermentation of rice milk with water kefir grains obtained aroma compounds that provided high sensory score. Use of water kefir grains are important for production of fermented plant-based milks.

Keywords: Functional foods, Water kefir, Plant based milk, Fermentation

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Vegan Chocolate

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For milky and caramel flavor, milk powder is added in chocolate. Milk fat addition reduces the hardness of chocolate because it dilutes the cocoa butter, and so increases the amount of the liquid phase. Lactose is also added to chocolate with addition of milk, and it also form suitable structure. Lactose intolerance is a common digestive problem where the body is unable to digest lactose, a type of sugar mainly found in milk and dairy products. One of the purpose of vegan chocholate production is to solve lactose intolerance problem for chocholate consumer having this disease. Chocolate contains animal fat which come from milk. Second purpose is replacing animal fat with plant based fat sources, to develop chocolate for vegans. Vegan chocolate does not contain animal raw material such as honey, animal gelatin and milk powder derivatives. Vegan chocolate is a rich food compared to other types of chocolate because of from less fat and calories. Nowadays, vegan nutrition is increasing day by day. Vegan nutrition has gained importance in terms of health and preference. Vegan nutrition is a diet that are not consumed products of animal origin. Development of vegan chocolate is an alternative new product for lactose intolerant and vegan consumers.

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Using of Plant Based Proteins for High Protein Beverages

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As a result of Increasing world population, many researches are being carried out to find new and sustainable protein sources. Although animal proteins are very rich in essential amino acids, there are some limitations in their consumption due to environmental and ethical concerns by the consumers.. Plant-based proteins have functional properties that have positive effect on health such as lowering cholesterol level, blood pressure and balancing blood sugar. Additionally, using plant-based proteins in ready-to-drink (RTD) high protein drinks provide alternative choice for vegans, vegetarians and people who suffer from lactose intolerance. Increasing demand for high protein beverages also increase the consumer interest to plant-based proteins. Pea, soya, chickpea aquafaba, lentil, favabean, oat and rice proteins are the most common use of plant-based protein sources in food industry. These protein sources have been used to enrich and increase functional properties of sauces, bakery and dairy products, juices and RTD high protein drinks. According to the Food and Drug Administration (FDA) RTD high protein drinks should contain a minimum of 10 g protein per 240 mL of the drink. The high amount of protein in beverages brings some problems such as sedimentation, decomposition, denaturation and high level of pH. In this study alternative solutions to these problems such as thickeners and pH agents are being mentioned.

Keywords: high protein beverage, plant based protein, protein, functional beverage

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The Effects of Milk Source on The Chemical and Physical Properties of Fermented Probiotic Ice Cream

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The aim of this study is to seize the opportunity of lactose-glucose conversion for sugar reduction, produce gradually lactose hydrolyzed ice cream with standard and sugar reduced recipes to observe the physical and chemical effects of hydrolysis and sugar reduction on the product. The controlled lactose conversion is set for 25,50,75 and 100% of hydrolysis. Nine ice cream with 37% total solids, 12.5% MSNF, 3.8% protein, 8% fat are produced to carry out the study. The subjects are as follows: a standard recipe based ice cream for reference, four lactose hydrolyzed ice cream and four sugar reduced and lactose hydrolyzed ice cream. Milk sources are skimmed milk powder and whey powder solutions. The solutions are incubated with β-galactosidase enzyme (Saphera 2600 L) for an hour at 4ºC. Viscosity, texture, pH, meltdown and total solids analyses are performed for all mixes. After hydrolysis of lactose, ice cream mixes show a decrease in pH values. Differences regarding texture, viscosity and melting rates are observed between standard and sugar reduced mixes. Lactose hydrolyzed ice cream mixes become more viscous and less firm compared to the reference ice cream. This study's results of meltdown analysis show that lactose hydrolysis decreases the melting rate of ice cream.

Keywords: Fermented Ice Cream, Probiotics, Non-dairy Ice Cream

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Controlled lactose hydrolysis and sugar reduction trials of dairy ice cream

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The aim of this study is to seize the opportunity of lactose-glucose conversion for sugar reduction, produce gradually lactose hydrolyzed ice cream with standard and sugar reduced recipes to observe the physical and chemical effects of hydrolysis and sugar reduction on the product. The controlled lactose conversion is set for 25,50,75 and 100% of hydrolysis. Nine ice cream with 37% total solids, 12.5% MSNF, 3.8% protein, 8% fat are produced to carry out the study. The subjects are as follows: a standard recipe based ice cream for reference, four lactose hydrolyzed ice cream and four sugar reduced and lactose hydrolyzed ice cream. Milk sources are skimmed milk powder and whey powder solutions. The solutions are incubated with β-galactosidase enzyme (Saphera 2600 L) for an hour at 4ºC. Viscosity, texture, pH, meltdown and total solids analyses are performed for all mixes. After hydrolysis of lactose, ice cream mixes show a decrease in pH values. Differences regarding texture, viscosity and melting rates are observed between standard and sugar reduced mixes. Lactose hydrolyzed ice cream mixes become more viscous and less firm compared to the reference ice cream. This study's results of meltdown analysis show that lactose hydrolysis decreases the melting rate of ice cream.

Keywords: Lactose-free Ice Cream, Sugar Reduction, Lactose Hydrolysis

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The Use of Probiotics and Prebiotics in Bakery Products

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Nowadays, the level of desire to consume healthy food of individuals in society has been increasing day by day. Their consumption of healthy food has therefore increased the production of these foods. So the food industry has become to produce products which contain functional ingredients. Bakery products are also gaining importance in the functional food market, thanks to their various advantages. In the various conducted studies show feasibility of developing functional bakery products with prebiotics or probiotics, as well as the raw materials in the products were replaced with natural ingredients that could create a functional effect. However, the point to be considered about the use of probiotics in bakery products is the baking process. Most probiotic microorganisms can not maintain their viability with this process. When the literature is examined, probiotics in bakery products have been studied with microencapsulation, edible film and coating applications to protect them from adverse conditons. Apart from these, another application is the use of spore-forming bacteria. On the other hand, there are many studies on adding prebiotics, which have beneficial effects, to bakery products from a wide variety of sources. In this study, recent developments in the development of various bakery products with probiotics and prebiotics are reviewed and their effects on the final product are discussed.

Keywords: bakery products, probiotics, prebiotics

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A Healty Fermented Beverage: Red Beetroot Juice

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Red beetroot (*Beta vulgaris* L.); compared to its other subspecies, Beta vulgaris subsp.vulgaris (altissima), a flowering plant belonging to the Amaranthaceae family and known as sugar beet, its sugar content is approximately 2 times lower. For this reason, red beetroot is grown to be used in food products (pickles, salads, vegetable juices) rather than sugar production.

Red beetroot has many beneficial properties in terms of health. It contains good amount of antioxidants and minerals such as calcium, magnesium, iron, potassium, phosphorus, sodium and zinc, vitamins such as biotin, folic acid, niacin, vitamin B6, water-soluble fiber and betalains from soluble pigments, such as betacyanins and betaxanthins. The intense red color of beetroot is due to its high concentrations of a group of phenolics, secondary plant metabolites anthocyanins and betalains. Betalains are used by the food industry as natural colorants and are receiving increasing attention due to their possible health benefits in humans, particularly their antioxidant and anti-inflammatory activities. Other important benefits of red beetroot inhibition of lipid peroxidation, increased resistance to oxidation of low-density lipoproteins, and chemo-preventive effects. And also, it's a good source of , which has shown to have the potential to significantly reduce systolic blood pressure in humans.
In 2020, according to reports the world sale of vegetable beverages was close to 21.4 billion dollars, and it estimates a growth of approximately 36.7 billion dollars by 2025, and the demand for milk substitutes of vegetable origin have improved significantly (60%–70%) compared with previous years. Turkey has fertile lands for red beetroot production In order for Turkey to increase its share in this market, the production of fermented red beetroot juice with well-defined production conditions, will be a good alternative.

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Evaluation of the Functionality of Propolis

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Propolis is a product obtained by honey bees by mixing the resins collected from plant buds and sprouts with beeswax and salivary secretions. It contains various chemical compounds such as polyphenols (phenolic acids and their esters, phenolic aldehydes, alcohols and ketones), sesquiterpene quinones, coumarins, steroids, amino acids and inorganic compounds. In addition to flavonoids such as pinosembrin, chrysin, rutin, catechin, quercetin, a large number of phenolic acids such as caffeic acid, coumaric acid, gallic acid and cinnamic acid were determined in the structure of propolis. In addition, it has been shown that propolis contains minerals such as magnesium, calcium, iodine, copper, zinc, vitamins A, C and E, and many fatty acids.It is known to have a wide range of biological and pharmacological properties such as antimicrobial, antioxidant, anti-inflammatory, immunomodulatory, antitumor, anticancer, cardioprotective, neuroprotective effects. With this phenolic component, vitamins and minerals it contains, propolis is a very important apitherapy product. Apitherapy is a treatment method made with products such as honey, pollen, propolis, royal jelly and bee venom. When pollen, propolis and honey samples, which are beekeeping products, are compared in terms of total phenolic substance and flavonoid amounts, it is seen that propolis contains higher amounts of phenolic substances and flavonoids compared to other products. The activity of propolis against polio, influenza A and B viruses, retroviruses as well as HSV-1 and HSV-2 viruses has been observed. HSV-1 replication was weakened after 24 hours, while HSV-2 showed weaker replication after 48 hours of incubation. A significant reduction in the number of copies of viruses was noted. HSV-1 activity is due to galangin and krisine, two components found in propolis. When the functional effects of propolis are examined, treatment of cardiovascular and blood systems, respiratory system, dental care, dermatology, cancer treatment, immune system support and improvement, digestive tracts.

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Use of Ultrasound Method in Food Industry

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Ultrasound applications are an alternative method in the food industry, as in many areas. Foodstuffs tend to deteriorate due to many microbiological enzymatic and chemical events during the time period from production to consumption. The most widely used food preservation method in the food industry is preservation by applying heat to foods. However, as a result, some losses occur in the physical, chemical and organoleptic properties of foods. Ultrasound (sonication) is expressed as a sound pressure wave emitting a frequency (20 kHz) that exceeds the upper limit of the human hearing range (16-18 kHz). Generally, different frequencies from 20 kHz to 10 MHz are used in food products. The application of ultrasound in food technology is divided into two. These; low-frequency-high-energy ultrasound and high-frequency-low-energy ultrasound technology. Low-energy ultrasound is used in the control of food processes and to obtain information about the physical-chemical properties of foods. High-energy ultrasound applications are applied to physically change the properties of food. Ultrasound is preferred to extend the shelf life of foods. The effect of the application on the microorganism occurs by breaking down the cell walls. Ultrasound technology in the food industry; It is used in pasteurization-sterilization, enzyme inactivation, drying, microorganism inhibition, homogenization, emulsification, filtration application, meat ripening, cooking, cutting, extrusion, marination, extraction, crystallization and defoaming. Ultrasound alone is sufficient in some areas, while in others it must be used together with applications such as heat and pressure. In this study, the application of ultrasound technique in food processing was evaluated. Since traditional heat treatment methods cause negative changes in the nutritional value, color and sensory properties of foods, it is thought that the food industry will combine ultrasound method with new technologies and apply it in much more common areas in the coming years.

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Novel Technologies in The Fruit Juice Industry

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In the food industry, most of the processes for preserving products are based on the temperature parameter. In this sense, researchers have started to search for innovative technologies that will not harm food and preserve it in the best possible way. These technologies; ultrasound technology, high pressure technology, pulsed electric field (PEF) technology, membrane technology, UV technology can be classified as applications as novel. Fruit is processed in a certain flow chart, and different options are created for consumers such as fruit juice and smoothies. the conversion of the fruit by proces, value added product end increases its economic value. In this way, the fruit industry is growing day by day around the world. Fruit juices contain many bioactive components such as C vitamin and phenolics. In recent years, many findings such as due to the use of new technologies in the fruit juice industry, especially the preservation of bioactive substances, the reduction of microbiological initial load with a minimal heat treatment combination have been found. It has been observed that it increases the yield in fruit processing with applications such as high pressure technology, ultraviolet light and PEF technology in different combinations and parameters. It has been determined that the organoleptic quality of the fruit can be preserved by consuming less energy with membrane technology compared to conventional methods. In studies with ultrasound technology, it has been observed that the process time is shortened compared to the conventional method. In addition, studies mention that not only reduction of the microbiological load; but also can be applied as a pre-process in order to ensure that the enzymatic reactions, the minimal loss of nutrient content value and increase the shelf life. In this review, the effects of novel technologies used in the fruit juice industry are discussed in detail and summarized.

Keywords: fruit juice, novel technologies, high pressure processing, ultrasound technology, pef technology, UV

FULL TEXTS

Effect of Ozone Micro/Nano Bubble Application on Yoghurt Viscosity and Whey Syneresis

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INTRODUCTION

In this study combine effect of ozone and micro/bubbles were investigated. Ozone is known as highly oxidizing gas and its use in dairy sector has already been extensively investigated (Varga and Szigeti, 2016; Khanashyam *et al*. 2021; Suprapto *et al*., 2021).

Micro/nano bubble treatments is an emerging technology for food industry (Phan *et al.,* 2021). It is already shown that the bubbles behave differently as its size decreases. Gas bubbles with a diameter over milimetres raise to liquid surface and burst on the air liquid interface. However, at micro scale, gas bubbles movements up to the liquid surface dramatically reduces according to Stoke's law. At nano scale, bubbles do not show any raising tendency towards liquid surface. Instead, nano bubbles floats in the liquid.Reduction in the bubble size results in an enourmous increase in the surface area of the bubbles leading to increased mass transfer from gas to liquid or incerease in chemical reactions occuring gas liquid interface.

This study aimed at revealing how incorporation of ozone micro/nano bubbles on yoghurt milk would affect the viscosity and whey syneresis of final product, set yoghurt.

MATERIAL AND METHODS

Material

Cows milk: Raw cows milk was supplied from the university training farm. After milking, milk was cooled below 10°C and transferred to the laboratory.

Starter culture: Yoghurt starter culture (Y400 serisi) was supplied from Maysa Ltd Şti., İstanbul, Turkey.

Methods

Micro/nano ozone bubble tretments: Raw cow's milk was subjected to ozone micro/nano bubble treatment for 0 (control), 10, 20 30 min. For this purpose an equippment designed by Safir Ozon (Ankara) was used. The equippment had a reservoir connected to the micro/nano bubble generating pump (Nikoni, Japan). Before the pump a venturi was placed for the suction of ozone from the ozone generator (Safir Ozon, Ankara) which was connected to an oxygen generator. The outlet of the pump was connected to the reservoire. 1 mL/min ozon was introduced trough a venturi. Yoghurt samples were prepared after 0 (control), 10, 20 and 30 min ozone micro/nano bubble treatment.

Yoghurt production: Standard yoghurt production was carried as follows. Ozone micro/nano bubble treated raw milk was heated to 90 for 10 min, cooled to 45 C, inoculated with yoghurt culture (2%), incubated at 43°C for approximately 3-3,5 hours until 4,5 pH was reached and then stored at refrigerator temperature (~7°C) for 24 h.

Viscosity: The measurement of apparent viscosity of milk and yoghurt was carried out using a Brookfield rotational viscometer (DVE, Ametek, USA). For milk samples R2 spindle was used at 100 rpm at about 25°C. For yoghurt samples, the measurements were taken with a R3 spindle at 100 rpm at 5-7°C until the readings were remained unchanged. Yoghurt samples were stirred using a hand blender for 20 sec before measurements. Results were reported as mPas.

Whey Syneresis: Syneresis was measured according to Tamime *et al*., 1996 with some modifications. Fifty g of yoghurt sample was weighed on a filter paper in a funnel placed on top of graducated cylinder. After 2h of drainage at 4°C, the volume of whey collected was recorded and used as an index of syneresis. Syneresis was expressed as volume of drained whey in mL/50 g sample..

The experiment was repeated three times.

RESULTS AND DISCUSSION

Atlhough data was not shown, it was observed that there was an increase in the milk volume as the micro/nano bubble application time increased. It was also noticeable that even though ozone micro/nano bubble treated milk was heated to 90 C for 10 min, the micro/nano bubbles seemed to persist to exists. The changes in viscosity of milk and yoghurt together with whey syneresis of set yoghurt produce from ozone micro/nano bubble treated raw cows milk was displayed in Figure 1, 2 and 3 respectively.
It is clear from Figure 1 that inclustion of ozone micro/nano bubbles initially increased the viscosity of milk thereafter the viscosity decreased gradually up to a certain point (20 min of treatment). This phenomenon suggest occuring of two mechanisims. The initial increase of milk viscosity could be due to cross linking of milk proteins due to ozone oxidation (Uzun *et al.*, 2012) while reduction in viscosity could be attributed to the dilution of milk owing to the inclusion of ozone micro/nano bubbles.

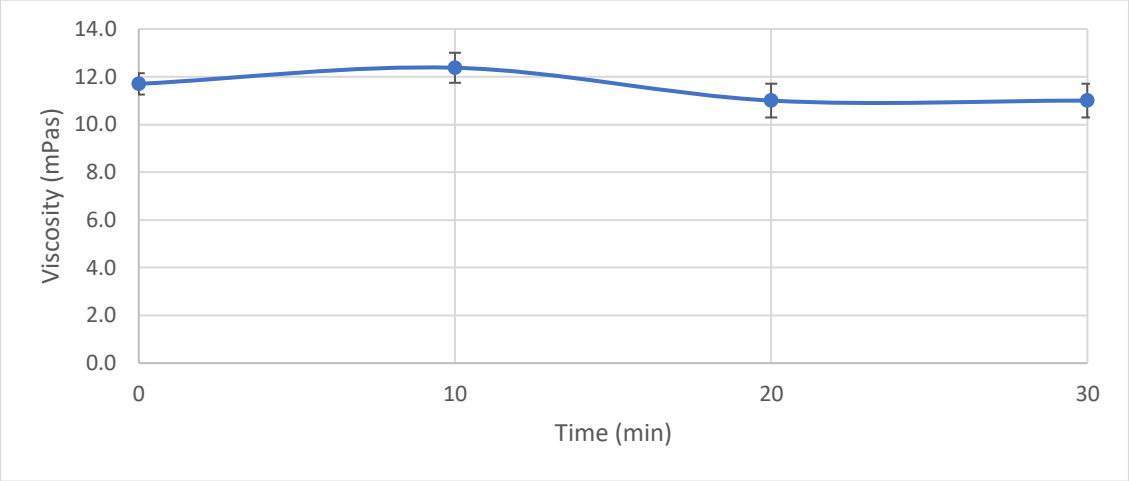

Figure 1. Changes in viscosity of raw milk treated with ozone micro/nano bubble for 0, 10, 20 and 30 min.

Figure 2 indicates the continuos reduction in yoghurt vicosity with increasing ozone micro/nano bubbles. After 30 min of bubble treatment more than 30% reduction was recorded compared to the initial viscosity. It was observed that heating yoghurt milk 90°C was not sufficient to remove the ozone micro/nano bubbles indicating their stability in yoghurt milk. It could be speculated that milk proteins covers the micro/nano bubbles like an envelope making them more stable.

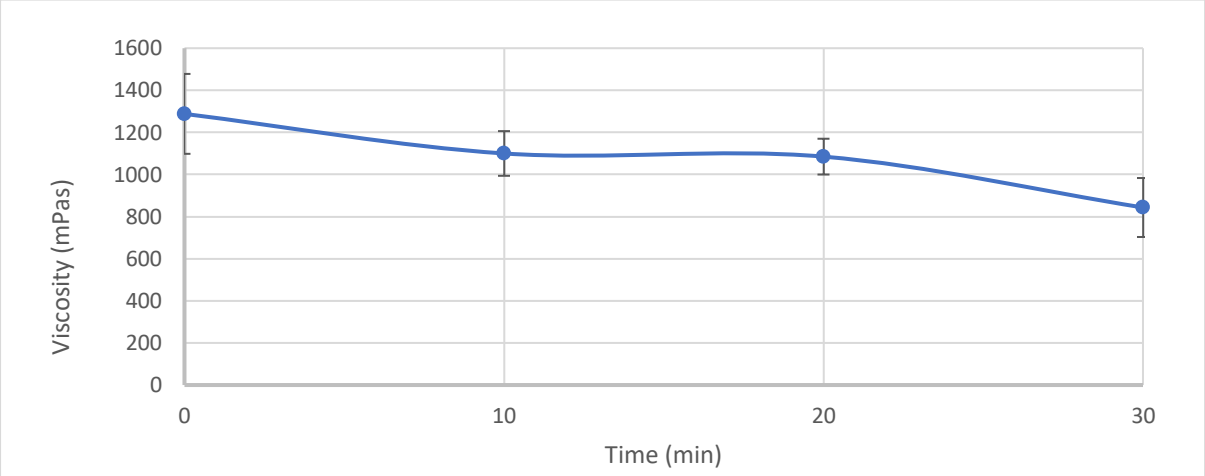

Figure 2. Changes in viscosity of yoghurt produced from milk treated with ozone micro/nano bubble for 0, 10, 20 and 30 min.

Finally, it was observed that the extent of whey syneresis did not appeared to be affected by the ozone micro/nano bubble treatment unlike viscosity. On one hand micro/nano scale bubbles entrapped in the

yoghurt matrix reduced the density of yoghurt which would suggest more whey syneresis, on the other hand micro/nano bubbles may act as a reservoir collecting whey inside thus preventing whey syneresis.

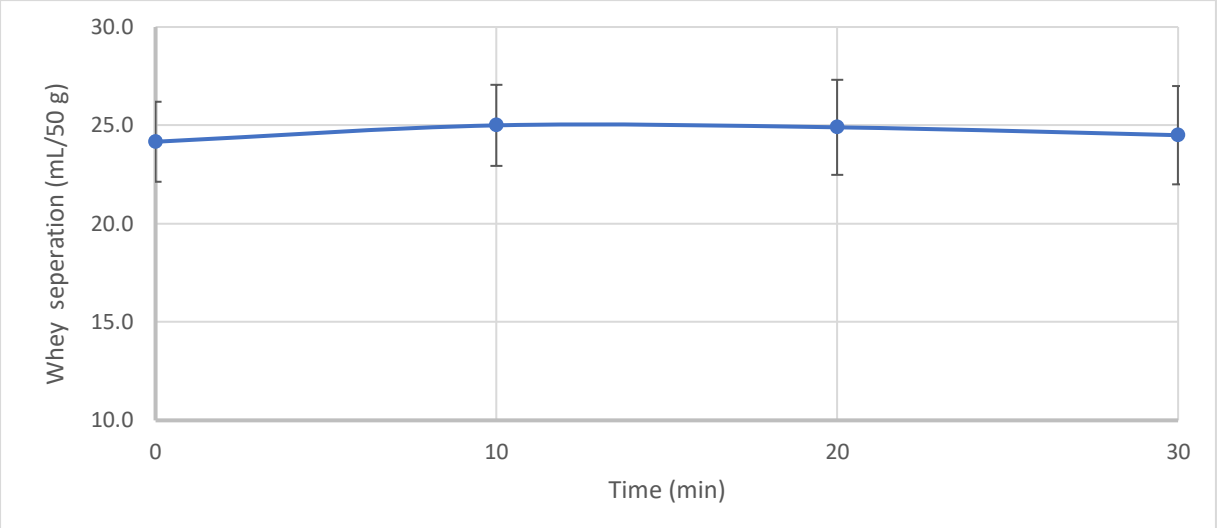

Figure 3. Changes in the whey separation of yoghurt produced from milk treated with ozone micro/nano bubble for 0, 10, 20 and 30 min.

CONCLUSION

Ozon micro/nano bubble application is an emerging technology that is yet to be explotited in food industry. As for yoghurt production, the preliminary results has shown that micro/nano scale bubbles were likely to be stable in milk system once entrapped. In addition, inclusions of bubbles at micro/nano scale reduced the viscosity of yoghurt with no major effect on whey syneresis. Using micro/nano scale bubbles yoghurt with weak matrix could be designed for babies or those having difficulties to eat or swallow. The effect of different foodgrade gases should also be exploited at micro and nano scale in dairy products.

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The Effect of Tarragon on Lipid Oxidation and Heterocyclic Aromatic Amine Formation in Meatball

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Abstract
Herein, the effects of the use (0.5, 1 and 1.5%) of tarragon in the meatball preparation on the lipid oxidation (TBARS) and heterocyclic aromatic amine (HAA) formation of meatballs cooked at 150, 200 and 250°C were determined. The usage of tarragon at the rate of 0.5% significantly decreased TBARS, whereas the usage of tarragon at the rate of 1 and 1.5% significantly increased TBARS value compared to the control group meatballs. Only IQx (up to 0.05 ng/g) and MeIQ (up to 0.26 ng/g) from the analyzed nine HAAs were determined in the meatballs. The use of tarragon had both an inhibitory and enhancing effect on the formation of HAAs, depending on the rate of use and the temperature of cooking. It could be recommended to use 0.5% tarragon in meatball production as it completely inhibits the HAA formation and reduces TBARS value compared to the control group meatballs.
Keywords: Meatball, heterocyclic aromatic amine, tarragon, lipid oxidation, cooking

Introduction

Studies have proven that certain food toxicants are formed as a result of cooking of proteinaceous foods, especially red meat, chicken and fish. Heterocyclic aromatic amines (HAAs) are compounds with highly toxic properties (Oz & Kaya, 2011a). It has been stated that HAAs are 2000 times more mutagenic than benzo[a]pyrene and 100 times more mutagenic than aflatoxin B1 (Skog, 2002). Epidemiologic studies have shown that some HAAs are carcinogenic for people (IARC, 1993). To date, about 30 HAAs have been discovered (Oz, 2020).

Tarragon is a durable, perennial shrub species belonging to the *Asteraceae* family. Its fresh or dried leaves are widely used as spices in the best cuisines of the world because of their highly effective condiment. In 100 g tarragon, there are 295 kcal energy, 7.7 g of water, 22.8 g of protein, 3.2 g of fat, 50.2 g of carbohydrate, 7.4 g of fiber, 12 g of ash, 1139 mg of Ca, 32 mg of Fe, 347 mg, 313 mg P, 3020 mg K, 62 mg Na, 4 mg Zn, 9 mg niacin, 1 mg riboflavin, 4200 IU vitamin A (Akgül, 1993). Tarragon is used as a sauce by pouring on light soups, chicken, fish, meat, and seafood after it fried in oil. As it has an aroma like mint-anise mixture, it affects the formation of a special taste in vinegar dishes and fish. Tarragon, which is used as an appetizer and digestive agent and as relieving intestinal gases in anti-rheumatic cures, can also be used to improve the blood circulation and give the body vitality, regulate the functioning of the stomach, and relieve toothache. In addition, tarragon is also used in food storage due to its antioxidant and antifungal properties (Anonymous, 2021).

Due to oxidative reactions known to affect the HAA formation, the use of synthetic antioxidants and spices with antioxidant properties and some food ingredients in the preparation, production and marination of meat and meat products are noteworthy (Murkovic et al. 1998). However, it has been determined in many studies that the use of spices and plant extracts rich in components with antioxidant activity instead of synthetic antioxidants prevents HAA formation (Murkovic et al., 1998; Oz & Kaya, 2011a and 2011b). Although there have been many studies in the literature showing the effects of various spices on the HAA formation in meatballs, including our studies, there is no study investigating the effect of tarragon usage on the HAA formation in meatball production. For this reason, the current study was planned and conducted to determine the effect of the use of tarragon at the rates of 0.5, 1 and 1.5% (w/w) in meatball preparation on the HAA formation in meatballs cooked at three different temperatures (150°C, 200°C and 250°C). In addition, the effect of tarragon on the several quality criteria of the meatballs was determined in the present research.

Material and Method

Material: Beef *Gluteus medius* muscle and intermuscular fat from the same carcass were obtained from Erzurum Meat and Milk Institute Meat Combine. The meat and fat were conveyed to the laboratory

under the cold chain and removed from the visible fat and connective tissues and then grounded. Tarragon was obtained from a local spice seller in Erzurum.

The preparation of the meatball: After adjusting the fat content of the meatballs to 15% fat with the intermuscular fat, the meatball dough was divided into four groups. To the first group, tarragon was not added and this group was selected as the control group. To the other groups, 0.5, 1 and 1.5% tarragon were added. All of the meatball groups were kept in the refrigerator for 12 hours after being thoroughly mixed. After the meatball dough was shaped by a metal shaping device (7x1 cm), the meatballs were cooked on a hot plate. To avoid any interaction, no salt, spice, or additives were added in the meatball dough.

Cooking Process: For the cooking process, a hot plate was used and neither fat nor oil was used in the cooking process. The meatballs were cooked on a hot plate preheated to 150°C, 200°C, and 250°C for 8 (4+4) min and the hot plate temperature was measured with the laboratory type thermometer (Testo, Lenzkirch, Germany).

The determination of lipid oxidation: Thiobarbituric acid reactive substances (TBARS) analysis was used to determine the lipid oxidation level of the samples and TBARS value was determined according to the method applied by Kılıç and Richards (2003).

DPPH free radical scavenging activity analysis: DPPH free radical scavenging activity analysis was used to determine the antioxidant capacity and DPPH analysis was determined according to the method applied by Gülçin et al. (2002). The free radical scavenging activity of tarragon was compared with BHT and gallic acid selected as standard.

Heterocyclic aromatic amine analysis: The HAA extraction of the cooked meatballs was done according to Messner and Murkovic (2002) with slight modifications (Oz, 2020).

Statistical analysis: The data obtained in the present study were subjected to variance analysis. The experiment was set up according to a completely randomized design. The results were analyzed using the SPSS package program and Duncan multiple comparison test was used to evaluate the differences between the average values found.

Results and Discussion

Some chemical and physicochemical properties of beef *Gluteus medius* muscle, the intermuscular fat and the raw meatballs are given in Table 1. The results were found to be in agreement with the literature (Serrano et al. 2007; Aksu et al. 2008; Nuray & Oz 2019).

Table 1. Water, pH and TBARS values of the raw materials

Sample	n	Water (%)	pH	TBARS (mg MDA/kg)
Meat	2	74.11±0.13	5.80±0.08	0.82±0.03
Intermuscular fat	2	24.08±4.37	7.51±0.03	0.74±0.07
Meatball	2	66.40±2.05	5.90±0.03	0.58±0.02

Free radical scavenging activity results of tarragon

The DPPH free radical scavenging activities of gallic acid and BHT selected as reference and tarragon were statistically different ($P<0.05$) from each other (n=6). The highest DPPH free radical scavenging activity was statistically found in gallic acid (17.11%) which is followed by tarragon (7.66%) > BHT (1.84%). Chaleshtori et al. (2013) reported that essential oils obtained from tarragon inhibited oxidation of linoleic acid, but this inhibition rate was lower than that of BHT.

TBARS results

Average TBARS values of the meatballs are given in Table 2. Tarragon usage significantly affected TBARS values of the samples ($P<0.01$). Use tarragon at the rate of 0.5% decreased the TBARS value compared to the control group meatballs, but this decrease was not significant ($P>0.05$). However, usage tarragon at the rates of 1 and 1.5% significantly caused an increase in TBARS value. Although the antioxidant capacity of tarragon was found to be better than that of BHT, it has been proved that some studies on model system and meat show a prooxidant effect depending on usage rate of antioxidants, structure, test system and substrate (Nuray & Oz, 2019). In the present study, cooking process did not

affect the TBARS value of the meatball (P>0.05), while cooking process increased TBARS values of the meatballs. There are studies showing that the effect of the cooking process on TBARS value of meat products is different in the literature. Some researchers stated that cooking process did not change TBARS value of samples, while some researchers found that cooking process increased TBARS value (Peiretti et al. 2012; Oz, 2014; Oz & Celik, 2015). In the present study, cooking temperature did not affect the TBARS value of the samples (P>0.05), while TBARS value of the meatballs increased with increasing the cooking temperature. Other researchers determined similar results. Uzun and Oz (2021) found that TBARS values of meatballs cooked at 150°C – 250°C were not statistically different and TBARS values ranged from 0.65 to 0.67 mg MDA/kg.

Table 2. The TBARS values of the meatballs

	n	TBARS (mg MDA/kg)
Usage Rate (%) (UR)		
0	12	0.62±0.08 b
0.5	12	0.58±0.04 c
1	12	0.90±0.41 a
1.5	12	0.97±0.11 a
Sign		**
Cooking Process (CP)		
Raw	24	0.71±0.16 a
Cooked	24	0.82±0.34 a
Sign		ns
Cooking Temperature (°C) (CT)		
150	16	0.73±0.17 a
200	16	0.74±0.19 a
250	16	0.84±0.39 a
Sign		ns

Heterocyclic aromatic amine results

The HAA results are given in Table 3. As can be seen from the table, only IQx (up to 0.08 ng/g) and MeIQ (up to 0.26 ng/g) from nine HAA analyzed in the present study were determined in the cooked meatballs.

Table 3. Individual and total HAA contents of the meatballs (ng/g)

Usage Rate (%)	Temperature (°C)	IQx	MeIQ	Total HAAs
0	150	nd	nd	nd
	200	nd	0.05	0.05
	250	nd	0.06	0.06
0.5	150	nd	nd	nd
	200	nd	nd	nd
	250	nd	nd	nd
1	150	nd	nd	nd
	200	nd	nd	nd
	250	0.05	0.09	0.14
1.5	150	nd	0.13	0.13
	200	0.08	0.14	0.22
	250	0.04	0.26	0.30

nd: not detected (nd=LOD>…) IQ, MeIQx, 7,8-DiMeIQx, 4,8-DiMeIQx, PhIP, AαC and MeAαC could not be detected.

IQx could not be detected in the control group meatballs and meatballs with 0.5% tarragon. Similarly, Quelhas et al. (2010) and Puangsombat et al. (2011) reported that they could not detect IQx in their beef

and meatball samples fried at degrees up to 275°C for up to 30 min. On the other side, up to 0.08 ng/g IQx was determined in the meatballs with 1 and 1.5% tarragon in the present study. Zeng et al. (2017a) investigated the effect of using red pepper extract at different rates in meatball production on HAA formation and determined IQx as 0.22 ng/g in control group meatballs, as non-detectable level in meatball with red pepper extract at 0.5%, as 0.36 ng/g in meatball with red pepper extract at 1% and as 0.26 ng/g in meatball with red pepper extract at 1.5%. Fay et al. (1997) determined 1.5 ng/g IQx in grilled beef samples. While Oz et al. (2016b) did not detect IQx in control group meatballs cooked at 150°C for 9 min, 0.02 ng/g and 0.12 ng/g IQx were determined in meatballs cooked at 200°C and 250°C by the same researchers, respectively.

IQ could not be detected in any of the samples analyzed. Similar studies are available in the literature. Similarly, Puangsombat et al. (2011) and Korkmaz and Oz (2020) declared that they could not detect IQ in their beef and meatball samples grilled or fried at degrees up to 250°C. On the other side, IQ was determined as 0.7 – 2.8 ng/g in beef meatball cooked at 175°C – 225°C for 12 min by Balogh et al. (2000), as 0.4 – 1.7 ng/g in beef meatball cooked at 160°C – 220°C for 14 min by Klassen et al. (2002) and as 11.2 ng/g in deep-fat fried beef meatball at 180°C for 3 min by Lu et al. (2018).

MeIQx could not be detected in any of the meatball samples analyzed. Similar studies are available in the literature. Indeed, Oz et al. (2016), Oz and Çakmak (2016), Nuray and Oz (2019) and Korkmaz and Oz (2020) reported that they could not detect in their beef and meatball samples grilled or fried at degrees up to 250°C. On the other side, MeIQx was determined as 0,08 ng/g in grilled beef meatball at 250°C for 8 min by Korkmaz and Oz (2020), as 0.09 ng/g in beef meatball cooked on hot plate at 250°C for 9 min by Oz et al. (2016), as 0.34 ng/g in pan fried beef samples at 160°C – 220°C for 14 min by Klassen et al. (2002), as 7 ng/g in pan fried beef meatball at 204°C for 10 min by Puangsombat et al. (2011) and as 13.2 ng/g in fried beef at 180°C by Murkovic et al. (1998).

MeIQ could not be detected in the control group meatballs cooked at 150°C and meatballs with 0.5% tarragon cooked at all cooking temperatures. On the other side, increasing the cooking temperature in the control group meatballs and meatballs with 1.5% tarragon caused an increase in MeIQ content. Cheng et al. (2007), Puangsombat et al. (2011) and Oz and Kaya (2011b) reported that they could not detect MeIQ in their beef, meatball and hamburger samples grilled, ovened or fried at degrees up to 275°C. On the other side, Nuray and Oz (2019) detected MeIQ in their control group meatballs, but they did not determine the amount of MeIQ. However, they reported that MeIQ amount in meatball with onion-water extract increased depend on type and usage rate and up to 0.05 ng/g MeIQ was determined. MeIQ was determined up to 2 ng/g in beef meatball cooked at different temperatures (175°C – 225°C) for 12 min by Balogh et al. (2000). In addition, Lu et al. (2018) determined 15.38 ng/g MeIQ in deep fat fried beef meatball at 180°C for 3 min.

7,8-DiMeIQx could not be detected in the present study. Similarly, Gross (1990), Toribio et al. (2007), Quelhas et al. (2010) and Zeng et al. (2017a) mentioned that they could not detect 7,8-DiMeIQx in their beef and meatball samples grilled or fried at degrees up to 275°C for up to 13 min. On the other side, 7,8-DiMeIQx was determined up to 0.21 ng/g in beef meatball cooked in oven at 225°C for 10 min by Zeng et al. (2017a) and up to 1.75 ng/g in pan fried beef meatball at 160°C – 220°C for 14 min by Klassen et al. (2002).

4,8-DiMeIQx could not be detected in any of the samples analyzed. Similarly, Gross et al. (1993) declared that they could not detect 4,8-DiMeIQx in their beef and meatball samples grilled or fried at degrees up to 275°C. On the other side, while Oz and Çakmak (2016) could not detect 4,8-DiMeIQx in their beef meatball samples cooked at 150°C for 9 min, they detected 4,8-DiMeIQx in beef meatball cooked at 200°C for 9 min, but they could not determine the amount of 4,8-DiMeIQx. The researchers determined 4,8-DiMeIQx up to 0.08 ng/g in beef meatball cooked at 250°C for 9 min. Zeng et al. (2017a) investigated the use of red pepper extract at different rates in beef meatball on HAA formation and determined 0.16 ng/g, 0.10 ng/g, 0.21 ng/g and 0.16 ng/g 4,8-DiMeIQx in control group meatball, meatball with red pepper extract at the rates of 0.5, 1 and 1.5%, respectively. 4,8-DiMeIQx was determined as 0.3 ng/g in cooked meatball with 15% fat at 200°C for 12 min and as 1.2 ng/g in cooked meatball at 250°C for 12 min by Felton et al. (1994) and as up to 4.5 ng/g in pan fried beef meatball at 175°C – 200°C for 12-20 min by Balogh et al. (2000).

PhIP could not be detected in the meatball samples. Similarly, Oz et al. (2016) and Nuray and Oz (2019) reported that they could not detect PhIP in their chop and meatball samples grilled or fried at degrees up to 200°C. On the other side, PhIP was determined as 0.19 ng/g in beef meatball cooked in oven, as 0.37 ng/g in grilled beef meatball, as 0.41 ng/g in barbecued beef meatball, as up to 1.1 ng/g in pan fried samples at 160°C – 220°C for 14 min by Klassen et al. (2002), as 3.1 ng/g in grilled meatball at 250°C – 270°C for 10 min by Gross et al. (1993), as up to 7.11 ng/g in beef meatball by Zeng et al. (2017b), as up to 6.2 ng/g in cooked beef meatball at 175°C for 12 – 20 min by Balogh et al. (2000), as 6.53 ng/g in pan fried beef meatball at 204°C for 10 min by Puangsombat et al. (2011), as 7.83 ng/g in fried beef meatball at 200°C for 12 min by Cheng et al. (2007) and as up to 48 ng/g in pan fried samples at 190°C for 6 – 13 min by Gross (1990).

AαC could not be detected in the present study. Similarly, Gross et al. (1993), Felton et al. (1994), Oz and Çakmak (2016), Zeng et al. (2017a) and Korkmaz and Oz (2020) reported that they could not detect AαC in their beef and meatball samples grilled, ovened or fried at degrees up to 270°C. On the other side, AαC was determined up to 0.33 ng/g in grilled beef at 180°C – 210°C for 4 min by Toribio et al. (2007), as up to 8.9 ng/g in pan fried beef at 190°C for 6 – 13 min by Gross (1990) and as 14.7 ng/g in pan fried beef at 180°C – 200°C for 8 min by Quelhas et al. (2010).

MeAαC could not be detected in the meatball samples of the present study. Similarly, Gross et al. (1993), Quelhas et al. (2010) and Zeng et al. (2017a) mentioned that they could not detect MeAαC in their beef and meatball samples grilled, ovened or fried at degrees up to 280°C. On the other side, MeAαC was determined as 0.15 ng/g in grilled beef at 180°C – 210°C for 4 min by Toribio et al. (2007).

The total HAA amount of the control group meatballs and meatballs with tarragon at different rates and cooked at different temperatures were changed between 0.05 – 0.30 ng/g. The total HAA content remained below the limit of detection (LOD) due to the fact that none of the analyzed HAAs in control group meatballs cooked at 150°C was detected. On the other side, in the control group meatballs cooked at 200°C and 250°C, only MeIQ was detected from the HAAs analyzed and it was determined that MeIQ and therefore total HAA content increased with increasing cooking temperature. The effect of tarragon usage on total HAA content in meatball production was determined to vary depending on the tarragon usage rate and the cooking temperature. The use of 0.5% tarragon in the production of meatballs completely inhibited the formation of MeIQ compared to the control group meatballs, so the total HAA content remained below the LOD value at all cooking temperatures. While the use of 1% tarragon in meatball production caused total HAA content to remain below the LOD value at 150°C and 200°C, the total HAA content at 250°C increased compared to control group meatballs. On the other side, the use of 1.5% tarragon in meatball production caused an increase in the total HAA content at all cooking temperatures compared to the control group meatballs, and the increase in cooking temperature increased the total HAA content. It was determined that the total HAA content of the control group meatballs belonged to MeIQ. On the other side, in the meatballs with 1% and 1.5% tarragon, it was determined that most of the total HAA content belongs to MeIQ and the rest was composed of IQx.

Balogh et al. (2000) studied effect of use of vitamin E and oleoresin rosemary in beef meatball production and cooking temperature on formation of HAAs and found that use of vitamin E and oleoresin rosemary in meatballs reduced the total amount of HAA by 45 - 75% and that total HAAs in meatballs increased in parallel with the increase in cooking temperature. The researchers stated that the total amount of HAA of meatballs ranged from 3 to 50.8 ng/g. Puangsombat and Smith (2010) investigated the effect of use of rosemary – water extract at different rates in meatball production on HAAs formation and reported that use of rosemary – water extract at different rates (0.05, 0.2 and 0.5%) reduced the total amount of HAA by 54.7 – 78.3%, increase in cooking temperature increased total HAA content of all meatballs and total HAA content of meatballs ranged from 1.76 to 11.82 ng/g. Oz, and Kaya (2011b) studied effect of red pepper usage in beef chop (M. *Longissimus dorsi*) on HAAs formation and reported that use of red pepper at 1% reduced total HAA amount in beef chop fried at different temperatures (175°C, 200°C and 225°C) by 75.67 – 100% and total HAA content of samples ranged between nd – 9.47 ng/g. Nuray and Oz (2019) investigated the effect of use of onion – water extract at different types (yellow, white and red) and rates (0.25, 0.50 and 0.75%, w/w) in meatball production on HAAs content and reported that use of onion - water extract increased total HAA content and total HAA content of meatballs ranged from nq - 0.10 ng/g.

The results obtained in the present study show that the use of tarragon in meatball production has both inhibitory and enhancing effect on both individual HAA and total HAA content depending on the usage rate and the cooking temperature. Tarragon has an antioxidant effect due to its phenolic compounds and flavonoids (Chaleshtori et al. 2013). While the inhibitory effect of tarragon on HAAs is thought to be due to the antioxidant effect of the phenolic compounds and flavonoids of the tarragon, the enhancing effect of the tarragon may be attributed to the prooxidant effect of the antioxidant compounds under the aforementioned conditions in the meatballs and also to the high carbohydrate content of tarragon (about 50%, Akgül, 1993). While antioxidants may lead to a decrease in HAA content due to the fact that they sometimes interfere with the different stages of radical reactions that play an important role in the formation of HAAs, they sometimes increase the formation of HAAs by showing prooxidant effect. There are many studies in the literature that antioxidants reduce the formation of HAAs (Cheng et al., 2007; Puangsombat & Smith, 2010; Oz & Kaya, 2011; Oz et al., 2016). On the other side, it is known that antioxidant substances may show prooxidant effect in systems depending on concentration, structure, test system and substrate used (Uzun & Oz, 2021). For this reason, the studies showing some antioxidants used in the production of meat products increase the formation of HAA are also in the literature (Oz & Çakmak, 2016; Zeng et al., 2017b; Uzun & Oz, 2021).

It is difficult to compare the total HAA content got in the present study with the results in the literature due to the fact that this study is the first study to investigate the effect of the use of tarragon in meatball production on the HAA formation. However, in the present study, it was found that the total HAA content of all the meatballs was quite low compared to the data in the literature. These differences are thought to be caused by factors such as the type of meat used, animal feeding conditions, cooking conditions (temperature, duration, equipment, etc.), precursor substances etc. (Felton et al., 1994; Skog, 2002; Oz & Kaya, 2011; Oz, 2019).

Conclusion

In conclusion, to the best of our knowledge, this is the first study to investigate the effect of tarragon usage in meatball production on the formation of heterocyclic aromatic amines and some quality properties of meatball. The use of tarragon had both an inhibitory and enhancing effect on the formation of HAAs, depending on the usage rate and cooking temperature. However, it could be recommended to use 0.5% tarragon in meatball production as it completely inhibits the HAA formation and reduces the TBARS value of meatballs compared to control group meatballs. On the other side, Skog (2002) reported that the acceptable daily consumption of HAAs ranged from 0 to 15 μg/person. In the present study, it is seen that even if 100 g of the meatballs containing 1.5% tarragon cooked at 250°C whose total amount of HAA content is the highest, is eaten, the intake amount is far below 1 μg (0.03 μg).

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Drying Rates Based on Variable Diffusion Coefficient

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Abstract: The aim of this study is to observe the variation of diffusivity coefficient over time and location in chickpea samples dried at 60°C, 1 m/s of air, 5% relative humidity, and 6 rev/min of tray rotation. Samples were taken from the dryer every 20 min. and analyzed for moisture content and signals of time-domain nuclear magnetic resonance (TD-NMR) and magnetic resonance imaging (MRI) analyses. The results of the TD-NMR, MRI method and the conventional oven were compared. Diffusion coefficient for center was calculated as $8.62*10^{-10}$ m^2/s by using moisture ratio method, $9.83*10^{-10}$ m^2/s by using TD-NMR and $5.78*10^{-10}$ m^2/s by using MRI data. On the other hand, diffusion coefficient for corner was calculated as $2.00*10^{-9}$ m^2/s by using moisture ratio method, $1.97*10^{-9}$ m^2/s by using TD-NMR and $2.93*10^{-9}$ m^2/s by using MRI data. Also, diffusion coefficient between center and corner(C-C) was calculated as $2.23*10^{-9}$ m^2/s by using moisture ratio method, $2.06*10^{-9}$ m^2/s by using TD-NMR and $3.67*10^{-9}$ m^2/s by using MRI data.

1-) Introduction

Fresh fruits and vegetables contain high moisture content. Therefore, fresh fruits and vegetables have a short shelf life. They are also susceptible to microbial spoilage and adverse enzyme reactions. The main purpose of the drying process is to reduce the moisture content of vegetables and fruits. Drying is used to inhibit the growth of microorganisms and to increase shelf life (Saavedra et al., 2016). During the drying process, quality characteristics such as taste, appearance, color, nutritional value should change as little as possible.

There are some factors that affect the drying rate. These are chemical composition and geometry of foods, drying temperature, air velocity and humidity (Guiné, 2018). Dissolved substances reduce the vapor pressure of water. Therefore, evaporation of water becomes difficult. Vegetables and fruits contain water inside and between cells. The removal of water between the cells accelerates the drying process (Yadav & Singh, 2012). The drying rate is directly proportional to the surface area of the particles and inversely proportional to their thickness. Therefore, the smaller the dried particles, the greater the surface area and the lesser the thickness. Thus, the drying rate is positively affected. The increase in temperature and air velocity has positive effects on the drying rate (Chanpet et al., 2020).

Spectroscopy is a method that determines the quantized energy levels of molecules, ions, and nuclei. Magnetic resonance can be used as a spectroscopy tool. As the definition of Nuclear Magnetic Resonance (NMR), hydrogen protons gain the ability to produce resonance when placed in a magnetic field and excited by radiation with the help of radio waves of the right frequency (Tognarelli et al., 2015). When the magnetic field and radio frequency are correctly matched, protons absorb and re-emit radio energy. By detecting the emitted energy and measuring its density, the number of resonant protons in the sample can be determined. The NMR signal can be effectively separated from the water and solids in the sample because there is a large variation in the magnetic resonance susceptibility of solids and bound water. The NMR signal originating from the water is normalized with the sample weight and then the amount of water (% w/w) is calculated using the appropriate calibration curve (Webb, 2016).

The time domain NMR measures the time it takes for nuclei to return to equilibrium after excitation. TD-NMR is a practical method because it does not damage samples during measurement. Thus, it is accepted as a fast analytical method (Besghini et al., 2019). In the TD-NMR method, the protons in the water generally reflect the longitudinal (T_1) and transverse (T_2) relaxation times. T_2 relaxation is the process of decay or phase distortion of the transverse components of magnetization (Cecil, 2013). T_1 relaxation can also take the form of a special dipolar interaction, informally known as a spin to spin. It takes advantage of differences in molecular motions between various food ingredients.

The aim of this study was to evaluate the change in diffusion constant over time and location during drying. The change in the amount of water during drying was associated to signals of TD-NMR and MRI methods.

2-) Material and Methods

2.1. Chickpea Samples Drying and TD-NMR Measurement

Canned boiled chickpea (Cicer arietinum) was purchased from local markets. Chickpeas were turned into chickpea flour using a blender. In this way, it has become easier to shape chickpeas. Chickpea flour was shaped into a cylinder with a diameter of 6 cm and a width of 1 cm.

A tray dryer (Eksis Endusriyel Kurutma Sistemleri, Isparta, Turkey) designed for laboratory studies was used for drying. The velocity of the air, the humidity of the air, the temperature of the air and the rotation speed of the tray are adjustable. The size of the trays used in drying is 30x30x2 cmxcmxcm. The humidity of the air is 5%, the velocity of the air is 1 m/s and the rotation speed of the tray was 6 revolution per minute. Drying took place for a total of 3 h and samples were taken every 20 min.

TD-NMR experiments were performed at 0.48 Tesla (1H frequency of 20.34 MHz). One centimeter chickpea was placed in the test tube. CPMG T2 parameter was used for data measurement. Echo time varied between 500-200 ms. Number of echoes changed between 100-50. The amount of scan for measurement was set to 4.

2.2. Mathematical Model

2.2.1. Analytical Solution

Equations of cylindrical coordinates system were used for modeling of drying. Changes in the r direction are important, as drying has a large effect in the r direction. Governing equation mass transfer equation at r-direction (Deen, 2013):

$$\frac{\partial M}{\partial t} = D_{eff}\,\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial M}{\partial r}\right)$$

Boundary conditions:

I.C $\quad t = 0, M(r,0) = M_0$

B.C.1 $\quad r = 0\ ,\ \frac{\partial M}{\partial r} = 0$

B.C.2 $\quad r = R\ ,\ -D_{eff}\frac{\partial M}{\partial r} = h_m(M_{final} - M_\infty)$

Assumptions:

-Initial moisture content is uniform.

-Reductions in diameter caused by shrinkage are neglected.

Moisture Ratio $= \frac{M_t - M_e}{M_0 - M_e} = \frac{4}{\xi_1^2}\exp\left(-\frac{t\,D_{eff}\xi_1^2}{r^2}\right)$

$\ln\left(\frac{M_t - M_e}{M_0 - M_e}\right) = A - Bt$ where A= $\left(\frac{4}{\xi_1^2}\right)$ and B=$\frac{D_{eff}\xi_1^2}{r^2}$

This equation is the first-order Bessel equation. Therefore, the Biot number can be defined as the mass transfer resistance inside (diffusional) and resistance on the surface (convective) (Porciuncula et al., 2013).

2.2.2. Effective Diffusion Coefficient Determination

The diffusion coefficient can be calculated using Fick's second law. For this, it is necessary to know the time dependent humidity change and the radius dependent humidity change. The variation of the effective diffusion coefficient with temperature can be explained by an Arrhenius-type exponential function (Sobukola et al., 2007).

$$D_{eff} = D_0 exp\left(-\frac{E_a}{RT}\right)$$

$$\ln\left(D_{eff}\right) = \ln(D_0) - \left(\frac{E_a}{R(T + 273.15)}\right)$$

where D_0(m^2/s) Arrhenius equation constant, E_a(kJ) activation energy, R(kJ/mol^{-1}) universal gas constant and T(K) temperature.

2.2.3. Calculation of Convective Heat Transfer Coefficient

Convective heat transfer coefficient depends on various factors. Most important factor is the velocity of the air. Forced convective heat transfer can be determined with the help of Reynold Prandtl and Nusselt number. These numbers are unitless numbers. Equations can be written using these numbers (Çengel, 2006). For laminar flow Re <5*10^5;

$$Nu = 0.06666 * Re_L^{0.5} * Pr^{1/3}$$

3-) Results and Discussion

During the drying process, the moisture ratio of chickpeas was reduced from 65.2 to 12.2%. While the moisture content at the center decreased to 22.5 %, samples taken from the corner possessed 12.2 % water. Thus, the water ratio varied with location (or space) in chickpea samples.

The magnetic resonance imaging (MRI) signals of chickpeas were reduced from 77.8 to 13.5 during the drying process. The MRI signals of the samples taken from the center of the chickpeas decreased to 24.8, while the MRI signals of the samples taken from the corner decreased to 13.5. MRI signals decreased in proportion to the water content of the samples.

Table 1

Moisture Content, MRI, NMR T_2 and NMR b data for center, corner and between center and corner(C-C) at 60°C.

	CENTER				CORNER				C-C			
TIME (min)	**Moisture Content**	**MRI**	**NMR T_2 (ms)**	**NMR b**	**Moisture Content**	**MRI**	**NMR T_2 (ms)**	**NMR b**	**Moisture Content**	**MRI**	**NMR T_2 (ms)**	**NMR b**
0	65.2	77.8	42.5	22.1	65.2	77.8	42.5	22.1	65.2	77.8	42.5	22.1
20	58.7	70.0	38.1	19.9	52.8	55.7	34.7	20.3	54.8	63.2	36.7	19.0
40	52.8	55.4	33.8	17.3	42.8	48.8	29.6	20.1	46.0	46.8	29.6	16.5

60	47.5	48.5	32.0	15.7	34.7	41.1	21.9	19.3	38.6	39.4	24.3	14.0
80	41.4	43.5	28.4	15.5	25.6	30.5	17.9	17.4	30.5	32.0	20.0	12.9
100	36.0	40.5	22.6	13.2	20.1	23.0	13.1	15.1	29.4	30.8	19.5	11.5
120	29.9	35.6	18.8	13.2	18.4	20.1	11.6	13.4	27.0	27.9	16.8	9.7
140	27.2	32.0	17.5	12.8	16.9	17.4	10.7	11.3	24.8	25.2	17.3	9.2
160	24.7	26.6	15.9	12.6	15.5	15.9	9.9	9.9	22.7	23.2	14.3	8.4
180	22.5	24.8	14.7	11.7	12.2	13.5	8.8	9.3	20.8	21.1	13.1	8.2

Diffusion coefficient was calculated from moisture ratio equation, TD-NMR and MRI data using analytical method. The diffusion coefficient results for the center of the chickpea were found to be $8.62*10^{-10}$ for moisture ratio equation, $9.83*10^{-10}$ for TD-NMR and $5.78*10^{-10}$ for MRI method at 60 °C. The corner samples were also handled in the same way and the results of diffusion coefficient were calculated as $2.00*10^{-9}$ for Moisture ratio equation, $1.97*10^{-9}$ for TD-NMR and $2.93*10^{-9}$ for MRI methods at 60 °C. Diffusion coefficient was then calculated as $2.23*10^{-9}$ for moisture ratio equation, $2.06*10^{-9}$ for TD-NMR and $3.67*10^{-9}$ for MRI methods between center and corner(C-C) of chickpea at 60 °C. The time-domain nuclear magnetic resonance (TD-NMR) relaxometry was used to measure longitudinal relaxation time and transverse relaxation time, which were then related to diffusivity and moisture change at different drying conditions. Mono-exponential($M=M_0*e^{-t/\lambda_2}$) function was used to determine the water content.

As can be seen from the results, the diffusion coefficient varies with location of the samples, as the diffusion coefficient and moisture ratio changes between the center and the corner of the chickpea are different from each other. On the other hand, moisture ratio and TD-NMR and MRI results support each other. It takes 12 h to determine the moisture ratio with the classical method. However, with TD-NMR and MRI, a signal can be obtained within few minutes. Thus, TD-NMR and MRI can be seen as an alternative method to determine the amount of moisture in foods.

Table 2

Diffusion coefficient by using moisture ratio (MR) equation, nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI) methods at 50°C, 60°C and 70°C.

	50 °C		60 °C		70 °C	
CENTER	MR	$7.84 * 10^{-10}$	MR	$8.62 * 10^{-10}$	MR	$9.73 * 10^{-10}$
	NMR	$8.95 * 10^{-10}$	NMR	$9.83 * 10^{-10}$	NMR	$1.07 * 10^{-9}$
	MRI	$5.26 * 10^{-10}$	MRI	$5.78 * 10^{-10}$	MRI	$6.29 * 10^{-10}$
CORNER	MR	$1.82 * 10^{-9}$	MR	$2.00 * 10^{-9}$	MR	$2.18 * 10^{-9}$
	NMR	$1.79 * 10^{-9}$	NMR	$1.97 * 10^{-9}$	NMR	$2.14 * 10^{-9}$
	MRI	$2.67 * 10^{-9}$	MRI	$2.93 * 10^{-10}$	MRI	$3.18 * 10^{-9}$
C-C	MR	$2.03 * 10^{-9}$	MR	$2.23 * 10^{-9}$	MR	$2.42 * 10^{-9}$

	NMR	$1.87 * 10^{-9}$	NMR	$2.06 * 10^{-9}$	NMR	$2.24 * 10^{-9}$
	MRI	$3.34 * 10^{-9}$	MRI	$3.67 * 10^{-9}$	MRI	$3.99 * 10^{-9}$

In addition, the activation energy(E_a) was calculated using the Arrhenius equation using the results at 50 °C and 70 °C. The activation energy was calculated as 17.99kJ/mol. In addition, convective heat transfer coefficent is calculated as 90.36 W/m^2.h. The convective heat transfer range for force convection is 10-500 W/m^2.h (Kosky et al., 2021).

4-) Conclusion

This study proves TD-NMR and MRI methods efficient and practical for determination of moisture content in chickpea samples. It was observed that the changes in diffusion coefficient varied with drying temperature, time and location. Further research is needed to better understand the underlying mechanism.

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Determination of Quality Characteristics of Naturally Debittered Olive Varieties in Turkey

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Abstract
Olive fruit (*Olea europea* l.), consumed as table olive or by processing to olive oil, has an important place in our country and in the world. Oleuropein, the dominant phenolic component in olive fruit, causes bitterness. While there is no need to remove oleuropein in olive oil production, it is removed in table olive production by brine or dry salting method. However, some special olive varieties in Turkey can be consumed as table olives without any pre-treatment (brine or dry salting). Attun, Kilis Yağlık olives are debittered by falling on the soil in Kilis region, Butko is debittered on the tree in Yusufeli district of Artvin, Hurma is debittered on the trees in the Izmir region, and Nizip Yaglik olive is debittered by falling on the soil in Nizip district of Gaziantep. These four olive varieties of which their bitterness decreased naturally, are special olives for Turkey. The aim of this study was to determine the moisture, protein and oil content, antioxidant activity, total phenolic content and fatty acid composition of Attun, Butko, Hurma and Nizip Yağlık olive varieties, which can be consumed as table olives without any pre-treatment. The moisture content of Attun, Butko, Hurma and Nizip Yağlık were determined as 6.84, 50.01, 38.61 and 27.92%, respectively. The protein content of the olive samples varied between 0.19-18.13%, and the oil content were between, 16.66-68.46%. DPPH radical scavenging capacity of Attun, Butko, Hurma and Nizip Yağlık were determined as 87.83, 77.56, 79.87, 83.46%, respectively. ABTS (mM trolox/g olive) values of Attun, Butko, Hurma and Nizip Yağlık were determined as 77.67, 26.00, 34.90, 51.62 and total phenolic content (mgGAE/100g) as 458.87, 152.09, 109.73, 234.33, respectively. The unsaturated fatty acid content of the olive samples was determined between 16.00-21.10%, whereas saturated fatty acid content of the olive samples were determined between 78.90-84.08%.
keywords; olive, table olives, natural debittering

Introduction

The olive tree, Olea europea, which is considered aa the symbol of goodness, wisdom, nobility and perseverance, is an evergreen tree native to the Mediterranean, Asia and Africa ((Ünsal, 2019; Wikipedia, 2019). Most of the olives are processed into oil and the remainder are processed into green and black olives (Kayahan and Tekin, 2006). The olive, which has a green color before ripening, begins to mature, depending on the variety, from yellow-green to brown, red-violet and gradually to black. The flesh of the olive fruit contains 60-75% water and 10-25% oil. In addition, the olive, which has low sugar content of 2-5%, contains more oil than other monoecious fruits, depending on the variety and harvest time. (Guo et al. 2018) Olive fruit contains 1.6% protein, 19% carbohydrate, 5.8% cellulose and 1.5% mineral matter, on average. Pectin, organic acid, pigments and phenol glycosides are important components of olive (Boskou et al. 2006).

The flesh of the olive fruit contains 2-3% phenolic compounds. These phenolic compounds are namely; oleuropein, hydroxytyrosol-4-β-D-glycoside, hydroxytyrosol, tyrosol, verbacoside, luteolin 7-Oglycoside, and rutin. The most dominant phenolic component in olives is oleuropein, and it is the compound that gives the bitter taste that prevents the direct consumption of olive fruit (Kailis and Harris, 2007). In order for olives to be consumed, it is necessary to remove the bitter compound oleuropein (Susamcı et al. 2017b). The bitterness of olive fruit, which is subjected to brine and fermentation,

decreases with the removal of oleuropein. As a result of the hydrolytic decomposition of oleuropein, ester and glycosidic bonds with the brine waiting process, it turns into hydroxytyrosol, elenoic acid glycoside and oleuropein aglycone, and the bitterness provided by oleuropein is reduced. Most of the fermentation starts spontaneously in the production of table olives, but Lactobacillus plantarum (L.plantarum) and Lactobacillus pentosus (L. pentosus) are used to ensure industrial fermentation (Guo et al. 2018). It is also known that the oleuropein compound contained in olives is hydrolyzed by enzymatic reactions. Hydrolysis by enzymatic reactions takes place in two stages. In the first stage, oleuropein is hydrolyzed to aglycone by the action of the enzyme oleuropein β-glucosidase, and in the second stage, it is hydrolyzed to hydroxytyrosol and elenoic acid by the action of the enzyme oleuropein aglycone esterase (Marsilio and Lanza 1998).

Table olives in the Turkish Food Codex are defined as "Cultured olive tree (Olea europaea L.) fruits subjected to pasteurization or sterilization process by removing the bitterness, by fermentation or not, and adding lactic acid and/or other additives when necessary, in accordance with the technique" (TGKY, 2014). However, as a result of the literature review, it has been determined that there are olive varieties which their bitterness reduced naturally. It has been understood that it is possible to consume these olive varieties without being subjected to fermentation. Throuba Thassos in Greece, Dhokar in Tunisia, Hurma in Turkey can be given as an example to this type of olive varieties (Jemai et al. 2009, Aktaş et al. 2014, Bouaziz et al. 2004, Melliou et al. 2015). However, as a result of the local researches, it was determined that the Kilis Yaglik olive (Attun), Butko olive and Nizip Yaglik olive varieties are naturally debittered. In this study, it was aimed to determine the quality characteristics of four olive varieties - Attun, Butko, Hurma and Nizip Yağlık- grown in Turkey that can be consumed without any pre-process.

Materials

Attun olives were collected from the olive trees of Kilis province known as "Gokdeniz". Butko olives were collected from Demirkent village of Yusufeli district of Artvin. Hurma olives were collected from the Karaburun district of Izmir. Nizip Yağlık olives were collected from the Nizip district of Gaziantep. Attun and Nizip Yağlık olives debittered on the soil were collected in first week of December 2019. Butko and Hurma olives were collected from the olive trees in second and third week of November 2019. Attun, Butko, Hurma and Nizip Yaglik olives were brought to Izmir after being picked. Olives were stored in a deep freezer at -18 °C until the analysis was completed.

Methods

Moisture Content: The olives whose flesh and kernelse were separated from each other were dried at 105±2°C until they reached a constant weight and the moisture content was calculated (Susamci et al. 2017a).

Oil Content: Olive samples, whose flesh and seed were separated, were dried in an oven at 105±2 °C. Dried olive fleshes were extracted with n-hexane in a soxhlet device for 8 hours (Susamcı et al. 2017 b).

Protein Content: The seed and flesh of the olives were separated and turned into olive paste. Protein content was determined by Dumas method by taking 0.25 grams of olive paste (Susamci et al. 2017a).

Total Phenolic Content: After separating the seeds, the olive samples were homogenized in the blender. 1.5 grams of sample was taken and 5 ml of methanol was added and mixed in a magnetic stirrer, this was repeated 5 times. After the evaporation of methanol, 5 ml of 80% methanol-water mixture (v/v) was added to the extract and passed through a 0.45-µm filter. 0.1 ml of the extract was taken, 5 ml of distilled water and 0.5 ml of Folin-Ciocalteu solution were added, and mixed in a vortex device for 5 minutes. 1 ml 7.5% Na_2CO_3 was added to the solution taken from the Vortex device and kept in the dark for 1 hour. At the end of the period, the absorbance value of the solution was determined at 750 nm by the

spectrophotometer. The total amount of phenolic substance in the olive samples was determined as gallic acid equivalent (Sahan et al. 2013).

Antioxidant Capacity:

Antioxidant activity determination was conducted by ABTS and DPPH methods. The same extraction method was used for both analyses.

Extraction: 250 ml of 80% methanol water mixture was added on 100 grams of homogenized olive paste. The solution was passed through filter paper after mixing, and washed with 100 ml of hexane to separate the olive oil. After the solvent phase in the extract is evaporated, it was kept at 0°C and in dark place until analysis (Jemai et al. 2009).

DPPH: 3.9 ml of 6×10−5 M DPPH solution was added on 0.1 ml of the extract and waited for 1 hour. Pure methanol was used as the blank solution and 3.9 ml of 6×10−5 M DPPH solution was added. The result was given as % inhibition value (Sahan et al. 2013).

ABTS: ABTS stock solution with a final concentration of 2.45 mM was reacted with potassium persulfate and left in the dark for 24 hours at room temperature. After a waiting period of 24 hours, dilution was made with phosphate buffer solution at 732 nanometers using the spectrophotometer until the absorbance value was brought to 0.70 ± 0.02. Olive extract (0.1 ml) was taken and 1.9 ml of ABTS solution with adjusted absorbance was added and the absorbance was determined. Readings are taken every minute until the 6th minute and the result was calculated in Trolox equivalent based on the calibration curve obtained with the trolox solution (Re et al. 1999, Jemai et al. 2009).

Fatty Acid Composition: After extracting 2 grams of pitted olive sample with 3 ml of cyclohexane the mixture was centrifuged at 4500 rpm for 30 minutes. After centrifugation the mixture was filtered on coarse filter paper and cyclohexane was evaporated (Cano-Lamadrid et al. 2015).

GC-FID (Agilent Technologies-7820A) was used to determine the fatty acid composition. In order to determine the fatty acid compositions, 0.2 g olive oil sample was weighed into a glass test tube and 0.4 ml of KOH solution with 4 ml of hexane and 2N methanol was added, this solution was centrifuged and 1µl was injected to the gas chromatography by taking the upper phase (García-González et al. 2014). SP-2380 column (60 meters long, 0.2 µm film thickness) was used and Helium was used as the carrier gas at 1ml/min flow rate. Temperature of the injector and detector was 250ºC. Temperature program was as follows: 170ºC for 10 minutes, the temperature was reached from 170ºC to 200ºC by increasing the temperatur 1.5ºC per minute and kept at 200ºC for 8 minutes.

Statistical Analysis

The data was analyzed by One-Way ANOVA Post-hoc Tukey's test at α=0.05 confidence interval by IBM SPSS 25 statistical program.

Results and Discussion

Moisture ,oil, protein , total phenolic content and antioxidant activity of the olive samples were given in

Table 1. Table 2 shows the results of fatty acid composition of the olive samples.

Table 1. Moisture, oil, protein, total phenolic content and antioxidant activity of naturally debittered olives

	Attun	Butko	Hurma	Nizip Yağlık
Moisture Content(%)	6.84±0.1^{a}	50.01±0.17^{d}	38.62±0.41^{c}	27.93±0.11^{b}
Oil Content (%)	68,46±0,1^{c}	16,66±1,31^{a}	36,29±3,46^{b}	34,88±3,39^{b}
Protein(%)	18.13±2.08^{c}	3.36±0.89^{ab}	0.19±0.082^{a}	4.46±1.04^{b}
Total Phenolic Compunds (mg GAE/ 100 g olive)	458.87±44.11^{c}	152.09±7.46^{a}	109.73±6.81^{a}	234.33±2.39^{b}
DPPH (%inhibition)	87.83±1.34^{c}	77.56±0.4^{a}	79.87±1.21^{a}	83.46±0.52^{b}

ABTS (mM Trolox/g olive)	77.67±1.91^{d}	26.03±0.58^{a}	34.9±0.51^{b}	51.62±1.14^{c}

Table 2. Fatty acid composition of olive varieties

Fatty Acid Composition	Attun	Butko	Hurma	Nizip Yağlık
Miristic acid(C14:0)	0.015±0.004^{bc}	0.009±0.001^{ab}	0.008±0.001^{a}	0.017±0.001^{c}
Palmitic acid(C16:0)	15.630±0.105^{c}	14.243±0.046^{a}	12.819±0.158^{b}	16.804±0.087d
Palmitoleic acid(C16:1)	1.305±0.013^{b}	2.202±0.017^{c}	0.713±0.011^{a}	1.292±0.007^{b}
Margaric acid(C17:0)	0.092±0.004^{b}	0.070±0.006^{a}	0.088±0.003^{b}	0.119±0.002^{c}
Margoleic acid(C17:1)	0.140±0.007^{a}	0.156±0.003^{a}	0.228±0.131^{a}	0.166±0.004^{a}
Stearic acid(C18:0)	3.480±0.006^{d}	2.880±0.018^{b}	2.582±0.013^{a}	3.386±0.003^{c}
Oleic acid(C18:1)	67.097±0.086^{c}	60.028±0.056^{a}	69.216±0.092^{d}	64.480±0.058^{b}
Linoleic acid(C18:2)	10,365±0,020^{a}	19,152±0,027^{d}	13,197±0,090^{c}	12,036±0.026^{b}
Linolenic acid(C18:3)	0.602±0.006^{b}	0.594±0.003^{b}	0.479±0.005^{a}	0.683±0.004^{c}
Arachidic acid(C20:0)	0.531±0.003^{c}	0.352±0.001^{a}	0.365±0.003^{b}	0.544±0.007^{d}
Gadoleic acid(C20:1)	0.252±0.003^{b}	0.194±0.002^{a}	0.251±0.006^{b}	0.244±0.003^{b}
Behenic acid(C22:0)	0.135±0.003^{c}	0.082±0.001^{a}	0.090±0.001^{b}	0.136±0.003^{c}
Lignoseric acid(C24:0)	0.086±0.001^{c}	0.039±0.002^{a}	0.047±0.002^{b}	0.095±0.002^{d}

Considering the moisture content, Butko was determined to have the highest moisture content (%50.01±0.17), and Attun the lowest moisture content (%6.84±0.1). The moisture content of Butko and Hurma was higher than Attun and Nizip Yağlık, because these 2 olives debittered before falling to the ground, and Attun and Nizip Yağlık debittered after falling to the ground. In addition, it was observed that Attun and Nizip Yaglik olives had wrinkled surface, while Butko and Hurma had a fleshier and smooth surface. While Nizip Yağlık, Hurma and Attun olives are statistically different, butko olives are statistically similar to Nizip Yalık and Hurma olives. When the oil content of olives was examined, it was determined that Attun olive had the highest oil content with 68.46%. Although the oil content of Hurma and Nizip Yaglik olives are statistically similar, Attun and Butko olives are statistically different from these two olives ($p<0.05$). It has been observed that Attun olive has the highest protein content with 18.13±2.08% protein content. The reason for this may be that the analysis result is given on a wet basis and that the attun olive has the highest dry matter among the four olive varieties. While there was no statistical difference between Butko and Hurma olives in terms of total phenolic content, statistical

difference was determined between Attun and Nizip Yaglik olives ($p<0.05$). While Attun had the highest phenolic content as 458.87±44.11 mg GAE/100g olive, Hurma olives had the lowest phenolic content as 109.73±6.81 mg GAE/100g olive. Similar results were obtained after ABTS and DPPH analyzes. In the DPPH method, Attun provided the highest inhibition with 87%, while Butko provided the lowest inhibition value with 77.56%. In ABTS method, Attun with 77.67 mM Trolox/g olive had the highest value, and Butko with 26.03 mM Trolox/g olive had the lowest value. However, in the results obtained with the ABTS method, statistical difference was observed in all 4 olive varieties, while no statistical difference was observed between the Butko and Hurma olives in the results obtained by the DPPH method.

Oleic acid content of Attun, Butko, Hurma and Nizip Yağlık olives were determined as % 67.097±0.086, 60.028±0.056, 69.216±0.092, 64.480±0.058, respectively. Linoleic acid content of Attun, Butko, Hurma and Nizip Yağlık olives were determined as % 10.365±0.020, 19.152±0.027, 13.197±0.090, 12.036±0.026, respectively. No statistical difference in margoleic acid values were determined for all the olive samples ($p<0.05$). Statistical difference was determined in palmitic acid, oleic acid, stearic acid, linoleic acid, arachidic acid and lignoceric acid for all the olive samples ($p<0.05$). Also according to the Turkish Food Codex, oils obtained for the analysis from olive samples are classified as extra virgin olive oil.

Conclusion

The quality characteristics of all four olive varieties in Turkey whose bitterness decreased naturally were determined in this study. Statistically, it was determined that all the olive samples were different from each other as a result of major fatty acids (palmitic, stearic, oleic, linoleic, araschidic and lignoseric acid) and moisture content. Attun olives had the highest oil, protein and total phenolic content, and DPPH radical scavenging (%inhibition) activity and ABTS (mM Trolox/g olive) was also determined to be high in Attun. Butko olives had the lowest oil content and DPPH radical scavenging (%inhibition) activity. Protein and total phenolic content were determined to be low in Hurma olive. In order to examine the growing and over-ripening

conditions of olives, different statistical methods should be carried out in future studies and the enzyme activities of olives under ripening conditions, the volatile components in the final product should be examined, and sensory analysis and market studies should be carried out in order to increase the consumption of these olives.

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Green Production of Bacterial Polygalacturonase Enzyme Using Apple Pomace to Minimize Waste Disposal

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Abstract

In this study, *Bacillus subtilis* was used as polygalacturonase (PGase) producer by growing in the fermentation medium prepared by hydrolyzing the dried and ground apple pomace with dilute acid with initial solid mass amount of 10 g/L. All fermentation experiments were conducted with 100 mL fermentation medium in 500 mL Erlenmeyer flasks at 30 °C, 130 rpm, and initial pH of 5.0. The PGase production and reducing sugar consumption were monitored every 24 h for 1-3 days using DNS method. The highest PGase production (9.8 U/mL) was observed at the second day of fermentation when the fermentation medium, whose pH value is 5, was provided with additional substrate of 1 g at the beginning of the fermentation; enzyme activity also increased (7.24 U/mL to 8.16 U/mL) when the additional pectin was supplemented to the fermentation medium after 24 h. The results indicated that apple pomace medium can be successfully manipulated to improve bacterial PGase production.

Introduction

Due to increased need of waste management and utilization, lignocellulosic residues which are the results of fruit or vegetable processing industries have recently been popular as a subject of scientific studies. One example, apple pomace is a lignocellulosic residue of apple processing industry, which is generally under-utilized and accounts for 30% of the original fruit. After the apples are processed to produce juice, jelly, etc., the remaining parts of the apple is considered as waste and is called apple pomace (Fig.1), and it mainly contains peel, core, seed, and soft tissue (Vendruscolo et al., 2008). Apple pomace is generally used as animal feed additive rather than animal feed due to its low protein and vitamin concentration; however, this utilization is not enough for recycling all the waste from apple processing industry considering millions of metric tons of apple pomace produced per year (Gama et al., 2015). Given that approximately 11.3 million metric tons of apple is processed globally, disposal of apple pomace without utilization creates a serious environmental burden (Masoodi et al., n.d.).

Turkey is the third largest apple producer, accounting for 4% of total worldwide production (Kuvvet et al., 2019). Despite large amounts of worldwide-generated apple pomace, only a small fraction of this waste is reused (Lyu et al., 2020). Due to its high pectin content, apple pomace is considered as a lignocellulosic material and is a good substrate for industrial enzyme production by microorganisms that can utilize pectin (Joshi et al., 2011); it can also be used for producing other commercial products, such as biofuel (bioethanol) and protein-enriched feeds (Vendruscolo et al., 2008). Hence, bioprocessing of apple pomace with bacteria for producing enzyme and other industrial products can extensively reduce the disposed amount of apple pomace, thus providing a green approach for producing commercially available products.

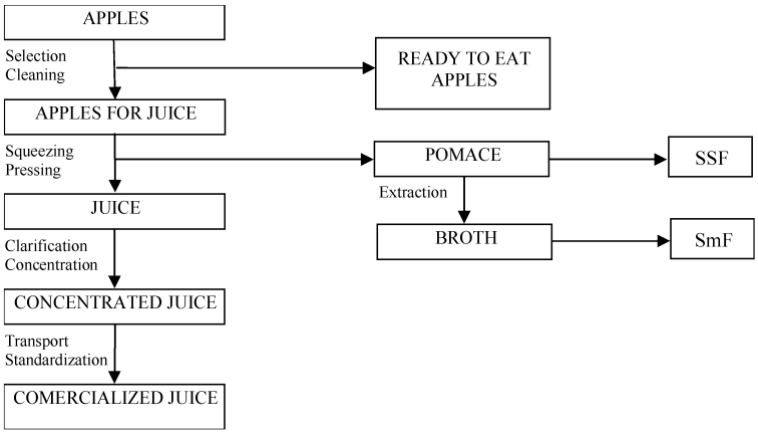

Figure 1. Flowchart of apple processing for juice production (Vendruscolo et al., 2008).

In this study, it was aimed at production of polygalacturonase (PGase), which is an enzyme belonging to the group of pectinases, from apple pomace using *Bacillus subtilis* NRRL B-4219 through submerged fermentation (SmF). The goal of the study is to minimize waste disposal by utilizing apple pomace, as well as to obtain PGase, whose substrate is D-galacturonic acid (main component of pectin), as a potential commercial product.

Materials and Methods

Apple pomace was obtained from Göknur Foodstuff Company in undried form. Subsequently, apple pomace was dried with a dryer machine and ground to obtain 1 mm particles (Fig. 2). For fermentation medium preparation, apple pomace was used at certain solid loads (1%, 3%, and 5% w/v) and treated with 2% w/v H_2SO_4 solution. Once the required amount was prepared in an autoclavable glass bottle, the resulting medium was autoclaved at 121 ^oC for 15 min. When the hydrolysate was cooled down to the temperature to be handled safely (usually 30-40 ^oC), it was vacuum filtered in order to eliminate the residual solid mass. The resulting liquid is so-called the apple pomace hydrolysate was utilized as fermentation medium after adjusting pH to required design values (5, 7, 9) and then centrifugation (at 8000xg for 10 minutes) to eliminate undesired particles (e.g., salt) resulting from adjusting the pH of the hydrolysate (Fig. 3). Finally, 100 mL of apple pomace hydrolysate was placed into 500 mL Erlenmeyer flasks that are subsequently sterilized by autoclave (at 121 ^oC for 15 min). After cooling down to the room temperature, fermentation media was inoculated with *Bacillus subtilis* to initiate the fermentation process.

Figure 2. Ground apple pomace with 1 mm particle size.

Figure 3. Apple pomace hydrolysate.

Nutrient broth (NB) was used for growing *Bacillus subtilis* NRRL B-4219. NB was prepared by autoclaving the dissolved medium at 121 ^oC for 15 min and cooling down to room temperature (Fig. 4). The sterile growth medium was inoculated by *Bacillus subtilis* NRRL B-4219 stored at -20 ^oC in 1.5 mL Eppendorf tubes with glycerol+water mix and subsequently placed into the shaker-incubator at 30 ^oC and 130 rpm up to optimal growth (OD at 600 nm is 1-2), typically lasted for 18 h.

Figure 4. Nutrient broth.

The fermentation was initiated by inoculating the fermentation media (apple pomace hydrolysate) with *Bacillus subtilis* grown in the nutrient broth. When it was required, a sample was taken at t = 0 immediately after inoculation. Flasks that contain the inoculated fermentation media were placed into the shaker incubator at 30 °C and 130 rpm. After starting the fermentation, 1 mL of sample was taken per day for analyses of enzyme activity and reducing sugar amount, with the first day being 24 h after the inoculation. Occasionally, additional samples were taken at different times of fermentation (every 6 hours, two times a day, every two hours during a 6-hour span). The samples were kept in 1.5 mL of Eppendorf tubes and centrifuged using a mini centrifuge for 10 min and the supernatant was used for the necessary analyses.

For the pectinase assay, appropriately diluted 0.5 mL of enzyme sample was mixed with 0.5 mL of substrate (PGA) and 0.5 mL phosphate buffer, and incubated at 50°C in a water bath for 30 min. Enzyme and substrate controls were also incubated along samples. Samples were heated at 95 °C in a water bath for 15 min after adding 3 mL DNS (Fig. 5). Subsequently samples were cooled to room temperature and their absorbance values were measured by a spectrophotometer at 575 nm (Fig. 6). Enzyme activity units was obtained with the aid of a standard curve. For the reducing sugar test, 3 mL of DNS was mixed with the diluted samples (with distilled water) and placed in the 95 °C water bath for 15 min. Absorbance was then measured by a spectrophotometer at 575 nm (Miller, 1959).

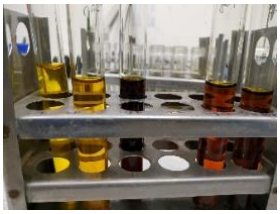

Figure 5. Reducing sugar test after water bath.

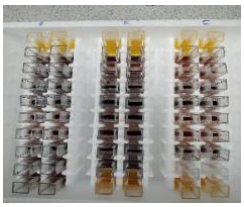

Figure 6. Samples for the spectrophotometer.

Additional substrate (pectin) was also used in some of the experiments. When it was added before the fermentation, solid form was directly added to the fermentation medium before the sterilization step. However, pectin was dissolved in distilled water to form a solution to add to the fermentation medium, in addition to using in the solid form (Fig. 7). In both solution and solid forms, pectin was sterilized before its addition to the fermentation medium.

Figure 7. Pectin in solution form (in distilled water & sterilized via autoclave).

Results and Discussion

The first experiment was to determine the optimal time for the maximum enzyme activity, i.e., to determine the optimal fermentation time using 1% solid load hydrolysate and monitoring for seven days for the enzyme activity and reducing sugar amount. The highest enzyme activity was observed on the first two days of fermentation (Table 1 and Fig. 8), therefore all the experiments after this one was carried out for 2 or 3 days.

Table 1. Enzyme activity and reducing sugar amount per day.

Day	Enzyme activity (U/mL)	Reducing sugar (g/L)
0		8.10
1	7.97	8.66
2	8.04	8.66
3	6.57	8.12
4	7.01	7.99
5	6.04	6.28
6	5.21	5.38
7	5.01	4.97

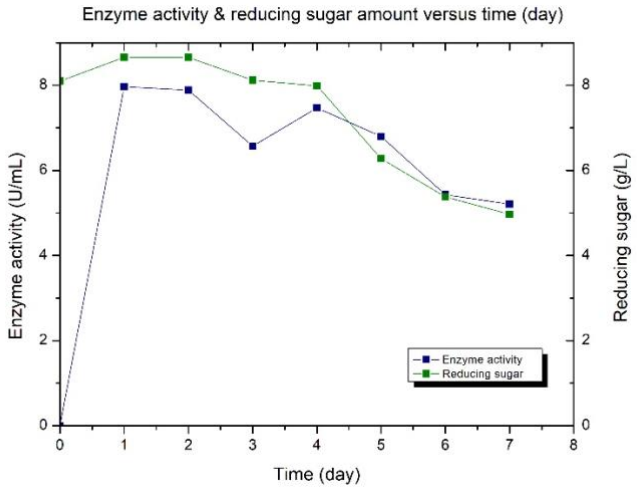

Figure 8. Enzyme activity and reducing sugar amount per day.

Second step was to determine the optimal solid load that would give the highest enzyme activity. Initial pH was 5 for all the experiments, where different solid loads were tried. The highest yield was observed with 1% solid load (Fig. 9); even though it is generally expected that enzyme activity would be higher when the initial fermentable sugar amount is higher. As a result, the rest of the experiments was carried out with 1% solid load.

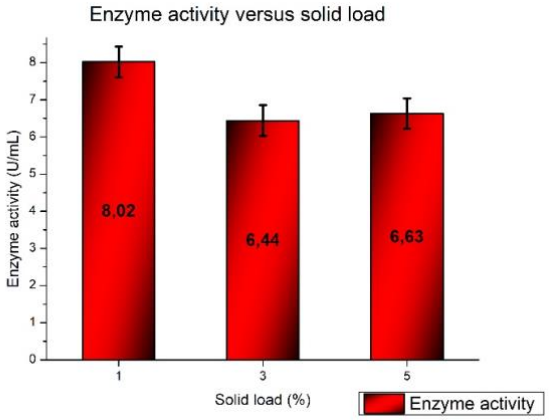

Figure 9. Enzyme activity on 2nd day for solid loads (apple pomace) 1%, 3%, and 5%.

The next step was to determine the optimal pH for *Bacillus subtilis* to grow desirably to produce the highest enzyme activity; pH values of 5,7, and 9 were tested while the solid load was the same for all (5%). Not only higher enzyme activity was observed at pH = 5 compared to the others, but also a drastic decrease was observed for pH = 7 & 9 on the third day (Table 2 and Fig. 10). More undesired substances (such as salt) might form when more alkali buffer was used to increase the pH to higher values; thus, altering the enzyme activity.

Table 2. Enzyme activities per day according to pH values.

Time (day)	Enzyme activity (U/mL)		
	pH = 5	**pH = 7**	**pH = 9**
1	4.95	Not determined	Not determined
2	6.63	6.22	6.66
3	6.95	3.55	2.78

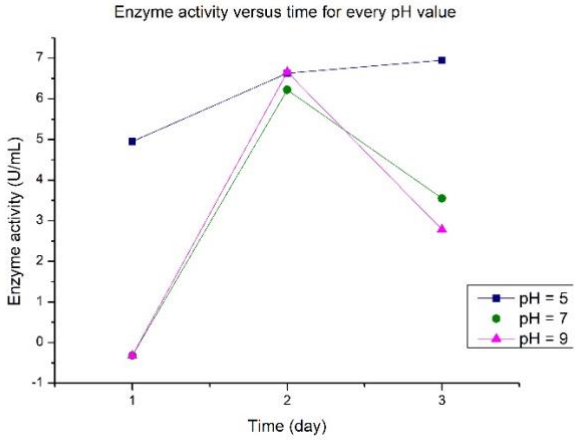

Figure 10. Enzyme activities per day according to pH values.

Finally, the effect of additional substrate (pectin) was observed: different amounts of pectin was added to the fermentation media before or during the fermentation process. The results were assessed by ANOVA, for the addition time and pectin amount factors separately (Table 3). When a Tukey's range test was applied, 1% - 0.02% and 1% - 0.03% groups of the pectin amount factor showed significant results with 95% confidence interval ($p < 0.05$) and t = 0h – t = 24h group of the addition time showed significant results with 95% confidence interval ($p < 0.05$) (Fig. 11&12).

Table3. Substrate addition before or during ongoing fermentation.

Pectin amount (%)	Addition time (h)	Enzyme activity (U/mL)
0.01	24	7.98 ±
0.01	24	7.95 ±
0.02	24	7.39 ±
0.02	24	7.32 ±
0.03	24	6.93 ±
0.03	24	7.37 ±
1	0	9.80 ±
1	0	8.57 ±
3	48	8.36 ±
3	48	8.44 ±

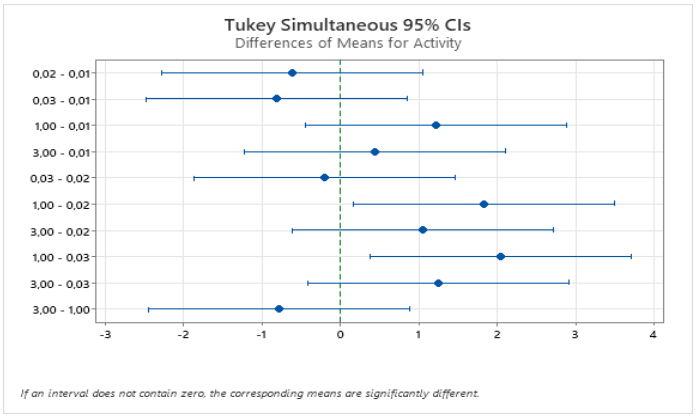

Figure 11. Tukey's range test for all groups of pectin amount factor.

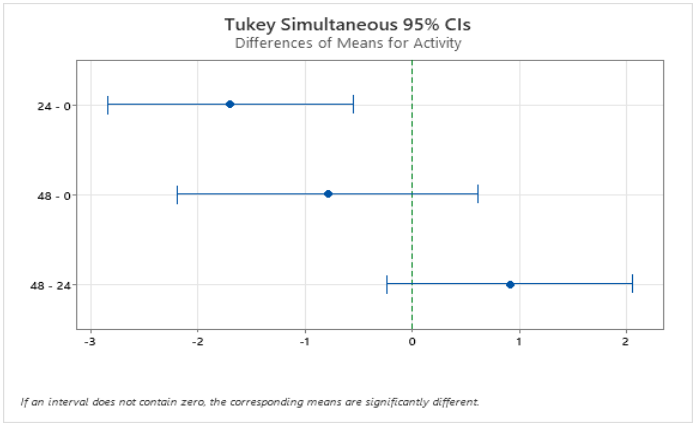

Figure 12. Tukey's range test for all groups of addition time factor.

Conclusion

Every year, millions of metric tons of apple is produced worldwide; a considerable amount of these apples are processed for various purposes, which also means tons of apple pomace to be generated. Given that disposal of this much apple pomace creates a major environmental problem, utilization of the apple pomace started to gain attention by industrial companies and scientists to obtain valuable products; such an example is producing bacterial polygalacturonase enzyme using microorganisms(Zheng & Shetty, 2000). In this study, *Bacillus subtilis* was used for producing polygalacturonase enzyme from the apple pomace with submerged fermentation (SmF). Initial results of our study indicate that the apple pomace, which has a high pectin content, is a suitable substrate for *Bacillus subtilis* to produce polygalacturonase enzyme (a member of the group of enzymes called

pectinases) under adjusted conditions and thus apple pomace has merit for use at a larger scale in further studies.

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Determination of hydroxymethylfurfural (HMF) Content in Different Types of Coffee Drinks Using by HPLC-DAD Method

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Abstract
Hydroxymethylfurfural (HMF) is formed by the dehydration of sugars in the final step of the Maillard reaction which is a non-enzymatic browning reaction. HMF has become a substance of interest since recent results showed a possible carcinogenic potential in consequence of a metabolic activation by sulfotransferases. The HMF content is an index of quality product and the severity of the heating processing. Coffee, as a source of HMF needs to be investigated to understand the contribution of different precursors. In this study, the analysis of HMF in different roasted (medium, dark) Turkish coffee powder and drink, instant coffee powder (classic, gold) and drink were determined. The HMF content in powder and coffee were analysed by high performance liquid chromatography (HPLC) coupled to diode array detector (DAD). In this study, we reported the HMF content of instant coffee was 1000-1500 mg/kg, Turkish coffee drinks varies between 300-400 mg/L. The highest HMF value was found in the 1000-2000 mg/kg range of instant coffee powders. HMF is formed during the roasting process in high amounts at 240 °C. However, the degradation is rather quick and commercially roasted coffee contains less HMF than expected. The differences in the HMF content of the types of coffee and powder were significant *(P<0.05)*.

Keywords: *Coffee, HMF, HPLC-DAD*

Introduction

Coffee is one of the world's most consumed foods. Coffee consumption is mainly known for its pleasant taste and aroma, the positive sensations it produces and its physiological effects (Pellegrini et al., 2003). However, excess coffee consumption may pose a health risk owing to exposure to some of the toxic substances produced in coffee (Farias-Pereira et al., 2019). Coffee is one of the most important sources of HMF. Furan and furan derivatives are recognized as potentially toxic to humans and animals and posing a genotoxic risk to humans (EFSA, 2011; Kim et al., 2015). HMF is converted *in vivo* to 5-sulphoxy-methylfurfural (Arribas-Lorenzo & Morales, 2010), which has shown to induce genotoxic and mutagenic effects in bacterial cells (Park et al., 2021).

The Maillard reaction product HMF is formed under acidic conditions by the dehydration of sugars in carbohydrate-based food products during heating and storage. It is one of the most significant products of non-enzymatic Maillard reaction (Morales, 2008). Upon heating food that contains sugar or carbohydrates, it forms because of hexose reduction reaction in the presence of amino-acids or proteins (Ruiz-Matute et al., 2010). Honey, juices, syrups, coffee, and most other carbohydrate-rich food contain HMF (Makawi et al., 2009). The presence of HMF has been reported in several foods, including honey, grain products, biscuits, cereals, UHT milk, tomato products, instant coffee, dried fruits, bread, pasta, citrus juices, beer, syrup, jams, canned peach, dried grape, alcohol, apple juice, milk and cereal based infant formula. Despite HMF is highly concentrated in some foods such as dried fruits and caramel products, coffee is the most important contributor to dietary HMF intake (Murkovic & Pichler, 2006).

The presence of HMF in foods reflects a breakdown or change of substances containing sugar, which is why HMF levels in food are generally analyzed for quality control purposes (Ünüvar, 2018). Some factors that influence the rate of HMF formation include the processing temperature, type of sugar, pH

and water activity. It is known that HMF levels increase in foods preparations stored at high temperatures and for long durations after production (Toker et al., 2013).

The amounts of HMF in coffee are affected by the type of coffee bean, and the roasting temperature and time (Guenther et al., 2010; Kim et al., 2021; Murkovic & Bornik, 2007). HMF, whose effects on health are still controversial, is one of the intermediates formed in coffee during roasting (Yaylayan et al., 2003; Hamzalıoğlu & Gökmen, 2020). It is mainly formed in foods because of thermal process via the Maillard reaction and directly from sugar decomposition. Its amount in foods is related to heat load applied during processing, and thus, it could be used as a quality marker in wide range of thermally processed foods including roasted coffee (Capuano & Fogliano, 2011). The coffee roasting degree is controlled by roasting time and temperature and is usually qualitatively assessed from color and classified as a light, medium or dark roast coffee (Somporn et al., 2011). The chemistry of coffee roasting is complex and is still not completely understood. Maillard reaction, lipid oxidation and sugar decomposition are the main reactions taking place simultaneously during roasting (Senyuva & Gökmen, 2005; Kocadağlı et al., 2012). The roasting process causes changes in the chemical composition and biological activity of the coffee: while natural phenolic compounds may be lost, other antioxidant compounds are formed, such as Maillard reaction products (Wang et al., 2011).

Various methods have been defined for the measurement of HMF levels, including colorimetric, spectroscopic, chromatographic, polarograph. HPLC method and spectrophotometric methods were recently tested by the International Honey Commission (IHC, 1999). In the other spectrophotometric method, the UV absorbance of solutions with barbituric acid and p-toluidine is measured. Although these two methods are fast, their sensitivity and specificity are not sufficient. In addition, the use of carcinogen p-toluidine in the spectrophotometric method is a disadvantage. The disadvantage of the HPLC method is that it is more expensive, but it provides advantages in terms of both labor and time (Ünüvar, 2018).

In this study, the analysis of HMF in different roasted (medium, dark) Turkish coffee powder and drink, instant coffee powder (classic, gold) and drink were determined. The HMF content in powder and coffee were analysed by high performance liquid chromatography (HPLC) coupled to diode array detector (DAD).

Material and Method

The study was carried out using different coffee samples obtained from a local coffee store in Manisa, and 0.5 mL were taken from the coffee samples and 0.5 grams were taken from the coffee powder samples. Then samples were dissolved in 10 mL of ultrapure water. Afterwards, the falcon tubes were kept for 15 minutes an ultrasonic water bath and centrifuge, respectively and the supernatant was taken. Before injection into the HPLC column, the solutions were sampled into syringes and passed through a 0.45 μm filter and then transferred to 1.5 mL amber vials (Toker et al., 2013).

Preparation of Coffee Samples

To ensure that the cooking method is standard, coffee samples (instant and Turkish) were prepared using the Coffee Machine (Arnica Foamy Rose, Turkey). The amount of coffee and water used in cooking is 5 g and 65 mL, respectively. The samples were prepared with a ratio of 5 g coffee/65 mL water (Kıvançlı & Elmacı, 2014). The analysis of HMF in different roasted (medium, dark) Turkish coffee powder and drink, instant coffee powder (classic, gold) and drink were determined.

Preparation of Standard Solutions

These were prepared 100 ppm of stock standard solution. From this stock standard were completed to using ultrapure water, which provided 0, 10, 50, 80, 100 ppm standard solutions ($y=512.54x+933.18$, $R^2=0.9963$).

HPLC Analysis

Chromatographic analysis of HMF were carried out using the methods described by Mortas et. al. 2017. The quantification of HMF were simultaneously conducted with a HPLC system (Agilent 1260 Infinity, USD) equipped with a pump, auto sampler, diod array detector. The chromatography column was an ACE 5 C18, 5 µm, 250 mm × 4.6 mm (Scotland). Isocratic elution was performed using water:acetonitrile:acetic acid (89:10:1, v:v:v) as the mobile phase at a flow rate of 0.7 mL/min. Injection volume was assayed as 50 µL. The detection of HMF was carried out at the wavelengths of maximum absorption of the compounds to 285 nm.

Statistical Analysis

All analytical determinations were performed in duplicate. Statistical analysis was performed using SPSS 22.0. The differences of mean values among samples was determined using One-way analysis of variance (ANOVA) followed by Duncan.

Results and Discussion

Figure 1 introduce chromatogram of HMF standard while Figure 2 introduce chromatogram of HMF in roasted coffee sample (Retention Time: 10 min)

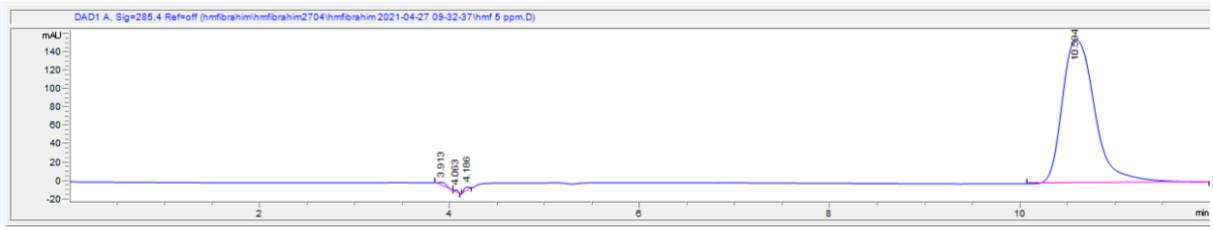

Figure 1. Chromatogram of injected standard HMF

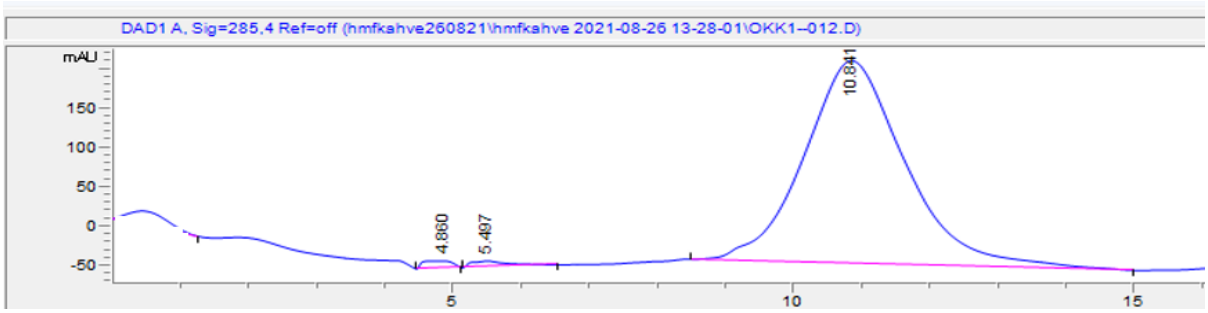

Figure 2. Chromatogram of HMF in a coffee sample

The total HMF content of the coffee powders subjected to different types of roasting and instant are shown in Table 1.

Table 1. HMF content of roasting and instant coffee powders

Sample	Concentration (mg/kg)
GP	$1936.37^{a} \pm 47.85$
CP	$1788.18^{a} \pm 78.79$
MRP	$1042.37^{c} \pm 52.06$
DRP	$936.38^{c} \pm 59.11$

GP: *Gold instant coffee powder*, CP: *Classic instant coffee powder*, MRP: *Medium roast coffee powder*, DRP: *Dark roast coffee powder*

The total HMF content of the coffee drinks subjected to different types of roasting and instant are shown in Table 2.

Table 2. HMF content of roasting and instant coffee drinks

Sample	Concentration (mg/L)
CC	$1176.64^{c} \pm 40.90$
GC	$1473.85^{b} \pm 31.75$
DRC	$358.82^{d} \pm 14.88$
MRC	$374.66^{d} \pm 28.16$

GC: *Gold instant coffee*, CC: *Classic instant coffee*, MRP: *Medium roast coffee*, DRP: *Dark roast coffee*

The HMF content in powder and coffee were analysed by HPLC coupled to diode array detector (DAD). In this study aimed to determine HMF levels in different coffee powders, roasted coffee, and instant coffee. HMF was found in all samples of coffee powder, roasted coffee, and instant coffee. The levels of HMF in instant coffee were significantly higher than those roasted coffee ($P<0.05$). The levels of HMF content in medium roasted coffee are higher than dark roasted coffee but there was no statistical difference ($P>0.05$). Further roasting leads to decreases in HMF contents probably because of the occurrence of consequent degradation reactions. This explains the decreases of HMF contents, which was noted in our study, in dark roasted coffee compared to other types.

In a study, the levels of HMF content in instant coffee samples varied between 525 – 2000 mg\kg (Alsubot & Aldiab, 2019). Similar results were obtained by Arribas-Lorenzo and Morales, the levels of HMF as 625, 2480 mg HMF/kg in roasting of coffee and instant coffee, respectively. Additionally, found that instant coffee showed the highest level (Arribas-Lorenzo & Morales, 2010). Other studies found that HMF content ranged between 400-5000 mg/kg in instant coffee and 250-550 mg/kg in roasting coffee (Husoy et al., 2008; Toker et al., 2013; Akılıoğlu & Gökmen, 2014; Mortas et al., 2017).

Several types of roasted coffee were analysed that contained from 300 to 2900 mg/kg of HMF (Murkovic & Pichler, 2006). HMF were quantified in 108 coffee models. The range of HMF in coffee samples was determined as 51-1143 ppm.The levels of HMF was increased with the addition of sugars but decreased when condensed milk was added. The results of this study can be useful to find the coffee-making conditions that reduce the contents of potentially toxic compounds, specifically, HMF (Park et al., 2021). HMF is formed during roasting of coffee as a result of the Maillard and sugar dehydration reactions. Its content ranges between 100 and 4000 mg/kg (Capuano & Fogliano, 2011). Its concentration reached to 237.90 ± 10.72 mg/kg, 449.78 ± 2.86 mg/kg and 233.71 ± 7.15 mg/kg HMF after 15 min, 10 min, and 8 min of roasting, at 200 °C, 220 °C and 240 °C, respectively (Kocadağlı, 2012; Hamzaoğlu&Gökmen, 2020). Coffee is known to be the most important source of HMF in daily diet (Arribas- Lorenzo & Morales, 2010). In a study on dietary exposure to HMF from a Norwegian population, coffee was identified as the most important source of HMF (63%), both because of the high levels of HMF in coffee because of the high consumption (Husøy et al., 2008).

Conclusion

Thermal processing contaminants like HMF is a very important issue for the food industry. Coffee is one of the most important sources of HMF. The coffee consumption of Turkish population has increased in recent years and coffee is known as one of the most important sources of HMF. In addition, there is no international or local regulation about the limit of HMF or related substance in coffee. Considering all these, first, the dietary exposure of HMF and other undesirable substances should be carefully re-evaluated after the investigation of their presence in the different classes of coffee present in the market and mitigation strategies specifically addressed to reduce HMF levels in coffee should be investigated.

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Effects of Autochthonous Lactic Acid Bacteria Strains on Growth of *Staphylococcus aureus* in Heat Treated Sucuk

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Abstract

The aim of the study was to investigate the effects of autochthonous lactic acid bacteria strains (*Lactobacillus plantarum* S91, *Lactobacillus sakei* S15, *Pediococcus acidilactici* S147b) on the growth of *Staphylococcus aureus* during fermentation in heat-treated sucuk.

Five different heat-treated sucuk batters were prepared using autochthonous strains (Control, *L. plantarum* S91, *L.sakei* S15, *P. acidilactici* S147b or *L. plantarum* S91 + *L. sakei* S15 + *P. acidilactici* S147b). Sucuk batters were contaminated with *S.aureus* at the level of 10^5 cfu/g. After fermentation (22°C) and heat treatment (68°C internal temperature), the heat-treated sucuk groups were dried at 18°C. Samples taken during fermentation (0, 24, 48 and 72 h) were analyzed. The samples taken after heat treatment and drying stages were also analyzed.

In the control group without starter culture, a significant increase in the count of *S. aureus* was determined during the fermentation stage. There were no significant changes in the count of *S. aureus* in the presence of autochthonous strains. The strains showed a good growth during fermentation and caused a significant decrease in pH value. After heat treatment, the counts of *S. aureus*, lactic acid bacteria, yeast and mold were found below the detectable limit (<100 cfu/g) in all heat-treated sucuk groups. At the end of drying, the a_w value varied between 0.927 and 0.935 in heat-treated sucuk groups. In addition, enterotoxin was not detected in the final products.

The autochthonous strains used decrease the pH value during fermentation in heat-treated sucuk, which is a semi-dry fermented sausage type, and thus the growth of *S. aureus* can be inhibited. On the other hand, even at the level of 10^6 cfu/g *S.aureus*, no enterotoxin is formed in the control group without starter culture.

Keywords: *S.aureus*, Heat-treated sucuk, Autochthonous strains, *L. sakei*, Staphylococcal enterotoxin

Introduction

Heat-treated sucuk is a type of semi-dry fermented sausage. Production of heat-treated sucuk was first seen in the 1980s by adding the heat treatment to the production process of sucuk due to food safety concerns. (Tayar 1989; Kaban and Bayrak 2015). Meat and meat products, including fermented sausages, constitute a significant proportion of staphylococcal intoxications (Ananou *et al.* 2005).

Fermented sausages present a good environment for *Staphylococcus aureus* with their initial pH and a_w values (Lücke 1998; Sameshima *et al.* 1998; Hampikyan 2009). Fermentation is also the most critical stage for the development of this pathogen. Fermented sausages are considered safe foods due to the decrease in pH and a_w during fermentation and drying. However, it is stated that pathogenic microorganisms can survive during ripening (Ferreira *et al*. 2006). In fact, it has been reported that *S. aureus*, an important foodborne pathogen, can grow during early stages of fermentation in dry fermented sausages and produce enterotoxins (Gonzalez-Fandos *et al.* 1999; Rajkovic *et al.* 2017; Paramithiotis and Drosinos 2017). On the other hand, inactivation of staphylococcal enterotoxins is not possible under heat treatment conditions (internal temperature of 60-68 °C) applied to heat-treated sucuk (Müller and Weber 1996; Akkaya *et al.* 2014). Therefore, the growth of *S.aureus* during the fermentation stage is of great importance for product safety.

No studies have been carried out on the growth and toxin production of *S. aureus* under the production conditions of heat-treated sucuk. The aim of the study was to determine the effect of autochthonous lactic acid bacteria strains (*Lactobacillus plantarum S91, Lactobacillus sakei S15, Pediococcus*

acidilactici S147b) on the growth of *S. aureus*. The study also aimed to investigate the presence of enterotoxins in the final products with and without autochthonous strains.

Material and Method

Material

Beef and beef meat fat were used as raw materials in the study. *Lactobacillus sakei* S15 (KR025387), *Lactobacillus plantarum* S91 (KT327838) and *Pediococcus acidilactici* S147b (KT275957) strains isolated from traditional sucuk samples were used as starter cultures. *S. aureus* ATCC 51740 strain was used in the inoculation of heat-treated sucuk batters with *Staphylococcus aureus*.

Heat-treated sucuk production

To produce heat-treated sucuk 20 g salt, 10 g garlic, 4 g sucrose, 2.5 g allspice, 5 g black pepper, 7 g red pepper, 9 g cumin and 0.15 g sodium nitrite were used for each kg of meat-fat mixture (80% lean beef + 20% meat fat). Productions were carried out using 3 different raw materials at 3 different times. Laboratory type cutter (MADO Type MTK 662, Dornhan /Schwarzwald) was used in the preparation of the batters. No starter culture was used in the control 1 group (Group A). Group B sausage batters was contaminated with *S. aureus* at the level of 10^5 cfu/g. For groups C, D, E and F, each strain was 10^7 cfu/g, respectively, *L. sakei* S15, *L. plantarum* S91, *P. acidilactici* S147b, *L. sakei* S15 + *L. plantarum* S91 + *P. acidilactici* S147b inoculated. Groups C, D, E and F were also contaminated with *S. aureus* at 10^5 cfu/g. A laboratory type filling machine (MADO Typ MTK 591, Dornhan/Schwarzwald) was used to fill the sausage batters. The fermentation was carried out at 22±1°C and 92±2% relative humidity for 3 days in a climate-chamber (Reich, Germany). After fermentation, each group was heat treated in a cooking chamber (Mauting, Czech Republic) until an internal temperature of 68°C. The heat-treated sucuk groups were taken back to the climate-chamber and dried at 18±1°C and 84±2% relative humidity.

Method

Sampling

The samples taken after the fermentation (24, 48 and 72 h), heat treatment and drying stages and the samples from the heat-treated sucuk batters were subjected to microbiological and physico-chemical analysis.

Analysis

Twenty five-gram samples were homogenized in 225 ml of sterile physiological saline (0.85% NaCl) for 1 min using a Stomacher Homogenizer (Lab Stomacher Blander 400—BA 7021, Seward Medical). Further decimal dilutions were prepared. Baird-Parker's egg yolk tellurite agar (BP, Merck) was used to determine the number of *S. aureus*. The plates were incubated at 37 °C for 48 h. The number of lactic acid bacteria was determined on De Man, Rogosa, Sharpe agar (MRS, Merck) at 30 °C for 48 h under anaerobic conditions (Anaerocult A, Merck), Enterobacteriaceae on Violet Red bile dextrose agar (VRBD, Merck) at 30 °C for 48 h under anaerobic conditions (Anaerocult A, Merck). The number of yeast and mold was determined on Rose Bengal Chloroamphenicol agar (RBC, Merck) at 25 °C for 5 days.

In the analysis of staphylococcal enterotoxin, the VIDAS Staph enterotoxin II (SET2; Biomerieux. REF 30 705) ELFA (enzyme-linked fluorescent immunoassay) method was used (AOAC 070404/2007:06).

The water activity value of the samples was measured using the water activity device (NOVASINA, Model TH 500, Switzerland).

To determine the pH values of the samples, 10 g of the sample was weighed, 100 ml of distilled water was added and homogenized for 1 minute using Ultra-Turrax (IKA T 25, Germany) and the pH values were determined using a pH-meter (Mettler Toledo, Switzerland).

The fermentation time (0, 24, 48 and 72 h) and the use of autochthonous strains were taken as factors. The experiments were carried out in triplicate according to a randomized complete block design. Two-way ANOVA was applied to the results and differences between means were evaluated by Duncan's multiple range test using SPSS statistic programme.

Results and discussion

pH and a_w values

The fermentation time and the use of autochthonous strain had a very significant effect on the pH value of the heat-treated sucuk (P<0,01). The interaction between the fermentation time and the use of autochthonous strains also showed a very significant effect on the pH value (P<0,01). The changes in pH value of heat-treated sucuk during fermentation are given in Figure 1. The use of both mono and mixed cultures resulted in significant decreases in pH during fermentation. The decrease in pH was greater in the first 24 h. Relatively less decreases were observed after 48 h. However, the pH did not fall below 5.3 in the group containing *P. acidilactici* in the first 24 h. According to this result, *L.sakei* S15 and *L. plantarum* S91 showed better growth at 22°C fermentation temperature than *P. acidilactici* S147b. *L. sakei* S15 showed a lower pH value than *L. plantarum* S91.

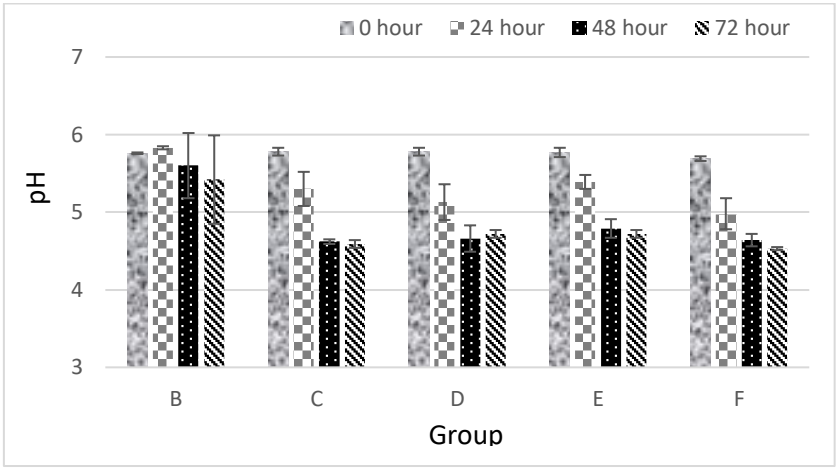

Figure 1. The changes in pH value of heat-treated sucuk during fermentation

The fermantation time had a very significant effect (P<0,01) on a_w value of heat-treated sucuk. The mean a_w value of heat-treated sucuk was 0.972 at the beginning, was determined to be 0.964, 0.951 and 0.939 after 24, 48 and 72 h of fermentation, respectively. The using autochthonous strains showed a significant effect (P<0,05) on a_w value. The lowest mean a_w value was determined in the presence of *L.sakei* S15. However, the difference between groups with *L. sakei* S15 and *P. acidilactici* S147b was not significant (P>0,05).

Microbiological counts

In the samples of the control group (group A) that were not inoculated with *S. aureus*, the number of *S. aureus* was found below the detection level (<100 cfu / g). The number of *S. aureus* in final products were also below detectable level.

The changes in *S.aureus* number of heat-treated sucuk inoculated with *S. aureus* during fermentation are shown in Figure 2. According to the results of analysis of variance, the use of autochthonous strains had a very significant effect on *S.aureus* (P<0,01). On the other hand, there was no significant effect of fermentation time on the number of *S.aureus* in heat-treated sucuk. In addition, the interaction of the

use of autochthonous strain x fermentation time had no significant effect on the number of *S.aureus* (P>0,05).

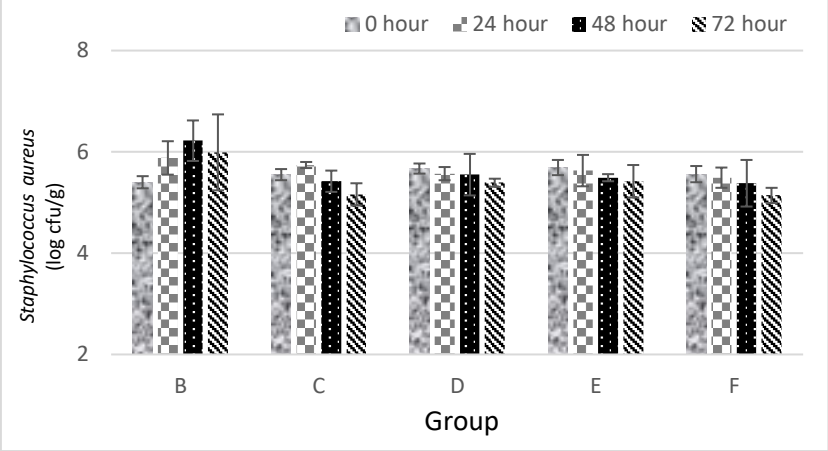

Figure 2. The changes in *S.aureus* number of heat-treated sucuk during fermentation

As can be seen from Table 1, the highest mean *S. aureus* number was determined in the control group (group B) (P<0,05). However, there were no statistically significant differences between the groups produced using the autochthonous strains (P>0,05) (Table 1). According to these results, the strains were well adapted to the fermentation environment and inhibited the growth of *S.aureus* by causing a significant decrease in pH value.

Table 1. The effects of different autochthonous strains on *S. aureus* number of heat treated sucuk (P<0,05)

Group (Strains)	**n**	***S.aureus* (cfu/g)**
B (Control 2)	12	5,87±0,50a*
C (*L. plantarum* S91)	12	5,47±0,26b
D (*L.sakei* S15)	12	5,55±0,22b
E (*P.acidilactici* S147b)	12	5,56±0,23b
F (*L.plantarum* S91+ *L.sakei* S15 + *P.acidilactici* S147b)	12	5,39±0,29b

*a-b: The averages marked with different letters are statistically different from each other ($P < 0.05$).

The changes in lactic acid bacteria number of heat-treated sucuk during fermentation are given in Figure 3. Spontaneous lactic acid bacteria (Group B) showed a slower growth in the first 24 h than autochthonous strains. These results showed that spontaneous lactic acid bacteria only reach a lactic acid bacteria count of about 10^8 cfu/g after 72 h of fermentation. Therefore, there was insufficient acidification, thus the *S. aureus* showed growth. In contrast, the number of *S. aureus* in the presence of autochthonous strains decreased due to the rapid acidification.

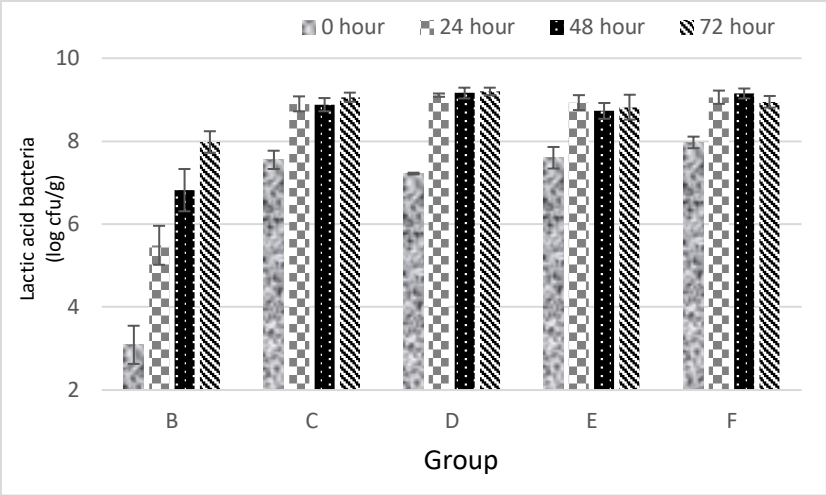

Figure 3. The changes in lactic acid bacteria number of heat-treated sucuk during fermentation

In the present study, it was found that the number of Enterobacteriaceae in the heat-treated sucuk batter was below the detectable level. The number of Enterobacteriaceae in the final products was also below the detectable level. On the other hand, the number of yeasts and molds generally varied between 10^2 and 10^3 cfu/g.

Enterotoxin Formation

After heat treatment (core temperature 68 °C) and drying (3 days at 18±1 ° C), it was found that the number of *S. aureus* in all heat-treated sucuk groups was below the detectable level. These heat-treated sucuk groups were analyzed for enterotoxin using the VIDAS method. Enterotoxin was not detected in the heat-treated sucuk samples examined in this study.

Conclusions

The rate and degree of acidification during the fermentation stage of heat-treated sucuk played an important role in preventing the growth of *S. aureus*, an important foodborne pathogen. Of the autochthonous strains examined, *L. sakei* S15 was more effective on the first day of fermentation, followed by *L. plantarum* S91. However, *S. aureus* can grow even at a fermentation temperature of 22°C in heat-treated sucuk produced without the use of starter culture. Higher fermentation temperatures may accelerate this growth.

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Exergy Analysis of Apple Juice Concentrate Production

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Exergy analysis plays an important role in the sustainability of industrial food processing systems. Considering the second law of thermodynamics, the exergy analysis method has become a useful tool to indicate the inefficiencies of the system of interest. The aim of this study is to perform exergy analysis of an apple juice concentrate production line and to define the energy and exergy destruction rates to assess the system performance. The mass and energy amounts of the inputs and outputs at each step in the apple juice concentrate production process were determined. Within the limits of this system, exergy destruction and exergy efficiency were calculated separately for each step. While the exergy destruction in the whole system was calculated as 6376.64 kW, the highest exergy destruction rate was found as 3560.60 kW and 2159.04 kW in the evaporation and first press steps, respectively. In addition to these results, the exergy efficiency of the evaporation and first press steps were calculated as 23% and 68%, respectively. The exergy efficiency of the total system was found as 14%.
Key words: Thermodynamic analysis, apple juice concentrate, exergy analysis, energy analysis, sustainability

1. Introduction

Energy plays a significant role in determining economic growth of countries around the world (Tan et al. 2010). Recently, the need for energy has been increasing because of the development of technology and the increase in the world population. The use of energy, which is necessary for the sustainable development of countries, causes environmental disasters such as global warming, acid rain, depletion of the ozone layer, and climate change. Conventionally, energy analysis based on first law of thermodynamics are applied to assess the performance of the systems. However, because of the shortcoming of the energy analysis, second law analysis or exergy analysis, has emerged as a fundamental tool for sustainable system design, analysis and optimization of thermal systems. Energy and exergy analysis are form of analysis that deals with the first and second laws of thermodynamics together and expresses the maximum use or usability of energy (Çengel and Boles, 2006). Exergy analysis has become more important especially in industrial-scale production and can reveal whether and how possible to design more efficient systems by reducing the existing sources of inefficiency (Bozkurt and Icier, 2010). There are many studies in literature focused on exergy analysis of different food production line (Darvishi et al. 2015; Genc et al. 2017; Genc and Yıldırım, 2017; Genc and Hepbasli, 2015; Khanali et al. 2019).

Apple is one of the fruits which are included in the temperate climate fruit species group and which has a high production rate in the world. It has also a widespread use and especially it is the most important raw material of fruit juice in the world (Khanali et al. 2019). The aim of this study is to perform exergy analysis of production line of apple concentrate. Exergy efficiency and exergy destruction rate of each component and the overall system are calculated to determine inefficiencies through assessing the system performance in terms of sustainability.

2. Materials and Method

2.1. General description of the apple juice concentrate production process

In general, the process steps of apple juice concentrate production are; washing, elevator, selecting, second washing, crushing, pressing, pre-evaporation (pasteurization), clarification, filtration, evaporation, cooling and filling stages. All stages of production are given in Fig.1. Numbers 1 to 34 indicate the incoming and outgoing each step and are shown in Table 1.

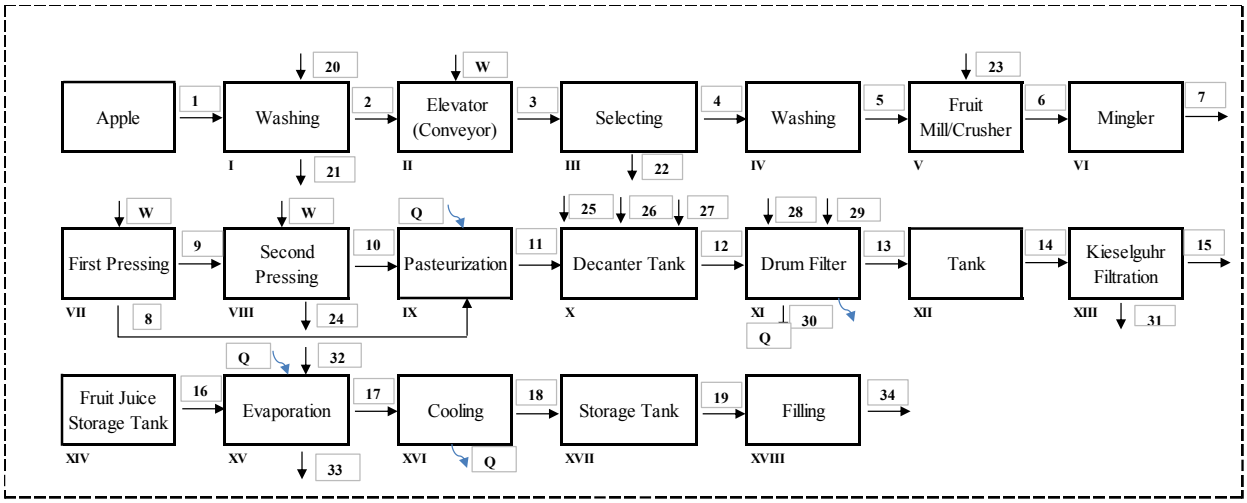

Fig.1. Flow diagram of the system of apple juice concentrate production process

2.2. Process modelling

The mass, energy, and exergy balance equations are applied to the system of interest to determine exergy destruction and efficiencies in which the system is at steady-state and steady-flow process.
In general, the mass balance equation is explained in the rate form as;

$$\sum \dot{m}_{in} = \sum \dot{m}_{out} \quad (1)$$

The general energy balance can be expressed as the total energy input equals the total energy output;

$$\sum \dot{E}_{in} = \sum \dot{E}_{out} \quad (2)$$

The general exergy balance equation is defined in the rate form as;

$$\sum \dot{m}_{in} ex_{in} - \sum \dot{m}_{out} ex_{out} + \sum \left(1 - \frac{T_0}{T_k}\right) \dot{Q}_k - \dot{W} = \sum \dot{E}x_D \quad (3)$$

Assumptions

The following assumptions are made for the exergy analysis of the system.

(a) All processes are steady state and steady flow with negligible potential and kinetic energy effects.

(b) The directions of heat transfer to to the system and work transfer from the system are positive.

(c) The mass flow rate of apple is assumed as 1 kg/s at the process entrance.

(d) The reference state temperature and pressure values are 293.15 K and 101.325 kPa, respectively. The pressure is ignored.

3. Results

For an illustrative case, the stream name, temperature, pressure, specific heat capacity (c_p, kj/kg K), mass flow rate (kg/s), specific physical (ex_{ph}, (kj/kg)) and chemical exergy rates (ex_ch, (kj/kg)) and total exergy rate for streams, energy and exergy rates together with the corresponding stream numbers specified in Fig. 1 are shown in Table 1.
The exergy destruction of the whole system is seen in Fig. 2. While the exergy destruction in the whole system was calculated as 6376.64 kW, the greatest irreversibility (exergy destruction) occurs in the evaporation step and exergy destruction rate was found as 3560.60 kW followed by the first press steps (2159.04 kW). In addition to these results, the exergy efficiency of the evaporation and first press steps were calculated as 23% and 68%, respectively. The washing, the elevator, the second washing, the mingler, the storage tank, the fruit juice storage tank and the filling processes have no exergy destructions as seen in Fig. 2. On the other hand, the exergy efficiency of the total system was found as 14%.
ıIn conclusion, the results obtained through this study can indicate the breakthrough points and potentials for further energy savings in fruit juice processing plant. Moreover, integrating exergy analysis with

exergoeconomic and exergoenvironmental analyses provides substantial information for designing more efficient and sustainable system.

Table 1. Thermodynamic properties of the system at operating conditions (T_{ref} = 298.15 K, P_{ref} = 101.325 kPa)

Point	Fluid	Temperature (K)	Pressure (kPa)	Mass Flowrate (kg/s)	c_p (kj/kg K)	ex_{ph} (kj/kg)	ex_{ch} (kj/kg)	Total specific exergy (kj/kg)	Energy rate (kW)	Exrate (kW)
1	Apple	298,15	101.3	2,77	3,36	0,14	2448,47	2448,62	2771,16	6782,67
2	Apple	298,15	101.3	2,77	3,36	0,14	2448,47	2448,62	2771,16	6782,67
3	Apple	298,15	101.3	2,77	3,36	0,14	2448,47	2448,62	2771,16	6782,67
4	Apple	298,15	101.3	2,77	3,36	0,14	2448,47	2448,62	2768,46	6776,06
5	Apple	298,15	101.3	2,77	3,36	0,14	2448,47	2448,62	2768,46	6776,06
6	Apple	298,15	101.3	2,77	3,36	0,14	2448,47	2448,62	2768,46	6776,06
7	Apple	298,15	101.3	2,77	3,36	0,14	2448,47	2448,62	2768,46	6776,06
8	Apple Juice	298,15	101.3	2,27	3,41	0,14	2053,85	2053,99	2306,34	4657,02
9	Pulp	298,15	101.3	0,50	2,10	0,09	13313,09	13313,18	313,22	6656,59
10	Apple Juice	298,15	101.3	0,03	3,41	0,14	2053,85	2053,99	30,52	61,62
11	Pasteurized Apple Juice	328,15	101.3	2,30	3,31	6,42	2053,85	2060,27	2497,38	4733,05
12	Clear apple juice	323,15	101.3	2,30	3,33	4,79	2053,85	2058,64	2472,08	4729,31
13	Apple Juice	313,15	101.3	2,25	3,36	2,20	2053,85	2056,05	2371,26	4628,78
14	Apple Juice	313,15	101.3	2,25	3,36	2,20	2053,85	2056,05	2371,26	4628,78
15	Apple Juice	313,15	101.3	2,24	3,36	2,20	2053,85	2056,05	2361,78	4610,27
16	Apple Juice	313,15	101.3	2,24	3,36	2,20	2053,85	2056,05	2361,78	4610,27
17	Concentrated Apple Juice	333,15	101.3	0,40	3,26	8,16	2385,82	2393,98	436,37	962,38
18	Chilled Concentrated Apple Juice	283,15	101.3	0,40	3,42	0,60	2385,82	2386,42	389,13	959,34
Point	**Fluid**	**Temperature (K)**	**Pressure(kPa)**	**Mass Flowrate(kg/s)**	**Cp(kj/kg K)**	**exph (kj/kg)**	**exch (kj/kg)**	**Total specific exergy (kj/kg)**	**Energy rate (kW)**	**Exrate (kW)**
19	Chilled Concentrated Apple Juice	279,15	101.3	0,40	3,43	1,18	2385,82	2387,00	384,94	959,58
20	Water	298,15	101.3	2,77	3,66	0,15	50,00	50,15	3024,84	138,93
21	Water	298,15	101.3	2,77	3,66	0,15	50,00	50,15	3024,84	138,93
22	Rotten apple	298,15	101.3	0,00	3,36	0,14	2448,47	2448,62	2,70	6,61
23	Pectolytic Enzyme	298,15	101.3	0,00	2,25	0,09	22610,00	22610,09	0,03	0,90
24	Pulp	298,15	101.3	0,47	2,10	0,09	13313,09	13313,18	294,43	6257,19
25	Pectolytic Enzyme	298,15	101.3	0,00	2,25	0,09	22610,00	22610,09	0,08	2,83
26	Amylase	298,15	101.3	0,00	2,25	0,09	22610,00	22610,09	0,03	0,90
27	Bentonite	298,15	101.3	0,00	1,33	0,06	20,00	20,06	1,07	0,05
28	Perlit	298,15	101.3	0,01	1,33	0,06	20,00	20,06	5,47	0,28
29	Water	298,15	101.3	1,38	3,66	0,15	50,00	50,15	1506,96	69,21
30	Pulp	313,15	101.3	0,05	2,07	1,35	13313,09	13314,44	29,86	612,46
31	Pulp	313,15	101.3	0,01	2,07	1,35	13313,09	13314,44	5,84	119,83
32	Water	333,15	101.3	5,20	3,54	8,86	50,00	58,86	6129,98	306,07
33	Evaporated water	318,15	101.3	1,84	3,59	3,63	50,00	53,63	2103,85	98,69
34	Concentrated Apple Juice	279,15	101.3	0,40	3,43	1,18	2385,82	2387,00	384,94	959,58

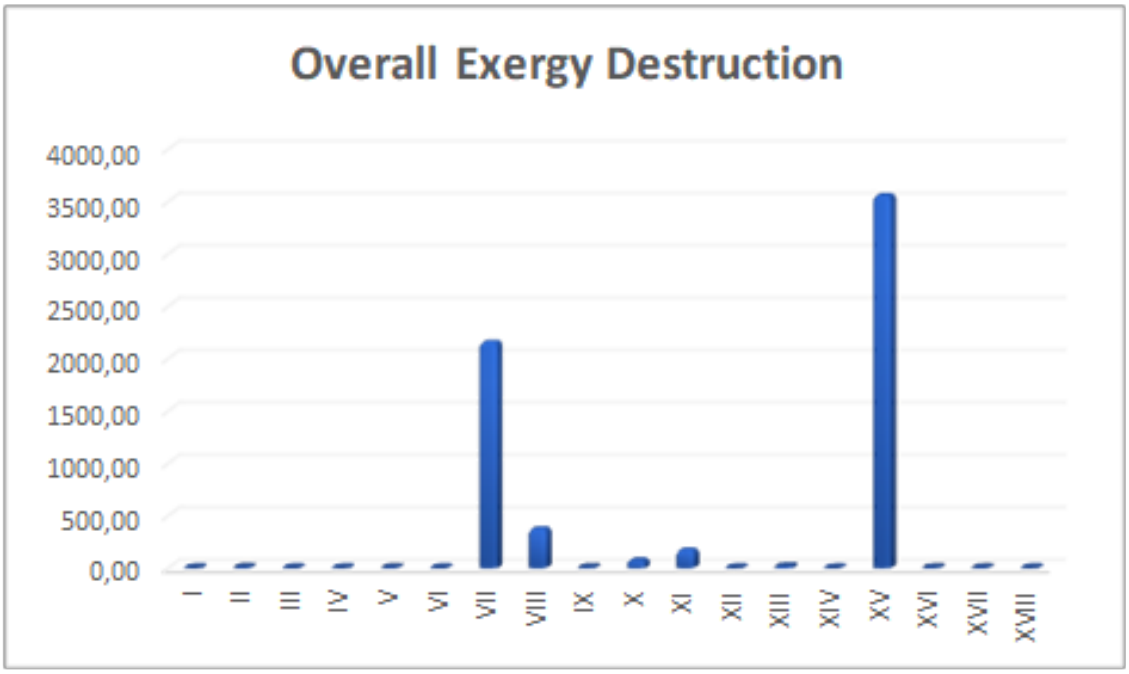

Fig.2. Flow diagram of the exergy destruction of the whole system

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Encapsulation of β-Carotene Loaded Sunflower Oil Droplets in Alginate Beads

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Abstract
The value-added product development from food processing wastes one of the main fields of the multiple disciplines such as food and environment in recent years. If we could produce valuable products from food industry by-products through new scientific, technological and eco-friendly methods, these by-products could be converted into products with a higher economic value than the main product. For a good waste management, it is necessary to conversion the by-product into the economy with environmentally friendly methods. In this study, β-carotene extraction from pumpkin peel was performed using sunflower oil instead of petroleum-based solvent and encapsulation was carried out by alginate beads method to increase the storage stability of the obtained β-carotene rich oil. Optimum conditions of the alginate concentration (1-2%), feed ratio (20-50%), height of feeding (1-10 cm) and flow rate (5-100 µL/min) were determined using Response-Surface Methodology (Optimal Custom Design) according to shape factor (maximum), sphericity value (minimum) and β-carotene content (maximum) responses. The results showed that alginate concentration was the limiting factor and desired capsules could not be obtained at maximum concentration. Optimum conditions of the alginate beads encapsulation process were determined as 1% alginate concentration, 50% (alginate:oil) feed ratio, 1.5 cm height and 74 µL/min flow rate. Shape factor, sphericity value and β-carotene content of the alginate beads obtained at a optimum conditions were found as 0.878, 0.002 and 0.527 mg/100g capsule, respectively. The β-carotene-enriched alginate beads produced under optimum conditions and the free-from β-carotene-rich sunflower oil extract were stored aat 55 °C for 15 days. The β-carotene content of the beads was monitored at 0, 6, 9, 12 and 15 days of storage. At the end of the storage period, the β-carotene loss of encapsulated oil and free-from β-carotene-rich sunflower oil was calculated as 14.42% and 25.81%, respectively.

Introduction
The pumpkin, belongs to Cucurbitaceous family, is cultivated throughout the world mainly for its consumption and also medicinal purpose. Pumpkin is a good source of carotenoids, especially β-carotene, which also gives its orange color (Atef, 2012; Maran et al., 2013). β-carotene is a lipophilic component, one of the solvents frequently used for its extraction is n-hexane. N-hexane, produced by controlled fractional distillation from petroleum mixtures and the easy production is the main advantage of this solvent. N-hexane is classified as CMR3 (Carcinogen, Mutagen, Toxic for Reproduction) by REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) and as reprotoxic named as a category 2. A similar classification has been made by the FDA for n-hexane (Radi and Abbasi, 2018; Chemat et al., 2019). Since it is risky in terms of both human health and environment in the food industry, it has gained importance to use edible plant resources by using environmentally friendly methods in traditional extraction, reducing energy comsumption and eliminating the use of organic solvents. Vegetable oils are non-polar lipophilic systems whose composition varies considerably according to their origin, quality and process techniques. Since vegetable oils have ideal solvent properties for many components, they are shown as an alternative solvent for green extraction principles (Yara-Varon et al., 2017). There are several studies performed on vegetables oils are used as solvents (Chen and Meyers, 1982; Antoun et al,. 1997; Marinova and Yanishlieva, 1997; Damechki et al., 2001; Moldao- Matins et al., 2004; Sachindra and Mahendrakar, 2005; Rao et al., 2007; Handayani et al., 2008; Kang and Sim, 2008; Pu et al., 2010; Orozca et al., 2011; Karoui et al., 2011; Orozco-Solano et al., 2011; Aydeniz and Yılmaz, 2012).
Encapsulation is defined as the confinement or retention of a sensitive substance or mixture into another substance or mixture that can form a protective shell or wall. Spray drying, spray cooling, extrusion coatin, fluidized bed coating, liposome entrapment, coacervation and entrapment in alginate beads are commonly used encapsulation methods (Madene et al., 2006). Alginate hydrogel beads are used to

encapsulate biologically important molecules such as food ingredients, enzymes, drugs, plant or animal cells. A key feature of alginate is that in the presence of divalent cations, it cross-links alginate molecules to from an "egg box" structure. Cationic cross-linked alginate hydrogel beads are highly water-swellable hydrophilic polymers (Chan et al., 2011).

In this study sunflower oil used as solvent to extract β-carotene from pumpkin peel and obtained β-carotene loaded oil encapsulated into alginate beads for improving storage stability against environmental conditions.

Material and method

Material

Pumpkin (C. moschata) peels were purchased from commercial restaurant in Antalya, Turkey. They were quickly frozen at -80 °C and then freeze-dried (OPERON FDU&FDA, Korea) until equilibrium moisture (4%) at -70 °C and 40 mmHg absolute pressure dried to substance content. The dried powders were passed through 50 µm sieves. Sunflower oil used for extraction (Yudum, Balıkesir, Turkey) was purchased from the commercial market. The analyses were purchased from Sigma-Aldrich (Darmstadt, Germany) and Merck (Darmstadt, Germany).

Method

β-carotene extraction

Extraction (1%, pumpkin peel:sunflower oil) was performed in water bath (Daihan WSB-30, South Korea) at 60 °C for 180 min under stirring (150 rpm). The obtained extracts were centrifuged at 15.000 rpm, 4 °C for 10 min. After centrifugation for a period of time, it was diluted with hexane and its absorbance was read in a spectrophotometer (Shimadzu UV-vis 160 A) at a wavelength of 446 nm, against the sunflower oil:hexane mixture (1:4).

Optimization of the encapsulation process with the alginate beads method

β-carotene-rich oil extract encapsulated into alginate beads using syringe pump (Thermo Fisher Syringe Fusion 100) for dripping the alginate solution during the formation of β-carotene capsules and syringe (500 µL, 22 G, Thermo Syringe) were used. In the optimization of encapsulation, the response surface method (optimal custom design) created in the Design Expert 10 package program was used (Table 3.1). 20-50 % β-carotene-rich extracts were added to alginate solutions prepared at different concentrations (1-1.5-2%). Homogenization was carried out with ultraturax for 5 minutes at a speed of 15000 rpm. The homogeneous alginate-extract mixture obtained was dropped into a 2% $CaCl_2$ solution for another half hour, then taken into distilled water and kept for 10 minutes at the same mixing speed to harden the capsules. After the capsules were filtered from pure water, dried on blotting paper for 10 minutes, β-carotene analysis was performed on the capsules and the size and shape of the capsules were determined with a microscope.

Table 1. Optimization of β-carotene-rich extracts by alginate beads method

Number	Alginate Concentration (%)	Feed Rate (%)	Height (cm)	Flow Speed (µL/min)
1	2	50	1	50
2	1.5	50	1	5
3	2	20	5	5
4	1.5	20	5	50
5	2	33	5	100
6	1.5	20	1	100
7	1	20	1	5
8	1	50	10	5
9	2	50	10	5
10	1	33	5	50
11	1.5	20	5	50

12	2	33	1	5
13	1	20	10	100
14	2	20	1	50
15	1	33	5	50
16	1.5	20	10	5
17	1	33	5	50
18	1.5	50	10	100
19	1.5	25	1	5
20	1	50	1	100
21	2	50	1	100
22	1.5	50	10	100
23	2	20	10	100
24	2	33	5	100
25	2	33	10	50

Storage of samples encapsulated by the alginate beads method

Encapsulated β-carotene-rich oil and free-form β-carotene-rich sunflower oil at 55 °C stored for 15 days for accelerated storage test. The β-carotene amounts of the encapsulated samples were analyzed at the 0, 6, 9,12 and 15th days and the change in β-carotene during storage was investigated.

Analyses

β-carotene values

The β-carotene values of the samples were determined spectrophotometrically and the results were calculated using the total carotenoid equation (Equation 3.1).

Total carotenoid, mg/100g = [(A*Sf)/ƹ]*1000

(A: The absorbance value determined in the extract, Sf: Dilution factor, ƹ: Extinction coefficient)

Determination of the dimensions and morphological properties of β-carotene capsules obtained by alginate beads method

Stereo-microscope (Stemi 2000-C, Zeiss, Germany) and AxioCamERc5 model camera (Stemi 2000-C, Zeiss, Göttingen, Germany) were used to determine the size and morphology of β-carotene capsules obtained by the alginate beads method. The size measurements of the capsules were performed using the program Zeiss (Carl Zeiss Microscopy GmbH, Germany). Shape factor (SF) and sphericity value (KD) data were calculated in order to define the shape of the obtained alginate spheres and sphericity. The equations given below were used to calculate the shape factor and sphericity (Lee et al. 2013).

$SF= (4\pi A)/P^2$

$KD= (D_{max} - D_{min})/(D_{max}+ D_{min})$

A: Area, P: Perimeter, D_{max}: Max diameter (mm), D_{min}: Min diameter (mm)

Results and discussion

The tested results of alginate beads were given in table 3.2, when Table 3.2 is examined, it was observed that the spherical structure did not form in the trials (1,9 and 21) where the alginate concentration (2%) and the feed rate (50%) were the highest, and the β-carotene amount of the alginate capsules obtained using other trial conditions were 0.068-0.597 mg/100 g capsules. As a response to the optimization experiments, the shape and sphericity values of the beads were used due to its effect on the β-carotene recovery and the release of the active substance, especially during the storage period.

Table 2. β-carotene content and morphological properties of microcapsules obtained by alginate beads method

Number	Alginate Concentration (%)	Feed Rate (%)	Height (cm)	Flow rate (µL/min)	β-carotene (mg/100 g capsule)	Sphericity value	Shape factor
1	2	50	1	50	a.o.	a.o	a.o
2	1.5	50	1	5	0.597	0.180	0.787
3	2	20	5	5	0.108	0.062	0.818

4	1.5	20	5	50	0.335	0.006	0.881
5	2	33	5	100	0.473	0.201	0.678
6	1.5	20	1	100	0.288	0.135	0.719
7	1	20	1	5	0.216	0.036	0.762
8	1	50	10	5	0.281	0.040	0.864
9	2	50	10	5	a.o.	a.o	a.o
10	1	33	5	50	0.493	0.026	0.814
11	1.5	20	5	50	0.206	0.029	0.858
12	2	33	1	5	0.360	0.211	0.686
13	1	20	10	100	0.268	0.043	0.812
14	2	20	1	50	0.083	0.058	0.800
15	1	33	5	50	0.502	0.049	0.808
16	1.5	20	10	5	0.252	0.020	0.813
17	1	33	5	50	0.448	0.037	0.824
18	1.5	50	10	100	0.418	0.086	0.800
19	1.5	25	1	5	0.298	0.046	0.831
20	1	50	1	100	0.397	0.028	0.826
21	2	50	1	100	a.o.	a.o	a.o
22	1.5	50	10	100	0.595	0.040	0.859
23	2	20	10	100	0.068	0.044	0.861
24	2	33	5	100	0.209	0.212	0.656
25	2	33	10	50	0.508	0.053	0.842

While the alginate concentration decreased in the interactions of the alginate concentration separately with the feed rate, height and flow rate, the shape factor values approached "1" with increase in the feed rate, height and flow rate. The height with the feed rate and the flow rate separately interactions, the shape factor value approached "1" with the decrease in the feeding ratio while the height increased; as the height decreased, the shape factor value moved away from "1" with the increase in flow rate (Figure 1). Chan (2011) reported that alginate concentration and encapsulated oil ratio have a significant effect on the shape of the beads as a result of their study. In a study on the encapsulation of black seed oil into alginate beads, it was determined that the droplet size and bead factor increased with the increase in flow rate (Azad et al., 2020). Optimum conditions were determined as 1% alginate concentration, 50% feed rate, 1.5 cm height and 74 µL/min. according to responses as the highest β-carotene amount, the highest shape factor and the lowest sphericity values.

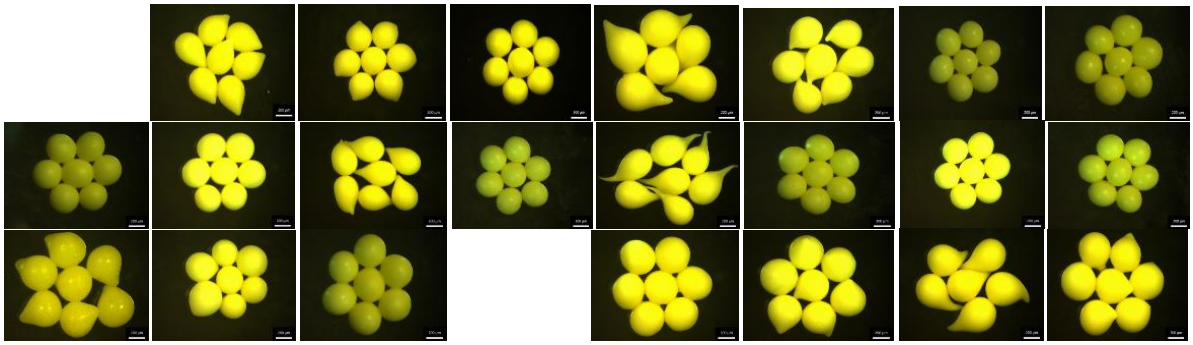

Figure 1. Images of β-carotene capsules obtained by the alginate beads method

Storage of alginate beads

Alginate beads obtained under optimum conditions and free-form β-carotene-rich sunflower oil extract as control at 55 °C for 15 days stored throughout. Alginate beads at 0, 6, 9, 12 and 15 days of storage and β-carotene analysis was performed in enriched oil samples. The β-carotene changes of the samples during storage are shown in Figure 5.

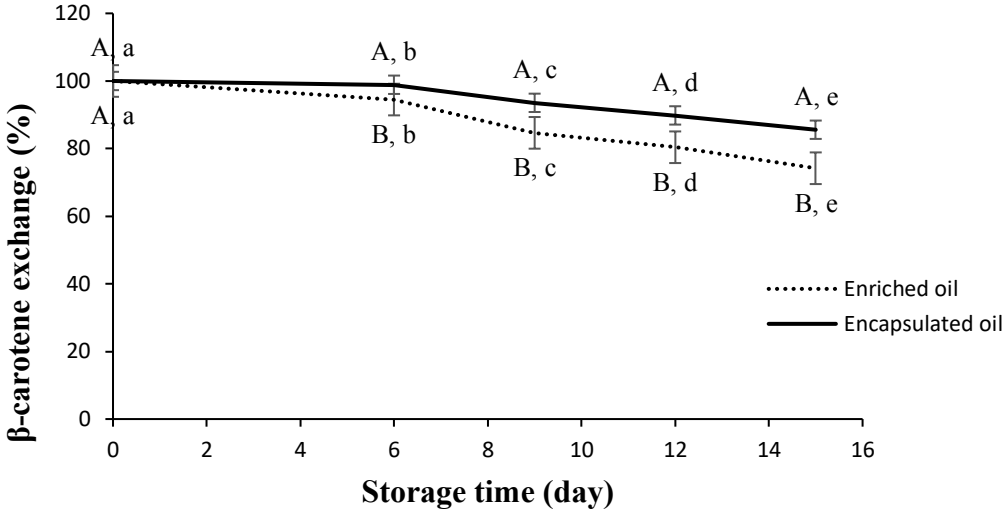

Figure 2. β-carotene changes due to storage time of samples

At the end of the storage period, the loss of β-carotene in free form oil was determined as 25.81%, while this loss was determined as 14.42% in encapsulated oil.

Conclusion

Alginate concentration was 3a limiting factor in the encapsulation of the β-carotene-rich extract obtained by the alginate beads method. In addition, it was observed that encapsulation did not occur with very high concentrations and rates of alginate solution. Optimal conditions in terms of β-carotene efficiency and shape homogeneity in the optimization of the encapsulation of the enriched oil with the alginate beads method; 1% alginate concentration, 1:1 (alginate enriched oil) feed rate was determined as 1.5 cm height and 74 µL/min flow rate. It was observed that encapsulation of β-carotene-rich oil by the alginate beads method prevented the degradation of β-carotene during storage. After 15 days of storage at 55 °C, the β-carotene loss of enriched oil and free-form β-carotene-rich sunflower oil encapsulated by the alginate beads method was 14.42% and 25.81% respectively, compared to the beginning of storage.

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Techniques for Increase the Stability of Natural Pigments in Foods

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ABSTRACT
Color is one of the most important sensory attributes of food, as it contributes to providing the consumers with a first impression of the food quality, but it is also associated with flavor, safety, and nutritional value. Pigments are the natural colorant compound, abundantly present in both animal and plant tissue. Natural pigments (NPs) are becoming very attractive for consumer mainly health safety and some trends like clean label. Unfortunately, their uses are limited by their lower stability and high cost compared to their synthetic counterparts. Most of the NPs are unstable compounds and their composition or color may be change in some environmental and chemical conditions such as pH, presence of metal ions, exposure to light, high temperatures, and oxygen, but it is also significantly influenced by the product enzymatic activities. So, food industry is focus on protect the natural pigment's properties, as in artificial, throughout the process and storage. Nano and micro technologies are very useful tool for eliminate such problems. Micro/nano encapsulation is defined a technology used to obtain capsules (microcapsules) with sizes ranging from micrometer to millimeter by wrapping an active substance (core material) with one or more coating materials (wall material). The main purpose of encapsulation is to create a barrier or matrix with the coating materials around the sensitive components. So that it is ensure that the minimizing of interaction between the components and the environment. Thanks to modern encapsulation technology methods, NP such as carotenoids can be stabilized as well as significantly improved solubility and bioavailability. This review is about the modern technologies for enhancement of natural pigments stability.

INTRODUCTION
Visual color is the first sensory characteristic that determining the consumer preference in food products. Since the color of food is a quality measure, it is essential for producer to select and implement acceptable and desirable synthetic/natural colorants. The growing of consumers' demand for natural products has led to an increase in food consumption that does not contain synthetic colorants (Jafari, 2017; Corradini, 2019). Food colorants are generally classified as (1) natural, (2) nature-identical, (3) synthetic and inorganic colors. Natural pigments (NPs) are found widespread in nature from fungi, plant, and animals. Strongly adding color food to the food material that is to be colored may be the simplest way the coloring food. However, this home-cooking method presents some problems in the industrial production such as low concentration, undesirable flavor and insoluble material. Therefore, pigments are usually extracted in industrial applications (Mortensen, 2006). At the same time, manufacturing and processing procedures, storage conditions may have an impact on color intensity and hue of final product (Martins et al., 2016). For the reasons mentioned above, it is very significant that maintain the original structure of pigments within the food matrix to sustain the quality of food products and enhance the acceptance of consumers. There are many techniques that have been implied to increase the stability of NPs such as copigmentation, complexation, polymerization, and encapsulation (Cavalcanti et al., 2011). One of the methods used to increase the stability of natural pigments is micro/nano encapsulation techniques. Encapsulation is basically the process of entrapping the active component with a carrier material or surrounding it as a film (Devi et al., 2017; El-Kader and Abu Hashish, 2020). The main purpose of this matrix is to protect the sensitive components from light, heat, pH, or moisture. With the aim of isolate and stabilize the pigments from environment factors that can cause color loss or change, it has been seen that the micro and nanoencapsulation technology is frequently applied (Sajilata and Singhal, 2006).

Natural Pigments

With the current understanding of potential negative health effect of synthetic pigments such as allergic reactions, carcinogenicity, natural products have seen safe and preferable for consumer compared to synthetic ones. As well as being aesthetic, natural colors have some health benefit due to their high antioxidant capacity (Caro et al., 2012; Sajilata and Singhal, 2006).

Although they have been diversity about their structural forms and origins, natural food pigments can be categorized into a few classes, the most important of which are: tetrapyrroles, tetraterpenoids, and flavonoids. While chlorophyll is the most important member of the tetrapyrroles; those of the tetraterpenoids are carotenoids and they have been associated with the color green and yellow-orange, respectively. Anthocyanins have been a class of flavonoids that related with red-purple color especially in berries. Anthra-quinones and betalains are other important class of natural colorants (Mortensen, 2006).

Chlorophylls

Chlorophylls are oil-soluble and the most widely distributed pigments responsible for the characteristic green color of plants. The major chlorophylls in foods are chlorophyll a and chlorophyll b (Ngamwonglumlert et al., 2017). Chlorophyll in natural sources is in an unsuitable form for use as a colorant because of its rapid degradation. It is rapidly degraded by enzymatic reaction or other factors such as acid, oxygen, light, and heat, resulting in chlorophyll derivatives (Özkan and Bilek, 2014). The inclusion of natural chlorophylls and carotenoids in food products may result in color loss and degradation during storage. Processing and storage practices may change the nature and properties of plant matrices resulting in variations of the chlorophylls and carotenoids release (Jurić et al.,2020).

Carotenoids

One of the most consumed carotenoid groups of pigments are responsible for the yellow, orange, and red color of many foods. Based on their structure, carotenoids can be divided into two groups, which are carotenes and xanthophylls. Carotenoids are unstable when they're exposed to light or oxygen because of their properties as highly conjugated and intensely colored isoprenoid plant compounds (Özkan and Bilek, 2014). Generally, lutein and other carotenoids are prone to degradation at high temperatures. In general, carotenoid retention can be improved by closed storage at low temperature, reduced water and cationic metal activities, and absence of light and oxygen (Jurić et al.,2020). Not only are carotenoids important as natural dyes and a source of provitamin A, but they also show biologic activities such as strengthening the immune system, decreasing the risk of degenerative illnesses such as cancer, preventing the risk of cardiovascular disease (Robert et al., 2003).

Anthocyanins

Anthocyanins are water-soluble pigments can be found in many sources such as roots, flowers, grain, nuts, but the most important groups are vegetables and fruits. Plums (*Prunus subg. Prunus*), different berries (strawberry, blackberry, blueberry, cranberry), purple grapes (*Vitis vinifera L.*), red cabbage *(Brassica oleracea L. var. capitata f. rubra*) are examples of products rich in these pigments (Jurić et al., 2020). They have a high potential as colorants because of their low toxicity (Özkan and Bilek, 2014). Factors which affect the color and stability of anthocyanins include structure and concentration, pH, temperature, light, presence of copigments, metallic ions, enzymes, oxygen, ascorbic acid, sugar and their degradation products, proteins, and sulphur dioxide (Ersus, and Yurdagel, 2007).

Micro and Nanoencapsulation

Encapsulation is defined as the technology of packaging solids, liquids, or gaseous materials they can called as core, active or internal substance in some kind of matrices (coating, membrane, shell, capsule, carrier material, outer phase or matrix) (de Boer et al., 2019; Nedovic et al., 2011). This process results in solid or liquid particles that protect the entrapped material from the external environment by enclosing it in a physical matrix (de Freitas Santos et al., 2021). Depending on the size of the particles, the process is called micro (1.0 μm- 5000 μm), macro (> 5000 μm) and nano (< 1.0 μm) encapsulation

(Jafari, 2017). The application of encapsulation techniques consists of two important stages, first one is the selection of the appropriate encapsulation technique and the second one is the coating material that is generally considered safe (GRAS) (Shishir et al., 2018). In the food industry, materials obtained from polysaccharides, proteins and lipids are used as a wall material of various bioactive compounds such as antioxidants, polyphenols, vitamins, enzymes, flavors, colorants. Maltodextrin, modified starch, milk proteins, gelatin, gums are frequently preferred as coating (Jain et al., 2016; Fathi et al., 2012). In the selection of these components technologically, Factors such as not reacting with the active component, having maximum resistance during processing and storage, and being economical are taken into consideration (El-Kader and Abu Hashish, 2020).

The most used encapsulation techniques are:
(i) physical methods (spray drying, lyophilization, supercritical fluid precipitation, solvent evaporation)
(ii) physicochemical methods (coacervation, ionic gelation, and encapsulation in liposomes)
(iii) chemical methods (interfacial polymerization, molecular inclusion complexation) (Ozkan et al., 2019).

Natural Pigments and Their Encapsulation Techniques

Natural pigments may quickly lose their functionality when added to foods. Because of their chemical structures, all natural pigments exhibit relatively low stability after extraction from their sources, especially when exposed to light, high temperature, pH extremes, oxygen, mechanical stresses, reactive food ingredients, during food manufacturing, preservation, storage, and preparation, as well as to the action of digestive enzymes during digestion. Consequently, NPs stabilization relates to their coloring and health-beneficial properties (Jurić et al.,2020). It seems clearly promising approach for the protect and stabilize of NPs by encapsulation with the recent research, shown on Table 1. In recent years, there is available data about using encapsulated NPs within food products such as cake (Rocha et all., 2012), cookies (Šaponjac et al., 2016), extruded cereal (Ruiz-Gutiérrez et al., 2017), yoghurt (Toniazzo et al., 2014; jelly (Mahdavi et al., 2016), gummy candy (Amjadi et al.,2018; Otálora et al., 2019), drinks (Aguilera et al., 2016; Burin et al., 2011).

Table 1. Techniques and materials used for the encapsulation of natural pigments

Nps	Encapsulation Methods	Results	Reference
Red beet betalains	Spray drying	• stability of betalains and betacyanins are increased • especially at room temperature, maintain their betalain stability for 6 months	Ozcan and Bilek., 2018
Black rice anthocyanins	Spray drying and freeze drying	• spray drying produced a brighter microcapsule color than freeze drying • the storage stability of freeze-dried anthocyanin was much lower than spray drying	Laokuldilok and Kanha, 2017
Red cabbage anthocyanins	Solid lipid nanoparticle	• The encapsulated bioactive compounds exhibited better stability than the free compounds especially high temperature conditions.	Ravanfar et al., 2016
Carrot carotenoids	Co-crystallization	• co-crystallization significantly improved the overall stability of the carotenoids • stability at 190 °C	Kaur et al., 2021

Carotenoids	Nanoliposome	• liposomal membrane can strongly retain b-carotene and lutein during storage • this effect was not found for lycopene and canthaxanthin	Tan et al., 2014

The latest studies shown that there are some benefits to applying micro or nanoencapsulation of colorants such as (Ghosh et al., 2021; Jafari, 2017):

- stabilization of pigments from environmental conditions
- decreasing unfavorable chemical interactions
- controlled release of bioactive components
- minimize the organoleptic change
- masking undesirable aroma, color, taste
- improved shelf-life

CONCLUSION

With the growing trend of consumers about natural food, the food industry and researchers have increased their efforts to meet this demand. Color is one of the basic parameters of food, which gives information about the characteristics of food such as freshness and quality and affects the decision to buy on the shelf and consume on the plate. Hence, it is important to obtain and sustain the desired color. Despite the advantage of natural colorants as safe alternatives to synthetic counterparts, some limitations such as destabilization or sensitivity, prevent the commercialization and execution of these pigments. Encapsulation techniques are an emerging way to protect these sensitive compounds. In this review, the natural colorants and encapsulation techniques were briefly introduced and the literature in this field was summarized.

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Modeling Inactivation of *E. coli* O157:H7 on Sucuk Slices by Pulsed UV Light

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Objective: The surface of sucuk is susceptible to contamination especially after processing. Pulsed UV (PUV) light technology is a non-chemical and non-thermal (for short treatment times) alternative to decontaminate food surfaces. PUV light consists of electromagnetic radiation ranging from ultraviolet to infrared that is emitted by an inert gas lamp as light pulses. *Escherichia coli* O157:H7 is a pathogen associated with the consumption of contaminated meat products. In this study, the effect of PUV light on *E. coli* O157:H7 on sucuk slices was investigated, and the inactivation was described by mathematical models.
Method: Sucuk slices inoculated with *E. coli* O157:H7 were treated at varying distances from the xenon lamp in a PUV-light system. In order to limit the confounding effect of temperature on the inactivation, only the following treatments were included: 5 cm (≤15 s), 8 cm (≤30 s) and 13 cm (≤45 s). The first-order, Membre, and Weibull models were used to describe the inactivation curves. Non-linear regression in MINITAB 17 was performed to determine the model parameters. The goodness-of-fit of models was determined using root mean square error (RMSE), regression coefficient (R^2), and slope of 'observed vs. predicted reductions'.
Results: Among the treatments included, the maximum reduction of 2.18 log cfu/cm^2 was obtained after the 13 cm-45 s treatment. Weibull model yielded the highest goodness-of-fit at 5 cm (RMSE: 0.0045, R^2: 1, Slope: 1) and 8 cm (RMSE: 0.1595, R^2: 0.966, Slope: 0.987), while Membre model provided the best fit at 13 cm (RMSE: 0.2785, R^2: 0.904, Slope: 0.949). According to these models, the decimal reduction dose was about 12.8, 13.3, and 23.8 J/cm^2 at 5, 8, and 13 cm, respectively.
Conclusion: PUV light may be used for effective postprocessing decontamination of meat products. PUV-light inactivation of *E. coli* O157:H7 on sucuk slices follows a nonlinear trend.

Keywords: *Escherichia coli* O157:H7, Mathematical modeling, Microbial inactivation, Pulsed UV light, Sucuk

Modeling Inactivation of E. coli O157:H7 on Sucuk Slices by Pulsed UV Light

Introduction

Escherichia coli O157:H7, is a serotype of the bacterial species *Escherichia coli* that causes hemorrhagic colitis and hemolytic uremic syndrome in infected humans (CDC, 2021). *E. coli* serotype O157:H7 can naturally be found in the intestinal contents of some cattle, goats, and even sheep. Also ruminants, especially cattle, are known to be a major reservoir of EHEC. Infection with *E. coli* O157:H7 follows ingestion of contaminated food or water, or oral contact with contaminated surfaces. It is highly virulent, with a low infectious dose: an inoculation of fewer than 10 to 100 CFU of *E. coli* O157:H7 is sufficient to cause infection, compared to over one-million CFU for other pathogenic *E. coli* strains. Foodborne disease outbreaks related to *E. coli* O157:H7 have been associated with the consumption of contaminated meat products. In an outbreak (June-September 2016) 7 people were infected in four states in the USA and 5 ill people hospitalized. Beef products of a slaughterhouse were the likely source (CDC, 2016).
Sucuk, a Turkish-Style Sausage, is a dry-fermented sausage traditionally produced in Turkey. Production Process of Sucuk includes grinding meat and fat, then mixing with spices, additives, and starter cultures, followed by filling, ripening (smoking), drying, packaging, and finally storage

(Heperkan ve Sözen, 1988). The surface of sucuk casing is prone to postprocessing contamination and microbial growth. Smoking during the ripening period poses significant health concerns.
Pulsed Ultraviolet (PUV) Light has short light pulses delivered by an inert gas lamp in a wavelength range of 100-1100 nm. There are different types like non-ionizing, non-chemical and non-thermal for short time. This method was approved by FDA in 1999. Also it is faster than conventional UV-C light and effective on a broad range of microorganisms. PUV Light process is a dry process and it can be applied on packaged foods. Concerns are the limited penetration and the high dependency of effectiveness on the transparency and color of food. Microbial inactivation with PUV light is mainly caused by damages to the DNA chain. Beside this photochemical effect, there are also photothermal and photophysical effects of PUV light on microbial cells (Krishnamurthy et al., 2010).
PUV light has been studied by a number of researchers. Yet, there is limited knowledge on the inactivation kinetics of pathogens on foods exposed to PUV light. Accurate estimation of survival rates by mathematical models would help adaptation of PUV light to industrial applications. The objective of this study is to investigate the inactivation kinetics of *E. coli* O157:H7 on sucuk slices exposed to PUV light.

Material & Methods

Sucuk samples & Microorganism: Sucuk was obtained from a local market as vacuum-packaged. The sucuk was stored in a refrigerator (4°C) and kept at room temperature for ~2 h before trials. *Escherichia coli* O157:H7 (NCTC 12900) was obtained from National Collection of Type Cultures, Public Health England (UK) and maintained on TSAYE slants at 4°C. It was subcultured biweekly to maintain the viability.

Preparation of inoculum solution & Inoculation of sucuk: Microbial culture was grown in 100 mL TSBYE for 24 h at 37°C and centrifugated for 12 min at 3000 rpm (1448 x g) at 4°C. Then, supernatant was discarded, and washed with sterile 0.85% PSS. After that, re-centrifugation was done and the supernatant was discarded. Finally, cells were suspended in 10 mL of 0.85% PSS to yield 10^8 – 10^9 cfu/mL. Firstly, sucuk was cut into slices (3 cm diameter x 0.5 cm thickness). Then, 100 µL of inoculum solution was inoculated on top side. After this, inoculated samples were kept at room temperature for 45 min. Finally about 7 $\log_{10}$ cfu was obtained on the 7.065-cm^2 surface.

PUV system specifications: A bench-type PUV light system (SteriPulse-XL System / RE-3000C, Xenon Corp, USA) was used with the following specifications: Input voltage of 3800 V; Pulse rate of 3 pulses/s; Pulse width of 360 µs; Quartz window located at 5.8 cm below the central axis of lamp; Energy output of1.27 J cm^{-2} $pulse^{-1}$ at 1.5 cm below lamp surface. Five different times (5,15,30,45,60 s) and three difeerent distances (5 cm,8 cm, 13 cm) were used for the treatments.

Microbiological analysis: The sucuk samples treated and untreated were pummeled in 50 ml BPW for 2 minutes and serial dilutions (10^0-10^4) were made. Then, they were spread-plated onto CT – SMAC and incubation at 37°C for 24 hr. Lastly, colony count (30-150 cfu) was performed. Enrichment was done for the treatments which gave zero counts. Sucuk samples were pummeled in 50 ml MTSB and incubation at 37°C for 24 h. After that, spread-plating onto CT-SMAC was done, and the plates were incubated at 37°C for 24 h. Finally, inspection of colonies was carried out. Rapid confirmatory latex agglutination test for *E. coli* O157: H7 (Microgen Bioproducts, UK) was performed to confirm the observed colonies.

Temperature and Energy Measurement: Temperature was measured with a K-type thermocouple inserted into 1-2 mm deep from surface. Energy was measured with a pyroelectric sensor (PE50-DIF-C, Ophir Optronics, Israel) by a Nova Laser Power energy monitor.

Statistical Analysis: Each treatment was replicated in triplicate. Microbial reductions and energy levels were analyzed by General Linear Model using MINITAB 17 (Minitab Inc., State College, PA, USA). Significant differences in mean values were determined using Tukey's method at 95% CI.

Mathematical models:
Three mathematical models were used to estimate the inactivation rates: First-order (Log-linear), Membre, and Weibull. Non-linear regression was performed to determine the model parameters by using MINITAB 17.
First-Order (Log-linear) equation is given in Eq. (1).

$$\log \frac{N}{N_0} = -k_1 D \tag{1}$$

where N is the number of cells after an energy dose of D is applied (cfu/cm^2), N_0 is the initial number of cells (cfu/cm^2), k_1 is the first-order extinction coefficient (cm^2/J), and D is the energy dose (J/cm^2) (Bialka et al., 2008; Keklik et al., 2012).

Membre model equation is given in Eq. (2).

$$log\frac{N}{N_0} = 1 - \exp(k_2 D) \tag{2}$$

where k_2 is the model parameter corresponding to the shape of the destruction curve. (Membré et al., 1997).

Weibull model equation is shown in Eq. (3).

$$log\frac{N}{N_0} = -\frac{1}{2.303}\left(\frac{D}{\alpha}\right)^{\beta} \tag{3}$$

where α is the scale parameter (s) and β is the shape parameter (unitless) (van Boekel, 2002).

Goodness-of-fit parameters were root mean square error (RMSE) (Eq. 4), R^2 value, and the slope of the plot (predicted vs observed log reductions).

$$RMSE = \sqrt{\left(\frac{\sum(predicted-observed)^2}{n-p}\right)} \tag{4}$$

where n is number of observations, and p is the number of model parameters (Chen and Hoover, 2003; Buzrul and Alpas, 2004).

Results & Discussion

The log reductions of *E. coli* O157:H7 on sliced sucuk after PUV light treatments are given in Table 1. Treatment distance, time, and distance*time were found to have a significant effect ($p<0.05$) on log reduction. The reductions ranged from 0.60 to >7.13 log cfu/cm^2, which were obtained after the 13 cm-5 s and 5 cm-60 s treatments, respectively. Positive enrichments were obtained for *E. coli* O157:H7 after the 5 cm-45 s and 8 cm-60 s treatments. This suggests that there were surviving cells on the samples that fell under the detection limit (1 cfu/plate). The enrichments yielded negative results after the 5 cm-60 s treatment, which indicates the 5 cm-60 s treatment completely inactivated *E. coli* O157:H7 on sucuk slices. Table 2 demonstrates the energy levels obtained at the treatment distances. The energy level decreased significantly ($p<0.05$) with greater distance from the quartz window. Fig. 1 shows the temperature increase in sucuk samples during the PUV light treatments. As it can be seen, temperature increased profoundly at 5 cm and reached to over 125°C at this distance. In order to limit

the confounding effect of temperature on the inactivation, only the following treatments were included in the modeling: 5 cm (≤15 s), 8 cm (≤30 s) and 13 cm (≤45 s).

Table 1. Inactivation levels obtained for *E. coli* O157:H7 on sucuk slices.

Treatment time	5 cm	8 cm	13 cm
5 s	0.82±0.07f	0.85±0.05ef	0.60±0.15f
15 s	1.34±0.12de	1.03±0.10ef	0.66±0.08f
30 s	1.79±0.09cd	1.73±0.08cd	0.91±0.12ef
45 s	7.13±0.24a[#1]	3.33±0.31b	2.18±0.16c
60 s	>7.13±0.24a[#2]	7.13±0.24a[#1]	2.99±0.13b

Means that do not share a letter are significantly ($p<0.05$) different.
#Minimum detection limit: 1 cfu/plate.
[1]Enrichments: positive.
[2]Enrichments: negative.

Table 2. PUV energy levels.

Distance	Energy level (J cm^{-2} s^{-1})
5 cm	1.6464±0.0042a
8 cm	1.3380±0.0022b
13 cm	0.8693±0.0006c

Means that do not share a letter are significantly ($p<0.05$) different.

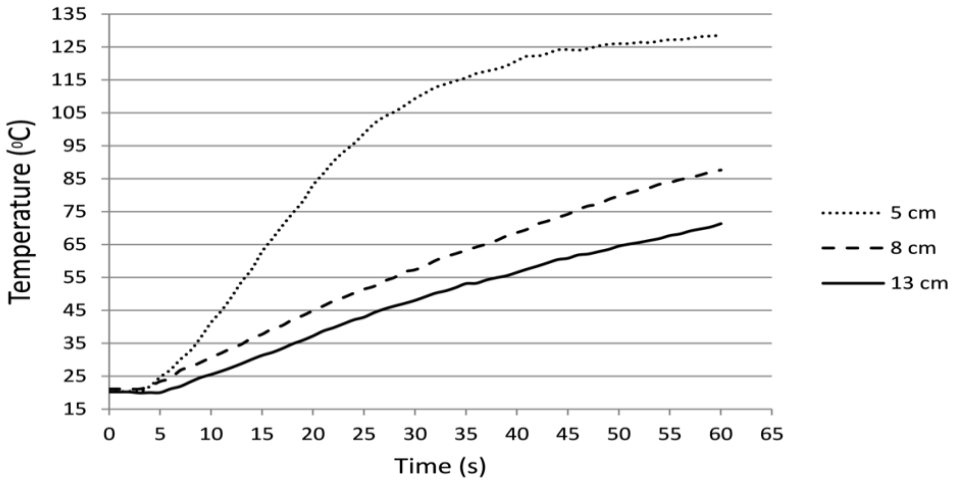

Fig. 1. Temperature of sucuk slices during PUV treatments.

Table 3 and Table 4 demonstrate the goodness-of-fit and model parameters obtained for the mathematical models, respectively. The smallest values of RMSE were obtained for the Weibull model at 5 and 8 cm and for Membre model at 13 cm. The values of R^2 and slope were closest to 1 for the Weibull model, except the values at 13 cm, which were closest to 1 for Membre's model. Thus, overall, the most accurate estimation of microbial inactivation was yielded by the Weibull model based on the goodness-of-fit parameters at 5 and 8 cm and Membre model at 13 cm. Fig. 2 demonstrate how the

models fitted to the inactivation data. The plots clearly show that at 5 and 8 cm Weibull model better predicted the inactivation data compared to other models, while at 13 cm Membre model was the best, although this model cannot be accepted due to the insufficiency of the goodness-of-fit parameters.

Table 3. Goodness-of-fit parameters of models.

GOF Parameter	PUV distance	First-order	Membre	Weibull
RMSE	5 cm	0.2504	0.3423	0.0045
	8 cm	0.3258	0.4341	0.1595
	13 cm	0.2966	0.2785	0.3419
R^2	5 cm	0.891	0.816	1
	8 cm	0.854	0.776	0.966
	13 cm	0.872	0.904	0.876
Slope	5 cm	0.948	0.889	1
	8 cm	0.933	0.862	0.987
	13 cm	0.943	0.949	0.944

Table 4. Model parameters.

Model	Treatment distance	Model parameters	
First-Order	5 cm	k_1: 0.0587	
	8 cm	k_1: 0.0465	
	13 cm	k_1: 0.0500	
Membre	5 cm	k_2: 0.0359	
	8 cm	k_2: 0.0263	
	13 cm	k_2: 0.0291	
Weibull	5 cm	α: 1.9269	β: 0.4412
	8 cm	α: 2.1022	β: 0.4523
	13 cm	α: 9.3028	β: 1.0566

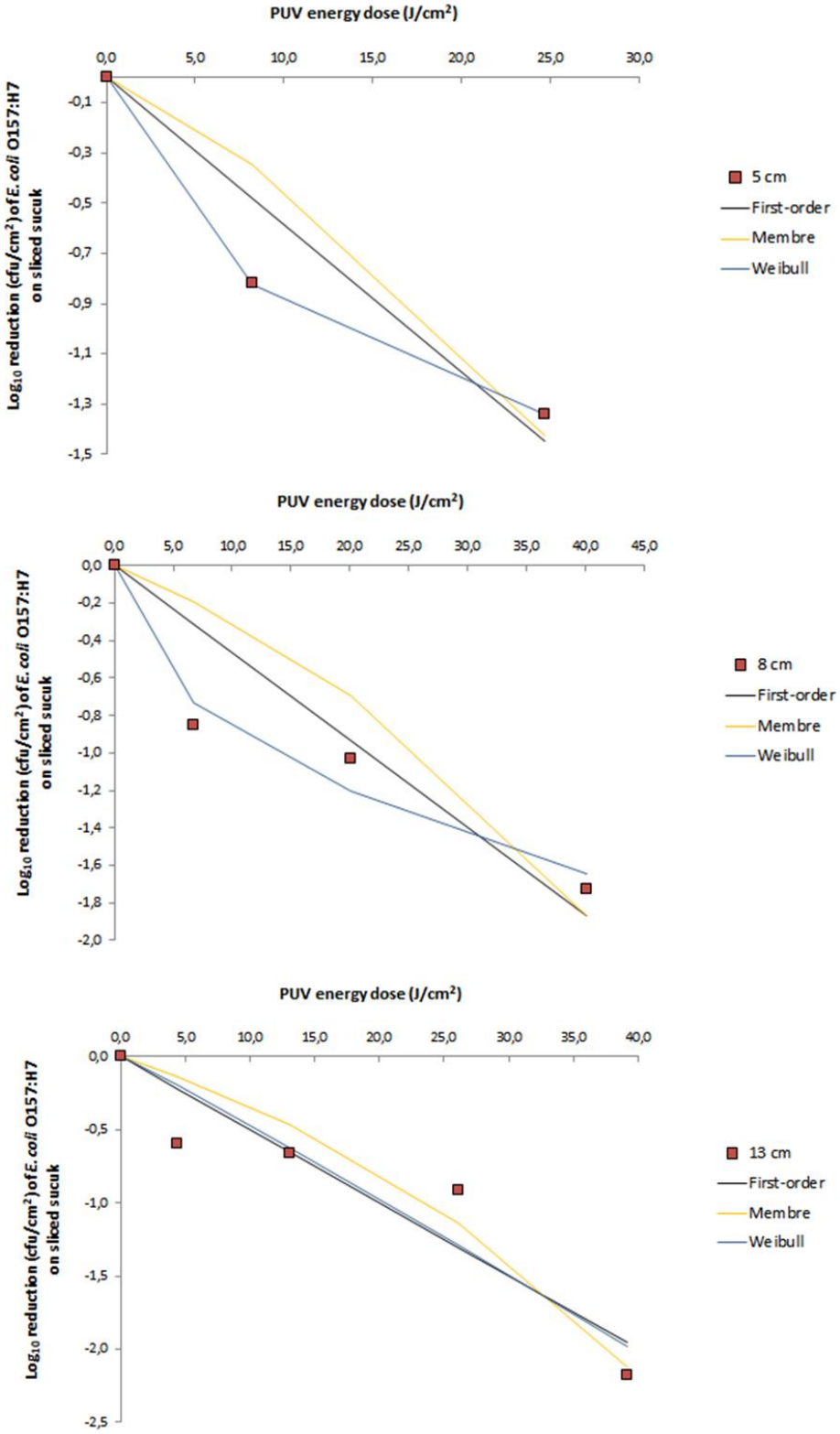

Fig. 2. Prediction of inactivation by the models

Conclusions

The 5 cm-60 s treatment at 98.78 J/cm^2 resulted in complete inactivation (>7.13 log cfu/cm^2) of *E. coli* O157:H7 on sucuk slice, which however was attributed to the high temperature reached. The PUV-light inactivation followed a non-linear pattern. Weibull model yielded the highest goodness-of-fit followed by Membre model and First-order kinetic model, respectively.

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Electrosprayed Food Grade Particles for Food Safety Applications

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Abstract

Electrospraying technique as a novel emerging technology has been proposed for obtaining the micro-, sub-micro- and nanoparticles for innovative food applications. This study used the electrospray technique to produce whey protein concentrate-lauric arginate particles to generate the micro–nanoparticles for food safety applications. The effect of lauric arginate (LAE) concentrations (2, 1, 0.5 % w/v) on the formation of whey protein concentrate (WPC) particles morphology, structure, and functional properties were examined. The optical and scanning electron microscopy (SEM) and, FT-IR analysis was applied to characterize the obtained particles. The SEM results demonstrated that the WPC particles could be obtained with different concentrations of LAE with spherical morphology and smooth surface. FT-IR analysis confirmed the interactions between whey protein concentrate and lauric arginate. The presence of LAE enhanced the electrospraying of WPC particles. The WPC-LAE particles were obtained under the applied voltage of 22 kV, a flow rate of 0.3 mL h-1 and a distance of 10 cm between the nozzle and collector. The obtained WPC-LAE particles antimicrobial activity tested against bacteria including Bacillus cereus, Listeria innocua, Escherichia coli, and Salmonella enterica subsp enterica serovar. The WPC-LAE particles possessed significant antimicrobial activity, and the activity was concentration-dependent. The antimicrobial food-grade WPC-LAE particles can respond to food industry demand for food safety applications with simple and low-cost novel electrospraying techniques.

Keywords: Whey protein concentrate, food-grade particles, lauric arginate, antimicrobial

Introduction

New technologies based on antimicrobial protection have been developed to prevent food contaminations from microorganisms such as bacteria, molds, and yeast. (Arserim-Uçar, D. K., & Çabuk, B. 2020). Electrospraying is the electrohydrodynamic process that fabricates nano-micro scale particles with a wide variety of food-grade natural polymers (Anu Bhushani & Anandharamakrishnan, 2014; Jaworek & Sobczyk, 2008). Electrospraying is an alternative to conventional micro-nano scale encapsulation techniques specifically for heat liable active food-grade ingredients (Asadi et al., 2021). Process parameters for electrospraying, including polymer solution concentration, used solvent, polymer pH, conductivity, and surface tension, can affect the structural and functional properties of the obtained micro/nano size product (Anu Bhushani & Anandharamakrishnan, 2014; Drosou et al., 2017). The main advantages of this technology are a one-step process, operating in mild process conditions resulting in dry powdered nano-micro size particles for food-grade materials (Zhang & Kawakami, 2010). Micro-nano size food grade electrosprayed antimicrobial particles have been formulated for food safety applications (Dhiman et al., 2021). Polymer-based nanoparticles have gained popularity because of their biocompatibility and functional properties as well as the availability of food grades. Several applications of the electrospray technique have been presented in the literature, such as curcumin in walnut protein (Asadi et al., 2021), rosemary essential oil in starch (Biduski et al., 2019), D-limonen in *Alyssum homolocarpum* seed gum (Khoshakhlagh et al., 2017) and eicosapentaenoic acid-rich oil in whey protein concentrate (David et al., 2021) have been formulated. Whey protein is one of the milk components, a coproduct of cheese proses, and has various functional properties, including emulsification, foaming, and gelation (Abbastabr et al., 2020; Bacenetti et al., 2018). Whey protein concentrate (WPC) has been used to develop in the process of different microparticles-based delivery systems (López-Rubio & Lagaron, 2012). Lauric arginate **(**LAE) is an FDA-approved cationic

surfactant which is derived from lauric acid, L-arginin, and ethanol (Shen et al., 2021). Antimicrobial activity of LAE has been reported against various microorganisms alone or in the combination of different formulations (Ma et al., 2020), in addition to food systems (Shen et al., 2021). The present study aimed to determine the potential of the electrospray technique to produce whey protein concentrate-lauric arginate food-grade microparticles and investigate characteristics of the obtained microparticles.

Material and Methods

Lauric arginate LAE (CytoGuard™) and whey protein concentrate (WPC) 80% HS was kindly provided by A&B Ingredients, Inc. (Field, NJ, USA) and Davisco Inc. (USA), respectively. WPC 2% was prepared by dissolving the protein in deionized water under continuous magnetic stirring. The concentrations of LAE were selected based on preliminary trials (2%, 1% and 0.5 % w/v). The polymer solutions were placed into 5 mL plastic syringes and attached to a 22-gauge nozzle. The electrospray operation was carried out by an electrospinning apparatus, supplied with a 0–50 kV power supply (OptoSense,Tekno-TIP, Turkey) and a syringe pump. Regarding preliminary trials, the electrospraying parameters was set to as; flow rate 0.3 mL/h and applied voltage 22 kV, tip-to-collector distance 10 cm. The morphology of the samples was analyzed using scanning electron microscopy (SEM) (**JEOL JSM 6510**) and optical microscopy (Camera Olympus SC180, BX43F, Tokyo, Japan). The infrared spectra of the electrosprayed particles were obtained using an FT-IR (PerkinElmer® Spectrum™ 100) equipped with an ATR, in a range of 550–4000 cm^{-1} at 4 cm^{-1} resolution averaging of 64 scans. The obtained WPC-LAE particles antimicrobial activity tested against bacteria including *Bacillus cereus* NRRL-B-3711, *Listeria innocua* ATCC 33090, *Escherichia coli* ATCC 25922, and *Salmonella enterica subsp enterica serovar* Typhimurium ATCC 14028. The obtained WPC-LAE microparticles antimicrobial activity was determined using the minimum inhibitory concentration (MIC) broth dilution method and the agar well diffusion method. Mueller Hilton broth was used in the microdilution method; the 96 well plates were inoculated at 37° C for 24 h. After 24 h, Triphenyltetrazolium chloride (TTC) was used to determine the minimum inhibition concentration. Regarding the TTC, a color change indicated the presence of viable bacteria. No color indicated the presence of nonviable microorganisms. Agar well diffusion assay was performed in 8 mm wells containing Mueller Hilton agar and WPC-LAE (2%, 1%, and 0.5 w/v) different concentrations and WPC. The colony suspensions of tested bacteria were adjusted to MacFarland 0.5 turbidity in 10 mL sterile 0.9% (w/v) NaCl for both used antimicrobial activity assays. The plates were inoculated at 37° C for 24 h. The results were obtained by measuring the mean value of the zone diameter. The experiment was done three times. One-way analysis of variance (ANOVA) by Tukey's was performed with Minitab 17 software version to estimate the significant differences between sample means. The data were recorded as mean ± standard deviation.

Results and Discussion

In this study, the WPC solution concentration was prepared using the slightly modified methodology proposed by David et al. (2021). WPC 20% (w/v) was applied to the electrospraying process at different LAE concentrations (2 %, 1%, and 0.5%). SEM results in Figure 1 demonstrated that the WPC particles obtained with different concentrations of LAE with an average particle size of 2.08±0.52 µm -1.88±0.74 µm with spherical morphology and smooth surface. The size of produced microparticles increased with increasing the concentration of LAE in the WPC solution. The particle size of WPC is around 1.5 ±0.66 µm and WPC-LAE (1%) 1.88±0.74 µm and the WPC-LAE (2%) 2.08±0.52 µm. David et al. (2021) obtained WPC microparticles with similar morphologies by encapsulating eicosapentaenoic acid-rich oil. The nature of formed microparticles was also confirmed by optical microscopy (Figure 1(D)).

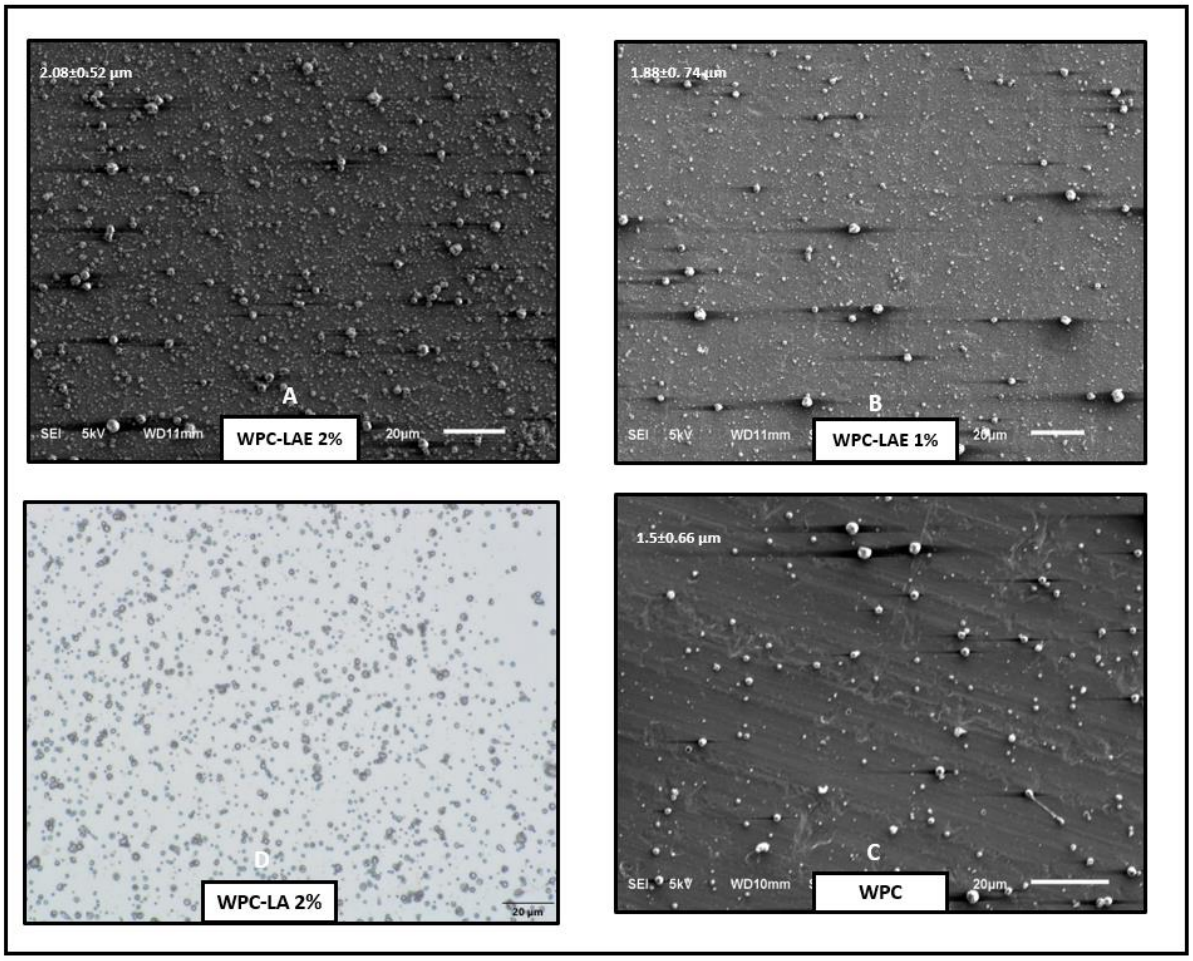

Figure 1. SEM of images WPC-LAE 2% (A), WPC-LAE 1% (B), WPC (C) and optical microscopy images of WPC-LAE 2% (D)

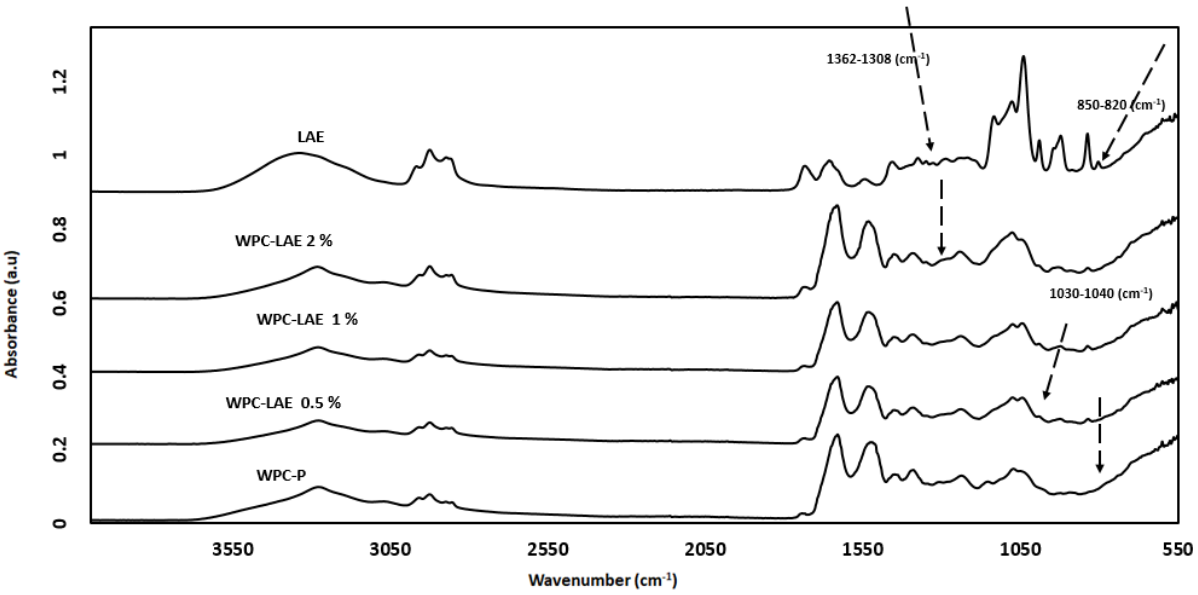

Figure 2. FTIR spectra of microparticles WPC, WPC-LAE (0.5%), WPC-LAE (1%), WPC-LAE (2%) and LAE

FT-IR analyses were performed in order to examine the structural changes that occurred in the samples with the presence of LAE concentrations. The FTIR spectra for WPC, WPC-LAE (0.5 %), WPC-LAE (1 %), WPC-LAE (2 %) microparticles and LAE are illustrated in Figure 2.
The characteristic band of WPC at 1650 cm^{-1} -1550 cm^{-1} is linked to amide I and amide II (David et al., 2021). The glycerol, alcohol contained WPC particles CO stretching band was observed spectra at 1030 cm^{-1} to 1040 cm^{-1}(López-Rubio & Lagaron, 2012). The most important absorption bands of the spectra changes were observed among the FTIR spectra of high concentrations of LAE containing whey protein particles. LAE related bands of FT-IR spectra were observed at 1362-1308 cm^{-1} and 850-820 cm^{-1}, indicating the molecular interaction between the WPC-LAE microparticles.

Table 1. Minimum inhibitory concentration (MIC) of WPC-LAE microparticles

	MIC (mg microparticles)			
WPC-LAE particles	***L. innocua***	***B. cereus***	***E. coli***	***S. Typhimurium***
WPC-LAE 2%	0.32	0.32	0.64	1.28
WPC-LAE 1%	0.64	0.64	1.28	2.56
WPC-LAE 0.5%	0.64	1.28	1.28	5.12
WPC	-	-	-	-

The antibacterial effect of WPC-LAE (2%, 1%, and 0.5 % w/v) microparticles on selected bacteria was assessed by determining minimum inhibitory concentration (MIC). Results are shown in Table 1. WPC-LAE microparticles showed inhibitory effects against Gram (+) bacteria, including *B. cereus, L. innocua,* and Gram (-) bacteria including *E. coli* and *S.* Typhimurium. Colorimetric interpretation by triphenyltetrazolium chloride was used to determine the minimum inhibition concentration. Colorimetric interpretation regarding the TTC (Triphenyltetrazolium chloride), red color indicated the presence of viable bacteria. The MIC value was defined as the lowest WPC-LAE microparticles concentrations at which no color change occurred (Panphut et al., 2020). The lowest MIC value was 0.32 mg/ml in *L. innocua,* and the highest MIC value was 1.28 mg/ml in *S.* Typhimurium at WPC-LAE (2%). WPC microparticles exhibited no inhibitory activity.

Table 2. The inhibition zone of obtained WPC-LAE microparticles

	Inhibition zone (mm)			
WPC-LAE particles	***L. innocua***	***B. cereus***	***E. coli***	***S. Typhimurium***
WPC-LAE 2%	20.17 ± 0.26^{a}	16.10 ± 0.43^{a}	14.30 ± 0.19^{a}	13.16 ± 0.07^{a}
WPC-LAE 1%	17.86 ± 1.83^{ab}	14.63 ± 0.18^{b}	12.63 ± 0.14^{b}	10.93 ± 0.09^{b}
WPC-LAE 0.5%	15.61 ± 0.33^{b}	14.58 ± 0.14^{b}	11.41 ± 0.11^{c}	-
WPC	-	-	-	-

a-b: Different letters between rows indicate different values ($p < 0.05$) according to the Tukey test.

The antimicrobial activity of obtained WPC-LAE (2%, 1%, and 0.5 % w/v) microparticles was determined using the agar well diffusion method. Results are shown in Table 2 and Figure 3. The antibacterial effect of WPC-LAE microparticles was higher against Gram (+) bacteria than Gram (-)

bacteria. The most sensitive one was *L. innocua,* and the most resistant was *S.* Typhimurium, among the tested LAE concentrations. It was observed that 2% of LAE contained WPC microparticles showed the highest antimicrobial activity compared to other LAE concentrations. No inhibitory activity was observed for WPC microparticles. Overall, the result of minimum inhibitory concentration (MIC) broth dilution and agar well diffusion methods was consistent.

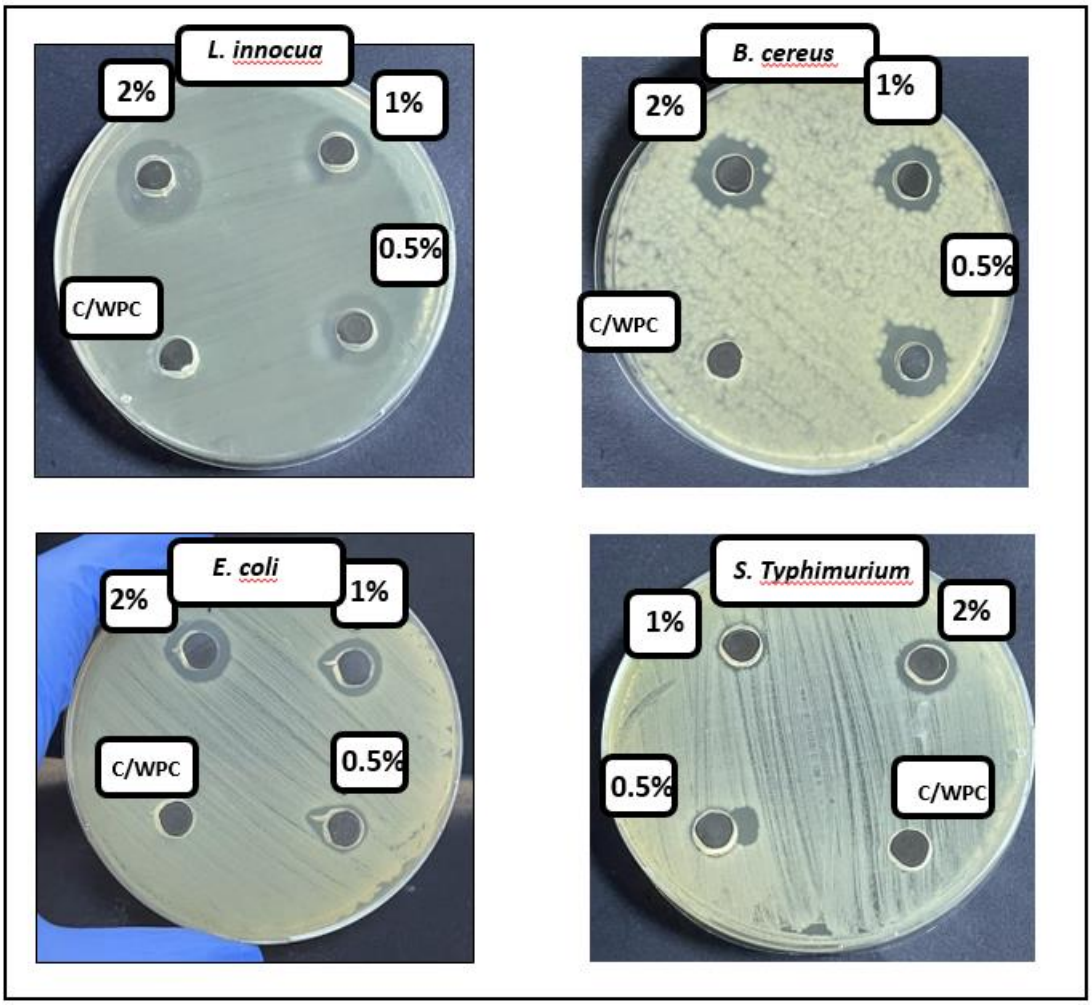

Figure 3. The antimicrobial activity of obtained WPC-LAE (2%, 1%, and 0.5 % w/v) microparticles on *B. cereus, L. innocua, E. coli,* and *S.* Typhimurium

Conclusion

In this work, WPC-LAE (2%, 1%, and 0.5 % w/v) microparticles were successfully obtained for the first time via the electrospraying process. WPC-LAE (2%, 1% and 0.5 % w/v) microparticles showed high antibacterial activity against the tested Gram (+) and Gram (-) bacteria. The obtained WPC-LAE microparticles could be used for controlling the microbial contamination in a different form for directly used as particles, spray on food, or sprayed on food packaging systems.

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The Effect of Cold Press Oil Extraction Method on Transfer of Ochratoxin A To The Oil From Contaminated Olives

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The aim of this study is to investigate the presence and amount of Ochratoxin A (OTA) in the final product as a result of olive oil extraction by cold press from olives contaminated with OTA which are both naturally (NC) and spiked with 15 µg kg^{-1} (SC). The cold press method was used for oil extraction from olives. OTA was extracted from samples using methanol, then it was purified with the immunoaffinity column and quantified in HPLC using a fluorescence detector. The recoveries and detection limits are 92% and 0.15 µg kg-1, respectively. Olive oil was obtained by processing SC samples, and finally, OTA was detected in olive oil between 4.32-6.29 µg kg^{-1}. Mean concentration was 5.42 µg kg^{-1} (36.13%). OTA concentrations in NC samples were between 0.589 and 12,005 µg kg^{-1}. Olive oil obtained from NC samples were contaminated with OTA in the range of 0.241 to 3.891 µg kg-1 (34.34%). As a result, similar results were obtained from both NC and SC samples. It was determined that in the cold pressing process, 35.23% of OTA in olive was transferred to olive oil.
Keywords: Olive Oil, Ochratoxin A, Cold Press, HPLC-FLD

The Effect Of Cold Press Oil Extraction Method On Transfer Of Ochratoxin A To The Oil From Contaminated Olives

1.INTRODUCTION

Ochratoxin A (OTA) is a highly toxic and carcinogenic mycotoxin which is produced by *Aspergillus ochraceus* and *Penicillium verrucosum* as a secondary metabolite. These molds can grow in different climates and on different plants, and therefore OTA contamination of food crops can occur worldwide. OTA can be found in a wide variety of human foods such as cereals, raisins, wine, cocoa, coffee and olives. (Fernane et al. 2010; Ghitakou et al. 2006)

OTA is one of the most studied mycotoxins because of its toxic effects on human and animals. It causes nephrotoxic, genotoxic, neurotoxic, immunotoxic, embryotoxic, teratogenic and carcinogenic effects in the human body. The International Agency for Research on Cancer (IARC) has classified OTA as a ‘‘possible human carcinogen’’ (Group 2B) (International Agency for Research on Cancer (IARC) in 1993 (Cavaliere et al. 2010; Raad et al. 2014)

Olive and its products are one of the most important foods of the Mediterranean diet. Fungal contamination can observe in natural or processed olives and in many different studies, it has been shown that different mycotoxins such as ochratoxin A, aflatoxins, citrinin and penicillium toxins can be found in olives. Some problems in olive cultivation such as damage to olives by insect, lack of favourable storage conditions and hygienic conditions during processing of olives and olive oil raises the possibility of mycotoxin contamination.(Daradimos, Marcaki, and Koupparis 2000; Ferracane et al. 2007)

There are limited research available to detect the presence of OTA in olives and olive oil. The risk of OTA in olives and olive oils has been reported by various authors. Firstly, Le Tutour et al. (1984)(Le Tutour, Tantaoui-Elaraki, and Aboussalim 1984) detected the presence of OTA in 3 of 60 crude olive oil samples using the classical thin layer chromatography method. Long after this study, Papachristou and Markaki (2004), found the presence of OTA at an average level of 267 µg/kg in 44 of 50 olive oil samples in Greece. Subsequently, Finoli et al. (2005), detected OTA in the range of 52-244 µg/kg in 13 of 28 extra virgin olive oil samples produced in Sicily, while they detected OTA in the range of 101-839 µg/kg in 30 of 45 green and black olive samples.

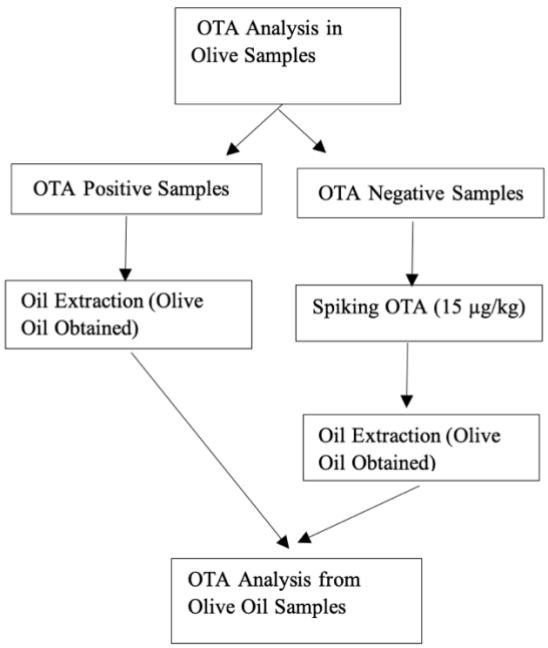
Ghitaku et al. (2006) investigated the presence of OTA in a total of 70 black and green olive samples, 40 from orchards and 30 from markets, in Athens. As a result of the research, they could not detect OTA in any of the samples taken from the garden, however, they detected the presence of OTA (average 1.58 µg/kg) in all of the samples taken from the market. El Adlouni et al. (2006), investigated OTA and

aflatoxin B1 content in 10 olive samples taken from retail outlets and supermarkets in Morocco in 2006. They determined that all olive samples contained OTA over 1.02 µg/kg. Ferracane et al. (2007), determined that 80% of the 30 olive oil samples taken from Italy and North Africa contained ochratoxin A, the highest of which was 17.0 µg/kg. Dazkır (2010), detected OTA in the range of 0.54-2.99 µg/kg in 22 of 30 olive samples collected from the Istanbul market and in the range of 0.36-2.10 µg/kg in 25 of 30 olive oil samples.
The aim of this study is to investigate the presence and amount of Ochratoxin A (OTA) in the final product as a result of olive oil extraction by cold press from olives contaminated with OTA which are both naturally (NC) and spiked with 15 µg kg-1 (SC). The cold press method was used for oil extraction from olives.

2. MATERIALS AND METHODS

2.1. Sample Collection:
The green olive samples were taken from the markets and producers in the Mersin region. Twenty olive samples were obtained, each in 2 kg packages.
2.2. Chemicals and Apparatus
OTA standard (purity ≥98%) was supplied by Sigma (Sigma-Aldrich Alcobendas, Spain). Acetonitrile, methanol, acetic acid and ethanol were purchased from Merck (Darmstadt, Germany). All the solvents were HPLC grade Immunoaffinity chromatography columns (IAC) for OTA clean-up were from Vicam (Watertown, MA). Pure water was collected using a Milli-Q apparatus (Millipore, Billerica, MA). Phosphate buffer saline (PBS) was prepared to one tablet solved in 200 mL of pure water (Sigma-Aldrich Alcobendas, Spain).
2.3. Methods:
At the beginning of the study, OTA analysis was performed on all olive samples. Samples in which no OTA was detected were spiked to provide a concentration of 15 µg/kg. Then, oil extraction was performed from the OTA positive and OTA spiked samples by cold pressing method. OTA analysis was also performed on the olive oil samples from the extraction and the rates of OTA in olive oil were determined. The processes applied to the olive samples are given in Table 1.

Table 1. The process applied to detect the transfer of OTA found in olive samples to olive oil.



2.3.1. OTA Spiking Method:
After grinding 100 g olive samples in a blender, 750 µl of 2 µg/ml stock OTA solution was added on it and left in a dark cabinet for 2 hours.

2.3.2. Olive Oil Extracting Method:
100 g olive sample was ground in a high-speed blender for 3-4 minutes. Then it was taken into centrifuge tubes and centrifuged at 6000 rpm for 30 minutes. Olive oil in the upper phase of the centrifuge tubes was taken with a pipette and OTA analysis was performed on this samples.

2.3.3. Determination of OTA in Olive Samples:

2.3.3.1. Sample Preparation:
50 g of olive sample was mixed with 100 mL of methanol+water (80:20, v/v) solution and mixed in a blender at high speed for 2 minutes. The mixture was first passed through coarse filter and then through Whatman No:4 filter paper. 2 mL of this filtrate was taken and diluted with 40 mL of PBS. It was mixed by vortex for 1 minute.

2.3.3.2. Affinity Chromatography:
The diluted filtrate was extracted from the OchraTest immunoaffinity column (Vicam) at 2 mL/min. passed with the flow rate. The column was washed with 20 mL of distilled water and finally air-dried. For the elution of OTA from the column, 1 mL of acetonitrile:acetic acid (98:2) solution, then 1 m of water was passed and collected in a sample vial. From the last eluate, 100 µL was injected into the HPLC. OTA quantities of standards and samples were determined using HPLC with fluorescent detection. An HPLC system consisted of a pump (Shimadzu, Japan) and a fluorescence detector (Shimadzu, Japan). OTA was separated in C-18 column (5 µm, ODS3, 4.6 x 250 mm, GL Science, Tokya, Japan) with a mobile phase of acetonitrile:water:acetic acid (48:51:1, v/v/v). Fluorescence detection was at an excitation wavelength of 333 nm an emission wavelength of 477 nm. Aflatoxin retention times with 1 ml/min flow rate were 14.025 min. for OTA while owen tempurature was 30 ºC. Total run time was 21 min. Spiked sample was injected 10 times. The recoveries and detection limits are 92% and 0.15 µg kg-1, respectively.(Ghitakou et al. 2006)

2.4. OTA Analysis in Olive Oil Samples

2.4.1. Sample Preparation:
10 g of olive oil sample was weighed into a 50 ml centrifuge tube and 10 ml of methanol:water (80:20) was added to it. This mixture was mixed in vortex at high speed for 2 minutes. Centrifugation was performed to extract Ochratoxin A in olive oil in liquid phase. Centrifugation was performed at 4000 rpm at +4 °C for 20 minutes and the supernatant was obtained clearly. 2 ml of supernatant was taken and 40 ml of PBS was added.

2.4.2. Affinity Chromatography
The diluted filtrate was extracted from the OchraTest immunoaffinity column (Vicam) at 2 mL/min. passed with the flow rate. The column was washed with 20 mL of distilled water and finally air-dried. For the elution of OTA from the column, 1 mL of acetonitrile:acetic acid (98:2) solution, then 1 mL of water was passed and collected in a sample vial. HPLC conditions were same as 2.3.3.2. (Daradimos et al. 2000)

3. RESULTS AND DISCUSSIONS:

3.1. OTA Occurence in Olive Samples
OTA contamination was detected in 8 of 20 olive samples taken from orchards and markets. Similarly Dazkır (2010) detected OTA, 22 of 30 olive samples collected from the Istanbul markets. Table 2. shows the results from an additional OTA determination of 20 olive samples originated from Mersin.

Table 2. OTA occurence in olive samples (p≤0.05)

Origin of Samples	n[a]	Number of contamination OTA (µg kg^{-1})				
		ND	0-1	1-5	5-10	>10
Markets	8		2	3	2	1
Producers	12	12				

OTA contamination was not found in the olive samples taken from the orchards, but it could be found in different concentrations in the samples taken from the markets. Based on this, it can be said that the risk of OTA formation is low if the olives are not damaged on the tree and stored for long periods after harvest. As a matter of fact, in a study conducted in Greece, OTA was found at low concentrations in only 2 of 30 olive samples taken from orchards (Ghitakou et al. 2006).

3.2. Determination OTA in SC Olive Samples

SC samples were spiked at a concentration of 15 (µg kg-1) and olive oil samples were obtained by cold pressing method. Table 3. shows that the degradation of OTA from SC samples to olive oil. When oil was extracted from SC samples, it was determined that there was an average of 63.87% degradation in OTA level.

Table 3. Determination of OTA in SC samples (p≤0.05)

Sample No	OTA in Spiked (SC) Olives (µg kg^{-1})	OTA in Oil Sample (µg kg^{-1})	Percent Degradation of OTA concentration (%)
1	15	4,51	69,93
2	15	5,88	60,8
3	15	5,63	62,47
4	15	5,89	60,73
5	15	6,29	58,07
6	15	4,79	68,07
7	15	6,12	59,2
8	15	5,77	61,53
9	15	4,78	68,13
10	15	5,45	63,67
11	15	5,59	62,73
12	15	4,32	71,2
Mean	15	5,42	63,87

3.3. Determination of OTA in NC olive oil samples:

Different concentrations of OTA were detected in NC samples. Table 4. shows that the degradation of OTA from NC samples to olive oil. When oil was extracted from NC samples, it was determined that there was an average of 65,66% degradation in OTA level.

Table 3. Determination of OTA in SC samples ($p \leq 0.05$)

Sample No	OTA in Naturally Contaminated (NC) Olives (µg kg^{-1})	OTA in Oil Sample (µg kg^{-1})	Percent Degradation of OTA concentration (%)
1	1,99	0,61	69,01
2	0,82	0,32	61,09
3	8,64	3,89	55,00
4	10,43	2,71	74,01
5	1,63	0,53	67,06
6	0,59	0,24	59,08
7	12,00	2,64	78,00
8	7,86	2,98	62,01
Mean	5,49	1,74	65,66

Olive and olive oil are one of the most important products of the Mediterranean basin. OTA has been found in olive and olive oil in few studies. Mold and mycotoxin formation in olives generally occur in the post-harvest period. Similarly, OTA could not be detected in all of the samples we took from the garden in our study. This study is the first to demonstrate on the mechanism of OTA transfer from olives into crude oil. We determined that when the oil was extracted with cold press from NC and SC samples, OTA was transferred to olive oil at the rates of 34.34% and 36.13%, respectively.

OTA is a very harmful mycotoxin in terms of health, but no limit has been determined for OTA contamination in olives and olive oils in the Turkish Food Codex and European Union legislation. Different extraction techniques and refining techniques can be applied to reduce OTA contamination in olive oils.

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