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VII INTERNATIONAL CONGRESS VII

ENGINEERING, ENVIRONMENT AND MATERIALS IN PROCESS INDUSTRY EEM2021

BOOK OF ABSTRACTS

JAHORINA
MARCH 17-19, 2021

REPUBLIC OF SRPSKA
BOSNIA AND HERZEGOVINA

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UNDER THE AUSPICES OF

MINISTRY OF SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT, HIGHER EDUCATION AND INFORMATION SOCIETY OF THE REPUBLIC OF SRPSKA
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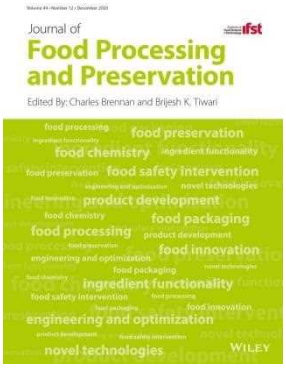

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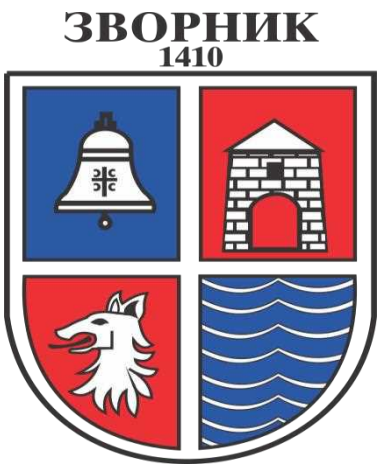

The municipality of Zvornik covers the surface area of 387 square kilometers in the north-eastern part of the Republic of Srpska in Bosnia and Herzegovina, an area with the population of 65 000. The town of Zvornik is situated on the eastern slopes of the mountain of Majevica, at 146 m above sea level. It is surrounded by the municipalities of Bratunac, Milići, Vlasenica (to the south), Šekovići, Osmaci, Sapna, Kalesija (to the west), Lopare, Ugljevik and Bijeljina (to the north). The river Drina on the east is a borderline with Republic of Serbia, i.e. the town of Loznica and the municipality of Zvornik.

The municipality of Zvornik is a crossroads of important roads to Sarajevo, Belgrade, Novi Sad, Bijeljina and Tuzla. Two bridges on the river Drina for road and rail traffic connect this area with the wider region, with Zvornik in the center, at equal distances from the three major cities – Belgrade, Novi Sad, and Sarajevo (approximately 160 km).

Fertile plains, a river rich in fish and suitable for navigation, mountains rich with forests, game and minerals have attracted people to settle the area since prehistoric times, and the earliest known inhabitants were the Scordisci, a Celtic tribe. The name Zvornik has been used since 1519, and the settlement was first mentioned in 1410 under the name of "Zvonik". Historic sites include the old town Đurđevgrad or the Zvornik fortress, the old town of Kušlat, The Andraš villa, the sheik's türbe, and the türbe of the poet Kaimija, necropolises and medieval tombstones called "stećci", the church St John the Baptist, and the local museum holds a collection of specimens of the cultural and historic heritage.

Natural resources include the hydro power potential of the river Drina as it runs through its territory for 50 km. Zvornik lake covers the surface area of 19 square kilometers (25 km in length and 1.3 km in width). It offers great possibilities for tourism, sports and recreation. The resources include the springs of mineral water from Kozluk and Vitinički Kiseljak, reserves of quartz sand, brick clay, structural stone, limestone and gravel. The municipality has 13 700 ha coverd by forest, 16 600 ha of arable land, and 10 500 farming housholds.

The municipality of Zvornik has 280 companies with 4500 employees, 800 businesses with 13000 employess, and around 40 institutions with approximately 2500 employees.

The most significant companies are AD Alumina factory Birač, Holding "Drinatrans" AD, AD "Zvornik putevi", AD "Vitinka", , DOO "Studen-prom", DOO "Obuća", AD "Vodovod i komunalije", DOO "Zo-Ži" , etc. Zvornik has founded a Business Zone covering a surface area of 10 ha with a cmplete infrastructure, suitable for investement.

Zvornik has 6 primary schools with 4200 pupils, two secondary schools with 18000 students, and one higher education institution - The Faculty of Technology. There is also Helath Institution and General Hospital important for the whole region.

German NGO *GTZ* has pronounced the municipality of Zvornik the best municipality in Bosnia and Herzegovina with respect to the treatment of the young, and the European Movement in Bosnia and Herzegovina has awarded Zvornik with "European open area" award.

ALUMINA DOO

Alumina d.o.o. was released into operation on 6th October 1978 and in the period 1984-1989 has paid a special attention to a development of products in the area of alumosilicate chemistry. During that period the company built five plants which also rely on the company's infrastructure and its raw material resources. The company is supplied with all the necessary raw materials, i.e. bauxite, quartz sand and energy from its immediate surroundings. Alumina d.o.o. is the only company in the Western Balkans and the southeastern Europe which uses the Bayer process to produce alumina and different types of hydrates from bauxite. Bauxite, supplied from the local mines, is advantageous in terms of micro impurity and the content of organic compounds. Alumina d.o.o. is also recognized by a symbiosis of several types of productions. Apart from hydrates and different types of alumina, the company also produces different types of zeolites, sodium silicates and liquid "water glass", and all products are in accordance with ISO and REACH Standards. The company's position in the eastern part of the Republic of Srpska and Bosnia and Herzegovina allows an easy access to the ports on the Adriatic sea and the river Danube, and, consequently, to the large number of countries to which it exports, such as Spain, France, Italy, Germany, Denmark, Netherland, Switzerland, Austria, Slovenia, Slovakia, Macedonia, Hungary, Czech Republic, Romania, Bulgaria, Poland, Ukraine, Russia, Belarus, Croatia, Serbia, Montenegro, Greece, Turkey, Israel, Saudi Arabia, Jordan, Tunis, Egypt, Sudan, Morocco, Algeria, Pakistan, India, China, USA, Columbia, Costa Rica.

ZEOCHEM DOO

Zeochem d.o.o. in Zvornik is a branch of a quality-oriented Swiss company with locations throughout the world. The company is a global market leader in complex industrial separation and purification processes. It makes molecular sieves that filter the impurities out of natural gas and bioethanol, and neutralize volatile organic compounds before they give off odors. The company creates the building blocks for OLEDs that conjure rasor-sharp images on smart phones and TVs. Zeochem supports the pharmaceuticals industry and the production of insulin and many other medicines, and by concentrating medical oxygen it improves many people's quality of life. The employees are committed to their customers worldwide and work with them to develop innovative solutions, products and processes. In recent years, the company has grown from a niche supplier to a global market leader in silicate chemistry. They produce in China, in the USA, in Bosnia and Herzegovina, and in Switzerland, and they are constantly expanding. Zeochem, a manufacturer of high-quality molecular sieves, chromatography gels and deuterated compounds, was established more than 200 years ago. In 1818, the Schnorf brothers lay the foundation stone for the CPH group to which Zeochem belongs when they opened a chemical factory in Switzerland. Swiss DNA is still a key factor in the company's success, shaping its identity and determining its actions. As a leading company in the silicate chemistry field, they set trends and create added value for their customers. The company's R&D teams focus on new product development, existing product improvement and understanding how their products are used in the customers' applications. Zeochem offers support for its customers as a trusted advisor and partner throughout the life of the products. Zeochem is committed to customer-focused innovation. The company continually develops new products with optimum performance for existing and new applications – offering better service lifetimes with more efficient materials.

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MASTIHA TREATMENT FOR OBESE WITH NAFLD DIAGNOSIS. THE MAST4HEALTH EU PROGRAM

George Dedoussis, on behalf of the MAST4HEALTH Program

Harokopio University of Athens, Greece

Abstract

MAST4HEALTH was set on the concept of a multidisciplinary approach to assess a non-pharmacological intervention for managing NAFLD/NASH, one of the most common complications of obesity and diabetes mellitus in Western populations affecting approximately 50% of diabetics and 76% of obese patients. Because of limitations in current NAFLD treatment therapies, many new efforts focus on exploring non-pharmacologic means for managing the disease and in particular through dietary substances or bioactive phytochemicals in fruits, vegetables, and plants or their products. MAST4HEALTH aimed at exploring the effect of Mastiha, a natural product of Greece which was recently shown to possess antioxidant/anti-inflammatory and lipid lowering properties. We designed a multicenter randomized double blind placebo controlled (parallel arm) clinical trial to test the effectiveness of Mastiha supplement as new non-pharmacologic strategy for NAFLD/NASH treatment. MAST4HEALTH explored gene-diet interactions, more specifically the potential personalized activity of the Mastiha, and correlated genetic and epigenetic markers with metabolomics and intestinal microbiota profiles pre- and post- intervention. The effectiveness of the proposed intervention was evaluated via clinical and laboratory markers of the disease. To this end, MAST4HEALTH trained a number of researchers and PhD students in multidisciplinary approaches of the survey. MAST4HEALTH was expected to build and enhance cooperation among partners meanwhile strengthening the interaction between our academic and non-academic sectors.

Key words: *Diet, NAFLD, genetic, nutrition, obesity*

VALORIZING SECONDARY SOURCES OF PHOSPHORUS: APPLICABILITY OF BIOLOGICAL APATITE IN SOIL REMEDIATION AND REHABILITATION

Ivana Smičiklas, Mihajlo Jović, Marija Šljivić-Ivanović

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Abstract

Soil contamination and nutrient depletion are among global threats to soil resources. Phosphorus (P) is an essential element for all living organisms, yet it is most frequently deficient in agricultural soils due to either reduced content or its availability to plants. The increased demand for mineral fertilizers and other phosphate products resulted in the depletion of limited phosphate rock deposits and positioned this non-renewable resource on the European Union's list of critical raw materials. Consequently, the recovery of P from wastes and by-products became a critical step in sustainable soil management. Furthermore, phosphate-rich materials addition to heavy metal contaminated soil represents an encouraging approach for in situ remediation by converting contaminants to less environmentally and biologically hazardous forms without their physical separation from the soil matrix. The availability, composition, and solubility of different P-sources impact the sustainability, cost-effectiveness, safety, mechanism, and efficiency of metal immobilization in the soil. In that sense, animal bones from the food industry meet important criteria: they are an abundant and rich secondary source in terms of P recovery viability with a low concentration of toxic and potentially toxic elements, and the mineral component of bones (bioapatite) represents an optimal matrix for heavy metal stabilization due to the specific crystal structure and moderate solubility. This review highlights the prospects of in situ metal stabilization in the soil, bioapatite properties, its recovery methods, and the factors influencing metal stabilization efficiency. The major challenges are as well discussed in line with available literature data. Overall results show that bioapatite induces redistribution of heavy metals to soil fractions with decreased mobility, bioavailability, and toxicity and point to the multiple benefits of its use in restoring soil quality and function, allowing the amount of animal waste to be reduced through the P recycling.

Key words: *Soil contamination; heavy metals; biogenic apatite; sustainable soil remediation.*

WASTE-TO-ENERGY IN THE LIGHT OF CIRCULAR ECONOMY AND EU WASTE MANAGEMENT PLANS

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Abstract

The EU circular economy and waste management plans are included in The European Green Deal presented in December 2019. This deal includes many sectors of society, also waste management. This strategic plan includes the ideas of circular economy that are based on a different lifestyle and business style, including the cascading use of material and energy sources and an almost zero level of residual waste and energy. Waste – to -energy is an integral part of the waste hierarchy and as such falls within the circular economy as the European Commission perceives. Of course, it should not negatively affect the reuse and recycling of waste, which are the preferred methods of waste management. The devices for waste – to – energy should be designed solely for material flows that can't be used otherwise. Energy use of waste is, in most cases, considered as energy production partly or entirely from renewable energy sources, which means lowering greenhouse gas emissions. It also means the utilization of the strategic domestic energy source and the reduction of domestic energy import dependence. Also, the reduction of landfill space needed greenhouse gas emissions and pollution in general. In this work waste – to – energy technologies are going to be presented. Depending on waste streams going into waste – to – energy systems technological solutions for each part of the system are going to be discussed. Proper introduction of circular economy systems, which also includes waste – to - energy, means sustainable economic growth, sustainable industrialization, green jobs and a contribution to achieving sustainable management of natural resources and their effective use.

Key words: *waste – to – energy, circular economy, waste management, climate change, renewable energy sources, incineration*

WHERE THE ENGINEERING MEETS THE NATURE: EXTERNAL CONTROL OF SENSORY-MOTOR SYSTEMS OF PERSONS WITH DISABILITY

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Abstract

An injury or disease which affects the central nervous system leads to sensory-motor disability. A neural prosthesis provides functional replacement of the diminished communication between the brain and the environment by replacing the missing natural triggering. A neural prosthesis activates: 1) the afferent neural pathways, thereby sending signals to the cortex, and 2) the efferent neural pathways, thereby activating the motor system (muscles). Artificial activation of cortical structures triggers the natural sensory mechanisms (sensations). External activation of the visual cortex directly or indirectly via the optical nerve results allows a blind person to regain vision. External activation of the auditory nerve allows a deaf person to the hearing sensation. The somatosensory systems' activation can reduce the pain and augment the perception of contact, force, vibration, etc. The activation of the spinal cord structures and peripheral nervous system can help a person with paralysis to restore reaching, grasping, standing, gait, and other functional movements. The lecture will discuss the specific aspects that need to be resolved for broader acceptance by the users. The talk will also discuss the efforts to combine neural-prostheses and exoskeletons to assist persons with disabilities better.

***Key words**: Neural prosthesis, Electrical stimulation, Paralysis, Cochlea, Retina, Exoskeleton*

PLASMA AS A TOOL FOR DECONTAMINATION OF NATURAL TOXINS

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Abstract

Naturally occurring toxins are typically secondary metabolite products of various filamentous fungi species, frequently found on food crops such as corn, wheat, cereals and nuts. Up to date, more than 400 structurally different mycotoxins were identified. These toxins can produce an assortment of toxic effects when consumed by vertebrates. Among these natural toxins, which are considered the greatest threat to human health, more than half of the world's population is chronically exposed. In this group, the aflatoxin B1 (AFB_1) is one of the most potent natural group 1 carcinogen, responsible for up to 155,000 (28 %) annual cases of human hepatocellular carcinoma cancer. For this reason, mycotoxins have become one of the most critical dietary risk factors, with the situation being further exasperated by the alarming increase in their occurrence on widely consumed food. Mycotoxin contamination is considered an unavoidable and unpredictable problem as they are readily found on crops where good agricultural, storage and processing practices have been implemented. To combat this growing issue, food producers are urgently seeking novel non-thermal decontamination methods that are able to rapidly eliminate mycotoxin contamination with negligible impact on the treated food product and environment. Current non-thermal approaches include UV irradiation, pulsed light treatment, gamma irradiation and ozonation, which induce the breakdown of the mycotoxin molecule by absorbing high energies or interaction with highly reactive chemical species. However, over the last several years, our group has implemented a novel and alternative approach to all existing methods by using non-equilibrium plasma. This approach is based on cold atmospheric pressure plasmas generated in ambient air, leading to orders of magnitude faster degradations of toxins. The system operates on targeted and rapid scission of the most toxic bonds, for example, a vinyl bond between 8- and 9-position on the terminal furan ring of aflatoxin B_1 which is the key for the suppression of molecule toxic potential. The detailed analyses of plasma reactive species-mediated degradation pathways demonstrated that this approach not only renders aflatoxin B_1 harmless but does so in order of magnitude less time than other methods currently under investigation.

Key words: *Plasma Agriculture, Atmospheric Pressure Plasma, Decontamination, Degradation, Mycotoxins*

ELEMENTAL METABOLOMICS

Constantinos Georgiou

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Abstract

Thorough elemental characterization of samples through mass spectrometry was successful in determining geographic, genetic or processing origin of samples. Important are ultralow level capabilities introduced by mass spectrometry, databases of elemental signatures along algorithms and tools for big data. Special mention will be given to the significance of isotopes, ultra-trace & rare earth elements and precious metals.
Elemental metabolomics is a solution for food authenticity. Examples will be discussed while the future in human health and nutrition will be highlighted.

Key words: *Elemental metabolomics, Mass spectrometry, Food authentication, Geographic origin, Genetic origin, Processing*

BIOREFINERY DEVELOPMENT FOR SUSTAINABLE PRODUCTION OF BIO-BASED PRODUCTS WITHIN A CIRCULAR BIO-ECONOMY CONTEXT

Apostolis Koutinas

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Abstract

The transition from the current fossil-based economy into the bio-economy era necessitates the utilisation of crude renewable resources as sustainable feedstocks for the production of bio-based chemicals, polymers and materials. The sustainable production of such bio-based products requires the development of innovative biorefinery concepts. Food supply chain waste and industrial side streams could be valorized via biorefining for the production of value-added co-products (e.g. lipids, protein, pectin) and fermentation products using the hydrolysed carbohydrate fraction as carbon source. The production of bio-based chemicals and polymers is currently not cost-efficient via conventional fermentation processes and crude resources should be used as feedstocks. This presentation will focus on biorefinery development and sustainability analysis using various crude renewable resources (e.g. the organic fraction of municipal solid waste, winery waste, sugar beet pulp).

***Key words**: Biorefineries, Industrial Biotechnology, Bio-based Chemicals, Biopolymers, Renewable Resources*

APPLICATION OF HYDROGELS IN AGRICULTURE

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Abstract

Hydrogels represent a special class of polymer networks that is elastic and swell in water, but do not dissolve in it. The hydrophilic structure makes hydrogels capable to absorb large amounts of water in their three-dimensional networks. The most important property of hydrogels is swelling, which depends on the nature of the polymer, the degree of crosslinking, the charge density, but also the environmental conditions. In the last five decades, hydrogels that change volume and structure as a result of respond to external stimuli such as pH, temperature, ionic strength, electric, magnetic field have been intensively studied. The use of these hydrogels is becoming more widespread in various branches of industry, while their application in modern agriculture is becoming more and more common, because of inadequate water supply problems on farms in Serbia. Currently in parts of Mačva as one of the most fertile land in Serbia, on average amount of rain for the summer period for last year was about 76-100 mm, which is the optimal amount of water for crops. However, the distribution of this precipitation was inadequate for crops, because in June fell 70% this amount, while in July it fell about 5% and in August 10%. For this reason is necessarily enable to crops optimal amount of water for all the period of growth. In this paper, the possibility of using polyurethane hydrogel to absorb excess water from the soil in the rainy months and release absorbed water in the dry months for crops growth, was investigated. The properties of water absorption and desorption was adjust depending on the type of soil and crops.. The release of water is controlled by the pH balance, and the degree of moisture that is established in the soil. The influence of hydrogel on the growth of 3 plant cultures in laboratory conditions that simulated crop conditions during the previous year: wheat, corn and beans were investigated. The root of the plant and the size of the stem in a period of 3 months were measured. The obtained data show that the same effect is achieved when the hydrogel is used for irrigation during irregular precipitation and when the plant is watered daily with the same amount of water.

Key words: *hydrogels, swelling ratio, controlled release of water, water capacity of hydrogel*

MORPHOLOGICAL PROPERTIES OF POLYURETHANE HYBRID HYDROGELS

Jelena Tanasić[1], Urszula Klekotka[2], Beata Kalska-Szostko[2], Ivan Krakovsky[3], Ivan Ristić[1]

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Abstract

Due to the extraordinary properties of polyurethanes, as the most commonly used polymers, numerous ideas have been developed for obtaining polyurethane hydrogels, as materials that will hold the properties of polyurethanes as extremely stable compounds, from one side and good swelling and morphology properties, which can be projected from the other. However, due to the hydrophobic nature of polyurethane compounds, the real challenge is to develop polyurethane hydrogels (which can swell in water, but cannot dissolve). Varying the ration of components in the polyurethane hydrogel changes the structure of the hydrogel, and thus the basic property of hydrogels - swelling. By varying the composition and ratio of the polyol and isocyanate components, the crosslinking density and the elasticity of the polymer network are affected, which results in changes in the swelling capacity. Polyurethane hydrogels, as composites, can be use in medical engineering, for tissue, , but they are also sustainable for another industry e.g. like sensors in agriculture for the presence of pesticides, the presence of heavy metals in water, and as bacteriological water sensors. In this paper, polyurethane hydrogels will be synthesis with polyethylene glycol (Mn 6000 g mol^{-1}) as a polyol component and a multifunctional isocyanate and appropriate catalyst. The influence of the addition of carbon nanotubes on the morphological properties and swelling properties of hydrogels were investigated. The morphological properties of polyurethane hydrogels were examined by scanning electron microscopy (SEM) and transmission electron microscopy (TEM), the swelling ratio of polyurethane hydrogels was measured and a correlation between the morphology and the degree of swelling was made. The results of the swelling degree show that with the addition of CNT there is an increase in the swelling degree. SEM images of lyophilized samples showed that with the addition of CNT, larger pores are formed in the sample, the consequence of this structure is a high swelling degree. TEM results showed good distribution of CNT in the samples. It can be concluded that the addition of CNT results in a slower reaction and the formation of a more uniform sample structure, which can formed better structure after swelling, which is confirmed with SEM and swelling ratio results.

Key words: *polyurethane hydrogels, swelling ratio, SEM, TEM.*

GREEN EXTRACTION APPROACH FOR THE RECOVERY OF BIOACTIVE COMPOUNDS FROM TOBACCO WASTE

Marija Banožić[1], Krunoslav Aladić[1], Jelena Vladić[2], Senka Vidović[2], Silvija Šafranko[1], Ana-Marija Cikoš[1], Stela Jokić[1]

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Abstract

Recent trends in the separation techniques have been largely focused on the green extraction techniques. The conventional extraction techniques require the high energy "input", including the consumption of harmful organic solvents, prolonged extraction time and utilization of high temperatures, and consequently degradation of thermolabile components occur. The novel extraction techniques such as supercritical CO_2 extraction, ultrasound assisted extraction, high voltage electric discharge assisted extraction and subcritical water extractions avoid or reduce these disadvantages and improve extraction efficiency. The aim of this paper is to give an overview of our results in the recovery of bioactive compounds from tobacco waste, with special attention to dominant bioactive compounds in tobacco waste, nicotine, chlorogenic acid and rutin, respectively. Three types of tobacco waste (scrap, dust and midrib) and Virginia leaf blend (composed by 73.3% Virginia and 26.7% oriental tobaccos) as starting material were obtained from tobacco factory "Fabrika duhana Sarajevo" and subjected to different extraction techniques and process conditions. Results showed that supercritical CO_2 extraction has advantages in extracting fatty acids and volatile organic compounds. Subcritical water extraction enabled high extraction yield, but some degradation products (furfurals) occurred on higher temperatures (above 250 °C). Ultrasound assisted extraction and high voltage electric discharge assisted extraction provided satisfying concentration of phenolic compounds (chlorogenic, acid and rutin). All tobacco waste types contained similar compounds as leaf blend but in lower concentrations.
Treatment of tobacco waste such as recycling and reusing are an imperative today due to rigorous environmental protection legislation. Studied green extraction techniques in this paper provided advantages over conventional extraction methods, such as being "greener", faster and more efficient.

Key words: *tobacco waste, bioactive compounds, green extraction techniques*

Acknowledgments: This work has been supported by Croatian Science Foundation under the project "Application of innovative techniques of the extraction of bioactive components from by-products of plant origin" (UIP-2017-05-9909).

THEORETICAL SUPPORT OF MODERN ISSUES RELATED TO LASER TECHNIQUES, APPLICATIONS OF COHERENT RADIATION AND MODERN TECHNOLOGIES

Milesa Srećković[1], Svetlana Pelemiš[2], Stanko Ostojić[3], Sanja Jevtić[4], Slađana Pantelić[1], Miloš Đurić[1], Branka Kaluđerović[5], Zoran Latinović[1], Nada Ratković Kovačević[6]

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Abstract

Starting from the past and present moment thinking is tearing us for a long time between the global & local and that can provide different images and problems groups. From the fact that is for discussion climate change globally to the fact that we must constantly remind ourselves to the ecology (air purity), a side of problems of every work trade, everyday life, on energy issues, on medically acute conditions related to pandemic, which we have almost forgotten long time and returning to the Middle Ages. The paper provide some assessments /reminders of possible realistic answers to seemingly still current questions and a reminder of work techniques and theoretical foundations of engineering approaches. We are reconsidering role of scattering, remote sensing, energy and simplified schemes of systems for responds. Limits of energy transformed and environment? New generations of nuclear plants and advantages /disadvantages? A few approaches answering today 's problems, without pretending to think that the application of lasers in problems is decisive. Experimental possibilities, and the assesment of severity, diagnostics will be presented through simulation that can in be developed with modeling in laboratory conditions. Analyses of scatterer size can distinguish ensembles (viruses, co rona covid 19, SAR, bacteria) or geometry (of Gaussian coil, sphere..). Vaccine administration through particle generators for agro-flora or fauna can be practically investigated through systems and interpretations reliable and supported with appropriate multidisciplinary teams. Laser role in protection measures by LIS, removing pollutants with interaction processes of laser beams with the material, find the other solutions with them. It relates to nuclear waste storage, reduce local radioactivity. It has a special role in relation to nuclear energy, protection and an input of fiber optic power supplies and laser roles in plant maintenance by measuring wind speed, blade condition, etc. The parallels related to the modern and previous applications of them will be considered, and the conditions with a covid, where the therapeutic biomodulation effect for recovery, disinfection, diagnostics, many laser spectroscopies, again starting from scattering (elastic/inelastic) in dispositions with photon beating or classic angular distributions. Analyzes and cases with shells around microparticles with finer approaches have long been over passed. Particle size define an extent of the danger to the lungs; that can be applied in experiments with lasers and Covid 19. The look at solutions with optical fibers, fiber laser and solutions in terms of powering sensors in potentially dangerous areas, and some considerations to other techniques as the thermo vision should be having in mind. The problem related to references and the accuracy of translating terminology from various languages will bring closer the expression related to mentioned topics (optics, energy and selected term from heritology to the Space and transform processes). Some of performed experiments of the pulse/cw lasers will be presented concerning mentioned problems based on processes of scattering, provoked acoustics phenomena, absorption, material modulation and diagnostics.

Key words: *energy, quantum generator, scattering, ecology, efficiency, corona virus*

PREDICTION OF THE RUBBER VULCANIZATION USING ARTIFICAL NEURAL NETWORK

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Abstract

Obtaining rubber rheological properties is indispensable in order to conduct efficient vulcanization process in rubber industry. The main aim of this study was the development of an advanced artificial neural network (ANN) to prediction vulcanization kinetics of commercially available rubber gum for tire production. Experimental dependence of torque on time is investigated using oscillating disc rheometer at five temperatures in the range from 140 to 180 °C, with a step of 10 °C. The ANN was specially developed using TensorFlow with Keras, a Python framework, where the model and optimizer were Sequential and adam. ReLU, Sigmoid, Softplus activation functions were used in order to minimize error, where the ANN model with Softplus gave the most accurate predicting results. The numbers of neurons (2, 3, 4, 5, 10, 15, 20) and layers (1, 2) were varied, where the ANN with two layers and 20 neurons in each layer showed the most convenient results. Proposed ANN was used in order to predict torque dependence on time at two temperatures (150, 170 °C), where the training of the network was conducted at 140, 160, 180 °C, and experimental data at 150, 170 °C were used for determining numerical error. Obtained solutions were confirmed as accurate prediction using different numerical methods at all examined temperatures, where R^2 values are greater than 0.98, and MAPE and MSE are less than 1.98%.

Key words: *rubber, artificial neural network, vulcanization*

Acknowledgements: *This research was conducted within the framework of project 451-03-68/2020-14/ 200134, funded by the Ministry of education, science and technological development, Republic of Serbia.*

ENCAPSULATION OF VITAMIN E USING CHITOSAN/SODIUM DODECYL SULFATE COMPLEX AS A WALL MATERIAL

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Abstract

Contemporary tendencies in production of food, cosmetics and pharmaceutical products indicate a wide use of biologically active substances that are very often incompatible with other ingredients or there is a need for their protection against harmful environmental influences and controlled release. One of them is vitamin E, a lipophilic natural antioxidant with important biological effects, scavenges free radicals and protects membrane lipids from oxidation. As it is relatively unstable and sensitive to high temperature, oxygen, and light, encapsulation is needed for its protection during shelf storage. The preparation of microcapsules of desired characteristics depends on various factors such as size and nature of the core substance, the properties of the wall material, techniques and parameters of encapsulation. Chitosan (Ch) is the second most abundant polysaccharide in the world and is obtained by alkaline N-deacetylation of chitin. The use of chitosan in the industry is particularly promising because of its biocompatibility and nontoxicity. Microcapsule wall properties can be changed by adding of cross-linking agents that are usually considered toxic for application. For this reasons the main goal of this study was to evaluate chitosan/sodium dodecyl sulfate (SDS) vitamin E microcapsules and influence of cross-linking agent on the properties of microcapsules.

In this study, 20% O/W emulsions stabilized with mixtures of Ch and SDS in mass ratios of 1:2, which contained vitamin E dissolved in neutral oil medium-chain triglycerides, was obtained by Ultra Turrax T25 homogenization. The emulsions without and with cross-linking agent (formaldehyde (FA) or glutaraldehyde (GA)) in a mass ratio of Ch:FA(GA) 1:1 and 1:2 dried by spray drying procedure. Microcapsules in powder form were obtained and their moisture content were investigated. Droplet and particle size distribution of the emulsion and suspensions of microcapsules, were investigated as well.

Addition of cross-linking agents, FA and GA, did not lead to significant differences in dispersion characteristics of obtained microcapsules. Obtained results prove that Ch/SDS complex without toxic cross-linking agents can be used as wall material for the microencapsulation of hydrophobic active molecules.

Key words: *chitosan, sodium dodecyl sulfate, microencapsulation, vitamin E.*

This work was financed by Ministry of Education, Science and Technological Development of the Republic of Serbia, Grant No 451-03- 68/2020-14/200134.

OSMOTIC DEHYDRATION OF PINEAPPLE SLICES PRE-TREATED BY ELECTROPLASMOLYSIS: DETERMINATION OF COLOR CHANGE KINETICS

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Abstract

The pineapple (Ananas comosus (L.) Merrill) is a commercial tropical fruit belonging to Bromeliaceae family. It is rich in organic acids (citric acid, malic acid), minerals (Fe, Mg, Ca, P, K and Zn), and vitamins (A, B_1, B_2, B_3 and B_6). Osmotic dehydration is a water removal technique by immersing the fruit in hypertonic solution to obtain minimally processed food with a longer shelf life and high nutritional value. It can also be considered as a pretreatment that reduces the required energy inputs for convective drying and freeze drying. Electroplasmolysis is an electrical method that is based on the growth of pores in cell membranes. It has an important effect on the dehydration and extraction processes as it increases the cell permeability and mass transfer coefficients of plant tissues. In this study, it was aimed to determine the effect of electroplasmolysis pretreatment on color change kinetics in osmotic dehydration of pineapple slices. Electroplasmolysis was applied by a drum-type electroplasmolyzator with 80 V/cm voltage gradient for 60 s. Osmotic dehydration was done in a sucrose solution under 30 °C. The concentrations of osmotic solutions were 40, 50 and 60 % of sucrose. Different time intervals 1, 3, 5 and 7 hours for each concentration were studied. Results showed that the changes in L^*, a^* and b^* values of osmotic dehydrated pineapple slices pre-treated by electroplasmolysis followed first order kinetics. Electrical pretreatment improved the mass transfer by degradation effect on the cells, so the dehydration becomes faster and easier. As a result of this, transfer of sugar into the cells protected the color values better in the samples which treated with electroplasmolysis compared to the control group. The combination of electrical pretreatment and osmotic dehydration provides the production of pineapple slices with better quality via color. Other fruits can be evaluated in further studies.

Keywords: *pineapple, electroplasmolysis, osmotic dehydration, color, kinetic, sucrose solution.*

REVIEW OF FOOD TREATED WITH IONIZING RADIATION AS A MEANS OF ITS PRESERVATION

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Abstract

Food irradiation is a process of exposing food to ionizing radiation in order to ensure its safety and preservation. Usually the process is applied to fresh or frozen products without affecting the nutritional value of the treated food. This type of radiation has its advantages and disadvantages, and when it comes to the benefits, the process implies destruction of microorganisms in food and extending its shelf life. The only disadvantage of food treated with ionizing radiation is that this process is very expensive i.e. it requires sophisticated machines. In addition, there is often a negative perception by consumers themselves that it is a matter of irradiated food. Consumers can recognize food treated in this way, whereby food irradiation is recognized by FAO/ a designationof the WHO according to Radura, an international symbol for irradiated food. The scientific records of food irradiation confirm that irradiated food is not radioactive considering that there is no contact of food and radiation sources, however, it is still necessary to follow the very process and the appropriate procedure to make sure that the radiation dose is not exceeded. Research confirms that properly irradiated food with this method will not affect consumer safety. The method of food irradiation as an efficient technology has been approved in more than 60 countries and there has been a significant growth of production and trade.

Key words: *Food irradiation, consumer health and perception, review.*

CUBEB PEPER (*Piper cubeba* L.) EXTRACTS AS A SOURCE OF NATURAL ANTIOXIDANTS, ANTIMICROBIAL AGENTS AND MINERALS

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Abstract

Cubeb pepper (Piper cubeba L.) is an evergreen plant of the family Piperaceae. The fruit of cubeb pepper is valuable not only as an excellent spice, but also for compounds like glycosides, alkaloids, tannins, and phenolics present in its ethanolic extract. In traditional medicine, the cubeb pepper fruit and ethanolic extract are used to relieve gastric pain, diarrhea, as stimulants, appetizers, expectorants, antioxidants, antimicrobial and anti-inflammatory agents. The main objective of this study was to determine the antioxidant and antimicrobial activity as well as the mineral composition of cubeb pepper ethanol extract. The ethanolic extract from cubeb pepper fruit was obtained by reflux extraction at the boiling temperature. Total phenols and total flavonoids content was determined spectrophotometrically by the method of Folin-Ciocalteu and by the method with $AlCl_3$, respectively. A high content of total phenols (75.59 ± 1.19 mgGAE/g d.e.) was determined, while the total flavonoid content was much lower (4.46 ± 0.24 mgRE/g d.e.) in the extract obtained. The concentrations of extract required to neutralize 50% of the initial concentration of DPPH radicals (EC_{50}) after 20 min incubation and immediately after adding DPPH radical solution were 0.378 mg/cm^3 and 3.327 mg/cm^3, respectively. The antimicrobial activity of the cubeb pepper ethanolic extract against the bacteria (Bacillus cereus, Salmonella enterica ssp. enterica) and the fungus (Candida albicans) were determined by the microdilution method. The minimal inhibitory and microbicidal concentrations were determined for the investigated extract against all the mentioned microorganisms, their reference, and isolate strains. The best inhibitory effect of the extract was noticed on the reference strain of B. cereus with MIC value 0.39 mg/cm^3 and on the isolate strain of S. enterica with MIC value 0.78 mg/cm^3. Ethanolic extract of cubeb pepper did not show a microbicidal effect on B. cereus strains, and the best microbicidal effect was noticed against the reference strain of C. albicans (MMC value was 3.25 mg/cm^3). The presence of 15 elements and their content was determined in the extract. Of the macroelements whose content was determined, the highest presence of sodium was detected (121.5 μg/cm^3). The presence of microelements such as iron, copper, and zinc was detected in the ethanolic extract of cubeb pepper as well, with the highest content of iron (0.35 μg/cm^3). The obtained results regarding the antioxidant and antimicrobial activity, as well as the minerals content of cubeb pepper extract, indicate its possible application in the food and pharmaceutical industry.

Key words: *Cubeb pepper, Ethanolic extract, Antioxidant activity, Antimicrobial activityy, Minerals.*

Acknowledgements: This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia under the Program of financing scientific research work, number 451-03-68/2020-14/200133 (Project assigned to the Faculty of Technology, Leskovac, University of Niš, researchers' group, TR 34012).

ACETYLATION OF POTATO STARCH IN COMBINATION WITH HIGH VOLTAGE ELECTRIC DISCHARGE AND PULSED ELECTRIC FIELD

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Abstract

The aim of this study was to determine the influence of high voltage electric discharge and pulsed electric field as contemporary (modern) non-thermal methods for potato starch modification and their impact on starch acetylation. The starch was acetylated with the addition of acetic anhydride (4, 6 and 8% w/w starch), and modification without and in combination with high electrical discharge or pulsed electric field was examined. Percent of acetylation and degree of substitution, swelling power and solubility index, the texture of starch gels and thermophysical properties were determined. Results showed that the acetylation percent and degree of substitution increased proportionally with the concentration of acetic anhydride. Acetylated starches gelatinized at lower temperatures, had higher values of swelling capacity and solubility index in comparison to the native potato starch. Furthermore, acetylated starch gels had lower hardness, fracturability and adhesiveness, wherein the case of acetylation in combination with high voltage electric discharge or pulsed electric field the effect was more pronounced in relation to the classic acetylation procedure.

Key words: *potato starch, acetylation, high voltage electric discharge, pulsed electric field, physical properties*

INVESTIGATION OF THE EFFECT OF ADDITIVES ON ENZYME ACTIVITY

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Abstract

Enzymes are biocatalysts that have a decisive role in all biochemical reactions and processes that occur in complex living systems, in a way that accelerates reactions in the human body. An important property of all enzymes is their catalytic power and specificity. In biochemistry, a substrate is defined as a molecule that is affected by an enzyme. Enzymes bind one or more substrates to their active site, thus forming an enzyme-substrate complex. The enzyme amylase was used in this work, and the substrate is starch. Substrate specificity is usually high, and sometimes complete. The addition of the additive leads to a decrease in the catalytic activity of the enzyme, whereby the additive acts as an inhibitor. In this work, we monitored the response of the immobilized enzyme to the GC (Glassy carbon) electrode by cyclic voltammetry, in relation to the electrode without the presence of the enzyme. Also, charge transfer processes and oxido-reduction processes were monitored. Cyclic voltammetry monitored the effect of different substrate concentrations on enzyme activity, and examined the effect of different scan rates on the appearance of voltamograms.

Key words: *amylase, additive, cyclic voltametry, chronoamperometry*

INVESTIGATION OF THE EFFECT OF COLD ATMOSPHERIC PLASMA ON GLIADINS AND GLUTENINS EXTRACTED FROM WHEAT FLOUR SAMPLES

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Abstract

Cold atmospheric plasma has played an important role in the food industry in recent years. As one of the food processing methods it has numerous advantages. The aim of this paper was to examine how cold atmospheric plasma affects gliadins and glutenins extracted from wheat flour samples. To examine the effect of cold atmospheric plasma, samples of wheat flour that were not treated with plasma were used, followed by extraction of gliadins and glutenins (T1), then samples of flour treated with plasma for 4 min, and then extracted of gliadins and glutenins (T2) and gliadins and glutenins extracts treated with plasma for 1 min (T3). Gliadins and glutenins (T1, T2 and T3) were chromatographically separated on apparatus Agilent Technologies 1260 Infinity. Absorbance was read at 210 and 280 nm. Based on the obtained results, the highest number of gliadin proteins after chromatographic separation at 210 nm was obtained from samples that were not treated with cold atmospheric plasma (T1, Xav=24.67), and the lowest number of proteins in samples whose extracts were treated (T3, Xav= 20.50). After chromatographic separation of gliadin proteins at 280 nm, the highest number of gliadin proteins was obtained from wheat flour samples treated with cold atmospheric plasma, followed by extraction (T2, Xav=22.83), and the lowest number in gliadins whose extracts were treated (T3, Xav=15.17). After the treatment of glutenins with cold atmospheric plasma, followed by chromatographic separation at 210 and 280 nm, the highest number of proteins was obtained from samples that were not treated with cold atmospheric plasma (T1, Xav=24.33 and Xav=22.83), and the lowest number in extracts of samples treated for 1 min (T3, Xav=19.67 and Xav=16.00).

Key words: *gliadins, glutenins, wheat flour, cold atmospheric plasma, RP-HPLC.*

EXAMINATION OF POSSIBILITIES OF RATIONAL USE OF WOODEN GREEN OF CETINAR AS A NATURAL RESOURCE OF THE REPUBLIC OF SRPSKA

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Abstract

This research was conducted in order to obtain data on the rational use of unused coniferous wood greenery from the territory of the Republic of Srpska. Republic of Srpska is half covered by forest, the annual volume of felling is large, small branches and needles as a by-product in exploitation remain in the forest, from them you can get quality essential oil that is used in certain industries, and all these are just some of the numerous objective reasons why it is necessary to seriously approach the planning of the production of essential oil from coniferous proby-ducts as natural resources. Necessary data related to the coniferous forest, taken from the valid Production and Financial Business Plan for 2019 JPŠ "Šume RS", a.d. Sokolac, which refer to etat (m^3), indicate that a total of about thirty thousand tons of unused raw materials suitable for the production of essential oil remained in the forest. The largest planned conifer eta for 2019 are in the areas covered by the forest farms "Romanija" (13%) and "Visočnik" (12.6%). During the development of forest management bases in the previous period, little attention was paid to other and by-products of the forest. However, in the next development period, the importance and need for research into the possibilities of collecting, producing and using other forest products, as well as performing the planned organization of production, is pointed out.

Key words: *coniferous wood, natural resource, essential oil.*

ANTIBACTERIAL ACTIVITY OF CLOVE ESSENTIAL OIL (*SYZYGIUM AROMATICUM L.)* ON *STAPHYLOCOCCUS PSEUDINTERMEDIUS*

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Abstract

Clove (Syzygium aromaticum L.) is a spice obtained by drying the buds that are harvested just before flowering when they are rich in essential oils. Clove essential oil is a very strong antiseptic and contributes to the preservation of food and the destruction of bacteria and also improves digestion. It is considered the best essential oil in aromatherapy. The main components of this oil are eugenol, eugenol acetate and caryophyllene. Clove essential oil is used as an analgesic, against nausea and vomiting. Have an excellent antirheumatic, antineuralgic, antispasmodic, antioxidant, antiseptic, anticancer, antiviral, carminative and expectorant effect, destroys insect larvae and as a stimulant gastric digestive. The antimicrobial activity of clove essential oil has been tested and proven in Gram-positive and Gram-negative bacteria and various types of fungi. Staphylococcus pseudintermedius is part of the physiological microflora of the skin and mucous membranes of healthy dogs and cats. It is the cause of superficial and deep pyoderma, inflammation of the ears, throat, nose and eyes, and in recent years and todaywe have strains that are resistant to methicillin. The aim of this study was to examine the antibacterial activity of clove essential oilon 11 clinical isolates of Staphylococcus pseudintermedius. The antibacterial activity of the essential oil was tested using an agar diffusion method on Müller Hinton agar. Clove essential oil showed antibacterial activity on 10 isolates with an inhibition zone in diameter from 11.00 to 23.66 mm. Also, the essential oil had a bacteriostatic effect on 8 tested isolates and bactericidal on 2 isolates. The shown antibacterial activity indicates a significant nutritional and phytomedical potential of the tested clove essential oil.

Key words: *inhibition, essential oil, antibacterial effect, clove (Syzygium aromaticum L.).*

TECHNOLOGICAL PROPERTIES OF WHEAT-TRITICALE-RYE FLOUR

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Abstract

The purpose and objectives of the research is to develop a technology for processing wheat-triticale-rye grain mixture and determine the baking properties of the obtained wheat-triticale-rye flour. Wheat grain line 5170, triticale grain Alexander and winter rye grain Moscovskaya 12 of 2017 were used as the objects of study. The baseline of wheat and triticale grain quality was determined by the infra-red analyzer of grain SpectraStar 2500 XL and is presented on Table 1.The quality evaluation of the obtained samples of wheat-triticale-rye flour was carried out in accordance with standards of GOST (State Standardization System) 26574 -2017 "Wheat bread flour. Technical specifications", GOST 34142-2017 "Triticale flour. Technical specifications" and GOST 7045-2017 "Rye bread flour. Technical specifications". In this paper, for the first time, comprehensive studies were carried out to determine the milling and baking properties of wheat –triticale- rye flour samples obtained by co-processing a grinding grain mixture of wheat, triticale and rye grain at the "Melnic 100 Lux" industrial mill. To determine and compare the milling and baking properties, we processed the original wheat grain and the grinding mixtures of wheat and triticale grain in proportions 50:40:10, 50:35:15, 50:30:20. According to the results of conducted tests it can be concluded that the original grinding mixture of wheat, triticale and rye grain in proportions 50:40:10 is the most optimal. In such proportions the yield and of high-grade flour and the total yield of flour is the highest and exceeds not only all other grinding wheat-triticale-rye grain mixtures but the control sample of wheat as well. In addition, the flour obtained from that grain grinding mixture has the highest whiteness typical of the highest quality flour. According to the results of the test laboratory baking it has been established that bread from wheat-triticale- rye in proportions of 50:40:10 has the most optimal quality indicator and is most similar to the control version of wheat bread.

Keywords: *grain mixture, clearance yield, wheat-triticale-rye flour, baking properties.*

SUPERCRITICAL FLUIDS: BASIC PRINCIPLES AND APPLICATIONS

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Abstract

Supercritical fluids are often referred as existing in a state somewhat between gases and liquids. In fact they are gases at pressure and temperatures above (but not much) those of the vapour-liquid critical point. As the critical pressures of known substances are (much) higher than atmospheric pressure, a first consequence is that a supercritical fluid is always a high pressure gas, and using them requires high pressure technology. Many books and reviews were published on different aspects of supercritical fluids. The most used supercritical solvent is carbon dioxide, somethimes modified by co-solvents such as ethanol or methanol. Most extraction applications are focused on natural products for human consumption, where the green status of carbon dioxide represents a clear benefit. Supercritical water is also used as supercritical fluid. Supercritical fluid based processes actually offer new opportunities to meet the challenge of producing high purity, chemically and physically stable micro- or nano-particles with low solvent residues.Processes involving supercritical fluids require less energy and are environmentally friendly compared to traditional processes involving organic solvents. Supercritical fluid extraction is a relatively new extraction process that has attracted great interest in many industries. This paper overviews the applications of supercritical fluid technology with using carbon dioxide as the ideal supercritical fluid because of its non-flammable, non-toxic, non-polluting and recoverable characteristics. A summary of commercial applications and examples of developments illustrate the different possibilities that SFE has in industrial processes.

Keywords: *carbon dioxide, processes, solvent, supercritical fluids, supercritical water.*

AN OVERVIEW OF BIODIESEL PRODUCTION

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Abstract

Accessibility of energy sources and climate change are the two biggest challenges that mankind facing in this century. The fast-growing population and the increasing prosperity have led to rapid rise in the energy demand. Every sector of the economy such as agriculture, industry, transport, commercial and domestic sectors require energy. The majority of the world energy needs, about 81.1% is supplied through petrochemical sources such as coal, oil and natural gas. Nuclear, hydro, biofuel and other renewable energy systems account only 18.9%. Diesel fuels have an essential function in the industrial economy of a developing country and used for transport of industrial and agricultural goods and operation of diesel tractor and pump sets in agricultural sector. One possible alternative to fossil fuel is the use of oils of plant origin like vegetable oils and tree borne oil seeds. This alternative diesel fuel can be termed as biodiesel. In this paper authors provide an overview of biodiesel production. It includes biodiesel superiority to conventional diesel, generations of biodiesel, production chemistry, models of production as well as techniques of transesterification. Based on the above, appropriate observations, conclusions as well as comparison between the techniques were presented.

Keywords: *biodiesel, catalyst, transesterification, vegetable oils.*

APPLICATION OF COLD PLASMA IN SUSTAINABLE FOOD PROCESSING

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Abstract

Food processing is one of the largest sources of environmental impact and sustainable sectors have focused its sustainability efforts to reduce CO_2 footprint, reduce waste, and to assure reduce, reduce, recycle principles. Nonthermal processing (NTP) has been investigated for food applications for the purpose of functionalisation and modification of physical properties of some macromolecules (i.e. starch) increasing shelf life, assuring food safety, extraction of bioactive compounds, to be used as pre-treatments before drying, freezing etc. Nonthermal technologies, can be applied as sustainable techniques, working in line with the sustainable development goals (SDGs) and Agenda 2030 issued by United Nations (UN). Cold plasma (CP) is nonthermal technology that has various application in different industries, like chemical and textile, and has possibility to be implemented in agriculture and food industry. There are electrotechnologies, like cold plasma processing, pulsed electric fields - PEFs, pulsed light – PL and e-beam processing. They have been extensively researched in laboratory conditions and possibility to scale up. Plasma is produced by ionization of gas and the results are production of free radicals, ions, electrons, and other discharges. There are advantages and disadvantages of using plasma, like for any other technology. Oxygen may cause food quality to decline, and there is possibility to reduce food quality. The advantages are reduced energy consumption and low temperature processing conditions. Cold plasma can be used for inactivation of pathogens due to formation reactive oxygen species (ROS) and reactive nitrogen species (RNS). Plasma activated water (PAW) and air (PAA) can be used for decontamination and improved seed germination rates. This approach uses a fluid (water) as a delivery media for plasma-generated reactive species. Plasma is also a promising technology for the control of pests in stored cereal crops and has insecticidal effects. Cold plasma treatment could offer various applications to replace conventional thermal, as well as enzymatic, processes for cell disintegration, particularly in the cereal industry. Waste, energy, economy, and environment are major pillar that needs to be managed in terms of Agenda 2030 and Sustainable Development Goals (SDGs). Product shelf-life extension is an identified global challenge to ensure food security and minimize waste. Cold plasma can be implemented in food industry in terms of reduced energy consumption, reducing energy costs and help to the society in general by reducing the use of energy resources and the emission of many air pollutants such as CO_2. In food processing industry, it has become significant to improve the energy efficiency and replace the existing energy-intensive unit operations, with new energy-efficient processes appropriate treatment of the discharged waste from the food industries is essential.

Key words: *plasma processing, sustainability, food waste, energy efficient processing, food industry.*

APPLICATION OF THE INTERACTIONS IN GELATIN/SODIUM CASEINATE SYSTEM FOR EDIBLE FILMS FORMATION

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Abstract

In order to increase sustainability in food industry the use of edible films as packing materials presents an attractive, ecofriendly alternative to the classic films made of synthetic polymers. The use of natural compounds, such as proteins, polysaccharides and lipids, as well as their combinations for the edible films and coating formation is becoming more common. Edible films are defined as a thin layers of biopolymers used to cover, package or wrap the food. Interactions in biopolymer solutions can be used to modify film properties. As a result of interactions in charged biopolymers solutions phase separation, i.e. coacervation, may occur. Coacarvation phenomenon has an application in various areas, including film formation.

The aim of the present work was to investigate the possibility of obtaining edible films based gelatin and sodium caseinate (NaCAS). Gelatin characteristics, including abundance, biocompatibility, low cost and absence of antigenicity, make gelatin an ideal raw material for food processing, packaging, as well as for pharmaceutical and biomedical applications. On the other hand, high nutritional value, the good sensory properties as well as the capability of protecting food products from their surrounding environment can be considered as the main reasons for the application of casein-based films in the food industry. Mixtures of gelatin and NaCAS, at various mass ratios, were casted in silicone molds and dried to prepare the films. Films were evaluated for FTIR analysis, mechanical, optical and barrier properties.

Obtained results showed that interactions in the system of these two biopolymers make an influence on films properties. Also, the influence of glycerin, as a plasticizer, addition was investigated.

***Key words:** : gelatin, sodium caseinate, edible films, coacervation.*

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EFFECT OF POSTHARVEST TREATMENT OF SALICYLIC ACID ON CHERRY INDICATORS OF THEIR PRODUCT QUALITY

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Abstract

Fruits of sour cherries are a food of high content of anthocyanins, quercetin, iron, potassium of vitamin C, and others. These ingredients and biologically active ingredients support human health, since sour cherry consumption prevents such diseases as cancer, cardiovascular system, diabetes, inflammatory disease. However, factors such as the degree of maturity in harvesting, storage conditions may reduce the nutrient content and biologically active components. Therefore, in over past years, there is an increased interest in using plant and material protection products prior to pre-treatment before storage: chitosan, morphine, salicylic acid, etc. Salicylic acid can be used both in the form of a vapor and a solution for spraying fruit. However, studies on the effects of post-harvest treatment with salicylic acid on sour cherry fruit are almost absent. Therefore, we were set to study the effect of treatment with salicylic acid on the quality of sour cherry fruit after storage. For this purpose, the sour cherry blossoms of the Lotovka variety in 2017-2019 were crop sprayed the day before the aqueous solution of 100 mg/l of salicylic acid was collected. Dried by natural way. After 24 hours, the fruits were taken from the tree typical of color and shape, placed in boxes № 5 of 5 kg of each. Storage at a temperature of 5 ± 0.5 °C and relative humidity of 95 ± 1%. By the following options: control - raw fruits and sour cherry fruits are treated with a solution of salicylic acid. After storage in the fruit, natural weight loss was determined in regard to the initial weight and yield of the product. According to researching results, after 15 days of storage, weight loss in sour cherry fruit was 4.9%. Then, for 21 days, fruit sour cherries processed with a solution of salicylic acid − 3.3%. Consequently, sour cherry fruit is a valuable source of biologically active substances, which can be saved through their pretreatment with salicylic acid solution. This will increase the output of commodity products by 84.4% with a mass loss of 3.3%.

Key words: *sour cherries, salicylic acid, storage, mass loss.*

ANTIOXIDANT ACTIVITIES OF SOY PROTEIN ISOLATES MODIFIED WITH THREE DIFFERENT PROTEASES

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Abstract

Nutritive, physicochemical and functional properties of plant-based protein products can be improved by physical, chemical and enzymatic treatment. In last 30 years, enzymatic hydrolysis has been recognized as effective and, from the standpoint of safety, the most appropriate way of plant protein modification. Peptides produced by partial proteolysis have smaller molecular size and less compact structure than original proteins. Such peptides contribute to increase in techno-functional and functional properties compared to those of the native proteins. To obtain desirable techno-functional properties of plant protein hydrolysates, hydrolysis must be done under strictly controlled conditions to a specified degree of hydrolysis (DH). A limited DH usually improves solubility, as well as emulsifying and foaming capacities, whereas excessive hydrolysis often causes decline in some of these functionalities. The objective of this work was to examine the effect of proteolysis on antioxidant properties of soy protein isolate. Soy protein isolate prepared by isoelectric precipitation was modified with two different commercial proteases (Alcalase and Flavourzyme) and papain for 30, 60 and 90 minutes. Hydrolysis was monitored by the change of DH and by SDS-PAGE. Antioxidant properties of the obtained hydrolysates were evaluated by three different methods: radical scavenging activity, reducing power and iron (II) chelating ability. The used enzymes differently affected antioxidant properties of soy isolate. All of three enzymes improved radical scavenging activity of initial isolate whereas the reducing power of all of investigated hydrolysates was lower than that of initial isolate. The effect of modification on iron (II) chelating ability depends on enzyme used. Alcalase and papain improved ability of isolate to chelate iron whereas Flavourzyme-modified isolates had reduced iron (II) chelating ability. The initial IC_{50} of soy isolate was improved by 31.55-43.87% (Alcalase-modified) and by 21.08-60.40% (papain-modified). In opposite, the IC_{50} value of Flavourzyme- modified isolates was 1.90- 3.15 times lower than initial isolate. Results of this research suggest that important factors that influence antioxidant properties of soy protein isolates are both type of enzyme and conditions under which the hydrolysis is performed. Proper selection of these parameters could result in production of modified soy protein isolates with excellent antioxidant properties. These isolates could be applied as functional ingredients in a wide range of food products.

Key words: *Antioxidant properties, soy protein isolate, enzymatic hydrolysis, degree of hydrolysis.*

PASTING PROPERTIES AND THE BAKING FUNCTIONALITY OF WHOLE-GRAIN WHEAT FLOUR WITH DIFFERENT AMYLOSE AND DIETARY FIBER CONTENT

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Abstract

Wheat starches of different amylose content, especially high amylose starches, have the potential to modify the texture and quality of end-use products by enhancing their nutritional functionality. In this study, the effect of starch structure, i.e. the content of amylose and amylopectin, as well as the content of protein and dietary fiber on pasting properties of whole-grain wheat flour was investigated. Pasting properties were analyzed through the viscosity profiles. Twenty-five varieties of wheat (Triticum aestivum L.) with diverse genetic backgrounds and geographic origins were used for testing. In addition, the baking functionality of wheat flour was determined using Solvent Retention Capacity method. The wheat genotypes were divided into five groups based on the amylose content: 1) 11-14%; 2) 15-17%; 3) 18-19%; 4) high amylose SBE I genotypes (over 35%) - 36.5-41%; and 5) waxy - 0% amylose (100% amylopectin). Viscosity curves of normal wheat groups 1, 2, and 3, with generally low amylose content, were similar in shape, although with considerable variations in peak and final viscosities. Genotypes with higher amylose content (group 4), produced no peak viscosity, while the pasting curve lowered with the increase of amylose content. As a result of starch granules swelling to the maximum, followed by a quick granule breakdown, flour paste of Waxy 1 genotype (100% of amylopectin) produced a peak viscosity at the lowest observed pasting temperature of 70°C and the shortest peak time. Results obtained in this study showed that amylose influenced viscosity by large. However, variations in pasting properties can as well be attributed to the differences in the non-starch structural and functional components such as proteins and dietary fibers. The results also indicate a difference in water, 50% sucrose, 5% sodium carbonate and 5% lactic acid absorption capacity between flours depending on the amylose content in it. The determined different viscosities and solvent retention capacities of whole-grain flour, indicate the possibility for the production of a range of bakery products from tested wheat genotypes.

Key words: *whole-grain wheat flour, amylose, dietary fiber, pasting properties, baking functionality.*

NEW FORM OF ELECTROSPUN NANOFIBERS LOADED WITH DRUG BASED-IONIC LIQUIDS FOR POTENTIAL TRANSDERMAL APPLICATION

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Abstract

In this work, a polymer film of nanofibers with satisfactory structure and uniformly distributed pharmacologically active ionic liquids (PAILs) on the nanofiber surface was obtained, by electrospinning aqueous solutions of PAILs and biocompatible polymers with different molecular weights, as well as by mass ratio variation of PAILs and polymer. In this way, an effective carrier for PAILs in electrospun composites is obtained, enabling their simple and safe application. The application of commercially available pharmaceutical substances to polymers by electrospinning was impossible and the technology of their conversion into ionic liquids has made this achievable. The field of ionic liquids covers all compounds which melt below 100 °C and usually are composed of large asymmetric cations and organic/inorganic anions and thus posses a unique and very practical advantage through their tunability. The concept of pharmacologically active ionic liquids synthesis represents the future of the pharmaceutical industry as they eliminate the main problems encountered by commercially available solid formulations: low solubility, polymorphism and low bioavailability. By adding nanofiber layer on the filter with a combined pharmacologically active ionic liquid, the novel product can be used as a source of antiviral, anti-inflammatory or any desired compound and developed in the form of optimized and more efficient transdermal skin patches or filters.
Firstly, lidocainium salicylate and procainium salicylate was chosen as PAILs, as a combination of a drug for local anaesthesia (lidocaine and procaine) and a nonsteroidal anti-inflammatory drug (salicylic acid), while a poly(ethylene oxide) was selected as a suitable biocompatible polymer. The polymer-IL blend solutions that enable their electrospinning and nanofiber formation were developed. To explain why the nanofibers can be formed, the electrospinning solution's properties were tested by viscosity and electrical conductivity measurements. Further, scanning electron microscopy (SEM) confirmed the surface morphology of the obtained nanofibers, while Fourier transform infrared spectroscopy (FTIR) verified the interactions between the ionic liquid and polymer in the nanofibers. The research revealed that the PEO-IL nanofibers' average diameter decreased with the increased IL content due to reduced viscosity and increased conductivity in the electrospinning solution. Also, thicker nanofibers were obtained with a higher molecular weight polymer. The electrospinning solution's electrical conductivity depended exclusively on the content of the ionic liquid, while there is no significant difference between the two ionic liquids. From obtained results, it can be concluded that nanofibers with loaded ionic liquid were successfully produced, which may present a novel acute transdermal drug delivery system.

Key words: *Nanofiber, Ionic liquid, drug, polymer, transdermal.*

THE HYDRATION PROPERTIES OF NOVEL, ZWITTERIONIC IONIC LIQUID

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Abstract

The replacement of organic solvents by eco-friendly alternatives would involve remarkable advances within the framework of green chemistry. Ionic liquids (ILs), also known as „designer solvents" are potential candidates for this aim. They are defined as compounds completely composed of ions with melting point below 100 ^{o}C, and with many attractive attributes, such as low flammability, low vapor pressure, excellent thermal and chemical stability. Zwitterionic ionic liquids (Zw-ILs) are structurally very similar to conventional ionic liquids, except that the positive and negative charges reside on the same molecule. These ionic liquids are used as enhanced solvents for cellulose dissolution while maintaining low toxicity and biocompatibility. For the first time, the carboxyl-functionalized Zw-IL 1-carboxyethyl-3-methylimidazolium chloride, [C_2COOHmim][Cl], was synthesized. Structure confirmation was obtained from recorded IR and NMR spectra. The acidity constant for this IL was determined experimentally and by computational simulations, and the results were compared with the acidity constant of propanoic acid. From these results, it can be noted that introduction of imidazolium ring in the structure of propanoic acid, instead of terminal hydrogen decrease acidity of ionic liquid. Based on density and viscosity measurements supported with computational simulations of the dilute aqueous solutions of [C_2COOHmim][Cl], interactions between water and newly synthesized ionic liquid were discussed. According to these results at different temperatures, it was concluded that [C_2COOHmim][Cl] manifests structure making properties. The calculated values of B-coefficient for 1-carboxyethyl-3-methylimidazolium cation were compared with literature values of propanoic acid and 1-ethyl-3-methylimidazolium cation. The highest B-coefficient values were obtained for [C_2COOHmim]$^{+}$. Additionally, computational simulations showed that the introduced carboxyl group enhances the structure making properties of the imidazolium-based ionic liquids. The introduction of the carboxyl group significiantly changes the water organization around imidazolium cation, promoting hydration properties of polar alkyl side chain and simultaneously reducing the hydration of imidazolium ring.

Key words: *Zwitterionic ionic liquids, simulations, structure maker, hydration.*

COMPARATIVE STUDY OF ANTIOXIDANT ACTIVITY OF META SUBSTITUTED CARBOHYDRAZONE AND THIOCARBOHYDRAZONE DERIVATIVES

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Abstract

Nowadays, many diseases such as diabetes, atherosclerosis, hypertension, heart, and other disorders are caused by the phenomenon of so-called oxidative stress, which is an imbalance between free radicals and antioxidants in the human body. A number of studies in the field of chemistry, biochemistry, and medicine are dedicated to the synthesis of new compounds and investigations of their antioxidant activity, in order to prevent the harmful effects of radical species. The efficacy of a compound as an antioxidant can significantly depend on its structure, type, and position of the substituent present. Many of the carbo- and thiocarbohydrazone based compounds tested so far have proven to be excellent antioxidant agents. Derivatives with halogen elements (such as chlorine and bromine), a hydroxyl, or a methoxy group as substituents stand out with particularly good activity. Considering previous studies, in this paper, the antioxidant activity of six meta-substituted carbohydrazone derivatives and the same number of analogous thiocarbohydrazone derivatives was examined using three different antioxidant assays: DPPH, ABTS, and FRAP assay. All tested compounds proved to be good antioxidant agents. The results obtained using the DPPH assay indicate better antioxidant activity of thiocarbohydrazone derivatives, while the values obtained using ABTS assay differ slightly from each other, so it can be concluded that this assay is not sensitive enough for the tested compounds. Finally, the FRAP assay turned out to be inadequate for examining the antioxidant activity of carbo- and thiocarbohydrazone derivatives due to the secondary reaction with iron ions.

Key words: *ABTS, antioxidants, carbohydrazones, DPPH, FRAP, thiocarbohydrrazones*

POSSIBILITY OF USING LANDFILL GAS AS ENERGY

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Abstract

Today, when energy efficiency and the use of energy from renewable sources have become imperative, with the aim of slowing down the process of climate change and global warming, the use of landfill gas for energy purposes should be an additional motive and one of the most important tasks of experts, who is dealing with waste management. Advanced knowledge of landfill behavior and municipal solid waste decomposition process has led to a concept that has enabled the upgrade of existing technology, from waste storage, to an approach, which is based on waste processing within the landfill, ie the so-called bioreactor landfill. As a result of anaerobic processes of waste decomposition inside the landfill, additionally stimulated by the action of moisture from recirculation of leachate, significantly higher landfill gas emissions are generated, ie each percentage increase in moisture inflow compared to the existing amount of incoming moisture, which includes precipitation with concentrate recirculation, leads to landfill gas production by 13.8%. The LandGEM model showed a significantly higher potential of landfill gas production compared to other models, which is shown to be possible, using the obtained dependence of gas production on moisture inflow and can be a form of verification of model results based on analysis conducted in this study.

Key words: *renewable energy, leachate recirculation, landfill gas, LandGEM model.*

BIO-RENEWABLE MEMBRANES BASED ON MODIFIED CELLULOSE, LIGNIN, AND TANNIC ACID FOR DIFENOCONAZOLE AND THIOPHANATE-METHYL REMOVAL

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Abstract

Aquatic pollution caused by pesticides as a consequence through run-off, leaching, and sub-surface drainage, may pose a serious health hazard for living being and ecosystems due to pesticides persistent nature and bio-magnification. Since most organic pesticides are non-degradable and carcinogenic, they represent a potent category of water contaminants. The aim of the presented work was to develope functional biodegradable membranes which could be used as an efficient adsorbent for the removal of pesticides (difenoconazole and thiophanate-methyl) from aquatic solutions. The bio-renewable membranes (Cell-El and Cell-El-Ta) based on epoxy-amino reactivity of the Cellulose fibres (Cell) modified with diethylenetriamine (Cell–Deta), (3-Glycidyloxypropyl)trimethoxysilane (Cell-Glymo), Lignin modified with epichlorohydrine (El) and Tannic acid (Ta), as an additional crosslinker, were produced by optimized methods through the application of novel approaches. The membrane preparation was conducted at the appropriate molar ratio of functional groups designed to provide numbers of residual functionalities effective for pesticide removal. The membranes were characterized by Fourier-Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscopy (SEM). FTIR spectral analysis was used to identify the characteristic functional groups of produced membranes and spectral pattern change as a result of the formation of coordination complexes of pesticides with surface functionalities. Controlled modification of Cell fibre and subsequent production of Cell-El and Cell-El-Ta membrane causes change fibres surface and material morphology, and SEM analysis proved successful modification and membrane production with formation a large number of fibres interconnections. The effects of contact time, temperature, and initial concentration of pesticides on adsorption were studied in a batch system. The Langmuir, Freundlich, Temkin, and Dubinin-Radushkevich (D-R) isotherm models were used to evaluate the adsorption process, and to predict the adsorption capacity of the adsorbents. The experimental results were best fitted with the Langmuir isotherm model. The calculated capacities: 32.2, 69.3, 45.1 and 83.2 mg g^{-1} for difenoconazole and thiophanate-methyl using Cell-El and Cell-El-Ta, respectively, were obtained from Langmuir model fitting at 25^{o}C. The thermodynamic parameters indicated spontaneous and low endothermic processes. The present study demonstrates that prepared membranes could be an effective and low-cost adsorbent to prevent contamination of water and consequently help minimize the environmental impact caused by the pesticides.

Key words: *Cellulose membrane, batch study, difenoconazole, thiophanate-methyl;*

INFLUENCE OF YOGURT FORTIFICATION WITH ENCAPSULATED CARROT WASTE EXTRACT ON FERMENTATION CULTURE DURING THE STORAGE PERIOD

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Abstract

In the past decades, the design of functional products in fermented dairy industry has potentiated the addition of extremely valuable bioactive components such as carotenoids, phenols, etc. This concept has multiple benefits that are reflected in the exploitation of a large amount of waste rich in bioactive components as well as reducing health problems associated with nutritional deficiencies. In this study, a microbiological study of kinetics models for fortified and a control yogurt during the storage period at 4°C during 28 days was done. The yogurt was fortified with different concentrations of encapsulated carrot waste rich in carotenoids in the final step of yogurt preparation. Kinetics modelling was done for fermentation culture which contained lactic acid bacteria Streptococcus thermophilus and Lactobacillus delbrueckki subsp. bulgaris. The addition of encapsulated carrot waste did not primarily affect the microbiological characteristics at all. On the other hand, some differences in kinetic models of the viability and behavior of the bacterial culture were observed in comparison to control and fortified yogurt during the storage period. In summary, the addition of encapsulated carrot waste did not cause a statistically significant difference in the bacterial viability during the complete observed period but affect bacterial behavior in fortified yogurts.

Keywords: *carrot waste extract, β-carotene, lactic acid bacteria, kinetic modelling.*

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SUSCEPTIBILITY OF WILD MICROBIAL STRAINS TO RASPBERRY (*Rubus idaeus* L.) FRUIT CULTIVARS

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Abstract

Rubus idaeus L. (raspberry) is one of the most famous Serbian fruit. Between 90 and 95% of cultivated raspberries in Serbia are "North American Willamette" cultivar, which is characterized by the excellent taste and a dark red colour. Besides the Willamette, it is requested and Meeker cultivar. Raspberry is rich in phenolic compounds such as phenolic acids, flavonoids and anthocyanins. Raspberry is not only available fresh, but is also generally consumable frozen and processed into juice, jam, ice cream and wine. Because of the biological properties associated with berry fruits, the identification of their antimicrobial activity against wild strains was the objective of this study. Tested strains were: Staphylococcus saprophyticus, Bacillus sp., Listeria monocytogenes (Gram-positive bacteria), Escherichia coli, Pseudomonas aeruginosa, Salmonella sp. (Gram-negative bacteria), Candida albicans (yeast), Aspergillus niger and Penicillium aurantiogriseum (moulds). Screening of antimicrobial activity of two raspberry cultivars (Meeker and Willamette) in concentration of 50 mg/ml, was performed by disc diffusion method (using 15 µl of extracts) and agar-well diffusion method (100 µl of extracts). Minimal inhibitory (MIC) and minimal bactericidal (MBC) concentrations of investigated extracts were determined by microdilution method. The least activity of raspberry extracts for all tested bacterial strains was obtained by disc diffusion method. Tested extracts in amount of 100 µl had an inhibitory activity against all tested bacteria, of which the most susceptible strain on both cultivars was Pseudomonas aeruginosa (inhibition zone 16 mm to Meeker and 18 mm to Willamette cultivar). There was no inhibition zones toward yeast and moulds, that indicate those strains are resistant to raspberry extracts. For Meeker cultivar, MIC were in the range 1.562 - 9.375 mg/ml, and MBC in the range 1.562 - >25 mg/ml. For Willamette cultivar, MIC were in the range 3.125 - 18.75 mg/ml, and MBC in the range 3.125 - >25 mg/ml. The most susceptible strain among Gram positive bacteria to both cultivars was Bacillus sp. (MIC = 1.562 mg/ml, MBC = 3.125 mg/ml). Among Gram negative bacteria Pseudomonas aeruginosa was the most susceptible strain to Meeker cultivar (MIC = 4.687 mg/ml, MBC = 12.5 mg/ml) and Salmonella sp. (MIC = 12.5 mg/ml, MBC = 25 mg/ml) to Willamette cultivar.

Key words: *antimicrobial activity, raspberry cultivars, minimal inhibitory concentration, minimal bactericidal concentration*

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SYNTHESIS, CHARACTERIZATION AND ANTIBACTERIAL ACTIVITY STUDY OF COBALT SALICYLATE AND DICANOATE

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Abstract

In this work we are interested in the synthesis and characterization of two cobalt (II) complexes. For this fact, decanoic acid, and salicylic acid were selected as the complexing ligand of cobalt by their acid function. The cobalt (II) complexes were synthesized in our laboratory by extractive way and under reflux. The coordinating method of ligands was determined by infrared spectrometry. A study by UV-Visible spectrometry was used to determine the mode of coordination and propose an octahedral environment for complexes with each ligand. The antibacterial activities study of these products showed that has different influences on the bacteria, while the effect of the complex decanoate show significant activity against Staphylococcus aureus and Escherichia coli. However, the salicylate complex was found to be more active against all tested bacterial strains because the ligand itself is active against microbes.

Key words: *Decanoic acid, Salicylic acid, Cobalt (II), Antibacterial activity.*

EFFICIENT REMOVAL OF Cd^{2+} FROM AQUEOUS SOLUTION USING SUBGLEBA OF MUSHROOM *Handkea utriformis*

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Abstract

[illegible]

Keywords: *adsorption; mushrooms; subgleba; Cd^{2+}; water treatment*

TESTING THE POSSIBILITY OF DYES ADSORPTION FROM AQUEOUS SOLUTIONS BY CHEMICALLY MODIFIED BENTONITE

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Abstract

Large number of chemical dyes used in various industries (such as textile industry, pharmaceutical industry, food industry, dyes industry, plastics industry and cosmetics industry) enter wastewater and become a danger to the aquatic environment by reducing the concentration of oxygen and preventing the penetration of light into deeper layers of water. The adsorption process proved to be one of the most efficient procedures for their removal. Due to the high cost of activated carbon as an adsorbent, other, cheaper solutions are being sought. Bentonite, although a very good adsorbent due to its hydrophilic surface is limited to the adsorption of polar inorganic pollutants. Chemical modification of the surface of bentonite with a surfactant changes its surface from hydrophilic to hydrophobic, and increases the adsorption capacity of organic pollutants such as dyes. The aim of this work is to modify bentonite with a cationic surfactant and to find the optimal concentration for modification. The modified bentonite will be used as a potential adsorbent to remove dyes from aqueous solutions. For the modification, a commercial product under the trade name STEPANTEX DC 90 was used, which is composed of quaternary ammonium salt (CAS 157905-74-3, 90%), with 10% isopropanol (CAS 67-63-0). The adsorption process proved to be one of the most efficient The bentonite structure was modified with a series of different concentrations of cationic surfactant, and their adsorption capacity was tested on two colors: bemacid red and methylene blue. In addition, the effect of adsorbent dose, adsorbate concentration, and contact time on the efficiency of dyes removal from the aqueous medium was examined. Bentonite modified with acationic surfactant shows the ability of adsorption of textile dyes from simulated wastewater, respectively from aqueous dye solutions. Increasing the mass of modified bentonite B10 increases the removal efficiency of both dyes. The optimal mass of bentonite sample for adsorption of methylene blue dye from aqueous solution (c = 100 mg/L) is 0.080 g. Modified bentonite B10 adsorbs the cationic color methylene blue better than the anionic dye bemacid red. By prolonging the contact time of the methylene blue dye solution and the bentonite B10 sample, the efficiency of dye removal from aqueous solutions also increases. As the concentration of the methylene blue dye solution increases, the adsorption efficiency with increase dose of bentonite B10 decreases.

Key words: *adsorption, dyes, water solutions, bentonite clay, modification of bentonite.*

UTILIZATION OF WASTEWATERS FROM RED WINE TECHNOLOGY FOR XANTHAN PRODUCTION IN LABORATORY BIOREACTOR

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Abstract

The sustainable management of agro-industrial waste is a cost-effective and eco-friendly approach for conservation of natural resources and preservation of environmental quality. Among the traditionally practiced agricultural and industrial activities, the wine production is of great importance, and with the improvements of living standards the red wines have become popular. Although wineries is not considered as a polluting facility, the wastewaters generated during the red grape processing into wine have notable negative environmental impact. These effluents are rich in various organic and inorganic contaminants, as well as components that contribute to dark color. It is known that winery wastewaters are usually disposed into the environment without adequate treatment because they are more difficult to treat than liquid effluents from other food industry due to seasonal nature of wine production. Considering that there is an increasing demand for wines, especially red wines, the main challenge in wine producing countries around the world is the sustainable management of variable quantity of wastewater with different pollution load. Over the past years, biotechnological processes for obtaining market-valuable products, as commercially important bacterial biopolymers like xanthan, have received a considerable attention for reuse of many waste streams, including wastewaters from white and rose wine production. In this study, the xanthan biosynthesis by Xanthomonas campestris ATCC 13951 is presented as a sustainable solution for utilization of wastewater from red wine technology. The cultivation of selected producing strain was carried out on media based on the wastewaters generated during washing of the crusher, press and fermentation tank with the same initial concentrations of sugars (25 g/L), in 3 L laboratory stirred tank bioreactor under optimal conditions for 120 h. The bioprocess efficacy was estimated based on the xanthan concentration and degree of nutrient conversions. The obtained results confirm the possibility of xanthan biosynthesis on media based on all investigated wastewaters from red wine technology. In applied experimental conditions, reference strain was produced xanthan in quantity of 9.24-16.46 g/L, while significant purification levels of winery effluents were simultaneously achieved, which is confirmed by relatively high values of nutrient conversions (38.41-74.69% for sugars, 22.34-49.68% for total nitrogen and 64.08-70.39% for total phosphorus). The present study provides valuable information about efficacy of utilization of wastewaters from red wine technology that can be used for further investigations which are necessary for industrialization of examined bioprocess.

Key words: *Red wine technology, Winery wastewater management, Biotechnological utilization, Xanthan production, Bioprocess monitoring.*

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UPGRADING OF A FUEL POTENTIAL OF WASTE BIOMASS VIA HYDROTHERMAL CARBONIZATION

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Abstract

In recent decades, the massive exploitation of fossil fuels, with a detrimental impact on the environment, caused a growing demand for the production of energies from renewable sources. One of the researchers' solutions was the application of waste biomass, but there are many disadvantages of its direct utilization, that include high moisture content, low energy content, high volatiles content, etc. In order to overcome these disadvantages, attention has been focused toward development of technologies for conversion of biomass into a multi-functional products. Hydrothermal carbonization (HTC) has recognized as highly effective technology for production of carbon rich material, hydrochar, from wet and waste biomass. Hydrochar possess a great potential for application as an energy source, for environmental protection, in agriculture. In this paper, three selected biomasses (corn cob (CC), Paulownia leafs (PL) and olive pomace (OP)) were hydrothermally carbonized at different temperatures (180, 220 and 260°C). The main goal of this study was to examine the influence of temperature on the structure and fuel characteristics of the obtained products and to compare it with the precursor. The results showed that the solid yiels decreases significantly with increasing temperature in all samples. On the other hand, C content increase upon temperature increment and reach the highest values in hydrochars obtained at 260°C (69.30% for CC, 64.54% for PL and 70.97% for OP). Also, a decrease in O/C and H/C atomic ratios with increasing temperature was observed. The results are shown in the Van Krevelen diagram, which reveals the transformation of precursors during carbonization from the biomass to the lignite region. Furthermore, with decrease of O/C and H/C ratio, higher heating value (HHV) was increasing and reaches the maximum values for hydrochars prepared at 260°C (27.33 MJ/kg for CC, 28.06 MJ/kg for PL and 30.55 MJ/kg for OP). The same trend is noticeable with ED contents. Also, the content of volatile matter (VM) was determined in all samples. VM decreases (from 90.45 to 55.42% for CC, from 76.70 to 62.10% for PL, from 82.86 to 66.77% for OP) with temperature contributes to less evaporation and pollutant emission during direct combustion. According to results, can be concluded that temperature has a great influence on the structure and characteristics of the obtained products, that dehydration and decarboxylation during HTC provoke intensive biomass carbonization and that hydrochars obtained at higher temperatures have significantly enhanced fuel properties and less volatiles compared to the biomass.

Key words: *hydrothermal carbonization, hydrochar, waste biomass, biofuel.*

ULTRASOUND-ENHANCED CATALYTIC DEGRADATION OF PHARMACEUTICALS BY MANGANESE OXIDE NANOPARTICLES

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Abstract

Water pollution by pharmaceuticals is an emerging problem in last few decades. It was found that antibiotics and analgesics in surface waters endanger small living organisms, causing genetic deformations, mutations, sterility and many other problems. In parallel, antibiotics in surface and waste water are significant problem. Namely, their presence in the biological waste water treatment plants is de-balancing the microbiological cultures, causing the decrease in efficiency of the treatments. For the same reason (preservation of the flora), too aggressive treatment is not an option. Therefore, solutions like pre-treatment of the waste water before the entrance into the biological treatment plant is a necessity.
Present research shows application of the manganese oxide nanoparticles, as a degradation catalyst for tetracycline and diclofenac molecules, known as some of the most frequent pharmaceutical pollutants [1,2,3]. There are already some reports on this subject in the literature, however, this is the first report on significant enhancements of this treatment with an application of ultrasound [4]. Characterization of synthesized manganese oxide nanoparticles (Figure 1) is performed by STEM and XRD instrumental methods and is used for discussion of degradation kinetics of these two pollutants.

Key words: *nano-manganese oxide, tetracycline, diclofenac, degradation, water treatment*

BIOCONTROL POTENTIAL OF DIFFERENT *TRICHODERMA* ISOLATES AGAINST MAIZE PHYTOPATHOGENS

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Abstract

Usage of chemical plant protection agents in agricultural production contributes to environmental pollution and emissions of factors harmful for human health. It has been noted that their overexploitation has resulted in the emergence of resistant species and chemical compounds in the food chain, which indicates the need to find new agents with improved characteristics. One of the solutions is certainly the use of beneficial microorganisms. Considering that maize is a significant agricultural crop very present in the human diet, its health safety is of great importance. In this paper, the ability of three Trichoderma isolates, isolated from the environment, in the biological control of the most common maize pathogens, was examined. Cultivation of Tricoderma isolates was performed on PDB (Potato Dextrose Broth) medium by shaking at 150 rpm for 7 days at 25°C. After 7 days of cultivation, the effect of both, cultivation broth and supernatant, against selected maize phytopathogens was examined using wells diffusion technique. The results showed that the cultivation broth showed a statistically significant efficacy on selected maize phytopathogens compared to the supernatant, using all Trichoderma isolates. By applying the Scheffe test, it was determined that the best effect on the test maize phytopathogens show cultivation broth of T. harzianum, forming maximum mean inhibition zone diameters of 50.33 mm for Fusarium graminearum, 40.67 mm for Helminthosporium carbonum, 25.67 mm for Aspergillus flavus and 25.33 mm for Penicillium sp. Since each inhibition zone larger than 22 mm shows that the produced agent is highly efficient, based on the obtained inhibition zone diameters of all tested isolates, it can be concluded that the produced T. harzianum cultivation broth shows high efficacy against four maize phytopathogens in vitro. This results once again confirms the great potential of Trichoderma isolates in biological control, which certainly contributes to the development of sustainable agricultural production and consequently has a positive impact on human health.

Key words: *Trichoderma spp., bioprocess, biological control, maize protection, phytopathogenic fungi.*

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ALGINATE-BASED ENCAPSULATION OF POLYPHENOLS FROM *ROSA CANINA* L. EXTRACT

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Abstract

Rosa canina L. (Rosaceae) is frequently employed in traditional medicine, due to its diuretic, anti-inflammatory, anti-allergic, antioxidant and analgesic effects. It is rich in various bioactive compounds, including polyphenols, carotenoids, ascorbic acid, mineral elements and fatty acids. Microencapsulation tehnique is a promising tool for improving R. canina polyphenols' functionality, stability and bioavailability. Electrostatic extrusion process was carried out to obtain calcium-alginate beads with encapsulated R. canina extract. In pure extract, total polyphenol content was 103.8±1.9 mg GAE/g, whereas the concentration of flavonoids was 64.2±2.40 mg CE/g. Furthermore, polyphenol and flavonoid contents in extract loaded hydrogel beads were 4.68±0.12 mg GAE/g and 2.93±0.23 mg CE/g, respectively. Thus, determined encapsulation efficiency was 45.04±1.15%. In ABTS test, antioxidant activity of pure extract and extract loaded hydrogel beads was 15.30±2.10 and 2.93±0.23 mg Trolox/g, respectively. In DPPH test, IC_{50} of pure extract and extract loaded hydrogel beads was 1.07±0.01 and 29.32±2.15 mg/mL, respectively. The size of the produced R. canina extract encapsulated hydrogel particles was 550.30±34.56 µm. In distilled water as a medium, most of polyphenols were released relatively rapidly from alginate beads (in the first 20 min), and the maximum release plateau was reached at 60 min. This study demonstrates the potential of using alginate for encapsulation of R. canina polyphenols, with the aim to improve their functionality, bioavailability and stability in food, cosmetic and pharmaceutical products.

Key words: *alginate beads, encapsulation, polyphenols, Rosa canina.*

GC-MS ANALYSIS AND BIOLOGICAL ACTIVITY OF ESSENTIAL OIL OF *PICEA ABIES* FROM THE REPUBLIC OF SRPSKA

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Abstract

The quality of the essential oil obtained from the wood verdure of spruce from the territory of the Republic of Srpska was analyzed by examining the chemical composition, antioxidant activity and antimicrobial activity of the samples produced by the process of hydrodistillation in industrial production conditions. The chemical composition of the essential oil was analyzed using GC/MS and GC/FID analysis. The antioxidant and antimicrobial activity of spruce essential oil has been examined for its possible application as a natural antioxidant and antimicrobial agent. The obtained results prove the presence of 38 components in the analyzed sample. The total components present (98.3%) were identified. The most common are monoterpene hydrocarbons, followed by oxygen-containing monoterpenes and sesquiterpene hydrocarbons. The antioxidant activity was investigated by the DPPH assay. Spruce essential oil has shown the best antioxidant properties after 120 minutes of incubation with an EC_{50} value of 20.15 ± 0.08 mg/ml. Antimicrobial activity was investigated using a disk diffusion method. The results showed large zones of inhibition for both tested oil sample and for all eight bacterial strains analyzed (from 14.33 ± 1.15 mm to 20.00 ± 0.00 mm) as well as for the fungal strain. The chemical composition, antioxidant and antimicrobial action of spruce essential oil obtained from plant material from the Republic of Srpska indicate significant phytomedicine potency.

Key words: *Essential oil, Pices abies, GC/MS analysis, Antioxidant activity, Antibacterial activity.*

ZEIN–RESIN COMPOSITE NANOPARTICLES WITH COENCAPSULATED CARVACROL

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Abstract

This paper evaluated the potential of zein–resins nanoparticles to act as a carrier for water–insoluble oil carvacrol. The rosin and shellac were used as natural resins in different mass ratio to plant protein zein. Zein is a major corn protein, inexpensive, biodegradable, and biocompatible. Rosin is one of the natural gums obtained as resinous constituent of the oleorosin. Shellac is a resinous secretion of the insect, which is a natural hydrophobic biopolymer. The influence of nanoparticle compositionon colloidal properties, encapsulation efficiency and release of oil was studied. Carvacrol encapsulating zein/rosin and zein/shellac nanoparticles with different carrier composition were synthesized using liquid-liquid dispersion method. Zeta potential and size of thus prepared nanoparticles were studied. Carvacrol encapsulation efficiency and release was determined by HPLC method developed for these compounds. Results showed that resin type and share affect encapsulation efficiency and release of carvacrol. It was also shown that addition of resins enhanced release from nanoparticles, compared to plain zein nanoparticles. Findings in the present work will help further understanding ofthe interaction between alcohol-soluble biopolymers (e.g.zein, rosin and shellac) and provide a new insight into the development of natural carriers for bioactive compounds.

Keywords: *protein, biopolymer, natural resins, oil encapsulation.*

INFLUENCE OF NATURAL EMULSIFIERS ON MECHANICAL PROPERTIES AND SURFACE MORPHOLOGY OF ALGINAT/PROTEIN/LECITHIN CARRIERS FOR ESSENTIAL OIL

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Abstract

Due to the increasing consumer awareness of the unhealthy effect of artificial preservatives, there is a growing interest in finding new, 'green' alternatives that will have a beneficial role in food preservation. Several studies have shown that thyme oil has a strong antimicrobial effect due to the high content of thymol and carvacrol. However, bioactive essential oil compounds are unstable and easily volatile, so great attention is focused on the development of encapsulation techniques that enable the biological activity of a given substance to be retained in order to preserve food for a long period. Alginate is one of the most used polysaccharides for encapsulation of various bioactive substances, due to its biocompatibility, non-toxicity and low cost. Unfortunately, the mechanical stability of alginate beads is a challenging task for various applications of these hydrogels in the food industry. This work aims to examine if the addition of natural emulsifiers (soy protein and soy lecithin) to alginate will form hydrogels with improved mechanical properties. Hydrogel beads were produced by combining the emulsion process, electrostatic extrusion and gelification. Different beads formulations, depending on the concentration of alginate (1-1.5 wt.%), protein (1-1.5 wt.%) and lecithin, were evaluated regarding its size, shape, encapsulation efficiency, porosity and mechanical stability. The encapsulation efficiency of hydrogel beads varied from 70% to 85.9%, depending on the formulation. The surface of the alginate/protein/lecithin hydrogels shows a noticeable change in comparison to the corresponding lecithin-free formulations - more curved but closed surface morphology. The synergistic effect of protein and lecithin at the interface, as well as an excess of lecithin in the continuous phase which contributed to the creation of phospholipid micelles, resulted in the improved mechanical stability of tested hydrogel beads. An increase in protein concentration also contributed to mechanical strength, wherein the best results for maximum force (0.326±0.014 N) and elastic modulus (123.7±4.70 kPa) were achieved for the carrier prepared with alginate 1.5 wt.% and soy protein 1.5wt. % with the addition of lecithin.

Key words: *alginate, SPI, lecithin, hydrogel,; mechanical properties.*

INFLUENCE OF TITANIUM OXIDE NANOPARTICLES ON THE THERMAL AND DIELECTRIC PROPERTIES OF ANTIMICROBIAL PRINTED TEXTILE

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Abstract

In this paper thermal and dielectric properties of antimicrobial printed cotton fabric and cotton knitwear are investigated. Also influence of titanium oxide nanoparticles on these properties are studied in detail. The samples are screen printed using alginate paste (CHT-NT) with alcoholic extract of Pinus sylvestris L. Alginate pasta is prepared by mixing with water (8/92 weight ratio) and after that alcoholic extract (100 mg/ml) and TiO_2 nanoparticles are added. Air permeability and thermal conductivity coefficient are measured for all samples and antimicrobial activity is confirmed. In addition, specific conductance and susceptance are measured in a wide frequency range at room temperature.

Key words: *Thermal properties, Dielectric properties, Antimicrobial activity, TiO_2 nanoparticles, Pinus sylvestris L., Cotton.*

CHANGES IN CHEMICAL PROPERTIES OF THERMALLY MODIFIED WOOD

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Abstract

Wood modification implies all physical and chemical changes that occur in wood to protect it, as well as to achieve better mechanical and aesthetic properties of wood as a material. Unlike many industrial protection processes, which are based on wood coating and impregnation with toxic chemicals, thermal modification is an environmentally friendly way for wood protection that provides the possibility of its application for interior designs. All changes in the chemical structure of wood, and its physical characteristics, depend on several important factors, such as the initial state of the wood, wood type, thermal profile and processing time, wet or dry processing atmosphere, sample dimensions and treatment duration. These parameters must be adapted to wood types and the final purpose of the heat-treated wood. In the last decade, various industrial wood heat treatment processes have been commercialized around the world. Different types of wood can be subjected to this treatment, but the process optimization must be carried out for each species, individually. For this research, fir, spruce, oak and pinewood were used as raw materials, as these are the most common wood types found in Republika Srpska and the wider region. The thermal process of modification was performed out in a dry environment, respectively in an air atmosphere and an atmosphere saturated with water vapor, at a temperature of 125°C, without prior drying. A laboratory dryer was used for treatment in a dry atmosphere, while a laboratory thermal chamber was constructed for the treatment in a wet atmosphere. Wood modification after heat treatment was evaluated based on the analysis of chemical and physical properties of wood and comparison with the properties of untreated wood samples.

Key words: *wood modification, heat treatment; weight loss; chemical changes.*

CHARACTERISTICS AND PHYSICAL-MECHANICAL PROPERTIES OF KAOLINIZED GRANITE

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Abstract

During the long geological past, the rocks of the Adriatic block were formed, which includes the rim of Cer and the Jadar basin. The rim of Cer is characterized by igneous rocks - granite, granodiorite and Paleozoic shale, while the main constituents of the Jadar basin are lake sediments like, clay, sand, gravel, sandstone, sandy limestone. Some of these constituents are classified as kaolin raw materials, which can be formed during hydrothermal decomposition. This process involves physical and chemical changes of various rocks of igneous origin that contain feldspar and mica, such as granite. Within this paper a detailed chemical-mineralogical-physical characterization of four kaolinized granite composites (KI, KII, KIII and KIV) from the Beli Majdan deposit-Jadranska Lešnica was done, since study of silicate raw materials used in the construction and ceramic industry is a very important and continuous problem. Kaolinized granites are formed by subvolcanic decay of granite. In technological terms, these are weakly bound rocks, which are comminuted into smaller aggregates by the grinding process. The techniques used in this study to examine kaolinized granite composite samples included chemical analysis, X-ray diffraction (X-ray), differential thermal analysis (DTA), and ignition tests at three selected temperatures (1000, 1100, and 1250°C). Based on X-ray analysis, it can be concluded that the mineral composition of the kaolinized granite composite "Beli Majdan"-Jadranska Lešnica includes quartz, feldspar, mica, calcite/dolomite and clay minerals, wherein the most common minerals are quartz and feldspar (aluminosilicate containing cations of alkali and alkaline earth metals). Minerals from the mica group as well as carbonates (Ca and Mg) occur in smaller quantities. The results of chemical analysis showed that the Al_2O_3 content in the tested composites ranged from 19.02 to 21.04%, and the Fe_2O_3 content from 1.48 to 1.65%. Additionally, the Na_2O content varied from 1.78 to 2.64%, while the K_2O content in the tested composites ranged from 5.32 to 6.45%, which indicates the presence of K-feldspar and muscovite. The results of DTA analysis in all investigated composites indicated the presence of quartz and clay minerals. Based on the obtained experimental results, it can be concluded that kaolinized granite "Beli Majdan"-Jadranska Lešnica is a quality raw material for composing ceramic masses in the production of ceramic tiles. It acts as a solvent and can partially or completely replace feldspar in ceramic masses.

Key words: *kaolinized granite, Beli Majdan, raw material characterizaton, minerals.*

ANTIMICROBIAL RESISTANCE OF *SALMONELLA* SPP. ISOLATED FROM FOOD

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Abstract

Foodborne disease has emerged as an important and growing public health and economic problem in many countries. Salmonella belong to the most significant pathogenic microorganisms and one of the most common causes of food poisoning. All species of this genus are pathogenic to humans and cause various diseases known as salmonellosis. People get infected through the faecal-oral route by consuming various types of contaminated food and water or in direct contact with an animal. Salmonella can be transmitted directly from person to person. It is most commonly transmitted to humans through contaminated food of animal origin. Salmonella strains that are resistant to antimicrobial drugs which can transfer resistance genes to other microorganisms, are particularly dangerous. The control of salmonellosis primarily depends on a good surveillance system because the use of antimicrobial drugs in therapy, prophylaxis and as a growth promoter in animals used for food production has opened the question of developing bacterial resistance in animals and possible transmission through the human food chain. The aim of this study was to examine the antimicrobial resistance of Salmonella spp. isolated from food (amoxicillin 30 µg, cefuroxime 30 µg, trimethoprim sulfamethoxazole 25 µg, chloramphenicol 30 µg, tetracycline 30 µg, ciprofloxacin 5 µg, gentamicin 30 µg, nalidixic acid). A total of 10 confirmed isolates of Salmonella spp. from chicken meat were tested. The obtained results show that the isolates showed 100% resistance to amoxicillin and that 70% of the isolates of Salmonella spp. were multi-drug resistant. In addition to amoxicillin the highest resistance of the isolates was to nalidixic acid and ciprofloxacin. The lowest resistance was found to gentamicin and cefuroxime.

Key words: *resistance, Salmonella spp., contamination, multi-drug resistance strains.*

FERMENTED BARLEY BRAN: AN IMPROVEMENT IN PHENOLIC COMPOUNDS AND ANTIOXIDANT PROPERTIES

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Abstract

Barley (Hordeum vulgare) is an *edible annual grass in the* family Poaceae, and is a major cereal grain *grown in temperate climates globally. Barley has high contents of bioactive compounds (phenolics, tannins and flavonoids) such as tocopherols; β-glucans; tocotrienols. These compounds are associated many health promoting effects in food, such as anti-carcinogenic, anti-microbial, and antioxidant properties. Fermentation is a process to increase the bioavailability of nutrients and to alter the health-promoting components (antioxidants) in whole grain products. Keeping this view, fermentation of barley bran was performed for 7 days with starter culture [Aspergillus oryzae (MTCC 3107)]. Non-fermented and fermented barley bran (powdered form) was extracted using ethanol (50%) at 50°C for 30 min in water bath. Fermentation positively affected the bioactive compounds of barley bran as indicated by enhanced TPC (from 1.23 to 14.32 mg GAE/g). An increase in bioactive compounds significantly enhanced the antioxidant potential of barley bran extracts. Further, more bioactive compounds in fermented barley bran extract as compared to non-fermented counterparts were confirmed using HPLC. Non-fermented samples indicated the presence of ascorbic acid (20.44 µg/g); gallic acid (12.75 µg/g) and catechin (9.9 µg/g). Fermented barley bran extract showed the presence of ascorbic acid (107.15 µg/g); gallic acid (405.5 µg/g); catechin (88.3 µg/g); vanillin (40.89 µg/g) and resorcinol (20.7 µg/g) respectively. The outcome of the present study may be helpful in designing barley bran based* functional food products which might help to combat oxidative stress and other health issues.

Key words: *fermented barley bran; HPLC; phenolic compounds; antioxidant activities*

XYLANASE PRODUCTION BY SUBMERGED FERMENTATION: SCREENING AND SELECTION OF PRODUCING FUNGI

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Abstract

Xylanases represent a diverse group of enzymes that degrade beta-1,4-xylan into xylose, thereby breaking down hemicellulose, one of the major components of plant cell walls. There are several industries that commercially use xylanase, such as pulp and paper making industry for chlorine-free bleaching of wood pulp and waste paper recycling, in food industry as food additives to poultry, in baking industry for improving dough handling and the quality of baked products. Xylanases are often used for the extraction of coffee, plant oils and in the first stage of starch extraction. Along with pectinase and cellulase, xylanases are also often used for clarification of fruit juices. Different microbial sources of xylanolytic enzymes have been reported such as bacteria, fungi, yeast and marine algae. The aim of this research was to find new fungi strains with xylanase production potential. Production of xylanase enzyme was done by submerged fermentation (SmF) with several different fungi species (Penicillium chrysogenum, Aspergillus niger, Aspergillus oryzae, Aspergillus flavus, Mucor sp., Rhizopus sp.) by using beechwood xylan as a substrate. The strains were previously screened for xylanase activity on selective xylan agar medium (XAM) plates over a period of 10 days. Among all the tested fungi, two exhibited significant results (Penicillium chrysogenum, Aspergillus flavus) for growth on XAM and were subjected to submerged fermentation in xylan broth medium for further analysis. Enzyme activities (IU/ml) monitored for both fungi showed a trend in value increase over the course of the first days of fermentation, where enzyme from Penicillium chrysogenum reached its maximum activity od 0.291 ± 0.018 IU/ml on day 4 of the fermentation. In comparison to Penicillium chrysogenum, enzyme activity measured for Aspergillus flavus was at least two-fold greater during all 12 days of fermentation, reaching its maximum of 0.655 ± 0.046 IU/ml on day 8 of the fermentation. pH and temperature optimum were analyzed for both of the selected fungi and the obtained optimal values were pH 5 and 37°C.

Key words: *xylanase, submerged fermentation, fungi, xylan.*

ENZYMATIC HYDROLYSIS OF SOFT WHEAT FLOUR: THE EFFECT OF PRESENT SOLIDS ON FUNCTIONAL PROPERTIES AND ALLERGENICITY REDUCTION

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Abstract

Enzymatic hydrolysis of wheat gluten at high solids concentrations is beneficial from both an ecological and an economic viewpoint, since wheat gluten can be hydrolyzed by either using the raw fraction of wheat gluten or directly from the soft wheat flour (SWF). Thus, in this study, the possibility to hydrolyze SWF with high concentration of solids, which implies in this case high starch content and the effect of its presence was investigated. SWF was hydrolyzed with Alcalase (pH 8.0, 60 °C) at different SWF concentrations while the enzyme to substrate (E/S) ratio was kept constant at 5%. By increasing the starch content in the sample and therefore reducing the amount of available water, greater degrees of hydrolysis (DH) were achieved. SWF prepared at 15% (w/w) showed greater DH compared to 5% (w/w) and 10% (w/w) mixtures. At a DH of 23.49%, sample prepared as 15% (w/w) showed greatest reduction in gliadin content, resulting in 9.42 ± 1.5 ppm of gluten, tested by competitive ELISA test. SDS-PAGE electrophoresis confirmed the differences in gliadin content for all of the prepared wheat flour hydrolysates (WFH). Enzymatic hydrolysis has removed glutenin subunits (GS), x-HMW-GS (83-88 kDa) and y-HMW-GS (67-74 kDa) and ω5-gliadins (49-55 kDa). All WFHs had significantly improved antioxidant (> 60%) and metal-ion chelating (> 80%) properties compared to SWF. Also, techno-functional properties were improved after enzymatic hydrolysis. Emulsifying activity and emulsion stability were significantly improved after hydrolysis and therefore more stable emulsion systems were formed. Foaming properties were also improved after hydrolysis. The changes in the WFHs macromolecular conformations and changes induced by the Alcalase, were inspected using Fourier transformation infrared spectroscopy (FTIR) and surface measurements. FTIR spectra confirmed structural changes in the Amide I (1,700-1,600 cm^{-1}) region. The changes in total zeta-potential and average particle size were in accordance with above-mentioned functional behaviors. The increase in the DH, with prolonged time of enzyme attack, affected the increase in the surface charge of the WFH molecules, suggesting that the stability and electrokinetic potential were maintained stable. The hydrolysis reaction was facilitated by the increase of the solids content since it interferes with the aggregation of gluten proteins, therefore less available water was proven beneficial for the enzymatic reaction. Regarding process feasibility on an industrial level, a more concentrated system may be used in order to produce WFHs with reduced allergenic and improved functional properties.

Key words: *wheat flour, wheat gluten, enzyme hydrolysis, allergenicity, functional properties, antioxidant properties*

TEXTURAL AND MORPHOLOGICAL CHARACTERISTICS OF BENTONITE BEFORE AND AFTER ACTIVATION AND COMPARISON WITH SYNTHETIC ZEOLITE

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Abstract

Different types of natural and modified adsorbents, as well as synthetic materials, are used to carry out various adsorption processes. Among a large number of adsorbents, bentonites and zeolites are widely used. Bentonites are aluminosilicate minerals, which have a layered structure, a great possibility of cation exchange, swelling ability, good adsorption power, the possibility of modification, etc. These characteristics are mostly based on montmorillonite as the dominant mineral. Zeolites are microporous materials, which, due to their structure and sorption characteristics, have a wide application, and one of them is the application in adsorption processes. The adsorption capacity of adsorbents depends on the specific surface area and porosity, which are mainly a function of their composition, physicochemical, structural, textural and morphological characteristics. The aim of the work described in this paper was to perform chemical activation of domestic natural bentonite, and then characterization of natural and activated bentonite, and synthetic zeolite type ZSM-100 (Zeochem Ltd. Zvornik). Natural bentonite from the Šipovo site, which contains 90% of montmorillonite, after annealing at a temperature of 450ºC for a period of 3 h, was activated with a 12% solution of sulfuric acid.
Textural characteristics were determined by low-temperature nitrogen adsorption (BET method), and morphological characteristics were determined by scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS). The results of the conducted tests showed that the activation of bentonite resulted in changes in structure, textural characteristics (specific surface area, porosity) and morphological characteristics. The specific BET area of natural bentonite of 83,1058 m^2/g and the volume of its micropores of 0,010801cm^3/g increased by 2,36 times and 1,49 times, respectively, after activation. The results of SEM and EDS, before and after bentonite activation, showed that there was a decrease in particle dimensions, as well as an increase in the Si/Al ratio by 1,15 times. The value of the specific surface area of zeolite ZSM-100 is 1,66 times higher, and the volume of micropores is even 6,92 times higher than the same characteristics of acid-activated bentonite. Morphological examinations of zeolites have shown that they have a regular spherical shape of a crystal grain. The adsorption power of the tested adsorbents will be determined in the process of bleaching edible oils.

Keywords: *natural bentonite, acid-activated bentonite, synthetic zeolite, textural and morphological characteristics, specific surface area, porosity.*

INFLUENCE OF ESTERIFICATION AGENT AND SUBSTITUTION DEGREE ON STARCH HYDROFOBICITY

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Abstract

Biodegradable polymers represent a solution to the problems of contamination caused by conventional synthetic polymers. For this purpose, starch is considered the most promising material because of its biodegradability, low price, and abundant availability (Khan et.al, 2016). However, the intermolecular forces and hydrogen bonds in starch prevent the processing of starches in the way typical to thermoplastic materials. By reducing those interactions, the hydrophilicity of starch could be also reduced. The aim of this study was to synthesize thermoplastic starch esters with controllable properties by using organic anhydrides of different chemical composition and varying the degree of substitution DS).

Potato starch was modified with acetic, succinic and octenyl succinic anhydrides and characterized by Fourier-transform infrared spectroscopy and thermogravimetric analysis. The hydrophobicity of the modified starches films was evaluated by performing water contact angle tests. When modified with acetic anhydride at low degree of substitution, DS being up to 0.3 the change of water contact angle of the films was not significant compared to that of starch. However, the water contact angle of the films of starch acetate with DS 0.5 was 30% higher than that of native starch. Further, the hydrophobicity of starch succinate was gradually increasing with increasing DS, as reflected by increasing water contact angle. Moreover, the modification of starch with octenyl succinic anhydride dramatically changed the hydrophobicity of starch. The water contact angle of starch octenyl succinate with DS 0.056 was twice higher compared to that of native starch.

Keywords: *starch acetate, starch succinate, starch octenylsuccinate, starch hydrophobicity*

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POSSIBILITY OF APPLICATION OF *URTICA DIOICA* L. LEAVES AND EXTRACTS FOR OBTAINING FUNCTIONAL BREAD

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Abstract

The aim of this study was to determine the possibility of application of Urtica dioica L. *leaves and liquid extracts for obtaining functional bread. Also, the aim was to determine the effect of the addition of the tested plant material, as well as additives, on the physical and sensory quality of bread. For preparing the bread, leaves of Urtica dioica* L. *were added in dough in concentration of 5 and 1 % counted on mass wheat flour. Further, Soxhlet extract (1:10) was added into the dough in concentration of 5 and 10 % of wheat flour mass. The quality of bread was assessed by determining the physical and sensory parameters 24 hours after baking, such as the height and volume of bread, mass of bread, dough and bread yield, losses during baking and during cooling, as well as the fineness and elasticity of the bread pores. The analysed parameters showed significant differences between wheat bread and supplemented samples. It can be concluded that the addition of an equivalent amount of Urtica dioica* L. *extract does not impair the technological quality of bread, as is the case with the addition of leaves, and that the obtaining functional bread is with significant content of biologically active compounds that can preserve human health.*

Key words*: functional food, bread, Urtica dioica L., leaves, extracts*.

NUTRITIVE COMPOSITION AND FUNCTIONALITY OF WILD CORNELIAN CHERRY FRUIT

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Abstract

Mature cornelian cherry (Cornus mas L.) fruit have specific sour, sweet and slightly pungent taste and it can be consumed fresh or prepared as different types of products which have been traditionally prepared since ancient times. These fruits are most often used to make jams, brandies and liqueurs. Cornelian cherry fruit contains biologically suitable compounds for human diet. Polyphenolic and mineral compounds have a great nutritional value. In this study physical and chemical characteristic, mineral composition, content of flavonols, flavan-3-ols and anthocyanins of wild cornelian cherry fruit from western and southern part of Bosnia and Herzegovina were determined. Anti-inflammatory and antimicrobial effect of examined fruit samples was determined. Values of flesh weight and fruit:flesh ratio were higher for samples from western region. Samples from southern region had significantly higher ($P \leq 0.05$) dry matter, total sugar and pectin content and colour parameters L and a* while samples from western region had significantly higher ($P \leq 0.05$) total acidity. These differences can be explained by the different growth and climate conditions, and soil on which the wild cornelian cherry grows.Significant content of potassium, calcium, magnesium and phosphorus were determined in all samples. There was not cadmium in the samples and lead was found in traces in WCC1 and WCC2 samples. A higher content of flavonols was found in the samples of cornelian cherry from the southern region, while a higher content of flavan-3-ols and anthocyanins was found in the samples from the western region. All cornelian cherry fruit samples showed anti-inflammatory and antimicrobial activity. Polyphenolic components had significant ($P \leq 0.05$) antimicrobial activity against Bacilus cereus and Escherichia coli cultures.*

Key words: *cornelian cherry fruit; mineral content; polyphenolic components; antimicrobial activity, anti-inflammatory activity.*

NUTRITIVE AND SENSORY QUALITY OF COMMERCIAL MEAT PRODUCTS WITH DIFFERENT SALT CONTENT

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Abstract

The salt content in dry-fermented sausages is a very important quality parameter and affects the physical and chemical properties and sensory quality of these products. Due to a growing demand for products with improved nutritional composition and the fact that excessive salt content negatively affects the health of consumers, reducing salt is a challenge in developing new and modifying existing market-recognizable products. The aim of this study was to evaluate the quality of dry-fermented pork sausages – "čajna" type from the market, with similar composition and different salt content. To achieve this goal, physicochemical parameters of selected samples were determined and sensory quality parameters were evaluated. In samples M and D, with significantly higher (P≤0.05) sodium chloride content, higher values of color parameter a and breaking force and lower values of pH and water activity were found compared to samples T and L. Sample D had the highest protein content (25.51%) and the lowest fat content (30.04%) so accordingly a better nutritional quality compared to other samples. However, this sample also has the highest sodium chloride content, which in nutritional terms is not in line with the expected quality. Results of descriptive sensory analysis of commercial dry-fermented sausages showed that samples M and D had significantly higher sensory quality, especially odor, aroma, taste and consistency and cross-section. These samples were evaluated as sausages with a pronounced pleasant aroma taste and odor characteristic for dry-fermented products, with pleasant salinity, appropriate for the product. The highest sensory quality was found in sample M with 92.05% of the maximum possible quality. Sample T was evaluated as sample with lowest overall sensory quality with 74.54% of the maximum possible quality. It can be concluded that samples with T and L had a less pronounced odor, aroma and salty taste than expected. Although dry-fermented sausage samples with a lower salt content had more acceptable nutritive value, their sensory quality was lower than expected.*

Key words: *dry-fermented sausage; sodium chloride; nutritive value; sensory analysis.*

THE USE OF DIFFERENT RACES OF YEAST FOR FERMENTING WORT FROM BEET MOLASSES IN THE TECHNOLOGY OF A STRONG ALCOHOLIC BEVERAGE

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Abstract

The article presents the results of studying the possibility of obtaining a strong alcoholic beverage such as rum from beet molasses. It is noted that rum is a fairly popular drink in the Russian Federation, however, most of the varieties presented on the domestic market are imported, which leads to an increased cost of this type of product. The main technological characteristics of beet and cane molasses are compared; it is shown that they have both similarities and differences, which should be taken into account when developing the technology of a strong alcoholic beverage. The results of fermentation of must from beet molasses with different concentrations of dry matter (22, 24, 26, 28%) at different temperatures (22, 25, 31oC) are presented. Wort samples were inoculated and fermented with Alcotec Rum, Kodzi Angel, Turbo, CS-31, SAF-Instant yeasts used in various branches of fermentation and bakery industries. Significant impact found fermentation parameters for the amount of carbon dioxide produced by different yeast races. The most intensively fermented molasses wort with a concentration of 22% Kodzi Angel yeast at 31°C. In general, the SAF-Instant yeast (bakery) is most expedient for fermenting wort of different concentrations at 31°C. Alcotec Rum yeast is effective for fermenting wort of different density at 22°C. An increase in the concentration of dry substances in the nutrient medium in all samples led to inhibition of the metabolism of yeast populations, as a consequence, to a decrease in the degree of fermentation. The data of organoleptic evaluation of some distillates are presented. The best sample was obtained from the wort fermented with Alcotec Rum yeast wort with a density of 22% at a temperature of 22°C for 4 days. The results of the chromatographic determination of compounds in it that form organoleptic characteristics inherent in many varieties of commercial rum are presented. It was revealed that only a part of these substances was present in the experimental sample of the distillate. It is concluded that the noted differences can be eliminated as a result of optimization of the modes of carrying out the stages of fermentation and distillation, as well as the establishment of rational parameters of exposure of rum distillate in contact with wood. As a result, it was suggested that it is advisable to continue research in the chosen direction.

Key words: *Beet molasses, cane molasses, yeast, fermentation parameters, sensory profile of distillate, chromatographic analysis.*

SINGLE STEP EXTRACTION AS A TOOL FOR BIOAVAILABILITY ASSESSMENT OF LINDAN

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Abstract

Sediment represents a sink for toxic and persistent organic chemicals. The presents itself does not necessarily mean that this compound is available for uptake by living organisms. Evaluation of this available fraction is extremely important for assessing their risk to the environment. It is considered that only the fraction which can be solubilised and/or easily extracted is the most accessible for bioaccumulation, biosorption and/or transformation. In the last decades scientists develop a set of chemical test that can be used for bioavailability assessment. Chemical extraction techniques like non-exhaustive extraction with Tenax, XAD-4 raisin, methyl-beta-cyclodextrin (MCD) or hydroxypropyl-β-cyclodextrin (HPCD) have been shown to measure the biodegradable fraction of pollutants present in sediment. However, there is little research on the chemical prediction of organochloride insecticide like lindane. Since 2008, lindane is banned for use. However, this insecticide was used in hundreds of thousands of tone for more than 50 years. Lindan is persistent in the environment, bioaccumulate in living organisms and he has proven to be toxic to human health and the environment. Furthermore, there is evidence of their long-range transport. The aim of this study was to investigate the potential of single extraction methods for Tenax, XAD-4 raisin, HPCD and MCD extractions to predict lindane bioavailability in sediment. Sediment was spiked with two different concentration of lindane (2230 µg/kg and 313 µg/kg) and all the experiment were conducted for these two concentration ranges. At the same time, the experiment without sorbents was setup as well. The results showed that all four non-exhaustive extraction procedures showed promising results for estimating the available contaminant fraction for both concentration ranges. In a direct comparison of the chosen extraction procedures, Tenax and XAD-4 extraction were assessed to be more time-consuming than HPCD and MCD extraction. However it should have in mind sediment/XAD-4 raisin or Tenax ratio, and a possibility of gaining the results that would overestimate the actual bioavailability. In this paper authors aimed to explain the sorption mechanism on the chosen sorbents, emphasizing the important of standardize and commercialize methods for risk assessment and moving from lab to field investigation.

Key words: *sediment, lindane, bioavailability,non-exhaustive extraction.*

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EVALUATION OF THE INSTRUMENTAL TEXTURE CHARACTERISTICS OF DRY-FERMENTED KULEN SAUSAGES

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Abstract

Nine different dry-fermented sausages (kulen) were compared for textural characteristics in order to provide complex overview of their quality. Instrumental texture profile analysis was carried out using a TA.XT2 texture analyser equipped with a standard cylindrical plate of 75 mm in diameter. The following parameters were quantified: hardness (g), springiness, cohesiveness and chewiness (g). Many significant or numerical differences were found in the mean values of texture characteristics among the particular sausages (kulen). The hardness, springiness, cohesiveness and chewiness values of nine different dry-fermented kulen sausages varied from 2740.9 to 26834.8 g, from 0.320 to 0.660, from 0.210 to 0.519 and from 190.5 to 3183.4 g, respectively. Obtained results should provide knowledge for possible improvements of the kulen production, in a way that these sausages could be produced in different manufacturers with consistent textural characteristics.

Key words: *fermented sausage, texture profile analysis, traditional product*

THE INFLUENCE OF SYNTHESIS CONDITIONS ON TEXTURAL PROPERTIES OF Al/Fe PILLARED CLAYS

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Abstract

Al/Fe pillared clays are obtained by intercalation of montmorillonite with mixed solution of two (Al^{3+} and $Fe^{3+)}$ polyhydroxocations. Representatives of solid, modern ecomaterials and heterogeneous catalysts. They are applied in the commercial catalytic technologies of the oil and petrochemical industry, and also in the field of environmental protection. For example, in photocatalytic treatment of wastewater contaminated with phenol. The paper examines the impact of copillaring conditions (Al/Fe ratio, pH of solution for co-pillaring) as well as drying and calcination temperatures on the textural properties of the obtained samples of Al/Fe pillared clays. It was assumed that the choice of conditions and methods of performing the montmorillonite copillaring process significantly affects the improvement of the textural properties of the obtained Al/Fe pillared clays compared to raw montmorillonite. The obtained results for the texture of the samples prepared at different Al/Fe rations and pH for pillaring (which are air-dried at 105°C during 4h) and calcined (at 300°C during 2h) show that there has been a significant improvement in the tested texture properties of all prepared samples compared to the raw montmorillonite texture. The obtained mutual differences in the textural properties of the samples prepared with the examined synthesis parameters were explained by the influence of different Fe^{3+}cations content, the influence of different pH of the copillaring solution and the temperature of subsequent thermal treatment on the formation of different pillars in the samples structure. The height of the formed pillars cause differences in the size of the formed pores and in other textural properties. Variation of the examined parameters of synthesis and subsequent thermal treatment of Al/Fe pillared clays samples significantly affects the textural properties of the resulting materials, which opens the possibility of their application in various industrial areas.

Key words: *Al/Fe pillared clays, conditions for co-pillaring, textural properties, eco-catalysts*

INVESTIGATION OF THE INFLUENCE OF SOLVENT TYPE ON THE EFFECTIVENESS OF ELECTROPHORETIC SEPARATION OF GLUTENINS BY CAPILLARY GEL ELECTROPHORESIS

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Abstract

Glutenins represent one of the gluten' fractions. Glutenins consist of two subunits. These are glutenins with high molecular weight (HMW glutenins) and glutenins with low molecular weight (LMW glutenins). The aim of this paper was to examine how the type of solvent affects the effectiveness of electrophoretic separation of glutenins by capillary gel electrophoresis. In this paper, the extraction of glutenins was performed from wheat flour type 500, purchased on the market of the Republic of Srpska/Bosnia and Herzegovina. Different solvents for extraction were used: Treatment buffer+H_2O, 50% (v/v) ethanol, 50% (v/v) 1-propanol and 50% (v/v) isopropanol with the addition of 1% DTT. Separation was performed by capillary gel electrophoresis, on apparatus capillary electrophoresis (Agilent CE 7100, a capillary with an inner diameter of 50 µm, a total length of 33 cm, and an effective length of 23.50 cm). The temperature of the capillary during separation was 25 °C, and the voltage on the electrodes was -16.5 kV. Based on the obtained results, 50% (v/v) 1-propanol with the addition of 1% DTT proved to be the most efficient solvent for glutenins extraction. After extraction with this solvent, a total number of proteins Xav=14.67 was observed. The number of proteins within LMW glutenins after extraction with this solvent was Xav=9.83, and the relative concentration was RC=19.69%, within HMW glutenins Xav=3.67 (RC=49.81%) and within ωb gliadins Xav=2.17 (RC=30.41%).

Key words: *wheat flour, glutenins, capillary gel electrophoresis (GCE).*

INFLUENCE OF CRYSTALLIZATION TIME ON THE PHYSICO-CHEMICAL CHARACTERISTICS OF THE NaY ZEOLITE

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Abstract

Hydrothermal synthesis method of NaY zeolite crystals forming is one of the most significant methods, which is affected by many factors: the chemical composition and pre-treatment of starting raw materials, methods of preparation reaction mixture, the molar ratio of the synthesis gel, the homogeneity and the pH of the reaction mixture, the temperature of the aging of the gel, the temperature and time of crystallization, etc. Parent/basic gel was obtained by mixing seeds with distilled water, water glass, synthetic aluminate solution, and sulfuric acid, to a molar ratio of synthesis (the parent) gel 1,9 Na_2O: Al_2O_3: 5.9 SiO_2: 94H_2O. The formation of NaY zeolite crystals was followed by crystallization at a temperature of 100°C and times of crystallization: 12, 14, 20 and 24 hrs. Following methods of analysis: chemical analyses, X-ray diffraction analysis - XRD (IR Aspecectroscopy, laser determination of particle size distribution, low temperature N_2 adsorption and scanning electron microscopy (SEM) were used in for this paper. The obtained results of the analysis show that the crystallization time of 12 hours was not sufficient for the formation of NaY zeolite crystals and the best time of crystallization was 24 h, at which was obtained crystallinity of zeolite from 110%, compared to commercial sample of CBV 100, the crystallinity higher than 90%. The Aspececific surface area of this sample obtained by the BET single-point method is 742,6787 m²/g, and according to the Langmuir 938,6226 ± 0.7980 m²/g. The forming of NaY zeolite crystals in it, the SEM analysis confirms as well.

***Keywords**: crystallization, NaY zeolite, times of crystallization, hydrothermal synthesis*

BUILDING A MATLAB APPLICATION FOR PRELIMINARY DESIGN AND OPTIMIZATION OF SHELL AND TUBE HEAT EXCHANGERS

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Abstract

Design of a shell and tube heat exchanger is a complex and time consuming procedure. Since they are one of the most common process units in process industry, great effort should be made to improve their design and to facilitate the design procedure. Therefore, in this study, easy-to-use MATLAB application for shell and tube heat exchanger preliminary design and optimization was developed. The application enables users to manually select operating parameters and test their effect on heat transfer area and pressure drop. Moreover, the application helps users to optimize the preliminary design, in terms of finding the minimal heat transfer area required to meet the process requirements. The validity of the application was tested on the example from the literature, where the heat transfer area was 61.91 m^2. During the proposed optimization procedure, different parameter values were tested and an optimal combination of parameters was found within 5 seconds (for all combinations), resulting in heat transfer area of 53.27 m^2. Application has a great feature of displaying the impact of baffle cut value and baffle spacing on most important design parameters: heat transfer area, tube – side pressure drops and shell – side pressure drops. Also, new correlations were developed for the calculation of Colburn's heat transfer factor and friction factor as a function of Reynolds number and baffle cut value. Overall, the application has proven to be useful for the preliminary design of shell and tube heat exchangers, and can represent the foundation for the development of advanced heat exchanger design applications.

Key words: *shell and tube heat exchanger, MATLAB app, design optimization, Kern's method.*

QUALITY OF BREAD PREPARED WITH WHEAT AND OILSEEDS FLOUR

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Abstract

The aim of this study was to determine the effect of different oilseeds flour supplementation on the physical and sensory quality of bread. For the preparation of bread, sesame and pumpkin flour were added in dough in concentration of 5 and 10% counted on mass wheat flour, as well as a mixture of pumpkin, sesame and flax flour. The quality of bread was assessed by determining the physical and sensory parameters 24 hours after baking, such as the height and volume of bread, yield of volume, spring oven, as well as the fineness and elasticity of the bread pores. The physical and sensory characteristics of the obtained bread were compared in relation to bread prepared from wheat flour. The sensory analysis revealed that adding a mixture of oilseed flour in dough is convenient affected the color of the crust and the crumb of the bread in relation to the control sample. The positive effect is observed in the color of the crust and crumb, because such a product is more acceptable for customer. The addition of 5% mixed oilseed flour gave the best overall sensory acceptability of bread, as well as improved physical characteristics.

Key words*: bread quality, wheat, sesame, pumpkin, flax*

THE INFLUENCE OF DIFFERENT MICROWAVE-ASSISTED EXTRACTION CONDITIONS ON POLYPHENOL YIELD AND ANTIOXIDANT ACTIVITY OF WILD THYME

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Abstract

Aromatic plants are commercially important and find wide use in food and pharmaceutical industry, because of health benefits related with their antioxidant, antimicrobial, anti-inflammatory, cardioprotective, cytotoxic, expectorant, anti-spasmodic and stimulant effects. Most of phytochemicals are impossible to synthesize, therefore the best option is their extraction from natural sources. Microwave-assisted extraction offers a rapid delivery of energy to a total volume of solvent and solid plant material, improving the recovery of polyphenols. In the study, wild thyme herb was evaluated as a source of polyphenols, which were extracted by the application of microwaves instead of the traditional extraction techniques. The objective of the present study was optimization of microwave-assisted extraction process through varying irradiation time (5-180 s), temperature (60-200°C), particle size (0.3, 0.7 and 1.5 mm), solvent-to-solid ratio (10:1, 20:1, 30:1 and 40:1) and ethanol concentration in the extraction medium (0-60%). Extraction efficiency was expressed via total polyphenol content (Folin-Ciocalteu method) and antioxidant activity (ABTS radical scavenging method). The statistical analysis (one-way ANOVA and Duncan's post-hoc test) has revealed that irradiation time above 15 s and particle size have not shown statistically significant influence on polyphenol yield, while there were significant differences between extracts obtained by various temperatures and solvent-to-solid ratios. Although the highest polyphenol yield has achieved by using 50% of ethanol, there was no statistically significant difference between ethanol concentration in the range from 30% to 50%. The highest polyphenol yield and antioxidant activity were achived in the extract with particle size of 0.3 mm, 30:1 ratio and 50% ethanol, after 15 s, at 200°C (45.11 mg GAE/L and 27.22 µmol/L Trolox). According to the presented results, microwave-assisted extraction may be used as an efficient and time saving alternative to traditional extraction techniques for extraction of bioactive polyphenolic compounds from wild thyme.

Key words: *antioxidant activity, microwave-assisted extraction, particle size, polyphenols, solvent-to-solid ratio.*

MORPHOLOGY OF THE ELECTRODEPOSITED Zn-Mn-Al_2O_3 COMPOSITE COATINGS: INFLUENCE OF AGITATION MODE

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Abstract

Electrodeposited protected coatings are used in different industrial fields for enchancing various surface properties. Zinc and zinc alloys coatings are commonly applied for the protection of steel. Zinc and zinc alloys composite coatings got a lot of attentions among researchers in last decades, due to increasing and demanding technological applications. For example, zinc doped with TiO_2, SiC, SiO_2, CeO_2, Al_2O_3 particles are reported as materials with enhanced wear, hardness and anticorrosion properties. The aim of this work is electrodeposition and characterization of Zn-Mn-Al_2O_3 composite coatings. Composite coatings were electrodeposited from four plating solutions: one without Mn^{2+} ions, three with different Zn^{2+} and Mn^{2+} ions ratio. The particles content were 1 g dm^{-3} in all examined solutions. The coatings were produced galvanostatically by 1; 2 and 4 A dm^{-2} deposition current density. In this research, two different agitation methods were used and compared: magnetic stirring (200rpm) and ultrasound stirring. The influence of the agitation method on the morphology of the deposited composite coatings was examined by scanning electron microscopy (SEM). The SEM results showed that ultrasound agitation was beneficial to compactness, uniformity and homogeneity of the deposited coatings. Ultrasound applied during electrodeposition found to be beneficial for nucleation rate, the morphology of the coatings and particles co-deposition process. Applied ultrasound in plating solution cause the different cavitation phenomena, namely, micro-jetting, acoustic streaming and shock waves, which affect the charge and mass transfer in electrodeposition process. Also, the ultrasound cleans the cathode surface and as results the influence of hydrogen evaluation during deposition on structure of the coatings is hindered. The agglomeration of the particles in the solution is reduced by presence of mentioned cavitation phenomena. The content of the alumina particles in the coatings was determined by energy dispersive X-ray spectroscopy (EDAX). The EDAX measurement showed that applied ultrasound and increase in deposition current density resulted in higher particles content in the coatings.

Key words: *electrodeposition, composite coatings, morphology, ultrasound.*

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ELECTRODEPOSITION AND CHARACTERIZATION OF Zn-Mn-CeO_2 COMPOSITE COATINGS

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Abstract

The main goal of this research was electrodeposition and characterization of Zn-Mn-CeO_2 nanocomposite coatings. Electrodeposition was performed gallvanostatically with different current densities: 1; 2 and 4 A dm^{-2} from chloride plating solutions. The first plating solution was used to obtain Zn-CeO_2 composite coatings which was compared to Zn-Mn-CeO_2 composite coatings deposited from three plating solutions with different [Zn^{2+}]: [Mn^{2+}] ions ratio. Magnetic stirring was applied to achieve homogeneity dispersion of the particles. The CeO_2 nanoparticles were used as dopant due to its known good properties. Ceria found application in different fields, like catalysis (effective photocatalyst) in fuel-cells, sensors, biomaterial, medicine, cosmetics etc. Also, the ceria is well-known corrosion inhibitor, and incorporated into coatings showed self-healing ability. Self-healing allows the repair of the coating surface during mechanical damage and during degradation caused by corrosive species in the environment. The morphology of the obtained coatings was examined by optical microscopy and no cracks or other defects were visible on the coatings surface. The composition of the deposited composite coatings was studied by energy dispersive X-ray spectroscopy and results confirmed the presence of ceria in all deposited coatings and the ceria content was in range 0.131-3.853 wt%. The higher amount of ceria incorporated in the coating the smaller content of manganese was present. The corrosion stability of the deposited composite coatings was examined by Tafel polarization method and spectroscopy of the electrochemical impedance. The results pointed that deposition current density influences the corrosion current density i.e. corrosion stability of the coatings. The higher deposition current density (4 A dm^{-2}) results in decrease in corrosion current density and increase in corrosion stability of the coatings in 3wt% NaCl.

Key words: *electrodeposition, composite coatings, nanoparticles, corrosion.*

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QUALITY CHARACTERISTICS OF TOMATO PASTE OBTAINED BY VACUUM OHMIC EVAPORATION METHOD: EFFECTS OF FREQUENCY, VOLTAGE GRADIENT AND WAVE FORM

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Abstract

Nowadays, studies on novel evaporation methods are increasing to prevent the undesirable component formation and to minimize quality losses during vacuum evaporation. Ohmic heating, which is one of the electrical methods, can be used to assist the evaporation process as an electrical heating source due to its potential to serve more uniform and faster heating, and higher conservation of the quality of food products. In this study, a vacuum ohmic evaporation (VOE) prototype was set up to obtain a tomato paste with 28% total soluble solids content (TSSC) at 25 kPa absolute pressure. VOE process applied at different process conditions consisting of combination of 2 different wave types (sine and square), 3 different voltage gradients (6-8-10 V/cm) and 3 different frequencies (50-775-1500 Hz). The vacuum evaporation (VE) was applied as control method. The effects of process conditions on final product quality such as color properties (L*, a*, b*, a/b), total dry content, invert sugar, titration acidity, black speckle, Howard mold count, and β-carotene lycopene were investigated. The wave types had significant effects on total dry matter, pH, black speck, invert sugar, lycopene ($p<0.05$). As the voltage gradient increased black speckles increased while howard mold count decreased. In addition, the voltage gradient had significant effects on β-carotene, titratable acidity and L* ($p<0.05$) while frequency affected a *, chroma, delta E, delta C, black speckle, and lycopene in addition to these properties. VOE method resulted production of superior quality of tomato paste in shorter process time compared to VE method. It can be concluded that VOE process could be an alternative method for produce tomato paste having 28% TSSC.

Keywords: Electrical process, Ohmic heating, Evaporation, Tomato paste, Quality

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NUMERICAL SIMULATION OF HIGH FREQUENCY OHMIC THAWING PROCESS

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Abstract

The freezing process is a crucial method for food preservation and processing operations. Ohmic thawing is one of the alternative novel thawing methods studied in recent years. In this study, the mathematical modeling of high frequency ohmic thawing method (1000 Hz) at 10 V/cm voltage gradient applied to minced beef samples having 10% fat content was aimed. The numerical equations were solved with the finite difference method (FDM) by code written in the MATLAB package program, and with the Finite Volume Method (FVM) in the ANSYS package program. Both methods were aimed to simplify the differential equation relations and the system to be studied by dividing a complex system into small parts (elements). The frequency effect on the electrical conductivity change during ohmic thawing were defined as mathematical models for both FDM and FVM. In the modeling process with the MATLAB program, the compatibility of 2 different models with different convective heat transfer coefficient (h) values with the experimental results was discussed. Model having the lower convection heat transfer coefficient was predicted a temperature change trend closer to the experimental results ($p<0.05$). As a result of the 3D simulation study solved with the ANSYS package program, the sample temperature and the ice fraction of the sample was modeled more homogeneously. Thus, the fast thawing process via ohmic method was able to be confirmed by simulation. The phase change situation during the ohmic thawing process was successfully simulated. The authors concluded that the modelling of the high frequency thawing process consisting of different transfer mechanisms with high accuracy would provide a valuable data for further studies and setting up of novel thawing systems.

Key words: *Ohmic heating, Modelling, Thawing, Finite Difference Method, Finite Volume Method.*

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A CONDUCTOMETRIC INVESTIGATION OF THE INTERACTIONS AND FOAMINESS IN BINARY MIXTURES OF ANIONIC SURFACTANTS

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Abstract

Formulations of surfactants used in cosmetic and pharmaceutical preparations, detergents and in other commercial products are commonly mixtures. Interactions between components of mixture produce interfacial and colloidal properties completely different from those of individual surfactants, such as surface tension, critical micellar concentration (CMC), foaminess etc.
In this paper interactions in binary mixtures of anionic surfactants, sodium stearate (NaS) and sodium dodecylbenzen sulfonate (NaDBS), in water at different mole fraction of NaS (α_1) in the mixture (0.82, 0.69, 0.53, 0.36 and 0.22) were studied by conductivity measurements at constant temperature (40 ºC). The CMC of pure surfactants and binary mixtures, was determined from the break point in the graph dependency specific conductivity of concentration. The results of the investigation have been tested using Clint´s, Rubingh´s and Motomura´s theories for binary mixtures of surfactants. By using these theories were determined the composition of mixed micelles and the interaction parameter (β). In investigated mixtures of surfactants positive values of β indicated to repulsive interactions between NaS and NaDBS and these micellar systems showed antagonistic effect. The foam is occur in many practical applications of surfactants, as a desirable or undesirable appearance. Formation and properties of foams in binary mixtures of NaS and NaDBS was determined by Ross-Miles method. Interactions between NaS and NaDBS modify of foam and the properties of formed foam in these systems in comparison with individual components. The foaminess of examined systems depends on mole fraction of NaS in mixtures and concentration of surfactants.

Key words: *critical micelle concentration, mixed micelle, sodium stearate, sodium dodecylbenzen sulfonate, interaction parameter, Ross-Miles method.*

TEXAS VARIETY ALMOND OIL EXTRACTION AND IN VITRO EVALUATION OF ITS BIOACTIVITIES

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Abstract

Globally, chronic inflammatory diseases such as cardiovascular disease, in which oxidation and thrombosis lurk as major triggering mechanisms, have increased morbidity and mortality. Many scientific investigations have documented the therapeutic and antioxidant properties of natural products which isolated from plant sources. Almonds as nuts are plant-based food and a rich source of lipids. The present study was therefore undertaken to evaluate the in vitro bioactivities of almond oil of the Texas variety.
Almond oil was appropriately extracted by a modification of the Folch method using less toxic solvents and ultrasounds assistance. The content of almond oil was compared with that of the standard Folch method. Bioactivities of the extract was determined and evaluated. Antioxidant activities were determined by the methods of 2,2-Diphenyl-1-picrylhydrazyl (DPPH), 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid (ABTS) and Cupric Reducing Antioxidant Capacity (CUPRAC) assays and expressed as Trolox equivalents. Anti-thrombotic activity was calculated as the ability to inhibit the thrombotic factor of platelet activating factor and expressed as amount of almond oil. Finally, in vitro anti-atherogenic activity was studied as the ability to inhibit copper induced human plasma oxidation and expressed as amount of almond oil.
Almond oil can be extracted in yields comparable to the Folch method by ultrasonic assistance and more environmentally friendly solvents compared to the chloroform used in the Folch method. The extracted almond oil exerts in vitro anti-oxidant, anti-thrombotic and anti-atherogenic activities and may represent an interesting alternative fat source for functional food development.

Key words: Almond oil; antioxidant; antithrombotic; In vitro bioactivities.

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THE KINETICS OF HEMPSEED OIL METHANOLYSIS OVER QUICKLIME

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Abstract

In the present paper, the hempseed oil methanolysis catalyzed by quicklime was studied. The hempseed oil was obtained by seed cold pressing whereby the oil yield of 25.4 g/100 g seed was obtained. The main goal of the study was to model the methanolysis reaction kinetics using a simple model that did not require complex computations. Because of a slightly higher free fatty acid (FFA) content in the oil (1.49%) than the maximum one acceptable for base-catalyzed methanolysis, the fatty acid methyl esters synthesis was performed in a two-step process that includes the acid-catalyzed FFA esterification followed by the base-catalyzed methanolysis of the esterified oil. The FFA esterification was performed in the presence of H_2SO_4 as a catalyst in the amount of 2% (based on the oil mass) at the methanol/oil molar ratio of 8.5:1, under the atmospheric pressure and temperature of 60^oC. The methanolysis of the esterified oil, after its separation from the water phase and purification, was catalyzed by quicklime at 60^oC under atmospheric pressure. The catalyst amount and the methanol/oil molar ratio were varied in the ranges of 3-7% (based on oil mass) and 6:1 to 12:1, respectively.
The methanolysis process kinetics was modeled using the irreversible pseudo-first reaction rate order with respect to triacylglycerols (TAG) due to a methanol excess. In the initial phase, the reaction rate was slow as a result of the glyceride mass transfer rate limitation. With the reaction progress, the volumetric glyceride mass transfer coefficient increased and the chemical reaction controlled the overall process rate. The volumetric mass transfer coefficient increased proportionally with increasing the catalyst and methanol concentrations with the coefficient of determination of 0.981. The reaction rate constant was independent of the catalyst and methanol amount with the average value of 0.141± 0.006 min^{-1}. The reliability of the proposed kinetic model was confirmed by a low value of the mean relative percentage deviation between the calculated and experimental values of the TAG conversion degree (±9.9%, based on 81 data).

Key words: *hempseed oil, mass transfer, methanolysis, kinetics, simulation.*

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THE OPTIMIZATION OF THE PLUM KERNEL OIL MACERATION

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Abstract

Plum is one of the most cultivated fruit in Serbia, which is the fourth country in the world in terms of plum production in 2019 (FOASTAT). Plum fruits are widely used in human nutrition, in fresh or dried form, or for preparing the jam and compote. Also, plum brandy, worldwide known as Serbian brand, is produced from plum fruits. When processing plum fruit, stones are separated and crushed to recover kernels. Plum kernels are rich in oil that is used in pharmaceutical, cosmetic, food industries, and recently in biodiesel production. Stone shells are used for energy production by combustion while the obtained ash can be used as a catalyst for biodiesel production or an adsorbent.

The present paper deals with the oil separation from plum kernels by a two-step process that includes cold pressing of kernels and the maceration of oil from press cake by n-hexane at various extraction conditions. The main goal was to determine the optimum maceration conditions (temperature, press cake/solvent ratio, and time) ensuring the best oil yield. The maceration was optimized in the following ranges of the operating conditions: the temperature of 20-70^{o}C, the press cake/solvent ratio of 1:3-1:10 g/ml, and the extraction time of 1-5 min. The ANOVA results showed that all individual maceration conditions had a significant influence on oil yield in the following order: temperature > press cake/solvent ratio > extraction time. The oil yield was modeled using a second-order polynomial equation which was validated by high values of the coefficients of determination (R2 = 0.979 and adjR2 = 0.952), and a low mean relative percentage deviation (±0.4 %, 17 data). The optimal extraction conditions were found to be as follows: the temperature of 70^{o}C, the press cake/solvent ratio of 1:10 g/ml, and the extraction time of 4 min. The predicted oil yield at the optimal extraction conditions (9.99 g oil/100 press cake) agreed well with the experimentally obtained value (9.91 g oil/100 press cake). With the two-step process, the oil yield of 39.97 g oil/100 kernel was achieved, which was 85.7% of the oil yield obtained by Soxhlet extraction.

Key words: *maceration, oil, optimization, plum kernel, press cake.*

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CONTRIBUTION OF PYROPHYLITE TO THE PRODUCTION OF SAFE FOOD - ANTIMICROBIAL ACTIVITIES

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Abstract

In recent years, there has been worldwide an increasing interest and more strict criteria for the food/feed safety including absence or reduction of the total number of microorganisms (bacteria, molds and yeasts). Besides heavy metals (copper, silver complexes etc.), materials of biological origin (plant extracts, bio waste, chitosan etc.), some mineral adsorbents also have antimicrobial properties. There are many information about the antibacterial activity of the modified bentonite, montmoriollonite, smectute, zeolites etc., and antifungal activity of various methal ion-exchanged zeolites and natural mineral clay (Kisameet clay), but there is almost no information about the antimicrobial properties of pyrophyllite, a monoclinic mineral from the group of phyllosilicates. Results from investigations of different faculties and institutions from the Federation of Bosnia and Herzegovina and the Republic of Serbia preliminary indicate that pyrophyllite from the mine Parsovići site, Bosnia and Herzegovina poses antibacterial properties against E. coli and E. faecalis, and antifungal properties against fungal pathogens (F. oxysporum, P. glomerata and R. solani). This mineral can also be used for biological control of F. oxysporum in the soil for growing potato. A particularly interesting subject of new research on antimicrobial properties of this clay is going to be the efficiency of the usage of different particle granulation of modified and activated pyrophyllite.

Key words: *antimicrobial agents, pyrophyllite, safe food.*

PEACH STONE BIOCHAR AS EFFICIENT ADSORBENT FOR Cd(II) REMOVAL FROM AQUEOUS PHASE

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Abstract

Lignocellulosic waste biomass (LCW) represents valuable resource whose implementation could help growing world demands in improving environmental problems. Fruit stones, as waste from food processing industry, are contributing toward negative stresses on our natural systems through impacts associated with both waste production and its disposal. Sustainable waste management practice necessitates that industries must shift from the current linear model to a circular based economy, utilizing wastes generated as initial materials for the production of new products, such as fuels, chemicals or materials which might help in solving environmental pollution topics. Waste biomass materials can be converted into value-added products using thermochemical methods, such as pyrolysis, whereby biomass is efficiently converted into biofuels, biochars and different value added products. This paper present current development work and evaluates potential opportunities for food processing waste pyrolysis focusing on the conversion of peach stones (PS) to biochar. The wasted PS were first crushed, milled to desired dimensions and then pyrolysed, heating from 25 to 500 oC at 10 oC/min heat flow, and kept at 500 °C for 2 h. The resulting biochar (PS-B) was characterized to determine the potential of this products for Cd(II) sorption as well as to distinguish sorption kinetics of Cd removal between raw and pyrolysed material. Kinetic experiments were performed in isothermal batch system with mixing (200 rpm), at 25 oC, adding 0.1g of sorbent in 50 ml of Cd(II) solution, with initial Cd concentration of 100 mg/L. Experimental results were modelled with three kinetics (pseudo-first, pseudo-second order and Elovich equation) and one diffusion model (Weber-Morris). Results of kinetic modelling indicated chemisorption mechanism with different diffusional behaviour of the samples. The contact pH (pHsus) of these materials were 4.10 (PS) and 5.76 (PS-B), indicating higher –OH content in biochars, which was also confirmed by FTIR analysis. Additional analyses of BET surface and SEM morphology indicated much higher surface area of PS-B with increased micro porosity and much lower micropores dimensions. Consequently, the experimental results indicated that PS-B has almost five times higher sorption capacity than the native material (PS), under the same operational conditions, 24.50 mg/g compared to 5.25 mg/g, respectively. Conclusively, the PS derived biochar can be used as an alternative to conventional sorbents in contaminated water treatment. Moreover, more research work needs to be conducted on this waste type to biochar in order to investigate optimal operational parameters as well as flow system behaviour.

Key words: *LCW biomass, peach stones, pyrolisis, biochar, cadmium, sorption.*

A COMPARATIVE STUDY OF THE EFFECT OF DIFFERENT COOKING METHODS ON THE QUALITY AND SHUCKING OF MUSSELS

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Abstract

Mussels are bivalve molluscs belonging to the Mytilidae family. There are many species differing from each other mainly in shape, size and place of origin. The most popular species are Mediterranean mussel (*Mytilus galloprovincialis*), blue mussel (*Mytilus edulis*), New Zealand mussel (*Perna canaliculus*) and green mussel (*Mytilus viridis*). During mussel heat processing, cooking loss is a very important factor strongly related to the heat treatment methods and affects the quality and yield of the final product. Although cooking may lead to significant cooking losses, it is required in order to facilitate the shucking of mussels. The present study was designed to explore and compare in a systematic way, the effect of employing different heating methods on the quality and shucking of shellstocks mussels. For this purpose, fresh mussels (*Mytilus* galloprovincialis*)* were heat-treated for various time intervals, using moist-heat and dry-heat processes such as boiling, steaming, baking and microwaving. The effect of heat treatment methods on the cooking loss and shucking (shell opening) efficiency of shellstocks mussels was investigated. A multiple response optimization was performed in order to determine the optimum operating conditions for achieving the minimum cooking loss combined with the most efficient shell opening of the heat-treated mussels. A macroscopic evaluation of mussel meat was also carried out. All heat treatment methods succeeded 100% shell opening. Results indicated that cooking loss and shell opening of the heat-treated mussels significantly increased with increasing process time. The cooking loss and shell opening was for the majority of the heat-treated mussels higher than 20% while greater cooking loss and shell opening occurred for longer process times. Microwave heating scored the best results in shell opening of the mussels compared to the other methods. It is suggested that the microwave heating method, has the potential to be applied in the industrial mussels processing, as an economically feasible method providing higher quality characteristics of the end product and efficient shell opening.

Keywords: Mussels, cooking loss, shell opening, microwaving, boiling, steaming.

KINETIC MODELING OF THE SUNFLOWER OIL METHANOLYSIS CATALYZED BY A CaO-GLYCEROL COMPLEX

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The mixtures of fatty acid methyl or ethyl esters are used as biodiesel, an alternative to fossil diesel in engines with internal combustion because of their many advantages. The biodiesel production processes are commonly based on homogeneously or heterogeneously catalyzed transesterification of triacylglycerols from edible, non-edible, used, and waste vegetable oils or animal fats with aliphatic alcohols, whereby the latter processes have offered many advantages over the former ones. Therefore, the researchers are more focused on the development of heterogeneous catalytic systems for biodiesel production based on inexpensive and environmentally friendly materials. Calcium oxide (CaO) is one of the most studied heterogeneous catalysts for biodiesel production. Previously reported studies have shown that the change of CaO surface occurs during oil methanolysis because of combining CaO with the by-product glycerol, thus generating a catalytic active phase, i.e. a calcium oxide-glycerol complex. In this study, the active complex of calcium oxide-glycerol was prepared using two methods: (a) by mixing of calcium oxide and commercial glycerol in the presence of methanol and (b) by mixing of calcium oxide and the deep eutectic solvent choline chloride:glycerol. The catalytic effect of the obtained CaO-glycerol complexes on the sunflower oil methanolysis reaction rate and fatty acid methyl esters content was monitored. The sunflower oil methanolysis was performed in a batch reactor under moderate reaction conditions (the methanol-to-oil molar ratio of 12:1, the catalyst loading of 0.5, 1, and 5% based on oil weight, the reaction temperature of 60 °C, and atmospheric pressure). In this study, the three- and four-parameter kinetic models, which were developed for describing the methanolysis reactions catalyzed by CaO-based catalysts, were evaluated. The kinetic parameters were estimated and optimized by using the Levenberg-Marquardt method to ensure the best fit for the experimental data. In both cases, the kinetic parameters depended on the catalyst concentration. The goodness of fit was evaluated based on the mean relative percentage deviation (MRPD). The predictions of both models were in good agreement with the experimental data (MRPD-values lower than 10 %).

Keywords: *biodiesel, calcium oxide, kinetics, methanolysis.*

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THE KINETICS OF THE TRANSESTERIFICATION REACTION CATALYZED BY HAZELNUT SHELL ASH

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Abstract

Among the various type of biomass, hazelnut shells as an agro-industrial waste from food processing represent a valuable source of energy due to their high heating value. New utilization of ash generated by the burning of hazelnut shells contributes to the sustainable use of this type of biomass. The ash composition (mainly high contents of K and Ca) indicates the possibility of its catalytic activity for the base-catalyzed transesterification. However, the kinetics of the transesterification of used cooking oil to biodiesel catalyzed by hazelnut shell ash (HSA) has not been studied yet. The kinetic study is important to understand the behavior of this HSA catalyzed reaction and to provide the essential information for the process development and optimization. In this study, the biodiesel production from used cooking sunflower oil over HSA as a catalyst was investigated. The aim was to analyze the influence of the amount of HSA (1,3, and 5%) on the reaction kinetics at a constant methanol-to-oil molar ratio (6:1). The ash was prepared by the combustion of hazelnut shells in the air followed by calcination at 800 ℃. The transesterification of used cooking oil with methanol was performed in a batch glass reactor at the reaction temperature of 60℃ and under atmospheric pressure. In a preliminary kinetic analysis, it was assumed that the HSA-catalyzed transesterification of used cooking oil was a pseudo-first-order irreversible reaction with respect to triacylglycerols (TAG) because of the methanol excess. The exponential curve of TAG conversion degree variations with reaction time showed the absence of the mass transfer resistance and the pseudo-homogeneous nature of the reaction. Therefore, the pseudo-first-order model was tested for modeling the kinetics of the transesterification reaction catalyzed by HSA. The determined values of the apparent reaction rate constant increased linearly with the catalyst concentration allowing the estimation of the reaction rate constant. It was found that the employed simple kinetic model gave a good prediction of the reaction behavior. The predicted values of the TAG conversion degree agreed well with the experimental data (the mean relative percentage deviation lower than 10%, based on 33 data).

Key words: *biodiesel, hazelnut shell ash, kinetics, transesterification.*

Acknowledgement

The present work has been funded by the Ministry of Education, Science and Technological development of the Republic of Serbia (Project assigned to the Faculty of Technology, Leskovac, University of Niš, Research Group III 45001, No. 451-03-68/2020-14/200133 and Project assigned to the Faculty of Agriculture, Kruševac, University of Niš, No. 451-03-9/2021-14/200383). It is also a part of the Project 0-14-18 of the SASA Branch in Niš, Serbia.

CARAWAY (*CARUM CARVI* L.) ESSENTIAL OIL IMPROVES QUALITY OF DRY-FERMENTED SAUSAGES PRODUCED WITH DIFFERENT LEVELS OF SODIUM NITRITE

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Abstract

*Caraway (Carum carvi L.) essential oil (CEO; 0.01, 0.05 and 0.10 µL/g) was added in dry-fermented sausages formulated with different levels of pork back fat (15 and 25%) and sodium nitrite (0, 75 and 150 mg/kg). The sausage samples were vacuum packed and their physico-chemical (pH, color - CIEL*a*b* values, TBARS, texture - hardness, springiness, cohesiveness and chewiness), microbiological (total plate count, lactic acid bacteria, Escherichia coli, Listeria monocytogenes, Salmonella spp. and sulfite-reducing clostridia count) and sensory (color, odor flavor) properties were assessed during 225 days of storage. A total of 288 dry-fermented sausages were analyzed. The most abundant compound of CEO was monoterpene carvone (77%). The inclusion of CEO had a significant ($P<0.05$) effect on pH, texture and sensory attributes. CEO addition significantly ($P<0.05$) reduced lightness (CIEL* value) of dry-fermented sausages. Total plate counts were not significantly ($P>0.05$) different between the sausage samples produced with different concentrations of CEO. The CEO addition significantly ($P<0.05$) decreased TBARS values. Moreover, all three concentrations CEO provided acceptable TBARS values (<0.3 mg MDA/kg) in the sausage samples produced without sodium nitrite throughout the storage. The highest concentration of CEO (0.10 µL/g) affected on the formation atypical flavor for dry-fermented sausage. Generally, our findings confirmed that the caraway essential oil addition showed promising results to development of dry-fermented sausages with reduced level of sodium nitrite, primarily regarding their oxidative stability.*

Key words: *caraway essential oil; sodium nitrite; dry-fermented sausages.*

TEMPERATURE STABILIZATION USING PELTIER MODULES IN HIGHLY DYNAMIC ENVIRONMENT

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Abstract

Precision of Inertial Navigational System (INS) is mostly related to the drift of the gyroscopes. Stability of biases and minimization of drift can be achieved by highly and accurately stabilized temperature of sensors themselves as well as all related electronic circuits. In this paper we present a very compact and economical solution for temperature stabilization of INS with the use of Peltier elements controlled by a single microcontroller. The basis of the INS container is an aluminum block which provides the most homogeneous temperature field with its high temperature conductivity. Temperature stability of INS container is achieved by assigning a group of four Peltier elements to the sides of the block, each coupled with a temperature sensor. The aluminum block is isolated on all six sides and Peltier modules are the only "openings" for heat flux. The mathematical model of Peltier element is derived and verified through measured performance. This model is expanded to take into account the influence of the environment as well as the internal heat source. Theoretical limitations are obtained using this mathematical model which is later compared to experimentally obtained limits. This type of the temperature stabilization can be used for different purposes where precise temperature stability is needed in its end application. Temperature stabilization achieved in this manner is highly adaptable to the changes in objects surroundings and keeps the objects inner temperature stable. Groups of Peltier modules and temperature sensors enable the object to have fully independent temperature stabilization on each of its sides, which in turn allows the temperature stabilization algorithm to adapt its performance to the objects surroundings. All Peltier elements are controlled and monitored by a single microcontroller, which also exposes a simple and intuitive communication interface for the end user. This concept was tested in highly non-stationary environment with rapid changes in surrounding conditions and the object inner temperature was kept stable up to the second decimal. Hardware limitations were introduced and the coefficient of performance was compared to its theoretical value.

Key words: *temperature stabilization, Peltier elements, INS.*

BIOCHEMICAL CHARACTERIZATION OF *AEROMONAS HYDROPHILA* ISOLATED FROM THE BROWN TROUT (*SALMO TRUTTA*)

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Abstract

Aeromonas hydrophila *is a ubiquitous species oftenly isolated from fish stored at 4 - 7 ^{o}C. As a psychrotrophic species it causes gastroenteritis in humans. Pathogenic strains of this bacterium are able to produce thermostable enterotoxin in food of animal origin. These alimentary toxoinfections are of special importance for the so-called "YOPI" population. Although some individuals are asymptomatic carriers, they may pose a risk when handling food, as a potential source of infection. Moreover, these pathogens are difficult to identify by routine microbiological tests. The object of this study was a strain of* Aeromonas hydrophila *isolated from samples of brown trout muscle tissue caught in the Vrla River in the area of Vlasina, Southeastern Serbia. Following growth media were used for isolation: Alcaline peptone water (APW), Starch ampicillin agar (SAA) i m-Aeromonas Selective Agar Base (supplemented with Ampicilin). Biochemical identification was performed using the commercial API 20 NE system, and 7577754 profile was obtained. The Apilabplus V 3.3.3 bioMerièux software revealed 99.7% identity. Positive biochemical tests were: oxidase, reduction of nitrates, indole production, D-glucose acid, arginine dihydrolase, esculin hydrolysis, gelatin hydrolysis, β-galactosidase (PNPG), glucose acid, glucose gas, L-arabinose acid, D-mannose acid, D-mannitol acid, N-acetyl-glucosamine (NAG) assimilation, maltose acid, gluconate assimilation, capprate assimilation, malate assimilation. Negative biochemical tests were: urea hydrolysis, adipate assimilation, citrate assimilation, phenyl - acetate assimilation. For a more precise identification additional tests would be needed: motility (+), MR (+), VP (+), citrate Christensen (+), H_2S production (+), sucrose acid (+), salicin acid (+) and 0/129 sensitivity (-).On the example of the examined strain* Aeormonas hydrophila *the API 20 NE system proved to be insufficiently efficient which is why a molecular characterization needs to be done*

Key words: *Aeromonas hydrophila, biochemical characterization, meat, Salmo trutta*

BIOCHEMICAL CHARACTERIZATION OF *ENTEROBACTER CLOACAE* FROM SHEEP CHEESE

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Abstract

Vlasina sheep's milk cheese is produced in the traditional way from raw sheep's milk, without the addition of starter cultures and enzymes for coagulation. The object of this study was a 10-day-old sheep's cheese collected from an individual household from Vlasina region, Southeastern Serbia. Using standard methods of microbiology we isolated Enterobacter cloacae. The presence of these coliform bacteria indicates inadequate hygiene of the production process, performed under conditions promoting the growth of these bacteria (at ambient temperature and heating of pears to 50° C). The content of the cheese dry matter was 73.40%. Biochemical identification was performed using the commercial API 20 E system, and 3305773 profile was obtained. The Apilabplus V 3.3.3 bioMerièux software revealed 79.3% identity (T=0.88). Positive biochemical tests were: arginine dihydrolase, ornithine decarboxylase, citrate utilization, acetoin production (VP), gelatin hydrolysis, glucose, mannitol, inositol, sorbitol, rhamnose, sucrose, melibiose, amygdalin, arabinose. Negative biochemical tests were: β-galactosidase (ONOG), lysine decarboxylase, H_2S production, urease, tryptophane deaminase, indole production, oxydase. For a more precise identification additional tests would be needed: catalase (+), methyl red (-), motility (+), lipase (-), production of yellow pigment (-). Enterobacter cloacae was sucessfuly identified by API 20E system. Since some strains of Enterobacter cloacae have a cytotoxic effect, the presence of this opportunistic pathogen in sheep cheese may cause serious diseases in the so-called YOPI population. The implementation of good hygiene in traditional practice of Vlasina sheep's milk cheese production would ensure the microbiological safety of high quality product.

Key words: *Enterobacter cloacae, biochemical characterization, Vlasina sheep's milk cheese.*

EFFECT OF REFINED AND WHOLEGRAIN WHEAT FLOUR ON FORMATION OF MAILLARD REACTION PRODUCTS IN COOKIES

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Abstract

Due to a high content of health beneficial compounds, wholegrain flour of wheat have been extensively used in the confectionery industry. In most cases, health beneficial compounds of wheat grain are concentrated in outer layers, i.e. bran and aleurone. Aleurone is also a protein-rich tissue with a good amino acid profile. However, as such, it is the significant source of precursors in Maillard reaction products (MRPs) formation. This study was performed to evaluate the effect of refined and wholegrain wheat flour on formation of MRPs such as 5-hydroxymethylfurfural (HMF), acrylamide, as well as N^{ϵ}-fructosyllysine (Furosine), N^{ϵ}-carboxymethyllysine (CML) and N^{ϵ}-carboxyethyllysine (CEL) in cookies. Wholegrain flour of bread wheat genotype and refined wheat flour type 400 purchased from a local supermarket were used to prepare cookies. The cookies were baked at 180^{o}C for 7, 10 and 13 min. The content of free asparagine and total lysine, as well as sugars was analyzed in wheat flours and correlated with MRPs in wheat-based cookies. Lower content of acrylamide was found in cookies prepared from refined wheat flour that also contained lower content of free asparagine than wholegrain wheat flour. After baking for 7, 10 and 13 min, the content of acrylamide in refined flour- and wholegrain flour-based cookies was 17.9 and 24.4 ng/g, 52 and 220 ng/g and 72.3 and 210 ng/g, respectively. In addition, lower content of sugars in refined wheat flour (glucose-0.06%, fructose-0.02% and sucrose-0.14%) compared to that in wholegrain wheat flour (glucose-0.23%, fructose-0.12% and sucrose-0.45%) contributed to lower content of HMF in cookies (from 1.3 to 8.1 µg/g). Lysine, as a major precursor in formation of protein bound MRP, was not predominantly represented in the outer layer of the grains. Therefore, the content of furosine and CML in the refined flour-based cookies baked for 10 min (247.3 and 19.2 mg/kg, respectively) and 13 min (120.1 and 22.0 mg/kg, respectively) was higher than that in the wholegrain wheat-based cookies, but not statistically significant. However, maximum values of furosine and CEL reached after 7 and 13 min of baking, respectively, were higher in the wholegrain wheat-based cookies. Although more samples should be tested to further validate the findings of this study, the results suggest that refined wheat flour have lower potential for the formation of MRPs in cookies.

Key words: *Wholegrain and refined wheat flour, cookies, Maillard reaction products, free asparagine, total lysine, sugars.*

IMPROVEMENT OF MEMBRANE FOULING BY ADJUSTING THE BIOLOGICAL OPERATING PARAMETERS IN MEMBRANE BIOREACTOR

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Abstract

Membrane bioreactors (MBRs) have been widely used during the last decades for wastewater treatment worldwide in large-scale plants, due to their various advantages, such as excellent effluent quality, small footprint, large SRT and low sludge production. However, they present a major disadvantage that resides in energy consumption, which is attributed to the membrane fouling problem. Membrane fouling is caused by the accumulation and deposition of activated sludge substances on the surface and in the pores of the membrane. Membrane fouling leads to an increase in trans-membrane pressure (TMP) by reducing the membrane permeability. The fouling mechanism in membranes has been extensively investigated in order to explain it as well as to confront it. According to such research works, irreversible membrane fouling has been attributed to the gradual deposition and aggregation of SMP within the membrane pores resulting in pore blockage and increased TMP. The irreversible membrane fouling in most cases has been semi-confronted with chemical cleaning of the membrane, usually in a special facility outside the MBR system, which implies considerable labor costs. In this research work, an innovative method was investigated in a pilot-real scale MBR, where indigenous filamentous microorganisms of the bioreactor were used. The experimental results were compared with a pilot-real scale control MBR in which no filamentous bacteria were grown. The MBR unit of filamentous bacteria growth consisted of a denitrification tank of dissolved oxygen DO = 0.2±0.05 mg/L, an aerated/filamentous' growth tank of DO = 0.5±0.3 mg/L, an aerated tank of DO = 2.5±0.5 mg/L followed by a membrane tank where membranes were immersed. On the other hand, the control MBR consisted of a denitrification tank of dissolved oxygen DO = 0.2±0.05 mg/L, an aerated tank of DO = 2.5±0.5 mg/L and a membrane tank. Finally, the controlled growth of filaments was achieved in the first MBR unit, favoring the creation of sludge with high porosity, contributing to the reduction of membrane fouling.

Keywords: *membrane bioreactor; membrane fouling; operating parameters; dissolved oxygen; filamentous bacteria.*

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MODULATION OF THE ANTIOXIDANT ACTIVITY OF A FUNCTIONAL OAT BEVERAGE BY ENRICHMENT WITH CHOKEBERRY JUICE

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Abstract

Modern functional food companies are focused on the development of products offering multiple health benefits through combining various functional ingredients. In order to meet consumer's demands, the new products must not only provide a balanced nutritional value, but also have goodsensory characteristics, and deliver positive effect on various physiological functions of the body such as boosting immunity, reducing cholesterol levels, protecting against infections, maintaining gastro-intestinal health, ensuring the balance of gut microbiome, etc.
Oats has become a favourable cereal crop for functional foods production due to itshigh protein content and balanced amino acid composition compared to other grains. Oat also containsunique antioxidants– avenanthramides, and is rich in vitamins and minerals.The main distinctivecomponent of oats which is attributing to its functionality is β-glucan, for which EFSA has authorised health claims related to maintenance ofnormalblood cholesterol levels thus reducing the risk of coronary heart disease, reduction of postprandial glycaemic response and maintenance of healthy blood glucose levels, as well as increased faecal bulkwhich ensures normal colon function.Unlike other cereal grains,oats can be used by Coeliac patients and oat products can be labelled as"very low gluten"or„gluten free". Oat materialshave been used as milk substitutes to deliver probiotic microorganisms and several functional probiotic oat beverages are already available at the market. Functionality of such products may potentially be further increased by the addition of other ingredients rich in biologically active compounds.
Aroniamelanocarpa, also known as black chokeberry, is receiving significant attention in the recent years as a valuable source of phenolic compounds (mainly polyphenols), anthocyanins, flavonoids, carotenoids and vitamins, which have antioxidant, anti-inflammatory, and anti-carcinogenic activities. Assimilation ofpolyphenol compounds in the gut is limited, but some studies suggest that fermentation may be an effective method of increasing the bioavailability of these antioxidants in foods.Since polyphenols in chokeberry are bound by aglycosidic bond to carbohydrate molecules, lactic acid bacteria may produce enzymes which increase polyphenol bioavailability.
The aim of this study wasto enrich a probiotic oat beverage with antioxidantsby the addition of chokeberry juice. Therefore, it was necessary to assess how different quantities of chokeberry juice(5%, 10%, 15%, 20% and 30%) affected the antioxidant activity of the oat beverage and the fermentation potential of the starter monoculture of Lactobacillus plantarum Pro in the liquid oat matrix.Results show that the starter culture was well tolerant to chokeberry juice of up to 20% added before fermentation. Also, fermentation of the oat matrix with aronia juice was proved to increase the total antioxidant activity of the product compared to addition of aronia juice after fermentation. The sensory evaluation of four beverage variants confirmed that supplementation with chokeberry juice can improve the sensory acceptance of a fermented oat beverage.

Key words: *Antioxidantactivity, chokeberry,functional oat beverage,probiotic beverage*

DETERMINATION OF VITAMIN C CONTENT IN COMMERCIAL PHARMACEUTICAL PREPARATIONS

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Abstract

Vitamin C (ascorbic acid) is a water-soluble vitamin and very effective antioxidant. It stimulates the work of the immune system through the production of antibodies and thus prevents and alleviates the symptoms of the common cold. It plays a significant role in the synthesis of collagen, neurotransmitters, steroid hormones, carnitine, causes the conversion of cholesterol into bile acids and increases the availability of iron. The most important and largest source of vitamin C are plants, but it is often used in dietary supplements, alone or in various combinations. The aim of this study was to validate the analytical method and to determine vitamin C content in pharmaceutical preparations available on the territory of the Republic of Serbia. Under the selected chromatographic conditions, working standard solutions of vitamin C were injected and passed through the column. 5 commercial vitamin C preparations were used in the analysis. For the analysis of vitamin C in commercial preparations, the method of liquid chromatography under high pressure - HPLC was applied. An analytical method for the determination of ascorbic acid was developed and validated, which provided high resolution and repeatability of the peaks. There was no interference from the other components used in the tablet formulations. The validation results show that the method used is simple, linear, precise, accurate and selective. The variation of the tablet mass of all manufacturers were in compliance with Pharmacopeia. The content of vitamin C varied from 100.55 to 100.77% in relation to the declared value, which is in accordance with the regulations of the Pharmacopeia (95-105%). Comparing the obtained results with a similar study in which the content of L-ascorbic acid in pharmaceutical preparations was determined using the HPLC-DAD method, approximately the same results were obtained (the content was 99.68% of the declared content). Analytical method for quantitative determination of vitamin C in pharmaceutical preparations (tablets) showed high sensitivity, precision, selectivity and ease of performance. The results of the analysis of the vitamin C content in all tablets are in accordance with the manufacturer's declaration.

Key words: *vitamin C, validation, HPLC.*

INVASIVE ACER NEGUNDO L. BIOMASS AS LEAD SORBENT FROM AQUEOUS SOLUTION

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Abstract

Acer negundo L. is recognized as an invasive deciduous tree species that tends to grow and spread out of its natural range posing a threat to the biodiversity of the impacted areas. Although invasive plant species are considered to negatively affect ecosystems, their biomass can be used for environmental benefits. In order to find abundant and inexpensive sorbent for wastewater purification and metal pollution minimization, A. negundo leaf biomass was selected and investigated for that purpose. Since lead is well known as a common pollutant occurring in various industrial effluents with harmful effects on biota, it was selected for the sorption experiments. Acer negundo L. (AN) samples were collected at the unpolluted area in Mountain Avala, Serbia. After milling and sieving, the prepared sorbent was used in batch system sorption experiments. Experiments were conducted under isothermal conditions, by adding a precise amount of sorbent in the lead solution of known initial concentration. The adsorption performance of the obtained biomass-derived material (AN) was evaluated by testing several operational parameters: initial pH value, initial sorbent dosage, contact time, and initial lead concentration. The experimental parameters were optimized in order to determine the most appropriate conditions for Pb(II) removal. Maximum lead uptake occurs at pH 5, with 2g/L of sorbent dosage. The kinetic study revealed very fast adsorption, with equilibrium occurring after an initial 15 min of contact between sorbent (A. negundo leaf biomass) and sorbate (1mmol/L of lead solution). After this contact time, the residual metal concentration started to increase indicating the desorption process. Data obtained from sorption experiments were subjected to equilibrium modeling: they were fitted by two-parameter models (Langmuir and Freundlich). Results showed that the maximal adsorption capacity of a sorbent is 109 mg/g. Obtained results suggest that Acer negundo leaf biomass can be successfully applied as a lead sorbent upon the optimization of the operating parameters. Studies of this type provide valuable information for future water remediation technology development.

Keywords*: invasive plant, Acer negundo, lead, sorption, wastewater treatment*

SUGAR BEET PULP AS BIOSORBENT FOR MOLASSIGENIC METALS: BATCH BIOSORPTION AND DESORPTION STUDIES

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Abstract

Sugar beet pulp (SBP), a by-product of the sugar-refining industry, is produced in a large amount every year. After extraction of sugar juice from SBP, pathways of SBP and sugar juice are separated following the different industrial process steps. The sugar juice purification stage affects sugar utilization and efficiency of the whole industrial process. Therefore, low-colored thin sugar juice with high sugar content and low molasses-forming metals (sodium, potassium and calcium) content indicates successful juice purification process. Additional purification techniques could be advantageous regarding juice purification improvement. The aim of this research is to investigate the sugar beet pulp sorptive characteristics regarding molasses-forming metals removal from alkalized sugar juice. Furthermore, the most effective desorption reagent upon molasses-forming metals elution from the sugar beet pulp was examined. Biosorption and desorption experiments were conducted in a batch system under the similar experimental conditions and adsorbent dose (0.05g/mL). In order to analyze the kinetics of sorption, metal content was determined in samples every 20 min during 180 min. During biosorption experiments, temperature and pH of alkalized juice were maintained at 70^{o}C and 10.5, respectively. The biosorption removal efficiency for sodium, potassium and calcium was 6.96, 9.35 and 30.00 %, respectively. The desorption process was performed with five desorption reagents (0.1 M): HCl, HNO_3, H_2SO_4, NaOH and EDTA. The desorption efficiency regarding three molasses-forming metals from the sugar beet pulp decreases in the following order : HCl > NaOH > HNO_3 > EDTA > H_2SO_4. HCl, as the most successful desorption reagent, removed calcium almost completely (98.12%), whereas sodium and potassium were transfred from the SBP into desorption reagent with 28.01 and 65.43% efficiency. Calcium, as divalent metal ion, has stronger sorption/desorption properties compared to the other investigated metals. This data emphasized that SBP could be used as an efficient and reusable biosorbent for sodium, potassium and calcium removal. SBP enriched with nutritionally valuable minerals represents a valuable livestock feed.

Key words: *biosorption, desorption, sugar beet pulp, molasses-forming metals.*

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THE EFFECT OF EXTRUSION CONDITIONS ON THE BULK DENSITY OF SPELT WHOLEGRAIN SNACK PRODUCT

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Abstract

The main purposes of this work are successful modeling of extrusion cooking process in order to evaluate the impact of extrusion parameters on bulk density(BD) of spelt wholegrain snack product. Wholegrain spelt flour was extruded using co-rotating twin-screw extruder (Bühler BTSK 30/28D, 7 sections, length/diameter ratio = 28:1, Bühler, Uzwil, Switzerland). The bulk density of snack products was determined using a device for determining the bulk density (Tonindustrie, West und Goslar, Germany). Central composite rotatable design (CCRD) was used to select the minimal number of experiments to build up an appropriate model for the extrusion process. Prior to ANN modelling, the second order polynomial (SOP) model was developed to check the impact of the input variables: feed moisture (M), feed rate (FR), screw speed (SS) over the output (bulk density). The ranges of input parameters were 15%<M <25%, 15kg/h <FR <25kg/h and 250rpm <SS <750rpm. The linear term of SS was most influential in the SOP model for BD calculation, statistically significant at p<0.01 level. The highest bulk density (478g/l) was achieved at the following operating conditions: screw speed (250 rpm), feed moisture (20%) and feed rate (20kg/h). The value of balk density was in range from 244.4g/l to 478 g/l.These results confirmed the increase in the value of BD from speltwholegrainsnack in relation to extrudates from corn grits.The bulk density decreases with increasing screw speed and the expansion index. Increased feed moisture content during extrusion may reduce the elasticity of the dough resulting in reduced specific mechanical energy, therefore reducing gelatinization, decreasing the expansion and increasing the bulk density of extrudate. Feed rate has no effect on the bulk density. From the Yoon's model it has been confirmed that the feed rate has the lowest influence, while the feed moisture has a positive effect, and screw speed has the highest, negative effect on bulk density.

Key words: *extrusion, bulk density, spelt, influence*

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PRESENCE OF *ALTERNARIA* TOXINS IN MAIZE FROM REPUBLIC OF SERBIA DURING 2016 - 2017

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Abstract

Due to the lack of comprehensive data available regarding toxicological effects and occurrence of Alternaria toxins, they are referred as "emerging" mycotoxins. They are produced by Alternaria species which are widespread in both humid and semi-arid regions. Due to their growth at wide ranges of air temperature and humidity, they are the principal contaminating fungi in small grain cereals, but they can contaminate as well maize, oilseeds, fruit and vegetables in the field. This fungal genus, by the infestation of numerous agricultural products associated mycotoxin contamination may implicate health concerns for humans and animals. Based on several published studies from around the world, maize can also be contaminated with Alternaria toxins. Taking into account the fact that maize is the most important cereal crops produced in the Republic of Serbia and represents a very important agricultural crop intended for export, the aim of this study was to apply modern analytical tools, liquid chromatography-tandem mass spectrometric method (LC-MS/MS), for identification and quantitation of Alternaria metabolites. Maize samples were collected from the main maize-producing regions (Bačka, Banat and Srem) of the Republic of Serbia during two harvest seasons (2016 and 2017). Four and seven different Alternaria toxins were detected in maize samples collected in 2016 and 2017 years, respectively. The most commonly detected Alternaria toxins in maize samples from both years was tenuazonic acid. On the other hand, determined mean concentrations of quantified tenuazonic acid were significantly higher in maize samples from Banat from both maize growing seasons in comparison to its concentrations in maize samples from Bačka and Srem. Further, the findings in this study indicate that the microclimate conditions in the investigated regions had a great influence on the contamination frequency of Alternaria toxins in maize. The highest percentages of contaminated maize samples by Alternaria toxins, both 2016 and 2017, years were 47% and 59% respectively from Srem, whilst the lowest percentages of 29% and 23% respectively were found in Bačka. The findings of our previous researches regarding the contamination of cereals from the Republic of Serbia with Alternaria toxins, as well as the results of this study indicate the need for continuous monitoring of Alternaria metabolites in small grain cereals as well as in maize.

Key words: *Alternaria toxins, maize, Republic of Serbia, LC-MS/MS*

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REDUCTION OF DEOXYNIVALENOL CONTENT IN THE WHEAT FLOUR BY ATMOSPHERIC COLD PLASMA TREATMENTS

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Abstract

The most commonly found mycotoxin in cereals and cereal-based products worldwide is deoxynivalenol (DON), categorized as a type B trichothecene. DON is a secondary metabolite of Fusarium spp. especially produced by Fusarium culmorum and Fusarium graminearum affected by environmental factors, and represents a significant hazard to the food and feed processing chain, causing economic losses. In the years when the contamination of wheat by DON is far above the maximum allowed limit, none of the conventional technological process in wheat processing chain can reduced its content in the white wheat flour below allowed level of 750 μg/kg. Therefore, the aim of this study was to explore the potency of cold atmospheric pressure plasma treatments, as a new non-thermal approach, for reduction of DON content in spiked white wheat flour samples (750 μg/kg of DON in flour). The flour samples were treated with non-equilibrium (cold) atmospheric pressure plasma generated in the air by using a surface dielectric barrier source. In the experiment we varied the treatment durations (30 s, 60 s, 90 s, 120 s, 150 s and 180 s) and sample distances from the cold plasma source (6 mm, 21 mm, 36 mm and 51 mm). The reduction of the DON content in the samples after treatment was monitored by the high performance liquid chromatography and diode-array detector at wavelength of 220 nm. The maximum reduction of the DON content was obtained after 150 s treatment performed at 51 mm distance from the plasma source, resulting in reduction of 71%. From the point of economic viability, the optimal treatment that provides a satisfactory reduction rate of DON (67.5%) was achieved when the wheat flour was treated for 60 s at 36 mm distance from the plasma source. According to the obtained experimental results, an empirical model in the form of the artificial neural network (ANN) was developed for the prediction of the DON reduction, temperature and moisture of the wheat flour. The model gave a good fit to the experimental data and was able to predict the variables successfully. The developed ANN model showed high coefficients of determination for prediction of experimental results (between 0.996 and 0.999).

Key words: *wheat flour, reduction of deoxynivalenol, atmospheric cold plasma, HPLC-DAD, mathematical modelling*

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DEVELOPMENT OF BARLEY EMULSION GELS AND EVALUATION OF THEIR RHEOLOGICAL PROPERTIES

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Abstract

Fat shortenings are an integral part of the bakery industry since it provides important sensory properties and quality attributes to the final products such as flavor, taste, texture and color; nevertheless, it is inextricably linked to the increased risk of cardiovascular diseases due to the high content of saturated fatty acids. Emulsion gels are considered as an innovative approach to substitute (partially or fully) the shortenings and margarine used extensively as ingredients in baked products. β-Glucan, a known dietary fiber extracted from barley and oat, is a useful material for the stabilization of emulsions and apart from that offers several health benefits. In this study, oil-in-water emulsion gels were formulated with varying proportions of barley flour enriched with β-glucan (~30% according to supplier)/olive oil/water (from 8/10/88 to 28/30/42) in order to use them as possible fat replacers in baked products with improved nutritional properties. Changes in rheological properties of barley emulsion gels were evaluated using dynamic rheometry (frequency sweep test) and large deformation mechanical test (compression test) during storage at 4°C for 7 days. Mechanical spectra showed a typical solid-like behavior for all barley emulsion gels, with the elastic modulus (G') being greater than the loss modulus (G'') over the whole frequency range. Additionally, the barley emulsion gels 28/30/42 exhibited the most elastic and viscous network and differed significantly ($p<0.05$) from the 8/10 formulation, which had the least viscous character among all samples throughout storage, followed by the 10/10/80 and 12/10/78 formulations. Moreover, hardness and cohesiveness of barley emulsion gels increased during storage implying a strong time dependency. Apart from that, the higher the concentration of barley flour enriched with β-glucan, the greater were the values of the above parameters, provided that the concentration of olive oil remained stable. Overall, there was agreement between the small and large deformation rheological measurements of barley emulsion gels.

Keywords: *Barley emulsion gels, fat substitutes, rheological properties*

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MODELING AND CALCULATION OF DESIGN PARAMETERS FOR A COLD CHAMBER USED IN MEAT INDUSTRY

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Abstract:

The present paper proposes a model for the calculation of the key parameters forcold chambers where meatcarcasses are chilled, foundin large refrigeration systems in meat processing industry. The total cooling load was calculated using the heat balance methodology.The heat flux of the condenser fan used and chamber lighting are the known values. The heat flux transferred from the outside environment towards the chamber was calculated using the standard methodology, whereas the heat flux caused by meat carcass chilling was calculated based on the temperature difference between the carcass and the mass flow of water evaporation.The air flow rate was calculated based on the cooling load and the temperature difference of the air in the chamber. In order to obtain a more accurate analysis, the heat of solidificationand the heat of evaporation of waterat a characteristic temperature werealso taken into account in the calculations. Sizing of the evaporator, i.e. determining the heat transfer surface area on the air side, was calculated based on the heat transfer equation, taking into consideration the heat flux suitable for the given heat of solidification. Finally, the model proposed was illustrated on a practical example from the meat processing industry with the calculation of all the characteristic parameters necessary for the cold chamber design.

Keywords: *meat carcasses, cold chamber, design parameters, cooling load, the heat of solidification and the heat of evaporation, air flow, heat transfer surface area.*

IMPACT OF CARBOHYDRATE-COATED CERIUM OXIDE NANOPARTICLES ON SEMI-VOLATILE COMPOUNDS IN TWO CROPS

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Abstract

Plants accumulate and synthesize various compounds, which are involved in plant-environment interaction. Among them are semi-volatile organic compounds of which 1700 are currently known to be emitted by plants. These compounds present 1% of plant secondary metabolites. The effect of cerium oxide nanoparticles ($nCeO_2$) on semi-volatile organic compounds in plants was not investigated. Redox properties of $nCeO_2$, based on their facile transition between Ce^{3+} and Ce^{4+} oxidation states are the main reason for their increased usage in the pharmaceutical industry, paints, cosmetics, electronics, and fuel additives. For that reason, $nCeO_2$ can be found in the environment so there is a need to analyze their ecotoxicity. To improve their solubility, $nCeO_2$ were coated with monosaccharide - glucose and microbial exopolysaccharides – levan, and pullulan. The main aim of this research was to study the effect of 200 mg/L glucose-, levan-, and pullulan-coated $nCeO_2$ (G-CeO_2, L-CeO_2, and P-CeO_2) in the shoot extracts of wheat and pea by screening the semi-volatile compounds with comprehensive two-dimensional gas chromatography (GC×GC-MS). The $nCeO_2$ were applied at a concentration of 200 mg/L during three weeks of plants' growth in hydroponics. The semi-volatile organic compounds were extracted from plant shoot extracts with methylene-chloride. Noticed coated $nCeO_2$ effect was compared with the effect of uncoated ones. Nonlinear principal component analysis (NLPCA) with optimal scaling was used for the evaluation of wheat and pea GC×GC chromatograms and the confirmation of differences in chemical composition between untreated and treated plants. Results revealed that wheat samples had a higher number of chemical compounds than a pea. The chemical composition of wheat was less affected by the treatments with coated nanoparticles compared to pea. Most compounds which content was significantly different compared to the control compounds were detected in wheat after the treatment with L-CeO_2 and P-CeO_2, and in pea after L-CeO_2 treatment. A semi-volatile profile was presented only as categorical variables, while unique fingerprint images were used for the inter-cultivar recognition. These results showed that GC×GC-MS as a screening method may be useful for monitoring the effects of various abiotic factors on different plant species.

Key words: *CeO_2, gas chromatography, nanoparticles, plant, screening.*

HEAT TREATMENT OF METAL-ADSORBED THERMAL PLANT SLAG AND FLY ASH: SAFE DISPOSAL AND SECONDARY APPLICATIONS

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Abstract

For a few more decades, Balkan region is probably going to rely on fossil fuels, especially coal in terms of energy production which causes a number of environmental problems. However, significant improvements are reached by building new state-of-the-art thermal plants or by building desulphurization plants as a way of treatment for exhaust gasses and particles. Even if in the future all of the thermal plants reach the complete control of emission such as achieved by Stanari and Ugljevik recently, large quantities of the slag and fly ash will still remain a demanding environmental issue. Their disposal is space demanding, yet they are often chemically inert and have a range of potential applications. One of the most cited applications is the use of these materials as the adsorbent for toxic metals in wastewater treatments. However, seldom, the fate of the metal-adsorbed slag or fly ash is discussed. Present study, therefore, deals with the complete cycle, both the adsorption potential and necessity of the safe disposal of metal-adsorbed slag and fly ash. In particular, adsorption potential for chromium of the Ugljevik thermal plant slag and fly ash was studied. However, at the same time, the heat treatment at 1100°C was used as a means to fix the metal ions into the structure of these waste materials and render them safe, by preventing the migration of toxic metals into the environment. Adsorption potential was found to be very promising. Moreover, thermal treatment has revealed completely unexpected results in which new stable crystal, almost vitrified structures appear. These results are supported by the powder X-ray diffraction method which shows that adsorbed metal ions might have served as the centers for nucleation of completely new crystal structures. If further confirmed, such results could open the potential use of metal-adsorbed slag from Ugljevik thermal plant as the construction material or even in the technical glass industry.

Key words: *slag, fly ash, chromium, adsorption, X-ray diffraction*

SPECTROFLUORIMETRIC DETERMINATION OF ASCORBIC ACID WITH BROMOCRESOL PURPLE

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Abstract

Ascorbic acid ((5R)-[(1S)-1,2-dihydroxyethyl]-3,4-dihydroxyfuran-2-(5H)-on) (AA), also known as vitamin C, is one of the most studied and the first synthetic vitamin. Vitamin C is an excellent antioxidant used to prevent and treat colds, infertility, cancer and AIDS. It is important for its role in biochemical processes such as electron transport, collagen synthesis, iron absorption, participation in cell protection against oxidative stress caused by free radicals, and the improvement of the immune system. For the determination of ascorbic acid in natural and commercial products, a large number of analytical methods have been developed such as spectrophotometric, fluorimetric, titration, electrochemical and highly efficient liquid chromatographic methods. Most analytical procedures for ascorbic acid analysis are based on its oxidative-reducing properties. In this paper, a new spectrofluorimetric method for analyzing the content of ascorbic acid in pharmaceutical preparations is proposed. The ascorbic acid in reaction with bromocresol purple (BCP) is oxidized to dehydroascorbic acid and the BCP passes into its reduced (Leuko-BCP) form in the buffer medium. The relative fluorescence intensity of the reaction was measured at wavelengths of 318 and 641 nm for excitation and emission. Based on the obtained experimental data, a new spectrofluorimetric method for the determination of AA in pharmaceutical preparations was developed. The influence of reaction conditions such as BCP concentration, reaction time, instrumental parameters (recording of fluorescence intensity at 1%T and all filters open) and linearity, accuracy, repeatability and precision were investigated. Linearity was achieved in the area of the AA concentration of $4.65x10^{-5}$ to $4.65x10^{-6}$ mol/L with the coefficient of correlation of 0.9964. The equation of the direction obtained from the calibration curve is y = -61836x + 8.5902. Limit detection (LOD) is $8.77x10^{-5}$ mol/L calculated as 3σ for n=9. The quantification limit (LOQ) is 2.345×10^{-4} mol/L calculated as 10σ for n=9. The standard SD deviation is $2.097x10^{-5}$ mol/L and RSD is 8.46%. The proposed method analyzed fifteen samples containing a different amount of AA. The effects of interfering components such as citrus bioflavonoids (routine and hesperidin), citric acid, magnesium and calcium carbonate, folic acid, paracetamol, and iron(II) sulfate on the intensity of fluorescence of AA were also investigated.

Key words: *ascorbic acid, bromocresol purple, spectrofluorimetry.*

ADSORPTION OF GLYPHOSATE ON PHYLLOSILICATE MINERAL: EFFECT OF pH AND CONTACT TIME

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Abstract

Glyphosate (GPS) is a non-selective, organophosphate herbicide that has the greatest global application. Due to its application, it can often be found in drinking water. The aim of this research is the potential removal of GPS from an aqueous solution by adsorption on phyllosilicate. The possibility and efficiency of GPS adsorption on phyllosilicate mineral 0.5 fraction were investigated in this paper. The adsorption efficiency of GPS on phyllosilicate mineral composed of aluminum silicate hydroxide: $Al_2Si_4O_{10}(OH)_2$ was tested using a horizontal and vertical stirrer with adjusting parameters (contact time, temperature, a mass of phyllosilicate mineral, different pH of the medium, and glyphosate concentrations). Glyphosate content before and after adsorption was determined spectrophotometrically by reaction with ninhydrin and sodium molybdate. By examining the effect of the contact time on a horizontal stirrer (30 to 180 minutes) for a glyphosate concentration of 5 mg/L, maximum adsorption is reached after a contact period of 60 minutes (20%), then decreases (after 180 minutes to 3.80%). For the concentration of 10 mg/L glyphosate, the results vary. Better adsorption efficiency was achieved at lower GPS concentrations. The highest proportion of GPS adsorption on the phyllosilicate mineral was achieved by stirring with a vertical stirrer and by adjusting the pH of the medium from 2 to 12.90. The adsorption efficiency of three different GPS concentrations (9.98, 12.48, and 19.97 mg/L) for three different contact times (12, 24, and 48 hours) in acidic, neutral, and basic media was investigated. The highest adsorption fraction was achieved during a 12-hour contact at a pH of about 6.17 for a concentration of 19.97 mg/L (68.96%). The adsorption efficiency at a contact time of 12 hours is best demonstrated in the pH range of about 3.09 to 6.17, while in the base range adsorption is best at a pH of about 12.90. Within 24 hours, the adsorption capacity of glyphosate to the phyllosilicate mineral decreases in acidic and neutral mediums. The base medium (pH 12.90) showed constant adsorption efficiency (32.53 to 39.36%) for all three contact times (12, 24, and 48 hours) and all three concentrations. So, this work showed that phyllosilicate mineral could be used for the adsorption of GPS from an aqueous solution. To our knowledge, these are the first data on the possibility of removal of GPS from aqueous solution by adsorption on this phyllosilicate mineral.

Key words: *glyphosate, adsorption, phyllosilicate mineral, aqueous solution*

STUDY OF TRANSFORMATIVE POTENTIAL OF HEMATITE ULTRAMICRO PARTICLES AS A DOMINANT PHASE IN RED MUD

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Abstract

Metallurgical and chemical processing of bauxite is one of the most intensive processing industries. The remaining waste material, a "red mud" is in recent decades often discussed and studied as the valuable secondary raw material. Red mud is a hazardous waste, which contains fine particles, has a strong alkalinity, and has to be monitored for radioactivity. However, it is undoubtable that it contains a large percent of iron oxide, some remaining aluminum oxide, silicon oxide and even traces of critical raw materials and rare earth metals. China has done most in the field of reuse of red mud. The patents in this country range from application of red mud for desulfurization of the flue gas, magnetic separation of iron component, and utilization of the aluminosilicate mineral fraction for cementing material of production or anhydrite binder materials, production of titanium dioxide and/or white carbon black. Many of these technologies are relying and hopeful of producing novel nanomaterials. Present research, however, focuses on the potential of the ultramicro and micro hematite particles as they are in the red mud, without complicated processing or necessarily dissolving the oxide phase. The paper presents a detailed X-ray diffraction, energy-dispersive X-ray spectrometry, scanning electron microscopy and compound microscopy of the samples from the red mud accumulation belonging to the "Alumina" company in Bosnia and Herzegovina. The economical sense of the process of neutralizing this highly caustic waste and energy-efficiently separating its hematite phase for further use is discussed. The accent is placed on the potential of hematite ultramicro and micro particles as the anode material for lithium batteries.

Key words: *red mud, hematite, rare earth metals, raw materials, reuse, lithium batteries.*

TEXTURAL, COLOR AND SENSORY CHARACTERIZATION OF SPELT WHOLEGRAIN SNACK WITH ADDED BETAINE

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Abstract

Betaine is a bioactive compound that has significant physiological functions in the human organism. The endogenous synthesis of betaine is generally insufficient to satisfy the requirements of the organism and therefore its intake is necessary through the food. Spelt wholegrain flour was chosen for snack production in this studybecause it is a rich source ofbetaine. Production of the snack product with the addition of betaine (addition level of betaine was at 9%) was performed on twin-screw extruder.This amount of added betaine was neededto satisfy accepted health statement.

The effect of extrusion condition, including feed rate (15–25 kg/h), screw speed (250–750 rpm) and feed moisture (15–25%) on hardness, color and sensory properties of an extruded snack spelt wholegrain flour products with added betaine was investigated. Wholegrain spelt flour was extruded using corotating twin-screw extruder (Bühler, Uzwil, Switzerland).

Hardness showeda high positive correlation with the feed moisture and negative correlation with the screw speed. The feed rate had the lowest effect on the hardness of extrudate. L color values (brightness) decreased after extrusion, while a*(greenness/redness)and b* (blueness/yellowness) values increased. Changes in color values might be due to the possible reaction of higher doses of betaine (amino acid) with sugar in Maillard reactions that contributed to the formation of colored products, thusdecreasingproducts brightness. Yoon's model has shown that feed moisture content hadthe greatest influence on the L*values. The higher feed moisture content prevents the effects of high temperatures and results in lower browning of the sample. The screw speed has the greatest influence on a* and b* values.*

Results of the sensory evaluation of snack product showed that the sample with maximal expansion was separated from other samples by the largest diameter and the most pronounced sweet taste, which was expected. Sample with the lowest hardness was distinguished by strong bitter and sweet taste after immersion in milk. Considering that this sample had the best rehydration properties (due to the weakest mechanical properties) and therefore absorbed the largest amount of milk, both tastes present in the sample became prominent due to the dissolution of substances that give a sweet and bitter taste in milk. Betaine addition did not affect the bitter taste of the snack extruded product (when the sample produced under optimal condition compared to control samplewithout betaine).

Key words: *extrusion, color, hardness, sensory analyis, spelt*

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STUDY OF ULTRASOUND-ASSISTED EXTRACTION KINETICS OF BETAINE FROM WHOLEGRAIN SPELT FLOUR

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Abstract

In the recent years betaine is recognized as an essential dietary supplement and as a functional ingredient that has a wide range of health benefits. Wholegrain spelt flour is a rich source of betaine. Therefore, betaine extraction from wholegrain spelt flour by ultrasound-assisted extraction, as a novel and fast method, was investigated. The effect of the ultrasound bath and probe was studied on the extraction yield. Different ultrasound frequency exposures were studied using a 20 kHz probe system (VC 750, Sonics and Materials Inc., USA) and multiple bath systems operating at frequencies of 25 and 45 kHz (Elma IT H5, Germany), and 35 kHz (Jencons-PLS S1000, UK). After the ultrasound treatments samples were transferred into an orbital shaker (S01, Stuart Scientific, UK), stirred at 250 rpm and withdrawn after 0h, 1 h, 2 h, 3 h, 5 h, 21 h and 24 h and centrifuged at 5000 rpm for 10 min (Sigma 2-16PK, UK). Betaine content was measured using a HPLC system (Agilent Technologies Inc., USA) equipped with a Kinetex HILIC (Phenomenex, Aschaffenburg, Germany) column (2.6 mm, 100x2.1 mm) and ELSD detector (1290 Infinity ELSD, Agilent Technologies). Ultrasound-assisted extraction gives a higher extraction yield in less time compared to the control extraction method with the orbital shaker. The highest betaine content was 215.9 mg/100 g DM obtained by ultrasound probe assisted extraction. Betaine content after 24 h of shaking in the orbital shaker was 167.7 mg/100 g. That value can be reached using ultrasound pretreatment at frequency of 45 kHz after only 3h of shaking. The well-known Peleg kinetic model was compared with the artificial neural network in order to find a better way to predict the yield of the betaine content at a selected time. The predicted values by the Peleg model and neural network showed a good agreement with the experimental data with coefficient of determination values greater than 0.98 and mean squared error lower than 69.1, where ANN had a slightly better prediction. Ultrasound-assisted extraction of betaine from wholegrain spelt flour is an effective and economic extraction process with the advantage of shorter time and higher extraction yield.

Key words: *ultrasound-assisted extraction (UAE), betaine, spelt.*

This work is financed by The Ministry of Education, Science and Technological Development of the Republic of Serbia (contract No. 451-03-9/2021-14/200222).

EFFECT OF GALACTO-OLIGOSACCHARIDES ON *STAPHYLOCOCCUS EPIDERMIDIS* GROWTH AND EXAMINATION OF THEIR DIFFUSION FROM COSMETIC FORMULATIONS

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Abstract

According to the current definition, a prebiotic is described as "a substrate that is selectively utilized by host microorganisms conferring a health benefit". Originally, the concept of prebiotics was defined for the gut microbiota. However, it can be also applied to modulate the composition of other microbiological populations, for example, skin microbiota. In recent years, scientific interest in the composition and function of the dermal microbiota has been growing, as it has been established that certain skin diseases are associated with dysbiosis of the skin microbiota. Consequently, for the cosmetics industry, it is of utmost importance to develop products that have a prebiotic effect and thus can provide a balanced composition of the skin microbiota. In this paper, an assessment of the galacto-oligosaccharides (GOS) prebiotic activity was performed by following the effect of the addition of these oligosaccharides on the growth of Staphylococcus epidermidis, a member of the permanent skin microbiota. Simultaneously, changes in nutrient medium composition during the fermentation were monitored using high-performance liquid chromatography. In the end, bearing in mind the future implementation of GOS in cosmetic formulations, the possibility of controlled release was determined using the Franz cell diffusion study. The obtained results showed that GOS has a stimulating effect on the growth of S. epidermidis since it has been noticed that the number of vegetative cells increases with increasing concentration of GOS up to the concentration of 5 % (w/v). Based on the change in the composition of soluble sugars in nutrient media enriched with oligosaccharides, it was confirmed that the bacteria S. epidermidis can utilize GOS. Finally, the effective diffusion coefficients of GOS, that have been incorporated into two different cosmetic formulations for previously defined optimal concentration (5 % w/v), were determined. Namely, the best results were obtained for formulation with Heliogel as a gelling agent - the effective diffusion coefficients of GOS trisaccharides (GOS3) and GOS tetrasaccharides (GOS4) were $1.904 \cdot 10^{-6}$ *cm*^{2}*/s and* $4.696 \cdot 10^{-9}$ *cm*^{2}*/s, respectively. On the other hand, the effective diffusion coefficient of GOS3 in hydrogel Aristoflex AVC was* $5.148 \cdot 10^{-8}$ *cm*^{2}*/s, while the diffusion coefficient of GOS4 could not be determined, due to the low diffused concentrations. This indicates that GOS3 diffuse significantly faster than GOS4 and the rate and mechanism of transport of these molecules are highly dependent upon the type and characteristics of the formulation.*

Key words: *GOS, prebiotics, Staphylococcus epidermidis, cosmetic formulation, diffusion coefficient*

DEVELOPMENT OF FRUCTOSYLTRANSFERASE NANOBIOCATALYST SYSTEMS FOR APPLICATION IN SYNTHESIS OF BIOACTIVE FRUCTO-OLIGOSACCHARIDES

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Abstract

Fructo-oligosaccharides (FOS) are recognized as prebiotic compounds which have the ability to stimulate the growth of gut microbiota, microorganisms that positively affect human health. Additionally, they have excellent nutrition- and health-relevant properties such as low caloric, non-cariogenicity, the ability to reduce total serum cholesterol levels, and many others. FOS can be found in various vegetables and fruits, but in low concentrations, which represents the main reason for their production on an industrial level. Production of FOS is predominantly based on the enzymatic transformation of sucrose using enzymes with transfructosylation activity such as fructosyltransferases or β-fructofuranosidases at the higher sucrose concentrations. In recent years, FOS growing market demand mainly as ingredients for food applications (bakery products, sweets, different types of beverages) has been increased, so there is a necessity for the development of new enzymatic systems for production of FOS with high yields and productivities. Enzyme immobilization techniques have been proposed as one of the potential solutions. Thus, this work aimed to evaluate the potential of amino-modified and cyanuric chloride functionalized amino-modified nonporous fumed silica nanoparticles (AFNS and CCAFNS, respectively) for the development of efficient nanobiocatalysts for application in the biosynthesis of FOS. Selected modified nanocarriers were applied for the immobilization of fructosyltransferase (FTase) from commercial enzyme preparation Pectinex® Ultra SP-L whereby the effects of immobilization parameters like initial enzyme concentration, immobilization time and pH were analysed. Among both used nanocarriers, the one with chloride groups (CCAFNS) exhibited the highest FTase binding capacity of 89 mg/g of support with the efficiency of 35 % at an initial enzyme concentration of 250 mg/g of support, pH 6.0, and immobilization time of 2.5 h. By examining the influence of immobilization time, it was found that the highest activity of 1576 IU/g of support was demonstrated by FTase immobilized on AFNS after 5 h, while FTase covalently immobilized on CCAFNS, exhibited activity of 1122 IU/g of support. According to the achieved activity, both obtained nanobiocatalysts were further applied in FOS production which was performed at 50 ^{0}C and sucrose concentration of 500 g/l during 48 h. Apparently, with CCAFNS preparation FOS production of 14 g/l/h was achieved as compared to 5.9 g/l/h by AFNS preparation. Since in both cases, high sucrose conversion of 89 % was accomplished, it can be concluded that covalent immobilization of FTase on CCAFNS has the better catalytic capability for FOS production than FTase immobilized on AFNS via electrostatic interactions.

Key words: *nanoparticles, immobilization, fructosyltransferase, transfructosylation, FOS, prebiotics.*

IMPACT OF LIGNIN–SOLVENT INTERACTIONS ON THE PEFORMANCE OF ELECTROHYDRODYNAMIC TECHNIQUES

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Abstract

The influence of the properties of lignin solutions in different organic and aqueous solvents on the formation of micro-structures through electrospinning and electrospraying was studied. A rheological and physicochemical characterization of different lignin solutions in several solvents such as, dimethylformamide (DMF), dimethyl sulfoxide (DMSO), dimethylacetamide (DMaC) and aqueous NaOH solution, at different lignin concentration (4 ,10, 20, 30, 35, 40 wt.%), was carried out. The influence of solvent, lignin type and processing parameters (temperature and time) on viscosity, electrical conductivity and surface tension of the solutions were analyzed. Processing temperature (25–100 ºC) and time (2–48 hours) did not significantly affect the rheological and physicochemical properties of solutions. However, the nature of lignin played a key role on the rheological response of the solutions studied. Finally, the electrospinability of these solutions and the morphology of the micro-structures obtained were analyzed and correlated with the solution physicochemical properties. Stable ejection was only possible with solution concentrations between 30-35%, i.e. when the critical entanglement concentration (C_c) in the solutions was exceeded. In general, lignin solutions were not able to form nanofibers by electrospinning, but rather micro-structures with beads of different sizes. This study offers some insights into the potential of lignin solutions to produce tailored micro- and nano-structures through electrohydrodynamic techniques.

Key words: *Lignin, electrospinning, organic solvents, micro-structures.*

DEVELOPMENT AND OPTIMIZATION OF GLUTEN FREE BISCUITS WITH CAROB FLOUR AND DRY APPLE POMACE

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Abstract

The objective of the present work was the formulation and quality evaluation of gluten free biscuits based on a rice and carob flour mixture enriched with dried apple pomace prepared with and without heat treatment (microwave blanching). The preparation of biscuits was based on a mixture experimental design including three components: dried apple pomace, carob flour and water in a range of 15.2%-76.2%, 15.2–70% and 19–47.6%, respectively, while the heat treatment of dried apple pomace was used as process variable with two levels. The optimization of the final product was based on the study of physical, mechanical, and colorimetric parameters that affect the overall product profile, as well as on the objective and hedonic sensory evaluation of the samples. According to the chemical analysis of the raw materials, dried apple pomace prepared without heat treatment was found to contain a higher percentage of dietary fiber and proteins, compared with the microwave heat-treated apple pomace. Furthermore, concerning the water holding capacity (WHC), it was noted that there was no difference between the blanched and not blanched apple pomace, however both types considerably outweigh rice and carob flour WHC. Microwave blanching was found not to affect the physicochemical and organoleptic profile of the biscuits. The statistical analysis showed that the increase of dried apple pomace concentration resulted in an increment of the intensity of apple aroma, brightness (L) and the red hue (a*) of biscuits. The organoleptic hardness and crispness were positively correlated with the mechanical fracturability and spread factor (W/T), demonstrating a similar increasing trend and were increased also by carob flour addition across all the examined levels. Moreover, the addition of carob flour increased the intensity of the brown color and aroma of biscuits, whereas it reduced the colorimetric parameters L*, a* and b*. The increase of water in the mixture caused a rapid increase in the humidity of the biscuits and a dramatic reduction of the organoleptic hardness and crispness as well as the mechanical fracturability and spread factor (W/T). On the contrary, it reduced the yellow tone of the biscuits (b*). The optimal formulation consists of 12,4 % dried apple pomace, 7,07 % carob flour, 12,97% water and 29,97% rice flour with no prior blanching of the apple pomace in the recipe.*

Key words: *gluten free, biscuits, carob flour, rice flour, apple pomace, sensory properties.*

A CORN AND WATER INTERACTIONS ON THE MICROSTRUCTURE OF GLUTEN-FREE YEASTED DOUGH

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Abstract

A strict gluten free diet is recommended to those suffering celiac disease. The use of acorn meal (AM) to formulate gluten-free (GF) breads is promising due to the high levels of bioactive compounds that it contains. The study of the dough microstructure when different combinations of water and AM is critical to reveal the linkage between structure and functionality.

This study evaluated the combined effect of AM addition (at levels 5/15/25%) and water (at levels, 65/70/75%) in the GF dough microstructure. Control GF dough recipe consisted of a mixture of rice and corn flour at a 1:1 ratio, 75% water, sodium caseinate, DATEM, CMC, dry yeast, olive oil, sugar and salt. First freeze-dried dough samples were explored by means of X-ray diffraction spectrometer, performing scans from 6° to 45° (0.008°/min, step size of 0.04°). Total crystallinity and the percentage that each peak contributes to the total crystallinity were considered. Then, variation in gellatinization enthalphy of starch (ΔH) and peak temperature was investigated by means of Differential scanning calorimetry (DSC). Moreover, structural changes in the dough structure were observed with scanning electron microscopy (SEM).

Both, amount of water and the type of starch affected the extent of starch gelatinization. Doughs displayed a very broad gelatinization endothermic transition with mean onset temperature, maximal peak temperature and final temperature in the range 16.8-25.8 °C, 27.2-42.2°C and 40.9-60.9 °C, respectively. At the lowest water level (65%) there is a significant increase of the thermal broadening (Tfinal–Tonset) with increasing amounts of AM. Gelatinization enthalpy increased with increasing of AM level and water content. Incorporation of AM increases the gelatinization enthalpy compared to control with no added AM.

Besides, the XRD spectra of all the dough samples showed four different peaks around 15°, 17-18, 20 and 23° suggesting the coexistence of "A" and "V" type starch structures. The results indicated that the crystallinity of doughs decreased with addition of AM and this decrease is more evident when at 70 and 75% water.

The findings suggest that by combining water and AM amounts in a GF recipe different levels of dough crystallinity could be obtained thus giving the possibility to manipulate the textural and nutritional qualities of the final bread.

Key words: *gluten-free, dough, crystallization, acorn meal, SEM, XRD*

GRAPE PROCESSING BY-PRODUCTS USE IN THE WHOLE-GRAIN CRACKERS TECHNOLOGY

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Abstract

The production of whole grain-based flour products is growing significantly. These products are characterized with a valuable nutritional composition due to the preservation of the whole grains components natural potential. It should be noted that flour products based on dispergated grain mass are characterized by worst organoleptic characteristics compared to products based on refined wheat flour, which is due to low quantity of generated carbon dioxide and acid production in semi-finished products from grain mass, despite the high activity of enzymes. The aim of this research was to study the feasibility of grape processing by-products to improve the whole grain cracker`s quality. Grape seed powder (GSP) and grape skin powder (GSkP) are a powerful source of the deficient nutrients - antioxidants, vitamins, minerals, organic acids, amino acids, dietary fiber, etc. Grape powders could be also an additional source of supplements for dough microflora and available sugars for fermentation. We evaluated the influence of grape wastes powders on the technological process, quality of finished products and their physiological value. It was found that full sugar replacement with GSP leads to an increase in the dough final acidity by 1.15 times, and with GSkP - by 1.3 times. Also, for these samples, there was a decrease in the dough ball floating time after 30 minutes of fermentation-resting by 1.3 ... 2.0 times. The obtained results indicate an increase in the amount of produced carbon dioxide and the formation of a more loosened structure of semi-finished products based on dispergated grain mass with grape powders during their fermentation. It was determined that the addition of powders had a positive effect on the cracker`s quality. For the samples with grape seed powder, the moisture absorbtion ability increased by 10 %, and with GSkP - by 15%. The results of sensory analysis showed that the crackers incorporated with grape pomace powders were characterized with a well-loosened structure, smooth surface, pleasant taste and aroma. Final products with GSP additionally had the "chocolate" color. The in vivo study has shown that the prophylactic feeding of the rat research groups with GSkP grain crackers prevented the development of negative consequences of antibiotic therapy: the development of dysbiosis and a decrease in the activity of the antioxidant system (a catalase activity increase in rats blood serum by 43 %, an urease activity decrease in the mucous membrane of the large intestine by 35 %).

Key words: *crackers, grape powders, whole grain mass, pastry, flour products.*

AQUERIOUS-PHASE DEHYDRATION OF XYLOSETOFURFURAL IN THE PRESENCE OF H-BETA ZEOLITE CATALYST

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Abstract

Concerns about increasing CO_2 concentration in the atmosphere, increasing energy demands, and limited reserves of fossil fuels are the largest incentives for the development of green processes where renewable biomass as feedstock for supplying fuels and other chemicals is used. For a sustainable future of chemical engineering, it is necessary to develop efficient strategies to convert biomass-derived carbohydrates into a variety of chemicals to suppress fossil fuel consumption. One possible route is the conversion of pentoses into furanic compounds, especially xylose. Furfural is used on multiple occasions as an extraction agent, solvent, agent for vulcanization, in the pharmaceutical and cosmetics industry, fragrances, as well as other products like household cleaners. In this work, xylose conversion was investigated over H-Betazeolite catalyst in aqueous media (Scheme 1).The reaction was conducted in a high pressure batch reactor (system of 6 parallel batch reactors), pressurized with N_2 to 5 bar. Before the reaction, xylose was dissolved in 120mL of deionized water and 1.5 grams of the catalyst was added into the mixture and stirred(1000 min^{-1}) for 6 h. Samples were collected every 30 minutes after reaching the reaction temperature and filtered with CA filters. The reaction mixture was analyzed by HPLC with RezexRHM-Monosaccharide H^+column using RI and UV-vis detectors. The effect of xylose/catalyst mass ratio, temperature, pressure and concentration of xylose on furfural yield wasextensively studied. H-Beta zeolite is a commercially available catalyst with a combination of Brönsted and Lewis acid sites which is shown high activityto furfural yield compared to catalyst-free reactions. It was found that the H-Beta zeolite catalyst achieved ahigh concentration of furfuralfaster than the blank reaction at the same reaction conditions. The yield of furfural over the H-Beta zeolite catalyst was 50 mol% higher than in blank reaction, but the selectivity of furfural was not exceeded of 35 mol% with the catalyst/xylose mass ratio of 5/1 at 160°C. This is a consequence of the fact that aqueous media is suitable for side reactions and humins production. In this case, furfural was the only determined product of the reaction but based on the reaction mixture and total carbon analysis humins were formed in a significant amount.

Key words: *xylose, dehydration, furfural, zeolite, water*

RHEOLOGICAL BEHAVIOUR OF ANCIENT WHEAT FLOURS

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Abstract

The need to preserve genetic diversity, the request for high adaptability to low agronomic input, along with the increasing demand for traditional products with better nutritional composition are recognized as a major driving forces behind the renewed consumers', manufacturers' and farmers' attention toward ancient wheat grains. In order to convert ancient grains into food products with acceptable techno-functional properties, dough's rheological behaviour has to be considered. In this study a comparative evaluation of the rheological properties of ancient wheat species (emmer, spelt and khorasan) was conducted. The wholegrain flours of these varieties were prepared and evaluated for chemical composition, wet gluten quantity and quality and rheological properties in terms of gluten aggregation and disruption kinetics (GlutoPeak), dough proofing (Rheofermentometer), as well as mixing and thermal behaviour (Mixolab). Although emmer and spelt flours had higher protein and wet gluten content, they were characterized with lower gluten indexes (GI) in comparison to khorasan flour (GI were 64, 50 and 11% for khorasan, spelt and emmer, respectively). This influenced significant differences in dough rheology of investigated ancient wheat flours. High wet gluten content of spelt flour led to formation of strong gluten network (high maximum torque as measured by GlutoPeak) with the highest Mixolab water absorption (62.6%) and maximum dough height (Hm at Rheofermentometer curve) in comparison to other varieties. On the contrary, khorasan flour, although having very low wet gluten content, exhibited the highest dough stability both during mixing (Mixolab test) and fermentation (Rheofermentometer dough development curve) due to high gluten index value. Despite being characterized with high wet gluten content, very low gluten index value of emmer flour affected dough development process, resulting in the lowest maximum dough height and pronounced loss in dough height during fermentation and the lowest percentage of gas retained in the dough relative to the total gas production compared to other wheat species. Emmer flour was also unable to form gluten aggregation peak under the conditions used during GlutoPeak test. The results obtained in this study can be used to better understand the techno-functionality and target application in cereal based products of different ancient wheat species.

Key words: *dough rheology, gluten quality, emmer, spelt, khorasan.*

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ENZYME ASSISTED EXTRACTION OF PROTEIN FROM WASTE GREEN LEAVES

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Abstract

Due to the increasing consumer demand attributable to various factors (health problems, vegetarianism, religious restrictions) an interest in plant proteins, as a replacement for animal proteins, is currently growing. Recently, scientific interest is focused on the utilization of plant material that presents agricultural waste and their valorization to produce proteins with significant functional and biological activities. Leaf material presents a major potential source of novel food proteins.

The objective of this study was to produce plant-based proteins from waste green leaves from four corps – cauliflower, cabbage, broccoli and beetroot. The effect of the enzyme assisted extraction method on protein yield was investigated. Enzyme-assisted extraction is green technology and provides to obtain high quality protein concentrate in terms of yield, nutritional and functional properties Some physical and functional quality properties of the protein powders were studied to determine their potential usage in the food industry.

The proteins were obtained from leaves of vegetables with alkaline extraction at pH 10, and their isoelectric precipitation at pH 4. Protein contents were in the range of 53.5%–72%, and the molecular weights of fractions were mostly about 45, 25 and 14 kDa. The protein yields significantly increased by enzyme assisted extraction.

Furthermore, future studies could be carried out to determine the functional properties of the protein concentrates such as sensory, flavor, taste, aroma, texture, viscosity, foaming, pulping, and emulsion gelation besides physical properties and extractability.

Key words: *leaf proteins; vegetable by-products; cell wall degrading enzymes.*

REMOVAL OF AMMONIUM ION BY ADSORPTION ON BENTONITE IN DRINKING WATER TREATMENT ON THE PILOT PLANT

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Abstract

Removal of ammonium ions from water to produce drinking water is a significant problem, which can be solved by applying various procedures such as microbiological transformation, chemical oxidation (breakpoint chlorination), ion exchange, membrane processes and adsorption. Adsorption processes are applied in drinking water treatment due to low cost, regeneration potential, biodegradability and efficiency. Natural and artificial clays and zeolites have proven to be suitable adsorbents. Clays used as adsorbents are aluminosilicate minerals that contain exchangeable ions on their surfaces. In the bentonite structure, there are exchangeable cations, such as calcium, sodium, magnesium, and potassium. This bentonite structure is responsible for the adsorption of many cationic water pollutants, including ammonium ions. This research presents the optimization of ammonium ions adsorption on bentonite in laboratory conditions. The possibility to use this type of adsorption in drinking water treatment was tested at the pilot plant in "Vodovod" Inc. Banja Luka. Kinetic studies showed that the adsorption of ammonium ions on bentonite is described as a linear pseudo-second-order kinetic model with a correlation coefficient R^2=0.9834, which is also confirmed by nonlinear modeling.By studying the dependence of the adsorption process from the initial bentonite concentrations, it was found that lower bentonite concentrations favor the adsorption process. The highest adsorption capacity (18.4 mg NH_4^+/g) was achieved at a bentonite concentration of 0.25g/dm^3, and an initial concentration of 36.2 mg NH_4^+/dm^3, and a contact time of 40 minutes. The adsorption process is best described with a nonlinear Freundlich isotherm model with a correlation coefficient R^2=0.9345. By examining the adsorption process on the Jar test, the influence of the coagulation and flocculation process in the process of preparation of drinking water in the batch system was simulated. It was found that the contact time of ammonium ions and bentonite, before the addition of coagulant and flocculant, directly affects the adsorption capacity. At a contact time of 2 minutes, before the addition of coagulant and flocculant, the adsorption capacity is 0.89 mg NH_4^+/g, while at a contact time of 10 minutes, the adsorption capacity is 1.46 mg NH_4^+/g. The optimal adsorbent doses, as well as the adsorption conditions obtained by laboratory experiments, were applied to a semi-industrial plant for the preparation of drinking water in "Vodovod" Inc. Banja Luka. The optimal bentonite concentration of 0.1 g/dm^3, determined by the Jar test, did not prove to be optimal in the flow system (pilot plant). Much more efficient was the bentonite concentration of 0.05 g/dm^3, which directly affected the reduction of turbidity in the water after filtration.

Keywords: *ammonium ion, bentonite, adsorption, pilot plant, drinking water.*

REACTIVITY OF POLYPHOSPHATE GLASS IN DIFFERENT MEDIUM

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Abstract

Information about the dissolution process and ion release of phosphate glasses in different environments is important for a wide range of engineering applications, from biomaterial design to environmental technologies. The dissolution of glass is a complex phenomenon and the kinetics of this process depend on the glass properties (composition, structure, surface condition, etc.) and environment (the type of solvent, leaching solution volume, pH, temperature, etc.). The dissolution behavior of glass is determined by the reactions of the glass network and the release of different ions to the solution. Surface conditions and layer formation, saturation effects, and solution chemistry must also be taken into account when describing the dissolution processes. Mechanism of chemical reactivity of a polyphosphate glass ($45P_2O_5 \cdot 3SiO_2 \cdot 25K_2O \cdot 15CaO \cdot 10MgO \cdot 1ZnO \cdot 1MnO$ (mol %)) in distilled water, the aqueous solution of 2% citric acid and SBF, under static and non-saturated conditions were presented. The leaching tests were performed with glass powder samples (0.3–0.65 mm) at T=37 °C for times up to 720 h. The mass loss of the samples, the changes of pH, the concentration of elements (P, K, Ca, Mg, Zn, and Mn) in solution, and the initial release rates (r_{0i}) and rate of glass hydrolysis (r_{hi}) were determined. The time dependence of the normalized concentration of ions in solution indicates that the dissolution of examined glass, for all investigated environments, occurs in three stages. For shorter times (stage I), the changes of the normalized concentration of ions in solution were linear with time, corresponding to the highest dissolution rates. During stage II, the changes of the normalized concentration of ions in solution with time were smaller due to lower dissolution rates. In stage III, the changes of the normalized concentration of ions in solution were very small and the dissolution rates were more than ten times lower compared to the initial rates. The initial release rates of cations were determined in the range of 0.17-12.92 g/m^2h. The release rates of cations r_{hi} by hydrolysis were determined in the range of $0.13 \cdot 10^{-2}$-$2.31 \cdot 10^{-2}$ g/m^2h. The time dependence of the solutions' pH is not the same for all of the three solvents. pH value decreased in the initial stage and then remained constant in distilled water and SBF, while in the aqueous solution of 2% citric acid pH value increased in the initial stage and then remained constant.

Keywords: *polyphosphate glass, dissolution, dissolution rate*

EFFECT OF FREEZING ON THE FUNCTIONAL PROPERTIES OF LIQUID EGG WHITE

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Abstract

Eggs are among the foods consumed all over the world. Eggs have a high biological value and are a cheaper source of protein than other animal-derived proteins such as meat and milk. They are sold not only in the form of shelled eggs but also as processed products, mainly among industrial users. Due to the sensitivity of egg proteins, egg products can only be heat-treated at low temperatures, so pasteurized products shelf life is maximum few weeks. However, freezing, for example, can increase the shelf life of egg products. In this study, we aimed to investigate the effect of freezing on the functional properties of liquid egg white. The liquid egg white produced in an eggplant was stored at -18 °C for 1, 7, 14, 30 and 90 days. The rheological behaviour of fresh and frozen-thawed liquid egg white was examined by a rotary rheometer. Measurements were performed by controlled shear rate and shear stress was measured. Herschel-Bulkley model was used to characterize the rheological behaviour. Calorimetric properties (denaturation enthalpy and denaturation temperature) were examined with a differential scanning calorimeter. Besides that, the foam stability was examined after making a hard foam by measuring the volume of the dripping liquid. In our study, we stated, that freezing had a significant effect on the denaturation enthalpy and foam stability of the frozen-thawed liquid egg white compared to the fresh sample. However, there was no significant difference in the case of the denaturation temperature of the protein fractions of conalbumin, ovalbumin and S-ovalbumin. The rheological behaviour of the samples also remained the same after freezing and thawing. In our study, we examined the effect of freezing on the thermal and rheological properties and the industrial usability of liquid egg white. We concluded that the frozen-thawed egg white can be used in industrial processing, but minor changes were detected in the functional properties.

Key words: *differential scanning calorimetry, rheological behaviour, liquid egg white, foam stability, freezing.*

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COPPER STRIP CORROSION TESTING IN BLENDED HYDROCRACKED BASE OIL IN THE PRESENCE OF DIFFERENT INHIBITORS

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Abstract

Base oils are produced by various technologies, but they do not have useful properties, until additives are added for certain purposes. One of the commonly used base oils for the production of lubricating oils are hydrocracked base oils, which are produced by hydrogenation and hydrocracking reactions. They are characterized by good thermo-oxidative stability, high viscosity index, low sulfur content and high content of saturated compounds. The addition of some additives in order to improve the performance of the lubricating oil may reduce its anticorrosive properties. Since the blended lubricating oil can be corrosive, due to the presence of additives of different chemical composition, corrosion inhibitors must also be added in the formulation of finished products.

In this paper, the corrosion test of copper in hydrocracked base oil (HC-8) was performed in the presence of an additive for extremely high pressures (EP additive) in different concentrations. EP additives are used to reduce wear in industrial applications, under high load conditions. However, some of their disadvantages are high reactivity, negative oxidation effects when used in some types of oils, the possibility of corrosive reaction, and reduced life time of the material. Since most of these additives are sulfur-based, whose compounds can be corrosive at high temperatures, their use leads to corrosion of some materials. To prevent corrosion in the base oil with EP additive, corrosion inhibitors are added. In the experimental part of the paper, three commercial corrosion inhibitors of different composition were used (RC 8210, RC 4220 and Irgamet 39). By chemical composition, the inhibitor RC 8210 is a derivative of dimercaptothiadiazole, RC 4220 is a synthetic neutral calcium sulphonate, and Irgamet 39 is a derivative of tolutriazole. The effeciency of the inhibitor was monitored by the ASTM D-130 method based on the change in color and tarnish level assessed against the ASTM copper strip corrosion standard. According to the method, the tests were performed at a temperature of 100°C±1°C for 3 hours. Studies have shown that Irgamet 39 is the most effective inhibitor at a concentration higher than 80 ppm, when the content of EP additives in the base oil is 0,75%.

Key words: *ASTM D-130, copper coupons, lubricating oil, Ep aditive.*

INFLUENCE OF BINDER AND MODIFIER QUANTITY ON PHYSICO-CHEMICAL AND ELECTROCHEMICAL CHARACTERISTICS OF MODIFIED CARBON PASTE ELECTRODES BY TiO_2 NANOPARTICLES

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Abstract

The paper presents an investigation of the influence of the amount of liquid binder and modifier on the physico-chemical and electrochemical characteristics of the modified carbon paste electrode modified with TiO_2 nanoparticles. The experiments were performed with the aim of optimizing the ratio of carbon material / binder / modifier in order to use the electrode material in electroanalytical methods. The analysis of the influence on the physico-chemical characteristics was performed regarding the results of ohmic resistance measurements, optical microscopy and infrared spectroscopy. The ohmic resistance of the modified carbon paste was measured using a digital multimeter DÜWI 07976. Morphology was examined using an optical microscope with a digital camera, OMAX M837 ZL series, magnification up to 2500x. Infrared spectroscopy was performed using FTIR, Shimadzu IRSpirit with ATR component. Electrochemical responses obtained by the cyclic voltammetry method were used for electrochemical characterization of the tested electrode material. Carbon pastes made of graphite powder and i) paraffin oil , ii) tricresol phosphate and iii) mixtures of paraffin oil and tricresol phosphate, modified with TiO_2 nanoparticles. Cyclic voltammograms of the electrode material were recorded on PAR 273A using a standard reversible redox system $\left(\left[Fe(CN)_6\right]^{3-/4-}\right)$*. The results of the research indicate a significant influence of the amount of carbon material / binder / modifier on the morphological characteristics of the electrode material. Adsorption of TiO_2 nanoparticles and binders on graphite particles was observed. The change in ohmic resistance depending on the composition of the modified carbon paste was interpreted using the model of "close packing of spherical particles". Experimental results show that modified carbon pastes with TiO_2 nanoparticles with a content of 40% binder and 6-8% TiO_2 nanoparticles have the lowest ohmic resistance values. The electrochemical behavior of the tested electrode materials is correlated with the results of ohmic resistance measurements. The results of the research represent a good basis for selecting the optimal amounts of binder and nanoparticle modifiers.*

Key words: *modified carbon paste electrode, nanoparticle TiO_2, binder, modifier.*

THE LEVEL OF MACROELEMENTS (Na, K, Ma, Ca) IN CANNED MEAT PRODUCTS FROM SERBIA

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Abstract

Physiological processes in human organisms are highly dependent on nutrient levels, wherein many mineral substances have a crucial role. Macroelements are minerals that are often required in grams or more. They play a structural role and participate in the synthesis of proteins, hormones, and vitamins. In this study, the content of some macroelements (Na, K, Ca, and Mg) in five types of meat products that members of the Serbian Armed Forces regularly use was examined. Cans of beef goulash (BG), pork ragout (PR), spam (SP), liver pate (LP), and meatballs in tomato sauce (MB), stored from one month to six years, were analyzed by the ICP-MS method. Studied macroelements are present in the body in amounts of at least 100 mg/(kg BW). Their physiological functions are diverse from blood pressure regulation, acid-base balance regulation, and muscle contraction, to maintaining bone and tooth density, etc. The deficiency of some macroelements can lead to some diseases of the gastrointestinal tract and kidneys. Canned food has many benefits for consumers, such as convenient use, long shelf life, year-round availability, reasonable price, and short preparation time, but this type of food often contains a high content of sodium. The risk of consuming canned meat on the soldiers' health can be expressed through the estimated daily intakes (EDI) of macroelements and their contributions to the adequate intakes. The results showed the same order of macroelement concentrations in different kinds of canned meat products was determined, where Na > K >> Ca ≅ Mg. In all types of food, the content of Na was much above the K content (Na/K>1). The Ca/Mg ratio was above 1 in BG, PR, and MB samples, while in SP and LP was below 1. It has been observed that after five years of the storage period, the level of all macroelements noticeably decreased. These results suggest that this type of canned food should be on the menu only occasionally, as planned by the diet of members of the Serbian Army.

Key words: *macroelements, canned meat, ingredients, storage, intake assessment*

POLYPHENOLS RECOVERY FROM *T. SERPYLLUM* INDUSTRIAL WASTE USING MICROWAVE-ASSISTED EXTRACTION – RSM APPROACH

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Abstract

Taking into account availability of large quantities of by-products from various industries, such as food, pharmaceutical industry or agriculture, as well as their negative impact on the environment, emphasis has been placed on their further use. Over the last few years, the recovery of polyphenols from by-products represents a great challenge, as well as opportunity for its commercial utilization. The aim of this study was to valorize T. serpyllum herbal dust, the particular fraction distinguished as an industrial waste from filter-tea production. This work demonstrated the optimization of microwave-assisted extraction (MAE) of bioactive compounds using face-centered central composite experimental design within the response surface methodology (RSM). In order to increase yield and amount of target compounds and minimize solvent, time, and energy consumption, ethanol concentration (45, 60 and 75%), extraction time (5, 12.5 and 20 min), liquid-solid ratio (10, 20 and 30 mL/g) and irradiation power (400, 600 and 800 W) were used as independent variables. Total extraction yield (Y), total phenols yield (TP), as well as antioxidant activity parameters obtained by DPPH, ABTS and FRAP assays were selected as responses. Experimental results were fitted to a quadratic polynomial model and fitness of the model was determined by regression analysis and analysis of variance (ANOVA). Maximized Y, TP and antioxidant activity of T. serpyllum extracts were obtained using 52,19% of ethanol as a solvent, extraction time of 20 min, liquid-solid ratio of 23,64 mL/g and irridation power of 400 W. Predicted values of responses at this set of MAE parameters were obtained with desirability of 0.88. It could be concluded that MAE technique in combination with RSM is a efficient approach for the extraction of biologically active compounds from T. serpyllum by-product, which represents the high-valuable source of natural antioxidants with great potential for further use in various forms within different branches of industry.

Key words: *Thymus serpyllum L., Microwave-assisted extraction (MAE), Polyphenols, Antioxidant activity, RSM optimization*

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CONVENTIONAL SOLID-LIQUID EXTRACTION OF PROPOLIS

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Abstract

In the last few years general interest and demand for the bee products has risen. Among all bee products (honey, royal jelly), propolis has stood out because of its numerous human health benefits. Propolis composition on the macromolecular level consists of resionous compounds, such as waxes, essential oils, pollen, and others, whereas on micromolecular level it contains phenolic acids and its esters, flavonoids (flavones, flavanones, flavonols and chalcones), terpenes, triterpenes, aldehydes, alcohols, fatty acids, stilbenes, steroids, amino acids and sugars. In this work, convetional solid-liquid extraction of propolis, using different ethanol concentrations (0, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 96%), was performed for 24 h at the 150 rpm shaking speed, while solid/liquid ratio was set to 1:10 (m/v). The most adequate concentration of ethanol for conventional solid-liquid extraction of propolis was 90% of ethanol in terms of Y (82.07 g/100 g), TP (26.9272 g GAE/100 g DW), DPPH (3.8096 mM TE/g DW), FRAP (1.4272 mM Fe^{2+}/g DW) and ABTS (1.6623 mM TE/g DW). On the other hand, the highest values of TF were observed when the ethanol concentration was 70%, e.g. 1.7996 g CE/100 g DW. When using conventional extraction technique to extract bioactive compounds it could be concluded that the most suitable concentration was 90% of ethanol, even though the most common propolis products on the market are produced using concentration of 70% ethanol. Traditional preparation of propolis is supported here only by the fact that the TF values were highest at concentrations of 70%. This study, especially in the term of ethanol concentration, will be used as a groundwork for all further investigations involving antioxidants recovery from propolis using novel extraction techniques, such as extractions using solvents at sub- and supercritical level, as well as extractions assisted with pulsed electric field, ultrasounds, microwave etc. Considering all information, propolis, as a such valuable source of bioactive compunds, has many different aspects to examine and analyze.

Key words: *Propolis, Conventional solid-liquid extraction, Antioxidant activity, Polyphenols*

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FATTY ACIDS AND PHENOLIC COMPOUNDS COMPOSITION OF ANISE SEED

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Abstract

Anise (Pimpinella anisum L.) seed demonstrated several therapeutic effect on conditions as dgestive, gynaecologic, neurologic, and respiratory disorders. In present work, the chemical compositions of fixed oil and successive methanol extracts of anise seed were investigated. The fatty acid profile in anise fixed oil (PA-SH) was determined via gas chromatography-mass spectrometry (GC/MS) technique. For this analysis, fixed oil was esterified with methanol. Fatty acid methyl esters were used as standard for identification and quantification. Analysis of the fixed oil resulted in the identification of six fatty acids. The extract was consisted of two saturated fatty acids (22.13%) and four unsaturated fatty acids (77.87%). Linoleic acid (44.96%), oleic acid (20.30%) and palmitoleic acid (12.61%) were the major components. Anise seed extract was prepared with 80% methanol in several steps to separate phenolics into four fractions i.e., fraction for free phenolics (PA-M1), fraction for esters (PA-M2), fraction for phenolic glycosides (PA-M3), and fraction for phenolics non-soluble in 80% methanol (PA-M4). Phenolic acids and flavonoids were determined using ultra-high performance liquid chromatography tandem mass spectrometry (UHPLC-MS/MS). The UHPLC-MS/MS method allowed the identification and quantification of 23 phenolic compounds (fifteen phenolic acid and eight flavonoid) within 15 minutes. Five phenolic acids (5-hydroxyferulic acid, 3-hydroxybenzoic acid, ferulic acid, sinapinic acid, salicilyc acid, and trans*-cinnamic acid) were found in four different fractions. Feruluc acid and salicilyc acid were detected in all four fraction, 3-hydroxybenzoic acid and sinapinic acid were found in three fraction* trans*-cinnamic acid in two fractions, and 5-hydroxyferulic acid in one fraction. Ferulic acid was the main component in all four fractions and highest content were in PA-M2 (1350.07±29.28 µg/g) and PA-M4 extract (1320.14±62.68 µg/g), respectively. Regarding the flavonoids profile, apigenin was only identified flavonoid in two fractions (PA-M1 and PA-M4) and its content were 41.24±0.91 µg/g. (PA-M1) and 1.90±0.15 µg/g (PA-M4).*

Key words: *anise, fatty acids, phenolic acids, flavonoids.*

INVESTIGATION OF RHEOLOGICAL PROPERTIES OF AN EGG WHITE BASED FUNCTIONAL MOLK REPLACEMENT

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Abstract

Today's consumers are suffering from several food allergies and intolerances. One of the most important allergic food group is the dairy products. Whey protein allergy and lactose intolerance are the most common problems for European population.
The replacement of dairy products with plant-based products are today well-known, but these products have worse sensorial and nutritional quality than dairy products. An appropriate solution may the development of egg white based dairy replacement products. Egg white has a high nutritional value, as long sensorial attributes can easily modify. In our study the goal was to develop an egg white based milk replacement product with added functional properties. A cowmilk analog product was developed from egg white using enzymatic reactions. This analog product was enriched with prebiotic compounds to reach a more functional product. As prebiotic compound inulin was added in different concentrations. After a sensory evaluation three different concentrations were chosen for further investigations.
In this study the rheological properties of the inulin-enriched milk replacement product are investigated. The measurements were carried out with an Anton Paar MCR 92 rheometers investigating the shear stress of samples, applying a CC27 system in rotation method between 10 and 1000 1/s shear rate.
Our results show that increased inulin concentration led to a thicker texture, so a significant apparent viscosity growth was observed compared to control sample. Herschel-Bulkly model was well fitted to the flow curves of control and inulin enriched samples (R^2=0,99).
The investigation of sensorial attributes, like taste and texture pointed out this « thicker » texture of inulin enriched samples as well.
Our results show that cowmilk can replaced with an egg white based drink, as long the functional properties are enhanced too. This development may allow a healthier opportunity to replace dairy products.

Key words: *functional food, rheological properties, egg white, dairy replacement*

CHANGES OF QUALITY AND ANTIOXIDANT ACTIVITY OF THE STRAWBERRY AND RASPBERRY FROZEN UNDER DIFFERENT CONDITIONS

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Abstract

Freezing is the most commonly used method for preservation of berry fruit. This study was conducted in order to investigate the effects of different freezing methods and a frozen storage on quality changes of the strawberry and raspberry fruits. The maintenance of antioxidant activity and their initial property after freezing at –20 °C in a cold chamber (discontinuous, slow freezing) and Individual Quick Freezing (IQF) in a FloFreeze tunnel was examined. A range of characteristics (dry matter content, pH, soluble solids, titratable acidity, quality index, vitamin C) were determined before and after freezing and the frozen storage. Strawberry and raspberry are known as rich sources of bioactive compounds, therefore the antioxidant activity of the fresh and frozen samples were estimated by DPPH assay. After thawing, the fruits were evaluated by sensory analysis in terms of four sensory attributes: colour, taste/flavour, texture/firmness and overall acceptance, and the results were compared with physicochemical properties. The results indicated that the freezing methods did not significantly affect the physicochemical parameters and the content of vitamin C. Moreover, the values of the antioxidant activity were higher in the frozen strawberry and raspberry compared to the fresh fruits. However, during the storage at –20 °C, the quality properties gradually decreased and became more evident as storage period continued, but the frozen storage up to 4 months did not significantly affect the analyzed compounds and the antioxidant activity of the samples. Despite the higher content of vitamin C, the strawberry demonstrated a lower antioxidant activity than the raspberry fruits. The freezing had a significant impact on the sensory properties of the tested fruits; the most considerable changes were recorded on their texture/firmness and consequently the loss of overall acceptance, especially after slow freezing. Generally, it can be suggested that the IQF freezing was a more suitable freezing method for preservation of the quality and antioxidant activity of the strawberry and raspberry.

Key words: *Freezing, IQF, strawberry, raspberry, quality, antioxidant activity.*

BIOLOGICAL POTENTIAL OF FIVE TRANSYLVANIAN WILD EDIBLE MUSHROOMS

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Abstract

Over the last decade, the proven health-promoting abilities of different food classes, especially wild foods originated from unpolluted areas (i.e. mountains) gain the attention of consumers and food industry. It is well known that, mushrooms are consumed as a delicacy for their texture and flavor and have an important nutritional value due to their high protein, essential amino acids and fibers content but a low fat content at the same time and proved to be effective mainly as antioxidants and antimicrobial agents.

In this study, five Romanian wild edible mushrooms varieties (A. bisporus, P. ostreatus, B. edulis, C. cibarius, L. pipperatus) were screened regarding their proximate composition, volatile profile and phenolic compounds. The nutritional value of the mushroom sample was analyzed using AOAC procedures concerning the composition in proteins, fat, ash, carbohydrates and energy. The analysis of volatile compounds was carried out on a GCMS QP-2010 model gas chromatograph - mass spectrometer and the phenolic acids identification and quantification were done by high-performance liquid chromatography coupled with mass spectrometry (HPLC-MS). The experimental results revealed that regardless the mushrooms species, 4-Hydroxybenzoic acid and cinnamic acid were the main phenolic compound present in all selected species. The main volatile compounds identified by the gas chromatography-mass spectrometry were hexanal, benzaldehyde and dodecanoic acid. According to the obtained results, the fruiting bodies of selected Romanian mushrooms are a rich source of bioactive molecules indicating that they may be further exploited as functional ingredients in the composition of innovative food products.

Key words: *chemical compounds, mushrooms, phenolic compounds, volatile profile*

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CHERRY SEED OIL: SUPERCRITICAL FLUID EXTRACTION KINETICS AND MATHEMATICAL MODELLING

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Abstract

Food waste represents a global problem of the modern age, due to its negative impact on environment. Cherry seeds and kernels are common fruit-processing by-products which can be used as a resource of oil rich in polyunsaturated fatty acids and other bioactive compounds. Recent researches have been directed to develop successful and cost-effective extraction techniques and valorize food by-products, while simultaneously minimizing environmental damage. Supercritical fluid extraction (SFE) uses CO_2 which is cheap, eco-friendly, non-toxic and has moderate critical parameters (31.4 °C and 74.8 bar). In addition, SFE process can be easily optimized through pressure, temperature and flow rate changes to achieve the highest total extract yield, the highest concentration of desired compounds or the highest possible recovery of the compounds from the plant material. Internal and external characteristics of the supercritical fluid influence the process and it is important to select appropriate experimental design and reduce material costs and energy loss. Mathematical modelling is an important method that provides insight into transport phenomena which occur during the extraction processes and decide its profitability and efficiency. Models can be classified into several groups: empirical models, heat-transfer analogy models, mass-transfer models or a combination of those models. Obtained models are useful for achieving best system performance, scaling-up the process from laboratory to industrial level and adding to economic value. The main aim of this study was optimization of supercritical fluid extraction of cherry seed oil using sequential extraction kinetics approach. The optimization of the process was performed applying Box-Behnken design with fifteen regular and six additional runs to determine the influence of independent variables on total extraction yield: pressure (200 – 350 bar), temperature (40 – 70 °C) and CO_2 flow rate (0.2 – 0.4 kg/h). Additional evaluation of particle size influence was carried out. In order to fit experimental data, extraction curves were fitted with five empirical equations and three mass-transfer models based on the Sovová SFE equations solution. According to tbe calculated statistical test (R^2, SSE and AARD), mass-transfer models exhibited better fit of experimental data. It can be concluded that the predominant factors are pressure and CO_2 flow rate.

Key words: *cherry seed oil, supercritical fluid extraction, mathematical modelling, mass-transfer model*

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CHEMICAL PROFILE AND ANTIOXIDANT ACTIVITY OF ESSENTIAL OILS FROM LAMIACEAE SPECIES GROWN IN SERBIA

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Abstract

Essential oils, as sources of natural products, represent an alternative to synthetic antioxidants and antimicrobial agents in food and pharmaceutical industry, alternative medicine and natural therapy. They have various bioactivities including antibacterial, antiviral, anti-inflammatory, antifungal, antimutagenic, anticarcinogenic and antioxidant as well as other miscellaneous activities. The main aims of this research were to determine the yield, chemical profile and antioxidant activity of essential oils obtained from plants belonging to the Lamiaceae family, i.e. peppermint (Mentha x Piperita), oregano (Origanum vulgare), winter savory (Satureja montana), marjoram (Origanum majorana), thyme (Thymus vulgaris), summer savory (Satureja hortensis), basil (Ocimum basilicum) and sage (Salvia officinalis), grown in Serbia. Samples of essential oils were obtained by the traditional method of distillation (hydrodistillation). During the distillation process, the pharmacologically crushed leaf and chopped herbs of the mentioned medicinal plants were used. The highest yield of essential oil had peppermint, sage, thyme, basil, summer savory, marjoram, winter savory and oregano with values of 2.15%, 1.42%, 0.99%, 0.88%, 0.71%, 0.26%, 0.12% and 0.08% (v:w), respectively. Chemical compounds in the samples were identified by gas chromatography/mass spectrometry (GC/MS). Analyses confirmed 104 oil components. The major constituents of the peppermint oil were menthol (37.63%) and menthone (31.75%), followed by eucalyptol (6.56%), and isomenthone (6.55%). Analysis of sage oil revealed camphor (26.48%) and α-thujone (25.80%) as major constituents, as well as manool (8.07%) and eucalyptol (7.27%). The most dominant constituent of thyme oil was thymol (55.65%), in addition to p-cymene (25.04%). The content of linalool (38.59%) was the highest in basil essential oil. Summer savory essential oil contained the following components carvacrol (61.32%) and γ-terpinene (29.14%), as dominant. Terpinen-4-ol (30.20%) and γ-terpinene (11.63%) were the most abundant compounds in marjoram oil. A few compounds were dominant in winter savory, such as p-cimene (19.24%), linalool (11.91%), geraniol (10.15%), geranyl acetate (12.64%). The chemical profile of oregano essential oil obtained the following components: trans-anethole (16.04%), trans-caryophyllene (14.60%), germacrene D (14.56%). Antioxidant activity was determined by DPPH and ABTS assays and essential oil obtained by basil was more potent comparing to peppermint, sage, thyme, summer savory, marjoram, winter savory and oregano.

Key words: *Lamiaceae species, essential oil, GC-MS, antioxidant activity*

Acknowledgements: *The authors would like to thank the Ministry of Education, Science and Technological Development, Republic of Serbia, for financial support (Project No. 451-03-68/2020-14/200134).*

IMPACT OF LACTIC ACID ON MICROBIOLOGICAL AND SENSORIAL PROPRIETES OF WHOLE LIQUID EGG DURING STORAGE

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Abstract

Egg and its products are considered as a perishable product. To improve the shelf life of egg products, beside heat treatment, the industrials ad additives to minimize the effect of heat on egg proteins. The aim of the study is to investigate the ad of Lactic Acid on the rheological proprieties of whole liquid egg (WLE) before heat treatment. Therefor, different volume of Lactic Acid was added to WLE until getting the desired pH (5.0, 5.5...7.0). After heat treatment (70°C for approximately 3 minutes), the samples are stored in a refrigeration room (4-3°C).
For each sample, pH and microbiology were measured for 15 days. And to determine the effect of the additive on the color, taste, smell, and texture of the whole liquid egg, a cupcake is made of it and taste it by the consumers. All a long of the storage time, pH values showed a small fluctuation. The viable cell count of the samples increased day by day although it still significantly lower than the viable cell count of raw WLE. The sensorial results showed that the sample of pH 6.5 is the most acceptable one by the consumer. The impact of Lactic Acid and heat treatment is visible on the different samples of whole liquid egg.

Key words: *whole egg, microbiology, sensorial.*

INNOVATIVE GRAIN PROCESSING TECHNOLOGY TRITIKALE IN VARIETY BAKERY FLOUR AND FLOUR FOR PASTA PRODUCTS

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Abstract

The results of studies of processing of initial samples of triticale grain into high-quality bakery flour and flour for pasta according to the developed technological schemes are presented. The technological scheme for processing triticale grain into high-quality bakery flour includes 4 torn, 2 grinding, 3 sieve and 6 grinding systems. The technological scheme for the processing of triticale grain into flour for pasta consists of 5 torn, 2 grinding and 3 sieve systems.
The high efficiency of the developed scheme for processing triticale grain using sieve machines is shown as a result of the analysis of triticale flour flows from all technological systems. The possibility and feasibility of using sieve systems was due to the nature of the formation of large-scale products on I-III torn systems. The formation of varieties of triticale flour was carried out by mixing various streams representing the central, intermediate and peripheral parts of the endosperm of the triticale grain.
When processing "Ramses" grain according to a reduced technological scheme, the yield of triticale flour of the T-70 variety (ash content not exceeding 0.70% according to GOST 34142-2017) amounted to 40%, and when processing according to a developed technological scheme - 63%. When processing grain of the "Saur" variety, the total yield of high-quality triticale flour according to the developed scheme in comparison with the reduced one increased by 0.6% and amounted to 78.0%. At the same time, the yield of the lowest-ash triticale flour grade T-60 according to the developed scheme was 46%, and according to the reduced scheme it was not possible to obtain flour of this grade.
For the first time, differences in the rheological properties of triticale flour from various technological systems using the mixolab system (Chopin Technologies, France) have been revealed. An increase in water absorption capacity (WTS), a decrease in the stability time during dough kneading with an increase in the number of peripheral parts of the caryopsis, a change in the value of the viscosity index, which increases from I to III of the broken system, and decreases from the 1st to the 6th grinding system. Excellent baking properties are possessed by the varieties of triticale flour T-70 and T-80, obtained from the central part of the endosperm, both according to reduced and developed schemes for processing triticale grain into varietal flour.
The most effective way of processing triticale grain into high-quality bakery flour is a developed technological scheme with the use of torn, strainer, grinding and grinding systems. The highest yield of both flour for pasta and the overall yield with flour of the second grade was obtained according to the third option with preliminary peeling of the TRP field and removing about 3% of the casings. At the same time, the quality of the obtained flour for pasta is on the same level with the products of processing of triticale grain, obtained by grinding without the peeling process. The flour yield for pasta from triticale grain with TRP and peeling was 51.4% with an ash content of 0.81%, the flour yield for pasta with TRP but without peeling was 48.9% with an ash content of 0.80%, flour for pasta without TRP, but with peeling was only 44.6% with an ash content of 1.00%.

Key words: *triticale, processing, yield, quality, flour, bread.*

EFFECT OF FREEZE-DRYING ON QUALITY AND ANTIOXIDANT CAPACITY OF RASPBERRY AND BLACKBERRY FRUITS

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Abstract

Raspberry and blackberry fruits are rich sources of phytonutrients and bioactive compounds, which possess high antioxidant capacity and demonstrate beneficial effects on human health. Berry fruits have a brief harvest season and are very sensitive to biochemical and microbial deterioration in a post-harvest period; consequently, they are available in the fresh form in a short period of time. Therefore, berries are candidates for further processing and preservation to enable their accessibility during a year. The method of dehydration may be used in order to extend the shelf life of raspberry and blackberry and enable their storage at room temperatures. However, removal of water during air-drying can leads to a loss of nutritional and sensory properties of food. Freeze-drying is a method of dehydration based on the sublimation of water from a frozen product. Due to the absence of liquid water and low temperature using in this technique, the quality of the final product may be greatly preserved. Therefore, in this study, the effect of freeze-drying on the maintenance of physicochemical and sensory characteristics, as well as antioxidant capacity of the raspberry and blackberry was investigated. The effects of freeze-drying method on physicochemical properties of the analyzed fruit were expressed in relation to the changes of the amount of total sugars and total acids, dry matter, pH and ascorbic acid content. Also, sensory properties of the freeze-dried raspberry and blackberry were investigated and expressed as changes in the colour, flavour, firmness and overall acceptance. Antioxidant capacity was measured by DPPH method, radical scavenging activity against the stable free radical 1,1-diphenyl-2-picrylhydrazyl (DPPH) and the results were expressed as Ec50 values. The results indicated that freeze-drying did not significantly affect the physicochemical parameters and ascorbic acid content of the analyzed fruit. The raspberry and blackberry retain high antioxidant capacity after freeze-drying. The results of sensory analysis showed that colour and flavour remained almost unchanged compared to the fresh fruits. Generally, it can be concluded that freeze-drying represent a very suitable method for preserving these delicate berry fruits.

Key words*: freeze-drying, raspberry, blackberry, quality, antioxidant capacity.*

BIOFILM FORMATION OF SALMONELLA ENTERITIDIS ON STAINLESS STEEL AND GLASS SURFACES

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Abstract

During the last decades comprehensive studies conducted in the field of microbial biofilms, point out that bacteria growing predominantly as biofilms on surfaces, , rather than in planktonic mode. Attachment of potential spoilage and pathogenic bacteria to food contact surfaces and the subsequent biofilm formation represent serious challenges to the food industry, since these may lead to cross-contamination of the products, resulting in reduced shelf life, impaired product safety, as well as diseases transmission. Thus their existence might cause major problems in medicine, agriculture, the food industry, and the household environment. This study aimed to compare the level of biofilm formation of referent strain and fourteen different strains of Salmonella Enteritidis on a stainless steel 304 (SS 304) and a glass surfaces on 25°C and 37°C for 48 h. Tests were performed with referent strain S. Enteritidis (ATCC 13076, SE1) and 14 strains of S. Enteritidis isolated from the meat poultry (SE2-SE15). Strains of S. Enteritidis were previously characterized depending on the expression of ECM components as rdar (cellulose + curly fimbriae), bdar (curly fimbriae), and saw morphotype (no matrix components are expressed). For each morphotype and tested surface biofilm formation was confirmed using scanning electron microscopy (SEM).

Obtained results showed that the incubation temperature of 25°C ($p<0.05$) had a more favorable effect on the level of biofilm formation, except for the SE3 isolate ($p>0.05$). Regarding the type of surface, slightly higher adhesion to stainless steel surface was found compared to glass surface. Levels of biofilm formation on the examined surfaces were significantly different among strains and depend on morphotype. Regarding morphotypes obtained on Congo red agar, the level of biofilm formation were significantly higher at rdar (SE5, SE7, SE11-SE15) and bdar (SE1, SE2, SE4, SE6, SE9, SE10) morphotype, compared to isolates that exhibiting the saw morphotype (SE3 and SE8).

Key words: *Biofilm formation, Salmonella Enteritidis, stainless steel, glass surface*

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THE ADSORPTION OF BENZENE-WATER VAPORS ON ZSM-5 ZEOLITE

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Abstract

One of the most common pollutants present in enclosed spaces in urban and industrial areas is benzene. Apart from benzene, the air also always contains water vapor. This paper presents the adsorption properties of ZSM-5 zeolite from the company Zeochem ZEOflair 110. Adsorption isotherms of the benzene-water vapor on the examined adsorbent are generated by simulating the adsorption process in an enclosed space (at the atmospheric pressure of 1062 mbar, a temperature of 27°C, and a chamber humidity of 62% at the beginning of adsorption), using the free diffusion mechanism. Experimental results show that benzene and water adsorption occurred simultaneously during the experiment. The mass of the absorbed water per gram of zeolite was constant, for all experimental points, at around 0.006g. Adsorption isotherms were determined as the dependency between the total mass of the benzene and water adsorbed per gram of zeolite ($q_{e,tot}$) and the equilibrium concentration of benzene (Ce), and between the total mass of the benzene adsorbed ($q_{e,B}$) and the equilibrium concentration of benzene (Ce), i.e. $q_{e,tot}=f(Ce)$ and $q_{e,b}=f(Ce)$. High coefficients of determination were obtained using the non-linear Langmuir and Freundlich models. The ZEO flair 110 sample shows a better performance with the Freundlich model, indicating that the adsorption of benzene-water vapor was favorable and occurred on heterogeneous surfaces.

Key words: *adsorption isotherms, benzene-water vapor, zeolite*

BIOGAS PRODUCTION OUT OF BEER SPENT GRAINS WITH ULTRASONIC TREATMENT

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Abstract

In recent years, interest in the processes of biogas production has significantly increased - this is manifested not only in the growing number of planned and built biogas plants, but also in the interest of an increasing number of agricultural structures, utilities, food industry enterprises. For the food industry, biogas production technologists provide a chance for cheap utilization of organic waste from the main production, as well as using biogas at your enterprise you can not only save money, but in many cases you can also get additional profit from "bio-electricity". This article describes the study of the effect of the pre-ultrasonic treatment process to increase the production of biogas from brewing waste - brewer's grains. The study was carried out by simulating the process of biogas synthesis in a single-phase laboratory anaerobic bioreactor for fermentation of brewer's grains by bacteria of the complex of anaerobic metangenetic bacteria (Methanobacteriales). The results show that the production of biogas in the methanogenic phase takes place at higher levels at temperatures in the range of 20–40 ° C. The methane content in biogas production can be maintained above 50% at temperatures above 20 ° C but below 60 ° C. It was unambiguously revealed that the characteristics of the acidogenic phase and the methanogenic phase significantly deteriorate with a decrease in temperature to 20 ° C, since at such temperatures, apparently, microbial activity is inhibited. Accordingly, such a lower temperature is unfavorable for the operation of the acidogenic and methanogenic phases, while moderate temperatures above 25 ° C are more favorable for increasing the efficiency of biogas production. The result of the work is an effective optimal mode of biogas production from brewer's grain by means of fermentation and preliminary ultrasonic treatment, developed on the basis of processing several groups of the results obtained. The developed and investigated optimal regime showed the most effective result in terms of methane content and biogas production rate.

Key words*: biogas, ultrasound, spent grain, processing, bioenergy, biotechnology, waste*

HEAT AND MASS TRANSPORTATION OF DIFFERENT SHAPED POROUS MOIST OBJECTS IN A CHANNEL

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Abstract

*Heat and mass transfer were investigated for convective drying of two different shaped porous food samples numerically. A 2D transient model was developed and laminar flow conditions were valid for drying air with constant channel inlet velocity and temperature. Effects of the arrangement of the triangular and rectangular porous objects in the channel on heat and moisture transfer were investigated. The behavior of the external flow domain through the channel was shown by streamlines and liquid saturation distribution was shown along the vertical midline of the objects at different drying times for varying configurations of the objects. Recirculation was mostly observed at the interspacing area of the objects and, it has been observed that the moisture content decreased as it approached the surface of the object. Average Nusselt number values and reduction in moisture content for different drying times were evaluated for two objects separately and results showed that triangular object has been evaporated more than rectangular object for all configurations. This state was proven that maximum reduction in moisture content has happened for triangle-triangle configuration with 51.8% reduction. The distance between the objects for maximum reduction value (l=7.5*h) also showed that the greater is the horizontal distance between the objects, the more evaporation was seen. On the contrary, in the rectangular shaped body, average convective heat transfer was more than in the triangular body; maximum Nusselt number value was 18.5 for the rectangle body in the triangle-rectangle configuration. Moisture contents were not uniform inside the objects during drying, this is because evaporation happens near the surfaces where unbound free water exists at the initial periods of drying, then vaporization causes the bound water loss from the inner parts of the objects at the latter periods. This nonuniformity is the result of the difference of local heat transfer values spatially. The results totally showed that convection is an important factor for evaporation of food samples and it is an efficient method for drying processes.*

Key words: *Convective drying, Heat and mass transfer, porous matrix, CFD.*

ENCAPSULATION OF VITAMIN E AND FOLIC ACID INTO LIPOSOMES – CARRIER STABILITY AND CONTROLLED RELEASE

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Abstract

In this study liposomes were investigated regarding the ability to encapsulate vitamins, vitamin E and folic acid. Liposomes were prepared using commercial mixture based on the soybean lecithin (Phospholipon 90 G) by the proliposome technique. High entrapment efficiency (85-90%) was achieved for both types of vitamins, while the size was dependent on the vitamin type (350 and 630 nm for vitamin E- and folic acid-containing liposomes). Physical stability expressed via changes of the size, polydispersity and zeta potential during storage was confirmed for the period of one month in case liposomes with folic acid and two months for the liposomes with vitamin E. The release study, done using Franc diffusion cell, under skin conditions (pH=5.5), showed that the release rate was determined by solubility of the vitamins.

Keywords: *liposomes; entrapment efficiency; vitamin E; folic acid; carrier stability; controlled release*.

EFFECTS OF A L-SHAPED BAFFLE ON HEAT TRANSFER AND TRANSFER OF DIFFERENT SHAPED POROUS MOIST OBJECTS IN A CHANNEL

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Abstract

Hot dry air with a uniform velocity flowed through the channel in transient conditions and effects of drying on heat and mass transfer were evaluated. A l-shaped baffle was mounted in the channel over the middle of two objects and the angle of the baffle was varied with five different values. The effects of drying were investigated by simulating the external air flow and the porous moist objects with solving the non-linear multiphase heat and mass transfer equations using the Finite Element discretization. A commercial code COMSOL was used to solve the problem. The objects were rectangular shaped and circular shaped domain were simulated as porous food samples, and the arrangement of the objects were varied as rectangle-rectangle, rectangle-circle, circle-circle and circle rectangle configurations. Effects of those configurations on evaporation and convective heat transfer has been evaluated for varying angles of the baffle over the objects and results have showed that the Results showed that shape and configuration of the porous objects had significant effects on both heat and moisture transport. There has been up to 16% difference between maximum and minimum values of moisture content reduction for domain 1 when the baffle's angle is -135° and 18% difference for domain 2 for the same angle for different configurations of the objects in the channel. This situation showed the importance of the shape and location of the object in the channel, for all arrangements circular shaped domain had higher reduce in moisture content except the situation that circular domain was behind the rectangular domain. Average heat transfer values were higher in the object at the front side of the channel than the object at the back for all configurations. The angle of the baffle mounted over the objects had important effects on drying, the highest evaporation was seen at the angle -135°.

Keywords : *Convective drying, Heat and moisture transport, porous domain, multiphase flows*

TWO YEARS STUDY OF ASPERGILLUS METABOLITES PREVALENCE IN MAIZE FROM REPUBLIC OF SERBIA

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Abstract

Aspergillus species are widely distributed fungi throughout the world in various cereal crops, especially in maize. Prevalence of Aspergillus metabolites in maize, especially mycotoxins, represents a significant health and economic issue worldwide. In the previous decades infections of maize by Aspergillus species and further contamination by Aspergillus metabolites were not very common under the climatic conditions of many European countries. However, over the past decade in the Republic of Serbia, changes in weather conditions followed by increased air temperature, number of tropical days, and decreased precipitation in summer months resulted in more frequent appearance of Aspergillus metabolites in maize, especially aflatoxins, which were also the most frequently examined among Aspergillus metabolites. Therefore, the aim of this study was to apply modern analytical tools, liquid chromatography-tandem mass spectrometric method (LC-MS/MS), for identification and quantitation of a few dozen of Aspergillus metabolites in maize samples. Prevalence of Aspergillus metabolites was examined in maize samples collected from the main maize-producing regions (Bačka, Banat and Srem) of the Republic of Serbia during two harvest seasons (2016 and 2017). Nine and twenty different Aspergillus metabolites were detected in maize samples collected in 2016 and 2017 years, respectively. The most commonly detected metabolites in samples from both years were kojic acid and 3-nitropropionic acid. Percentage of contaminated samples as well as determined mean concentrations of quantified Aspergillus metabolites was significantly lower in maize samples from 2016 in comparison to samples from 2017. The differences in prevalence of Aspergillus metabolites between samples originated from different years may be explained by differences in weather conditions. Maize growing season in 2017 was characterized by higher deviations of air temperature and a smaller amount of precipitation, which resulted in favorable conditions for Aspergillus species, especially in the period from May to August. Based on the obtained results in this two years study, climate changes prediction and the fact that maize is the most important cereal crops produced in the Republic of Serbia, it is evident that a systematic and constant monitoring for Aspergillus metabolites should be taken in order to applications of adequate measures during the maize cultivation, to minimize the extent problems in future, from both economic and health point of view.

Key words: *Aspergillus metabolites, maize, Republic of Serbia, LC-MS/MS*

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SURFACE-WAVE MICROWAVE DISCHARGE: A POSSIBLE TOOL IN PLASMA AGRICULTURE

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Abstract

In the last decade the research on the application of low temperature plasmas in agriculture gained a large impulse, with main interests in the increase of the seeds germination, the disinfection of seeds, the increase of the production yield, and to improve the stress tolerance of plants. In the case of seeds germination, it has been suggested that reactive oxygen species (ROS) and NO are crucial for breaking the dormancy, while for disinfection additionally the UV radiation may be required. The increase of the plant tolerance has been investigated by applying plasma-activated water by making use of the RONS created in the liquid through the plasma-liquid interaction, characteristically the NO_2^-, NO_3^- and H_2O_2. The surface-wave microwave discharge generated with the help of a surfatron wave launcher is a very flexible system, since discharge can be ignited in a wide pressure range from mbar up to atmospheric pressure. Both at low and atmospheric pressures, the species concentrations in the discharge and afterglow region can be easily tuned with the system parameters, initial gas mixture compositions and flow rate. In the case of low pressure, a flowing Ar/N_2-O_2 surface-wave afterglow is particularly well adapted to provide a low gas temperature plasma free of charged species (avoiding ion bombardment damage of biological material), and rich in reactive oxygen and nitrogen species (e.g. O and/or N atoms, $O_2(a)$ and NO molecules) and a high intensity of UV radiation finely tuned with the help of the initial gas mixture composition and the gas pressure. At atmospheric pressure the characteristics of the plasma plume that is in contact with the water can be tuned with the initial gas mixture composition and the treatment distance (discharge tube to the water surface). By tuning the plasma composition, i.e. the concentration of electrons and nitrogen and oxygen content species at the plasma-liquid interface, the creation of NO_2^-, NO_3^- and H_2O_2 species in the liquid can be controlled. As a consequence, plasma-activated liquids with very different compositions can be produced, which allow the systematic study of the effect of RONS on the seeds and plants.

Key words: *surface-wave microwave discharge, afterglow, plasma-activated liquid*

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INFLUENCE OF CRUDE OIL TYPE AND REFINING CONDITIONS ON YIELD OF PETROL FRACTION

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Abstract

Different types of natural a Crude oil is a complex mixture of a large number of paraffinic, naphthenic and aromatic hydrocarbons, with small amounts of hetero compounds of sulfur, nitrogen and oxygen. By atmospheric and vacuum distillation processes, it is separated into fractions of the narrower distillation area. Detailed knowledge of the chemical composition and physicochemical characteristics of crude oil is of great importance for: determining the yield of individual fractions, choosing the operating mode, or optimizing refinery processes in order to achieve a defined product quality, without endangering the environment. The needs for petroleum products are constantly growing, and the reserves of high-quality crude oil are decreasing, which is why continuous work is being done on the improvement of process plants for petroleum refining. There are significant differences in the composition, appearance and characteristics of crude oil from one oil field to another, which affect the quality and yield of individual fractions. Refineries process mixtures of different types of petroleum and apply different modes of operation in order to obtain the required quantity and quality of individual fractions, especially gasoline and gas oil fractions. Low-density petroleum contain a higher amount of light derivatives, and a lower amount of sulfur in petroleum reduces the costs of processing and maintenance of process equipment. True boiling point (TBP) curves, specific densities and sulfur content are the data that accompany each delivery of petroleum. To assess the quality of crude oil, in addition to numerous laboratory physico-chemical tests, tests are conducted in semi-industrial distillation plants in order to determine the structure and yield of individual fractions. In this paper, the influence of different types of crude oil on the yield and characteristics of the main petroleum fractions was investigated. For laboratory and semi-industrial tests, 3 samples of crude oil from oil fields of the Republic of Serbia were used, which are characterized by low sulfur content (paraffinic-light, paraffinic-heavy and naphthenic), as well as 4 samples of imported petroleum from different oil fields (different types of crude oil and sulfur content in them). The basic physicochemical characteristics of crude oil samples, TBP and ASTM distillation curves (ASTM D5236, ASTM D2892) and sulfur content were determined. The content of gasoline in the tested oil samples was determined by the ASTM D86 method.
Three different operating modes and appropriate mixtures of tested crude oils were selected, and the yield of the gasoline fraction was determined. Tests have shown that depending on the composition of crude oil and the selected mode of operation, both the characteristics and yield of individual oil fractions depend. The largest amount of gasoline fraction was obtained in bituminous mode.

Keywords: *crude oil, primary refining, physicochemical characteristics, refining conditions, ASTM and TBP distillation, sulfur content, gasoline fraction, yield*

WATER REUSE AND ENERGY INTEGRATION MINIMIZING THE ENVIRONMENTAL IMPACT OF THE VULCANIZATION PROCESS IN RUBBER INDUSTRY

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Abstract

In this paper, vulcanization, a process widely used in the rubber industry, is analysed in terms of its flexibility to reduce energy consumption and environmental impact. In the observed case of the study - production of rubber hoses for car engine cooling systems, the main goal was to identify interactions between equipment design and energy sources (hot water and water vapour) to avoid unnecessary process modifications and inefficient reductions. The water reuse system was modelled and calculations were performed based on case data. The results show that the implementations are viable, and they will be used as input for further simulations and optimization studies based on the proposed model.

Key words: *energy integration, water reuse, model, steam, autoclave.*

AB INITIO MODELLING OF ELECTROOXIDATION OF ORGANIC POLLUTANTS

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Abstract

Within the fast development of the computational technologies during the past two decades, applications of theoretical chemistry emerged to almost every aspect of scientific research, including materials research, electrocatalysis and environmental protection. Removal of organic pollutant by electrochemical oxidation is a rather novel, perspective method with a lot of space for further improvement, particularly by introducing novel electrode materials. In this contribution, possibilities to use ab initio *calculations for prediction of the efficiency of electrochemical oxidation of organic molecules on various electrode materials are summarized and discussed. In a first approach, electrochemical degradation efficiency, which is in close connection with oxidation potential, can be correlated with the electronic properties of isolated molecules of organic pollutants. Modelling of adsorption properties of pollutant molecules, which takes into account properties of both pollutant and electrode material, can be correlated with electron transfer efficiency. In particular, calculated adsorption properties of indirectly involved species and spectator species, such as hydroxil radical and chlorine, can provide insight into the overall efficiency of so-called indirect oxidation route, mechanisms of electrode poisonong and/or formation of undesired byproducts.*

Key words: *Density functional theory, ab initio calculations, Electrochemistry, Organic pollutants*

TECHNO-ECONOMICAL ANALYSIS AND OPTIMIZATION OF INOVATIVE ENVIRONMENTALLY FRIENDLY METHOD OF STARCH OXIDATION BY HYDROGEN PEROXIDE IN COMPARE TO STARCH OXIDATION BY POTASSIUM PERSULFATE

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Abstract

Oxidized starch, an additive used in the paper products manufacturing for construction industry, is usually produced using harmful oxidants, such as hypochlorites or periodates. In regard to obtain oxidized starch, methods by different oxidizing reagents were compared in this approach. Towards development of environmentally friendly processess, a simple and efficient laboratory and industrial processes for preparation of oxidized starch using hydrogen peroxide as environmentally friendly oxidant is developed. This process of oxidized starch using hydrogen peroxide was compared to process of oxidized starch by potassium persulfate in regard to determinate process efficiency. Optimization procedure was performed using response surface methodology. The optimal conditions were determined to be temperature of 80^{o}C (353 K) and 3.6 ml of oxidante as the most efficient for starch oxidation. The processes of oxidized starch by different reagents as hydrogen peroxide and potassium persulfate were compared and approved in their advantages with aim of sustaintable efficency and ecological implementation. According to the quantities of reactants and reaction conditions on industrial level of the technological process for the starch oxidation by hydrogen peroxide and potassium persulfate, economic advantage of hydrogen peroxide were examined. The economic feasibility of developed technology was evaluated analyzing variable costs of applied materials and sources.

Key words: *starch, oxidation, hydrogen peroxide, potassium persulfate, environmentally friendly process, techno-economical analysis, optimization.*

INFLUENCE OF THE FATTY ACIDS UNSATURATION DEGREE ON THE RANCIDITY OF BLENDED VEGETABLE OILS

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Abstract

Edible vegetable oils are a main source of lipids and energy in diet. Saturated fatty acids in diet usually cause coronary heart diseases. Thus, unsaturated and polyunsaturated fatty acids are recommended for healthy life. Vegetable oils are rich in unsaturated and polyunsaturated fatty acids. Sunflower oil is a source of linoleic acid while flaxseed oil is rich in alpha-linolenic fatty acid. Linoleic acid represents essential omega 6 fatty acid while alpha-linolenic is essential omega 3 fatty acid. Blending sunflower and flaxseed oil is possible to obtain new oil with balanced omega 3 and omega 6 fatty acids ratio. Defect of unsaturated and polyunsaturated fatty acids is low oxidative stability, ie toxic products are being formed rapidly. The aim of this study was to create new binary oil blends containing refined sunflower oil and cold pressed flaxseed oil and to examine the rancidity of five oils under accelerated thermal stability test conditions - Rancimat test. Also, the influence of the degree of unsaturation of oil (ie iodine value) on its rancidity was examined. The increase of the share of flaxseed oil in the oil blends led to the increase of the iodine value and decrease of the induction period obtained by Rancimat accelerated stability test. Thus, the iodine value of the oil blend with 30 % of flaxseed oil amounted 144.71 ± 0.01 g I_2/100g, while in pure flaxseed oil was 190.04 ± 0.17 g I_2/100g. Induction period determined in these two samples was 6.46 ± 0.08 h and 2.27 ± 0.06 h, respectively. Also, very strong negative linear dependence of iodine value and induction period was determined (r = -0.9959).

Key words: *sunflower oil, flaxseed oil, oil blends, Rancimat test, iodine value*

QUALITY ASSESSMENT OF CATERING HONEY AND COMPLIANCE WITH REGULATORY REQUIREMENTS

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Abstract

Honey placed on the market or used in any product intended for human consumption must not contain any additives, including food additives other than honey, in order to preserve its specific properties. Since honey is more expensive than sugar, there have always been unscrupulous beekeepers who have tried to take advantage of this fact and produce adulteration of honey, products that are only similar to honey. One of the important parameters of honey quality is the content of hydroxymethylfurfural (HMF). HMF is a cyclic aldehyde formed by dehydration of fructose and glucose in an acidic medium, but can also be formed in Maillard reactions. Initially, it was used as an indicator of honey adulteration by adding invert sugar syrup. However, later the proportion of this substance became an indicator of heating and inadequate storage of honey. Nevertheless, extremely high levels can still be an indicator of honey adulteration. No less important parameter of honey quality is the activity of the enzyme diastase (α-amylase), which is also related to the storage conditions and the degree of heating of the honey.The aim of this study is to determine the content of HMF and diastase in honey, sampled during the official control in catering facilities in the Republic of Srpska, and based on the test results to assess the quality of honey and their compliance with regulatory requirements. In the period from January to March 2020, a total of 49 different types of honey were analyzed. HMF content ranged from 0.1 to 2157.5 mg/kg and diastase from 0 to 42.26 DN. Based on the obtained test results, it was determined that a significant number of honey samples (about 39%) didn't comply with regulatory requirements due to the content of HMF and diastase activity. In most cases, in samples with low diastase activity or even without determined values of diastase activity, a very high content of HMF was determined, which indicates inadequate manipulation of honey or suspicion of honey adulteration. The results of the official control of honey indicated that there is a serious problem when it comes to the quality of honey in catering facilities. Although the monitoring of honey was carried out at the time of year when honey is most consumed, we believe that it is necessary to continuously monitor the quality of honey throughout the year, with special attention to catering honey.

Key words: *honey, quality, HMF, diastase activity, adulteration*

DISTRIBUTION OF WATER SOLUBLE POTASSIUM IN SOIL FROM THE SKOPJE CITY AREA

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Abstract

In this research, the content of water soluble potassium in the soil of the Skopje city and its surroundings was examined. The top soil samples for analysis were collected from 16 samples point in Jun 2020. Samples for analysis were collected from soils of the city of Skopje, as well as from soils of the surrounding area. The content of water soluble potassium was determined on a flame photometer. The content of water soluble potassium varies in the range 10-200 ppm. The samples collected from soils of the surrounding area without anthropogenic impact have the lowest content of water soluble potassium 10-20 ppm. The urban soils contain water soluble potassium in the range of 50-80 ppm. The agricultural soils from the surrounding area of the city of Skopje have a higher content of water soluble potassium in the range of 120-200 ppm. Higher content of water soluble potassium is a consequence of deposited fertilizer on the agricultural soils. The deposited quantities of potassium vary in a wide range, and the determined values do not have a negative impact on soil properties.

Key words: *soil, potassium, water soluble, Skopje.*

COMPARISON OF THE KINETICS OF ABSORPTION OF METHOMYL AND DIMETOATE IN BRARY CLAY

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Abstract

The study focuses on comparing the adsorption kinetics of methomyl and dimethoate in Brary clay: (Tirana) 41°21'14.49"N;19°50'17.74.E, we analyzed the adsorption and desorption of pesticides (dimetoate and methomyl) in Brary natural and activated clay. Activation with 10% sulfuric acid 20g clay + 160 g sulfuric acid solution. Solution 1.21mL (2.22g) H_2SO_4 96% and 157.78 mL of distilled water. White test (without clay) dimethoate concentration: C_0 = 155.5 µg / ml; volume of extract: v = 15 ml, mass of dimetoate: mx = 155.5 µg / ml × 15 ml = 2332.5 µg = 2.3325 mg. The total (theoretical) amount of 25 ml is: m_0 = 5 mg, the recovery coefficient: KR = m_x / m_0 × 100% = 46.65%. Dimethoate hydrolyzes 4.3% (KR decreases 4.3%). After 24 h C_x = 122.58 µg / ml and the mass found: $m_x = C_x \times v$ = 1.8387 mg, which must be corrected with the hydrated part (4.3%) and the corrected mass is obtained: MK = m_x + 0.043 × m_x = 1.9389 mg. From the difference between the mass found in the white clay-free sample and the mass found in the clay test the adsorbed dimethoate mass is obtained: $M_{adsorbed}$ = m_x - mK = 2.3325 mg -1.9389 mg = 0.3936 mg, this for 5 g of clay or:78.72 µg / g clay (0.07872 mg / g). In the same experimental conditions the mass of adsorbed (Ma) of methomyl in the brary clay is 0.0364 mg/g. The brary clay the dimethoate adsorbs in time from 12 to 48 h, the maximum adsorption is achieved in time 48 h, while the maximum adsorption of methyl in the brary clay is reached in time 12 h. For the comparison of the adsorption kinetics of dimethoate and methomyl in Brary clay, the times of their degradation in water were also taken into account. Dimetoati adsorbed on the brary clay desorption soon enough, just a touch clay - water of at least 1-2 h, because it has dimetoati solubility in water 25 g / L at 25 ° C and $t_{1/2}$ = 30 days. Methomyl in water has a high solubility of 58 g / L at 25 °C, with $t_{1/2}$ =14 days. Methomyl and dimethoate have low affinity to bind to brary clay, so they can potentially contaminate surface and groundwater.

Key words: *methomyl, dimetoate, clay, brary, adsorption, kinetics, etc.*

OPPORTUNITIES REGARDING THE USE OF TECHNOLOGIES OF ENERGY RECOVERY FROM SEWAGE SLUDGE

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Abstract

Based on the global need to efficiently eliminate highly produced amounts of sewage sludge, alternative technologies are required to be practically developed. Appropriate technologies for treating sewage sludge are currently considered, e.g. incineration, gasification and pyrolysis. Bioenergy can be efficiently obtained from pyrolysis, with less release of harmful organic pollutants and pathogens. The residue left after the pyrolysis process can be used to develop potential useful adsorbents. The main products generated during the pyrolysis process are bio-gas, bio-oil and bio-residue, providing sustainable fuels/ biofuels and adsorbents.A comparison of different types of sewage sludge elimination for the energy recovery is described in the present paper.The technological, economical, social and environmental advantages and disadvantages are also presented.

Key words: *sewage sludge, valorization, pyrolysis, gasification*

COMPARISON OF THE BATCH AND ANNULAR SLURRY REACTOR EFFECTIVENESS FOR PHOTOCATALYTIC DEGRADATION: A CASE OF METOPROLOL AND PROPRANOLOL IN ENVIRONMENTAL WATERS

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Abstract

Despite the extensive research efforts, photocatalysis is still rarely used in the industry. There are two research areas which need more detailed research for further development and use of photocatalysis in industry. These areas refer to finding suitable, nontoxic, and cheap catalyst, and efficient reactors to alleviate environmental problems. Metoprolol (MET) and propranolol (PRO) are detected in the mixture in the influent of sewage treatment plants in daily loadings of 374 g/d of MET and 520 g/d of PRO. Therefore, degradation studies of these two β-blockers in the mixture are necessary, as no such studies have been conducted before. Photodegradation of MET and PRO was studied in five different water types (ultrapure water (UPW), Jegrička surface water, underground spring called Iron water, canal Danube-Tisa-Danube, and underground spring called Topli Do) under simulated solar radiation. Experiments were carried out in a batch reactor with a cell made of Pyrex glass containing plain window on which the radiation was focused, and in the laboratory-scale annular slurry reactor (ASR) with glass column surrounded by a set of six lamps, which was operated in a circular'closed-loop'mode. The kinetics of photocatalytic degradation was monitored using HPLC–DAD while mineralization was determined using COD measurements. Using a batch reactor, degradation of MET and PRO in UPW was 72.4 and 78.2%, respectively, after 90 min of irradiation. When MET and PRO were degraded in natural waters, the degree of degradation was higher than in the UPW, it was in the range 78–87% for MET and 92–95% for PRO, after 90 min. In ASR degradation efficiency was the lowest in the mixture in UPW, and it was 87.8% for MET and 89.2% for PRO, after 180 min. Degradation was slightly increased in all natural waters. Effect of mineralization of mixture of MET and PRO was in a good co-relationship with kinetic curves. In a batch reactor mineralization was in the range 71–91% while in ASR was in the range 33–62%, after 90 min. For more apparent, and real comparison of the efficiency of photodegradation in batch reactor and ASR, figure-of-merit calculations for low concentrations (electric energy per order of magnitude, E_{EO}), were used. ASR proved to be more efficient, both for the degradation of MET and PRO. Calculated E_{EO} pointed out that degradation was above 20 times efficient using ASR (with a few deviations). The photocatalytic process's efficiency was calculated when 27.6% of 0.05 mmol/dm^3 of MET, and PRO solution was degraded.

Key words: *β-blockers, Environmental waters, Photocatalysis, Batch reactor, Annular slurry reactor, ZnO.*

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ANALYSIS OF THE WASTE MANAGEMENT PROCESS AT THE THERMAL POWER PLANT NIKOLA TESLA IN SERBIA

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Abstract

In Serbia, there are eight thermal power plants which use lignite as fuel. The branch of the thermal power plant Nikola Tesla is the largest producer of electricity in Southeast Europe. The data from 2016 show that in Europe sulphur dioxide was mostly emitted by Kostolac B thermal power plant, followed by Ugljevik, and Nikola Tesla A thermal power plant. According to the data from the same year considering emissions of powdery materials, the main pollutant is the power plant Kosovo B, with Kolubara A placed third followed by the thermal power plant Nikola Tesla A. When it comes to Serbia, 80% of the total produced industrial waste is waste from the operation of thermal power plants (ash and slag). In the period of 2016 to 2018, on average, about seven million tons of waste was generated within the plant of PC EPS (Public Company of the Electric Power Industry of Serbia), and 93% refers to the generated ash in thermal power plants in Obrenovac and Kostolac. The fact that about 80% of the produced waste remains at the location of the producer indicates that in the Republic of Serbia there is a low percentage of industrial waste treatment, as well as insufficient use of waste as a raw material. One of the goals of the Law on Waste Management is to provide and ensure the conditions for reuse and recycling of waste and use of waste as an energy source. The law stipulates that waste management is performed in a manner that ensures the lowest risk to endangering the life and health of people and the environment. Industrial waste in Serbia is processed in a small percentage, unlike in the European Union where a large percentage of waste is processed. According to the Eurostat data for 2016, Serbia is one of the countries with the lowest percentage of treated waste as only 10% of the produced waste has been handed over for treatment. Electrostatic precipitator fly ash, as a by-product of coal combustion in thermal power plants, has been used as a building material in Europe for more than 50 years, especially in the production of concrete and cement. The National Waste Management Strategy has already envisaged the use of ash from the thermal power plants as a secondary raw material (cement plants, construction material). In the most favorable circumstances, it is possible to market and use about two million tons of ash produced in Serbia in this manner every year. The Regulation stipulates that the ash from thermal power plants is used as a construction material for building, reconstruction, rehabilitation and maintenance of public infrastructure, as a raw material for cement production, as a concrete admixture, in the construction of embankments and for other purposes. Although it is a known fact that with certain recycling investment costs every company benefits and the environment is protected, in our environment these procedures are dramatically late. Writing papers on this topic permanently indicates the need for more energetic action in this area. In its introductory part, the paper will give an overview of legal regulations in the field of environmental protection. The second part of the paper will present the current situation related to the emission of polluting substances and waste from production in the thermal power plant. A waste management analysis with suggestions for improvement will also be performed. After the elaboration of waste management, a case study on the impact of greenery on nature protection in the vicinity of the thermal power plant will be presented.

Key words: *waste management, thermal power plant, environmental protection*

EFFECTS OF WASTEWATER FROM CERTAIN FACTORIES OF THE FOOD INDUSTRY ON THE DEVASTATION OF THE CANAL NETWORK WATER IN THE VICINITY OF NOVI SAD

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Abstract

According to the data of the Public Utility Company of Vojvodina Water, there are 497 registered water pollutants on the territory of Vojvodina. Among these, there are 326 companies registered as industrial pollutants, with 118 belonging to the food industry, 113 belonging to agriculture, 30 belonging to settlements. Out of these, as many as 321 companies do not have any type of treatment, 83 companies independently treat wastewater, and 71 companies include their wastewater in the treatment system together with municipal wastewater. Numerous tests show that surface water quality is deteriorating and that insufficient investment is being made in treatment plants. The paper presents the monitoring of the canal network in the vicinity of Novi Sad at several sites in the period from 2018 to 2020. The analysis included 16 general physical and chemical parameters at 6 different sites. Measurements showed that extremely high values of COD, water and chloride conductivity led to the devastation of water bodies and the inadequacy of their use for irrigation and fishing. Concentrations of certain heavy metals in the samples were also determined, and an increased iron content which is on the border of quality class III and IV was detected. In this regard, it was noted that the Koteks produkt and Heineken factories do not adequately treat their wastewater and it is obvious that the secondary treatment does not operate with a satisfactory degree of treatment. In addition, by examining the whole wastewater treatment procedure of the Koteks produkt, it is established that the huge concentration of chloride detected in values that exceed all prescribed categories of surface water cannot be removed by this treatment. Both conventional and modern methods for the elimination of all pollutants that make wastewater at these sites toxic are known and developed. The aim of this paper is to warn of the lack of good practice in wastewater management in Serbia and propose addressing it at the local level in order to have a perspective to meet the requirements of the European standards. The paper will be presented in such a manner that the introductory part shows an overview of the canal network condition in the vicinity of Novi Sad, with a description of the location where the three-year monitoring was conducted. Afterwards, a description of measurement methods and results will be presented with a comparison and discussion of values that confirm the assumption that it is a highly polluted aquatic environment. In order to improve the condition of these canals, which significantly affect the quality of the environment in the region, a proposal will be made to take urgent measures to revitalize the water as soon as possible. If there is no reaction, these canals will remain a potential ecological bomb in the immediate vicinity of the capital of Vojvodina.

Key words: *surface water monitoring, pollution, food industry, Novi Sad*

REMOVAL OF THE AS(V) FROM THE WATER USING MAGNETITE/3D-PRINTED WOLLASTONITE HYBRID SORBENT

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Abstract

The very serious problem in developing countries has become the presence of the arsenic contamination in the water for the public health. Still, millions of people in their daily lives are highly dependent on groundwater containing high levels of arsenic, as well as, in drinking water, which causes excessive exposure to this toxic element, due to the high cost and lack of water-treatment infrastructures. The maximal allowed concentration (MAC) for As(V) in water decreased from 50 to 10 μg/l, by considering the harmful effects of arsenic on the environment and human health. In order to achieve the established rigorous requirements, it is necessary to develop new materials and design new forms of adsorbents that can reduce the concentration of arsenic in drinking water. Therefore, in this study, the target was to synthesize magnetite/3D-printed wollastonite hybrid sorbent that was used to remove As(V) from aqueous solutions. 3D-printed wollastonite was obtained using the 3D-printing technique from methylhydrocyclosiloxane and calcium carbonate as precursors. Synthesis of adsorption material was carried out by depositing magnetite from an iron(II)-sulfate solution by potassium hydroxide on 3D-printed wollastonite. Characterization of the obtained material was performed using FTIR and SEM. An investigation of the sorption properties of hybrid adsorbents was carried out for As(V) removal - one relative to the starting pH value of the solution, the adsorbent mass and the temperature and the adsorption time. Determination of adsorption parameters was performed by applying Langmuir, Freundlich and Dubinin-Radushkevich equations. Determination of kinetics and adhesion parameters at three different temperatures enabled the calculation of thermodynamic and activation parameters of the adsorption process, which contributed to a better understanding of the adsorption mechanism. Also, based on the results, it was noticed that the highest adsorption capacity of the mentioned material for arsenic ions at a temperature of 45 °C. The compact filter presented in this report should serve well as a small-scale water-purification unit that can be easily carried to any site having water contaminated with arsenic.

Key words: *water contamination, As(V), adsorbens, magnetite/3D-printed wollastonite, adsorption, filter*

CONTROL UTILIZATION OF PM EMISSION PROTECTIVE METHODS ON CONSTRUCTION SITES IN THE CITY OF KRAGUJEVAC

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Abstract

Particulate Matter (PM) as dominant polluting matter in 21st century is considered to be very hazard for the whole environment, due to its high sorption potential, abilities and amplified concentrations. Recent researches indicate that exposure to PM can have severe health effects. PM emission during construction and demolition activities is known, but insufficiently researched fact. Developed countries recognized the problem of PM emission from construction sites and issued different guidelines for its mitigation and prevention. Developing countries such as Serbia don't have adequately regulated monitoring and prevention systems leading to increased and uncontrolled PM emission. Kragujevac is the regional industrial centre for the "Šumadija" region in Serbia, with more than 100 planed and active construction sites (in 2020) as significant indicators of city progress and expansion. This research investigates current level of utilization of PM emission protection methods in 2020. on construction sites in city of Kragujevac for the first time.

Key words: *PM emission, construction sites, pollution prevention.*

BRIDGING THE GAP BETWEEN SUSTAINABILITY AND DYE REMOVAL PROCESSES: DYE BIODEGRADATION BY PEROXIDASE FROM AGROINDUSTRIAL WASTE

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Abstract

Textile manufacturing is among the industries with the highest adverse environmental impact as the greatest consumers and contaminants of water. One of the main pollutants are dyes used in the coloring process, which concentration in effluents range 10-200 mg/L. The spent textile dyes released in wastewater can cause pH imbalance; eutrophication; photosynthesis deterioration; suppression of growth, development and reproduction of aquatic biota. According to their chemical structure, dyes can be classified as azo, anthraquinone, nitro, nitroso, phtalocyanine, acridine, oxazine, triphenylmethane, methane etc. Anthraquinone dyes are the second most used dyes in textile industry. Their application includes dyeing of silk, wool and poliamide materials with fine dyeing properties such as color fastness, brilliance and thermal stability. Although their application is widespread, their complex structure of fused aromatic rings makes them difficult for degradation. Therefore, plenty of physical, chemical, biological and combined methods have been developed. Most common physical methods are based on adsorption with activated charcoal as an adsorbent. Even though its production is simple, this methods lead to solid waste generation. Chemical methods involve mostly the use of harsh chemicals. Methods including microorganisms are time consuming with sludge generation. Enzymes are an effective alternative due to the reduction of sludge volume and degradation products that are less toxic. In anticipation of "greener" and cost effective process, agroindustrial waste may serve as an enzyme source. In this study, a crude enzyme extract from agroindustrial waste- potato peel and soybean hull, is obtained for biodegradation of anthraninone dye Acid Violet 109. In order to achieve maximum biodegradation, the process parameters: contact time, pH, enzyme, hydrogen peroxide, dye concentration and temperature were optimized. Apart from this, kinetic parameters are the key factors for designing an efficient process. With the kinetic parameters, the right enzyme or enzyme source can be selected. Eventually, kinetic parameters aid in substantial acceleration of the process with minimal inhibition of the biocatalyst. Thus, the initial kinetics of the given enzymes was inspected and later the experimentally acquired values were modelled by the kinetic of bisupstrate reactions. Under the optimal conditions, 92% and 88% biodegradation was achieved with potato peel peroxidase, and soybean hull, respectively. As most of the industrial wastewater treatments require higher temperatures, both soybean hull and potato peel peroxidase were subjected and proved to be able to operate at significantly higher temperatures up to 70°C.

Key words: *peroxidase, agroindustrial waste, dye treatment, ping pong bi-bi, Acid Violet 109*

DEPENDENCE OF MICROBIOLOGICAL INDICATORS ON SAMPLING POINTS BY USING STATISTICAL METHOD ANOVA

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Abstract

Water is a tasteless, odourless and colourless fluid which represents one of the basic conditions for life. Recreational uses of water have significant and major influences on human health and well-being. Water pollution has been very widespread under which it implies a decrease in water quality due to subsequently received specimens. Pollution implies the degradation of quality water by physical, chemical, biological or radiological contamination to the extent that it is impossible its use and such water is harmful to human health. Water quality, which represents the presence of individual indicators of a particular substance or energy, is a criterion for determining the basic classification of water use. In order to test the quality of bathing water, data are collected through a continuous process of surface water monitoring. The quality of bathing water depends primarily on microbiological indicators, i.e. on the amount of Escherichia coli and intestinal enterococci. The testing of bathing water quality was conducted at 19 sampling points at two locations in the city of Zagreb (Lake Bundek and Lake Jarun). In order to examine the relation of the number of microbiological parameters (E. coli and intestinal enterococci) to sampling points ANOVA statistical method was used. Analysis of variance (ANOVA) is a statistical procedure that allows one or more factors to be examined simultaneously in a large number of groups of subjects. In other words, ANOVA is a criterion that shows whether differences between groups are accidentally greater than differences within groups. It is most commonly used to determine whether there are differences between several arithmetic means and whether these differences are statistically significant or random. Excel was used for calculating parameters of one-factor analysis of variance, which determined that there was no statistical correlation between microbiological parameters and sampling points at Lake Jarun, whereas at Lake Bundek there was a correlation at one location. Given that a number of results indicate that there is no significant correlation between microbiological indicators and sampling points, it is very important to conduct regular sampling and analysis of water quality, which enables swimmers to enjoy swimming and reduces the probability of forbidding swimming due to poor water quality.

Key words: *ANOVA, Escherichia coli, intestinal enterococci, microbiological indicators, water quality*

ANALYSIS OF POLYCYCLIC AROMATIC HYDROCARBONS ON UPPER COURSE OF THE DRAVA RIVER

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Abstract

Polycyclic aromatic hydrocarbons (PAH) are a large group of organic compounds consisting of two or more fused aromatic rings. They are lipophilic compounds, which means that they are less soluble in water, and their behavior in water depends on various physicochemical parameters. Although hundreds of PAHs exist, 16 of them are listed as priority pollutants - naphthalene, acenaphthylene, acenaphthene, anthracene, fluorene, phenanthrene, fluoranthene, chrysene, pyrene, benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd] pyrene, benzo[g,h,i]perylene, and dibenz[a,h]anthracene. Naturally, they occur during volcanic eruptions and forest fires, and the production itself depends on meteorological conditions such as wind, humidity, temperature and moisture content, type of wood, changes in wood through the seasons, etc. However, their presence in the environment is primarily due to anthropogenic activities. In the last 50 years, the increase of the population and human activity caused an increase in the concentration of PAHs which are easily produced as a consequence of incomplete combustion of wood, coal, gas, oil and other fuel sources composed of carbon compounds. Smaller, low-molecular-weight PAHs (two and three rings) appear in the atmosphere mainly in the vapour phase, while larger, multi-ringed PAHs (five rings or more) are mainly bound to particles. PAHs can enter surface waters due to the discharge of untreated wastewater and municipal water or through precipitation. They stay in the environment for a long time due to their inertness and chemical stability. Since PAHs have toxic and carcinogenic effect, both in humans and animals, elevated concentrations of these compounds raise health concerns. For that reason, monitoring of the PAHs concentrations in surface waters is very important. The PAH analysis was performed at various locations on the Drava river in the north-western part of Croatia and includes the lower peripheral channel of the Čakovec hydropower plant; Štefanec, Melačka, and Vularija bayou. The use of gas chromatography with the mass spectrometry method enabled the detection of very low concentrations of PAH. The results indicate a PAH concentration that does not exceed the maximum allowable values, with small oscillations in the concentrations. Although the water quality of the covered sites is currently satisfactory, it is necessary to monitor PAH concentrations in surface waters.

Key words: *polycyclic aromatic hydrocarbons, chromatography, mass spectrometry, surface water, pollution*

STARCH ACETATE SORBENT FOR REMOVAL OF ALKYL PARABENS FROM AQUEOUS ENVIRONMENTS

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Abstract

Over the past several decades, there is extensive use of cosmetic and personal care products (CPCPs). The occurrence of CPCP residues in domestic sewage, municipal waste water and waste water treatment systems is inevitable. The monitoring results showed their ambient accumulation exhibiting an increasing trend during the past few years. Among the observed constituents of CPCP residuals, parabens are a group of compounds of concern because of their popularity as additives. Due to their potential toxicity and estrogen-mimicking property, the presence of parabens also poses a potential threat to the stability of microbial communities in a biological treatment system as well as in the ecological environment. Hence, there is a need for search for new ways to additionally eliminate those contaminants. In this research the microgranular starch acetate has been synthesized and tested as a potential sorbent for removal of alkyl parabens from aqueous medium. Starch acetate (SA) microgranules with the degree of substitution of acetyl groups of 0.41 was obtained by reacting potato starch granules with acetic anhydride using aqueous NaOH solution as a catalyst. The adsorption of alkyl parabens, namely methylparaben, ethylparaben and propylparaben, on SA microgranules in water has been investigated by employing the equilibrium adsorption method. The adsorption kinetics studies showed that the adsorption equilibrium has been reached within 7 min. The Langmuir, Freundlich and Dubinin–Radushkevich adsorption models were used to describe the adsorption isotherms. The adsorption model parameters data revealed that adsorption was mainly due to physical interactions. The values of Langmuir sorption capacity increased by increasing the length of alkyl chain in paraben molecule, in the following order: propylparaben > ethylparaben > methylparaben. The obtained results confirmed that SA granules can be promising adsorbent for the removal of parabens from aqueous medium.

Key words*: starch, chemical modification, adsorption, parabens removal*

XPS AND SEM-EDX INVESTIGATIONS OF THE DISSOLUTION PRODUCTS OF SEVERAL METALS IN AN ACIDIC BROMINE-CONTAINING LIXIVIANT

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Abstract

Waste printed circuit boards (WPCBs) contain metals with various ranges of concentrations, including Cu, hazardous elements (Pb, As, Cd, Hg), base (Sn, Pb, Zn, Ni, Fe) and precious (Au, Ag, Pd) metals. For a sustainable environment and resources re-utilization, the leaching of metals from WPCBs and their subsequent recovery are regarded as major challenges nowadays. A previous research demonstrated the ability of the acidic Br^-/Br_2 leaching system to remove the exposed metallic parts from different models of computer motherboards, with cathodic and anodic mean current efficiencies of around 43.6% and 58.4%, respectively. Fast leaching rate, low-toxicity, and applicability over a wide range of pH values (from acidic to neutral) are important characteristics of the bromine-containing leaching system. In the present work, the dissolution products developed on the surface of the main metals (Cu, Sn, Pb and Zn) found in WPCBs after their initial exposure to the acidic Br^-/Br_2 leaching system were studied by XPS and SEM-EDX techniques. SEM investigations revealed marked differences between the surface textures of the analysed samples. XPS chemical assessment allowed the identification of the dissolution products formed on the metallic surfaces in the initial stages of the dissolution process. They consist mainly of metallic oxides in the case of Cu, Zn and Sn samples, while the presence of a layer of $PbBr_2$ was noticed on Pb surface.

Key words: *metals dissolution, bromine-containing leaching, XPS, SEM-EDX.*

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IDENTIFICATION OF PRESSURES AND THE APPLICATION OF DIFFERENT RISK ASSESSMENT METHODS FROM CONCENTRATED SOURCES ON THE BEGEJ WATER BODY

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Abstract

The DPSIR (Driving Forces-Pressure-State-Impact-Response) analytical framework can be seen as a mean to obtain useful information and to demonstrate cause-and-effect relationships between environmental indicators. Interactions between causes and effects are complex and act cumulatively. The effects of pressures on surface water bodies can be a threat to human health due to a reduction in the amount of available water. It is very important to determine all sources of pollution, their spatial distribution, as well as the type and amount of emitted pollution. The benefits of applying the DPSIR analytical framework are reflected in its ability to explain the relationship between cause and effect. For a successful risk assessment, it is necessary to analyze the interactions between pressures and the water bodies, in order to determine how these interactions may affect the ecological conditions needed to achieve the ecological objectives. The examined area is the river Begej, which springs in Romania and flows through Serbia for 75 km and flows into the Tisza river. The research within this paper included the following steps: identification and characterization of pressure sources, analysis of the significance of pressures, characterization of surface water quality, impact assessment and risk assessment of non-compliance with surface water quality objectives. The analysis and interpretation of the results is in accordance with the relevant current legislation. The results cover the 2010-2020 trial period. Based on the data obtained by measuring the quantity and quality of wastewater, the total load was calculated, expressed as minimum, medium and maximum, depending on the work capacity and compared with the maximum tolerating daily intake of pollution. Simulations were performed depending on different operating modes and water flow. Trends in nutrient concentrations were determined using the nonparametric Mann-Kendall test and specific risk ratios for the study period were calculated, as well as risk indices for each sampling point. The results showed that there is a large load of wastewater with organic matter and nutrients, which due to the low flow capacity of watercourses, negatively affect the aquatic life in it, as well as on the disruption of the chemical regime. The water quality of Begej is unsatisfactory from the very border, especially around Zrenjanin. The applied simulations of the operation regime and water flow in the watercourse have shown that the receiving power of the recipient, even at the maximum measured flow, is not sufficient to receive the emitted load from concentrated pollution sources.

Key words: *DPSIR, monitoring, pressure, impact assessment, wastewater*

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THE ROLE OF FOURIER SERIES IN THE ENVIRONMENTAL ENGINEERING

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Abstract

Fourier series represents a powerful mathematical tool which is used in many areas of natural and technical sciences. Fourier series dissembles periodical functions into the sum of trigonometric functions sinuses and cosinuses. In this paper the theory of Fourier series will be defined. Many types of functions, like periodical, aperiodical functions, and odd and steam functions, and their differences are going to be listed. The theoretical part is followed by the application of the Fourier series in the environmetal engineering. A few types of measuring sensors are given.. With usage of measuring sensors, data and variables of various physical or chemical values of natural phenomena can be collected. Signals are divided into digital and analog type of signals. An analog signal is a time continuous signal whose amplitude or the volume changes continuously and continuously over time, while the digital signal contains discrete functions, which are obtained by sampling the state record of the analog wave in certain time steps whose length depends on the frequency or frequency signal. In other words, to obtain a digital signal from an analog signal, it is necessary is to use FFT, or fast Fourier transform. Some other types of signals are going to be list, with appropriate examples for those signals. From the series of time functions the spectra will be explained. The spectrum in mathematics is defined as a two - dimensional graph of a complex wave shown in some other measures. The spectrum is the intensity distribution of the measured quantities that are in dependence on some physical quantities, such as energy, frequency, speed, mass and other measured quantities. The use of Fourier series is important in measuring sensors and processing of measured signals in environmental engineering in which the filtering of the measured signal from noise plays an important role. Signal filtering is the separation of signal frequencies from noise and interference frequencies. Signal can be filtered by a low pass filter, a high pass filter and a bandpass filter.

Key words: *Fourier series, Fourier coefficients, sensors, signal, spectrum*

PARTICULATE MATTER (PM) AND GASEOUS POLLUTANTS IN AMBIENT AIR OF ŠABAC, SERBIA

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Abstract

Air pollution today poses the greatest health risk when it comes to environmental quality. Among air pollutants, particulate matter (PM) are undoubtedly one of the most important in terms of health effects. In the previous period, there was no systematic monitoring of PM concentration in ambient air on the territory of Šabac. In this paper, the values of PM_{10}, $PM_{2.5}$, and PM_1 concentrations measured at the mobile measuring station Šabac (MŠA) during the three winter months were analyzed. The average concentrations of PM_{10}, $PM_{2.5}$, PM_1 were 29.6, 26.8 and 25.9 $\mu g\ m^{-3}$, with maximum daily mean values of 96.4, 88.6 and 86.6 $\mu g\ m^{-3}$, respectively. Concerning the particles size distribution in the mass concentrations, PM_1 on average counted for about 96.2% of $PM_{2.5}$ and 87.4% of PM_{10}, while $PM_{2.5}$ counted 90.7% of PM_{10}. During the observed period the measured daily mean concentrations of PM_{10} were above the daily limit value of 50 $\mu g\ m^{-3}$ for ten days (10.9% of the time), while the measured average daily concentrations of $PM_{2.5}$ were above the values prescribed by the World Health Organisation (WHO) air quality guidelines (25 $\mu g\ m^{-3}$) for forty-three days (46.7 % of the time). The values of concentrations of gaseous pollutants (SO_2, NO_2, NO, NO_x, CO) measured at the mobile measuring station Šabac (MŠA) and the suburban background measuring station Šabac (ŠA) also were analyzed.

Key words: air pollution, PM_{10}, $PM_{2.5}$, PM_1, gaseous pollutants, Šabac.

REMOVAL OF DIESEL POLLUTION BY BIOCHAR – SUPPORT IN WATER REMEDIATION

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Abstract

Water contaminated with diesel oil is one of the great challenges in waste water management. It is crucial to remove the water soluble fractions (WSF) from water in order to avoid toxic effects of these compounds and to meet the discharge regulations set by the environmental authorities. Biochar sorbents have generated a lot of attention as a new type of material due to their low cost origin and surface properties which lead to exceptionally high sorption capacities in water-pollution separation process. In this study, we have reported the synthesis and characteristics of novel biochar sorbent made from waste lignocellulosic biomass (peach stones) and evaluated its possible application in removal of WSF from synthetic wastewater. The synthesized biochar materials were characterized using scanning electron microscopy (SEM), Fourier (FTIR) and Brunauer, Emmett and Teller (BET) technique, while the elemental analysis was also done. Characterisation of peach stone biochar (PS-B) indicated multi porous high surface area (159.1 m2/g), with an average pore diameter of 2.66 nm. FTIR results indicated the presence of more aromatic compounds in biochar compared to peach stones. The sorption experiments were performed in batch system with mixing, with initial WSF of diesel components of 20 mg/L. The application of peach stone biochar (PS-B) resulted in more than 95% removal of diesel WSF, with reaching equilibrium after 5h of contact (under described operational conditions). Sorption mechanism can be described as multilayer chemisorption process, well described by Freundlich equation, which was also confirmed by pseudo-second order equation. Ecotoxicology tests have shown a decrease of toxicity of contaminated water on A. fischeri after the treatment of water by biochar sample. Therefore these forms of carbon based sorbents have great potential to be good sorbents of petroleum hydrocarbons WSF and can be successfully applied for their removal in water treatments.

***Key words**: diesel, WSF, food processing waste, biochar, sorption, ecotoxicology.*

INTRODUCTION OF REAL-TIME WATER QUALITY MONITORING IN A TROUT POND

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Abstract

Automated real-time monitoring represents a reliable solution which enables instant delivery of water quality analysis results. The aim of this paper is to provide a conceptual solution for this type of monitoring in a trout pond located at an altitude of 1090 meters in Vlasina, Southeastern Serbia. The monitoring is based on SCADA system consisting of hardware and software which are designed to provide a flexible set of functions for collecting data from sensors, processing thereof, monitoring and adequate response. The SCADA system consists of functionally connected units: measuring sensors in the pond, hardware subsystem, software subsystem and communication subsystem. The software includes a computer operating system, SCADA software, a PLC operating system, programs for local management using PLCs, communication programs, and network control software. The hardware subsystem consists of computer equipment, PLC, communication hardware, indicators, encoders, modems, cables and other equipment. SCADA manages the hardware via a PLC that executes the program written in accordance with the IEC 61131-3 standard. The SCADA system can use a combination of radio and telephone lines for communication as well as satellite systems. The SCADA system consists of one or more MTUs (Master Terminal Units) or workstations where the appropriate software is installed. The system consists of a submersible UV/VIS spectrophotometer (ISA) and sensors for control of water quality parameters: temperature, dissolved oxygen, chemical oxygen demand (COD), biochemical oxygen demand (BOD), nitrate content, conductivity, pH, color, ammonium content, turbidity (FNU) and total suspended solids (TSS). The system also includes a so-called "contamination alarm" that activates when one of the parameters exceeds the critical limit. The system is modular and scalable, with a possibility of installing application for the smartphone.

Key words: *Real-time online monitoring, SCADA system, trout pond*

CLEANING METAL-POLLUTED WATER USING MICROORGANISMS GENERALLY RECOGNIZED AS SAFE FOR HUMANS

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Abstract

The accumulation of microbial metals has received considerable attention in recent decades due to the potential use of microorganisms to clean water contaminated with metals. Heavy metals are natural elements in the earth's crust that can pass into human food through industrial, agricultural or polluted mining waters. These elements are not biodegradable, some of them are known as pollutants and toxins, and their bioaccumulation in plant and animal tissues can cause unwanted effects for humans. Therefore, their amount in water and food should always be under control. Bioremediation of mining water using microorganisms has generated interest for researchers, for their advantages, such as the quality of being more accurate and environmentally friendly. Among the microorganisms that are capable of bioremediation of heavy metals, Saccharomyces cerevisiae, Pichia pastoris are remarkable choices, being generally recognized as safe (GRAS) for humans. The aim of this research was to investigate the bioremediation conditions of copper in synthetic water. In our study, the efficiency of copper accumulation was determined using various genetically modified strains of Saccharomyces cerevisiae, Pichia pastoris and Escherichia coli. The growth rate of strains grown in specific liquid medium containing a concentration of 1 mM copper sulphate was analyzed by measuring the optical density of the cultures at 600 nm. Optical emission spectrometry with inductively coupled plasma (ICP-OES) analysis was performed on supernatant samples in order to identify the concentration of copper accumulated into the cells. The results showed that tolerance of bacteria strains on copper-containing media 1 mM was lower than the tolerance of yeast strains on the same concentration of copper. ICP-OES analysis shows that E. coli BL21 (DE3) RIL strain has the best copper accumulation efficiency. S. cerevisiae BJ5465 yeast strain is most efficient in the accumulation of copper from a total of six yeast strains used. Genetic modified yeasts and bacteria can be successful candidates for copper accumulation, in order to remove over-limit concentrations of copper from water.

Key words: *copper accumulation efficiency, Escherichia coli, Saccharomyces cerevisiae, growth rate.*

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QUALITY OF WATER IN MOLDOVA NOUA MINING AREA, ROMANIA

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Abstract

The accessibility of good quality water is an indispensable feature for the prevention of diseases and the improvement of the quality of life. Natural water contains different types of impurities that are introduced into aquatic systems in different ways, such as rock degradation and soil leaching, dissolving aerosol particles from the atmosphere and from many human activities, including mining, processing and use of metal-based materials. The economic development of a country also involves the development of the mining industry. But mining generates water and soil pollution in the areas around the mines. Monitoring water and soil and proposing methods of remediation and recovery of metals without interrupting mining activities is a solution for maintaining a balance between economic, environmental and human health needs. Romania is a country with such an industry, where mining areas are under the control of researchers. This paper presents the results obtained from the chemical analysis of water, sediments and soil from different locations (rivers, wells) in the mining area of New Moldova (Romania). In situ analyzes (pH, turbidity, conductivity, dissolved oxygen) and ex situ analyzes (in the laboratory) were performed. The results of the concentration of heavy metals and other elements such as Cu, Zn, Mn, Mo, Cr, Fe, Cd, Pb, As, Ni, Se and S were evaluated using optical emission spectrometry (ICP-OES) and mass spectrometry with inductively coupled plasma (ICP-MS). All parameters and results obtained were compared with the safe limits set by World Health Organization (WHO) and National Drinking Water Quality Standard (NDWQS). The values of water quality parameters such as pH, conductivity, turbidity, and dissolved oxygen from all samples collected were found to be within the recommended limits of WHO and NDWQS. The concentrations of metals and nonmetals were also measured and found to be below the standard maximum concentrations accepted. Therefore, the quality of wells and rivers water is good in the mining area of Moldova Noua.

Key words: *heavy metals, copper, rivers, wells, sediments.*

Funding: This work was financially supported by the Project RoRS 337- ROmania Serbia NETwork for assessing and disseminating the impact of copper mining activities on water quality in the cross-border area (RoS-NET2), implemented under the Interreg-IPA Cross-border Cooperation Romania-Serbia Programme that is financed by the European Union under the Instrument for Pre-accession Assistance (IPA II) and co-financed by the partner states in the program.

APPLICATION OF SPENT FILTER SAND FOR THE REMOVAL OF ARSENIC FROM GROUNDWATER

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Abstract

Sand filtration is commonly applied after aeration for the removal of iron and manganese from drinking waters extracted from fluvial sediments by river bank filtration systems. Over time, the sand is coated with oxides of these metals, begins to lose its efficacy for iron and manganese removal and must eventually be replaced. Instead of disposing of the spent sand at landfill, a more sustainable option is investigated in this work, whereby the sand is used elsewhere as an adsorbent for the removal of arsenic from groundwaters in smaller waterworks in the vicinity. Vojvodina, the northern province of Serbia, has many such settlements with arsenic concentrations ranging as high as 240 µg/l, and much recent work has been performed using a variety of iron oxide based adsorbents to solve this problem. The physicochemical characteristics of the spent filter sand (SFS) were analysed, and its performance for arsenic(III) removal compared with two synthetic iron oxide coated sands (IOCS1 and IOCS2) which were prepared in the laboratory from $FeCl_3$ and $Fe(NO_3)_3$ respectively. BET specific surface areas were determined by Quantachrome Autosorb IQ and SEM and EDS analyses were carried out by JEOL JSM 6460 LV scanning electron microscope. Different doses of sorbent were used to treat 20 ml of synthetic matrix (initial As(III) concentration 200 µg/l), and residual As was analysed by graphite furnace atomic adsorption spectroscopy (GFAAS; AAnalyst 700, PerkinElmer).
The BET specific surface area of the SFS was about 4 times larger than the specific surface area of IOCS1 and IOCS2 and is comparable with other adsorbents in the literature, indicating the SFS should be suitable for arsenic removal. The EDS results were particularly interesting, as the surface of the SFS was shown to be an iron manganese binary oxide. The iron coverage of SFS was similar to IOCS1 and IOCS2, but there was twice as much manganese as iron on the SFS. This means a significantly greater proportion of the surface of SFS is available for As adsorption. These results were backed up by the As(III) removals achieved, with SPS displaying better performance than IOCS1 and IOCS2. The percentage removals of As(III) achieved at a dose of 0.5 g were 70.9% for IOCS1, 76.2% for IOCS2, and 93.4% for SFS. This is explained by the presence of the manganese oxide, which is able to remove As(III) by chemisorption as well as physisorption. The results presented here suggest that the application of SFS is a viable solution for As(III) removal. Given the status of SFS as a waste material which is generated in already existing large water treatment plants in Vojvodina, its further use as an alternative to often expensive adsorbents it highly attractive for nearby waterworks where arsenic represents a serious problem.

Key words: *spent filter sand, iron oxide coated sand, adsorption, arsenic removal*

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MECHANICALLY END CHEMICALLY MODIFIED PYROPHYLITE FOR REMOVAL OF HEAVY METALS FROM AQUEOUS SOLUTION

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Abstract

Pollution of the environment with heavy metals is one of the greatest contemporary problems. Pyrophyllite is a hydrous aluminum silicate, with a wide variety of applications due to its high melting point and stable chemical properties. This study aims to examine the sorption properties of the mechanochemical activated pyrophyllite for the removal of divalent heavy metal ions (Zn, Cd, Pb, Cu and Ni). The mechanochemical activated pyrophyllite (by milling and treated with boric acid) was obtained from the Parsovići mine, Konjic site, AD Harbi Ltd., Sarajevo, Bosnia and Herzegovina. Heavy metal sorption experiments were performed by the "batch" method. Results clearly showed that the sorption of Me(II) is affected by granulation and amount of pyrophyllite, and sorption time. The following results were obtained: (1) the smaller pyrophyllite particle the removal of Me(II) is more efficient and the shorter contact time is required; (2) the sorption of Me(II) on pyrophyllite decreases in the following order (Cu > Pb > Cd > Zn > Ni); (3) the increase of contact time increases the removal of Me(II) from the aqueous solution; (4) mutual competition of Me(II) for pyrophyllite binding sites – significantly more efficient sorption of Cd(II), Zn(II) and Ni(II) was achieved from individual solutions compared to the mixture; (5) adsorption of Cd(II), Zn(II) and Ni(II) is higher on chemically activated pyrophyllite with boric acid but it is not clear whether it is a specific effect of boron from boric acid or the consequences of the acid modifications of the material. Our results show the high potential of pyrophyllite as a material for the removal of heavy metals from aqueous solutions.

Key words: *pyrophyllite, heavy metals, sorption, modified materials.*

MEDICAL WASTE MANAGEMENT ON THE TERRITORY OF THE MUNICIPALITY OF ARANĐELOVAC - MEASURES FOR IMPROVEMENT OF THE SYSTEM

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Abstract

Within this work, research was conducted in the Health Center Arandjelovac, which relates to the type, quantity, methods of treatment and other parameters related to medical waste. Based on the conducted research, the paper also presents a proposal of measures for the improvement of the medical decline management system on the territory of the municipality of Arandjelovac. Given that medical waste belongs to the category of hazardous waste that negatively affects human health and the environment, the establishment of an integrated system and the adoption of measures that can contribute to the improvement of the system, the problem of medical waste becomes solvable. Educating the population in the field of waste management can contribute to raising awareness of the importance of waste for human health and the environment.

Key words: *medical waste management, human health, environment*

REMOVING TOXIC CADMIUM(II)-ION FROM WASTEWATER WITH ZERO-VALENT IRON NICKEL MODIFIED NATURAL ZEOLITE MATERIAL: PRELIMINARY STUDY

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Abstract

Cadmium(II)-ion is a toxic pollutant, which occurs in the environment mostly from agriculture and industrial wastewaters. In this study, we investigated sorbent potential for Cd(II)-ion of a newly synthesized material based on a natural zeolite (Zlatokop, Serbia), which was chemically modified by including zero-valent bimetallic iron-nickel particles. The results from a preliminary study on a wastewater model system showed that this new material has excellent sorption properties under investigated conditions, which urges our further investigation into its sorbent potential for other inorganic and organic pollutants under various experimental conditions.

Key words: *wastewater treatment, chemically modified zeolite, zero-valent iron nickel material, environmentally friendly sorbent, Cd(II)-ion pollutant*

USE OF FLY ASH IN THE ADSORPTION OF POLLUTANTS FROM WASTEWATER – A REVIEW

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Abstract

Depending on the origin, wastewater can contain different types and quantities of waste materials. These waste materials could be classified as harmful and toxic to living organisms, both in the aquatic environment and outside the recipient of wastewater. Some substances have the ability to accumulate in living organisms (such as heavy metals), so they can reach humans through the food chain. Purification of wastewater prior to final discharge into the recipient has legally regulated, wherein maximum allowable concentration of certain pollutants in the purrified waste water are defined. Conventional treatments involve mechanical, physico-chemical and biological processes, and implementation of these processes can significantly increase the cost of wastewater management. Therefore, researches are based on finding new purification solutions, using cheaper and simple technologies. The use of industrial by-products, such as fly ash, is very significant. Fly ash is formed during the combustion of coal in the furnaces of thermal power plants. Fly ash consists of fine abrasive particles, which are separated from the stream of flue gas during the purification. Due to the shape and size of the particles, ie their high porosity and specific surface area, fly ash could be used as a substitute for conventional adsorbents. In general, the amounts of fly ash generated in thermal power plants are large, so its further use would be useful in terms of reducing the use of more expensive adsorbents such as activated carbon and various types of zeolites. The aim of this paper is to present an overview of the possibilities of using fly ash in wastewater treatment, ie adsorption of certain pollutants from wastewater.

***Key words**: wastewater, fly ash, adsorption, pollutants*

A REVIEW OF SEWAGE SLUDGE UTILIZATION OPTIONS

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Abstract

Wastewater purification is very significant activity, in order to reduce the pressure of waste materials discharge into the environment. The output streams of waste water treatment process are the following: treated water (with suitable quality for discharge in the recipient) and sewage sludge. The generated sludge requires adequate storage, treatment and disposal. Which available treatments will be applied, mainly depends on the amount and characteristics of sewage sludge. Characterization of the sewage sludge is described by its physical, chemical and biological properties. Dry matter of sludge, water content and type of sewage sludge are common parameters which are used to describe sewage sludge. Often, especially in the earlier praxis, the untreated sludge have been disposed nearby the purification plant, or directly to the landfill, which results in the occupation of land, as well as the production of unpleasant odors due to the biological activity and release of harmful substances into the environment. In order to minimize the negative impact, the legal regulations (such as Directive 91/271/EEC and Directive 99/31/EEC) limit the direct disposal of sewage sludge and other ways of final disposal are recommended. That includes the use of potentially useful components contained in the sludge and its energy potential. Also, sewage sludge pretreatment is very significant. This provides reduce of the volume of the sludge, remove the excess water, reduce the content of pathogenic microorganisms and harmful substances, and remove of degradable material which could cause the unpleasant odors. The aim of the research is to evaluate possible options for sewage sludge utilization, as well as a brief summary of sewage sludge management in European countries. Regarding the possible options for the use of sewage sludge, the paper gives an overview of the possibilities. These include the use of sludge in agriculture, thermal treatment (incineration, gasification, and pyrolysis), biogas production and other options such as wet air oxidation.

Key words: *sewage sludge, landfilling, incineration, pyrolysis, fertilizer, biogas production*

ECOLOGICAL RISK ASSESSMENT OF TRACE ELEMENTS IN URBAN SOIL OF ŠABAC

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Abstract

The aim of this study was to study ecological risk assessment of trace elements in Šabac surface urban soil. A total of 32 samples of the surface layer of soil (up to 10 cm deep) were collected from the locations of three city parks. Pseudototal concentrations of seven elements: copper (Cu), lead (Pb), cobalt (Co), nickel (Ni), manganese (Mn), cadmium (Cd) and chrome (Cr) were determined in the samples after aqua regia digestion, using atomic absorption spectrophotometry. Based on the obtained results, the level of soil contamination with trace elements were assessed by the contamination factor (CF) and ecological risk (ER). Contamination factor (CF) were in the order of Cd>Pb>Mn>Co>Cr, Ni, Cu. Mean values of contamination factors indicate that the soil from all three examined sites is contaminated with Pb and Cd, while Cd has a higher individual potential ecological risk than other elements.

Key words: *trace elements, AAS, ecological risk, contamination factor.*

THE MISTICAL AND MAGIC ICOSAHEDRON STRUCTURE OF LIQUID WATER IN ENVIRONMENT

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Abstract

Water is the most important and essential medium with the mystical and magic icosahedron characteristics and structure biological liquid for human and bio system existence with the essential role in physics, chemistry, biology, ecology, environmental engineering disciplines, medicine, health, sport, and others. The water is the strategic focal point forthe economy and development of every society and all anthropogenic and industrial activities. The icosahedron geometry of liquid water is related to the 14-molecule tetrahedral structures of hexagonal and cubic ice.Twenty of the 14-molecule tetrahedral units may form a 3 nm in diameter of icosahedral structure. The icosahedral (H2O)280 network of water cluster shows increased stabilization as the shells the icosahedron increase order in the structure. As the consequences of the mystic icosahedron structure of water are characterized by at least 41 known physicochemical anomalies. In the field of environmental research and protection engineering and health care, each chemical species is enfolded in a water cloud which can be portrayed as [Chem. Spec.]aq. The icosahedral cluster and network structure of H2On is responsible for the protective water shells, "scafander" of all polar and non polar compounds, ionic species, organic molecules of sugars, proteins, DNA, toxins, viruses (COVID19), emergent substances and xenobiotics (pesticides, pharmaceuticals and others). Water from various sources contains dissolved gases, minerals, organic and inorganic substances that are transferred to water during transformation, passage and water cycle. COVID19 is nano spherical suspended particles of supra molecule organic protein and nucleon entities with the high organization icosahedron structure, not pseudo live physicochemical species primary parasitic personality. The virus is situated in icosahedron water aerosols (nano water particulates in gas-atmosphere) present mostly in fog. In the paper the mystical icosahedron structure of liquid water will be presented in the intercorrelation with nano particles. Nano physical, chemical and toxic phenomena in the environmental protection research area is the challenge of the 21st century.

Key words: *Icosahedron structure, nano particles, viruses, interrelation.*

AIR QUALITY AND PROPOSED MEASURES FOR ITS IMPROVEMENT ON THE TERRITORY OF THE CITY OF VRANJE

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Abstract

Air pollution represents the presence of various substances and gases in the air, which can cause a risk to human health. Air pollutants are: sulfur dioxide, nitrogen oxides, carbon dioxide, solid particles, volatile organic substances and toxic substances. On the territory of the City of Vranje, air quality control is performed daily at 2 measuring points in the local network: the Institute for Public Health Vranje and The Primary School "Svetozar Marković". The paper will present data on air quality measurements of air pollutants: sulfur dioxide, soot and nitrogen dioxide. Analyzes of these air pollutants were performed according to standard methods in the accredited laboratory of the Institute of Public Health Vranje according to the standards SRPS ISO/IEC 17025:2006. The analysis of data on concentration of pollutants indicates that at the measuring point the Public Health Institute Vranje air pollution concentration was increased on a daily basis during the winter months of the /year 2019. At the measuring point the Primary School "Svetozar Marković" in Vranje, daily measured increased concentrations of soot during the winter months of 2019 are a consequence of the combustion process during the heating season and from the motor vehicles. Considering that the main sources of air pollution in the City of Vranje are thermal power stations and motor vehicles, this paper will propose measures to reduce air pollution that could lead to a reduction in the emission of basic pollutants in the air.

Key words*: Air pollutant, measuring points, sulfur dioxide, soot, nitrogen dioxide*.

AC CONDUCTIVITY OF GAMMA IRRADIATED LOW-DENSITY POLYETHYLENE–ZEOLITIC IMIDAZOLATE FRAMEWORK-8 COMPOSITE

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Abstract

Low-density polyethylene (LDPE) – micro sized zeolitic imidazolate framework-8 (ZIF-8) composite, obtained by melt mixing (95/5 weight ratio), was gamma irradiated at room temperature to different absorbed doses up to 300 kGy. Infrared spectroscopy and optical microscopy confirmed the degradation of ZIF-8 due to gamma irradiation. Electrical AC conductivity of the composite samples have been studied in the frequency range between 24 Hz and 120 kHz at room temperature. The composite shows larger admittance components relative to the admittance components of pure LDPE, and this phenomenon is most pronounced in non-irradiated samples.

Key words: *LDPE, ZIF-8, AC conductivity, gamma irradiation.*

THE ENVIRONMENT`S INFLUENCE ON THE CORROSION OF CuAlNi ALLOY IN THE BOKA KOTORSKA BAY

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Abstract

Thanks to the increasingly rapid development of marine resources a lot of different metal constructions come into contact with the coastal environment. As is well known, the coastal conditions are some of the most corrosive natural environments. Because of that, corrosion of different metal structures in marine environments is a problem that has to be considered during both the design and maintenance of this type of constructions. Shape Memory Alloys represent a relatively new group of intelligent materials whose application in the marine environments has become increasingly common. The aim of this study was to monitor the corrosion behaviour of CuAlNi Shape Memory Alloy in different coastal environments. After 6 months of exposure to the corrosion effect of the different environments, alloy samples were analysed using an Energy Dispersive Spectrometer (EDS). Due to the large scattering of the obtained results within each sample in all investigated marine zones, it was very difficult to make the right conclusions about the real impact of each tested corrosion environment on the corrosion behaviour of this Shape Memory Alloy. Because of that, the results obtained by EDS were correlated by applying linear regression analysis and two multivariate methods, Cluster Analysis (CA) and Principal Component Analysis (PCA), to identify the most important corrosion factors, as well as their effect on the degradation of this alloy depending on the given conditions. Based on the obtained correlations, it can be concluded that CA and PCA can be used as good and sufficiently sensitive methods for examining the influence of various environments on the corrosion processes of the tested CuAlNi alloy, and also for finding the correlations between the most important degradation products of this alloy in the given conditions. Using these methods, we obtained information from a large number of heterogeneous data about factors that have a dominant influence on the corrosion of the tested alloy in the given conditions.

Key words: *Shape Memory Alloy, corrosion, multivariate analysis.*

MULTILAYER THIN FILMS PROCESSING WITH FEMTOSECOND LASER PULSES

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Abstract

Laser processing is a technique that makes possible non-contact handling of materials. The main advantages of the usage of ultra-short laser pulses, as femtosecond (fs) ones, compared to longer pulses, are high localized deposition of the pulse energy, fast heating, and cooling, as well as precise surface and volume modifications. The femtosecond lasers have been extensively used in many areas such as surface processing of materials, thin film deposition, surgery, fast laser plasma ignition, ultrafast spectrometry, high-resolution microscopy, etc. Titanium based alloys have very good physicochemical characteristics like good corrosion resistance, good strength, and ductility and excellent biocompatibility. Deposited thin films usually show properties that cannot be achieved in the same bulk materials. However, the multilayer thin films (MTFs) composed of alternating nano-layer thin films have some advantages over single component ones. In this presentation, morphological and compositional changes of the Ti/Al and Al/Ti films, performed by femtosecond laser, will be reported. The experimental samples were prepared by physical vapour deposition technique. Ti and Al of different thicknesses were alternatively deposited on a silicone substrate. The fs laser irradiation of the samples was done with a ytterbium-doped fiber laser (λ = 515 nm, τ = 300 fs) in the air. Pulse energies varied from 0.02 μJ to 1.2 μJ. The laser beams were focused perpendicularly on the surfaces of the samples. Before and after the irradiation, surface morphology of the samples was monitored by optical microscopy (OM), scanning electron microscopy (SEM), and profilometry. The SEM was coupled to an energy dispersive analyzer (EDX) for determining surface composition. It was shown that the laser induced morphological and compositional changes depend on laser pulse energy and the samples' composition. These results show in what way difference in thickness of the thin film samples and laser pulse energy affect the surface morphology. Studying the effects of the fs laser irradiation of the Ti based MTF films is important for experimental, theoretical and practical points of view.

Key words: *femtosecond laser, thin films, SEM, profilometry.*

AMINO ACID IMIDAYOLIUM ZWITTERION AS GREEN CORROSION INHIBITOR FOR MILD STEEL

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Abstract

Corrosion, although a natural process, presents a costly problem with the possibly dangerous outcome. Mild steel, which is an alloy used in many industrial applications, manifests poor corrosion resistance when in contact with corrosive environments and even more so in presence of chloride ions. This is a particularly important problem in a variety of industrial applications related to oil and gas processing such as pipeline cleaning pipeline/acid descaling, and oil well acidizing, where the use of mineral acids (commonly hydrochloric acid) is necessary for achieving satisfying productivity levels. The most practical method to combat the corrosion issue is the use of corrosion inhibitors. Organic inhibitors with functional groups such as –OH, –COOH, NH_2, etc, when added in small concentrations to a corrosive solution, can lower the corrosion rate very efficiently, especially in acidic media. Being that they are also inexpensive, these organic inhibitors are successfully used for corrosion prevention. A great variety of organic inhibitors has opened a door to environmentally friendly corrosion inhibition. One of the environmentally friendly organic compounds are amino acids. They are non-toxic biomolecules completely soluble in aqueous media and are produced with high purity and at low cost which makes them a great candidate for a safe corrosion inhibitor. The application of amino acids and their derivatives against corrosion of iron and its alloys has been investigated so far.
Amino acid based corrosion inhibitor was synthesized by condensing formaldehyde, glyoxal, and β-alanine, and characterized using FTIR and NMR spectroscopic methods. Imidazolium zwitterion has been investigated as a corrosion inhibitor on mild steel in 1 M HCl solution using electrochemical methods: electrochemical impedance (EIS) and linear polarization resistance (LPR). Different concentrations of inhibitor were used to find the best efficiency. This compound gave a maximum inhibition efficiency of 74.3 % at 10.7 ppm. The adsorption of inhibitor on mild steel surface followed the Langmuir adsorption isotherm. Furthermore, electrochemical measurement results demonstrated that inhibitors act as mixed-type inhibitors (anodic and cathodic).

Key words: *zwitterion, corrosion inhibition, mild steel, green and organic chemistry*

IMPORTANT PHYSICAL FEATURES OF POLYAMIDE FABRIC AFTER PROCESSING WITH BORON COMPOUNDS UNDER HIGH PRESSURE

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Abstract

In this paper, the influence of boron compounds on important physical properties of polyamide 6 fabric under conditions of elevated pressure is investigated. Polyamide belongs to the group of synthetic fibers, with good physical properties. Boron has non-metallic properties; it is trivalent and relatively rare. In nature, it occurs in the form of compounds with oxygen, often as borax and kernite, while in some sites it is found in quantities that are profitable for exploitation. Boric acid, first used as an antiseptic, antibiotic and insecticide, has recently become interesting as a precursor to other forms of boron compounds with oxygen. In fact, boric acid derivatives have been shown to have an effect on biological systems. Borax is an important boron chemical compound, mineral and boric acid salt. It is mainly in the form of a white powder consisting of soft colorless crystals easily soluble in water. 100% raw polyamide fabric was used in the research. The longitudinal mass of the warp yarn is 100 tex and the weft yarn 83 tex, while the surface mass of the fabric is 282 g/m^2. Polyamide fabric is treated with boron compounds, ie. with sodium tetraborate and boric acid. The concentrations of boric acid and sodium tetraborate were 5 and 10%. The samples were processed discontinuously in a batch reactor under atmospheric flow for 60 minutes at a temperature of 95-100 °C at a bath ratio of R 1:40. The aim of the research is to check the effects of finishing raw polyamide fabric under high pressure in laboratory conditions based on data from the latest scientific papers. According to the data presented in this paper, as well as the analysis in laboratory conditions, tests were performed at certain temperatures and at appropriate concentrations of sodium tetraborate and boric acid in a batch reactor under high pressure. These are treatments under high pressure that improve properties such as hydrophilicity, burning ability, etc.

***Key words**: polyamide fabric, boric acid, sodium tetraborate, physical properties*

PRE-TREATMENT WITH METALOIDS AND DYEING OF POLYAMIDE FABRIC UNDER PRESSURE CONDITIONS

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Abstract

This paper describes the influence of pre - treatment with metalloids on the dyeing of polyamide fabric under overpressure conditions. The dyeing of polyamide fabric is determined depending on the dye concentration on the fiber and the dye concentration in the solution after dyeing. Polyamide is a chemical fiber obtained from synthetically produced polymers. According to their chemical and physical - mechanical properties, polyamide fibers represent connection between hydrophilic - natural and hydrophobic - synthetic fibers. Precisely because of that, the dyeing of these fibers can be done with a wide range of colors in a wide range of shades. A special feature of this system is the rapid dye adsorption immediately after immersion of the material in the dye solution at relatively low temperatures, which often leads to uneven dyeing. Direct dyes are mainly sulfonated azo compounds, which are derived from bendisidine and its derivatives or amines of the diaminostilbene type, etc. All direct dyes are soluble in water, but some of them are soluble in a slightly alkaline solution. Boron compounds have numerous uses in various industrial fields. The detergent industry uses boron compounds such as sodium perborate in large quantities as bleach, while the glass industry uses boron and boron compounds to make cups and ceramics with good resistance to chemicals and large temperature changes. 100% raw polyamide 6 fabric was used in this study. Polyamide fabric is dyed with an unconventional direct dye of a specific structure that has a predisposition of bonding to the fabric. In the experimental part, the raw polyamide fabric was treated in a batch reactor under atmospheric pressure in the presence of 5% and 10% boric acid and sodium tetraborate at 95-100 °C at a bath size of R 1:40. Dyeing of such treated samples was performed in a batch reactor under elevated pressure for 120 minutes, at a bath size of R 1:30 at a temperature of 120-130 °C with the addition of 5 g/dm^3 NaCl and 0,1 cm^3 HCOOH, at concentrations of direct dye Solophenyl green 5BL (Huntsman, USA) 10, 20, 30, 40, 50 and 60 mg/dm^3.

Key words*: polyamide, dyeing, boric acid, sodium tetraborate, direct dye*

ON POLYMER - CLAY NANOCOMPOSITES

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Abstract

In the paper, unmixed, intercalated and exfoliated structures of polymer-clay nanocomposites (PCN) are described and « tortuous path model» relating to barrier properties of PCN structures is explained. Then, the mechanism of clay nanoparticles exfoliation is depicted by mean-field, lattice-based model and step-wise skewing model. Next, solution induced intercalation, melt intercalation, in situ polymerization and electrostatic layer-by-layer self-assembly are presented as methods of PCNs preparation. Subsequently, mechanical, thermal, barrier and flame retardancy properties of PCNs are considered. Finally, fields of PCNs applications are depicted, with special attention to the fields of commercial applications in auto industry. It is concluded that enhanced properties of PCNs are related to the degree of dispersion and the degree of exfoliation (dispersion of platelets) of the tactoids (clay platelet stacks) in the polymer matrix.

Key words: *clay, exfoliation**,** dispersion.*

STRENGTHENING OF CYLINDERS CONCRETE CONFINED WITH GLASS FIBRE REINFORCED POLYMER

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Abstract

External strengthening with Fibre Reinforced Polymers (FRP) has been growing in recent years for strengthening and retrofitting of concrete and steel structures. Most of the studies focused on high-strength concretes, and research on FRP-confined low-strength concrete has been very limited. Hence an endeavour has been made to examine the compressive behavior of concrete specimens (cylinders) strengthened with FRP. This study exemplifies the results of experimental investigation on the behaviour of axially loaded concrete wrapped with glass fibre reinforced polymer (GFRP) compared with unconfined concrete strength in the range of 25 MPa. Totally ten cylinders specimens were fabricated and tested under axial compression load. Two specimens were retained as control specimen and the remaining eight specimens were wrapping used GFRP fabrics strips. This study investigated three variables included full confined wrapped, spacing and orientation of GFRP strips were examined. The result of this investigation indicates that the gain in compressive strength varied between 30.80 % and 41.40%. In addition to ease of application, compressive strength of GFRP-confined concrete was enhanced in all strengthening parameters indicating that strengthening of concrete using GFRP strips is an effective process, thus helping to reduce life cycle costs.

Key words: *Glass, Fibre Reinforced Polymer, Ultimate load, Confined, Strengthening*

CORROSION RESISTANCE OF DOUBLE (Ge–Sn) AND TRIPLE (Ge-In-Sn) ALLOYS IN 3% NaCl

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Abstract

The importance of these alloys can be attributed to the specific properties of the Ge and Sn elements themselves, such as good insulating properties, easy machinability, forging, corrosion resistance and many others. Also, Ge-based alloys are necessary for the development of flash memory materials, etc. This paper presents corrosion resistance of double alloys ($Ge_{50}Sn_{50}$, $Ge_{50}In_{50}$, $In_{50}Sn_{50}$) and triple $Ge_{20}In_{40}Sn_{40}$,$Ge_{40}In_{30}Sn_{30,}$ $Ge_{40}In_{20}Sn_{40}$,$Ge_{17,5}In_{65}Sn_{17,5}$,$Ge_{35}In_{35}Sn_{30}$,$Ge_{15}In_{15}Sn_{70}$,$Ge_{10}In_{10}Sn_{80}$ alloy in this test solution. The mass of the tested samples was 7 g with dimensions (15x15x1) mm. The corrosion resistance of these alloys was examined by the potentiodynamic polarization method - Tafel polarization diagrams and the method of electrochemical impedance spectroscopy (EIS). Tafel polarization diagrams were fitted using DC Corrosion Technique software. The results of electrochemical impedance spectroscopy (EIS) were fitted using the Gamry Echem Analyst program and the corresponding equivalent circuit. The value of the exponent n is used to determine the degree that controls the rate of the electrochemical reaction in a given system. The corrosion resistance of double alloys decreases in the following order: $Ge_{50}In_{50}$, $Ge_{50}Sn_{50}$, $In_{50}Sn_{50}$ .The corrosion resistance of triple alloys decreases in the following order ($Ge_{10}In_{10}Sn_{80}$), ($Ge_{15}In_{15}Sn_{70}$), ($Ge_{40}In_{30}Sn_{30}$), ($Ge_{40}In_{20}Sn_{40}$), ($Ge_{20}In_{40}Sn_{40}$) ,($Ge_{17.5}In_{65}Sn_{17.5}$), ($Ge_{35}In_{35}Sn_{30}$). The obtained results of corrosion resistance using the used methods are compatible, have fundamental and practical significance. They enable a better understanding and understanding of the possibilities of practical application of the tested alloys.

Key words: *corrosion resistance, double alloys, triple alloys, potentiodynamic polarization, electrochemical impedance spectroscopy*

HYDROGELS BASED ON POLY(METHACRYLIC ACID) AND NANOCELLULOSE WITH POTENTIAL APPLICATION IN DENTAL TREATMENTS

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Abstract

pH sensitive hydrogels, such as hydrogels based on poly(methacrylic acid) (PMAA), are tremendous materials with great properties due to which they have application in many fields, such as: targeted drug delivery, tissue engineering, as contact lenses etc. Hydrogels based on PMAA are non-toxic, biocompatible and able to absorb and retain huge amount of water. These hydrogels are widely used for targeted drug delivery due to their specific pH swelling behavior which enable drug release in environments with pH values higher than pKa(PMAA). However, poor mechanical properties of hydrogels based on PMAA often limit their application. In order to overcome this limitation, green approach is used in present study. Namely, nanocellulose (NC) extracted from wood waste material is added to PMAA due to NC non-toxicity, biocompatibility, biodegradability and great mechanical properties (which is used for improvement of hydrogels mechanical characteristics). Further improvement of hydrogels based on PMAA and NC is achieved by adding carboxymethyl cellulose (CMC). CMC is non-toxic, biocompatible, biodegradable, pH-sensitive derivate of cellulose widely used in drug delivery systems. Drug delivery system prepared in that way can enable controlled release of drug (such as lidocaine hydrochloride (Lid)) for prolonged period of time and therefore, reduce the number of acquired drug dosages which further lead to safe and efficient drug application. Therefore, Lid is encapsulated in hydrogels based on PMAA, NC and CMC (PM/NC-Lid). Lid is local anesthetic often used in dental treatment and it is usually administrated by injection, which is painful, unpleasant and treatment is often required several dosages. These limitations can be overcome by applying PM/NC-Lid hydrogels as buccal patches for controlled release of lidocaine hydrochloride. Present study describes green synthesis and characterization of PM/NC-Lid hydrogels (using the Fourier Transform Infrared spectroscopy (FT-IR), the Scanning Electron Microscopy (SEM) and the single compression tests). Also, PM/NC-Lid swelling behavior and Lid controlled release from PM/NC-Lid hydrogels is investigated depending on the variable synthesis parameter (NC wt%) in simulated buccal environment. Results presented in this study show that PM/NC-Lid hydrogels are promising materials for controlled release of anesthetic drugs and for potential application as buccal patches in dental treatments.

Key words: *poly(methacrylic acid), nanocellulose, lidocaine hydrochloride, pH sensitive hydrogels, controlled release, dental treatments.*

LASER TREATMENT FOR REINFORCEMENT OF DRILLING HOLES ON NIMONIC 263 SUPERALLOY

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Abstract

With the significant impact on their properties and application, the research of surface modification of the laser processed structural metallic materials is of great importance. Reliable and resilient constructions are basics for ensuring the safety of various structures. Due to their remarkable mechanical properties and endurance, superalloys are used as constructive materials. However, even these materials can have certain areas where the stress concentration is expected, such as drilling holes which are common in various structures that need additional enhancement. In this paper, the sheets of commercial Nimonic 263 superalloy are cut to the rectangular shape and series of holes with the same diameter were created by mechanical drilling, under the same conditions. Surface laser modifications of the areas surrounding the holes, which are made in the ambience conditions of standard temperature, humidity and in the air atmosphere, are done on both sides of the sheets, by pulsed picosecond and nanosecond Nd:YAG lasers, emitting in the near – IR spectrum. The resulting effects were analyzed by scanning electron microscopy, optical microscopy, and compared with the untreated surface while the elemental surface analysis was performed using energy-dispersive X-ray spectroscopy. Qualitative and quantitative analysis was done by X-ray fluorescence and micro-hardness measurements were performed by Vikers test. Also, changes in topography of irradiated surfaces were analyzed using a non-contact optical profilometry and characteristic surface parameters were analyzed. The effectiveness of enhancement was analyzed by deformation and stress tests after the laser surface treatment. Nimonic 263 tiles are loaded to tension with an axial force of 5 kN intensity. Aramis system for non-contact measurement of displacement, deformation and stress was used to determine deformations and stresses.

Key words: *picosecond laser, nanosecond laser, laser treatment, Ni-based superalloys, properties enhancement.*

SYNTHESIS AND BIOLOGICAL ACTIVITY OF THE NANOMATERIALS BASED ON BIGINELLI HYBRIDS

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Abstract

Tetrahydropyrimidine derivatives or as they are called Biginelli hybrids are a class of azaheterocycle obtained from the Biginelli reaction. During the past years, this class of compounds has attracted huge interest among scientists especially in medicinal chemistry due to a wide pharmacological activity (anticancer, antiviral, anti-inflammatory, antidiabetic, antituberculosis activities, etc.) According to SciFinder®, more than 70 000 different Biginelli-like compounds have been represented in publications. However, none of the mentioned compounds have been incorporated into a carrier. As one of the biggest problems in therapy is drug delivery, nanoparticles (NPs) have been considered such a great transporter due to having the ability to adsorb and carry different molecules and interact with different biological systems. Though, it is still difficult to choose the right carrier. Biodegradable polymers are very suitable for drug formulations as they do not require to be eliminated from the human body. Chitosan (Ch) is one of the most studied and suitable for nanoformulation. Ch is a linear polysaccharide made of glucosamine and N-acetylglucosamine units. The amine groups in glucosamine units are protonated under slightly acidic conditions. As a result, the whole molecule has cationic properties which allows interactions with different anionic structures, such as cell membranes, nucleic acids, and macromolecules. So, it is not surprising that Ch has been expansible used as a cationic polymer material in the delivery of anticancer drugs in recent years. Considering above mentioned information, we have investigated spherical nanoparticles made of Ch and loaded with three different THPMs with anticancer activity. During the SEM analysis, two types of particles were registered in the investigated systems, larger – with an average diameter of 100-200 nm, and smaller – with an average diameter of 30-100 nm. The selectivity of the prepared NPs was examined using the MTT test in HeLa, LS-174, A549, MRC-5. The obtained results indicate that all nanoparticulate systems exhibit significantly greater cytotoxicity to the selected cancer cell lines than THPMs.

Key words: *tetrahydropyrimidines, nanoparticles, chitosan*

TRANS-GENERATIONAL EFFECT OF CARBOHYDRATE-COATED CERIUM OXIDE NANOPARTICLES IN TWO HERBACEOUS WEEDY ANNUALS

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Abstract

Cerium oxide nanoparticles ($nCeO_2$) are nanomaterial widely used in electronics, cosmetics, catalysis, and fuel additives production due to their transition between Ce^{3+} and Ce^{4+} oxidation states. Their increasing production (around 10,000 metric tons per year) makes them one of the most produced metal oxide nanoparticles which can lead to unexpected consequences to environmental health and safety. Coating $nCeO_2$ with different polymers is a very popular way to increase their suspension stability, but the data on their effect on cultivated plants are scarce. Environmental effects on morphological and physiological properties of offspring which occur during the development of the mother plant are called maternal environmental effects. Their expression depends on the offspring's environment, they are expressed throughout the life cycle of the offspring and may persist for several generations. It was suggested that components of the nonenzymatic antioxidant system might participate in the mechanism governing the maternal environmental effects. Total antioxidant activity (TAA) comprises the contribution of different non-enzymatic components with antioxidant capacity. Herbaceous weedy annuals Sinapis alba and Chenopodium rubrum were selected, as a heavy metal hyperaccumulator plant i.e. a species with strong maternal effects, respectively. The effect of uncoated (CeO_2) and glucose-, levan-, and pullulan- coated nanoparticles (G-CeO_2, L-CeO_2, P-CeO_2) treatment of Chenopodium rubrum and Sinapis alba seeds during germination, on TAA of seeds produced in two subsequent generations of plants grown in a greenhouse, were investigated. TAA was measured using the ABTS/HRP end point method. Results showed that the effect of $nCeO_2$ treatments was more expressed in Sinapis alba seeds; mainly all nanoparticles treatments during germination of mother plants resulted in the increase in TAA of produced seeds in both monitored generations. In contrast, in Chenopodium rubrum CeO_2 treatment resulted mainly in the decrease in TAA of produced seeds in both monitored generations. The presented effect was equally expressed in both generations. Among nanoparticles, L-CeO_2 showed the most pronounced effect in both generations of the plants. We showed that the effect of $nCeO_2$, applied during the early development of mother plants (germination), is visible in changes in the components of the nonenzymatic antioxidant system of produced seeds and that it persists for (at least) two generations. In other words, seed priming with $nCeO_2$ might affect changes in yield antioxidant capacity through several generations.

Key words: *CeO_2, coating, nanoparticles, plants, total antioxidative activity.*

CYSTEINE AND MODIFIED CYSTEINE AS GREEN INHIBITORS OF ALUMINUM ALLOY CORROSION

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Abstract

In its pure form, aluminum is easy to process and has a high level of corrosion resistance. However, due to its low strength the possibility of application of pure aluminum is reduced. When alloyed, aluminum alloys are widely used material in construction, different industries, airspace and military. Commercial 7000 series aluminum alloys have zinc as the main alloying element, followed by magnesium. This 7000 aluminum series offers a very high strength when heat-treated, which comes from its composition. The life time of these alloys is reduced due to corrosion damage. It is known that corrosion directly or indirectly affects materials, human health and safety, and it causes global economic and environmental problem. The use of inhibitors in corrosion protection is the simplest, most economical and most efficient approach that is routinely used to 'reduce' this problem in industry. The most widely used inorganic inhibitors, such as chromates, are not safe, causing health and safety problems due to their toxicity. Organic compounds have increased interest of the scientific community as potential inhibitors in exchange for the most commonly used. The aim of this study was to investigate new green, eco-friendly inhibitors from the group of amino acid and their combination with lanthanides. For the purposes of this investigation, cerium-cysteine complex was synthesized and analyzed by Fourier-Transform Infrared spectroscopy (FTIR), Scanning Electron Microscopy with Energy Dispersive Spectroscopy (SEM / EDS), Potentiostatic Electrochemical Impedance Spectroscopy (PEIS) and Linear Sweep Voltammetry (LSV) analyses. SEM/EDS was used for morphological analysis and to determine the composition of the aluminum alloy on which the electrochemical tests have been performed. Electrochemical measurements (PEIS, LSV) were performed in order to test the inhibitory efficacy in 0.1M NaCl at room temperature. Different concentrations of cysteine and Ce-cysteine complex were examined to optimize the process. The adsorption of the inhibitor follows the Langmuir isotherm, and based on the electrochemical results and calculated thermodynamic potential (Gibbs free energy) it can be concluded that both cysteine and cerium-cysteine complex are mixed type of inhibitors. It can be concluded that both cysteine and Ce-cysteine complex inhibitors satisfactory inhibition effect on aluminum alloy corrosion.

Key words: *cysteine, Ce-cysteine complex, corrosion, corrosion inhibitor, aluminum alloy*

HARDNESS AND CORROSION RESISTANCE OF Zn-Mn/Al_2O_3 COMPOSITE COATINGS

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Abstract

Zinc coating has been widely applied in the corrosion protection of steel substrate. The coating microstructure and properties such as morphology, microhardness, fracture strength, wear and corrosion resistance, are often improved by Zn alloying or Zn composite coatings. This work focuses on the development of a novel Zn-alloy-composite coating, i.e. the coating that will benefit from the insertion of both an additional metal and ceramic particles into the Zn matrix. A number of Zn based coatings of this type have been produced by electrodeposition until now, for example Zn-Ni/Al_2O_3; Zn–Ni- or Zn-Fe-P or Zn-Co-carbon nanotubes, Zn-Co/TiO_2 etc. However, we are not aware of the published research on the electrodeposition of Zn-Mn/Al_2O_3 coatings. Therefore, the aim of the present study is twofold: (1) probing the electrodeposition of Zn-Mn/Al_2O_3 coatings from chloride bath and (2) characterizing the obtained coatings in terms of their corrosion resistance, morphology, and microhardness. The coatings were electrodeposited at a constant current density of 40 or 50 mA cm^{-2} from a chloride bath to which 1.0 g dm^{-3} Al_2O_3 powder with an average particle size of 300 nm was added. To maintain a uniform alumina particle concentration in the bulk solution, two agitation methods were used during the electrodeposition process: agitation by a magnetic stirrer (w=300 rpm), and ultrasonic energy (US) by an ultrasonic bath (24 kHz). The obtained composite coatings contained between 1.29 and 4.78 mass. % of Al_2O_3. The nanoindentation measurements showed that the Zn–Mn/Al_2O_3 composite coatings deposited with US have significantly higher hardness as compared to the alumina free Zn-Mn coatings. Over the immersion period of 96h in 3.5% NaCl solution, the corrosion resistance values increased slightly (from ~600 – 800 to ~800 – 1100 Ω cm^2) for all investigated coatings. These changes could be mainly ascribed to the evolution of the corrosion product layer that shows some protective ability at Zn-Mn alloy coatings. Although the differences between the samples are rather small, it was observed that the coatings containing Al_2O_3 possessed higher corrosion resistance than alumina-free alloy coatings, probably due to the barrier effect provided by alumina particles.

Key words: *Zn-Mn alloy, Al_2O_3 particles, composite coating, hardness, corrosion.*

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INVESTIGATION OF THE INFLUENCE OF DIFFERENT NANOPARTICLES ON THE GROWTH OF SOIL MICROORGANISMS AND ORGANIC MUNGO BEAN

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Abstract

Silver and titanium dioxide nanoparticles (NPs) are the most produced NPs worldwide due to their antimicrobial properties. These NPs are widely used in many fields including agriculture, where they can inhibit the growth of plant pathogens and stimulate plant growth. However, there are concerns about nanoparticles reaching the environment, as they can also manifest the adverse effects. In this study, the effects of TiO_2 and two types of Ag NPs (synthesized by chemical reduction and dextran-coated) on soil microorganisms and organic bean were investigated. Two different species of rhizospheric soil microorganisms, namely actinomycetes Streptomyces microflavus and nitrogen-fixing soil bacteria Rhizobium sp. were exposed to the low concentration of NPs. For that purpose, microorganisms were grown in nutrient media supplemented with 0.2 mM NPs. After 24 h of exposure, numbers of viable cells of both tested microorganisms were higher in the samples compared to the controls (media without NPs) for all three NPs, suggesting their stimulatory effect on the soil microorganisms' growth. The highest positive effect was observed for Rhizobium sp. treated with TiO_2 NPs (number of viable cells increased for two orders of magnitude, from ~10^6 to ~10^8 CFU/mL). Ag NPs showed the equal influence on both tested microorganisms, with dextran-coated Ag NPs were more effective. In the experiment with organic mungo beans, the same solutions of Ag NPs and TiO_2 NPs had stimulating effect on the germination and root length of this plant, also. The number of germinated seeds was the same as in the control, while the average root length was higher in the samples than in the control. The average root length was 1.47 cm in the control. Seeds treated with dextran-coated Ag NPs had the average root length even 82 % higher compared to the control. The stimulatory effect was also observed in the case of seeds treated with Ag NPs synthesized by chemical reduction and TiO_2 NPs, where the average root lengths were higher for 40% and 76 %, respectively, than in the control. Germination index values, which are higher than 100%, suggest that tested nanoparticles can be used as fertilizers in the agriculture. Moreover, the obtained results show that silver nanoparticles and titanium dioxide nanoparticles have stimulatory effect on the soil bacteria and organic mungo bean, which prove their safety for this kind of application.

***Key words**: Silver nanoparticles, titanium dioxide nanoparticles, soil microorganisms, organic bean*

SYNTHESIS AND CHARACTERIZATION OF AGAR-AGAR – CHITOSAN COMPOSITE FILMS INCORPORATED WITH GREEN SYNTHESIZED SILVER NANOPARTICLES

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Abstract

Antimicrobial properties of silver nanoparticles (Ag NPs) are well known and widely exploited. Various approaches have been applied for preparation of Ag NPs. Nowadays, „green" methods are attracting more attention since they are eco-friendly and generally cheap. Moreover, incorporation of Ag NPs into various natural polymers enables preparation of biocompatible antimicrobial materials with controlled releasing of Ag NPs. Polymeric material also provides long term stability of Ag NPs. The aim of this study was to develop antimicrobial materials based on silver nanoparticles using green approach. Reduction of silver was performed by plant extracts of horsetail (Equisetum arvense L.) and cocoa (Theobroma cacao); the obtained nanoparticles were designated as EA Ag NPs and TC Ag NPs, respectively. The effect of extract concentration on particle size distribution and antimicrobial activity against Gram-negative bacteria Escherichia coli and Gram-positive bacteria Staphylococcus aureus were investigated. The smallest particles with the narrowest size distribution (between 46 nm and 91 nm) were obtained with the lowest tested concentration (10% v/v) of plant extract for both horsetail and cacao. These samples also showed the highest antibacterial activities, so they were selected for preparation of nanocomposite films based on agar-agar and chitosan. It has been shown that incorporation of both EA and TC Ag NPs significantly improved antibacterial properties of the films against E. coli (≈80% higher inhibition in comparison to the pristine agar-agar/chitosan films). In the case of S. aures, TC Ag NPs incorporated in agar-agar/chitosan films enhanced inhibition of the film for 60%. On the other side, incorporation of EA Ag NPs into agar-agar/chitosan film increased the growth inhibition for only 20%. This might be due to the contribution of cocoa extract itself, i.e. some active components that inhibit the growth of S. aureus. Our results show that agar-agar/chitosan films with incorporated green synthesized Ag NPs have potential application in the areas where usage of biodegradable and biocompatible materials with high antibacterial activity is desired, such as food package, wound healing, coatings for medical devices etc.

Key words: *Silver nanoparticles, antibacterial activity, nanocomposite films*

PHOTOCATALYTIC ACTIVITY OF LASER SYNTHESIZED TiO_2 AND ZnO NANOPARTICLES

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Abstract

In this paper we examined the photocatalytic activityof a laser-synthesized colloidal solution of TiO_2 and ZnO nanoparticles synthesized by laser ablation in water. A photocatalytic degradation of visible and UV-irradiated Methylene Blue and Rhodamine B solutions of dfferent concentration in the presence of dfferent ZnO catalyst mass concentrations was studied in order to examine their influence on photodegradation rates. ZnO nanoparticles have shown high photocatalytic effciency in UV, which is limited due to dfferent effects related to UV light transmittivity through the colloidal solution. TiO_2 nanoparticles show high photocatalytic efficiency as compared to Aeroxide P25 using UV and visible irradiation. These findings are important for further water purification applications of laser-synthesized TiO_2 and ZnO nanoparticles.

Key words: *photocatalysis, ZnO nanoparticles, TiO_2 nanoparticles, laser synthesis of nanoparticles, Methylene Blue, Rhodamine B*

CHEMICAL ANALYSIS OF MORTAR OBTAINED BY PARTIAL SUBSTITUTION OF CEMENT FOR POWDERED CATHODE RAY TUBE (CRT) GLASS

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Abstract

Cathode ray tube (CRT) is classified as a hazardous glass waste and, as such, cannot be easily recycled. This study determines the content of environmentally dangerous metals (Cr, Pb, Ba, and Cd), as well as some common metals (Mn, Co, Ni, Cu, and Zn) in mortar materials obtained by partially replacing cement with finely ground CRT glass. Our previous investigations of chemical composition, mechanical properties and durability of these blends suggest they have a potential for application in construction. The results of this study showed that content of toxic metals in such mixtures is below the allowed limits for these metals in the leachate of waste materials. Thus, practical implementation of these mortar mixtures could lead to the reduction of hazardous waste material and cement consumption without further risk to the environment.

Key words: *mortar, cathode ray tube, chemical analysis, cement.*

SYNTHESIS OF BISMUTH OXIDE AND ITS APPLICATION FOR PHOTOCATALYTIC DECOLORIZATION OF REACTIVE BLUE 19

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Abstract

Bismuth oxide was synthesized by precipitation method and further thermal treatment at 350 ºC. Material characterization was done by XRD analysis. XRD analysis confirmed that the structure of synthesized material is β-Bi_2O_3 with crystallite size of 24.6 nm. In order to determine its photocatalytic activity, the synthesized material was applied for photocatalytic decolorization of textile dye Reactive Blue 19 (RB19). The results show that complete decolorization of RB19 solution (25.0 mg dm^{-3}) was achieved in 60 min using the obtained Bi_2O_3. Also, the obtained photocatalyst showed high efficiency in removing RB19 from the model solution of polluted river water.

Key words: *material synthesis, bismuth oxide, photocatalysis, water treatment, textile dyes, river water pollution.*

APPLICATION OF WB-ZrO_2 SORBENT FOR Cr(III) IONS REMOVAL

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Abstract

A new wood-based sorbent obtained by chemical modification of woodchips using ZrO_2 was synthetised and applied for removal of Cr(III) ions from water. The woodchips were obtained as a waste material from oak tree (Quercus robur) during furniture manufacturing. To define the optimal sorption process conditions for Cr(III) ions removal using wood-based-ZrO_2 sorbent (WB-ZrO_2), effects of pH, sorbent dose and Cr(III) concentration, were examinated. The increase in the solution pH from 1.0 to 6.0 led to a increase of removal efficiency of Cr(III) ions. The highest removal efficiency of Cr(III) ions was achieved at higher pH (pH 4 and 5) and reached 99.5%. The increase of WB-ZrO_2 dose from 0.5 to 8.0 g dm^{-3} led to an increase of removal efficiency of Cr(III) ions and optimal sorbent dose was 2.0 g dm^{-3}. With the increase of initial Cr(III) ions concentration, the removal efficiency decreases. In addition to the high removal efficiency, WB-ZrO_2 possesses other benefits, such as: mechanical stability, ease and costless synthesis, biocompatibility, which all make it excellent ecologically and economically solution for purification of polluted water by metal ions.

Key words: *wood biowaste, sorbent, ZrO_2, removal, Cr(III) ions.*

CYTOTOXICITY OF MULTIFUNCTIONAL COMPOSITES OF AMORPHOUS CALCIUM PHOSPHATE CONTAINING CHITOSAN ON TITANIUM OBTAINED BY NOVEL *IN SITU* ANODIC PROCESS

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Abstract

Calcium phosphates (CP), amongst which amorphous calcium phosphate (ACP) and hydroxyapatite (HAp), along with Ti and TiO_2 layers, have found vast applications in preventive and regenerative medicine due to their excellent biocompatibility, nontoxic properties and ability to participate in the normal metabolism of organisms. In this paper cytotoxicity of amorphous calcium phosphate (ACP) and chitosan lactate (ChOL) multifunctional and hybrid composite coatings on MRC-5 human lung fibroblast cell line is presented. ACP/TiO_2 and ACP/TiO_2/ChOL are deposited by coatings new in situ anodization/anaphoretic deposition process at constant voltage of 60 V for 180 s at 25 °C. Cytotoxicity tests showed that there was no significant decrease in the survival of healthy MRC-5 cells in the Ti and ACP/TiO_2 composite samples, while there was an increase in the number of viable cells in the ACP/TiO_2/ChOL sample. There is improved cell proliferation, differentiation and cell viability in the later. Sample containing ACP/TiO_2/ChOL coating showed negative cytotoxicity in both DET and MTT tests. Greater recovery of MRC-5 human lung fibroblasts cells was observed compared to the control sample after 48 h of recovery. From these results, it can be concluded that not only the ACP/TiO_2/ChOL multifunctional composite coating is non-cytotoxic, but the presence of ChOL in the coating improves cell proliferation, differentiation and cell viability. Based on the obtained results, it can be concluded that both composite materials used in the studies are non-cytotoxic to the cell lines used, and that 5 wt.% of ChOL has a positive effect on the non-toxicity of the material. Based on presented results in this paper and previous published results of the physicochemical and bioactive properties of the ACP/TiO_2/ChOL composite material, it can be concluded that further development as well as potential preclinical studies would be largely justified.

Key words: *cytotoxicity, dye exclusion test, colorimetric test with tetrazolium salts, amorphous calcium phosphate, chitosan oligolactate.*

MASTERING OF HEAT CORROSION - RESISTANT COATING TYPE SERMETEL AND SERMASEAL, SPECIFICS OF THE QUALITY OF SERMETEL COATINGS, PART II

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Abstract

SERMETEL and SERMASEAL are thermal and corrosion-resistant coatings resistant to engine oils, lubricants, fuels and hydraulic fluids, and as such need to be applied in order to achieve higher flight safety. These coatings are used to protect specific steel parts of the engine, with maximum temperature resistance of the coating during continuous exposure on steels with 12% Cr, 600ºC, and on low-alloy steels, 500ºC. In order to ensure the maximum protection of R / D engines, it is also necessary to provide electrical conductivity of the coating. The paper presents series specifics of heat-corrosion resistant base coatings of Sermetel type and finishing coat, Sermasel.

Key words: *spare parts, temperature-resistant coatings, specificties of coating quality*

DETERMINATION OF THE PHENOLIC PROFILE OF RED ONION SKIN EXTRACT

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Abstract

The red onion skin is the main source of antioxidants and phytonutrients that have beneficial effects on general human health. The supplements based on the extract of red onion skin significantly influence the decrease of serum levels of low-density lipoprotein cholesterol (LDL-cholesterol) and increase of high-density lipoprotein cholesterol (HDL-cholesterol). It is known that LDL cholesterol regulates blood pressure and prevents cardiovascular diseases, including arteriosclerosis and cancer. This study aimed to identify phenolic compounds in red onion skin extract that are responsible for this behavior. The extract was obtained under reflux at the boiling point of the solvent. The extraction time of 50 min, 80% (v/v) ethanol adjusted to pH 1.0, and the liquid-to-solid ratio of 65 mL/g were obtained as the optimal conditions for extraction of polyphenols from red onion skin in our previous study. The identification and quantification of polyphenols in the extract were performed using the HPLC method. The separation of the compounds was carried out on a Zorbax Eclipse XDB-C18 column using a gradient elution of the mobile phase consisted of 1% aqueous acetic acid solution and methanol. The chromatograms were acquired at three different wavelengths 254, 278, and 300 nm. Five compounds were identified and quantified in extract: gallic acid (1.91 mg/100 g dry weight, R_t = 5.38 min, λ_{max} = 278 nm), syringic acid (74.90 mg/100 g dry weight, R_t = 37.15 min, λ_{max} = 278 nm), epicatechin (26.73 mg/100 g dry weight, R_t = 41.40, λ_{max} = 278 nm), caffeic acid (310.37 mg/100 g dry weight, R_t = 31.00, λ_{max} = 300 nm) and coumaric acid (71.37 mg/100 g dry weight, R_t = 46.20, λ_{max} = 300 nm). Caffeic acid was the most abundant compound found in the extract of red onion skin. Accordingly, further investigations should be done for the isolation and purification of this phenolic compound for both medicinal and industrial uses. The main contribution of this study was the utilization of waste produced in the food industry which is significant from an ecological point of view.

Key words: *waste, polyphenols, extraction, HPLC, analysis.*

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KINETIC STUDY OF PENTAVALENT VANADIUM SORPTION ON MAGNETIC MACROPOROUS COPOLYMER OF GLYCIDYL METHACRYLATE

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Abstract

Chelating copolymers show high efficiency in sorption of different ionic species in aqueous solutions. The specific structure of chelating macroporous copolymers made by the porous matrix and functional groups with the heteroatoms N, O, S and P; allows them to establish various types of interactions with ions and molecules from the immediate surroundings. Furthermore amino-functionalized macroporous copolymer of glycidyl methacrylate and ethylene glycol dimethacrylate poli (GME) has a high capacity and good selectivity for the precious and heavy metal ions over alkali and alkaline earth metals. In this study, amino-functionalized magnetic macroporous m-poli (GME)-deta was fully characterized in terms of its structural properties using: FTIR, SEM/EDX and XRD analysis. The macroporous copolymer was further used to investigate the sorption of pentavalent vanadium oxyanions from diluted aqueous solutions (C_i = 25 ppm) in a batch system, at room temperature (298 K). The oxyanion concentrations in a solution was determined by inductively coupled plasma atomic emission spectroscopy (ICP-AES).The pseudo-first-order (PFO), pseudo-second-order (PSO), Elovich and intra-particle diffusion (IPD) models were used to analyze the kinetic data. The study has shown that sorption is rapid, i.e. the half-sorption time, $t_{1/2}$ is approximately 1 minute. Initially, it has been the dominant sorption on the surface of the particles and the process has been best described by the PSO model (which takes into account the binding between sorbate and sorbent). The moment it has reached saturation of the sorbents surface active sites, sorption rate decreases significantly because the sorption has been limited by the rate of diffusion through the pores and kinetic has been controlled by the intraparticle diffusion process. IPD kinetic model showed a good fit to the experimental data with R^2 values > 0.95.

Key words: *magnetic macroporous copolymer, amino-functionalization, vanadium sorption, kinetic study.*

ADSORPTION OF HEXAVALENT CHROMIUM FROM AN AQUEOUS SOLUTION ONTO KAOLINITE

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Abstract

This paper studies results from adsorption experiments of hexavalent chromium onto kaolinite (kaolinite mine "Motajica", Kobas, Srbac). The influence of various parameters, such as mass of adsorbent, contact time, pH of solution and temperature was examined, and the optimal experimental conditions found to be: mass of adsorbent m=0.5 g; contact time t=1 h; pH value of solution pH=3.0 and temperature t=35ºC. The removal efficiency at these parameters was 31.12%. The pH value of the solution plays a key role in the adsorption capacity of kaolinite, due to the charge of the kaolinite surface and the state of hexavalent chromium ionic species. It can be concluded that electrostatic interactions are the dominant adsorption mechanism in this study. The experimentally obtained data were analyzed using three linearized adsorption isotherm models: Freundlich, Langmuir and Temkin. It was found that the adsorption process of hexavalent chromium Cr(VI) onto kaolinite can be the best described by the Freundlich istoherm model (R^2=0.961). The value of the Freundlich constant, (K_F=0.0416 (mgg^{-1}) (mgL^{-1})$^{1/n}$)), indicates that kaolinite has a relatively low adsorption capacity to hexavalent chromium, Cr(VI), while the value of the second Freundlich constant, (n=1.2516), indicates that it is a favored adsorption. Based on the analysis of experimental results, it can be concluded that the natural clay kaolinite shows sufficient efficiency and can be used as an adsorbent to remove hexavalent chromium Cr(VI) from aqueous solution, and with possible further modification could be a very effective adsorbent.

Key words: *adsorption, kaolinite, hexavalent chromium Cr(VI), Freundlich, Langmuir, Temkin isotherm.*

STUDY OF THE CAPACITY OF NATURAL CLAYS BRARY (TIRANA) AND PEAR (KORÇA) FOR THE ADSORPTION OF DIMETHOAT AT TEMPERATURE, TIME AND DIFFERENT CONCENTRATIONS

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Abstract

In this research we have studied the adsorption of dimethoate in natural brary (Tirana) 41°21'14.49"N;19°50'17.74"E and dardha (Korça) 40°31'16.59" N; 20°49'33.69"E clays depending on time, temperature and concentration, in other words the ability of natural brary and pear clays to adsorb dimethoate has been studied. Studying the dependence of the adsorption of dimethoate on the brary clay at t = 35 ºC and contact time we have: 24h = 1. 96 mg / g; 48h = 1. 48 mg / g; 72h = 1. 29 mg / g; 96h = 1.15 mg / g; 120h = 0.612 mg / g in aqueous solutions. While in pear clay we have: 24h = 1. 26 mg / g; 48h = 1. 057 mg / g; 72h = 0. 93 mg / g; 96h = 0.780 mg / g; 120h = 0.390 mg / g in aqueous solutions. From the time of contact clay + water, it is noticed that from 2 hours to 24 hours there is no visible adsorption of dimethoate in clays and therefore as we have presented. We have oriented further studies in time intervals from 24h to 120h. Time intervals longer than 120h are of no interest because the rate of spontaneous hydrolysis of dimethoate is greatly increased, which is clearly seen in chromatograms in practice, but also from the theoretical data that well explain this phenomenon. From the experimental data, where we studied the adsorption of dimethoate on natural clays of pear and brary depending on the concentration and contact time 48h we have: the concentration of dimethoate 0.2 mg / ml in aqueous solution of brary clay the adsorbed amount of dimethoate is 0.2505 mg / g; the concentration of dimethoate 0.3 mg / ml in the aqueous solution of brown clay the adsorbed amount of dimethoate is 0.4720 mg / g; the concentration of dimethoate 0.5 mg / ml in the aqueous solution of brary clay the adsorbed amount of dimethoate is 0.8220 mg / g. Whereas the concentration of dimethoate 0.2 mg / ml in aqueous solution of pear clay the adsorbed amount of dimethoate is 0.1884 mg / g; concentration of dimethoate 0.3 mg / ml in aqueous solution of pear clay adsorbed amount of dimethoate is 0.329 mg / g; concentration of dimethoate 0.5 mg / ml in aqueous solution of pear clay the adsorbed amount of dimethoate is 0.464 mg / g.

Key words: *dimethoate, clay, brary, pear, adsorption.*

ASSESSMENT OF LIPOPHILICITY AND TOXICITY OF NOVEL ISATIN DERIVATIVES

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Abstract

The modern design of novel bioactive compounds is increasingly based on in silico studies. The synthesis of the novel compound is preceded by the examination of its bioavailability, i.e. the study of its absorption, distribution, metabolism, elimination and toxicity (ADMET). The most important molecular descriptor that is closely related to the compounds' bioavailability is lipophilicity. Lipophilicity of the selected isatin derivatives was determined by using reversed phase thin-layer chromatography (RPTLC18F$_{254s}$) in the presence of two organic modifiers (ethanol and dioxane), as well as by using appropriate software packages. The effect of the substituent's nature and position, and the applied organic modifier on the chromatographic behavior of the examined derivatives was studied. Chromatographic parameters (R_M^0, m and C_0) of isatin derivatives as asassumed measures of their lipophilicity were correlated with software obtained values of standard measure of lipophilicity, partition coefficient (logP) and selected parameters of toxicity whereby good linear dependencies were obtained (average correlation coefficient, r, 0.950 and 0.920). Thus it was confirmed that chromatographic parameters determined by RPTLC18F$_{254s}$ can be accurately and reliably applied as alternative measures of lipophilicity of and toxicity of the studied isatin derivatives. Also, it was found that the studied isatin derivatives, fulfilling Lipinski's rule, have a theoretical predisposition for good bioavailability in the organism.

Key words: *isatin derivatives, lipophilicity, chromatographic parameters, bioavailability toxicity.*

MACROCYCLIC Co(II) and Cu(II) COMPLEXES WITH ADDITIONAL DICARBOXILATE LIGANDS: ANTIMICROBIAL AND CYTOTOXIC PROPERTIES

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Abstract

Actually cancers account for one in every seven deaths worldwide. A lot of people are suffering from cancers each year and cancers continue to be the second killer of people globally now. Conventional treatment for cancers includes the use of chemotherapeutic drugs, radiation therapy and surgical treatment. As the most widely used anticancer chemotherapeutics, platinum agents, however, are hindered by systemic toxicities such as nephrotoxicity, neurotoxicity and ototoxicity as well as serious drug resistance either natural or gradually acquired to several cancers. Metal anticancer complexes are being developed to overcome drawbacks of platinum anticancer chemotherapeutics. They block DNA replication in tumor cells by interacting with DNA. Also, the design and synthesis of metal complexes, which show antimicrobial and antiproliferative activity, has been of considerable interest in recent years, because cancer patients very often have bacterial infections. In particular, macrocycle complexes of Cu(II) and Co(II) are of increasing interest in last decade. In addition, copper and cobalt macrocycle complexes with additional ligands can adopt diverse geometries with different coordination numbers. Complexes of transition metals with fully N-functionalized ligand N,N',N'',N'''-tetrakis(2-pyridylmethyl)tetraazacyclotetradecane (tpmc) are interesting in terms of their structure, stability, spectral, redox and magnetic properties. Tpmc with pendant N-donor arms can accommodate to different additional ligands in a variety of coordination ways giving stable complexes. In our investigations we used different additional ligands like aliphatic and aromatic di- and polycarboxylates. To date, macrocyclic complexes have been reported to work as compounds with cytotoxic activity toward human malignant cells and antibacterial properties. The complexes synthesized in this way were tested for antibacterial activity against Gram (+) and Gram (-) bacteria, molds and fungi. They were also determined for cytotoxic and antiproliferative activity according to human cancer cell lines: HeLa (human adenocarcinoma), K562 (chronic myelogenous leukaemia, estrogen-receptor-positive human breast cancer (MCF-7), and the human Caucasian Burkitt's lymphoma (Ramos). Cell survival was determined by MTS test, after 48 h exposure to compounds. All synthesized compounds have promoted significant decreases in the metabolic activity of the cell lines used which occurred in a dose-dependent fashion. In this paper we are presenting cytotoxic activity in vitro of Co(II) and Cu(II)-tpmc dicarboxilate complexes with succinate, adipato, glutarato, sebacinato and piromellitato additional ligands with formulas: $[Cu_4(succinato)(tpmc)_2](ClO_4)_6 \cdot C_2H_5OH \cdot 4H_2O$, $[Cu_4(glut)(tpmc)_2](ClO_4)_6 \cdot 2H_2O$; $[Cu_4(adip)(tpmc)_2](ClO_4)_6 \cdot 7H_2O$, $[Cu_4(seb)(tpmc)_2](ClO_4)_6 \cdot 6H_2O$; $[Cu_2(pma)tpmc] \cdot 8H_2O$ and $[Co_4(pma)(tpmc)_2](ClO_4)_4 \cdot 6H_2O$.

Key words: *Co(II)complex, Cu(II) complex, Tpmc, Dicarboxilate ligands, Cytotoxic activity.*

CROSS-LINKING OF STARCH OF VARIOUS BOTANICAL ORIGIN AND CROSS-LINKING DEGREE DETERMINATION

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Abstract

The use of native starches is limited, since their pastes are unstable when changing temperature or pH, retrogradate and have low transparency. Starch granules of different botanical origin are of different shape and diameter is ranging from 1 to 100 µm. The starch properties can be altered by chemical modification. Cross-linking of starch granules can be achieved by employing a widespread cross-linking agent, epichlorohydrin (EPI), and the catalyst NaOH when forming covalent intermolecular ether bonds between the hydroxyl groups of starch macromolecules. The aim of this research is to contribute to the understanding of the mechanism of cross-linking of starches of different botanical origin with epichlorohydrin at low concentrations of modifier when comparing the degree of cross-linking by employing several different characterization methods. Starches of different botanical origin, namely potato, wheat and corn were cross-linked with EPI at cross-linking agent to starch molar ratios of 0.0005:1, 0.0017:1, 0.0055:1 and 0.01:1. The degree of cross-linking was evaluated by determining the solubility in aqueous 1M KOH solution or assessing pasting properties of aqueous starch suspensions. At low degree of modification, the results of viscoamylography studies were ambiguous and not suitable for the determination of this parameter. Meanwhile, the solubility in alkali solution method can be used when determining the degree of cross-linking in wide range. Particle size analysis revealed variations in starch granules diameter which was ranging from 15.4 to 45.8. It has been revealed that the size of starch microgranules affects the extent of cross-linking and the smaller are the granules, the more cross-linking agent is required to achieve the same solubility or viscosity characteristics.

Key words : *epichlorohydrin, cross-linked starch, degree of cross-linking.*

RECOVERABLE MODIFIED STARCH SORBENTS FOR IBUPROFEN REMOVAL FROM AQUEOUS ENVIRONMENTS

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Abstract

Ibuprofen is widely used non-steroidal anti-inflammatory drug (NSAID). These drugs treat human and animal diseases in terms of analgesic, anti-inflammatory, and antipyretic actions. However, NSAIDs are also among the most detected drugs in the aquatic environment. Unfortunately, the use of traditional mechanical and biological wastewater treatment technologies results in insufficient removal of this type of contaminants. The aim of this research was to study the application of developed modified starch sorbents for ibuprofen adsorption and their regeneration.

Cross-linked cationic starch (CLCS) microgranular sorbent was obtained by the means of chemical modification of potato starch. CLCS was obtained by cross-linking potato starch with 0.1 mol/AGU (anhydroglucoside unit) of epichlorohydrin and then cationizated with 2,3-epoxypropyltrimethyammonium chloride by using various molar ratios of reagents. The starch derivatives with the degree of substitution of quaternary ammonium groups of 0.33 and 0.21 were synthesized. Sorbent granules were characterized by scanning electron microscopy, Fourier-transform infrared spectroscopy and thermogravimetric analysis.

The ibuprofen was adsorbed onto CLCS-0.33 and CLCS-0.21 microgranules from aqueous medium. The sorption capacities were 80 mg/g and 76 mg/g for CLCS-0.33 and CLCS-0.21, respectively. The regeneration of sorbents was performed by using ethanol, acetone, distilled water and sodium chloride solution of various concentration. During the regeneration process by using 0.25 mol/l sodium chloride solution by replacing adsorbed ibuprofen molecules with chloride ions best regeneration results have been achieved. After four regeneration cycles removal of ibuprofen decreased from 79 to 71 % and from 76 to 65 % using CLCS-0.33 and CLCS-0.21, respectively. Hence, modified starch sorbents are recoverable and could be potentially applied for the removal of ibuprofen from aqueous environments.

Key words: *ibuprofen, starch, sorbents.*

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IMMUNOLOGICAL REACTION TO COAL DUST IN COAL WORKERS

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Abstract

World health Organization estimates that in 2016 7.6% of people died from air pollution. Inhalation of coal dust during blasting in brown coal mines leads to the development of lung diseases caused by coal dust. It is known that cytokines play an important role as cause of these diseases. The main goal was to elucidate the immunological mechanisms of action of coal dust on the cytokine profile. A cross-sectional study was conducted between two groups of employees in the brown coal mine in Ugljevik, Republic of Srpska, Bosnia and Herzegovina. The first group was represented by employees who were exposed to coal dust, and the second by employees who were not exposed. Respondents were selected by random selection with prior informed consent. All respondents completed a questionnaire, which contained demographic and health data. Cytokine concentrations were determined in the serum of subjects using fluorescent beads labeled with anti-cytokine antibodies (Biolegend, San Diego, CA, USA) on a flow cytofluorimeter. The research included 100 respondents in the Brown Coal Mine in Ugljevik, of which 50 were exposed to coal dust and 50 were not. The majority of respondents were men (58%), while 48% of respondents were female. The production of anti and proinflammatory cytokines IL-2, 4, 5, 9, 10, 13, 17A, 17F, 21, 22 and IFN-γ was examined. It was observed that the average values of anti-inflammatory cytokines IL-6 ($p = 0.03$), IL-10 ($p = 0.02$), IL-4 ($p = 0.02$), IL-17A ($p = 0.02$), were significantly higher in the control group of subjects compared to the group exposed to coal dust. Serum concentrations of anti-inflammatory cytokines IL-6, IL-10, IL-4 and IL-17A were significantly lower in subjects exposed to coal dust compared to the control group, indicating a significant protective role of these cytokines in the formation diseases associated with coal dust.

Key words: *coal dust, coal workers.*

CANNABIDIOL CONTENT IN CANNABIS PLANT SAMPLES FROM THE ASPECT OF IMPACT ON PSYCHOACTIVE POTENTIAL

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Abstract

The Cannabis sativa L. plant contains more than 100 cannabinoids which are the characteristic ingredients of this plant. Tetrahydrocannabinol (THC) is the main psychoactive ingredient, while the effects of the others are not fully known. The psychoactive potential of cannabis preparations is usually expressed by the content of tetrahydrocannabinol, but the pharmacological effects of cannabis is a complex issue and depends on several factors. It is known that cannabidiol (CBD) has the ability to reduce the psychoactive effects of tetrahydrocannabinol. Therefore, for a more complete picture of the pharmacological properties of cannabis, the CBD content should also be considered.

Although the high content of THC and low content of CBD are characteristics of the so-called drug-type varieties of cannabis plants, it has been observed that the difference in the content of these two basic cannabinoids in illegal samples is more pronounced in recent years. More and more cannabis samples have a very high THC content and a significantly lower CBD content than in the previous period. It has also been observed that more and more samples do not contain CBD at all, which was not the case before. This trend is associated with improved methods of indoor growing cannabis plants with the aim of producing highly potent cannabis.

For a better insight into the situation in the field, the CBD content in illegal cannabis plant samples, seized in the territory of Republic of Srpska, was monitored for a long time. The results of the analyses showed that the concentration of CBD in plant samples has been declining in the last few years. Thus, until 2012, the concentration of CBD averaged about 0.5% in the dry weight of plant material, while until 2016, the CBD content fell by half, to about 0.25%. At the same time, an increasing number of samples that do not contain CBD at all were observed. Namely, until 2006, CBD was regularly present in samples, in 2007 it was noted that 3.6% of samples do not contain CBD. The number of samples without CBD continued to increase, so their share in 2013 was 6.7%, while in 2014 the number of samples without CBD increased to 17.4%. In the same period, a larger number of cannabis plant samples with a high content of THC were noticed, so it can be said that in parallel with the increase in the number of highly potent samples, the number of samples with low content or without CBD also increased.

As CBD has anti-psychotic effects, i.e. reduces the psychoactive potential of THC, consumers who use cannabis without CBD may be at higher risk, because high-potency cannabis products without CBD have the potential to be more harmful. Therefore, the United Nations Office on Drugs and Crime recommends monitoring CBD levels in addition to THC, for a comprehensive assessment of the overall psychoactive potential of cannabis.

Key words: *Cannabis sativa L., tetrahydrocannabinol, cannabidiol, psychoactive potential.*

CHARACTERIZATION OF NANOSTRUCTURES IN THE WOOD CHARCOAL OBTAINED BY TRADITIONAL DESTRUCTIVE DISTILLATION

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Abstract

Carbon nanomaterials are one of the most cited scientific topics in the last four decades. Numerous advances have been reported in different areas including nanoelectronics, battery technologies, catalysis and photocatalysis, nanomedicine, as well as some revolutionary processes in pharmaceutical, cosmetic and food industries. Because of their large surface area, adsorption potential is one of the most recognizable characteristics of carbon nanomaterials. Thus, they find applications in resolving numerous environmental issues, such as wastewater and air pollution. The production of nanosized carbon materials is usually expensive, complex and long-lasting. On the other hand, during the process of dry wood distillation, an immense mass of charcoal is produced, along with the acetic acid and number of other liquid products and side products. Commercialization of the wooden charcoal as a fossil fuel, in the past, was contributing to the whole process of economic justification. Therefore, its physico-chemical characteristics were not thoroughly studied. The main focus of this research was the characterization of charcoal from the organic chemistry and nanotechnology aspects. Moreover, the investment possibility for developing more added-value products was studied. Present international collaborative study has revealed, for the first time ever, a palette of highly developed nanostructures in the wood charcoal produced in Bosnia and Herzegovina's industry. Several sophisticated physico-chemical methods were used for detailed characterizations of raw samples and those treated with water and organic solvents in order to expand nanostructure. HR-SEM (High Resolution Scanning Electron Microscopy) imaging, FIB (Focused Ion Beam) imaging, FTIR (Fourier Transform Infrared) Microscopy, ATR-FTIR (Attenuated Total Reflection Fourier Transform Infrared) spectroscopy, and BET (Brunauer-Emmett-Teller) surface area analysis are presented and arguments for the more complex potential applications of wooden charcoal are given.

Key words: *charcoal, nanocarbon, destructive distillation, FTIR microscopy, SEM imaging, BET surface area analysis.*

IN VITRO ANTICANCER ACTIVITY STUDY ON SOME AZO PYRIDONE DYES DERIVED FROM DHPM SCAFFOLD

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Abstract

In recent years, the growing interest in the synthesis of heterocyclic azo dyes can be assigned to a versatile application and biological activities such as antibacterial, antifungal, antioxidant, analgesic, antitubercular and anticancer, of these compounds. Azo dyes based on 2-pyridone core are important since they manifest a variety of biological properties, including potency for the cancer therapy. Moreover, DHPM (3,4-dihydropyrimidin-2(1H)-on) scaffold displays a wide range of biological activities, which has led to the development of numerous drug candidates, based on this structure. Since the cancer is one of the main targets in therapeutic chemistry, we have made an effort to design azo molecules with potential anticancer activity. In this direction, we have synthesized DHPM scaffold suitable for diazo coupling reaction with different 2-pyridones, in order to design a novel series of azo pyridone molecules. The chemical structures of obtained dyes have been confirmed by ATR-FTIR, NMR, UV-Vis, MS and elemental analysis. The antioxidant activity has been evaluated by ABTS (2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid)) assay. In vitro antitumor action of DHPM precursor and related azo dyes was determined against prostate adenocarcinoma (PC-3), lung carcinoma (A549) and chronic myelogenous leukemia (K562) tumor cell lines, as well as against human normal lung fibroblast (MRC-5), using MTT (microculture tetrazolium test) assay. The physicochemical parameters, druglikeness and ADME properties of novel compounds were evaluated in silico by SwissADME. The ATR-FTIR and NMR spectroscopy confirmed that obtained dyes exist in hydrazone tautomeric form. The antioxidant assay evinced that three members of this dyes' series are promising antioxidant candidates. Examination of cytotoxic effects on human cancer cell lines showed the concentration dependent cytotoxicity of all investigated compounds. It has been noted that cytotoxic activity of investigated dyes depends on the structure of pyridone moiety since DHPM adduct expressed low cytotoxic activity against all investigated cancer cell lines. All tested cancer cell lines were the most sensitive to the cytotoxic action of compound carrying 4-phenyl group in the pyridone moiety. Furthermore, this compound was particularly prominent and selective in cytotoxic action between K562 (24.97 μM) and PC-3 (48.98 μM) cancer cells, and normal MRC-5 (91.11 μM) cells. The last but not the least, ADME evaluation in silico has shown that all investigated compounds may be orally bioavailable. Altogether, it can be concluded that designed dyes' molecules may serve for further structural modification and development of new anticancer drugs.

Key words: *hydrazone, Biginelli synthesis, antitumor action, ADME.*

TRITERPENE PROFILE AND COLOR OF DIFFERENTLY PREPARED *Ganoderma lucidum* ETHANOLIC EXTRACTS

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Abstract

Ganoderma lucidum is one of the most notable medicinal fungus, widely used for the prevention and treatment of many diseases in traditional medicine. The medicinal fungi, including G. lucidum, have a woody structure. Consequently, it is used in the form of different extracts in daily diet. The extracts of G. lucidum fruit bodies, mycelia, and spores, are a rich source of diverse groups of bioactive compounds, including terpenes, polysaccharides, and polyphenols. It has been identified more than 150 highly oxygenated lanostane type triterpenoids in the different parts of fungi so far. Generally, the extraction conditions have a strong influence on the qualitative and quantitative profiles of extracts. Thus, in order to optimize the preparation process of the G. lucidum ethanolic extract, the influence of extraction time (1, 15, and 30 days) and particle size (0.13 mm and 1 cm) on the content of triterpene was investigated. Since the color of prepared extracts has a pivotal influence on the consumers' selection, the influence of preparation condition on the color of prepared extracts was also examined. HPLC-DAD/ESI-ToF-MS analysis was used for the determination and quantification of triterpene compounds. Color measurements of G. lucidum extracts were performed using a portable tristimulus Chroma Meter CR-400 (Konica Minolta, Osaka, Japan). Following parameters were measured using a D65 light source and the observer angle of 2°: L (lightness), a* (+a* = redness, -a* = greenness), b* (+b* = yellowness, -b* = blueness), C* (chroma or saturation), and h (hue angle). The extraction parameters (particle size and extraction time) did not have a significant influence on the qualitative, but only on quantitative triterpene profiles of prepared extracts. A total of 15 compounds were quantified, demonstrating the presence of ganoderic acids (A, B, C2, C6, D, F, G, J), ganoderenic acid (D), lucidenic acids (A, E, D2, LM1), 12-hydroxy- ganoderic acid D and elfingenic acid A. Ganoderic acid A was the most abundant in all prepared extracts, in a range from 0.58 to 0.78 mg/100 g. The extraction time did not have a significant influence on the color of differently prepared G. lucidum ethanolic extract with the same particle size.*

Key words: *triterpene content, Ganoderma lucidum, color, ethanolic extracts.*

EFFECTS OF HUMIC SUBSTANCES ON THE PHOTODEGRADATION OF ALACHLOR IN UV ACTIVATED HYDROGEN PEROXIDE AND PERSULFATE PROCESSES

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Abstract

Alachlor (2-chloro-N-(2,6-diethylphenyl)-N-(methoxymethyl)-acetamide) belongs to the group of chloroacetanilide herbicides and is one of the most frequently used pesticides in agriculture. Due to the significant risk to aquatic ecosystems, and thus human health, alachlor is included in the list of priority substances under the EU Water Framework Directive (2013/39/EU). Great attention has therefore been paid to the removal of herbicide residues from the environment. In addition to hydroxyl radical based advanced oxidation processes (AOPs), more recently sulfate radical based AOPs have been extensively investigated for water treatment. This study investigates the effects of humic acids (HA), used as a surrogate for natural organic matter, on the photodegradation of alachlor in synthetic water using ultraviolet (UV) activated hydrogen peroxide (UV/H_2O_2) and persulfate - PS ($UV/S_2O_8^{2-}$) processes. Synthetic water matrices containing 4.9±0.2 mg C/l of dissolved organic carbon (DOC) and 100 µg/l of alachlor were subjected to photochemical treatment using a photochemical reactor equipped with an 253.7 nm UV low pressure mercury lamp. A slightly higher degree of alachlor degradation in the presence of HA was achieved by the $UV/S_2O_8^{2-}$ (95%) compared to the UV/H_2O_2 process (91%), probably as a result of the $S_2O_8^{2-}$ faster photolysis rate and hydroxyl and sulfate radical synergistic effect. Alachlor followed the pseudo-first order degradation kinetics which dropped significantly in the presence of HA compared to ultrapure water, indicating a strong scavenging effect of specific HA functional groups including carboxylic acids, phenols and quinines, in addition to the absorption of light by HA in the UV-C range. The proposed alachlor degradation pathway includes cleavage of the N-methoxymethyl group and N-chloroacetyl moiety, the oxidation of the aryl ethyl group, cyclization and cleavage of the benzene ring to carboxylic acids.

Key words: *photodegradation, alachlor, humic acids, UV/H_2O_2, UV/PS.*

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DETERMINATION OF THE MICROPLASTIC PARTICLE RELEASE BY TEA BAGS DURING BREWING

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Abstract

The presence of microscopic particles of plastic (MP) in food is currently an urgent problem in the modern food industry and one of the main issues of food safety. However, there are no clear methods for the determination of such particles, nor methods for cleaning food products from them.

In the present work, for the first time, the method of Dynamic Laser Light Scattering (DLS) was used to determine the plastic nanoparticles from tea bags when they were boiled in boiling water. It has been established that some of the studied samples of sachets release a huge amount of such nanoparticles into water. Moreover, hundreds of millions of nanoparticles are released per microscopic particle.

Key words*: Dynamic Laser Light Scattering, microplastic, nanoparticles, tea bags.*

APPLICATION OF NOBLE METALS MODIFIED WO_3 FOR HYDROGEN GENERATION AND CEFTRIAXONE REMOVAL UNDER THE INFLUENCE OF SIMULATED SOLAR RADIATION

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Abstract

Four photocatalysts with a different mass ratio of noble metal (NM) to WO_3 were synthesized by a photochemical reductive method. To determine the elemental composition, size and shape of photocatalyst particles, scanning electron microscopy (SEM) combined with energy dispersive spectrometery (EDS) was used. The photocatalytic efficiency of these materials, for hydrogen generation and ceftriaxone photodegradation in the presence of simulated solar radiation (SSR), was investigated. The hydrogen production rates were monitored by GC–TCD and kinetics of photocatalytic degradation of ceftriaxone were monitored by HPLC–DAD. The presence of noble metals, except platinum in the WO_3–based photocatalysts, led to a significant increase in hydrogen generation efficiency. Higher photocatalytic efficiency was found for all synthesized NM/WO_3 materials compared to the unmodified WO_3 catalyst. Chemical oxygen demand (COD) and degree of mineralization of ceftriaxone using different catalysts under SSR were also examined.

Key words: *Water splitting, Photocatalytic H_2-production, Photodegradation, Ceftriaxone, Noble metal, WO_3.*

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ENCAPSULATION OF POT MARIGOLD (*CALENDULA OFFICINALIS* L.) FLOWERS EXTRACT IN CALCIUM ALGINATE MICROPARTICLES

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Abstract

This study aimed to encapsulate the aqueous extract of pot marigold flowers in the calcium alginate microparticles. The aqueous extract prepared by ultrasound-assisted extraction had Folin-Ciocalteu reagent reducing capacity of 5.59 g GAE/100 g dry weight and half maximal inhibitory concentration of 0.096 mg/mL. The microparticles were produced using extrusion-assisted by a secondary airflow. The average particle sizes of control and encapsulated alginate microparticles were 643.7 and 789.3 µm, respectively. The moisture content of microparticles was found to be 87.4%. The FT-IR analysis showed that the chemical interactions between compounds of pot marigold flowers and alginate have not occurred. The release of antioxidants from alginate microparticles was monitored in the conditions of the simulated gastrointestinal tract at 37 °C. The higher release of antioxidants (about 70%) was noticed in the simulated conditions of the intestinal. The release of antioxidants from the microparticles was consistent with Higuchi's model. Also, the antioxidant activity of the extract was retained after its release in the gastrointestinal tract. These results suggested that alginate microparticles are a promising delivery system for water-soluble antioxidants of pot marigold flowers in pharmaceutical products.

Key words: *polyphenols, antioxidants, extraction, in vitro, release.*

STUDY OF METHYLENE BLUE REMOVAL USING TUNGSTEN(VI)-OXIDE IMMOBILIZED ON COMMERCIAL POLYVINYL CHLORIDE SUPPORT IN PRESENCE SIMULATED SOLAR RADIATION

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Abstract

In this paper, the efficiency of tungsten oxide/polyvinyl chloride (WO_3/PVC) composites with a different mass ratio of WO_3 to PVC (1%, 2.5%, and 5%) for methylene blue ($c_0=2.45\cdot10^{-5}$ mol dm^{-3}) removal in the presence/absence of simulated solar radiation was investigated. The composites were used in the form of tablets with a diameter of 5 mm and a thickness of 2 mm. The optimal mass ratio of WO_3 towards PVC, in the presence of the simulated solar radiation, was 2.5%. The contribution of adsorption and photodegradation to the total removal efficiency of methylene blue was observed. The methylene blue removal kinetics were monitored by UV/Vis spectrophotometry. The same technique was used for the determination of the COD removal efficiency. Finally, for the most efficient WO_3/PVC composite, the possibility of photo-cleaning and reusing tablets was also examined.

Key words: *Methylene blue, WO_3/PVC composite, Chemical oxygen demand, Adsorption, Photo-cleaning.*

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THE INFLUENCE OF ENVIRONMENTAL WATERS IONIC COMPOSITION ON PHOTODEGRADATION OF COMMONLY USED β-BLOCKERS IN THE PRESENCE OF UV–LED RADIATION

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Abstract

Photolytic and photocatalytic degradation of pharmaceuticals metoprolol (MET) and propranolol (PRO) was investigated in different types of environmental waters (Jegrička, "Iron water", DTD, and Topli Do) under UV–LED radiation. Obtained results in environmental waters were compared with ultrapure water (UPW). MET and PRO were not degraded in higher amounts during direct photolysis. The presence of ZnO in water solution had a strong influence on MET and PRO degradation efficiency. Also, photocatalytic degradation of both compounds was more efficient in environmental waters, compared to the UPW. This was the consequence of the presence of different ions in environmental waters. It is possible that occurs simultaneous interaction of MET and PRO with ions in water. Mineralization in the case of direct photolysis was not significant, while significantly higher mineralization was observed in the case of photocatalysis. The kinetics of photocatalytic degradation of MET and PRO were monitored by UFLC–PDA, and the ionic composition of waters and mixtures obtained after degradation was monitored by IC.

Key words: *β-blockers, Environmental water, ZnO, Photocatalysis, Ionic composition, UV–LED radiation.*

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THERMAL BEHAVIOR AND CYTOTOXIC ACTIVITY OF $[Co_2(Cl)_2\ tpmc](BF_4)_2$ COMPLEX

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Abstract

The fundamental role of cobalt and the recognition of its complexes as important bioactive compounds in vitro and in vivo aroused an ever-increasing interest in these agents as potential drugs for therapeutic intervention in various diseases. The vast array of information available for their bioinorganic properties and mode of action in several biological systems, combined with the new opportunities offered by the flourishing technologies of medicinal chemistry, is creating an exciting scenario for the development of a novel generation of highly active drugs with minimized side effects which could add significantly to the current clinical research and practice. In this paper we attempt to present some properties of the earlier isolated the first Co(II)tpm complex for which crystal structure confirmed chair conformation of macrocycle. Complex with formula $[Co_2(Cl)_2tpmc](BF_4)_2$ (tpmc = N,N′,N″,N‴- tetrakis(2-pyridylmethyl)-1,4,8,11-tetraazacyclotetradecane), was studied on thermal behaviour and cytotoxic activity against two human cancer cell lines: HeLa (human cervix adenocarcinoma) and K562 (human myelogenous leukaemia). TG-DTA analysis indicates that complex decomposition in a single step in the range of 365 -435 °C. Biological investigations show the complex has significant cytotoxic potential.

Key words: *Co(II) complex, tpmc, cytotoxic activity, thermal behavior.*

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ARMILLARIA MELLEA: IN VITRO ANTIOXIDANT AND ANTIPROLIFERATIVE EFFECTS

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Abstract

Edible mushrooms are a valuable source of nutrients and bioactive compounds in addition to a growing appeal for humans by their flavuors and culinary features. Recently, they have become increasingly attractive as functional foods for their potential beneficial effects on human health. Hence, food industry is especially interested in cultivated and wild edible mushrooms. The aim of this work was to study bioactivity of crude extracts (aqueous - AMAq and ethanol – AMEtOH) prepared from wild-growing sporocarps of edible fungal species Armillaria mellea collected in Eastern Serbia (Sikole, near Negotin). The bioactivity profile included antiradical (OH•, NO•, SO•) and antiproliferative (human breast MCF-7 cancer cell-line; MTT assay) effects. Armillaria mellea ethanolic extract exhibited the strongest activity against OH radicals (IC_{50}= 0.543 µg/mL) and NO radicals (IC_{25}=22.433 µg/mL). In comparison with AMEtOH (IC_{50} = 39.2034 µg/mL), polar extract AMAq showed slightly better anti-SO radical activity (IC_{50} = 31.848 µg/mL). The modest activities were found against MCF-7 cells AMEtOH 72 h, IC_{50} = 674.6 µg/mL and AMEtOH 24 h, 241.0µg/mL extract fractions. According to the obtained experimental data Armillaria mellea can be considered as a good source of novel and potent natural antioxidants for regular human's diet.

Key words: *Armillaria mellea, antiradical activity, antiproliferative activity.*

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CHALLENGES IN DETERMINATION OF MONILIFORMIN IN MAIZE SAMPLES BY HPLC-DAD

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Abstract

Moniliformin (MON) is a mycotoxin with low molecular weight produced by Fusarium species, mainly Fusarium proliferatum, Fusarium avenaceum, Fusarium subglutinans and Fusarim verticilloides. MON frequently detected in cereal grains such as wheat, oats, rice, rye, barley and triticale, while the highest contamination was detected in maize samples. MON generally occurs in nature as a sodium or potassium salt of 3-hydroxy-3-cyclobutene-1,2-dione, also known as semisquaric acid. The limited information available on toxicity in experimental and farm animals indicated cardiotoxicity and haematotoxicity as the main adverse health effects of MON. Existing literature data indicate that the highest percentages of analytical analyses for the determination of MON were achieved by high performance liquid chromatography with tandem mass spectrometry (LC-MS/MS) method, where its determination is mainly included in the scope of multi-components methods. Furthermore, there are only few data on the application of the high performance liquid chromatography with diode array detector (HPLC-DAD) method and other analytical methods for its determination. Due to the ionic character of MON that requires special attention during the development of the method and chromatographic separation, DAD detection is not the best choice and it showed a lower sensitivity, specificity and accuracy compared to LC-MS/MS. On the other hand, the expensive instrument (LC/MS/MS) is not affordable for every laboratory, therefore, the intention of this study was to develop an HPLC-DAD method for the detection of moniliformin in maize. An analytical principle common for HPLC-DAD analysis of MON is the application of ion-pair reagents to achieve good chromatographic separation. To fulfill this objective, we tested different extraction and clean-up protocols, two different C18 columns, one HILIC column and different chromatography conditions such as mobile phase, flow rate and injection volume. Furthermore, in this study addition of ion-pair reagent to the mobile phase was investigated, aiming at improving peak shapes and MON separation. Finally, a suitable extraction (acetonitrile/water, 84:16, v/v) without clean-up protocols provided the best MON recoveries from maize. The mobile phase was water with ion-pair reagent/acetonitrile (87.5:12.5, v/v) or water/acetonitrile (87.5:12.5, v/v) using an isocratic method, while MON was evaluated by the RP-HPLC (C18, 5µm, 4.6x250mm) column.

Key words: *maize, moniliformin, HPLC-DAD, development.*

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ANALYSIS OF HEAVY METALS IN ASHES OF WOOD BIOMASS

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Abstract

Solid and gaseous biomass fuels, such as wood biomass are the most important renewable energy source in the European Union. Wood pellets are one of the largest internationally traded solid biomass raw materials used specifically for energy purposes. Wood pellets are an easily available domestic heat and energy source. After the complete combustion of wood pellets, wood pellet ash remains as a byproduct. The amount of wood biomass ash in the world is increasing, which is a problem of pollution caused by its non-selective disposal. Therefore, the problem of pollution from ash disposal is particularly serious, as it can contain high concentrations of heavy metal. Therefore, the aim was to determine the heavy metal concentrations in the ashes of wood pellets obtained by burning wood pellets available on the market of Bosnia and Herzegovina. The heavy metal analysis was performed on the ashes of five wood pellets. The pellet combustion process was performed as follows: 1 h at 300 °C, 1 h at 400 °C, and 6 h at 550 °C. Wet digestion was performed with 65% HNO_3. The concentration of metals in the ash was determined by flame atomic absorption spectrometry (FAAS) (SpectraAA-10, AA240FS, Varian). The obtained results show that the heavy metal concentrations in the analyzed ash range from 0.11 to 1.02 mg kg^{-1} for Cd, from 0.04 to 0.84 mg kg^{-1} for Co, from 0.29 to 2.04 mg kg^{-1} for Cr, from 1.25 to 3.38 mg kg^{-1} for Cu, from 31.25 to 190 mg kg^{-1} for Fe, from 34.88 to 110.50 mg kg^{-1} for Mn, from 0.66 to 1.49 mg kg^{-1} for Ni, from 0.24 to 0.67 mg kg^{-1} for Pb, and from 5.83 to 12.84 mg kg^{-1} for Zn. The heating in B&H is based on the use of solid, conventional fuels. However, the requirements for the use of renewable energy sources have increased the share of wood biomass use. The use of wood biomass leads to an increase in incinerated waste, mainly in the form of ash. Given the above and the established heavy metal concentrations, it is necessary to investigate the assessment of potential environmental and health risks.

Key words: *heavy metals, wood biomass, FAAS.*

DETERMINATION OF ANIONS IN CRUDE RIVER WATER BEFORE DRINKING WATER TREATMENT BY ION CHROMATOGRAPHY

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Abstract

A sufficient amount of drinking water is the main condition for life, but also a danger if we do not take care of its quality. Quality water consists of a balanced composition of minerals and trace elements. In drinking water treatment plants, raw water taken from open watercourses is processed, with the addition of appropriate chemicals, into drinking water, which must comply with the applicable legal norms on the quality of drinking water. Knowledge of the physical, chemical and microbiological characteristics of raw water is of crucial importance because it is on this knowledge that the methods and techniques of purification are based.
The paper describes the qualitative and quantitative determination of anions (fluoride, chloride, bromide, sulfate, nitrate, and phosphate) by ion chromatography in samples of untreated, raw water of the Sava and Danube rivers used by the Belgrade water supply system. The analysis in the tested water samples showed that the concentration of the tested anions (Cl^-, Br^-, NO_3^-, SO_4^{2-} and PO_4^{3-}) is within the limits prescribed by the Ordinance on the hygienic safety of drinking water. Such good quality of raw water can be further improved after the final treatment - which is important for drinking water.

Key words: *raw water, anions, ion chromatography.*

COMPUTATIONAL STUDY OF AMILORIDE – A WADA BANNED MOLECULE

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Abstract

Amiloride (AMI) is a representative of diuretics. Among other purposes, it is utilized for high blood pressure or swelling induced by heart failure. While it is identified as one of the safest medicines available, it is also listed in the World Anti-doping Agency's list of substances banned in sport, because it is considered a masking agent. Since it has been abused in sports, methods have been developed to be able to detect it during doping controls. We have computationally investigated selected structural and reactive properties of the AMI molecule in this work, employing density functional theory calculations.

Key words: *amiloride, DFT, reactivity, structure.*

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APPLICATION OF PROTON TRANSFER MASS SPECTROSCOPY FOR DETECTING THE DEGREE OF ORGANIC RESIDUES DECOMPOSITION

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Abstract

Volatile organic compounds in the air (VOC) are formed as an inevitable product in the process of decomposition of organic tissue, primarily caused by bacteria. However, in order to fully describe the process in a particular situation, it is necessary to find an adequate analytical method that can precisely and quickly identify bacteria responsible for the production of detected VOC and also to link the duration of the decomposition process to the concentration of produced compounds. Proton transfer mass spectroscopy (PTR-MS) is a widely used mass spectroscopy technique developed for the real-time detection of VOC. In medicine, applications of PTR-MS are numerous, including breath analysis, urine analysis, in vivo analysis of human skin, etc. The idea behind this research is to test the possibility to employ the PTR-MS for forensic investigations of tissue decomposition, i.e., to provide a reliable data-based estimate of the post-mortem interval of a corpse buried in the ground after the murder. In the experiment, we analysed pork samples stored in the soil of known chemical and mineral composition. The PTR-MS measurements were performed before the sample storage and consecutively in several time points up to thirty eight days after. As the PTR-MS detects molecules' mass/charge ratio (their molecular mass plus 1), we first identified the compounds that can be used as indicators of the decay process. From the results obtained, we monitored concentrations of volatile organic compounds of several molecular weights over time and linked the masses to particular by-products of a certain group of bacteria significant for the tissue decay process. The overall results showed that PTR-MS could identify specific bacteria from the mass spectroscopy results and also to provide an accurate determination of the time-interval the buried tissue spent in the ground.

Key words: *PTR-MS, VOC, bacteria, tissue samples, soil, forensic method.*

AN OVERVIEW OF CERTIFIED MANAGEMENT SYSTEMS IN THE REGION AREA

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Abstract

It is known that in the last five years there have been significant revisions of most international standards, as well as, the publication of new series of standards. In this regard, organizations had the opportunity to adapt their business policies, practices and documentation to the new requirements of the standards. Certified management systems may provide preconditions for increasing the activities of economic subjects in the surrounding countries and their export potential, which is directly correlated with the number but also the type of certified management systems. Based on the practical experiences of the authors, it is especially important to emphasize the need of an organization to integrate different management systems with different requirements of standards. Namely, the integration of these systems can still be a challenge in practice, which can ultimately lead to the determination of management to establish and certify such a management system. Although a sufficient transition period has been provided for harmonization, due to dynamic changes in the business environment of the region, there have been significant changes in trends in terms of certified management systems. In this paper, the authors provide an overview of the general concept, current situation, as well as quantitative analysis of organizations with a certified management system in the region in the context of the latest published data of the International Organization for Standardization (ISO), including the number, types and trends of certified management systems in the region. Based on the above, appropriate observations, conclusions as well as recommendations regarding the improvement of the current situation and the number of certified management systems in the region were presented.

Keywords: *certification, system, standard.*

THE ANALYSIS OF EFFICIENCY OF JET VENTILATION IN CASE OF SMOKE DRAINAGE FROM GARAGE

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Abstract

Garages are facilities that, due to their location, specific fire load, ventilation and other factors, represent a challenge for all those who deal with fire protection. The causes of fires in these facilities are mainly the consequences of vehicle malfunctions or possible work on vehicles. Due to the presence of flammable materials on vehicles (plastic, rubber, textiles,) and flammable liquids, as a fuel for vehicles, possible fires in underground garages spread quickly, and there is a danger of possible explosions. Due to poor ventilation of the space, and high smoke and high temperature, the actions of extinguishing and rescuing in these facilities are very complex. The conventional method of ventilation and smoke extraction of such spaces implies the installation of ventilation supply and exhaust ducts around the room and the blowing and extraction of air at certain points. As it is necessary to keep the air speed in these lines within certain minimum limits, and considering the relatively large amount of air that needs to be brought in and out during the fire, these are large ventilation ducts and take up a lot of space. This method of ventilation often has a lot of disadvantages that make it difficult or impossible to install. That is why a new concept has been developed - IMPULSE (JET) ventilation. The system uses a different approach than the conventional one and is based on the thrust principle. JET fans, arranged on the ceiling of the parking lot, blow out the air at a relatively high speed and transfer all the energy to the surrounding air and accelerate it. With the correct arrangement of JET fans, it is achieved that the entire air mass of the parking space gets controlled movement in the desired speed range. The paper presents an analysis of JET fans and with possible improvement of work efficiency in order to better prevent fire protection.

Key words: *garage, ventilation, fire protection.*

THE IMPACT OF FLOOD ON THE MULTI-RISK ASSESSMENT IN THE MUNICIPALITY OF SMEDEREVO

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Abstract

A flood is an overflow of water that submerges land that is usually dry. Floods are an area of study in the discipline of hydrology. They are the most common and widespread natural severe weather event. Floods can look very different because flooding covers anything from a few inches of water to several feet. They can also come on quickly or build gradually. There are five types of floods: River Flood, Coastal Flood, Storm Surge, Inland Flooding and Flash Flood. As you can infer from the list above, flooding can happen anywhere, including both coastal and inland locations. In the urban area and in the wider vicinity of Smederevo, where loose and irresistible lake sediments are present, there are typical examples of landslides, which, according to the dynamics of movement and surface, are among the largest landslides in Serbia. Therefore, it is important to correctly calculate the multi-risk in order to anticipate adequate organizational and technical measures for the preservation of the ecological equilibrium. Therefore, it is necessary to carry out a multi-risk assessment, which in principle acts and processes, with a specific example of assessment. The paper made a multi-risk assessment for the municipality of Smederevo, which had a major problem with floods and erosions in the past, using GIS.

Key words: *multi-risk assessment, floods, erosions, prevention.*

EFFECT OF WELDED JOINT IMPERFECTION ON THE LOAD-CARRYING CAPACITY OF PIPE ELBOWS SUBJECTED TO IN – PLANE BENDING MOMENT

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Abstract

The main objective of this study is to analyse the influence of welded joint imperfection on the load carrying capacity of the pipe elbows subjected to in-plane bending moment. The defects in pipe elbows can, depending on their size and position, affect the integrity and safe service, as well as deformation ability of the piping systems in exploitation. Incompletely filled groove, which is the type of defect examined here, was observed by ultrasonic measurement on the pipeline in the regulation system of the hydro power plant Đerdap. Three-dimensional finite element analysis is performed using Simulia Abaqus software package. First, the models with dimensions of the defects observed by non-destructive examination are formed. Stress and strain fields for different loading types are shown and commented. The influence of the defect dimensions on the pipe elbow load-carrying capacity is determined through plastic collapse loads, which are obtained from diagrams bending moment - rotation angle. Twice elastic slope (TES) technique is applied. Additionally, some more severe defects are considered, in the form of sharp pre-cracks at the bottom of the defect; plastic collapse loads are also determined for these geometries. Both opening and closing bending moment are taken into consideration and results are discussed and compared with two closed-form solutions from the literature. The influence of the boundary conditions applied for examination of the pipe elbows is commented.

Key words: *Pipe elbow, Incompletely filled groove, In-plane bending moment, Finite element method, Plastic collapse load.*

DISTRIBUTION OF THE LAND FACTOR TRANSFER - WOODEN PERIODIC PLANTS IN PCINJA DISTRICT

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Abstract

This paper presents the results of testing the transfer factors in the food chain of soil-woody perennial crops (bull, oak, mulberry, acacia, apricot, plum) in the Pcinja district. Transfer factors, as a quantitative measure of the process for all analyzed samples of woody perennial crops, were significantly lower by ^{226}Ra than by ^{232}Th and ^{40}K. The results of transfer factors showed that in some of the cereals in the Pcinja district, the ratio of the given radionuclides is harmonious and is most pronounced for the radionuclide ^{40}K. The aim of this paper was to obtain the first results of the transfer of land-cereal factors, which would be of great importance for farmers producing these types of cereals in this region.

Key words: *Transfer factor, radionuclides, soil, woody perennial crops.*

EATING HABITS OF RESIDENTS OF THE EASTERN PART OF THE REPUBLIC OF SRPSKA

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Abstract

Nutrition is a significant factor in the life every person, which has an impact on health throughout the life of an individual. Food provides the energy needed for growth, physical activity and physiological functions (e.g. breathing, body temperature control, mental work, circulation, digestion). Food contributes to the maintenance of physical and mental fitness, and improves resistance to disease. Given the link between diet and health and the increasing incidence of chronic non-communicable diseases, regardless of age, knowledge of proper eating habits in the context of dietary standards is essential to achieve optimal quality of life, especially among young people, who are the focus of this research. The main goal of this paper is to examine the eating habits of people in the eastern part of the Republic of Srpska, in age span from 10 to 30 years. Survey questionnaire (twenty-four-hour nutrition survey), specially constructed for this research, and an interview were used as research instruments. Based on available anthropometric measures of the respondents from the data in the surveys, the BMI index (Body Mass Index) was determined in order to determine the degree of nutrition.

Key words: *balanced nutrition, twenty-four-hour nutrition surveys, interview, Body Mass Index.*

HEALTH RISK ASSESSMENT BASED ON HEAVY METALS POLLUTION OF WOOD BIOMASS ASH

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Abstract

Biomass from the wood industry, such as wood waste and wood residues, has been an unused potential in the past. However, recently wood waste and wood residues have been used to produce particularly current forms of wood biomass: pellets and briquettes. The trend towards using wood biomass as a renewable energy source has led to an increase in the quantity of wood biomass ash produced as waste. This study aimed to assess health risks due to the content of heavy metals in the ash of wood biomass from Bosnia and Herzegovina. The analysis of wood biomass ash pollution was performed on the ash obtained by burning ten samples of wood pellets available on the Bosnian and Herzegovina market. After the analysis of the measured content of heavy metals: Mn, Ni, Co, Cd, Pb, Zn, Cu, and Cr, the values for the hazard coefficient (HQ) and the non-carcinogenic hazard index (HI) were calculated. The health risk was calculated for three main pathways of exposure to wood pellet ash: ingestion, inhalation, and dermal. The general exposure equations used in this study have been adjusted following the guidelines of the US Environmental Protection Agency. The obtained results show that the values for HQ_{ing} range from $2.19 \cdot 10^{-5}$ for Co to $6.66 \cdot 10^{-3}$ for Mn, HQ_{inh} range from $1.29 \cdot 10^{-7}$ for Cu to $9.24 \cdot 10^{-7}$ for Co, HQ_{der} range from $8.25 \cdot 10^{-7}$ for Co to $3.54 \cdot 10^{-3}$ for Cd. The highest value of HI for adults was calculated for the ingestion ($1.03 \cdot 10^{-2}$), followed by dermal contact ($4.80 \cdot 10^{-3}$), and the inhalation pathway has the lowest values ($1.77 \cdot 10^{-6}$). For adults, our results showed that the total hazard index HI for non-carcinogenic substances was $1.51 \cdot 10^{-2}$. The ingestion pathway posed the highest risk, followed by dermal contact and the inhalation pathway posed the lowest risk. Regarding total non-carcinogenic risk for adults, it has a value less than 1 (HI<1), which shows that there is a very low non-carcinogenic risk for heavy metals in the ash formed by burning wood biomass, and do not pose a danger to adults.

Key words: *wood biomass, ash, heavy metals, health risk.*

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