

# BOOK OF ABSTRACTS



SARAJEVO 1-2 DECEMBER 2022

**32<sup>nd</sup> International Scientific-Expert  
Conference of Agriculture and Food Industry  
1<sup>st</sup>-2<sup>nd</sup> December 2022  
Sarajevo, Bosnia and Herzegovina**



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## **KEYNOTE SPEAKERS**

# PEST MANAGEMENT CHALLENGES FOR LOCAL FOOD PRODUCTION SYSTEMS

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Protecting plant health can help end hunger, reduce poverty, protect the environment, and promote economic development. In the latter half of the 20th century, pesticides were used primarily to protect plant health, and this practice has led to growing consumer concern about the effects of pesticides on the environment and human health. The European Green Deal set new goals and established a roadmap through the Farm to Fork and Biodiversity 2030 strategy. The use and risks of chemical pesticides are to be reduced by 50% by 2030. In the absence of suitable alternative crop protection strategies, this target could lead to significant yield losses due to pests, diseases and weed competition, weakening domestic food security and leading to higher food imports. This inevitably brings new challenges, namely (i) the reduced number of available and approved active ingredients for pest control; (ii) the increased risk of developing pest resistance due to the use of a limited number of active ingredients with the same mode of action; (iii) the consequent abandonment of the cultivation of some crops due to the lack of appropriate means of protection against pests; (iv) the lack of research at the local level to improve forecasting methods, develop forecasting systems, discover new active ingredients, and develop new strategies to control pests with minimal use of chemical pesticides; (v) the need for an educational system for farmers to train them in the use of new technologies. To achieve a 50% reduction, farming and food systems must be completely transformed.

*Keywords: alternative strategies, chemical pesticides, education, pest resistance*

# THE BENEFITS OF LOCAL FOOD PRODUCTION SYSTEMS - CIRCULAR ECONOMY PERSPECTIVE

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The dynamics of development and globalization of a food system have been increasingly recognized as a major cause of planet ecosystem degradation, increase of greenhouse gas emissions and severe public health problems (including pandemics). The conventional linear models focused on food supply and value chains neither adequately reflect the complexity of food system impact nor help people engage with their increasingly invisible social, economic and environmental consequences turning them into consumers only. The shift from global food systems to locally supported agriculture and food production cannot be left without the broader prospect of revitalizing the region's economy and boosting agri-food businesses. Environmental limitations can no longer be seen as restrictions, but should be viewed as "healthy borders" in the perspective of the planet's health. In an era of advanced technological solutions, a closed-loop economy and wise management of raw materials is no longer a problem of "how to do it," but more of "what technology best fits the region." The analysis presented here provides insight into the possibilities of reorienting food system dynamics toward sustainability goals using a set of best-fit technologies and business models.

*Keywords: food system, food production, economy, business models*

# **PERSPECTIVES FOR WEST BALKAN AGRICULTURE: WHICH BUSINESS MODELS FOR A FUTURE INSIDE EU?**

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Business models describe of how an organization creates, delivers and captures value. They may support existing agricultural enterprises of all sizes to define their future strategy. Likewise, they are essential for new entrants in agriculture and new entrepreneurs for young businesses in rural areas. The presentation starts with an introduction to main types of agricultural business models and discusses then, how European Agriculture will look like in 2040. Six hypothesis of future characteristics of European Agriculture are proposed: 1. Productive and competitive, 2. Oriented towards new value chains, 3. Enhancing animal welfare and biodiversity, 4. Energy efficient and climate saving, 5. Labor saving and digitalized, 6. Realized in natural landscape, indoor farms and biorefineries. A most important challenge will be winning young people to continue farm businesses or starting new enterprises in agriculture and rural areas: Agricultural research, formation and extension should act together for a strong support and seeking for EU-funds. Finally, a short outlook is given on how developing and jointly supporting the potential of West Balkan Agriculture on its way towards EU.

*Keywords: business models, European Agriculture, rural areas*

**FOOD TECHNOLOGY (FOOD & NUTRITION)**

# IMPACT OF POTATO STORAGE CONDITIONS ON THE QUALITY OF STARCH

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Potato (*Solanum tuberosum*) is one of the crops with the highest cultivation rate worldwide. Although a part of it is used for table consumption, most of it is still processed into various food products, whereas starch production stands out. Starch is of great importance for the food industry. It is used as a basic raw material or thickening agent for achieving the desired rheological properties of many products. Since the fresh potato is available only for a few months during the year, the starch and food industry must rely on the use of stored potato. The quality of potato starch highly depends on storage conditions such as temperature, humidity and duration. The aim of this investigation was to produce and analyse the yield and quality of starch from potatoes stored at different temperatures during two months. Physical-chemical analysis of starch included determination of starch particles size, water, amylose and amylopectin content, pH value, swelling capacity, as well as transparency, viscosity and firmness of the formed gel. The obtained results showed that the inadequate way of storage for prolonged period have negative effect on the yield and quality of starch gel. Extended potato storage, particularly on room temperature, had lead to decrease in its starch ability to swell and form gel with desirable transparency, viscosity and firmness.

*Keywords: potato, storage, starch yield and quality*

# PLANT-BASED DIET AS A SUSTAINABLE DIET OR A NEW DIET TREND

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Nutrition that is based on mostly consuming plant origin food, also known as „plant-based“ diet, generates multiple forms of dietary patterns, which in common have lower consumption of animal based food. „Plant-based“ diet must not be mistaken for a vegetarian diet, or subcategories of the one, even though they all have in common lower intake of animal based food. „Plant-based“ diet is promoted because of its' multiple health benefits.

The aim of this research is to evaluate „plant-based“ diet as a sustainable diet or as a new diet trend. Results of this research demonstrate: positive effect on a cardiovascular health (positive effect on the decrease of lipid blood concentration, the decrease of blood pressure, the decrease of body weight, the improvement of blood sugar control, the improvement of the overall lifestyle), enablement of required protein intake among the athletes, enablement of the intake of dietary fibres, plant oils, nuts, seeds and nutritive rich food. On the contrary „plant-based“ diet is not represented as a safe diet for children and pregnant women.

„Plant-based“ diet satisfies all aspects of sustainability, fulfilling the regulations of environment protection, preserving humans' health, enabling easy meal preparation and respecting peoples' cultural habits. Popularization of the „plant-based“ diet would ensure industry change, improvement of peoples' overall health and satisfaction of social and ecological aspects of worlds' population.

*Keywords: „plant-based“ diet, sustainable diet, healthy diet*



# USAGE OF BIOPLASTICS IN FOOD INDUSTRY

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Plastics are petroleum-based products which also emit huge amounts of carbon dioxide, resulting in environmental problems in addition to being quite stable that do not easily degrade in nature. Recently, environmental consciousness and eco-friendly production approach have pushed researchers to come up with new alternatives. The innovative strategy for manufacturing biodegradable materials includes organic matter-based polymer production, which is stated as “bioplastics”. Biological sources such as protein, starch, cellulose, poly lactic acid, etc. can be used for this purpose. Moreover, utilization from food wastes is also possible. Bioplastics can be used in any field of industry, including food industry. Because there has been an increasing demand for utilization of natural sources in the production as a whole within the concept of “healthy products” & “healthy production techniques” all over the world. So, food packaging has been evaluated within this scope as one of the potential bioplastic applications related to food industry. There have been successful examples of biodegradable packaging materials in the literature and the most commonly used resources for manufacturing food packages are starch and cellulose (agro polymers), while there have also been some other sources with different production strategies (e.g. microorganism derived bioplastics: polyhydroxybutyrate, biotechnological process based bioplastics: poly lactic acid). This study aims to present the promising applications of bioplastics in food industry, including a wide variety of product groups such as frozen foods, fresh vegetables, candies, chips, chocolates, etc.

*Keywords: bioplastics, biodegradable, food industry, food packaging*

# SCREENING BASED APPROACH TO RATIONAL UTILIZATION OF GMO TESTING RESOURCES: CASE OF DP305423 SOYBEAN

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The Law on GMO in B&H provisions are event based; the official testing laboratories should be able to detect GMO presence, and identify and quantify authorized and unauthorized GMO events. The laboratories are required to perform under ISO17025 and introduce accredited methods according to new authorizations in the EU. They are not able to maintain financial sustainability within limited B&H market, so they focus on the detection methods and identification of the events authorized for use in feed. Such setting justifies concerns that certain GM events evade the detection and reach the market. In order to assess the risk thereof, we screened food and feed for the presence of soybean DP305423. This GM event is modified for increased production of oleic acid and is grown in closed loop system. DP305423 is not detectable with the standard set of detection markers (p-35S, p-FMV, t-NOS, pat/bar) so the EU testing laboratories maintain the event specific method for the purposes of detection, identification and quantification. The samples of food and feed, previously screened for GMO in our laboratory, were tested for DP305423 using EURL-GMFF validated RealTime PCR based identification method (QT-EVE-GM-008). We detected no DP305423 among 95 samples of diverse food and feed products. We conclude that DP305423 is a low-risk GM event, so the introduction of event-specific method should not be a priority. Instead, we propose market screening strategy for prioritizing the future introduction of new event-specific methods.

*Keywords: DP305423 soybean, GMO, RealTime PCR, event-specific method*

# DETERMINATION OF PATULIN CONTENT IN ALCOHOLIC BEVERAGES BY UHPLC-MS/MS

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Patulin is considered the most important fruit toxin at the global level and is increasingly attracting the attention of the scientific and general public. Patulin is the regulated toxin in apple and apple-based products, spirit drinks, cider, and other fermented drinks derived from apples or containing apple juice. Accordingly, the aim of this work was to develop a fast and reliable method for the determination of patulin in alcoholic beverages using ultra-high performance liquid chromatography with heated electrospray ionization triple quadrupole mass spectrometry (UHPLC/HESI-MS/MS). Extraction of patulin from 30 samples of domestically produced alcoholic beverages was performed by a simple non-specific sample preparation method based on solid phase extraction (Oasis HLB, Waters). Chromatographic separation was achieved in less than 4 min. The developed method was validated through an "in-house" procedure taking into account the following parameters: linearity, limits of detection and quantification, precision (RSD%), and accuracy (recovery from samples spiked at 25 and 50 µg/kg). Average recoveries obtained for spiked levels were in the range from 70 to 85% and were in accordance with EC regulation, with RSD below 15%. The reliability of the developed method was confirmed by the analysis of the certified reference material (CRMPommeau – Sample 0628). The contents of patulin in the analyzed samples of alcoholic beverages were in all samples lower than limit of quantification (LOQ = 10 µg/kg).

*Keywords: patulin, UHPLS-MS/MS, alcoholic beverages, Serbian market and products*

*Acknowledgements: This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia under Grant [number 451-03-68/2022-14/200134].*

# EDIBLE INSECTS AS INNOVATIVE FACTOR FOR LOCAL CIRCULAR ECONOMY APPROACH

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According to demographic predictions, the global population will exceed 9 billion in 2050, so the global economy has to deal with the problem of supply chain losses and food waste. Food losses occur throughout leakage in the supply chain - e.g. in transport, during storage. It is often associated with inadequate technologies, a lack of knowledge or skills, flaws in logistic systems, or the ineffectiveness of market mechanisms.

Food waste is when food products are thrown away at the retailer and consumer levels. This way, valuable resources - farmland, water, energy and labour - are depleted, and unnecessary greenhouse gas emissions are generated. Prevention of both phenomena requires a huge increase in the efficiency of the supply chain and a crucial change in dietary habits - lower meat consumption.

Edible insects are a novel food ingredient with great potential that may contribute to ensuring global food security. They are rich in nutrients (protein, minerals, vitamins), including those considered essential (essential amino acids, polyunsaturated fatty acids) for the proper development and functioning of the human body. Edible insects can therefore be widely used in the food industry. They can be used to enrich the diet, especially the plant one based on cereal proteins, which are poor in essential amino acids, such as lysine, threonine, and tryptophan. Edible insects can also form the basis for the development of high-protein products. The study aimed to discuss selected species of edible insects (*Acheta domesticus* and *Tenebrio molitor*) as food waste transformers (insects breeding) and cheap but valuable, locally bred of low cost, protein source for food products.

*Keywords: edible insects, food waste, circular economy*

# APPLICATION OF OIL CAKES FOR PROTEIN SHAKES AND DETERMINATION OF THEIR ENERGY VALUE

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Oil cakes are a by-product that remains during the production of cold-pressed oils. They were usually used as animal feed, especially for ruminants and fish. Still, their purpose has been different for a long time, and they represent an important component as a substitute for wheat flour in the production of various confectionery and bakery products. The influence of the addition of sunflower and pumpkin oil cakes on the nutritional characteristics of protein shakes was investigated. In addition to sunflower and pumpkin oil cakes, the main ingredient of protein shakes was soy milk powder. Probiotic cultures (*Lb. plantarum* 299v and *Lb. rhamnosus* GG), fructose, chia seeds, organic chokeberry powder and cocoa powder, were added to achieve better nutritional and sensory characteristics. Good textural properties of the final product were achieved by optimizing the granulation of the oil cake in industrial mills. The total protein content obtained in shakes with sunflower and pumpkin oil cake was 14,5 g/100g and 20,4 g/100g, while the total energy value of the product was 1845 kJ/100g and 1888 kJ/100g, respectively.

*Keywords: oil cakes, protein content, shakes, energy value*

# QUALITY PARAMETERS OF SOME COMMERCIAL SAUCES AND DRESSINGS

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Sauces and dressings are very wide group of ready to eat product, which are mainly used as condiments and seasoning product for different kind of cold or hot savoury dishes. Sauces can be divided into different groups, depending on their state (cold and warm), colour (light and dark), consistency (thin and thick) and taste intensity. Cold sauces are usually served with cold dishes like sandwiches and salads. On the other hand, warm sauces are used with warm dishes. Dressings are liquid thin and cold type of sauces usually used for seasoning of salads.

The aim of this paper is to investigate the main quality parameters of common commercial cold dressings and sauces, and to research the relationships between their physical, chemical and sensory properties. Research was done on different types of commercial cold salad dressings and sauces (yoghurt based dressing, tartar sauce, curry sauce, Italian dressing, honey-mustard dressing, and garden herbs dressing).

All sauces had more or less sour taste with pH value bellow 4.5. The lowest salt content was noticed in yoghurt dressing and curry sauce, while the highest fat content was in tartar sauce. Sensory evaluation showed that all sauces had acceptable sensory properties. Yoghurt had the highest scores for taste, odour, aroma and overall acceptability. The lowest sensorial acceptability was recognized in Italian and garden herbs dressings.

*Keywords: sauces, dressings, sensory properties, physical properties, chemical properties*

# QUALITY OF COMMERCIAL BLENDS FOR TARHANA, BEY`S AND SARAJEVSKA SOUPS

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Some of popular traditional Bosnian soups are tarhana, bey`s (Begova) and sarajevska. Due to rapid lifestyle, the instant, dehydrated soups become very popular among consumers in Bosnia and Herzegovina and worldwide. For this reason, industrial producers try to develop appropriate recipes and to produce dehydrated powdered instant soups with characteristics similar to traditional, but which could be packed in the small bags, stored at room temperature and prepared for consumption in very short time.

The aim of this study was to investigate different quality parameters of commercial produced powdered Bosnian traditional soups. Samples were collected from local industrial producer and analyzed for different physical, chemical and sensory properties.

The results showed that all samples were in agreement with Codex Standard for soups, bouillons and consommés and official Bosnian Standard for quality of soup, sauces, food seasonings and related products. Bulk density ranged between 0.59 to 0.62 g/ml. Fat content in powdered samples varied between 4.30 and 12.46%. The highest values of viscosity and fat amount were noticed in bey`s soup, while tarhana had the lowest viscosity and fat content. In terms of sensory properties, all samples were evaluated as moderate acceptable to acceptable.

*Keywords: commercial powdered soup, traditional dehydrated soups, tarhana, physical and chemical properties, sensory properties*

# TESTING OF DEVIATIONS OF PATE FILLING SYSTEM USING PARETO METHOD

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The main goal of this researching study was to find the causes of the deviation system for filling chicken pate with samples of different weights, with 27 g and 45 g. By applying the recognized methods of determining the level of process control for the calculation of the potential index (Cp) and the capacity index (Cpk) of the process, it was necessary to determine whether the charging process is under the control.

The research was performed in the plant for the production of chicken pate, and the samples needed for the research were collected on the technological line for the production of chicken pate, at the process steps for filling and closing. Samples were taken from the charging line periodically at intervals of 30 minutes to 60 minutes. For each group, 500 measurements were performed over a period of several days depending on the production plan for a given group of samples.

The results of the research show that the examined filling processes in both groups meet the requirements on filling quantities prescribed by the Internal Regulations, as well as the EU Directive on prepacked products (76/211 / EEC, ANEX 1) and (75/106 / EEC). Calculations of process ability indicators indicated that according to the values of Cp and Cpk index (precision and adjustment), the process of filling 27 g of chicken pate belongs to the group of precise and adjusted process, while the process of filling 45 g of chicken pate belongs to the group of precise but unadjusted processes. CpU and CpL centering indicators indicate the non-centering of both processes, ie the measured values in both, group I and group II go towards the upper limit of the specifications. The results showed that in the first process there is no defect at all, so there are no measured values outside the specifications, while in the second process the percentage of defects is 31.4%. Determining the causes of deviation using the Pareto method indicated the fact that overload dosing, lack of weight in the dosing can and damage to the packaging cause the largest number of defects (89.5%).

*Keywords: filling system, chicken pate, Pareto method, potential index, capacity index*



# STUDY OF THE INFLUENCE OF TECHNOLOGICAL PARAMETERS AND STARTER CULTURES ON THE QUALITY OF SAINT-PAULIN CHEESE

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Modern cheesemaking intends to produce a high-quality product with lower investment costs through technical and technological solutions and rationalization of the process itself (by reducing energy consumption, shorter ripening, etc.). Saint-Paulin cheese belongs to the group of semi-hard cheeses that are distributed on the market after 30 days of ripening.

The aim of this work was to examine the quality of Saint-Paulin cheese depending on the used starter cultures (Alp D and FLAV 222, Danisco), the modification of the technological procedure for curd washing (with and without NaCl), and the surface treatment of the cheese during ripening (without treatment, with natamycin coating and with foil). After 30 days of ripening in all cheeses were determined: physical and chemical composition, degree of tempering, and the cheeses were sensory evaluated.

The average sensory score (18.63) of the experimental cheeses after 30 days of ripening indicated that they belong to the extra quality. The results of the physico-chemical analysis showed that the examined parameters of the starter cultures and the modification of the technological procedures of curd washing had no effect on the quality of Saint-Paulin cheese. Cheeses produced by using the FLAV 222 starter culture and the technological operation of curd washing with the addition of NaCl had better sensory characteristics. The analysis of variance (ANOVA) showed a statistically significant effect of the examined parameter "Surface treatment of cheese" on weight loss of cheese. T-test determined that cheeses without treatment recorded the highest weight loss of cheese.

*Keywords: Saint-Paulin cheese, starter cultures, surface treatment of cheese*

# THE EFFECT OF ESSENTIAL OILS ON THE QUALITY AND OXIDATIVE STABILITY OF LINSEED OIL

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In this work, the quality and oxidative stability of linseed oil, with and without the addition of essential oils, were examined. The content of carotenoids, chlorophylls and total phenols, then the content of water, insoluble impurities, the composition of saturated and unsaturated fatty acids, the content of free fatty acids and the peroxide number were examined in linseed oil (initial analysis without the addition of essential oils). In the basic sample of linseed oil, different essential oils were added: garlic, thyme and oregano in different concentrations of 0,1% and 0,5%. The samples were stored for 30 days at a temperature of 18 to 20°C in different conditions, in daylight and in the dark. With the addition of different essential oils, the content of water and insoluble impurities increased in proportion to the addition of a higher concentration of essential oil. PUFA acids are more abundant than MUFA. Linolenic fatty acid was dominant in all samples, with the content higher than 50% especially in samples with 0,1% oregano essential oil addition. The content of free fatty acids decreased and the peroxide number increased in all samples after 15 and 30 days of storage in the light and in the dark. The sample with the addition of essential oil of garlic in a concentration of 0,1% had the lowest value of the peroxide number, i.e. the best oxidative stability, while the sample with the addition of essential oil of thyme in a concentration of 0,5% had the highest peroxide number and the lowest oxidative stability.

*Keywords: linseed oil, essential oils, antioxidants, fatty acids, oxidative stability*

# CHARACTERISTICS OF FUNCTIONAL CHEESE SPREAD ENRICHED WITH PUMPKIN SEED OIL

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Cheese spreads are a good matrix for incorporating various bioactive supplements. Apart from its characteristic color, unique aroma and nutty taste, pumpkin seed oil has a very high nutritional value and health-improving effects. The aim of this study was to investigate the effect of the addition of pumpkin seed oil on the characteristics of cheese spread. Functional cheese spreads are prepared in two series with two different percentages of total fat in the product, the standard version with 22% and the light version with 15% fat. Each series had four samples; three samples manufactured by adding pumpkin seed oil to the cheese base in ratios of 7.5%, 10.0% and 12.5% and one sample without oil as a control. The basic chemical composition of the final products was tested using NIR spectroscopy, color by spectrophotometric ( $L^*a^*b^*$  colorimetric system), spreadability using a texture analyser and acceptability of the product using a hedonic scale. The obtained results showed that the addition of pumpkin seed oil increased the greenness and yellowness of the cheese spread and had a positive effect on the spreadability of the product. Cheese spread samples produced in the standard variant, with 22% total fat in the product, received the highest scores. Based on the overall results, the optimal proportion of pumpkin seed oil added to the cheese base was 7.5%.

*Keywords: cheese spread, pumpkin seed oil, spreadability, sensory properties*

# STEVIOL GLYCOSIDE – PROPERTIES AND ROLE IN SUCROSE SUBSTITUTION

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*Stevia rebaudiana* Bertoni or stevia is a small branched perennial shrub from the Asteraceae family. It is available on the market in the form of tablets, powder and liquid. It is used in herbal medicines (diabetic tonics), food industry (confectionery, desserts, ice cream, sauces, ketchup, drinks, soft drinks, formulas for athletes) and cosmetics (mouthwashes and toothpastes, creams). The feeling of sweetness in stevia is caused by steviol glycosides. The four main steviol glycosides are: stevioside, rebaudioside A, rebaudioside C, dulcoside A. Stevia belongs to the natural non-nutritive intensive sweeteners. Stevia has a much greater advantage over other sweeteners (sucrose and artificial sweeteners) as an ingredient for use in the food industry and is a suitable substitute for sucrose in beverages and food products. Stevia enhances the taste of food, helps digestion, weight loss, has antioxidant and antimicrobial action, prevents tooth decay among diabetics and healthy people who care about their health. Stevia is likely to become a major source of high-strength sweeteners for the growing natural food market in the future.

*Keywords: steviol glycoside, stevia, sucrose substitute in food and beverages*

# QUALITY AND TECHNOLOGY OF WHITE SHEEP'S CHEESE FROM BJELAŠNICA

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The sheep's cheese produced on the Bjelašnica mountain belongs to the group of white brine cheeses, which are predominantly produced in the countries of the Mediterranean and the Balkan Peninsula. For production, the milk of sheep of the autochthonous Pramenka breed, Dubski strain, was used, without the addition of starter cultures.

The main task of this study was to research the technological process of white sheep's cheese production and to determine the quality of sheep's milk and cheese based on the results of the analysis.

By examining the physico-chemical composition and hygienic condition of 7 milk samples, it was determined that all samples meet the quality requirements. The average values of the chemical composition of sheep's milk were (%): dry matter 19.88, fat 8.15, proteins 6.44, lactose 3.90, fat-free dry matter 11.63.

Based on the examination of 7 samples of mature sheep's cheese, the average values of the chemical composition were (%): dry matter 45.60, fat 26.86, proteins 15.63, salt 4.57.

Sensory analysis of the sheep's cheese from Bjelašnica revealed that 43% of the evaluated samples were of the extra class, 43% of the first-class cheeses, while 14% of the second-class cheeses were included.

*Keywords: sheep's, milk, cheese, quality, technology*

# COMPARISON OF THE ORGANIZATION AND QUALITY OF NUTRITION IN KINDERGARTENS IN BOSNIA AND HERZEGOVINA AND SLOVENIA (KOKIV)

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Adequate nutrition during childhood is essential to ensure optimum health, growth and intellectual development of children, as well as for the prevention of some health problems and nutrition-related chronic diseases in adulthood. The kindergarten environment is a place where children spend a lot of time most days of the week, and they should be provided with healthy meals and healthy choices. Meals should be prepared in accordance with the nutritional and energy needs of children, depending on age, gender and physical activity. For a healthy diet and a healthy growth and development of children, a supportive environment is also needed: optimal hygiene and sanitary conditions, the absence of unhealthy food advertising and regular monitoring of children development.

Nutrition in kindergartens in B&H has been managed and organized by cooks or economists, but not professional staff because there was no education in this field until recently. In recent years, B&H has been actively reviewing nutrition policy and standards (HACCP) in kindergartens, which would ensure nutritionally adequate and safe food.

In Slovenia, diet in educational institutions is regulated by law. In planning and preparing meals in kindergartens, professional staff follows the dietary guidelines in educational institutions. The guidelines combine professional and practical guidance and include the educational aspect related to nutrition and the public health aspect. Within the frames of the organized system of kindergarten diet, up to four meals per day are available to children in kindergarten, which provide 70-80 % of daily energy intake. Bilateral project (2021-2023) is designed to analyze and compare the organization and nutritional quality of the daily meals and to gain knowledge about mentioned issue in kindergartens in capital cities of both countries. The obtained results will provide the basis for further research and for possible cooperation between researchers on the project and interested educational institutions in the two countries.

*Keywords: kindergartens, B&H, Slovenia, healthy meals, cooperation*

*Acknowledgments: This work was supported by Slovenian Research Agency (project BI-BA/21-23-034 and programme P3-0395) and Federal Ministry of Education and Science (project code: 1000065).*

# EXAMINATION OF SWEETENERS ADDITION ON THE PROPERTIES OF STARCH GEL

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Starch is a reserve plant polysaccharide that is commercially obtained from various sources, such as corn, potatoes, wheat, tapioca, etc. It is widely used in the food industry as a raw material for the production of certain products (pudding, turkish delight) or as thickening agent. Starch thickening feature arrives from its ability to swell and to form a gel during heating in water medium. However, gelatinization process can be disturbed if some other components are present. It is known that sucrose has a particularly unfavorable effect on the formation of starch gel due to competition with starch granules for water. That is particularly evident in confectionery products in which sugar concentrations are often very high. Due to the raising awareness of negative impact of sugar on human health, recently there has been an increasingly present global trend of complete or partial sugar replacement in confectionery products with some of the low-calorie natural sweeteners, such as steviol glycosides, sugar alcohols or their combinations. The aim of this research was to examine and compare the effects of the addition of sucrose and commercial natural sweetener (steviol glycosides and erythritol) in different concentrations (low, medium and high) on the physical-chemical and functional properties of corn and tapioca starch gels.

The results showed that addition of sucrose and sweetener decreases the swelling capacity of starches, which leads to formation of gel with undesirable transparency, viscosity and firmness. The negative effect was more evident in the case of sweetener addition.

*Keywords: starch, sugar, sweeteners, properties*

# **GREEN SYNTHESIS OF SILVER NANOPARTICLES FROM *Mentha piperita* EXTRACT AND THEIR ANTIMICROBIAL ACTIVITY**

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Recently, we are increasingly growing interest in nanotechnology, which has developed over the years and based on which research has been conducted in various fields, from medicine to the food industry.

Green synthesis involves the use of an acceptable solvent, an environmentally friendly reducing agent and the selection of non-toxic substances to stabilize the synthesized nanoparticles.

Increasing interest is related to silver nanoparticles and their antimicrobial activity.

This work presents the results of the synthesis of silver nanoparticles from extract of *Mentha piperita* and their antimicrobial activity towards the bacteria *Escherichia coli* and *Salmonella*. The extract of *Mentha piperita* was used because of her wide pharmacy application, including the shampoo and fragrance industry to the confectionary and food industry, as well as her medicinal effect on the human body.

*Keywords: nanotechnology, green synthesis, silver nanoparticles, antimicrobial activity, Mentha piperita*



# DETERMINATION OF ANTIOXIDANT ACTIVITY IN SELECTED HERBS USING DPPH AND pFRAP METHODS

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Natural antioxidants are considered to be substances that, in small quantities, have the ability to neutralize free radicals. Antioxidant properties are attributed to herbs, which is positively correlated with health effects. Antioxidant activity, as a link between nutrition and disease, finds increasing interest in research. The aim of this assay was to determine the antioxidant activity in herbs and the effect of drying treatment on the antioxidant potential. Plants from Apiaceae family, namely parsley (*Petroselinum crispum*), dill (*Anethum graveolens*), and coriander (*Coriandrum sativum*) and basil (*Ocimum basilicum*) from Lamiaceae family, have been selected for this research (fresh, oven drying (45°C) and air drying). Two different methods for antioxidant activity determination were used: DPPH (2,2-diphenyl-1-picrylhydrazyl), a stable free radical that is decolorized in the presence of antioxidants, and the pFRAP (potassium ferricyanide reducing power) method, based on reaction between phenolic compounds and pFRAP, resulting with blue complex with absorbance at 700 nm. Fresh samples showed high antioxidant power against the DPPH radical, as follows: basil (90.54%)>dill (82.92%)>coriander (79.06%)>parsley (75.64%). The ability to eliminate DPPH radicals in dried samples varied from 82.83% in air-dried basil to 24.97% in oven-dried coriander. The highest antioxidant activity was recorded in fresh basil (1097.80±17.57 mgGAE/100g dry matter), and the lowest in oven-dried coriander (12.31±0.82 mgGAE/100g dry matter) using the pFRAP method. The values obtained by determining the pFRAP activity of the reduction of Fe<sup>3+</sup> to Fe<sup>2+</sup> suggested that herbs contribute with good reducing potential, which can be a useful system for the prevention of oxidation. For all analyzed plants, drying resulted with decrease in antioxidant activity.

*Keywords: antioxidative activity, herbs, DPPH, pFRAP*

# ANTIOXIDANT ACTIVITY AND TOTAL PHENOLIC CONTENT DETERMINING IN SAMPLES OF CELANDINE (*Chelidonium majus* L.) BY APPLYING DIFFERENT SOLVENTS

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Celandine (*Chelidonium majus*) is herbaceous, medicinal herb used in traditional medicine for internal use as tea, syrup, but also for external use. Teas from Celandine contain phenolic compounds that have a high antioxidant activity which creates positive effects on human health. Antioxidants are substances that protects cells from oxidative effects of free radicals.

The aim of this study is to determine the content of phenol and antioxidant activity in fresh and dry parts of plants (leaf and the stem) with using water, methanol, ethanol (as solvents), for 15 minutes at 70°C. The samples of plant Celandine (*Chelidonium majus*) originates from Canton Sarajevo, Bosnia and Herzegovina. Total phenols were determined by *Folin-Ciocalteu* method (600nm), antioxidant activity was determined by using *pFRAP* (700 nm). Gallic acid was used as the standard, and the results are expressed in mg GAE/100g. The results proved that the samples of fresh leaf have a higher content compared to samples of dried leaf, particularly when ethanol was used as a solvent. Based on the obtained results it can be concluded that the samples of dried leaf have higher content of antioxidant activity in comparison to fresh leaf, particularly for case when methanol was used as a solvent. Also, fresh and dry Celandine leaf have higher phenolic content and antioxidant activity compared to fresh and dry stem. During the extraction it was proved that both fresh and dry parts (leaves and the stem) showed the lowest phenolic content and antioxidant activity when water was used as a solvent.

*Keywords: Celandine, antioxidants, polyphenols, leaf, stem*

## **ECONOMIC ANALYSIS OF SEMI-HARD CHEESE PRODUCTION DEPENDING ON THE APPLIED TECHNOLOGY**

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The analysis of milk processing in Bosnia and Herzegovina showed the orientation of the dairy sector towards liquid and fermented products. During 2021, the export of dairy products from BiH amounted to 94 million KM (mainly drinking milk and cream), while the import reached 175 million KM, with the import of cheese (predominantly semi-hard) exceeding half of the stated amount.

In order to reduce the market deficit of semi-hard cheeses, the research was based on the analysis of the profitability of investment in the technology of semi-hard type cheeses.

Business risk assessment using analytical calculations was done on the basis of the applied technology of Gouda and Saint Paulin, the duration of technological operations, consumption of the amount of milk per 1 kg of cheeses, and the degree of tempering, while other parameters (rennet, culture starter, energy, etc.) were fixed in the calculations.

The results of the analysis of the experimentally produced cheeses showed that the production of 1 kg of Gouda cheese requires 10.22 liters, while for 1 kg of St. Paulin cheese is required 8.76 liters of milk. Cheese yield was 9.80 kg (Gouda) and 8.38 kg (St. Paulin). The average duration of the primary production period for Gouda cheese technology was 5.01, and 3.83 hours for St. Paulin's cheese.

This research showed that technology of St. Paulin cheese is more economical, and this type of cheese can be recommended for the production.

*Keywords: technology of semi-hard cheese, cheese yield, economic aspects*

# EFFECT OF ANTIOXIDANTS ON THE QUALITY AND STABILITY OF OLIVE OIL

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The quality of olive oil, besides the method of production, is conditioned by the method of storage. Olive oil is often exposed to the influence of light and high temperatures, where hydrolytic and oxidative spoilage occurs, which can significantly affect its quality. In addition to changes in the organoleptic properties of oils and fats, their nutritional value also changes. Furthermore, in addition to the mentioned factors, the stability (sustainability) of olive oil can be affected by both natural and synthetic antioxidants. In this work, the quality and oxidation stability of olive oil with and without the addition of natural and synthetic antioxidants, as well as the content of chlorophylls, carotenoids and phenols, were examined. The natural antioxidants that were used were immortelle, milk thistle and smoketree, while the synthetic antioxidants were: propyl gallate (PG), butylhydroxyanisole (BHA) and butylhydroxytoluene (BHT). Four samples of olive oil were used for analysis. Different types of natural antioxidants were added with a concentration of 0.2%, while the concentration of synthetic antioxidants was 0.01%. The aim of this work was to apply the Schaal-Oven test for 96 hours and to monitor the influence of elevated temperature on oil quality parameters such as peroxide number and oil acidity, that is, the amount of free fatty acids expressed as oleic acids. Analyses have shown that temperature has a significant influence on the change in oil quality, especially when it comes to the total acidity of the oil and the peroxide number, because there was an increase in them. After the completed analyses, the conclusions are that in all four tested samples, when it comes to the peroxide number, the natural antioxidant that slowed down spoilage and contributed to the stability of olive oil was smoketree, while propyl gallate had the best effect on synthetic antioxidants. As far as the acid number is concerned, immortelle and smoketree behaved significantly well as natural antioxidants, while butylhydroxytoluene performed well as synthetic antioxidant.

*Keywords: olive oil, antioxidants, oil stability, peroxide number, acid number*

## **COMPARATIVE ANALYSIS OF THE DIET OF USERS OF TWO DIFFERENT FITNESS CENTERS**

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Athlete nutrition is important aspect as training itself. Athletes must take in sufficient amounts of all nutrients (carbohydrates, fats and proteins) on a daily basis, as well as vitamins and minerals that often have a crucial impact on the quality of training. Daily caloric vary depending on the intensity of training, gender and body weight of the individual. Satisfaction of daily caloric needs is crucial in maintaining a constant body weight, achieving fast recovery after activity, and growth and regeneration of skeletal muscles. The objective of the study was to determine the differences in eating habits of users of two different fitness centers. The study included 90 subjects of both gender, different ages, who are users of two different fitness centers. Fitness centers are different according to the type of exercise they practice: crossfit and classic fitness center. The survey was specially designed for this type of research. In one fitness center, the survey was conducted "live", and in another online. The results of the research showed that there is no statistically significant difference between the respondents of the fitness center who practice classical fitness and the respondents of the fitness center who practice crossfit when choosing foods, and the frequency of their use. It was also found that there was no statistically significant difference in water intake on a daily basis between the respondents of both fitness centers.

*Keywords: athlete nutrition, nutrients, caloric needs, fitness, crossfit*

# IDENTIFICATION OF ANTHOCYANINS AND ANTHOCYANIN-DERIVATIVES IN VRANEC WINES DURING AGING

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This study aimed to characterization of the major anthocyanins (3-monoglucosides, 3-acetylglucosides, and 3-coumaroylglucosides), pyranoanthocyanins and hydroxyphenyl-pyranoanthocyanins in Vranec wines during aging of three years. The HPLC-DAD-ESI-MS<sup>n</sup> technique was used for identification of the analytes. Anthocyanins presented mass spectra characterized with two signals, molecular ion M<sup>+</sup> and fragment ions [M-162]<sup>+</sup>, [M-204]<sup>+</sup> and [M-308]<sup>+</sup> which resulted from the loss of glucose, acetylglucose and p-coumaroylglucose groups, respectively. The pyranoanthocyanins derived from pyruvic acid, called 10-carboxy-pyranoanthocyanins or A-type vitisins, such as 10-carboxy-pyranomalvidin-3-glucoside (vitisin A), 10-carboxy-pyranomalvidin-3-acetylglucoside (acetyl-vitisin A) and 10-carboxy-pyranomalvidin-3-p-coumaroylglucoside (p-coumaroyl-vitisin A) were identified according to their molecular ions (M<sup>+</sup>) and the characteristic fragment ([M+H]<sup>+</sup> = m/z 399). B-type vitisins, resulting from cycloaddition reaction between anthocyanins and acetaldehyde, including pyranomalvidin-3-glucoside (vitisin B) and pyranomalvidin-3-acetylglucoside (acetyl-vitisin B), presented molecular signals M<sup>+</sup> at m/z 517 and 559 and producing a fragment ion at m/z 355 by loss of glucoside (162u) and acetylglucoside (204u) groups, respectively. Moreover, six hydroxyphenyl-pyranoanthocyanins produced in the reaction of caffeic acid (10-(3''',4'''-dihydroxyphenyl)-pyranomalvidin-3-glucoside, 10-(3''',4'''-dihydroxyphenyl)-pyranomalvidin-3-acetylglucoside and 10-(3''',4'''-dihydroxyphenyl)-pyranomalvidin-3-p-coumaroylglucoside) and p-coumaric acid (10-(4'''-monohydroxyphenyl) derivatives of pyranomalvidin-3-glucoside, pyranomalvidin-3-acetylglucoside and pyranomalvidin-3-p-coumaroylglucoside) with different anthocyanins, were detected in the wines.

*Keywords: anthocyanins, pyranoanthocyanins, hydroxyphenyl-pyranoanthocyanins, Vranec wine, HPLC-DAD-ESI-MS<sup>n</sup>*

## DETERMINATION OF ELEMENTS COMPOSITION IN VRANEC WINES PRODUCED WITH DIFFERENT MACERATION TIME

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Vranec is one of the most important red grape varieties in Republic of N. Macedonia, grown in all vineyards, mostly in the Tikveš wine region. In this study, Vranec wines were produced with different maceration times (4, 7, 14 and 30 days) in order to determine the influence of vinification conditions on the elements profile. Analysis was performed with inductively coupled plasma – optical emission spectrometry (ICP-AES) for accurate determination of the concentration of 18 elements (Al, Ba, Bi, Ca, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, P, S, Sr, V, Zn). The results demonstrate that K, P, Mg and Ca were the dominant elements in the wines, regardless the maceration time. Most of the elements, such as Al, Ba, Bi, Mg, Mn, Na, Ni, P, Sr, P and Zn increased during maceration. Copper was present in highest concentration in the wine macerated for 4 days (average value: 0,026 mg/L), followed by decreasing of the content during maceration, as it was expected. In general, the content of toxic elements Cu and Fe was lower than maximal allowed concentrations, concluding that studied Vranec wines did not contain heavy hazard metals and confirming their nutritional value with high level of macroelements such as K, P, Mg and Ca.

*Keywords: elements, Vranec wine, maceration, ICP-AES*

# ANTHOCYANIN PROFILES OF POMACE SKINS OF INTERNATIONAL AND INDIGENOUS GRAPE VARIETETY DETERMINED BY UHPLC-MS/MS ORBITRAP

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During the winemaking production, a significant amount of different by-products is generated, which can be used as a rich source of valuable phenolic compounds, primarily anthocyanins. The aim of this study was to determine anthocyanin profiles of oven dried non-fermented grape pomace skins (GPS) of international (Merlot) and autochthonous (Prokupac) grape varieties. Anthocyanins were extracted from GPS with acidified methanol (MeOH) and aqueous ethanol (50:50 v/v, EtOH), evaporated to dryness, reconstituted in milliQ water and further analysed by UHPLC-MS/MS OrbiTrap. Both GPS extracts of international Merlot wine variety had a significantly higher content of total (6.95-9.97 times) and individual anthocyanins, in comparison to the GPS extracts of the autochthonous Prokupac variety. Further, the content of total and individual anthocyanins were significantly higher in the MeOH extracts, probably due to the increased stability of anthocyanins in an acidic environment. In total, thirteen anthocyanin derivatives were identified in all analysed GPS extracts, primarily malvidin derivatives for both varieties (70.8-81.4% of total quantified anthocyanins); which is in agreement with literature data. Malvidin, peonidin and petunidin glucoside were predominantly quantified in MeOH extracts of Merlot (142.79, 53.30 and 43.28 mg/kg DM), while other glucosides were detected in traces. Methanolic and aqueous extracts originated from Merlot variety, contained various acetyl, caffeoyl and coumaroyl derivatives of anthocyanins found in significant amounts, primarily malvidin-3-*O*-(6"-acetyl)hexoside (100.82 and 112.98 mg/kg DM) and malvidin-3-*O*-(6"-*p*-coumaroyl)hexoside (9.47-145.96 mg/kg DM). Based on data, GPS can be a good source of anthocyanins (primarily from Merlot variety), potential natural colorants and functional additives in the food industry.

*Keywords: grape pomace skin; Merlot; Prokupac; UHPLC-MS/MS OrbiTrap; anthocyanins*



# ROLE OF SENSORY EVALUATION AND QUALITY IN CONSUMERS' ACCEPTANCE OF SMOKED MEAT PRODUCTS

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This paper reviews the most important trends and developments in meat sensory analysis in 2022 according to German Agricultural Society (DLG). The document titled as “DLG Trend Monitor - Food Sensors 2022” build on the results from 2009 to 2019 but also focus on other current aspects and development trends of sensory activities in food production in connection with the corona pandemic.

On the other hand, selected results concerning sensory properties and quality of smoked meat products from Serbia and Montenegro are presented. These researches are results of long and a successful collaboration between Institute of Meat Hygiene and Technology, Belgrade, Serbia and Federal Centre for Meat Research, Kulmbach, Germany (now Max Rubner-Institute). Sensory evaluation of the products was done according to the DLG-5-point-testing-scheme by DLG trained experts, in Kulmbach, Germany. The DLG-5-points-scheme is a descriptive sensory analysis with scales on the basis of assessment by experts. Analysis included visual (appearance/exterior), haptic (consistence/texture), olfactory (odour) and gustative (taste) criteria of the meat products. Meat products that pass the DLG tests receive a “DLG award winner” medal in Gold, Silver or Bronze. DLG medals are ambassadors for good taste and high-quality foods.

Quality of traditional smoked meat products were tested by performing different physico-chemical parameters (pH-value; aw-value; peroxide value; acid value; content of water, protein, fat, ash, sodium chloride, nitrite, nitrate). Fatty acids composition and content of polycyclic aromatic hydrocarbons (PAHs) were performed by applying GC/ECD and HRGC/MS/MS, respectively.

*Keywords: sensory evaluation, consumers' acceptance, traditional products, smoked meat*

# INULIN AS A FAT - REDUCTION INGREDIENT IN CHICKEN FRANKFURTERS - TECHNOLOGICAL PROPERTIES AND CONSUMER ACCEPTANCE

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Since the demand for low-fat, healthier meat product is high, the industry is being pushed to find alternative strategies in order to reduce the fat content of products that could resemble full-fat doublet regarding various technological properties as well as sensory characteristics. Due to inulin's ability to bind water, gel-forming properties, and the capability to create a mouth-full sensation of fat in low-fat products, four groups of chicken frankfurters were created containing: 0%, 50%, 75%, and 100% inulin-gel as a fat replacement for fatty tissue (100%, 50%, 25%, 0%, respectively). After preparing the samples, chemical analysis, technological characteristics, and sensory properties were evaluated. The fat content decreased with increasing levels of inulin-gel substitution while the treatment containing 100% inulin-gel substitution had the maximum amount of sugar and moisture ( $p < 0.01$ ). The increase of inulin-gel reduced  $a^*$ , while the levels of  $b^*$  and  $L$  were significantly higher ( $p < 0.01$ ). Sensory evaluation showed that the increase in the amount of inulin-gel in the sample did affect the overall scores of the groups regarding color, appearance, and texture. The groups containing 50% and 75% inulin-gel replacement were similar in taste and texture. The obtained results showed that inulin can be recommended as a fat substitute in the formulation of chicken sausages in order to create a healthier product that could be declared as "low-fat".

*Keywords: inulin, fat substitution, chicken frankfurters*

# ACRYLAMIDE CONTENT IN SALTY SNACKS AND COOKIES FROM THE SERBIAN MARKET

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Acrylamide, as a possible human carcinogen with adverse health effects, can appear in food during processes such as frying, roasting, and baking. This imposed the need to study the potential risk caused by the presence of acrylamide in food for human health, efforts to minimize its formation, as well as the monitoring of its content in food categories considered relevant. Thus, the aim of this study was to develop a reliable analytical method for the quantification of acrylamide content. In total 41 samples representing 2 product categories (salted snacks and cookies) were collected from the Serbian market. Acrylamide was extracted from the samples with methanol and the obtained extracts were purified using a dispersive primary secondary amine. Identification and quantification of analyte was performed by ultra-high performance liquid chromatography with heated electrospray ionization triple quadrupole mass spectrometry (UHPLC/HESI-MS/MS). The developed method was validated by an in-house quality control procedure. The limit of quantification was 14 µg/kg, while the mean recovery was 92% with a relative standard deviation lower than 10%. Content of acrylamide ranged between 15 and 73 µg/kg for salted snacks and between 21 and 203 µg/kg for cookies. These levels did not exceed the maximum allowed levels proposed by the European Commission. The obtained data will serve as a basis for assessing the exposure of the Serbian population and compared with those from the available literature.

*Keywords: acrylamide, UHPLS-MS/MS, Serbian market and products, health risk assessment*

*Acknowledgement: This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia under Grant [number 451-03-68/2022-14/200134].*

# PRESCHOOL MENUS COMPOSITION AS INDICATOR OF LOCAL FOOD MARKET

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High quality food and proper nutrition patterns are among the most important environmental factors affecting human health. In Poland, for many years, over 50 % of mortality cases resulted from diseases related to “fatal trio” as inadequate nutrition, low quality of food and lack of physical activity. These are mainly: cardiovascular diseases, diet-related cancers, e.g. colorectal cancer, stomach cancer, breast cancer in women, prostate cancer in men, obesity.

Preschool children constitute a particularly susceptible group towards inadequate nutrition. A child spends about 7–8 h a day in a kindergarten; therefore, meals served there should be balanced appropriately to ensure the full psychophysical development of the young organism. The most recommended food products should be of local origin, fresh and minimally processed.

Based on 10-day menus, the study aimed to estimate children's diets' energy and nutritional value at four randomly selected kindergartens in the Wroclaw district, Poland. The data from kindergartens were analyzed based on the Diet 6D (National Institute of Public Health, Poland) software.

Unfortunately in all the kindergartens, the analyzed food rations showed irregularities related to excessive supplies of salt, magnesium, and vitamin A. The preschool food rations did not cover demands with respect to calcium, and vitamin D which are important factors for bone growth.

On average, the share of local products in the studied menus was 75%. Among the non-local products served in the kindergarten, there were mainly fruit (bananas, mandarins, lemons), cereal products (rice) and fish (pollock).

*Keywords: menu, kindergarten, local product*

# EFFECT OF THE ALCOHOL CONTENT ON SENSORY PERCEPTION OF THE FRUIT SPIRITS

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Spirits is a popular alcoholic beverage due to its specific smell and taste. Although the main ingredients of fruit spirits are water and ethanol, they do not determine the type and sensory quality of the drink. That is due to numerous compounds that belong to aromatic substances. Therefore, fruit spirits must have an aroma from the obtained raw material and the aroma must be harmonized with ethanol. Many aroma substances are better soluble in ethanol than in water, so ethanol is main carrier of aroma substances. It seems that content of alcohol is important for the sensory profile of spirits. It is very common that fruit spirits are consumed with 40 or more % vol of alcohol. Regulations allows minimal content of alcohol 37.5% vol. and many distilleries use this minimal content for their fruit spirits. The aim of this paper is to determine how much the consumer is able to detect the difference in the quality of fruit brandies due to different concentrations of alcohol. On that occasion, 5 pairs of fruit brandies made of different fruits were taken, with a standard and reduced concentration of 37.5% by volume of alcohol, namely: pear, plum, apple, raspberry and grape brandy. Sensory analysis was performed to assess the quality of the obtained beverages. The obtained results showed that consumers were able to recognize the difference in the alcohol content of fruit spirits, and they preferred spirits with a higher concentration of alcohol.

*Keywords: fruit spirits, alcohol content, aroma, sensory perception*

# CHEMICAL COMPOSITION OF APPLE PEKMEZ PRODUCED IN BOSNIA AND HERZEGOVINA

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An apple pekmez produced mostly from local apple cultivars using traditional method is highly appreciated product by consumers in Bosnia and Herzegovina due to its nutritional value, unique sensory properties as well as positive impact on the human health.

As available literature sources on the characteristics of this valuable product in Bosnia and Herzegovina are scarce, the aim of the paper is to investigate the specificity of pekmez processing in B&H and its impact on the quality. Based on sensory evaluation of about 50 apple pekmezes, 20 samples were selected in this study. Analysis on pekmez samples ('sweet' and 'sour' type) included determination of soluble solid content, total ash, metal content such as potassium, calcium, magnesium, iron, copper, chromium, manganese, lead, zinc and cadmium as well as total phenol content.

The obtained results showed significant variations in the analyzed parameters both between sour and sweet apple pekmez and within the same type. Soluble solid and total ash content of pekmez ranged from 64.54 to 80.74 % and from 0.43 to 1.79 %, respectively. All samples contained high amounts of potassium, magnesium and calcium while the lowest content for cadmium. These values for pekmez samples varied between 2708.44 and 3563.18 mg/kg for potassium, 299.72 and 803.31 mg/kg for magnesium and 3.28 and 224.79 mg/kg for calcium. The phenol content of samples was found between 399.32 and 1422.73 mg GAE/100g.

*Keywords: traditional food, mineral content, total phenols*

# DETERMINATION OF PROBIOTIC VIABILITY IN HONEY ADDED YOGURTS ENRICHED WITH DIFFERENT PROBIOTICS AND PREBIOTICS

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Yogurt which contains important food nutrients is vital for human diet and health in terms of having high biological value and being digestible easily. Consuming yogurts especially fortified with probiotic have numerous positive effects on human health. The main advantage of probiotic is able to balance between the pathogens and bacteria in human intestines. Prebiotics that are nondigestible but fermentable carbohydrates have a positive effect on human and animal health. Additionally, prebiotics encourage the growth of probiotics. Especially walnuts, almonds, peanuts, and hazelnuts, which are oilseeds, contain many nutritional components that are beneficial for health, and also have prebiotic properties. The increase in consumer awareness and the tendency of people to eat probiotic/prebiotic-containing foods have led to the development of studies in this area. Enhancing the viability of probiotic during the shelf life of yoghurts with added prebiotics is among the main objectives of the industry and studies. Aim of the study was to determine the probiotic viability of yogurts fortified with honey during storage that was produced by adding different prebiotic, probiotic, and traditional yogurt cultures. With this purpose *L. acidophilus*, *L. rhamnosus*, *L. casei*, *B. lactis* was used as probiotic and almond and peanut powders was used as prebiotic and eight different yogurt was produced (LAB: *L. acidophilus*+ almond, LAY: *L. acidophilus* +peanut, BB: *B. lactis*+almond, BY: *B. lactis*+ peanut, CB: *L. casei*+ almond, CY: *L. casei*+ peanut, RB: *L. rhamnosus*+ almond, RY: *L. casei*+ peanut). As a result, it was determined that addition of peanut and almond powder had positive effects on different probiotic. The probiotic level was maintained in all groups during storage but the effect of each probiotic and prebiotic was different.

*Keywords: probiotic, almond, peanut, yogurt, viability*

# SOME POMOLOGICAL AND PHYSICOCHEMICAL CHARACTERISTICS OF THE TRADITIONAL PEAR VARIETY *LAZANKA*

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In this work, pomological and physicochemical analysis of traditional *Lazanka* pear harvested at the same time from two different locations (L1, L2) in Slavonia, was performed. The content of important phytochemicals such as ascorbic acid and polyphenolic compounds in different parts of the pears (exocarp-skin, mesocarp-pulp) and the whole fruit was determined, as well as antioxidant activity. In terms of the pomological characteristics, no difference in the pear samples between the two localities was recorded. The higher total and soluble solids, total acids and sugars content (reducing and total) in pears at L2 was measured. Pears harvested at L1 had higher values of pectic compounds, flesh firmness and lightness with more greenish pear skin (colour parameters  $L^*$  and  $a^*$ ). The content of ascorbic acid was the lowest in the pear pulp at L1, while there were no significant differences in its content between the skin and the whole fruit, between two locations. The greatest antioxidant activity had the skin, then the whole fruit and the lowest was the pulp of pears at L2. The highest values of total phenols were found in the peel of the pear samples at L2 ( $0.429 \text{ g L}^{-1}$ ), and the lowest in the pulp of the pears at L1 ( $0.165 \text{ g L}^{-1}$ ). *Lazanka* pear as well as other traditional varieties with their quality characteristics, provide a diverse gene fund important in the process of developing new varieties and improving some disadvantages in the existing ones (for example fruit mass and ripening period).

*Keywords: pear, Lazanka, pomological and physicochemical analysis*



# THE INFLUENCE OF DIFFERENT YEAST SPECIES ON MICROBIOLOGICAL AND SENSORIAL PROPERTIES ON KEFIR

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Kefir is a fermented dairy product that contains many lactic acid bacteria and different types of yeast. Yeasts in kefir culture are important in the formation of unique properties. Yeasts included in commercially kefir cultures may be single or can be consisted of combinations of species. Due to the CO<sub>2</sub> produced as a result of the alcoholic fermentation of yeasts, effervescence occurs in the packaging of the products, which creates deformity. For this reason, some commercial starter cultures used for industrial production of kefir do not contain yeasts. When yeasts are not involved in kefir production, the unique properties of kefir do not obtain. In this study, the effects of using different yeasts that may cause deformity in the production of industrially produced kefir were investigated. In this context, commercial kefir culture, which does not contain yeasts, was combined with the *Kluyveromyces marxianus*, *Kluyveromyces lactis*, *Saccharomyces bouardii*, *Saccharomyces cerevisia*, *Debaryomyces hansenii*, *Candida colliculosa*, *Yarrowia lipolytica* and *Geotricum candidum* and as such used in kefir production. It was aimed to determine the yeast species that caused the least deformation and investigated the microbiological and sensory properties of kefirs during the 28-day storage.

*Keywords: kefir, yeasts, microbiological properties, sensory analysis*

# ASSESSMENT OF ANTIOXIDANT PROPERTIES IN THE FRUITS OF FIVE HYBRID GRAPE CULTIVARS FROM POLAND

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The growing popularity of health-promoting nutritional trends among consumers contributed to the search for raw materials and products with high antioxidant and bioactive values. The total phenolics, flavonoids, anthocyanins and antioxidant activity in different parts of grape of five hybrid grapevine cultivars grown in Poland were characterized. The highest antioxidant activity measured by DPPH method was observed in the grape skin, which ranged from 3.31 mg to 4.34 mg of Trolox equivalent, for Alwood and Beta cultivars, respectively. The highest antioxidant activity measured by ABTS method was also found in the grape skin, ranging from 2.36 mg to 6.60 mg TE/g f.m. for Alwood and Beta cultivars, respectively. The highest reducing activity was recorded in the grape skin, ranging from 2.33 mg to 4.08 mg FeSO<sub>4</sub><sup>2-</sup>/g f.m., for Beta and Alwood cultivars, respectively. The total phenolic and anthocyanin contents were found to be the highest in the grape skin of Alwood cultivar, while the highest total flavonoid contents were observed in berry pulp of the same cultivar. The conducted research shows that non-commercial hybrid grapevine cultivars can be a valuable raw material for food applications.

*Keywords: grape hybrids, polyphenols, antioxidant activity, anthocyanins*

## DEVELOPMENT OF INNOVATIVE CONFECTIONERY PRODUCT USING FOOD INDUSTRY BY-PRODUCTS

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Since the modern diet abounds in confectionery products, efforts are being made to increase their nutritional composition both by adding functional ingredients and by reducing the amount of processed sugar in order to achieve benefits for the consumers' health. The objective of this research was to develop and sensorially evaluate an innovative composite confectionery product using molasses and pumpkin seed cake flour, by-products of the sugar and pumpkin oil processing, as a available and environmentally friendly raw materials. Molasses is rich in betaine, pumpkin seed cake in protein, while both contain minerals, vitamins and antioxidants. The developed product consisted of three layers: a biscuit base made from pumpkin seed cake, rice and millet flours (50:25:25), a central confectionery agar jelly with molasses, and protective coat of chia seeds, used due to their moisture holding capacity. Based on the sensory analysis conducted by a trained panel (n=8) using the scoring method, the final product was rated as excellent (4,55), receiving higher scores for appearance ( $X_m=4,31$ ) and taste ( $X_m=4,62$ ) compared to the test sample ( $X_{mt}=4,15$  and  $X_{mt}=4,25$ , respectively) which was ranked in the very good quality category (4,32). The texture – structure was assessed particularly high ( $X_m=4,75$ , in relation to  $X_{mt}=4,25$ ) due to multi-layeredness and the crackling sensation from chia seeds. Developed product is free of gluten, artificial flavors, colors and sweeteners, suitable for vegans and consumers of all ages seeking for healthier diet, and represents a good alternative to jelly confections burdened with empty calories and a lack of essential nutrients.

*Keywords: molasses, pumpkin seed cake flour, confectionery, gluten free, vegan*

## NUTMEG SPICE – SOURCE OF NATURAL ANTIOXIDANTS

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Nutmeg is the spice from evergreen-tree *Myristica fragrans* from family Myristicaceae, obtained by peeling seeds from cover (mace). Nutmeg is sold as whole seed or ground spice, and is also a raw material for several commercial products: essential oil and nutmeg butter. The modern lifestyle in many ways contributes to the generation of free radicals and other reactive oxygen species (ROS), which leads to the appearance of oxidative stress in the human body. Since oxidative stress is found in the pathophysiology of many current diseases, (cardiovascular, diabetes, cancer, atherosclerosis) supplementation of products rich in antioxidants is resorted to. Plants, including spices, are recognized as an excellent source of natural antioxidants. Many studies have reported a wide range of pharmacological properties of nutmeg spice, including antioxidant, hepatoprotective, anti-inflammatory, antifungal, antibacterial. The antioxidant activity of nutmeg is attributed to the rich content of total phenolics, especially caffeic acid and catechin. In this research, local purchased ground nutmeg spice was used to prepare extracts in 80% acetone and warm water (50 °C), using ultrasound assisted extraction and without ultrasound assisted extraction technique. The aim of study was to determine antioxidant activity of nutmeg spice by using spectrophotometric assays: 2,2-diphenyl-1-picrylhydrazyl (DPPH•) radical scavenging, cupric reducing antioxidant capacity (CUPRAC), ferric reducing power (FRP) and *in vitro* phosphomolybdenum assay. The highest antioxidant capacity was observed in acetone extract obtained by UAE, in DPPH• assay ( $57.49 \pm 5.01$  % Inh). The lowest antioxidant capacity was measured in water extracts, in FRAP assay, and obtained results was same for both extraction techniques ( $0.20 \pm 0.00$  mg/g ascorbic acid equivalents (AAE)). In general, acetone extracts exhibited a stronger antioxidant activity compared to water extracts, regardless of the applied extraction technique.

*Keywords: antioxidant capacity, Myristica fragrans, nutmeg, spice*

# THE UTILIZATION OF PECTIN EXTRACTED FROM WATERMELON SKIN AS AN EMULSIFIER IN HAMBURGER PATTIES

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The sustainability, which has come to the fore in food businesses in recent years, has increased the importance of the evaluation of food waste and food security. In this context, the fruit and vegetable sector has taken the issue of waste evaluation into its agenda. As it is known, because of the consumption of any fresh or processed fruit and vegetable, waste and by-products are generated that can increase environmental concerns. One of the fruits with high waste rate is watermelon. It is thought that watermelon skins, which make up about 30% of the total mass of the fruit, can be used as a potential source of pectin, since they contain a high amount of pectin. Although pectin is widely found in all land plants, it is obtained commercially from only a few sources, particularly citrus peels or apple pulp. However, due to the preference of high quality pectin in the industry, the need to obtain pectin from different raw materials is increasing day by day. The pectin has a wide range of uses in the food industry as an emulsifier, thickener, improving texture properties and stabilizing due to its gelling feature. In this study, it was aimed to obtain pectin from watermelon peel waste by microwave extraction method and to investigate the use of the obtained pectin as an emulsifying agent in hamburger patties. The physicochemical properties of the samples obtained at the end of the study will be examined.

*Keywords: emulsifier, hamburger patty, watermelon peel, microwave extraction, pectin*

# EFFECT OF MICROWAVE RADIATION ON ANTIOXIDANT ACTIVITY AND POLYPHENOL CONTENT IN PEPPER

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Microwave processes are mainly used to induce thermal changes in food, which depend on processing time, microwave power and the amount of food processed. Thermal changes are related to the modification of the bioactive properties in food. The aim of the study was to investigate the effect of microwave radiation on the total antioxidant capacity (TAC) and the content of polyphenolic compounds in three types of red, yellow and green peppers. The TACs were analyzed for both fresh and microwaved vegetables. Heating was performed in a microwave oven for 15 minutes, with a rated power of 800 W and a frequency of 2450 MHz. In methanol and ethanol homogenates, the antioxidant potential was assessed using the DPPH, ABTS and FRAP methods, as well as the content of polyphenols using the F-C method.

Microwave radiation caused significant ( $p \leq 0.05$ ) changes in bioactive properties. In yellow peppers, the TAC was reduced to a greater extent than in red peppers. The greater reduction in TAC (25%) observed for red peppers may be due to the specific thermolabile compounds typical for the red peppers. This observation in fact opens the discussion about the microwave treatment impact on TAC of treated vegetables. At the same time, microwave treatment did not change the total polyphenol content of the yellow pepper. This suggests that consuming microwaved plant foods may not be associated with reduced health benefits.

*Keywords: microwave treatment, peppers, polyphenols, antioxidant activity*

# DETERMINATION OF METHANOL CONTENT IN HOMEMADE BRANDY USING RAMAN SPECTROSCOPY

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Methanol and ethanol are alcohols naturally produced during fermentation. While similar in physical and chemical properties their toxicity is very different. Small quantities of methanol as low as 10 ml can cause permanent blindness while larger quantities have lethal outcomes. The history of human alcohol consumption is marked with instances of accidental methanol poisoning which led to many lives being lost. Methanol content in alcoholic beverages is highly monitored and regulated by law to prevent accidental poisonings. The method commonly used for methanol content determination is the spectrophotometric method using chromotropic acid. This method requires a lengthy process of sample preparation and the use of many chemical reagents which is not the most practical approach, especially if there are many samples to be analysed. Raman spectroscopy is a non-destructive, quick instrumental method that can be used to determine methanol content in alcoholic beverages utilising the characteristic band of methanol noticeable in the recorded spectra of samples. Considering the tradition of homemade brandy production and consumption in Bosnia and Herzegovina as well as in neighbouring countries, accidental methanol poisoning is a possible occurrence. The goal of this study was to analyse the methanol content in homemade brandy samples which usually do not undergo any inspection before consumption. Fifteen samples of fruit brandy were analysed using both Raman spectroscopy and the chromotropic acid method. Out of these fifteen samples only one of them had a methanol content below the legal limit.

*Keywords: methanol, alcoholic beverages, Raman spectroscopy*

## GROWTH AND METABOLIC CHARACTERIZATION OF THREE LACTIC ACID BACTERIA SPECIES

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Starter cultures of lactic acid bacteria (LAB): four *Lacticaseibacillus paracasei/casei*, five *Levilactobacillus brevis* and five *Leuconostoc mesenteroides* strains were used for milk inoculation. Microbial counts, pH, sugars, organic acids and volatile compounds in fermented milk samples were analyzed after 72h of incubation at 30°C. Maximum cell counts in milk were attained by *Lacticaseibacillus paracasei/casei* strains (log 9.79-10.88 cfu mL<sup>-1</sup>), then by *Levilactobacillus brevis* strains (>log 9.00 cfu mL<sup>-1</sup>) and minimal by *Leuconostoc mesenteroides* strains (<log 9.00 cfu mL<sup>-1</sup>). *Lacticaseibacillus paracasei/casei* strains utilized lactose, glucose and galactose concurrently, as well as two citrate positive strains of *Lactobacillus brevis*. *Lacticaseibacillus paracasei/casei* strains produced the highest amounts of lactate (12.46-14.07 g kg<sup>-1</sup>), fumarate (0.14-0.25 g kg<sup>-1</sup>), succinate (0.53-0.64 g kg<sup>-1</sup>) as well as significant concentrations of two volatile compounds diacetyl and acetoin. Two citrate positive strains of *Levilactobacillus brevis* produced lactate between 6.90 and 9.50 g kg<sup>-1</sup> and the highest amount of acetate (1.10-1.30g kg<sup>-1</sup>). The most important metabolic products of three *Leuconostoc mesenteroides* strains were ethanol and acetoin. The representative strain of *Leuconostoc mesenteroides* produced 1.50 g kg<sup>-1</sup> of ethanol as well as significant concentrations of acetic acid, acetoin, diacetyl and acetone. Principal component analysis (PCA) was used to identify strains with the highest technological potential on the base of their biotechnological properties.

**Keywords:** lactic acid bacteria, organic acids, cell counts, volatile compounds



# THE CHEMISTRY OF FERMENTED AND PICKLED FOOD

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Fermentation, as one of the primary metabolic pathways for energy extraction, has been utilised since antiquity as a means to preserve different types of food. In the most basic of definitions, it includes the breakdown of carbohydrates due to microbial activity. Fermented food has found its place in traditional cuisines all over the world and is consumed by many people on a daily basis. Pickling, another way to ensure consumption and preservation of mostly vegetables even out of season, can be done in one of two ways: by anaerobic fermentation in brine or by immersion in vinegar.

Both fermentation and pickling change the chemical composition of the food. This review aims to showcase what happens during these food preservation processes on a molecular level and discuss the possible health benefits as well as detriments that come with consumption of food processed this way.

*Keywords: fermentation, pickling, preserved food, food chemistry*

## PHYTOMELATONIN: RECENT ADVANCES – SYSTEMATIC REVIEW

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Human hormone melatonin (N-acetyl-5-methoxy tryptamine), is a tryptophan metabolite synthesized in pineal gland. Melatonin is shown to control and a modulate circadian rhythms, seasonal reproduction, sleep regulation, retinal physiology. Besides its physiological role, the role of melatonin as a strong antioxidant that can subdue inflammatory pathways and scavenge free radicals has been proven in a numerous studies. Antioxidative ability of melatonin is based on its role as a scavenger of reactive oxygen species including hydroxyl radical, superoxide ion, peroxy radicals, singlet oxygen, nitric oxide, peroxynitrate and its metabolites. Antioxidative mechanism can proceed through several mechanistic pathways including hydrogen atom transfer, electron transfer and formation of radical adducts. Only much later melatonin has been detected in a different plant species. High concentrations of melatonin have been found in a different medicinal plant. Amounts of melatonin in these plant tissues amounted to several micrograms per gram of tissue (amounts more than those found in blood).

Daytime melatonin concentrations are related to light intensity to which the plants are exposed. Meanwhile, it has been shown in various plants that contain large amounts of melatonin to respond to intense light, especially UV, by increasing of methoxyl indole. This suggests a photoprotective role, which it already is presumably because of the numerous photoreactions to which melatonin is subject and ability melatonin to neutralize singlet oxygen and free radicals caused by UV rays. Recent research shows that melatonin concentrations differ not only between plants species but also among varieties of the same species, and to a considerable extent about the degree of growth, location, specific plant organ, as well as the time and season of harvest. At the current level of understanding, the presence of melatonin in plants is, in most cases, accepted although there are still many unanswered questions. Thus, we performed systematic review of a literature according to PRISMA protocol to analyze the origin, content in various plant species, detection and therapeutic potentials of phytomelatonin.

*Keywords: melatonin, antioxidant, plants, phytomelatonin, plant hormone*

## **AGRICULTURAL PLANT PRODUCTION**

# EFFECTS OF MOWING HEIGHTS ON THE TURF PERFORMANCES OF SOME TALL FESCUE (*Festuca arundinacea* Schreb.) CULTIVARS UNDER MEDITERRANEAN ECOLOGICAL CONDITIONS

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Tall Fescue (*Festuca arundinacea* Schreb.) is one of the most drought, heat and wear tolerant cool-season turfgrass species. Due to its large and deep root system, it is able to take up water in dry periods when other grasses have stopped their growth in the Mediterranean ecology. This research study conducted in the experimental areas of Field Crops Department, Agriculture Faculty of Ege University in 2017-2019. In this study, it was aimed to investigate the effects of different mowing heights (10-20-30 mm) on the turf performances of ten different Tall Fescue cultivars (Avenger, Essential, Filippa, Galatea, Granditte, Greenfront, Olympus, Rendition, Stingray and Titan Rx). For this purpose, traits such as winter resistance (1-9 score), regenerative capacity (1-9 score), weed infestation (1-9 score) and rate of thinning (1-9 score) were investigated.

According to the results, it was concluded that mowing heights of 20 and 30 mm were more suitable for turf maintenance and persistence. The cultivar Stingray found to be the most successful in terms of winter resistance, regenerative capacity and weed infestation traits. In terms of thinning rate, the most successful cultivar was Filippa. The cultivars Stingray, Avenger and Olympus should be preferred because of their high scores and superior performance in terms of characteristics investigated in the Mediterranean region.

*Keywords: Festuca arundinacea, cultivar, mowing height, turf performance, Mediterranean ecology*

# THE LANDSCAPING OF THE GREEN AREA OF THE RAVNE VISOKO SITE

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Suburban greenery represents a significant part of all structural and functional zones of the settlement and connects the settlements with its natural environment. Skilful and creative use of compositional elements and aesthetic principles creates optimal conditions for life, work and rest of the inhabitants of the urban environment. This paper presents the phases of the development of the conceptual design through the analysis and valorization of biological and architectural components of the initial state necessary for the landscaping of the green area of the Ravne Visoko site.

The proposed landscaping of the selected green area seeks to eliminate all shortcomings and introduce new useful elements, and direct the goal towards meeting the functions, primarily biological-sanitary-hygienic, cultural-educational and then optimize it with functionality according to the category of greenery to which it belongs.

*Keywords: suburban greenery, a vacation of inhabitants, conceptual design, analysis, landscaping*

# THE STATE OF PEOPLE'S AWARENESS ABOUT CLIMATE CHANGES AND ENVIRONMENTAL PROTECTION IN BOSNIA AND HERZEGOVINA

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Most of the food we consume today comes from the soil, indicating the importance of its since it has a direct impact on its functionality, i.e., only healthy land, as well as other natural resources, will provide quality food. Agricultural production depends the most on the weather and the state of natural resources; therefore, it is important to covert to sustainable and smart agriculture, more precisely to use natural resources sustainably and efficiently in order to protect them, at the same time sustainable production strengthens resistance to climate change and enables environmental protection for current and future generations.

Promoting and raising environmental awareness is a frequent goal of many development documents and projects both in the world and in Bosnia and Herzegovina (BiH). However, the question arises, what is the current state of people's awareness regarding the environment, climate change and agriculture importance in BiH? How do people view the introduction of new technologies and digitization as a path to a greener future? The research analyzed exactly that. In order to obtain the necessary information, a quantitative method of data collection and research, by forming a survey questionnaire (*LimeSurvey.org*) was used.

The total number of those surveyed was 337. The results showed that the people of BiH are aware of the need to protect nature and the importance of agriculture, and that this field should be given more importance, especially by the relevant state institutions. The respondents are also familiar with the concept of sustainability and smart agriculture, and they believe that it is possible to apply them in BiH areas, thanks to which the negative consequences of natural disasters can be significantly mitigated, especially in the environmental sector, agriculture and society in general.

*Keywords: smart agriculture, climate change, raising awareness, environmental protection*

## AUTHENTIC BOSNIAN GARDEN THROUGH HISTORY

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Bosnia and Herzegovina is a country with a rich cultural and historical heritage, of which the least researched is the heritage in the field of landscape architecture. The influence of the Orient on the Bosnian courtyards was very great during the rule of the Ottoman Empire, and combining their style of building gardens with the needs of the then population of Bosnia and Herzegovina, a characteristic style of gardening, called 'Bosnian flower courtyard'. The protection of Bosnian gardens as a cultural and historical heritage requires a multidisciplinary approach from the aspect of analysis of a large number of factors. Bosnia and Herzegovina, located at the crossroads of East and West, sublimates the influence of both cultures in its garden architecture. Spatial planning represents the cultural heritage of a nation, its identity, tradition, culture and religion. The Turkish tradition of nurturing flower courts and gardens in Bosnia and Herzegovina and some of its cities has been preserved to this day. The gardens of each country have their own specifics and are a reflection of tradition, culture and religion. As such garden styles must be nurtured and preserved from oblivion.

*Keywords: landscape architecture, cultural and historical heritage, Bosnian garden, garden architecture*

# **EFFECT OF THE HARVEST DATE AND 1-METHYLCYCLOPROPENE (MCP) APPLICATION ON THE QUALITY AND STORAGE OF 'GRANNY SMITH' APPLE FRUITS**

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The experiment was conducted in the Municipality of Gradačac during the years 2018. and 2019. The goals of the research were to determine the influence of the harvest date and 1-methylcyclopropene (MCP) application on the quality and storage of 'Granny Smith' apple fruits. The harvesting was done in two moments with the interval of ten days (October 14, 2018 and October 24, 2018). Fruits from two different harvest dates were treated with 1-MCP (SmartFresh™) immediately after harvest, and stored in a normal atmosphere (2-4°C) and relative humidity 80-95%) for 180 days. Assessments of the superficial scald severity, fruit weight, firmness, total soluble solids and titratable acidity were recorded every 60 days (three times during storage period). Perlim and Thiault indexes (PI and TI) were used to determine fruit quality. Based on the obtained results, it can be concluded that the harvesting moment does not have a statistical influence on the maturity indices. The treatment of 1-MCP and the duration of storage had a statistically significant effect on the analysed fruit quality parameters. 1-MCP was determined to have a positive effect on retention of firmness, total soluble solids and titratable acidity during storage.

Assessments of the Perlim and Thiault indexes at the end of storage (180 days), indicates a greater decline in fruit quality was observed in the control group of fruits compared with treatment of MCP.

*Keywords: apple, fruit quality, fruit storage, 1-methylcyclopropene, harvest date*



# EFFECTIVENESS OF THE INSECTICIDES CHLORANTRANILIPROLE, METHOXYFENOZIDE AND EMAMECTIN BENZOATE IN CONTROLLING THE TOMATO MOTH USING THE MODIFIED “LEAF-DEEP” METHOD

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*Tuta absoluta* (Lepidoptera: Gelechiidae) is the most abundant pest of vegetable species from the *Solanaceae* family, which has been member of entomofauna of Bosnia and Herzegovina since 2010. It is widespread in the protected production spaces of the Mediterranean and continental areas of B&H, and has become a serious problem in tomato protection. The measures, used for tomato moth control are very complex. Biology of the pest itself is main limitation because of large capacity for reproduction and resistance to insecticides. In the early eighties of the last century, chemical agents based on organophosphate and synthetic pyrethroids were mostly used to control tomato moth. Frequent use of these preparations has led to an increased resistance of tomato moth, and as a consequence, new insecticides have been developed. The aim of the work was to examine the effectiveness of newer generation insecticides based on active substances: Chlorantraniliprole, Methoxyfenozide and Emamectin benzoate in controlling tomato moth population that was collected from the area of Herzegovina. Insecticides were applied in different concentrations to three tomato hybrids (Matias, Belle, Rally) under controlled conditions. Test was performed according to the modified „leaf-deep method“ (IRAC). The effectiveness of the investigated insecticides primarily depended on the applied concentration and the duration of exposure to the active substances.

*Keywords: tomato moth (Tuta absoluta), Chlorantraniliprole, Methoxyfenozide, Emamectin benzoate, "leaf-deep" method*

# IMPACT OF MANAGEMENT PRACTICES ON SOIL MICROBIAL ACTIVITY

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Soil is the substrate of plant nutrition, the habitat of numerous microorganisms and animals where their mutual interactions affect its fertility. Microorganisms in the soil have a very important role because they participate in numerous processes, the most important of which are the humification and mineralization of organic matter. However, intensive and/or inadequate use of the soil leads to disturbance of the plant - microbial interactions, a decline in its productivity and degradation. Abundance and microbiological activity of a certain ecosystem are considered one of the indicators of soil fertility, so the determination of this parameter is a crucial parameter of soil quality. In this paper, samples of grassland, agricultural soil, forest soil and coal-mine-affected soil at the Banovići municipality (Tuzla Canton, Bosnia and Herzegovina) were used for chemical and microbiological characterization. Soil sampling (0-20 and 20-40 cm) was performed in October 2021. Chemical analyses were performed using the standard methodology, while the total number of bacteria, the number of ammonifiers, oligonitrophiles and actinomycetes were determined by the agar plate method. Enzyme production was expressed through dehydrogenase activity. The lowest pH value was recorded in forest soil, while the highest in the grassland. Different humus and available phosphorus content, and low potassium content in soil were recorded. In all samples, the lowest microbial activity was observed in coal mine-affected soil. The highest value of the total number of bacteria and ammonifiers was recorded in forest soil. Oligonitrophiles were most abundant in agricultural soil, whilst a number of actinomycetes was highest in grassland. Dehydrogenase activity was highest in forest and agricultural soil. This research confirms the importance of parameters of microbial activity in the estimation of soil quality and fertility.

*Keywords: soil, chemical characterisation, microbial abundance, soil dehydrogenase activity*

# THE IMPACT OF MULCH TYPE ON BASIL YIELD AND ESSENTIAL OIL CONTENT

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The use of medicinal and aromatic plants has always been a topic of human interest but occupation for cultivation and technologies that will ensure good properties of cultivated crops is growing in recent years. One of the economically important crops is basil (*Ocimum basilicum* L.). It is grown for obtaining fresh and dry leaf mass and for the production of essential oil for food, cosmetic and pharmaceutical industries. Given that its market value is most often determined by the content of secondary metabolites, producers try to ensure good yields and quality through application of different agrotechnical measures. The aim of this work was to investigate the influence of application of different mulch types and irrigation on the yield, content of essential oil and total phenolic content in basil. The field experiment was conducted at the Butmir experimental field of the Faculty of Agriculture and Food Science in Sarajevo. The treatments used in this study consisted of a combination of different mulches (wheat straw mulch, black mulch film and control) and irrigation (irrigated and non-irrigated). The tested parameters were plant height, green mass yield, dry mass yield and essential oil content. As the research results show, higher average height (41.37 cm), higher fresh mass yield per plant (165.73 g) and higher dry mass yield per plant (34.73 g) were achieved on the irrigated plots. Essential oil content ranged from 0.84 (wheat straw mulch) to 0.91 mL 100<sup>-1</sup> g (control).

*Keywords: basil, mulch, essential oil, yield*

# ASSESSMENT OF THE EFFICIENCY OF PLUM HARVESTING IN INTENSIVE PLANTATIONS

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The performance of plum harvesting depends on the shape of the crown and the height of the tree, the fertility, the size of the fruits, the skills of the workers and the organization of the harvest. The aim of the paper is to evaluate the efficiency of plum harvesting in intensive plum plantations. The paper analyzed the efficiency of harvesting for the following varieties: Čačanska leptica, Čačanska rodna, Čačanska najbolja, Elena, Hanita and Stanley. The research was done during 2018 and 2019. The analysis of harvesting efficiency was carried out in the production plantation of the company "Agro-voće". Planting density for all varieties is 4.0 x 1.8 m. The analysis of the efficiency of manual picking of plum fruits was performed for each variety on ten randomly selected trees. Fruit harvesting was done by workers who regularly perform this activity. Measurements included the time required for harvesting the upper and lower part of the canopy, total harvesting time per tree and unit area. It took the most time to harvest the fruits of the Elena variety. For most varieties, the harvest took longer in 2018 than during the 2019. Depending on the variety and year, harvesting time ranged from 28 to 106 working days. Harvesting is a labor-intensive operation that employs many workers in a short period of time and represents the largest item in the cost structure. Bearing in mind the above, activities to find the possibility of mechanized harvesting are gaining more and more importance.

*Keywords: plum, variety, harvest, efficiency*

# DETERMINATION OF CHLORIDE CONTENT IN SOIL SAMPLES BY AUTOMATIC TITRATION, AND MINIMIZING INTERFERENCES CAUSED BY THE PRESENCE OF Fe IONS

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Chloride ion (Cl<sup>-</sup>) is one of the main inorganic anions in water. In the soil, it originates from many chlorine minerals. Chlorides in soil can be released also as constituent of fertilizers. Fertilizers in greenhouses are used in high amount, where salinization of soil often happens. Increased chloride content on arable land can significantly affect the cultivation of certain agricultural crops, and the first step towards solving this problem must be to determine the chloride content as accurately as possible. The aim of this research is to determine the chloride content in soil samples from greenhouses by use of automatic titration, and to record possible disturbances caused by certain cations (iron), and to propose a way to minimize them. The following samples were used as material: soil from five greenhouses, soil samples outside the greenhouse - control, and irrigation water samples. In the samples following basic parameters were measured: hygroscopic water content, pH value in water and CaCl<sub>2</sub>, redox potential and electrical conductivity. Chloride content was measured with automatic titrator, and iron content with atomic absorption spectrophotometry with flame atomization (Shimadzu AA 7000 instrument). Irrigation water had a neutral pH value, while the soil samples were slightly acidic (6.74) to alkaline (8.36). Irrigation water does not contribute in chloride content in soils. The highest chloride content was 226.7 mg/kg, and at this chloride value, moderately resistant plants can show negative changes. There is a certain difference in chloride content with and without EDTA addition, but amount of iron was not high enough to cause significant interference (average: 9.86 mg/kg).

*Keywords: chlorides, automatic titration, greenhouse, salinization, interference*

# THE INFLUENCE OF THE VEGETATION CYCLE AND MIXTURE (GRASS AND LEGUMINUS) ON PLANT HEIGHT OF SOWED LAWNS

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The speed of growth as well as the height of plants on sown lawns are important from the point of view of the possibility of obtaining a larger number of swaths, if the growth is faster, and obtaining a higher yield, if the plants are of a higher age, at the same crop density. Sown lawns, usually called grass-leguminous mixtures in practice, are composed of different types of grasses and legumes. Depending on the variety, growing conditions, vegetation cycle and the like, in principle, the plants of the first vegetation cycle (first cutting) reach the highest height. Considering the mentioned facts, the goal of the proposed research was to analyze the influence of the vegetation cycle and the mixture on the height of grass and leguminous plants in the plant community under different defoliation regimes.

The obtained three-year research results showed that the height of the plants at mowing depended on the species (mixture), year (age of plants and weather conditions) and vegetation cycle. In general, the lowest are the plants, of all species, in the year of sowing. In the second and third year, the plants of the first cut are the tallest, almost with all mowing regimes. However, the tallest plants in the first swath are in the flowering phase of the plants, where among the tested species, the tallest plants are orchard grass in all mixtures (average 91.99 cm), followed by Italian ryegrass (average 82.77 cm), and the lowest plants are bird's foot trefoil (average 48.97 cm).

*Keywords: grasslands, stage of plant development, vegetation cycle, plant height*

# **EFFECT OF VERMICOMPOST AND MINERAL FERTILIZER APPLICATIONS ON SOME PROPERTIES OF LOAM TEXTURE SOIL AND PEPPER YIELD**

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In this study, the effects of vermicompost doses and mineral fertilizer applications on the properties of loamy soil and the yield of pepper grown were investigated. According to the data obtained at the end of the experiment, the doses of vermicompost significantly increased the organic matter, total nitrogen, EC, Mg, Fe, P, K content and porosity values of the soil compared to the control. The pH, bulk density, suspension percentage, aggregation percentage and structure stability index values of the soil decreased statistically with the application of vermicompost. There were no statistically significant changes in the particle density, lime content, field capacity, wilting point, available water, aggregation percentage obtained by wet sieving, and Cu, Na, Ca, Zn, K, Mn values that can be taken by plants with vermicompost applications. A statistically significant increase was determined in the yield of pepper compared to the control with vermicompost applications. Due to the positive effects of vermicompost on some soil properties and yield of pepper, it may be preferred to use it as a fertilizer material and soil conditioner instead of mineral fertilizer.

*Keywords: mineral fertilizer, pepper yield, soil properties, vermicompost*

# **IMPACT OF CLIMATE CHANGE ON THE ANNUAL AND SEASONAL SOIL WATER BALANCE IN THE MUNICIPALITY SANSKI MOST, BOSNIA AND HERZEGOVINA**

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Given that global climate change affects the agricultural sector, often negatively affecting yields and food quality, it is very important to understand these impacts at the local level. The municipality of Sanski Most belongs to the Peripannon macroregion and it is located in the northwestern part of Bosnia and Herzegovina. In this municipality agriculture represents one of the most important economy sectors. Therefore, it is extremely important to conduct a detailed analysis of the agroclimatic conditions and soil water balance in order to determine the current situation, but also to adapt agriculture and society as a whole to the coming changes. The analysis of the impact of climate change was performed by observing two climate periods, namely the reference climate period (1961-1990) and the current climate period (1991-2020). Comparing these two climate periods an increase in the annual amount of precipitation by 38 mm was found. Although there is a positive trend at the level of the year, it is negative during the summer months (-14.73 mm per decade), when the plant needs water the most. Also, the mean air temperature shows a positive trend in all seasons, with the largest increase in the summer months (0.49 °C per decade). In the summer period, the deficit of water in the soil becomes more and more present, that is, the need for irrigation increases. The difference in the average amount of soil water deficit between the two climatic periods is 48 mm, with a positive trend of 14.49 mm per decade. Also, one of the more visible differences is the increase in reference evapotranspiration ( $ET_0$ ), which increased by 50 mm between these two climatic periods.

*Keywords: Sanski Most, agriculture, soil water balance, climate change, trend*



# THE INFLUENCE OF SELECTED HERBICIDES ON THE GROWTH OF BACTERIAL SPECIES *BACILLUS MYCOIDES* AND *ESCHERICHIA COLI*

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It is well known that weeds cause the greatest damage to agricultural crops compared to phytopathogenic organisms and pests. The use of herbicides from the moment of pesticides synthesis until today has become one of the mandatory agrotechnical measures used to control weeds in the protection of a large number of agricultural crops. According to the latest statistical analyses, herbicides take first place in terms of utility value compared to zoocides, fungicides and bactericides. In addition to all the advantages that herbicides provide, the wider implications of their frequent use for human health and the biosphere as a whole began to be seen in the early 1960s. Recently, there has been an increasing focus on research into the impact of herbicides on the diversity and activity of both beneficial and harmful soil microorganisms.

The goal of this study was to examine the influence of different concentrations of herbicides based on active substances (a. s.): nicosulfuron, pendimethalin and dicamba on the growth of bacterial species *Bacillus mycoides* and *Escherichia coli*. The mentioned herbicides are prepared in concentrations that according to the instructions for use in agricultural practice correspond to their minimum recommended doses dissolved in the minimum recommended water consumption (200 L ha<sup>-1</sup>) and the maximum recommended water consumption (400 L ha<sup>-1</sup>). Accordingly, the examined herbicides were prepared in the following concentrations: nicosulfuron 0.5% and 0.25%, pendimethalin 2% and 1% and dicamba 0.3% and 0.15%. The examination was performed in laboratory conditions using the Kirby-Bauer test diffusion method. The most significant inhibitory effect on the growth of the species *Bacillus mycoides* has a herbicide based on a. s. pendimethalin in a concentration of 2% with an average zone of inhibition 22.7 mm. The most significant, almost identical inhibitory effect on the growth of *Escherichia coli* species has a herbicide based on a. s. dicamba in both tested concentrations (0.3% and 0.15%) with an average zone of inhibition 7.7 mm and 7.5 mm, respectively.

*Keywords: nicosulfuron, pendimethalin, dicamba, test diffusion method, inhibition, stimulation, Escherichia coli, Bacillus mycoides*

# EFFECTS OF MULCHING AND IRRIGATION ON ANTIOXIDANT ACTIVITY AND ANTIMICROBIAL PROPERTIES OF BASIL (*Ocimum basilicum* L.)

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Basil (*Ocimum basilicum* L.) is an annual herb from the mint family. It is used as a fresh and dry spice, and in the form of an essential oil. Antioxidant activity and antimicrobial properties of basil depend on genetic properties, environmental conditions and growing technology. Therefore, the objective of this study was to determine the effects of growing technology on antioxidant activity and antimicrobial properties of basil. The field experiment was conducted at the Butmir experimental field of the Faculty of Agriculture and Food Science in Sarajevo. The treatments used in this study consisted of a combination of different mulches (wheat straw mulch, black mulch film and control) and irrigation (irrigated and non-irrigated). The tested properties were total phenolic content, flavonoids content, antioxidant activity and antimicrobial properties of the essential oil. Experimental results suggested that growing technology impact on the researched traits. The highest total phenolic content (69.94 mg GAE g<sup>-1</sup>), total flavonoid contents (35.77 mg CAE g<sup>-1</sup>) and antioxidant capacity (45.13 μM Fe<sup>2+</sup> g<sup>-1</sup>) were recorded in the treatment with black mulch film. The research results showed that the essential oil has a growth inhibition zone diameter of 8.68 mm for *E. coli* and 10.85 mm for *Salmonella spp.*

*Keywords: basil, mulch, essential oil, antioxidant activity, antimicrobial activity*

# ROLE OF DIFFERENT NITROGEN RATE AND CUTTING HEIGHTS ON THE YIELD AND SOME FORAGE QUALITY COMPONENTS OF GIANT KING GRAS

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Giant king grass (GKG) (*Pennisetum hybridum*) as a field crop is a perennial forage grass, native to Africa, with a high growth rate, high productivity and good nutritive value and it is mostly used for -cut and carry- system over the tropical and sub-tropical areas of the world. Forage crops differ considerably in terms of their ability to recover from defoliation, which is strongly influenced by cutting height. The use of modern commercial nitrogen (N) fertilizers in agricultural production results in increased crop yields in addition to the effect of better plant nutrition through N fertilizers signify themselves not only in increasing yields, but also in an increase in the total biomass production. This study was conducted to determine the effects of different cutting heights (0, 5, 10, 15 and 20 cm) and N rates (0, 50, 100, 150 and 200 kg N ha<sup>-1</sup>) on the forage yield and some quality parameters of GKG. The experiment was carried out at Ege University, Faculty of Agriculture in Turkey, during the summer growth seasons of 2019 and 2020. Some characteristics were measured such dry matter (DM) yield, concentrations of crude protein (CP), NDF and ADF. Results indicated that increasing N rates increased DM yield and CP content, and improved NDF and ADF concentrations compared to the control. Although lower cutting heights increased DM yield, CP content decreased. Cutting heights of 10- to 15- cm and application of 150 kg N ha<sup>-1</sup> can be recommended throughout the growing season for silage production of GKG for plant persistence, with high yield and acceptable forage quality, and for the safe operation of the harvest equipment's.

*Keywords: giant king grass, cutting height, N rate, yield, quality*

## **EFFECT OF PRUNING ON MECHANICAL COMPOSITION OF CLUSTER OF TABLE GRAPE VARIETIES (*Vitis vinifera* L.)**

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The aim of the research was to study the effect of pruning on the mechanical composition of the clusters of three introduced table grape varieties (Black Magic, Muscat Bleu and Alphonse Lavallee) in the area of Mostar. The research lasted three years (2011-2013), each variety had three variant of pruning, and each variant had four repetitions. The crop load levels studied in this research were 28 (variant I), 32 (variant II) and 40 (variant III) buds per vine. The following parameters were measured: cluster weight, berries and rachis weight, number of berries in a cluster and single berry weight, length and width of cluster and berry. The highest values of the parameters: cluster weight, berry and rachis weight, single berry weight and berry width were in the variety Alphonse Lavallee variant II, while the longest cluster was in the variety Black Magic variant II, and the cluster widest in variant III, as well as the berry length. The largest number of berries in a cluster was recorded in the variety Muscat Bleu variant II.

*Keywords: mechanical composition of cluster, table grapevine, pruning*

# DETECTION OF BLUEBERRY LATENT VIRUS ON HIGHBUSH BLUEBERRIES IN MONTENEGRO

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The highbush blueberry (*Vaccinium corymbosum* L.) is a relatively new fruit species for fruit growing in Montenegro. Established plantations are located in the northern part of the country.

To investigate the presence of viruses in blueberry plantations in Montenegro during 2022, visual inspections of plantations were carried out. Seventeen leaf samples of five cultivars ('Aurora', 'Bluecrop', 'Brigita Blue', 'Duke', and 'Earlyblue') were collected and analyzed.

The samples were tested by enzyme-linked immunosorbent assay (ELISA) for the presence of: blueberry shock virus (BShV), blueberry scorch virus (BScV), blueberry shoestring virus (BSSV), blueberry leaf mottle virus (BLMoV), tomato ringspot virus (ToRSV), and tobacco ringspot virus (TRSV). The samples were further tested for the presence of blueberry mosaic-associated virus (BIMaV) and blueberry latent virus (BILV) using RT-PCR and for the presence of the blueberry red ringspot virus (BRRV) using PCR. Extraction of total nucleic acids was performed with 2% CTAB buffer. Reverse transcription was performed using pd(N)6 random primers, and PCR reactions were performed using virus-specific primers. PCR products were analyzed by electrophoresis in a 1.5% agarose gel and stained with ethidium bromide.

The presence of blueberry latent virus was confirmed in 10 blueberry samples (59%) in cultivars 'Duke', 'Bluecrop', and 'Earlyblue'. Virus identification was confirmed by sequencing the amplified fusion protein gene fragments of all 10 isolates. No other viruses were confirmed in the tested samples.

This is the first survey for virus presence in blueberries in Montenegro and the first finding of blueberry latent virus in the country.

*Keywords: Vaccinium corymbosum L., viruses, ELISA, PCR, latency*

# THE USE OF PYROPHYLLITE FOR THE PURPOSE OF REMEDIATION OF LAND CONTAMINATED WITH HEAVY METALS IN THE INDUSTRIALS ZONE OF KAKANJ

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From the large number of pollutants that enter the soil through human activity, special attention should be paid to heavy metals due to their toxic effects on the environment.

The toxic effects of heavy metals manifest themselves through the pollution of land and water systems. Through plants they enter the food chain and manifest their harmful effects on human health.

The pyrophyllite as aluminosilicate material can potentially be used as a remedial measure because it reduces the presence of heavy metals in the soil, and thus its absorption into the plant. The location of the field experiment is in the immediate vicinity of the thermal power plant and the cement factory in Kakanj, which are among the biggest environmental polluters in the Zenica-Doboj canton.

Pyrophyllite particles with a size of 100  $\mu\text{m}$  were added in the soil of potato field in amounts of 200, 400 and 600  $\text{kg ha}^{-1}$ , in three repetitions. Accessible forms of heavy metals from soil samples and potato leaves were extracted with EDTA solution ( $0.01 \text{ mol dm}^{-3} \text{ C}_{10}\text{H}_{16}\text{N}_2\text{O}_8$  and  $1 \text{ mol dm}^{-3} (\text{NH}_4)_2\text{CO}_3$ , adjusted to pH 8.6), and their concentrations in the obtained extract were determined by the method of atomic absorption spectrophotometry.

In the conditions of the conducted experiment, the application of pyrophyllite, regardless of the applied dose, reduced the availability of Zn, Mn, Cd and Co in the tested soil.

*Keywords: heavy metals, pyrophyllite, remediation*

# LEAF DISEASES OF WILD BARLEY (*Hordeum spontaneum*) IN BİNGÖL UNIVERSITY CAMPUS, TURKEY

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In May 2022, a survey was carried out in the campus area of Bingöl University, Turkey, and diseases in wild barley (*Hordeum spontaneum*) populations were determined. A total of 15 *H. spontaneum* populations were examined. In these populations, powdery mildew caused by *Blumeria graminis* f. sp. *hordei*, scald caused by *Rhynchosporium commune*, the net form of net blotch caused by *Pyrenophora teres* f. *teres*, and spot form of net blotch caused by *Pyrenophora teres* f. *maculata* were determined by visual identification. Powdery mildew was observed in all 15 populations. Scald, the net form of net blotch, and spot form of net blotch were observed in 7, 3, and 2 populations, respectively. In these areas, the percentages of these diseases varied between 50-90% for powdery mildew, 10-30% for scald, 2-3% for the net form of net blotch, and 1-2% for the spot form of net blotch. Scale values for disease severity were higher in powdery mildew (between 5-9), 3-5 for scald, and low in both forms of net blotch (1-3, and 1-2).

*Keywords: wild barley, Hordeum spontaneum, wild barley diseases, Bingöl, Turkey*

# EXAMINATION OF POMOLOGICAL AND TECHNOLOGICAL CHARACTERISTICS OF SOME CHERRY VARIETIES IN THE DISTRICT OF MAČVA

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During 2022. the pomological-technological characteristics of the varieties were measured at the localities of Mačva Burlat, Carmen, Gray Star, Kordia, Ferovia, Regina varieties. Citric acid and content of total dry matter expressed in degrees Brix°. Varieties are arranged chronologically according to ripening time. According to the weight of the fruit, the variety Carmen (13.99 g) and the variety Gray Star (12.75 g) are the largest, and the smallest is Regina (9.96 g). The stoneless fruit mass is the highest in the Carmen variety (12.64 g), and the smallest in the Regina variety (8.97 g). The weight of the pod is the highest in the Carmen variety (1.35 g), and the smallest pod mass is in the variety (Kordia 0.65 g). Radman is the largest in the Kordia variety, while it is the smallest in the Carmen and Regina varieties. According to the length of the stem, it can be said that the earlier varieties have a shorter stem, so the stem length of the earliest variety Burlata is 41.36 mm, and that of Ferovia is 58.22 mm. The highest acids are found in the Regina variety, and the lowest in the Carmen variety. The degree of Brix is the highest in the Regina variety, and the lowest in the Gray Star variety.

*Keywords: cherry, fruit weight, stem length*



# SOIL POLLUTION BY HEAVY METALS NEAR THE LUKAVAC COKE INDUSTRY AND MODELS OF ITS PROTECTION AND REMEDIATION

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Soil represents a limited and invaluable natural resource that has multiple functions: production, ecological, filtration-buffering, raw material and construction functions. However, industrial, technical-technological development and certain activities that people carry out today, unfortunately cause numerous forms of soil degradation. One of these forms of degradation is pollution and contamination of the soil with agrochemicals and heavy metals.

The aim of this work was to determine the level of contamination of agricultural soils with heavy metals in the narrow zone of the coke industry in Lukavac, (44°49'23"N, 18°41'21"E). After that, in accordance with the obtained results, appropriate remedial measures are taken on the contaminated soils in order to reduce the degree of their contamination.

The results of the research showed that according to the classification of soil contamination with heavy metals (Bašić, 1994), the soil in the vicinity of the Lukavac coke industry is classified as class III. It means that this soil belongs to the class with a high degree of contamination with heavy metals. Also this means that this soil can be used for growing agricultural crops, but enhanced protection measures are needed.

For the purpose of chemical stabilization of heavy metals in this soil and their reduced accessibility for plants, natural aluminosilicate materials such as zeolite and pyrophyllite were used in this experiment. Research has shown that pyrophyllite had a significant impact on reducing the content of accessible forms of zinc (Zn), cobalt (Co) and manganese (Mn).

*Keywords: soil, heavy metals, pollution, zeolite, pyrophyllite*

# THE EFFECT OF BIOFERTILIZATION ON POTATO YIELD COMPONENTS

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The potato (*Solanum tuberosum* L.) is the third most important food crop in Bosnia and Herzegovina after maize and wheat. It was grown on an area of 39,051 ha with an average yield of 11.3 t ha<sup>-1</sup> in 2020. The potato root system is often characterized as shallow with poor ability to extract nutrients from the soil. Therefore, in order to achieve high yields, potatoes should be provided with enough nutrients during cultivation. The aim of this work was to examine the impact of biofertilizers on potato yield in the agroecological conditions of central Bosnia and Herzegovina. The treatments used in this study consisted of several different fertilizers (mineral fertilizer, mineral fertilizer + biofertilizer, manure, manure + biofertilizer and control). The Carrera variety was used in the research. The research results showed that biofertilizer increased the number of tubers per plant. Biofertilizer variants had more tubers per plant (7.12) than those without it (6.93). The range of tuber mass was between 115.80 g (organic fertilizer) to 134.91 g (mineral fertilizer). Depending on the year of research, potato yield ranged from 34.83 t ha<sup>-1</sup> (2018) to 37.51 t ha<sup>-1</sup> (2019). The applied fertilizers did not significantly affect the content of dry matter in the potato tuber.

*Keywords: potatoes, biofertilizer, manure, yield*

# OFFER AND TECHNICAL CORRECTNESS OF SPRAYER NOZZLES FOR PESTICIDES APPLICATION IN BOSNIA AND HERZEGOVINA

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Nozzles are supplies that are deformed during the work process and can affect the quality of pesticides application. The quality of pesticides application is reflected in coverage, flow, drift and droplet size, which mostly depends on the technical correctness of the nozzle. The goal of the paper is to determine the offer of the nozzles for pesticides application in Bosnia and Herzegovina, to examine technical correctness of the new nozzles and deviations of the nozzle flow from the declaration values. Examination was conducted on different types and brands of nozzles that can be found on Bosnia and Herzegovina market. Examination included three different working pressures, 3, 5 and 8 bars and six different nozzle brands. Nozzle flow measurement was done with special equipment for testing devices for pesticides application, model “*Schachtner tipcontrol B20*” and portable agricultural tractor sprayer, model “*Agromehanika 330*”, applying European normative *EN ISO 16122*. For statistical analyses, *IBM SPSS Statistics* software, version 20, was used. Some nozzle brands had statistically significant deviations from declaration flow, while some brands satisfied *ISO 16122* standards. The flow deviation of nozzle brands, marked with D, B and F didn’t satisfy the mentioned standard. The largest average deviation had nozzles of brand A made of metal (69,6%) and the smallest average deviation had nozzles of brand B made of metal (2,9%). Conducted research indicates, on Bosnia and Herzegovina market are nozzles whose flow rate didn’t correspond to declaration flow and there need to intensify inspection supervision on Bosnia and Herzegovina market.

*Keywords: nozzle, flow, pesticides application, deviations*

## ANTIFUNGAL POTENTIAL OF PEPPERMINT, BASIL AND SAGE ESSENTIAL OILS

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The most effective protection against plant pathogens is still the use of synthetic fungicides. However, their uncontrolled and long-term use can lead to many harmful effects, such as deterioration of environmental quality, human health problems, and pathogen resistance. Biological compounds found in essential oils do not show any harmful effects on humans or the environment, so in certain cases, they can be an alternative to synthetic fungicides. Essential oils are products of plant metabolism and often show antifungal, antiviral, antibacterial, and insecticidal effects. This study aimed to examine the antimicrobial potential of peppermint, basil, and sage essential oils, obtained by hydrodistillation on the growth of *Fusarium sp.* and *Aspergillus sp.* The experiment was performed using potato dextrose agar. After inoculation of agar by fungal mycelia, paper discs impregnated with 10 µl of oils were placed onto the agar surface. In control, impregnation was performed using distilled water. The measurement of the inhibition zones was performed after 3, 6, and 9 days. The results showed that peppermint oil has the highest antimicrobial potential compared with other oils. Sage essential oils showed the lowest antifungal suppression. In control, a negligible inhibition zone was noticed. Statistically significant influence of oils and time of incubation was observed in this research. Our results confirm the potential use of peppermint essential oils in the suppression of *Fusarium sp.* and *Aspergillus sp.* growth.

*Keywords: plant essential oils, antifungal potential, inhibition zone, Fusarium, Aspergillus*

## **PRODUCTIVE CHARACTERISTICS OF A NEW VARIETY OF PURPLE POTATO (*Solanum tuberosum* cv. Bergerac)**

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Potato, as one of the most important crops in Bosnia and Herzegovina, covers an area of 35,000 ha with average yield of up to 12 t/ha. New potato variety -Bergerac, with purple flash and skin, has been used for comparison with traditionally used Desire variety. Research was carried out during 2021. Two ways of planting were used: with and without (control) microbiological fertilizer *Slavol* application. In both varieties, *slavol* affected yield, height, and the number and size of tubers per plant.

The average yield in the control variant (without the application of microbiological fertilizer) for the variety Desire was 31.2 t/ha and 33.1 t/ha for the variety Bergerac. With *Slavol*, Desire variety achieved an average yield of 48.4 t/ha, while Bergerac produced a yield of 37.1 t/ha. The average number of tubers per plant was higher in Bergerac variety, while Desire had larger tubers (average diameter  $\geq 40$  mm).

Study indicates that potatoes with purple flesh have a higher antioxidant activity. The antioxidant activity for the Bergerac variety was 53.7% higher than Desire with 267.23 mg GAE/kg FW, while Desire variety had average amount of 123.68 mg GAE/kg FW.

*Keywords: potato, variety, microbiological fertilizer, yield, antioxidant activity*

# SUPPRESSION OF PHYTOPATHOGENIC FUNGI BY GARLIC, HORSETAIL, AND YARROW PLANT EXTRACTS

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Organic production is a system of sustainable agriculture based on a high respect for environmental principles through the rational use of natural resources, renewable energy sources, conservation of natural diversity and environmental protection. Plant cultivation in organic production implies the application of preparations on a natural basis, which is most often used as a preventive measure, without the application of agrochemicals. Therefore, the use of "domestic" natural pesticides is increasingly present. In this study, the antimicrobial effect of garlic (*Allium sativum* L.), horsetail (*Equisetum arvense* L.) and yarrow (*Achillea millefolium* L.) extracts on the growth of phytopathogenic fungi of the genus *Fusarium*, *Alternaria*, and *Aspergillus*. The potato dextrose agar was inoculated with the mycelia of fungi. The filter paper discs impregnated with 15 µL of plant extracts were placed onto agar. In control, distilled water was used for the impregnation of paper discs. All experiments were performed in triplicate. Inhibition zone measurements were performed on the third day. The results showed that each of the mentioned plant extracts inhibited the growth of the phytopathogenic fungi. The lowest inhibition zone was observed using the garlic extract, while the highest inhibition zone was detected at yarrow. These results confirm the use of plant extracts in the suppression of phytopathogenic fungi.

*Keywords: antifungal activity, incubation, plant extracts, phytopathogenic fungi*

## THE WEED SEED BANK

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The weed seed bank is an important source of crop weeding. Knowledge of the weed seed bank is very important for the prediction of weed germination and the proper selection of herbicides. The aim of this research was to determine the weed seed bank on parcels that were previously used for the production of potato, alfalfa, and wheat. Soil samples were taken at three different depths: 0 - 10 cm, 10 - 20 cm and 20 - 30cm. Two methods were applied: physical seed extraction and germination method. A greater number of weed species were identified using the germination method (23), while 19 species were recorded using the physical extraction method. The largest number of weed was recorded in the sample where the previous crop was wheat, followed by alfalfa, and the least after potato.

*Keywords: weed seed bank, dormancy, wheat, alfalfa, potato, soil depth*

# IMPACT OF THE YEAR AND REGIONAL DISTRIBUTION ON THE QUALITY OF WHEAT IN THE REPUBLIC OF NORTH MACEDONIA

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Wheat is a cereal feed widely used in animal nutrition, ranking third among other cereals, with a global production volume estimated at approximately 715 million tons per year. The chemical composition of the wheat can vary significantly, depending on the agro-climatic conditions in different regions and years. This paper provides an overview of the wheat quality for animal nutrition in North Macedonia, based on a comparison between the Macedonian national legislation requirements for feed quality and the result of 394 wheat grain samples analyzed with conventional chemical analysis. Wheat quality analysis included five accredited physical-chemical methods: moisture, crude protein, crude fat, crude fiber, and ash, compared by year (2014-2019) and region (Vardar, East and Pelagonija regions). The average values for the period 2014-2019 ranged between: moisture: 10,24 – 10,92%; ash: 1,86 – 3,23%; crude protein: 11,24 – 12,73%; crude fat: 1,52 – 2,80%; and crude fiber: 2,87 – 3,30%. The highest and most frequent deviations from the reference values were observed in 2019. Namely, the standard deviation and coefficient of variation values in 2019 indicate a relatively high standard deviation, with a variation coefficient of 24.78% for crude protein, 23.63% for moisture, 39.95% for crude fiber, 65.37% for ash, and 70.66% for crude fat. The high deviations correspond to the extremely high values measured in 2019 for ash content (9.06%) and crude fat (8.31%), as well as the significantly low values for crude protein (7, 11%) and moisture (6.73%). Regarding the specific weight values, a deviation was observed only in 2019 (65.88), where the average of the analyzed samples does not meet the required minimum of 68.00 kg/hL for wheat grain. The analysis indicated no significant differences for specific weight mass in the regional distribution.

*Keywords: wheat grain, physical-chemical analysis, national reference limits*



# SAFE AND ENVIRONMENTALLY ACCEPTABLE MANAGEMENT OF PESTICIDE'S PLASTIC PACKAGING WASTE IN BOSNIA AND HERZEGOVINA

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According to the approach developed by FAO, “sustainable agriculture” is essentially an integrated system of plant and livestock production practices with the aim of meeting people's food needs in the long term, but not at the expense of preserving the quality of the environment and natural resources. Within the EU, “green agriculture” implies, among others, the prevention of environmental degradation through a high degree of recycling and reduction of waste, especially hazardous one. This also means that within the framework of this concept, the "Green Agenda" should be applied in all policies of the agricultural food system.

The subject of this paper is research into the development of a management system for pesticides' plastic packaging waste, which is very dangerous for all elements of the ecosystem. The research is conducted within the framework of the wider project "Environmentally Sound Management of Persistent Organic Pollutants (POPs) in Industrial and Hazardous Waste Sectors", implemented by UNDP B&H and financed by the Swedish government. The research aims to identify the current state and practices in B&H when it comes to waste management of pesticide containers. The research is conducted in six municipalities across B&H and Brčko District of B&H. The aim of the research is to present and investigate the process of education of trainers and farmers, the method of collecting, handling and final disposal of 30 tons of discarded empty containers of this hazardous waste, and the effects and significance for environmental protection, in order to establish a strategic framework and achieve the goals of the EU “Green Agenda” and circular economy.

*Keywords: Green Agenda, hazardous waste, environment, circular economy*

# **POLLUTION OF PEATLAND ON ABANDONED RECLAMATION AREA AND AFTER FIRE**

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Ždralovac peatland in the karst field Livanjsko polje in southwestern Bosnia and Herzegovina with a total area of about 3,500 ha has always been drained and used for the needs of the people of that region. But drainage, agriculture and climate change cause the peat to dry out in the summer and create the conditions for frequent fires and serious changes in the properties of the peat. Since 1,000 ha of peatland was used for agricultural production (abandoned areas for 25 years that are being cultivated again today), and the extracted peat is used as a raw material in the production of substrate for growing plants, the presence of certain pollutants is a good indicator of the suitability of peat for the production of plant crops. In this paper, the state of peat related to contamination with heavy metals, polycyclic aromatic hydrocarbons - PAHs and pesticide residues was investigated in undrained peat areas, reclamation areas and peat burning sites.

The presence of heavy metals in concentrations higher than permitted was not recorded on all investigated surfaces. The presence of combustion products was recorded on all surfaces, but they did not exceed the permitted concentrations of organic pollutants (PAHs). Among pesticide residues, only the presence of DDT was recorded in abandoned meliorated areas used in agriculture, and that in a concentration that exceeded the level of uncontaminated land.

*Keywords: peatland, reclamation, fires, pollution*

# VASCULAR FLORA OF MEDIEVAL FORTRESSES OF BOSNIA AND HERZEGOVINA

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With the objective to add to the knowledge of the vascular flora of medieval sites in Bosnia and Herzegovina, eight limestone fortresses situated in different regions and subjected to different intensity of anthropogenic impact were selected. All native and subsynchronous alien vascular plant taxa were recorded, resulting in a total of 714 taxa, ranging from 82 to 384 in individual sites. The share of most numerous families and life forms was in accordance with the situation recorded in similar habitats across Europe. Despite many common features, the flora composition of surveyed fortresses varies significantly, mainly as a result of their geographical location, local environmental factors as well as the intensity of anthropogenic pressure. The main reason for the differences in floristic composition is the fact that only ten taxa were found in all eight fortresses, and a presence of numerous "site-specific" species that were found at only one of the surveyed fortresses. Although the indicators of anthropogenic changes indicate the strong anthropogenic influence on the flora, expressed through urbanization and maintenance degree, which influenced the presence and number of endemic and alien taxa, as well as the high percentage of therophytes and widespread plants, the analysis of the overall floristic assemblages showed the major significance of biogeographical position, reflected in preferences for the environmental factors in general floral composition and supported by the distribution of floristic elements.

*Keywords: Bosnia and Herzegovina, fortress flora, ecological factors, urbanization*

# THE GROWTH DYNAMICS AND YIELD COMPONENTS OF THE SELECTED WATERMELON CULTIVARS

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Watermelon is a popularly consumed vegetable well known for its health and nutritional value. It is rich in vitamins, especially in vitamin C and other bioactive compounds with high antioxidant properties. Main goals of modern watermelon cultivars are to satisfy the particular tastes of consumers and to achieve a high yield for producers. An appropriate combination of cultivars and production technology can have a positive effect on the yield and quality of the fruit. Nowadays watermelon production in Bosnia and Herzegovina is usually based on grafted seedlings. The objective of this study was to determine the main morphological and productive differences between grafted watermelon cultivars. Young seedlings of a watermelon cultivars (*Citrulus vulgaris* L. Farao F1, Constallation F1, Red Star F1 and Bonanza F1) were grafted onto rootstock (*Cucurbita maxima* × *Cucurbita moschata*) by the splice grafting (SG) method. The research was conducted during the growing season 2021 in region of Sarajevo in Bosnia and Herzegovina. The experiment was set in randomized block design with three repetitions. The examined parameters were: fruits number and weight, rind thickness content of sugar and vitamin C in marketable fruits. All examined parameters showed significant differences between cultivars. The highest fruits weight was achieved by Farao F1 cultivar ( $12.43 \pm 0.91$  kg fruit<sup>-1</sup>) which also had the highest content of sugar ( $11.70 \pm 0.91$  Brix).

*Keywords: Citrulus vulgaris, hybrids, grafting, rind thickness, vitamin C*

# **INFLUENCE OF PYROPHYLLITE AS A SOIL CONDITIONER ON PRODUCTIVITY AND ACCUMULATION OF NITRATE IN LETTUCE (*Lactuca sativa* L.)**

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Lettuce (*Lactuca sativa* L.) plays an important role in human nutrition. It is rich in vitamins, minerals, proteins, amino acids, phenols and other bioactive substances. On the other hand, lettuce is considered a vegetable that is a great source of nitrates. Nitrates themselves are not toxic, but they can be endogenously transformed into nitrites that can react with amines and amides to give N-nitrosamine compounds that can cause diseases. Lettuce can be grown throughout the year and achieve high yields. However, the production of lettuce requires the application of a large amount of mineral fertilizers. In addition, environmental problems associated with the application of mineral fertilizers are also a major concern of society.

The aim of this research was to determine whether the use of pyrophyllite can reduce the use of mineral fertilizers without negative effects on the yield and quality of lettuce. The experiment was conducted in a greenhouse from November 2019 to April 2020 on a family farm in Srebrenik, Bosnia and Herzegovina. The experiment was set up using the split-plot method in three repetitions with variants in which the fertilizer was replaced with pyrophyllite ore in the amount of 25%, 50%, 75% of the recommended amount of fertilizer and with a control variant where 100% of the recommended amount of fertilizer was used. The results of this research show that the replacement of mineral fertilizer with pyrophyllite in the amount of 25% and 50% of the recommended fertilization rate in the conditions of the experiment increases the yield of lettuce and improves the quality compared to the control variant, i.e. applying 100% of the recommended amount of mineral fertilizer.

*Keywords: pyrophyllite, mineral fertilizers, lettuce production*

# SPONTANEOUS FLORA OF URBAN DOMESTIC GARDENS OF THE CITY OF SARAJEVO

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Gardens around private houses are complex urban habitats, and generally consist of a mosaic of different microhabitats including hedges, paved surfaces, lawns, flowerbeds, fruit trees, vegetable patches and areas of uncultivated land. Although their individual size is small, domestic gardens significantly contribute to the overall flora of the urban areas. The floristic composition of domestic gardens is influenced by both natural processes and by the activities of the owners, who shape them according to their own preferences, depending on culture and lifestyle. Domestic gardens have not been represented in ecological studies until recently, primarily due to lack of access and were deliberately omitted, but it has been showed that they represent the greatest source of potentially invasive alien plants. This study, conducted in the area of 32 km<sup>2</sup>, as a part of a wider study of the urban flora of the city of Sarajevo, presents the first detailed analysis of the spontaneous flora in the domestic gardens and provides new knowledge on the flora of this, often overlooked, habitat.

*Keywords: domestic gardens, Sarajevo, floristic composition, urbanization*

# **WATER DEFICIT IN ORCHARDS, VINEYARDS, MEADOWS AND PASTURES IN CLIMATE CHANGE CONDITIONS**

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Climate change has a very significant impact on plants' water needs. In this research, an analysis of the water deficit was carried out in an observed period (2000-2019), a period of the past (1986-2005) and three periods of the future: 2021-2040, 2041-2060 and 2081- 2100 year for orchards, vineyards, grasslands in different regions of Serbia. Using the FAO IDP (Irrigation and Drainage Paper) 56 methodology, effective precipitation, reference evapotranspiration, crop evapotranspiration and water deficit were calculated. Necessary climatic data of an observed period for the calculations of the mentioned parameters were taken from meteorological stations of the Republic of Serbia Hydrometeorological Institute. Climate data for the past period and three future periods were obtained using the RCP8.5 (Relative Concentration Pathway) climate scenario and an ensemble of 8 regional climate of models. Average value of the water deficit of orchards, vineyards, meadows and pastures in the Region of Eastern and Southern Serbia in the observed period (2000-2019) was 421 mm, 255 mm and 181 mm, respectively, while in the Region of Šumadija, Central and Western Serbia it was 300 mm, 143 mm and 95 mm, respectively. The increase in the water deficit will continue in the coming decades. The greatest increase in water deficit in the future is predicted for orchards (66%), vineyards, grasslands (100%) for the period of the end of the century (2081-2100) compared to the observed period. The results of these studies show the significant impact of climate change on the increase in the water needs for plant production.

*Keywords: water deficit, regions, climate changes, agricultural crops*

## **AGRICULTURAL ANIMAL PRODUCTION**



# ANALYSIS OF THE BREEDING OF LIPIZZANER HORSES AT THE STATE STUD FARM ĐAKOVO

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In the Republic of Croatia, the Lipizzan horse breed is a member of the protected breeds group. The State Stud Farm Đakovo carries out its breeding and selection work according to the breeding program of the Lipizzan breed in the Republic of Croatia. It is also a Lipizzan International Federation (LIF) member, following their breeding goals and principles. The State Stud Farm Đakovo currently breeds 7 sire lines of stallions, 11 mare families, and has 178 horses of the Lipizzan breed at two locations. Out of the total number of horses, mares are the most represented, followed by stallions, which makes up about 60% of the herd. Within the paper framework, the numerical quantity and the representation of lines and breeds of Lipizzan horses in the Đakovo State Stud Farm for the past 10 years (2012 - 2021) were analyzed. Analysis shows that the most represented sire lines are Maestoso, Siglavy and Neapolitano, followed by Conversano, Favory and Tulipan, while Pluto is the least represented sire line. By analysing the collected data on the number of mares, it is shown that the most represented mare families are Mara, Montenegro, and Mima, while the least represented is the mare family Krabbe. Observing the overall analysis of graphs and tables, according to the lines and families of stallions and mares, we can see that proper and high-quality breeding and selection planning is a very complex job, which requires a lot of effort, knowledge, and skills to preserve the representation and uniformity of lines to obtain the best possible quality offspring.

*Keywords: Lipizzaner, stud farm, Đakovo, numerical quantity*

**SEASONAL IMPACT OF HARVESTING ON THE FRESHNESS AND  
QUALITY OF EUROPEAN SEABASS MEAT (*Dicentrarchus labrax*  
Linnaeus, 1758)**

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The main goal and task of this research is to determine the most suitable and effective method of stunning fish during harvesting which affects the maintenance of freshness and quality of fresh market size seabass meat, and also to determine in which season during storage seabass maintains better quality and freshness of meat. Fish harvesting and stunning were performed twice on the fish farm in the Bay of Neum, during summer and winter period. The fish were stunned using two methods, stunning in ice/sea water mixture (group I) and stunning with anaesthetic (group II). Values of temperature and pH of fish meat and lactate in the blood were also recorded during the fieldwork, then each fish was transported to Sarajevo for further analysis. In the laboratory were conducted the following methods and analysis: measured length and weight for each fish; the chemical composition of fish meat was determined; physico-chemical characteristics of meat; values of the Quality Index Method (QIM) were determined. The results of temperature and pH of meat and content of lactate in the blood don't show statistically significant differences between two groups. QIM results don't show statistically significant differences between two groups within one season, but QIM results show statistically significant differences when comparing summer and winter period, and on the basis of these results it is concluded that seabass during winter storage maintains a longer period of time better quality and freshness than in summer period.

*Keywords: seabass, harvesting, stunning, quality, freshness*

# INFLUENCE OF STUNNING METHODS ON THE FRESHNESS OF RAINBOW TROUT MEAT (*Oncorhynchus mykiss* Walbaum, 1792)

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The method of fish harvesting, which largely causes stress in fish and a number of other changes in the postmortem phase, reflects on the freshness and quality of the fish meat. The main goal of this research is to determine the impact of stunning methods on the incidence of stress and other post-mortem processes that take place on the freshness and quality of fish meat during storage and conservation, since the fish, due to their chemical composition of meat and increased water content, is a perishable food. The research included a number of tasks: determining the chemical composition of fish meat, the implementation of sensory analysis (QIM) of fish meat, monitoring the degree of rigor mortis in fish, color shift tracking of fish meat and fillets, and a number of other non-core analysis and measurement. The trial included working with three different groups of stunned fish: by dull thud (hammer) in the head, stunning in ice/freshwater mixture and in CO<sub>2</sub> solution. From the third group (CO<sub>2</sub>) have been prepared fillets, 10 fresh and 10 vacuum. The pH measurements of fish and the concentration of lactate in the blood, after harvesting and stunning showed no statistically significant difference between the groups, which means that they have almost the same level of stress. The obtained values of rigor mortis during the analysis showed constant decline for both groups, and that there are no statistically significant differences between two fish groups. QIM grades showed no significant differences between groups.

*Keywords: meat freshness, stunning methods, rainbow trout, sensory analysis, quality*

# INFLUENCE OF THE HONEYBEE COLONY STRENGTH ON COLLECTING BEE VENOM BY ELECTRO STIMULATION METHOD

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Honey production has become lately more and more risky because of the frequent extreme climate changes. For this reason, it is necessary to develop production and other bee products. One of the bee products that deserves attention is certainly bee venom. Therefore, it is necessary to complete the knowledge on the possibilities of producing bee venom by a modern method of electro stimulation.

The study was conducted in Pale near Sarajevo in the village Podmjedenik. The experiment was carried out on a total of 6 honeybee colonies divided into three groups of two colonies. Collection of bee venom from worker bees was carried out by two electro stimulation devices.

The study showed statistically significant differences in bee venom weight between strong (0.3 mg), medium strong (0.2 mg) and between medium strong and weak (0.11 mg) honeybee colonies. A statistically significant difference was also found in the amount of collected bee venom in the morning (0.3 mg) compared to the amount collected in the afternoon (0.1 mg), as well as the amount in the early evening (0.2 mg) and afternoon hours. There were no statistically significant differences between the morning and the early evening hours in the amount of collected bee venom.

*Keywords: beekeeping, bee products, honeybee colony, bee venom, electro stimulation method*

# INNOVATIVE USING FACILITIES OF BEE VENOM

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**Abstract:** Venom production from honey bees has been done since ancient times. Techniques for obtaining bee venom have been developed in the process extending to the present day. With the new techniques applied, higher quality and purity medicinal bee venom can be obtained. Bee venom is a bee product with a colorless, sharp and bitter taste, raw banana odor, slightly acidic (pH 5.0-5.5) structure. It contains peptide, active amine and enzymes such as histamine, mellitin, apamin, MCD peptide, phospholipase-A, hyaluronidase. Bee venom, which is clear and acidic, dries in a short time and crystallizes. It means, liquidity form of bee venom transform of solid form with the interaction with air. Bee venom quality varies depending on the technical structure of the collection unit, the collection method, the nectar flow, the type and amount of pollen in the environment, the weather conditions, the age of the bees in the hive during milking and the strength of the colony. Harvested bee venom, taking into account the hygienic conditions, is preserved in its pure form in dark-colored small bottles sealed by waxing in a cool and shaded place. Pure bee venom is prepared in solution. If the bee venom is exposed to oxidation and moisture, a color change will occur and its medicinal quality will deteriorate. Improper processing methods can reduce the effectiveness of bee venom. Although it is a new sector in our country, it is observed that bee venom has a developing market trend in the world, and it is evaluated in the pharmaceutical industry, especially because it is used in Apitherapy. Creams, ointments and needle solutions are produced from bee venom, and these are used successfully in the treatment of neurodegenerative diseases such as Multiple Sclerosis, Alzheimer's and rheumatic diseases. The developed nano-bee venom production technology shows promising results in the treatment of geriatrics and cancer diseases. The problems of beekeepers in the production and marketing of bee venom can be overcome with the support and incentives to be provided by the state. The development of advanced bee venom innovative products will open up new market opportunities in the bee products industry.

*Keywords: honey bee, bee venom, innovation, marketing, health*

# THE PHYSICALLY EFFECTIVNES OF DIETRY FIBERS ON THE BLOOD METABOLIC PROFILE AND MILK PRODUCTION IN EARLY LACTATION COWS

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Abruptly increase in milk yield production in the early phase of lactation is the result of physiological (metabolic) changes caused by parturition (birth), due to the interaction between nutritional, energetic and hormonal changes. The impossibility of timely adaptation of cows to new metabolic (physiological) changes, leads them to a state of negative energy balance (NEB). Negative energy balance is a physiological phenomenon that accompanies production and health conditions and is most pronounced at highly productive cows during the transition period. The main reason for this is that their nutritive requirements increase significantly in the mentioned period. A crucial prerequisite for maintaining the stability of the ecosystem in the rumen is to provide a functional meal by maximization of dry matter intake (DMI) with appropriate physical and chemical properties. The importance of nutritional physical parameters (effectiveness) of meals is undoubtedly significant and is achieved through ensuring optimal bioecological conditions inside the rumen (rumination, salivation and buffering of contents).

The main goal of the conducted research is to evaluate the impact of particle size reduction on the physiological and production performance of cows in early lactation using the PSPS measurement method in order to alleviate the condition of NEB.

For this purpose, the nutritional status of the selected dairy cows was investigated, and the relevant parameters of blood metabolic profile and raw milk productivity and quality were examined.

A total of 30 multiples of Holstein-Friesian early lactation cows period with of average body weight (BW) were divided into three uniformed groups. The farm diet is based on an *ad libitum* complete mixed ration (TMR), based on corn silage. During the adaptation period (21 days), cows were given three different rations (A<sub>K</sub>, B<sub>1</sub>, and B<sub>2</sub>), which were almost identical in chemistry, but differed in their content of physically effective fibers (peNDF), distribution and particles sizes (6,9 ± 2,4; 5,5 ± 2,3, and 5,4 ± 2,3 mm). After adaptation period, sampling of blood and milk was carried out. The diet content of physically effective fibers was 23,5%, 21,8% and 20,0% at the 4,0 mm level and 17,5%, 14,0% and 12,4% at the 8,0 mm sieve level.

The general conclusion is that the conducted study on the effect of fiber effectiveness (peNDF) on test diets on blood parameters and milk production results showed no symptomatic effect due to the significant voluminousness of the diet. This only confirms previous research that the physical effectiveness of diets does not play a significant role and the justification for diets with a significant content of voluminous forages (> 50%) and the lower content of readily degradable carbohydrates.

*Keywords: physically effective fibers, blood metabolic profile, milk production, early lactation*

## NEW APPROACH IN PREPARTUM FEEDING OF DAIRY COWS

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Traditionally, feeding cows through dry period based on using two different diets with explanation that higher energy density in close-up period/diet (typically last three weeks before calving) increase dry matter intake, enable the rumen to adapt to the change in structure of diets in subsequent lactation and consequently improves cows' productivity in early lactation. But negative energy balance and rate of disorders (ketosis, metritis, retained placenta, etc.) are still highly pronounced in dairy cows' herds in early lactation. An alternative approach to minimize health disorders and maximize productivity in the subsequent lactation is dry cows feeding by high fibre diet (chopped straw) containing low or moderate (slightly below NRC recommendations) amount of energy. Some investigations indicate that using low energy diets in dry period resulting in better energy balances as well as in decreasing mobilization of body fat what is followed by lower NEFA and BHBA concentrations in blood. In recent time some authors promote strategy of reducing energy intake of cows in close-up period because it is difficult to avoid overfeeding dry cows in late dry period, especially on TMR. Several diverse ways of controlling energy consumption by cows in dry period, including the use of single low-energy ration, the restrictive feeding of cows with rations with moderate energy, feeding management of dry cow rations and their effect in metabolic profile, disorders, productivity, and cows' welfare will be reviewed in this paper.

*Keywords: cows, dry period, low energy, feeding strategy*

# **A STUDY OF SOME PRODUCTION CHARACTERISTICS OF DUPKA PRAMENKA LAMBS WITH THE AIM OF GENETIC CHARACTERIZATION OF THE BREED**

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Characterization of animal genetic resources includes all activities related to morphometric, production and genetic characterization. The aim of these work was production characterization of Dupska pramenka, as a valuable genetic resource of Bosnia and Herzegovina. In these paper, parameters of birth weight and development of lambs up to the age of 180 days were monitored. The lambs were raised in extensive feeding conditions. Birth weight was measured for a total of 116 lambs, 47 female and 69 male. The average birth weight of lambs is 3.81 kg, females 3.78 and males 3.83. The weight of the lambs was also recorded at the age of 30, 90 and 180 days old. A total of 30 lambs were monitored, 15 female and 15 male. The average weight of lambs was 10.43 kg (30 days), 20.95 kg (90 days) and 32.75 kg (180 days). Average daily gain of lambs was 221.00 g (0-30 days), 175.67 g (30-90 days) and 130.33 g (90-180 days). The total gain of lambs was 6.62 kg (0-30 days), 10.51 kg (30-90 days) and 11.70 kg (90-180 days). The results showed that there is a statistically significant correlation between some analyzed parameters.

*Keywords: autochthonous breed, characterization, weigh of lambs, daily and total gain, correlation*



# SUSTAINABLE PIG PRODUCTION IN BOSNIA AND HERZEGOVINA IN THE CONTEXT OF THE GREEN DEAL

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Pig farming in Bosnia and Herzegovina has a long tradition, which is a consequence of favorable natural conditions for the production of fodder in its northern parts (Posavina, Semberija), especially corn, as well as the eating habits of a part of the population whose consumption of pork is not limited by religious beliefs (Croatian and Serbian ethnic groups). As in the entire European Union, pig production in Bosnia and Herzegovina will have to undergo a transformation that will lead in the direction of sustainable management, which implies production that meets, in addition to economic, high ecological and social standards, which is in the spirit of good animal husbandry practices and health and welfare of animals. One of the directions of development certainly lies in breeding in the traditional way (breeding on straw and outdoors) and the use of autochthonous, resistant breeds of pigs for the production of products with added value, in order to make the most of the geographical and micro- and macroclimatic limitations that exist in some parts of Bosnia and Herzegovina. The aim of this thesis was to describe the possibilities of the development and transformation of pig farming in Bosnia and Herzegovina in the context of the European Green Deal, with an emphasis on the development of a circular form of management and adaptation to the common European agricultural policy.

*Keywords: pig farming, green plan, circular economy, deep litter breeding*

# THE VARIATIONS IN BIOCHEMICAL PARAMETERS IN BLOOD AND MILK DUE TO MASTITIS INDICATION AND COW'S PARITY

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With the aim of determination of the variability of biochemical parameters in blood plasma and milk samples depending on mastitis incidence and parity, blood and milk samples were taken from 75 high-yielding Holstein cows. The mastitis incidence was defined accordingly to daily lactose content and daily somatic cell count (test-day records). The obtained results indicate that the differences between the analysed biochemical parameters in blood plasma, due to mastitis score classes (accordingly to daily somatic cell count, SCC) were present and statistically significant ( $P < 0.05$ ) in some parameters (AST and GGT). Also, different patterns regarding mastitis scoring (DCL of SCC) were determined in some parameters. It was established that there was an increase in the levels of most of the analysed biochemical parameters in blood plasma and milk compared due to animal parity, except for TGC and Fe in blood plasma, and milk glucose where the concentrations were mostly lower in the following parity. Therefore, when using test-day records as an indicator for the mastitis risk and health status of an animal both scoring ways should be used, but in the case of mastitis risk or mastitis occurrence, other diagnostic methods (such as various mastitis tests) should be used for explicit detection.

*Keywords: biochemical parameters, test-day records, mastitis, Holstein*

# THE EFFECT OF METABOLIC DISORDER RISK ON THE VARIABILITY OF BIOCHEMICAL PARAMETERS IN COWS' BLOOD AND MILK REGARDING THE SAMPLING MONTH

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Aiming the determination the variability of biochemical parameters in blood plasma and milk of Holstein cows regarding the metabolic disorder risk (based on F/P ratio classes) separately for each sampling month (May, June, July), blood and milk were sampled from 75 high-yielding Holsteins reared on a dairy cattle farm in East Croatia. The metabolic disorder risk was defined concerning the daily fat/protein ratio (F/P) obtained from test-day records (F/P < 1.1 indicating acidosis risk; F/P in [1.1, 1.5], the normal status of an animal; F/P > 1.5, indicating ketosis risk).

The conducted analysis showed variability in the values of the biochemical parameters in both blood plasma and milk due to metabolic disorder risk and month of sampling. Accordingly, when different metabolites are used as an indicator of the metabolic disorder risk, correction for the systematic effects (stage of lactation and parity, sampling month) should be applied.

*Keywords: biochemical parameters, blood, milk, metabolic disorders, Holstein*

# CASE STUDIES ON THE USE OF BY-PRODUCTS FROM LIVESTOCK PRODUCTION AND PROCESSING OF ANIMAL PRODUCTS

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In the spirit of environmental protection, but also for the purpose of expanding the range of products of animal origin, this paper presents several examples in which the authors participated. Blood waste: In Macedonia, about 1000 tons of blood waste from industrial slaughterhouses flow into natural watercourses every year. On the one hand, this endangers the living world in these waters, and on the other hand, about 250 tons of high-quality proteins are lost. In the past, this waste was used for the production of blood meal as animal feed, but today, due to hygiene and health reasons, blood meal is no longer used as animal feed. But this by-product finds application as a fertilizer and for the production of adhesive mass that can be used in various industries. During the research dehemination and precipitation of blood proteins was approached with combinations of hydrogen peroxide, acetone and hydrochloric acid. Deproteinized lamb plasma: For decades, preparations obtained from deproteinized plasma from domestic animals. It has a wide application in tissue regeneration through rapid epithelization caused by increasing the speed of oxygenation during metabolic processes. The collection of lamb plasma and its deproteinization was done following the example of the well-known product Solcoseryl, which is obtained and commercialized from calf deproteinized plasma. For the preservation of the deproteinized plasma we have been used methyl and propyl paraben in appropriate ratio. Its composition and effects in cell culture were analyzed using reverse phase and thin layer chromatography. Unfortunately, the mechanisms of activity of this by-product, as well as for Solcoseryl, have not yet been determined. Whey: After the cheese production process, the whey, obtained as a by-product, is not valorised and remains in the waste water which is usually disposed of in natural watercourses. The aim of this study was to analyse the profile of whey proteins, as well as, to quantify the amount of those fractions using electrophoretic techniques. Predominantly,  $\beta$ -lactoglobulin was present in the analysed samples. The valorisation of the waste whey obtained in the white cheese production, and development of new product also contributes in the environment protection.

*Keywords: utilization, animal, by-products, blood waste, whey*

# A REVIEW OF USING ALGAE MEAL IN FEEDING OF FRESHWATER FISH SPECIES

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World aquaculture production of farmed aquatic animals grew on average at 5.3 percent per year in the period 2001–2018 (FAO, 2020). This trend imposes an increased demand for fishmeal and fish oil as the two major dietary ingredients used in compound aquafeeds. Global awareness of the need to manage aquatic ecosystems in a sustainable manner require the use of alternative protein sources in fish nutrition as a replacement for the mentioned marine ingredients in aquafeeds. Due to the high content of proteins, whose amino acid composition is similar to the amino acid composition of fishmeal proteins, as well as the content of vitamins, natural carotenoids, polyunsaturated fatty acids and other bioactive substances, the use of algae as feed is one of the options for the complete or partial replacement of fishmeal in fish nutrition. High yields of algal biomass per unit area, grow ability using non-potable water, low production cost and cultivation in an environment friendly way is crucial for the development and sustainability of aquaculture. This review highlights the effect of replacing fishmeal with blue-green algae *Spirulina platensis* in compound aquafeeds on the production performances of different freshwater fish species.

*Keywords: algae meal, fishmeal, freshwater fish, spirulina*

## CONTEMPORARY CATTLE BREEDING AND CLIMATE CHANGE- CHALLENGES AND RESPONSES

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According to the reports of the UN Food and Agriculture Organization (FAO), in anthropogenic emissions of greenhouse gases, animal husbandry participates with 14.5% (translated into CO<sub>2</sub> equivalent, about 7.1 Gt), which puts it in third place, behind the energy sector and industry. and in front of the traffic. On the other hand, climate changes significantly affect livestock production in terms of increasing the frequency of animal diseases (heat stress), changes in environmental factors (microclimatic conditions) and changes in nutritional conditions (impact on grassland composition). Reducing greenhouse gas emissions will only be possible by adopting good agricultural practices. That is why the researches carried out for this purpose are more numerous and more current in a large number of countries.

*Keywords: animal husbandry, climate change, heat stress, greenhouse gases*

# THE ASPECTS OF THE PROTECTION OF AQUATIC PRODUCTS WITH PDO LABEL: THE EXAMPLE OF THE NOVIGRAD MUSSEL

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Product quality is one of the main criteria influencing customers to choose a product. Moreover, research has shown that potential customers are willing to pay more for a product that offers them higher quality. Geographical indications allow producers to protect products that differ from others on the domestic and international market by some characteristics and properties, the way of processing and production. At the level of the European Union, three labels are distinguished: "protected designation of origin" - PDO, "protected geographical indication" - PGI and "traditional specialities" - TSG. The introduction of geographical indications encourages the rural economy and thus contributes to increasing farmers' income and retaining the population in remote areas and areas with difficult management conditions. In this way, the market value of the products of economic entities also increases. In this paper, using the example of the Novigrad mussel, the aspects of protecting aquatic products with the label protected designation of origin will be presented. The paper's purpose is to show how a positive change, such as obtaining a PDO label, can improve business and increase the quality and recognition of local products.

*Keywords: protected designation of origin (PDO), Aquatic products; Novigrad mussel*

# THE METABOLISM OF AMINO ACIDS

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Amino acids are the building blocks of proteins and have both structural and metabolic functions in humans and animals. Considering that amino acids play a crucial role in the existence of all living beings, the goal of this review was to analyze their metabolism. The main role in the metabolism of amino acids in humans and animals is played by the liver. Amino acids are divided into essential and non-essential. Amino acids that reach the blood are transported through cell membranes in various tissues, primarily via  $\text{Na}^+$  dependent cotransport systems. In most land animals, the ammonium ion is converted to urea. Excess  $\text{NH}_4^+$  is converted into urea. The process by which this takes place is called the urea cycle. Glutamate dehydrogenase is a key enzyme in the process because it generates free  $\text{NH}_4^+$  previously transferred to  $\alpha$ -ketoglutarate from many amino acids via transaminases. The amino acid arginine is synthesized as a product of the urea cycle. Fumarate, another product, links the urea cycle to the TCA cycle. The two input nitrogen atoms exit the cycle as urea, which the liver releases into the blood for disposal in the urine via the kidneys.

*Keywords: amino acids, metabolism, urea cycle*



# CHANGES IN THE COMPOSITION OF MARE'S MILK THROUGH THE ORDINAL NUMBER OF LACTATION

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Mare's milk was traditionally used by nomadic peoples in the regions of Central Asia, where its use goes back a long way in history. In recent decades, the mare's milk has been researched as a functional food throughout Europe. The production of the mare's milk is technologically demanding. Changes in the composition of the mare's milk have been poorly investigated in the raw material production. The aim of the work was to determine whether the composition of the Lipizzaner mare's milk change through the ordinal number of lactation. Mare's milk was collected from the 17 Lipizzaner mares bred at a stud farm in Slavonia (eastern Croatia). The Lipizzaner mares were classified into two groups: (A) younger (first to third lactation, n = 8) and (B) older (over third lactation, n = 8). The composition of milk fat, protein and lactose in the mare's milk in the 4th and 6th months of lactation was analysed. It was found that the amount of milk fat and lactose in the mare's milk of older mares increases, while the amount of protein decreases. The most important composition of mare's milk from the aspect of functional food in the human diet is precisely the protein composition. Therefore, it can be concluded that the milk of the younger mares is richer in protein and more acceptable as a functional food. The protein composition of mare's milk should be identified further.

*Keywords: mare's milk, functional food, composition*

# ORGANIC BEEF PRODUCTION AS A SUSTAINABLE SOLUTION FOR THE EU MARKET – A CASE STUDY OF THE REPUBLIC OF SERBIA

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The European Green Plan and its implementation strategies defined very demanding and ambitious goals for establishing the first "climate neutral continent" in the world. The implementation of the "Farm to Fork Strategy" (F2F) strategy will have an extremely immense effect on quantitative changes in the area of animal production (reduction in the number of animals and volume of production), increase in prices of beef and products of animal origin, the decrease in citizens' standards and increase in inflation. The appearance of the so-called "leakage effects" can be expected in NON-EU regions with the lowest population density (LU/ha), such as Serbia and the countries of the Western Balkans. At the same time, this effect represents a development opportunity for organizing extensive to semi-intensive production of organic beef based on the Cow-calf system - grass-fed beef production. In addition to the production of organic meat, these systems will contribute to improving biodiversity, maintaining the microbiological and pedological structure of the soil, regulating the carbon cycle, preventing erosion and forest fires, stopping population migration from villages to cities, reducing the use of artificial fertilizers and biocides, etc.

*Keywords: organic production, beef, sustainable, EU market*

# INFLUENCE OF SEASON ON SHEEP UTERINE MORPHOMETRY

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Domestic animals are of great importance for humans, due to various animal products that are irreplaceable in food and clothing. Owing to the development of the digestive organs and the richness in the microflora of the rumen, some types of domestic animals (ruminants) are able to refine and transform various types of plant nutrients and food by-products into high-value animal products, such as meat, milk and wool. Sheep breeding in our country is significantly less important than cattle breeding, meaning that the sheep production is not satisfactory. Numerous factors have caused such situation, and it is clear that more serious work must be done on the development of sheep breeding, since Bosnia and Herzegovina has extremely favorable conditions for raising sheep.

Successful sheep production depends mostly on good reproduction, and reproduction depends primarily on the normal and proper development of sexual organs. Numerous factors influence development of sexual organs, including genetic (species and breed of domestic animals) and paragenetic, the most important of which are handling and care, nutrition, breeding season, etc. The influence of the annual breeding season on the establishment of sexual activity in domestic animals is well-known, and this is especially pronounced in sheep. The aim of this work was to determine whether the season influences development of the sexual organs of sheep. The research was conducted on uteri of sacrificed animals taken at the slaughterhouse. The following were examined and measured: 30 uteri of prepubertal sheep (15 in the autumn-winter season and 15 in the spring-summer season) and 30 ewes (15 in the autumn-winter season and 15 in the spring-summer season). The following morphometric parameters were measured: the mass of the uterus with ligaments, the mass of the preserved uterus, the mass of the ovaries, the length of uterine horns, the length and width of the uterus, the length of the fallopian tubes.

The obtained results indicate that the examined season influences the dynamics of the development of sexual organs in sheep. This is especially pronounced in ewe hoggs.

*Keywords: sheep, development, parameters, uterus*

## **INFLUENCE OF PROLACTIN UDDER DEVELOPMENT IN PREPUBERTAL SHEEP**

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One of the main agricultural activities in Bosnia and Herzegovina is the production of milk, both from beef and sheep. According to the available data, the number of sheep in the world has exceeded one billion (1.08 billion), and in B&H it is slightly higher than one million (1,021,000 heads). About 8.3 million tons of sheep's milk is produced in the world. The structure and function of the mammary gland is of crucial importance for milk production. The development of the mammary gland is influenced by a number of factors. One of the most important is the action of hormones. A crucial role for the development of the mammary gland is played by prolactin, which simultaneously affects the initiation and maintenance of lactation. Based on the set experiments, exogenous application of prolactin, its influence on the development of the udder in prepubertal females and the histological picture of the udder in untreated and treated udders were established. Treatment with prolactin was carried out by intramuscular injections in a dose of 5 IU, three times during 60 days (every 20 days). One group (36) was treated in the period of early spring (April-May), and the other (36) in the period of early autumn (September-October). Female lambs were on average 250 days old (8.5 months) at the time of treatment. Sixty days after the treatment, the animals were sacrificed and the complete udders with ligaments were taken, which were then measured. The following measurements were taken: mass of the complete udder, mass of the udder without skin and ligaments, length of the udder, width of the udder and diagonal length. The results obtained during both seasons showed that prolactin had an effect on the development of the mammary gland in sheep.

*Keywords: sheep, hormone, season, development, udder*

## **AGRICULTURAL ECONOMICS**

# GREEN AGENDA AS A NEW PARADIGM OF AGRICULTURE IN BOSNIA AND HERZEGOVINA

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By signing the Sofia Declaration on the Green Agenda for the Western Balkans, the leaders of the countries, including Bosnia and Herzegovina, committed themselves to the implementation of five basic courses of action established by the action plan, which include: 1) decarbonization, 2) circular economy, 3) depollution, 4) sustainable agriculture and 5) protection of nature and biodiversity. This commitment means that the creation and implementation of policies should be strongly marked by an environmental approach, not only because of EU requirements but also because of the practical importance for overall sustainable development. Because of this, support measures in an increasing number of countries imply the application of measures such as making direct payments subject to the fulfilment of the so-called cross-compliance or special payments for agroecological practices, sustainable land management, etc. However, the measures included in the Green Agenda in Bosnia and Herzegovina are applied very modestly, which will be presented in this paper for the period 2018-2021. Practically, measures to support organic production, soil fertility control, and protection of genetic resources are the only ones on track with the Green Deal goals. It is expected that the new strategic documents in the field of agriculture will take into account the objectives of the CAP, and thus the Green Deal, and will bring the agriculture policy of BiH closer to the policy of the EU, for which BiH decided a long time ago. The paper provides an overview of the measures for the period 2018-2021, which in the current agricultural policy of BiH are following the principles of the Green Agenda.

*Keywords: Green Agenda, measures, support, Bosnia and Herzegovina*

# IMPACT OF THE ECONOMIC CRISIS TO THE APPLES PRODUCTION PRICE IN THE REPUBLIC OF NORTH MACEDONIA

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Apple production is the main type of production in the fruit sector in the Republic of North Macedonia, sharing 56% of the total fruit production. Apple plantations in 2020 amounts 5,900 ha, taking up 34.5% of the total area of orchards (17,095 ha). The orchards production is occupation of around 35,549 rural households, out of which only 82 are business entities. Most of the orchard households are apple growers. As a result of the Covid-19 pandemic crisis and Ukraine war, the world is facing an economic crisis followed by agriculture markets shocks and food insecurity. As a consequence, the agriculture producers faced a situation of imminent price raise of raw materials used in production. In this manner, the main goal of this paper is to evaluate the impact of the global economic crisis on the apple production cost and production price. The Institute of Agriculture has performed normative calculation of the production costs and production price of apples in years 2020 & 2021. These calculations are used as reference years in order to perform comparative analysis with production costs in 2022 based on normative calculation in line with the actual (present) prices of inputs, assets and investments in apple production in 2022. The production costs calculation is based on calculation of variable and fixed costs of grape production, including the investment cost for new apple plantations establishment. The data for the prices of inputs, assets and other costs are collected by commercial companies, suppliers of raw materials and farmers. The results show that the economic crisis has a large negative economic impact on the apple production as the production costs and production price of apples in 2022 have increased by 25% compared with average production price of apples in 2020 & 2021 which was in average 0.18 EUR/kg. Even that it is predicted that the selling price of apple will increase, still the increase of production costs will have negative socio-economic impact of apple producers and their households. The policy makers should react to this trend and respond to the emerging situation with adequate public policies for development and support of this important sector for the Macedonian agriculture.

*Keywords: agriculture economy, socio-economic, economic crisis, apples, production price, cost of production*

# INTERNATIONAL MARKETS IMPACT ON WHEAT PRICES IN THE REPUBLIC OF NORTH MACEDONIA

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The production of wheat, as one of the elementary and strategic nutrition crops, in North Macedonia is insufficient and cannot meet the national demands, which results with negative trade balance with import of 74,937 tons of wheat valued at 17.9 million EUR. The main goal of this paper is to analyse the influence of international markets on wheat prices in the Republic of North Macedonia. Data on the purchase price of wheat have been analysed using statistical methods and models from December 2009 to December 2021. A total of 145 months times series with data on the purchase price of wheat for Macedonia, the EU, Bulgaria, Romania and Serbia have been analysed and compared. The Pearson correlation coefficient shows a relatively high relationship and mutual dependence of purchase prices in Macedonia, compared to prices in the EU, Bulgaria, Romania and Serbia (over 65%). The purchase prices of wheat in Macedonia have the highest relationship and mutual dependence with the price movement in Serbia (0.78), and the lowest with the price movement in the EU (0.66). Estimating the lag length of autoregressive process (AIC, BIC, FPE and HQIC tests), on average shows 2 lags (months) later time reaction of the wheat prices in Macedonia with compared countries. The forecasting model (Granger causality test) shows that wheat prices time series can be convenient in forecasting wheat prices in Macedonia. The model from October 2021, clearly shows the impact of food economic crisis and unexpected, immediate rise of wheat prices as result of the post Covid-19 and Ukraine war crisis. This research can provide significant information for the wheat price trends, forecasting and markets shock, as management and decision making tools for producers, traders and processors, but also for the policy makers.

*Keywords: international markets, agri-food prices, wheat prices, forecasting*



# **AGRO-ECOLOGICAL ZONING AS THE BASIS FOR PLANNING AGRICULTURAL PRODUCTION IN THE AREA OF THE CITY OF TUZLA**

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In addition to economic and social circumstances, soil properties and their production potential are the main initiator of agricultural production and its economic success. In planning of agricultural production in a certain area, it should be considered that certain agricultural crops on different soil types thrive differently in the given agro-ecological conditions. The main goal of this research is to show the natural potential of certain soil types and subtypes in the City of Tuzla, to group them into agroecological zones, and to perform spatial distribution and optimization of production based on the characteristics of individual soil types and requirements of individual crops, and possible potential planning from the point of view of socio-economic and social aspect, as well as the needs of the City of Tuzla population. In this research, the FAO Agro-Ecological Zoning (AEZ) methodology was applied, with a focus on soil parameters. Considering that the soil parameters (pH, texture, humus) and the terrain slope, there were identified specific restrictions for the cultivation of agricultural crops. Combining the up mentioned parameters were determined new benefits for the cultivation of chokeberry and blueberry which were shown on the maps. The given results could be used for agricultural production planning. By using AEZ results, it is possible to achieve up to 10 times higher production than the current one, which would meet domestic needs, but also achieve exports. This would ensure the economic stability of agricultural farms, but also improve the general socio-economic situation.

*Keywords: agro-ecological zoning, agricultural production, planning, sustainability, soil parameters*

# CONSUMER PURCHASING BEHAVIOR TOWARDS THE DAIRY PRODUCTS IN BOSNIA AND HERZEGOVINA

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The analysis of consumer behaviour is an important part of marketing and should be the basis for defining and building the overall market strategy and overall business policy, but also the basis for building competitive advantages that will enable companies to be recognizable on the market and achieve long-term success.

Getting to know consumer habits is very important. They change over time. The more knowledge we have about the current and expected habits of buying individual products, the more successfully we can adapt the entire marketing program and thus make the marketing system as a whole more efficient. Precisely for this reason, in this paper, the habits of consumers when purchasing dairy products related to the time and place of consumption, places of purchase, frequency of purchase and frequency of consumption were investigated. Also, in this paper, the level of sophistication of consumers of dairy products was investigated, also the level of involvement, which is determined by the level of information, considering that consumers who express a high level of involvement are more inclined to seek information about the product they are interested in. All this affects the level of loyalty, so consumer loyalty is also tested. The consumer survey was conducted in the territory of Bosnia and Herzegovina. 250 respondents participated in the research. The results obtained in this paper will contribute to a better understanding of the consumers buying habits in Bosnia and Herzegovina.

*Keywords: consumer behaviour, dairy products, involvement*

# DECENTRALIZATION OF AUTHORITY, POSSIBILITIES AND OBSTACLES TO ATTRACTING INVESTMENTS IN AGRICULTURAL PRODUCTION IN THE EXAMPLE OF SERBIA, BOSNIA AND HERZEGOVINA AND CROATIA

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The goal of this research was, based on the actual jurisdiction of local governments, assigned after the decentralization of the central government, to analyze the possible assumptions that affect the attraction of investments in agricultural production and to point out the current weaknesses of individual segments of economic policy.

The paper analyzes individual indicators that, according to the Doing business list, make it easier to start a business using an analytical method. The research was conducted for Serbia, Bosnia and Herzegovina and Croatia for the period 2019 and 2020. Furthermore, the focus of the research is on those indicators that are the responsibility of local politics, and which can contribute to a better competitive position in the market.

The general conclusion from the presented data is that there is room for reforms and that at all levels of government, and especially at the local level, additional measures must be taken to improve and facilitate business conditions. The analyzed indicators are very significant because they show the willingness of local governments to adapt to market trends. Furthermore, local plans, studies and strategies must facilitate procedures that would prioritize the development and improvement of agricultural production.

*Keywords: decentralization, spatial plan, local policy, investment policy, investments*

# **IMPORTANCE OF DEFINING MARKETING MIX INSTRUMENTS FOR BLUEBERRY EXPORT IN SERBIA QUALITY, MECHANIZATION, PRICE, DISTRIBUTION, PROMOTION**

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In today's world, the demand for fresh, healthy and organic food has increased drastically. The COVID-19 pandemic, on the one hand, caused problems for supply chains, while, on the other hand, it enabled and created opportunities for the promotion and placement of domestic goods. Poland is the largest blueberry producer in Europe. How much interest there is in blueberry planting in Poland is also shown by the fact that apple producers are increasingly replacing their old seedlings with young blueberry seedlings. As for Serbia, there is an increased demand for blueberries, especially on the European Union market, but also on the world market, where it has increased by 12% over the last 10 years. This trend of growth will continue, but experts warn that the growth of production will reach the expected growth of consumption, which will inevitably cause a drop in the price of blueberries on the market in the next 5 years. In Serbia, blueberries are mostly grown in forest areas at the foot of hills on "peat" land, where there are orchards, meadows and pastures. The most famous plantations are located in the vicinity of Lajkovac, but also in the whole of Šumadija, where the altitude is in the range of 120-760 meters, i.e. in the vicinity of Zlatibor. The greatest progress was made in the vicinity of Šabac, where quality standards were accepted, which opened up the Dutch export market, where the highest price was achieved. According to data from 2021, the total number of blueberries planted in Serbia was 2,500 hectares. The quality of blueberries is also significantly affected by the proper use of agricultural machinery, primarily for irrigation and weed protection, as well as for picking fruits. In addition, the pandemic accelerated the process of promotion and international export, where existing producers found their way to consumers through internet sales, which for a long period of time recorded a noticeable growth trend. When creating a blueberry export marketing strategy, it is important to offer a product with the required level of quality, so that the price is acceptable for both exporters and foreign buyers. In addition, it is necessary to select adequate distribution channels and promotional activities. The goal of our work is to indicate the importance of marketing instruments (quality, mechanization, price, distribution, promotion) in the export of blueberries in Serbia. In addition to the introduction, the paper consists of three parts. The first part of the paper analyzes the basic instruments of the marketing mix. The second part of the paper indicates the importance of the process of promotion and international export, while the third part assesses the state of blueberry exports in the Republic of Serbia. At the end, a conclusion is given.

*Keywords: blueberry, marketing mix, export, quality, mechanization, price, distribution, promotion*

## **LOCAL AND SUSTAINABLE FOOD CONSUMPTION IN B&H – MISSING OR LONG-AWAITED OPPORTUNITY?**

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The food system nowadays is facing multiple challenges, many associated with unsustainable consumption practices that resulted in many negative environmental, social, and economic consequences. The rise of new, modern, alternative food value chains, among them, local (short) food supply chains provides an answer. This paper provides an understanding of lifestyle patterns that influence sustainable (local) food consumption among consumers in Bosnia and Herzegovina. The reduced form of food-related lifestyle (FRL) and theory of planned behaviour (TPB) were used to understand and map consumer food-related attitudes and behaviours. An online questionnaire was developed and distributed using available social media. Results of the study could be used by many actors along the food value chain, agricultural producers, processors, and distributors to align production methods with consumer requirements, develop and adjust marketing strategies, and focus on high-value-added products and the development of extended customer satisfaction. Based on study results policy-makers would receive inputs for the preparation and implementation of new policies targeting and stimulating the development of alternative and short food supply chains, and/or consumption of local products which is a necessary condition for the development of a circular economy.

*Keywords: local food, sustainable food, food related lifestyle, theory of planned behaviour, consumer behaviour*

# **CREATION OF A MARKETING STRATEGY FOR THE EXPORT OF RASPBERRIES WITH SPECIAL REFERENCE TO THE IMPORTANCE OF MECHANIZATION - A CASE STUDY FOR SERBIA**

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Among berry fruit species, raspberry has occupied the most important place in production in Serbia for over two decades. It is extremely profitable for production and is characterized by numerous nutritious, protective, dietary, medicinal and antioxidant properties. Although Serbia is considered to be one of the largest exporters of raspberries in the world, there is an evident trend of declining exports in the current year compared to the previous one (as much as 33%). The problem is the lack of manpower in the harvesting process, where for larger plots profitability is achieved exclusively by the use of agricultural harvesting machines, i.e. raspberry harvesters. However, despite this, this year's export revenues increased compared to 2021, and the reason for this is the higher purchase price, which reached a record. However, due to the drop in sales in supermarkets and less demand in the fruit processing industry throughout Europe (primarily in Germany as our largest exporter), there was a significant drop in demand for Serbian raspberries, which caused a drop in price. The downward trend is still expected, primarily due to a significant drop in demand from the USA, as well as the already mentioned drop in demand in Western Europe. Despite the increase in raspberry sales in newer markets (Argentina and Saudi Arabia), the amount exported is still small and has little effect on the overall increase in exports. We should not forget the fact that the demand for the group of products to which raspberries belong is extremely elastic and that consumers in Serbia and around the world prefer to decide for staple foods. Given that the criteria of quality and size of fruit from Serbia have been increasing over the years, a critical factor in the success of raspberry exports is linked to continuous efforts in the area of raising the level of quality, yield and modern mechanization in raspberry harvesting and transport. By taking adequate care of the product, without neglecting the other instruments of the marketing mix, over time one can look for a chance to increase raspberry exports.

*Keywords: marketing strategy, export, raspberries, mechanization, Serbia*

# **AGRICULTURE AS A POTENTIAL OF THE ECONOMY DEVELOPMENT IN KOSOVO**

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The purpose of this study is to analyze and evaluate the agriculture potential in the development of the economy of Kosovo. The study is based on two sources, primary and secondary, within the primary sources field interviews were conducted in seven (7) regions of Kosovo, while within the secondary sources are made in desk research. The interviews were conducted about the potential and role of agriculture and the management of agricultural projects, the competitiveness of farms and their products. Also included in the research are the activities that should be prioritized in the fastest development of Kosovo's economy. The results in this scientific paper show that Kosovo has the potential to develop sustainable and competitive agriculture that leads to economic development. In this study, we conclude that the farms are small and very scattered, based on field surveys but also on various reports and studies where it is emphasized that the average of agricultural farms is 2.36 ha of agricultural land, 2.01 ha of cultivated land, 1.30 and 0.70 ha are meadows, pastures and wasteland, while the average of the plots are 3.20 ha.

*Keywords: farm size, survey, sustainable development, economy of Kosovo*

# UNLEASHING THE POWER OF RURAL-URBAN CONTINUUM - APPLICATION OF S3 POLICY APPROACH

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The multifunctional, complex and heterogeneous rural areas are facing numerous challenges, among which the most important include climate change, depopulation, migrations, poor infrastructure, and the lack of attractive working places. Such a situation calls for transformative change in both rural and urban areas, where innovations and transformation of agri-food system towards technology-native sectors, is one of the priorities. Deep and ongoing socioeconomic transformation driven by Industry 4.0 develops a digital twin of physical reality making irrelevant the location or place where we work, teach, learn, produce or sell. So, a division between rural and urban areas cannot be formed on proximity from/to the center as a reflection of marginalization, or growing distance from the source of knowledge, capital, infrastructure, and socio-economic power that shapes the quality of life for the communities. This deep transformation brings closer urban and rural areas building one integral space, the rural-urban continuum.

It calls for change in governance and public policies toward a policy approach called Smart specialization strategy (S3) that combines industrial, educational, and innovation policies, which among many, already achieving positive results in many countries. This conceptual paper, with the application of a bibliometric tool (VOSviewer) and narrative literature review aimed to (i) raise awareness of the rural-urban continuum concept as a simplified, yet holistic version of reality that facilitates decision-making process and articulate complex challenges, and (ii) draw attention to the innovative approach to territorial development - Smart specialization strategy as a tool to recognize economic, innovative and scientific potential and build a coalition of different stakeholders able to realize new and innovative solutions with a strong focus on sustainability, inclusiveness and citizens well-being in a new Cyber-Physical–Social Environment.

This review outlines that a new environment, urban-rural continuum requires innovative development solutions and policies that are based on the enrichment of social capital and resilient social fabrics that enables rapid, coordinated action of all stakeholders creating “agents of change” while building space for economic, political and social activism necessary for co-creation and sharing knowledge and ideas to build a path towards sustainable future.

*Keywords: smart specialization strategy, Industry 4.0, rural development, conceptual paper, bibliometric analysis*



**INNOVATIVE TECHNOLOGIES IN AGRICULTURE AND FOOD  
INDUSTRY**

# APPLICATION OF AGRICULTURAL MACHINERY IN BERRY HARVESTING

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Modern fruit growing involves the intensive use of agricultural machinery in the harvesting of all types of fruit, including berries. The reasons are numerous, but the primary one can be singled out is the increased demand for larger quantities of berries on the market, larger areas under planting, but also the lack of manpower to do the manual picking. In practice, different types of harvesting machines are encountered, but they are mainly classified as Over-The-Row Harvester and Side-Row Harvester type machines. Innovative solutions are reflected in the application of pickers that use air picking technology. Robotic strawberry harvesting machines are used around the world, which take into account the mechanical impact on the fruit and the degree of its damage. Although the use of mechanization in harvesting is justified from an economic point of view, there are also its negative effects on the quality of harvested fruits, the soil under planting and the environment.

*Keywords: agricultural machines, harvesting, berries*

## NANOTOXICOLOGY IN FOOD TECHNOLOGY

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In addition to the benefits of nanotechnology, a number of experts and researchers have raised concerns about the potential toxicity of nano-food. The study of interactions between nanostructures and biological systems is the focus of the specialized field of toxicology known as nanotoxicology, which also emphasizes the relationship between the physicochemical characteristics of nanoparticles and their toxicological consequences. For instance, we are aware of the toxicological consequences of persistent exposure to heavy metals, asbestos, silicate surfaces, or autoimmune responses caused by silicate surfaces (causing genotoxicity, neurodegenerative problems and liver disease). Scientists and researchers believed that new nanomaterials might exhibit some toxicological effects similar to those previously mentioned because of how similar these elements are to nanostructures (such as carbon nanotubes with asbestos, silicon nanomaterials with silicon dust, and quantum dots containing heavy metals). Increasing concern is becoming legitimate, because of as many scientific papers have proven that nanoparticles at the nanometer level show different properties compared to particles in the macro and micro dimensions. Well, because due to their size, nanoparticles have the ability to enter by ingestion, inhalation, transdermally or intravenously into cells, tissues and other organs, can cause adverse effects on human health, such as brain diseases, heart diseases, gastrointestinal tract disease, lungs disease, lymphatic and circulatory systems disease.

*Keywords: nanotoxicology, nano-food, toxicity of nanoparticles, effects on human health*

# SPATIO-TEMPORAL ANALYSIS OF AGRICULTURAL LANDSCAPE DYNAMICS IN EFELER, AYDIN / TURKEY USING MOVING WINDOW ANALYSIS

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With the pressure of urbanization, many agricultural lands have been converted to urban or other built-up uses and is under intense threat from urban development. This situation is experienced intensely in Aydın province, which is located in the Aegean Region of Turkey and whose economy is basically based on agriculture. Particularly, agricultural lands in Efeler district of Aydın province are extremely vulnerable to urbanization and have made up a great amount of agricultural land loss in the region. In this context, the aim of the study is to examine the change in agricultural areas between the years of 1990-2019 in Aydın province Efeler district with moving window analysis. The study used Landsat 5TM, Landsat 8 OLI satellite images, Digital Elevation Model (DEM) and NDVI maps for the delineation of Land Use / Land Cover (LULC) maps. LULC maps were created using an object-based classification method (supervised Classification based on the Nearest Neighborhood algorithm) in eCognition Developer 64 (7 broad LULC types). In order to analyse spatio-temporal changes in agricultural areas, the study utilised from the moving window analysis in FRAGSTATS 4.2 with class level metrics. Our results revealed that even though the overall area of agricultural lands were increased in Efeler district, urban development and sprawl effected the pattern of those lands with more patches and less connectivity among patches.

*Keywords: Aydın, Efeler district, FRAGSTATS, moving window analysis, spatio-temporal change*

# EFFECTS OF ELECTROSPINNING PARAMETERS ON PRODUCTION OF POLY(VINYL ALCOHOL)/PULLULAN BLEND NANOFIBRES

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The electrospinning technique is a simple and an effective approach to produce nanofibers. Due to these properties, this technique has attracted much interest among academic and industrial scientists. The electrospun nanofibers have various applications such as biomedical engineering, filtration, food packaging, protective clothing, catalysis reactions, and sensors. In this study the electrospun fibers of poly (vinyl alcohol) (PVA)/ pullulan (PULL) blend are produced from their solution in water under ambient conditions. Polymer solutions with 12 wt.% total polymer concentration and 80:20 of blend ratios were used to investigate the effect of some parameters such as tip-to-collector distance (TCD), applied voltage and flow rate on the morphologies and properties of PVA/PULL nanofibres. These electrospinning conditions were adjusted to produce uniform and bead-free nanofibres. The produced nanofibers were characterized by scanning electron microscopy (SEM) and the average diameters of the fibers were measured using ImageJ software. In the experiments, homogeneous and bead-free nanofibers were produced under electrospinning conditions at 20 kV voltage, 10 cm distances between the nozzle and the collector, and a flow rate of 5  $\mu$ l/m. This study is a part of preliminary experiments of PVA/PULL nanofibers produced to be used as a packaging material in food. This study was supported by the Manisa Celal Bayar University Scientific Research Projects Coordination Unit. Project Number: 2021-095.

*Keywords: nanofiber, electrospinning, poly(vinyl alcohol), pullulan*

# ANALYSIS OF AGRICULTURAL LANDSCAPE CHANGE USING LANDSCAPE METRICS: THE CASE OF MENEMEN, IZMIR

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Today, the change in land use/land cover (LU/LC) caused by urban sprawl affect natural and cultural landscapes. Especially, it is necessary to determine the temporal and spatial changes of agricultural areas, which constitute an important part of the cultural landscape with their ecological, economic and social values, in order to ensure the sustainability of the ecological balance in the agricultural landscape structure. In this context, the aim of this study is to examine the change in the Menemen district of Izmir, where the agricultural landscape is dominant, over a 30-year period. In the study, LU/LC maps obtained as a result of pixel-based classification and screen digitization methods of Landsat 5 TM of 1990 and Landsat 8 OLI satellite images of 2020 were used to determine the change in agricultural landscape structure. Based on the CORINE Land Cover Classification, the produced LU/LC maps were classified under eight heading: Artificial Surfaces, Roads, Agricultural Areas, Forests, Shrubs River, Wetlands and Water Bodies. To analyse the agricultural landscape structure of the district, a total of seven landscape metrics were used, Class Area (CA), Percentage of Landscape (PLAND), Number of Patches (NP), Mean Patch Area (AREA\_MN), Area Weighted Mean Patch Area (AREA\_AM), Mean Euclidean Nearest Neighbor Distance (ENN\_MN), and Connectance Index (CONNECT). As a result of the study, depending on urban sprawl in the 30-year period, agricultural landscape is transformed into impermeable areas such as artificial surfaces and transport units. Accordingly, it was determined that the pattern size decreased and the landscape structure changed.

*Keywords: spatio-temporal change, agricultural landscape, FRAGSTATS, land use/land cover*

# SNP2STR: A USER FRIENDLY SOFTWARE FOR CREATING INPUT FILES FOR STRUCTURE SOFTWARE FROM SNP DATA

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Structure is a software package that uses molecular data from multiple loci to analyze population structure. In order to analyze Single Nucleotide Polymorphism (SNP) data in the Structure software, a specific input file needs to be created. However, since SNP studies often rely on the analyses of thousands of loci, the input files are usually too large to be edited manually. To tackle this matter, a number of different software and functions have been developed. However, at least in the case of plant data, some of them either failed to compute or delivered inaccurate input files. In order to address this issue, a new software solution has been developed. The newly developed SNP2STR software arranges the SNP data in the input format required for Structure software. This means that it creates a file with the first row that contains marker names (which is also optional), and creates two rows with different dataset according to the corresponding marker for each individual. Input files the software requires are .map and .ped which are usually used as input files for or can be generated in PLINK from .vcf file.

*Keywords: SNP, molecular data, PLINK, Structure software*

# PRODUCTION OF BIOGAS FROM ORGANIC WASTE FROM SOYBEAN CLEANING

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Soy is mainly used as a base for the production of food. The first step in the technological processing of soybeans is mechanical cleaning from impurities. Cleaning process creates waste with great energy potential. In 2021 228.000 tons of soybeans were produced in the Croatia, and according to data for 2022 from one of the buyers of soybeans in the Croatia, the average amount of impurities was 6,79%. Taking into account the stated percentage of impurities, we can conclude that in 2021 about 15.481 tons of waste from soybean were generated. By using the mentioned waste as a raw material in the anaerobic digestion process, a significant amount of biogas can be produced, which can be used as fuel for energy production. Laboratory tests have shown that one ton of soybean cleaning waste can produce about 513,81 m<sup>3</sup> of biogas, of which about 57,2% is CH<sub>4</sub>. We calculate that the specified amount of waste is sufficient for the production of 19.000 MWh of electrical energy per year. With the average consumption of electrical energy in households in 2021 in Croatia of 2.728 kWh, the total electrical energy produced from soybean waste is sufficient to meet the annual electrical energy needs of 6,980 households.

*Keywords: soybean, anaerobic digestion, organic waste, energy*



# DEVELOPING SIMPLE AND CHEAP MEASUREMENT SYSTEM AND LOGGING BOX FOR OBTAINING CULTIVATOR LEGS DRAFT FORCE USING ARDUINO BOARD

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Measurement of draft force in agricultural machines is important for design and improving tillage performance. Smart agricultural machines demand new sensor and measurement systems. A cheap and affordable measurement system is important for competition.

In this work, an Arduino based system to measure the draft resistance of an individual cultivator leg was developed. Two types of cultivator legs were used; S-type spring leg and rigid leg. An extended octagonal ring was used as the sensor. The strength and strain analyses of the ring were performed by a finite element software. The locations of the strain-gauges were selected so that the load-cell amplifier gives high output voltages. The total cost of the measuring system for obtaining leg's draft force was approximately 180 USD. This is very low value when compare the professional measuring system prices.

The measuring system outputs were calibrated with the digital force gauge meter. R-squared value was observed as 0.9999. The Designed and produced measuring system was tested on the tractor in the field successfully. Different tractor speeds, tillage depths and cultivator legs were considered. The measurement values recorded in the SD card with the measurement system were transferred to the computer and analysed. It was observed that when the tillage depth and the tractor speed increase then the draft force values also increase.

As a result of this study, an Arduino-based low-cost draft force measurement system for obtaining draft force of soil tillage machine has been designed, produced, and used successfully.

*Keywords: draft force, cultivator's leg, octagonal ring, Arduino, measurement*

# ENCAPSULATION AND ITS POSSIBLE APPLICATION IN THE TECHNOLOGY OF READY-MADE FOOD – A REVIEW

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Encapsulation is the process of entrapping or packaging of some active compound into the structure of a coating or carrier material. The product of encapsulation is a capsule. Each capsule contains two main materials: 1) the carrier, matrix, or coating material, and 2) the active compound or enkapsulant. The main purpose of encapsulation is to protect and/or control the release of active compounds. The common coating materials are different macromolecular hydrocolloids (polysaccharides or proteins) like starch, cellulose, alginate, carrageenan, casein, gelatin, etc.

Encapsulation is widely used in the pharmaceutical industry. Nowadays, encapsulation has an increasing number of applications in food technology, mostly in bakery products, functional foods and beverages.

Encapsulation in ready-made and ready-to-eat foods is still poorly researched. But in recent times, there are many examples of encapsulation in ready-made food technology for both experimental and practical purposes.

The common encapsulated compounds used in ready-made food are: essential oils, vitamins, fish oil, probiotics, folic acid, beta-carotene, etc. Nano- and microcapsules with encapsulated active compounds can be added to improve the nutritional or sensory quality and shelf life of different kinds of ready-made foods, like instant soups, mayonnaise, sauces, dressings, meat or fish burgers, tortillas, spicy and seasoning powders and dried mixtures for different dishes.

There are two main ways of encapsulation and its utilization in ready-made and ready-to-eat foods: 1) addition of prepared micro- or nanocapsules with encapsulated active substance to a ready-made food product during its production; and 2) production of macrocapsules with encapsulated liquid ready-to-eat food, such as soy sauce, salad dressings, other kinds of sauces, and spicy extracts.

*Keywords: encapsulation, active compound protection, soups, sauces, ready-made/ready-to-eat foods*