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SPECIFIČNOSTI REGULISANJA RADA SUŠARA ZA ZRNO KONTINUALNOG TIPRA

Mirko BABIĆ, Ljiljana BABIĆ

Univerzitet u Novom Sadu, Poljoprivredni fakultet Novi Sad, Trg Dositeja Obradovića 8

E-mail: mbab@polj.uns.ac.rs

Regulisanje rada ili kontrola procesa može biti i jednostavan, ali i složen zadatak za inženjere koji se bave time. Sušenje zrnastih poljoprivrednih proizvoda u sušarama kontinualnog tipa je zahtevan zadatak. Pri ovom tehnološkom postupku glavna regulisana veličina je vlažnost materijala na izlazu iz sušare, ali su bitne kontrole i drugih parametara rada koji mogu bitno uticati na kvalitet proizvoda. To su pre svega temperature vazduha (agensa) za sušenje i sama temperatura materija koji se suši, tokom procesa i na izlasku iz postrojenja. Dominantni tip kontinualne sušare je vertikalna gravitaciona sušara sa krovčićima kao ispunom, mada je još uvek u Srbiji u primeni i veliki broj istorijskih sušara sa ispunom u obliku saća. U sušarama sa „saćem“, pored konvektivnog, prisutan je i konduktivni vid razmene toplote. Bez obzira na ovo, razlike u kinetici sušenja nise velike, je se u analizi i izboru tehnike kontrole procesa mora voditi računa o vremenskim parametrima kinetike sušenja. Ova kinetika je veoma istraživana i opisivina u velikom broju literaturnih izvora. Specifičnost prenosnih funkcija procesa sušenja je značajno prenosno vreme kao i vreme zaleta. Ako se izazove skokoviti poremećaj vlažnosti zrna na ulazu u sušaru potrebno je dosta vremena da se počne enajti vlažnost na izlazu iz sušare. Promena sadržaja vlage na izlazu iz sušare nije skokovita, zbog opisanog karaktera prenosne funkcije.

Duga tradicija rukovanja sušarom bez automatske kontrole generisala je dobro iskustvo kod rukovaoca sušara. Dobar rukovaoc pažljivo prati promene vlažnosti i na ulazu i na izlazu, ali i na kraju zone sušenja, kako bi kvalitetno i na vreme uticao na regulisanu veličinu. Neadekvatno rukovanje dovodi do presušivanja ili, još gore, do nedovoljno osušenog zrna i naknadnih ozbiljnih problema zbog toga. Pored nepotrebnog utroška energije i presušeno i ne dosušeno zrno su faktori pogoršanja kvaliteta.

Savremeni tehnički sistemi treba da „imitiraju“ dobre rukovaoca sa iskustvom. Naime, „pametni“ regulatori (kontroleri) su uređaji koji nelinearnim dejstvom (kombinacija proporcionalnog, integralnog i diferencijalnog dejstva), koristeći dostignuća fazi logike (neuronskih mreža) mogu kvalitetno da zamene rukovaoca u priličnoj meri. Ali, rukovaoc mora da bude uz sušaru i u slučaju ovakvih sistema, kako bi se izbegli rizici grešaka i neidealnosti startovanja i zaustavljanja rada sušare. Isto tako, sve diskontinualnosti tehnoloških parametara uzrokovane spoljnjim dejstvima mogu dovesti do finansijskih gubitaka, ako nema rukovaoca da to primeti i interveniše.

Ključne reči: automatska regulacija, sušare za zrno, sušenje, rukovanje sušarom

THE CONTROL PROCESS SPECIFICITIES OF THE CONTINUOUS TYPE GRAIN DRYERS

Mirko BABIĆ, Ljiljana BABIĆ

University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, Novi Sad, Serbia

E-mail: mbab@polj.uns.ac.rs

The process controlling can be a simple and a complex task for the engineers involved. Grain drying of agricultural products in dryers of the continuous type is a demanding task.

In this technological procedure, the main regulated value is the moisture content of the material at the outlet of the dryer, but there are important controls and other operating parameters that can significantly affect the quality of the product. These are primarily the temperatures of the air (drying agent) and the temperature of the material to be dried, during the process and at the exit from the plant. The dominant type of continuous dryer is the vertical gravity dryer with foof ducts as a filling, although a large number of historical dryers with a „honeycomb“ filling are still in use in Serbia. In dryers with "honeycomb", in addition to convective, there is also a conductive type of heat exchange. Regardless of this, the differences in the drying kinetics are not large, the analysis and selection of the process control devices must take into account the time parameters of the drying kinetics. This kinetics is highly researched and descriptive in a large number of literature sources. The specificity of the transfer functions of the drying process is the significant transfer time as well as the take-off time. If a sudden disturbance of grain moisture content is caused at the entrance to the dryer, it takes a long time to start changing this value at the exit of the dryer. The change in the moisture content of the dryer effluent is not abrupt, due to the described character of the transfer function.

A long tradition of the dryer handling without automatic control has generated a good experience for the dryer operators. A good operator carefully monitors changes in moisture content at both the inlet and outlet, but also at the end of the drying zone, in order to qualitatively and timely affect the regulated values. Inadequate handling leads to drying out or, worse, to insufficiently dried grain and subsequent serious problems due to that. In addition to unnecessary energy consumption, both dried and not dried grain are factors of deteriorating quality.

Modern technical systems should "imitate" good managers with experience. Namely, "smart" regulators (controllers) are devices that by non-linear action (combination of proportional, integral and differential action), using the achievements of fuzzy logic (neural networks) can qualitatively replace the operator to a large extent. However, the operator must be with the dryer in the case of such systems, in order to avoid the risk of errors and non-ideals of starting and stopping the dryer. Also, all discontinuities of technological parameters caused by external actions can lead to financial losses, if there is no operator to notice and intervene.

Key words: automatic control, grain dryers, drying, dryer handling

**EKONOMSKI OPTIMALNA PRIMENA FOTONAPONSKIH ELEMENATA
U POLJOPRIVREDI: NEMAČKA I SRBIJA***Ilija BATAS BJELIC**Institut Tehničkih Nauka SANU, Knez Mihailova 35/IV, 11000 Beograd, Srbija**E-mail: ilija.batas-bjelic@itn.sanu.ac.rs*

Tematika primene fotonaponskih elemenata u poljoprivredi prvi put se spominje u istraživanjima u Nemačkoj 1982. godine, dok se na prostoru Srbije prvi radovi pojavljuju već 1986. godine. Ideja primene je varirala od države do države sa vremenom i padom cena panela. U jednom periodu dok je cena panela bila visoka akcenat je bio na optimalnom pozicioniranju panela na najboljim lokacijama, što je dovelo do konflikta sa poljoprivrednom proizvodnjom. Sa padom cene panela, i pojavom dvostranih panela otvaraju se mogućnosti za vertikalno pozicioniranje ali i povećanje razmaka između redova kako bi se poljoprivredna proizvodnja nesmetano obavljala. Poslednja istraživanja pokazuju da je na ovaj način moguće povećati i poljoprivrednu proizvodnju i obezbediti dodatne količine električne energije za poljoprivredu. Dodatne količine energije za poljoprivredu mogu biti iskorišćene za produžavanje osvetljenosti biljaka, ali i ostale delatnosti navodnjavanje, grejanje, hlađenje, transport, proizvodnja organskog gnojiva itd. Stoga se odustalo od prvobitnih ideja, tj. umesto da se energija proizvodi na račun poljoprivrede, ideja je da se poveća proizvodnja na račun optimalnog iskoriscenja sunca. Ovo je od posebnog značaja u situaciji finansijskog pritiska na sektor poljoprivrede usled energetske šokova (2021-2022. godine) koji su doveli do povećanja cene sirove nafte. Takođe očekuje se da troškovi ugljenično intenzivne poljoprivrede budu rasli uz primenu mera prekogranične kontrole i oporezivanja emisija. U radu će biti prikazano stanje u oblasti inovativne primene fotonaponskih elemenata u poljoprivredi kroz pregled najznačajnijih publikacija i predložiti najpodesniji koncept ekonomski optimalnog iskoriscenja sunčeve energije na studijama slučaja Nemačke i Srbije.

Ključne reči: fotonaponski elementi, poljoprivreda, optimizacija

UTJECAJ TEHNOLOGIJE PULSIRAJUĆEG ELEKTRIČNOG POLJA NA STABILNOST POLIFENOLA U SOKOVIMA OD JAGODA

Anica BEBEK MARKOVINOVIĆ, Višnja STULIĆ, Luka BATUR, Predrag PUTNIK, Tomislava VUKUŠIĆ, Zoran HERCEG, Boris DURALIJA, Sandra ZAVADLAV, Danijela BURSAC KOVAČEVIĆ
Prehrambeno-biotehnološki fakultet, Sveučilište u Zagrebu, Pierottijeva 6, 10000 Zagreb, Hrvatska
Odjel za prehrambenu tehnologiju, Sveučilište Sjever, Trg Dr. Žarka Dolinara 1, 48000 Koprivnica,
Hrvatska

Veleučilište u Karlovcu, Odjel za prehrambenu tehnologiju, Trg J. J. Strossmayera 9, 47 000 Karlovac,
Hrvatska;

Agronomski fakultet, Sveučilište u Zagrebu, Svetošimunska cesta 25, 10000 Zagreb, Croatia

E-mail: dbursac@pbf.hr

U novije vrijeme potrošači sve više potražuju kvalitetnu hranu i prehrambene proizvode koji pozitivno utječu na zdravlje, stoga se povećala potražnja za funkcionalnom hranom. Jagoda se zbog svog nutritivnog i biološkog sastava može smatrati funkcionalnom hranom. No, zbog kratkog roka trajanja obično se konzumira svježa, no sve je veći interes i za sokove od jagoda. Sokovi se obično konzerviraju termalnim tehnologijama iako primjena visokih temperatura tijekom tretmana negativno utječe na nutritivnu kvalitetu hrane. Zbog toga je razvoj i primjena tehnologija netermalne obrade, kao što je pulsirajuće električno polje (PEF) privukao veliku pozornost. Cilj ovog istraživanja bio je istražiti učinke PEF tehnologije na sadržaj topljive suhe tvari (SSC), pH vrijednost i stabilnost polifenola u sokovima od jagoda tijekom sedam dana skladištenja na 4 °C. Sok je pripremljen od svježih plodova jagoda (*Fragaria x ananassa* Duch.) sorte 'Albion', koji su ubrani u 75 %-tnoj (J1) i 100 %-tnoj (J2) zrelosti. Parametri PEF tretmana bili su: (i) jakost električnog polja (40 i 50 kV), (ii) frekvencija (100 i 200 Hz) i (iii) vrijeme tretiranja (3 i 6 min) uz trajanje pulsa 0,5 μs. Svi rezultati analizirani su multifaktorskom analizom varijance ($p \leq 0,05$). Ukupni sadržaj polifenola (TPC) određen je Folin Ciocalteu spektrofotometrijskom metodom. Kontrolni (netretirani) uzorci soka od jagode J2 imali su značajno veći udio SSC, značajno viši pH i značajno niži TPC u usporedbi s kontrolnim uzorcima soka od jagoda J1. Skladištenje kontrolnih uzoraka soka od jagode na temperaturi od 4°C tijekom sedam dana rezultiralo je značajnim smanjenjem SSC i pH te značajnim povećanjem TPC. PEF sokovi od jagode J1 imali su značajno niže vrijednosti SSC i pH od PEF sokova od jagode J2. Tretirani uzorci sokova iz obje zrelosti skladišteni na 4°C tijekom sedam dana imali su značajno niži SSC, dok se pH vrijednosti nisu značajno razlikovale u odnosu na sokove nultog dana skladištenja. Jačina električnog polja od 50 kV pokazala se kao jedini signifikantan parametar PEF tehnologije koji je utjecao na značajno povećanje TPC-a u usporedbi s jakosti od 40 kV. PEF-tretirani J1 uzorci imali su značajno veći TPC od J2. Bez obzira na zrelost, skladištenje tretiranih uzoraka na temperaturi od 4°C tijekom sedam dana rezultiralo je statistički značajnim povećanjem TPC-a. Općenito se može zaključiti da PEF tehnologija pozitivno utječe na stabilnost TPC-a u sokovima od jagoda tijekom sedam dana skladištenja na 4°C, te da su i jagode niže zrelosti pogodne za proizvodnju funkcionalnih voćnih sokova.

Ključne riječi: PEF, polifenoli, sok od jagode, stupanj zrelosti

EFFECT OF PULSED ELECTRIC FIELD TREATMENT ON POLYPHENOLS STABILITY IN STRAWBERRY JUICES

Anica BEBEK MARKOVINOVIĆ, Višnja STULIĆ, Luka BATUR, Predrag PUTNIK, Tomislava VUKUŠIĆ, Zoran HERCEG, Boris DURALIJA, Sandra ZAVADLAV, Danijela BURSAĆ KOVAČEVIĆ
Faculty of Food Technology and Biotechnology, University of Zagreb, Pierottijeva 6, 10000 Zagreb, Croatia

Department of Food Technology, University North, Trg Dr. Žarka Dolinara 1, 48000 Koprivnica, Croatia

Karlovac University of Applied Sciences, Department of Food Technology, Trg J. J. Strossmayera 9, 47 000 Karlovac, Croatia;

Faculty of Agriculture, University of Zagreb, Svetošimunska cesta 25, 10000 Zagreb, Croatia
E-mail: dbursac@pbf.hr

Nowadays, consumers are increasingly looking for high-quality foods and food products that have positive impacts on health. Therefore, the demand for functional foods has also increased. Strawberry can be considered as a functional food due to its nutritional and biological composition. However, due to its short shelf life, it is usually consumed fresh, nevertheless, there is also growing interest for their juices. Juices are usually preserved by thermal technologies although the application of high-temperature treatments negatively affects the nutritional quality of the food. For this reason, the development and application of non-thermal processing technologies, such as a pulsed electric field (PEF), has attracted much attention. The aim of this study was to investigate the effects of PEF technology on soluble solids content (SSC), pH, and stability of polyphenols in strawberry juice during seven days of storage at 4 °C. Juice was prepared from strawberries (*Fragaria x ananassa* Duch.) cultivar 'Albion', whose fruits were harvested at 75 % (J1) and 100 % (J2) maturity. The parameters of the PEF treatment were: (i) electric field strength (40 and 50 kV), (ii) frequency (100 and 200 Hz), and (iii) treatment time (3 and 6 min) with pulse duration 0,5 μs. All results were analyzed by multifactorial analysis of variance ($p \leq 0.05$). Total polyphenolic content (TPC) was determined by the Folin Ciocalteu spectrophotometric method. The control (untreated) samples of strawberry juice J2 had significantly higher SSC, significantly higher pH, and significantly lower TPC compared to the control samples of strawberry juice samples J1. Storage of the control samples of strawberry juice at a temperature of 4°C for seven days resulted in a significant decrease in SSC and pH, and a significant increase in TPC. Treated samples of strawberry juice J1 had significantly lower SSC and pH than treated samples of strawberry juice J2. Treated juice samples of both ripeness levels stored at 4°C for seven days had significantly lower SSC, while pH values were not significantly different from the first day of storage. The electric field strength of 50 kV proved to be the only statistically significant parameter of the PEF technology that led to a significant increase in TPC, as compared to the 40 kV strength. PEF-treated J1 samples had significantly higher TPC than J2. Regardless of maturity, storage of treated samples at a temperature of 4°C for seven days resulted in a statistically significant increase in TPC. In general, it can be concluded that PEF technology positively affects the stability of TPC in strawberry juices during seven days of storage at 4°C, and that strawberries with lower ripeness are also suitable for the production of functional fruit juices.

Key words: PEF, polyphenols, strawberry juice, ripeness stage

PLOD MAGINJE (*Arbutus unedo* L.) KAO VRIJEDAN SASTOJAK ZA PROIZVODNJU FUNKCIONALNE HRANE

Anica BEBEK MARKOVINOVIĆ, Dario LASIĆ, Karlo JURICA, Irena BRČIĆ KARAČONJI, Dora BRDAR, Adela KRIVOHLAVEK, Martina IVEŠIĆ, Ivana MANDIĆ ANDAČIĆ, Iva PALAC BEŠLIĆ, Predrag PUTNIK, Danijela BURSAĆ KOVAČEVIĆ

*Nastavni zavod za javno zdravstvo “Andrija Štampar”, Mirogojska 16, 10000 Zagreb, Hrvatska
Prehrambeno-biotehnološki fakultet, Sveučilište u Zagrebu, Pierottijeva 6, 10000 Zagreb, Hrvatska
Odjel za prehrambenu tehnologiju, Sveučilište Sjever, Trg Dr. Žarka Dolinara 1, 48000 Koprivnica, Hrvatska*

Ministarstvo unutarnjih poslova Republike Hrvatske, Ulica grada Vukovara 33, 10000 Zagreb, Hrvatska

*Institut za medicinska istraživanja i medicinu rada, Ksaverska cesta 2, 10000 Zagreb, Hrvatska
Fakultet zdravstvenih studija, Sveučilište u Rijeci, Viktora Cara Emina 5, 51000 Rijeka, Hrvatska*

E-mail: pputnik@alumni.uconn.edu

Hrvatska ima dugu tradiciju u voćarstvu zbog svog zemljopisnog položaja, klimatskih uvjeta i visoke kvalitete voćarskih kultura. Autohtone sorte voćaka odlikuju se dobrim morfološko-pomološkim svojstvima, ali je njihov nutritivni i biološki potencijal nedovoljno istražen. Plodovi stabla planike (*Arbutus unedo* L.) nedovoljno su cijenjena voćna vrsta u Hrvatskoj, čiji potencijal za uzgoj i konzumaciju još nije dovoljno iskorišten. Nasuprot tome, mogu se smatrati izvrsnom sirovinom za proizvodnju funkcionalne hrane koja je u sve većoj potražnji od strane potrošača. Cilj ovog istraživanja bio je istražiti kemijsku i biološku vrijednost plodova maginje sakupljenih u listopadu 2021. godine na otoku Malom Lošinju u Hrvatskoj. Od kemijskih svojstava određen je sadržaj topljive suhe tvari (SSC), pH vrijednost, ugljikohidrati, lipidi, bjelančevine, sirova vlakna, energetska vrijednost i udjeli šećera. Od bioaktivnih spojeva analiziran je sadržaj ukupnih fenola (TPC), ukupnih flavonoida (TF), antocijana (ANT), hidrokscimetnih kiselina (HCA), flavonola (FL) i kondenziranih tanina (CT). Dobiveni rezultati pokazali su da uzorci ploda maginje sadrže visok udjel topljive suhe tvari (38 %), te da imaju pH 4,6, dok je udio ugljikohidrata iznosio 30,28 g/100 g, udio lipida <0,5 g/100 g, udio bjelančevina 0,67 g/100 g, udio sirovih vlakana u 6,43 g/100 g, uz energetska vrijednost od 136,7 kcal/100 g. Određivanje sastava šećera HPLC-om pokazalo je da je fruktoza prevladavajući šećer (8,79 g/100 g), kojeg slijedi glukoza u gotovo dvostruko nižem udjelu (4,36 g/100 g). Ostali šećeri, poput saharoze, laktoze i maltoze, pronađeni su u udjelima ispod limita kvantifikacije (< 0,35 g/100 g). Rezultati određivanja bioaktivnih spojeva također su pokazali da je plod maginje izvrstan izvor različitih bioloških spojeva. Sukladno tome, TPC je određen u koncentraciji 524,69 ±10,64 mg GAE/100 g. Među svim bioaktivnim spojevima CT su pronađeni u najvišim udjelima (39 %), a slijede ih HCA (6,3 %). Štoviše, rezultati su pokazali da su derivati HCA šire rasprostranjeni od derivata flavonoida, jer su TF određeni u udjelu od 2,6 %. Antocijani odgovorni za crvenu boju ploda maginje određeni su u koncentraciji od 6,00 mg Cyd-3-gal/100 g. Budući da su CT dominantna podskupina fenolnih spojeva u plodu maginje, ne čudi da su FL kao monomerne jedinice također određene u većoj koncentraciji od antocijana (12,58 g QE/100 g). Iz dobivenih rezultata može se zaključiti da je plod maginje izvrсна sirovina koja nije dovoljno istražena i iskorištena za preradu. Dobra kemijska svojstva ploda maginje upućuju na to da se može dodavati i raznim funkcionalnim proizvodima kao dodatak, na primjer u 3D ispisu hrane.

Ključne riječi: plod maginje, *Arbutus unedo* L., funkcionalna hrana, kemijski sastav, bioaktivni spojevi

STRAWBERRY TREE FRUIT (*Arbutus unedo* L.) AS A VALUABLE INGREDIENT FOR FUNCTIONAL FOOD PRODUCTION

Anica BEBEK MARKOVINOVIĆ, Dario LASIĆ, Karlo JURICA, Irena BRČIĆ KARAČONJI, Dora BRDAR, Adela KRIVOHLAVEK, Martina IVEŠIĆ, Ivana MANDIĆ ANDAČIĆ, Iva PALAC BEŠLIĆ, Predrag PUTNIK, Danijela BURSAC KOVAČEVIĆ

Andrija Štampar Teaching Institute of Public Health, Mirogojska 16, 10000 Zagreb, Croatia
Faculty of Food Technology and Biotechnology, University of Zagreb, Pierottijeva 6, 10000 Zagreb, Croatia

Department of Food Technology, University North, Trg Dr. Žarka Dolinara 1, 48000 Koprivnica, Croatia

Ministry of the Interior of the Republic of Croatia, Ulica grada Vukovara 33, 10000 Zagreb, Croatia
Institute for Medical Research and Occupational Health, Ksaverska cesta 2, 10000 Zagreb, Croatia
Faculty of Health Studies, University of Rijeka, Viktora Cara Emina 5, 51000 Rijeka, Croatia

E-mail: pputnik@alumni.uconn.edu

Croatia has a long tradition in fruit growing due to its geographical position, climatic conditions and high quality of fruit crops. The indigenous fruit varieties are characterized by good morphological/pomological properties, but their nutritional and biological potential is underutilized. The fruits of the strawberry tree (*Arbutus unedo* L.) are an underappreciated fruit species in Croatia, whose potential for cultivation and consumption has not yet been sufficiently utilized. On the other hand, it can be considered as an excellent raw material for the production of functional foods, which are under increasing demand by consumers. The aim of this study was to investigate the chemical and biological value of strawberry tree fruit collected in October 2021 in island Mali Lošinj, Croatia. Among the chemical properties, soluble solids content (SSC), pH, total carbohydrates, lipids, crude protein, crude cellulose, crude energy and sugar content were determined. Among bioactive compounds, total phenolic content (TPC), total flavonoids (TF), anthocyanins (ANT), hydroxycinnamic acids (HCA), flavonols (FL) and condensed tannins (CT) were analyzed. The obtained results showed that strawberry fruit samples contained high SSC (38 %), pH 4.6, total carbohydrates 30.28 g/100 g, lipids <0.5 g/100 g, crude protein 0.67 g/100 g, crude cellulose 6.43 g/100 g, and crude energy 136.7 kcal/100 g. The HPLC determination of sugar composition revealed that fructose was the predominant compound (8.79 g/100 g) followed by glucose (4.36 g/100 g). Other sugars, like sucrose, lactose and maltose were found <LOQ (below the limit of quantification of the method) in concentrations less than 0.35 g/100 g. The results of the determination of bioactive compounds also showed that strawberry tree fruit is an excellent source of various biological compounds. Accordingly, TPC was found at a concentration of 524.69±1.64 mg GAE/100 g. Among all bioactive compounds CT were found with the highest levels (39 %), followed by HCA (6.3 %). Moreover, the results indicated that HCA derivatives are more widely distributed than flavonoid derivatives, as TF were found at a percentage of 2.6 %. The anthocyanins responsible for the red color of strawberry fruit were detected at a concentration of 6.00 mg Cyd-3-gal/100 g. Since CT are the dominant subclass of phenolic compounds from strawberry tree, it is not surprising that FL as monomeric units were also found in greater amounts than anthocyanins (12.58 g QE/100 g). From the obtained results it can be concluded that strawberry tree fruit is an excellent raw material that has not been sufficiently explored and exploited for processing. The good chemical properties of strawberry tree fruit suggested that it can also be added to various functional products as raw material, for example in the 3D printing of food.

Key words: Strawberry tree fruit, *Arbutus unedo* L., functional food, chemical composition, bioactive compounds

MERENJE GUSTINE JONSKOG BIOFLUIDA*Siniša BIKIĆ¹, Milivoj RADOJČIN², Maša BUKUROV¹**Ivan PAVKOV², Milan VRANEŠ³, Snežana PAPOVIĆ³, Edin BERBEROVIĆ⁴*¹*Univerzitet u Novom Sadu, Fakultet tehničkih nauka, Trg Dositeja Obradovića 6,
21000 Novi Sad, Republika Srbija*²*Univerzitet u Novom Sadu, Poljoprivredni fakultet, Trg Dositeja Obradovića 6,
21000 Novi Sad, Republika Srbija*³*Univerzitet u Novom Sadu, Prirodno-matematički fakultet, Trg Dositeja Obradovića 3,
21000 Novi Sad, Republika Srbija*⁴*Univerzitet u Zenici, Politehnički fakultet, Fakultetska 1,
72000 Zenica, Bosna i Hercegovina**E-mail: bika@uns.ac.rs*

Predmet istraživanja u radu bila je gustina jonskog biofluida dobijenog suspendovanjem čestica poljoprivredne biomase u jonskoj tečnosti kao osnovnom fluidu. Cilj istraživanja bio je da se nastavi razvoj nove klase disperzija dobijenih korišćenjem poljoprivrednog otpada kao održiva zamena za jonske nanofluide. Stabljike suncokreta kao poljoprivredna otpadna biomasa korišćene su za proizvodnju čestica. Jonska tečnost (2-hidroksipropil)amonijum-formijat $[H_3N_3(2^{\cdot}OH)] [For]$ korišćena je kao bazni fluid. Jonski biofluid pripremljen je uobičajenom metodom u dva koraka. U prvom koraku čestice su dobijene hidrotermalnom karbonizacijom i tretmanom u peći sa inertnom atmosferom. U drugom koraku čestice su suspendovane u jonskoj tečnosti. Gustina jonskog biofluida merena je pomoću piknometra, precizne vage i vodenog kupatila. Urađeno je merenje gustine jonskog biofluida različitih koncentracija (0 wt%, 1 wt%, 3 wt%, 5 wt%, 7 wt% and 10 wt%) na različitim temperaturama (20 °C, 30 °C, 40 °C, 50 °C, 60 °C i 70 °C). Utvrđeno je da gustina jonskog biofluida raste sa porastom masene koncentracije čestica, a snižava se sa porastom temperature.

Key words: jonski bio fluid, jonska tečnost, poljoprivredna biomasa, nanočestice, nanofluidi

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DENSITY MEASUREMENT OF IONIC BIO FLUID*Siniša BIKIĆ¹, Milivoj RADOJČIN², Maša BUKUROV¹,**Ivan PAVKOV², Milan VRANEŠ³, Snežana PAPOVIĆ³, Edin BERBEROVIĆ⁴**¹University of Novi Sad, Faculty of Technical Sciences, Trg Dositeja Obradovića 6,
21000 Novi Sad, Republic of Serbia**²University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 6,
21000 Novi Sad, Republic of Serbia**³University of Novi Sad, Faculty of Sciences, Trg Dositeja Obradovića 3,
21000 Novi Sad, Republic of Serbia**⁴University of Zenica, Politechnic Faculty, Fakultetska 1,
72000 Zenica, Bosna and Hercegovina**E-mail: bika@uns.ac.rs*

The subject of the research in this work was density of ionic bio fluid obtained by suspending of agricultural biomass particles in an ionic liquid as a base fluid. The aim of the research was to continue development of new class of dispersions obtained using agricultural waste biomass as a sustainable alternative to ionic nanofluids. Sunflower stalks as agricultural waste biomass were used to produce particles. The ionic liquid (2-hydroxypropyl) ammonium - formate $[H_3N_3(2'OH)][For]$ was used as a base fluid. The dispersion was prepared using the most widely applied two-step method. In the first step particles were produced as dry powder utilizing hydrothermal carbonization and heat treatment in the oven with inert atmosphere. In the second step particles were dispersed into the ionic liquid. Density of ionic bio fluid was measured by pycnometer, analytical balance and thermal bath model. Measurements of density of ionic bio fluid with different mass concentration of particles (0 wt%, 1 wt%, 3 wt%, 5 wt%, 7 wt% and 10 wt%) at different temperatures (20 °C, 30 °C, 40 °C, 50 °C, 60 °C and 70 °C) were conducted. The density of ionic bio fluid was found to be increasing with mass concentration of particles and decreasing with temperature.

Key words: ionic bio fluid, ionic liquid, agricultural biomass, nanoparticles, nanofluids

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MODERNIZACIJA NADZORNO UPRAVLJAČKOG SISTEMA PRIJEMA ZRNA U SILOSIMA

Vladimir BUGARSKI, Perica NIKOLIĆ, Filip KULIĆ, Ilija KAMENKO

Univerzitet u Novom Sadu, Fakultet tehničkih nauka, Trg Dositeja Obradovića 6, Novi sad

E-mail: bugarski@uns.ac.rs

Biljne kulture čiji je plod zrno zauzimaju najznačajnije mesto u poljoprivrednoj proizvodnji. Zbog karakteristika zrnastih kultura (kratko ubiranje a potrošnja tokom cele godine; podložnost kvaru) njihovo skladištenje ima prevashodni značaj u očuvanju zdravstvene i tehnološke ispravnosti. Odatle proizilaze i potrebe za skladištima opremljenim moćnim transportnim sredstvima što danas zahteva sofisticiranu merno regulacionu tehniku i računare čime skladištenje prerasta u vrlo složen tehnološki proces.

U ovom radu je prikazan jedan primer sistema za prikupljanje podataka i upravljanje prijemom zrna uz pomoć računara, programabilnog logičkog kontrolera (PLC – Programmable Logic Controller) i odgovarajućeg softvera za vizuelizaciju podataka i upravljanje na nižem i višem nivou. Takav jedan sistem je realizovan u pogonu za prijem zrna u silosima jedne fabrike za preradu uljarica u Vojvodini. U radu je prikazano rešenje koje je implementirano, testirano i pušteno u rad u toku 2020. i 2021. godine.

Upravljački sistem na nižem nivou obuhvata PLC srednjeg nivoa performansi na kome se izvršava softver koji neposredno prikuplja podatke sa senzora i direktno upravlja motornim pozicijama za pogon lančastih i pužnih transporterata, elevatora, rotacionih zaustava, zasuna, ventilatora, filtera (ukupno 22 motorne pozicije) i drugih izvršnih organa. Hardverska konfiguracija PLC obuhvata i PC sistem i dve distribuirane periferije sa signalnim modulima (karticama) digitalnih i analognih ulaza i izlaza. Ovi uređaji međusobno komuniciraju Profinet standardom preko industrijskog eterneta. Ukupan broj signala koji su ožičeni do PLC-a iznosi 113 od čega većina izlaznih signala odlazi na upravljačke komande za motorne pozicije dok ulazni signali većinom pokrivaju merenje struja (važno zbog opterećenja transporterata) i potvrde rada i položaja svih aktuatora.

Upravljački sistem na višem nivou je realizovan kao moderan SCADA (Supervisory Control And data Acquisition) sistem realizovan kroz softver na računaru. Računar je fizički lociran u komandnoj sobi tako da operateri mogu na jednom mestu da imaju detaljan pregled stanja opreme, kao i mogućnost upravljanja u ručnom i automatskom režimu rada. Pored glavnog preglednog ekrana, kroz navigacioni meni operaterima je omogućen i pojedinačni detaljni prikaz parametara svake mašine, kao i pregled aktivnih alarmnih poruka, prikaz prikupljenih vrednosti u formi trendova (grafika) i tabela u posebnim ekranima.

Predloženi sistem je implementiran kao zamena za klasični analogni sistem. Cilj ove modernizacije je bio olakšavanje upravljanja i povećanje kapaciteta, što je na pomenutom pogonu ispunjeno u potpunosti.

Neke od prednosti novog sistema u odnosu na stari su: lako definisanje različitih transportnih puteva, dugoročno prikupljanje podataka (baza podataka) za kasniju evaluaciju, automatski start čitavog pogona, sistem alarmnih poruka i upozorenja sa zvučnom signalizacijom, praćenje ukupnog vremena rada pojedinačnih mašina i druge.

Ključne reči: silosi, prijem zrna, SCADA, PLC

RESEARCH ON THE PERCEPTION OF CONSUMPTION OF COW'S CHEESE FORTIFIED WITH SPIRULINA PLATENSIS

Mirela Gianina CALU, Violeta GAGU (LEOČĂ)

“Dunărea de Jos University of Galați, Romania

E-mail: mirelacalu@yahoo.com

In order to make decisions about the choice, purchase and consumption of food, it is necessary to analyze consumer behavior. It is necessary to study the consumer's perception in order to meet his requirements. The criteria on the basis of which consumers choose foods of high biological value are elements that can be used in obtaining protein-enriched foods, respectively cow's cheese with the addition of *Spirulina platensis* in powder form. Functional foods can bring many potential health benefits. *Spirulina platensis* is used as a dietary supplement, due to its function of stimulating the immune system and due to its antiviral activity. This research analyzed the consumer's perception of the ratio of consumption of functional foods and their quality, including the consumption of innovative food cow's cheese with the addition of *Spirulina platensis*. Exploratory research has shown that there is a favorable image among consumers of foods that can also contribute to improving or maintaining health. The SAIN-LIM questionnaire and method are the tools used in exploratory marketing research.

Keywords: consumer perception, functional foods, health, quality

MOGUĆNOSTI KORIŠĆENJA FOTONAPONSKOG PRETVARANJA SOLARNE ENERGIJE U POLJOPRIVREDI POSLE DONOŠENJA NOVIH ZAKONA O ENERGETICI I KORIŠĆENJU OBNOVLJIVIH IZVORA ENERGIJE

Zoltan ČORBA, Bane POPADIĆ, Boris DUMNIĆ, Dragan MILIĆEVIĆ
Univerzitet u Novom Sadu, Fakultet tehničkih nauka, Trg Dositeja Obradovića 6
E-mail: zobos@uns.ac.rs

Donošenjem novog zakona o energetici i korišćenju obnovljivih izvora energije proširuju se mogućnosti korišćenja obnovljivih izvora energije (OIE). Obezbeđuje se veća pristupačnost korišćenju OIE, naročito za eksploataciju solarne energije putem fotonaponskog pretvaranja. Relativno pojednostavljene procedure omogućavaju izgradnju fotonaponskih elektrana širokoj populaciji. Pre svega se misli na domaćinstva, mala preduzeća ali i velike korporacije. Samim tim, otvaraju se nove mogućnosti u korišćenju fotonaponskog pretvaranja energije u svim oblastima poljoprivrede.

Opšta globalna svetska situacija je dovela do značajnog povećanja cene energenata, pa samim tim i električne energije. Idealna prilika da se kompenzuju povećani troškovi je proizvodnja električne energije iz sopstvene elektrane. Jedna od mogućnosti u poljoprivredi je izgradnja biogasnih postrojenja, međutim za to nema svako odgovarajuće tehničke uslove. Za široku populaciju najpristupačnija je varijanta korišćenja solarne energije za dobijanje električne. S toga, zainteresovanost malih i velikih poljoprivrednih gazdinstva, onih koji se bave kako primarnom tako i prerađivačkom proizvodnjom je naglo porasla za izgradnjom fotonaponskih elektrana, od kad su doneti gore spomenuti zakoni.

U radu se opisuju mogućnosti koje su na raspolaganju, procedure i pravila o izgradnji elektrana koji koriste OIE prema novo donetim zakonima. Poseban akcenat se stavlja na izgradnju fotonaponskih elektrana. Biće opisano nekoliko primera iz prakse na poljoprivrednim gazdinstvima. Kroz te primere se objašnjava na koji način definisati snagu fotonaponske elektrane u funkciji potrošnje. U zavisnosti od potrošnje i proizvodnje analizira se način korišćenja električne energije sa aspekta priključenja na distributivnu električnu mrežu.

Ključne reči: fotonaponske elektrane, status kupac-proizvođač, poljoprivreda

VALORIZATION OF SEA BUCKTHORN BERRY (*HIPPOPHAE RHAMNOIDES* L.) OIL AS A POTENTIAL SOURCE OF LIPOPHILIC BIOACTIVE MOLECULES

Patricija ČULINA¹, Sandra BALBINO², Ivona Elez GAROFULIĆ², Maja REPAJIĆ², Sanja LONČARIĆ², Stela JOKIĆ³, Verica DRAGOVIĆ-UZELAC², Sandra PEDISIĆ¹

¹Faculty of Food Technology and Biotechnology, University of Zagreb, P. Kasandrića 3, 23000 Zadar, Croatia

²Faculty of Food Technology and Biotechnology, University of Zagreb, Pierottijeva 6, 10000 Zagreb, Croatia

³Faculty of Food and Technology Osijek, J.J. Strossmayera 170, 31000 Osijek, Croatia

E-mail: plisica@pbf.hr

Production of natural compounds from medicinal plants with many biological effects have become very popular due to increasing concern regarding the safety of using synthetic compounds and the impact of *COVID-19 on health*. Sea buckthorn (*Hippophae rhamnoides* L., Elaeagnaceae), (SB) is well known as an important source of natural antioxidant and antimicrobial bioactive molecules (BAM) but also when incorporated in food improve sensorial properties, microbiological stability and shelf life of products. The most recognizable sea buckthorn product is berry oil (SBO) (Yu et al., 2017) which contains high amounts of lipophilic BAM such as unsaturated fatty acids, tocopherols, carotenoids and sterols (Koskovic et al., 2017) but variations in their composition have been revealed among cultivar and growing conditions (Christe et al., 2020). Furthermore, the isolation of oil and BAM from plant materials is influenced by the applied extraction methods (Cenkowski, 2006). Supercritical CO₂ extraction of oil as an advanced method gains increasing popularity due to better extraction efficiency compared to conventional extraction methods. Also, CO₂ as environmentally friendly and safe solvent (GRAS) is easily removed from the oil. Therefore, the aim of this study was to evaluate fatty acid, sterol and α -tocopherol content, as well as antioxidant capacity (AC) of SBO obtained by supercritical CO₂ extraction from SB berries grown in Croatia. Tocopherol content of SBO extracts was determined using HPLC/FLD, fatty acid and sterol content using GC-MS and AC using lipophilic ORAC method, respectively. A total of 16 sterols were determined and the most represented was sitosterol (589.28 mg/100 g of oil), followed by campesterol (31.97 mg/100g of oil), uvaol (21.79 mg/100g of oil) and obtusifoliol (12.99 mg/100g of oil). Moreover, high amounts of unsaturated fatty acids, such as omega-7 palmitoleic fatty acid (34.54%) and omega-6 γ -linolenic acid (10.78%) were determined. SBO was characterized with high α -tocopherol content (275.63 mg/100g oil) and high ORAC antioxidant capacity (1676.90 μ mol TE/100g of oil). Obtained results indicated that SBO is rich source of various lipophilic BAM with high antioxidant capacity which could be used in the production of natural compounds and functional foods as well as food additives.

Key words: sea buckthorn pulp oil, α -tocopherol, fatty acids, sterols, antioxidant capacity

POTENCIJALNI RIZICI I PROBLEMI KOD GAJENJA VIŠEGODIŠNJIH BIOENERGETSKIH USEVA

Željko DŽELETOVIĆ¹, Gordana ANDREJIĆ¹, Aleksandar SIMIĆ², Hakan GEREN³, Uroš ALEKSIĆ¹,
Snežana BRAJEVIĆ²

¹Univerzitet u Beogradu, Institut za primenu nuklearne energije (INEP), Banatska 31-B, 11080 Zemun,
Srbija

²Univerzitet u Beogradu, Poljoprivredni fakultet, Nemanjina 6, 11080 Zemun, Srbija

³University of Ege, Faculty of Agriculture, Department of Field Crops, Izmir, Turkey

E-mail: zdzeletovic@inep.co.rs

Proizvodni sistemi druge generacije biogoriva su znatno bolji od sistema prve generacije. Međutim, veličina površina na kojima se gaje zavise od javne podrške i one opadaju kada izostane podrška. Uprkos svim mogućim životno-sredinskim i ekonomskim koristima, višegodišnji bioenergetski usevi trenutno ne igraju značajniju ulogu u EU. Tek treba da se razvije tržište za bioenergetsku biomasu. Smatra se da će u EU osnovni ograničavajući faktor za razvoj biogorivnih useva biti raspoložive zemljišne površine. U jugoistočnoj Evropi, pak, postoji veliki neiskorišćeni potencijal za proizvodnju biomase i bioenergije na napuštenim i marginalnim poljoprivrednim površinama. Kritičan faktor u prihvatanju novih useva, kao što su bioenergetski usevi, je njihova profitabilnost u odnosu na postojeće usevne sisteme. Pri tom, višegodišnji bioenergetski usevi predstavljaju i rizične investicije. Ekonomski održiva proizvodnja namenskog energetskog useva, će biti teško ostvariva na većini zemljišta bonitetnih klasa V-VIII.

U pogledu rizičnosti farmerskih ulaganja, kukuruz ima prednost nad svim višegodišnjim sistemima bioenergetskih useva. Identifikovano je čak 9 vrsta rizika za njihovu uspešnu proizvodnju: (1) Obezbeđenost useva vodom; (2) Prisustvo korova u usevu; (3) Opasnost od izmrzavanja useva; (4) Poleganje useva; (5) Bolesti useva; (6) Kratki žetveni rokovi i varijabilni prinosi; (7) Ekonomičnost gajenja na zemljištima nižih bonitetnih klasa; (8) Uticaj agrotehnike i agroekoloških uslova na kvalitet biomase; i (9) Skladištenje požnjevene biomase i opasnost od požara. Za sada, smatra se da je tranzicija ka 100% obnovljivoj proizvodnji u sektoru električne energije nedostižna. Zbog toga, gajenje višegodišnjih bioenergetskih kultura se mora sistemski planirati i dalje unapređivati.

**POTENTIAL RISKS AND PROBLEMS IN THE GROWING OF PERENNIAL
BIOENERGY CROPS**

Željko DŽELETOVIĆ¹, Gordana ANDREJIĆ¹, Aleksandar SIMIĆ², Hakan GEREN³, Uroš ALEKSIC¹,
Snežana BRAJEVIĆ²

¹ *University of Belgrade, Institute for the Application of Nuclear Energy (INEP), Banatska 31-B, 11080
Zemun, Serbia*

² *University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11080 Zemun, Serbia*

³ *University of Ege, Faculty of Agriculture, Department of Field Crops, Izmir, Turkey*

E-mail: zdzeletovic@inep.co.rs

Second generation biofuel production systems are significantly better than the first generation systems. However, the size of areas on which the energy crops are grown depends on the public support and it decreases if the public support is missing. Despite all the environmental and economic benefits, perennial bioenergy crops do not currently play a significant role in the EU. The market for bioenergy biomass has yet to be developed. It is believed that the basic limiting factor for the development of biofuel crops in the EU will be available land areas. On the other hand, in Southeast Europe there is great untapped potential for biomass and bioenergy production in abandoned and marginal agricultural areas. Crucial factor in accepting new crops, such as bioenergy crops, is their profitability compared to already existing crop systems. At the same time, perennial bioenergy crops are investments that come with the certain risks. Economically viable production of dedicated energy crops will be difficult to achieve on most lands classified into V-VIII land capability class.

In terms of risk of farming investments, corn has an advantage over all perennial bioenergy crop systems. As many as 9 types of risk for the successful production of bioenergy crops have been identified: (1) Water supply of the crop; (2) The presence of weeds in the crop; (3) Frost and chilling stress of crops; (4) Crop lodging; (5) Crop diseases; (6) Short harvest times and variable yields; (7) Economic viability of cultivation on land areas of lower land capability class; (8) Influence of agricultural techniques and agro-ecological conditions on biomass quality; and (9) Storage of harvested biomass and fire hazard. The transition to 100% renewable generation in the electricity sector is considered unattainable, at least for now. Therefore, the cultivation of perennial bioenergy crops must be systematically planned and further improved.

UNUTRAŠNJI KVALITET JAJA KOKOŠI IZ ORGANSKE I KONVENCIONALNE PROIZVODNJE

Mirjana ĐUKIĆ STOJČIĆ, Lidija PERIĆ, Sava SPIRIDNOVIĆ,

University of Novi Sad, Faculty of Agriculture, Trg D. Obradovića 8, 21000 Novi Sad, Serbia

E-mail: mirjana.djukicstojcic@stocarstvo.edu.rs

Cilj ovog rada je bio da se odredi unutrašnji kvalitet jaja kokoši koje su gajene u različitim sistemima držanja: organskoj proizvodnji i u kaveznom sistemu držanja (obogaćeni kavezima). U uzorku od 30 jaja iz svakog sistema držanja ispitivane su osobine unutrašnjeg kvaliteta jaja: visina belanca, boja žumanca, visina žumanca, širina žumanca, indeks žumanca, HU jedinice, pH vrednost i prisustvo mrlja. Visina belanca i žumanca je merena pomoću triploidnog mikrometra. Boja žumanca je merena pomoću Rošove lepeze tako što se vizuelno upoređuje boja žumanceta sa paletom boja. Širina žumanca merena je pomoću šublera. Indeks žumanca dobijen je računskim putem, deljenjem visine žumanca sa širinom i množenjem sa 100%. Hogove jedinice (HU) izračunate su prema formuli od Haugh, (1937) na osnovu parametara mase jaja i visine belanca. Merenje pH se vršilo pomoću pH metra u rastvoru žumanca i belanca.

Rezultati istraživanja pokazuju da su visina belanca, Hogove jedinice i boja žumanca veoma važni parametri koji određuju i utiču na unutrašnji kvalitet jaja. Statistički značajan efekat sistema držanja je pronađen na sledećim parametrima: visini belanca ($P < 0.01$), Hogovim jedinicama ($P < 0.01$), boji ($P < 0.01$ širina žumanca), širini ($P < 0.015$), i indeksu ($P < 0.05$) žumanca. Kod parametara visina žumanca, pH vrednost i prisustvu mrlja nije ustanovljena statistički značajna razlika između dva posmatrana sistema držanja.

Prosečna visina belanca kod jaja iz kaveznog sistema je iznosila 9.95 mm dok je kod jaja iz organske proizvodnje bila 6.60mm. Samim tim i Hogove jedinice su bile znatno veće kod jaja koja potiču iz kaveznog sistema držanja. Boja žumanceta kao bitan parametar za kvalitet jaja kod samih potrošača je bila znatno svetlija kod jaja iz organske proizvodnje.

Prikazani rezultati istraživanja pokazuju da su visina belanca, Hogove jedinice i boja žumanca, vrlo značajni parametri kvaliteta jaja, kako sa stanovišta prerađivačke industrije tako i sa stanovišta dopadljivosti potrošača, bili bolji kod jaja iz kaveznog sistema držanja.

Ključne reči: kokoši nosilje, sistemi držanja, kvalitet jaja

KORIVA KAO SUPSTRAT ZA RAST *LACTICASEIBACILLUS SP. I* *LIGILACTOBACILLUS SP.*

Aleksandra ĐUKIĆ-VUKOVIĆ¹, Mihajlo BOGDANOVIĆ¹, Jovana GRBIĆ², Dragana
MLADENOVIĆ,² Ljiljana MOJOVIĆ¹

¹ Univerzitet u Beogradu, Tehnološko-metalurški fakultet, Karnegijeva 4, 11120 Beograd, Srbija

² Inovacioni centar Tehnološko-metalurškog fakulteta Univerziteta u Beogradu, Karnegijeva 4, 11120
Beograd, Srbija

E-mail: adjukic@tmf.bg.ac.rs

Kopriva (*Urtica dioica*) je široko rasprostranjena biljka koja raste širom Evrope. Koristi se za ishranu, kao čaj ili u formi ekstrakta u dijetetskim suplementima. Tokom prerade herbe koprive i pakovanja za primenu u formi čajeva nastaje značajna količina otpada – izdrobljene herbe koprive. Ovaj otpad se za sada ne koristi i smatra se otpadom, ali bi se mogao koristiti za ekstrakcije. Suvi i tečni ekstrakti koprive farmakopejskog kvaliteta se koriste za tretmanu anemija, reumatoidnih bolesti, hipertenzije i hiperglikemijskih poremećaja. Zeleni rastvarači, voda i etanol su najpogodniji za dobijanje ekstrakata na održiv način za prehrambene i farmaceutske primene. Takođe, ovi rastvarači pogoduju ekstrakciji polarnih jedinjenja kao što su glikozidi koje mogu da fermentišu mikroorganizmi. Vodeni ekstrakti se mogu koristiti bez tretmana, jer ne utiču negativno na rast mikroorganizama, dok je iz etanolnih ekstrakata neophodno ukloniti etanol pre fermentacije.

U radu smo proučavali vodenu ekstrakciju herbe koprive i otpada dobijenog preradom herbe. Testirali smo ekstrakte kao supstrate za rast *Ligilactobacillus salivarius* i *Lacticaseibacillus rhamnosus*, bakterija sa probiotskim potencijalom i antioksidantnu aktivnost ekstrakata (DPPH i ABTS metode). Antioksidantna aktivnost i rast *L. salivarius* i *L. rhamnosus* su ispitivani u ekstraktima koprive dobijenim pod različitim uslovima. Ekstrakti dobijeni iz otpadna herbe koprive su pokazali sličnu ili čak bolju antioksidativnu aktivnost u odnosu na ekstrakte standardno korišćene herbe. Ekstrakti koprive bez dopune izvorima ugljenika ili azota su bili loš supstrat za rast *L. salivarius* i *L. rhamnosus*, dok su ekstrakti obogaćeni bujonom u niskom procentu pokazali rast bolji od kontrolnog uzorka. Rezultati rada ukazuju na potencijal otpada iz prerade koprive za primenu u prehrambenoj industriji čime bi se izbeglo odlaganje na deponije i bacanje ovog vrednog resursa.

Ključne reči: antioksidansi, probiotici, zelena ekstrakcija, kopriva, održivost, otpad

**COMMON NETTLE AS SUBSTRATE FOR THE GROWTH OF
LACTICASEIBACILLUS SP. AND LIGILACTOBACILLUS SP.**

*Aleksandra DJUKIĆ-VUKOVIĆ¹, Mihajlo BOGDANOVIĆ¹, Jovana GRBIĆ², Dragana
MLADENOVIĆ,² Ljiljana MOJOVIĆ¹*

¹ *University of Belgrade, Faculty of Technology and Metallurgy, University of Belgrade, Karnegijeva
4, 11120 Belgrade, Serbia*

² *Innovation centre of Faculty of Technology and Metallurgy, University of Belgrade, Karnegijeva 4,
11120 Belgrade, Serbia*

E-mail: adjukic@tmf.bg.ac.rs

Common nettle (*Urtica dioica*) is widely spread medicinal plant growing in Europe. It is used as food, herbal tea or extract in dietary supplements. Significant amount of common nettle herb residues remains during standard herb processing in herbal tea production – due to grinding and fragility of dried common nettle’s leaf. These residues are currently underexploited and are considered waste, but could be used for extraction. Dried or liquid extracts of pharmacopoeial-level quality common nettle are used in iron supplementation, in treatments of rheumatoid diseases, hypertension or hyperglycemic disorders. Green solvents, water and ethanol are preferable for sustainable extractions and food and health related applications. Additionally, these solvents favour extraction of polar compounds like glycosides which could be metabolized by microorganisms. Water extracts do not harm microorganisms and are used as such in fermentation while ethanol have to be removed before fermentations.

In our work, we studied water extraction of common nettle herb and its residues and tested these extracts as substrates for the growth of *Ligilactobacillus salivarius* and *Lacticaseibacillus rhamnosus*, bacteria with probiotic potential. Antioxidant activity (DPPH and ABTS methods) and growth of *L. salivarius* and *L. rhamnosus* were common nettle’s extracts obtained under different conditions. The extracts obtained from residues showed comparable or even superior antioxidant activity to extracts obtained from standard herb. Common nettle extracts without carbon or nitrogen supplementation were poor substrates for the growth of *L. salivarius* and *L. rhamnosus*, while supplementation with broth in low percentages resulted in growth stimulation above control. Findings suggest that common nettle herb residues could be valorised in food chain avoiding landfill disposal and wasting of this valuable resource.

Keywords: antioxidants, probiotics, green extraction, stinging nettle, sustainability, waste

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ULJE OD LANIKA I ŠAFRANIKE - FUNKCIONALNI DODATAK U HRANI ZA KUĆNE LJUBIMCE

*Olivera ĐURAGIĆ¹, Slađana RAKITA¹, Nedeljka SPASEVSKI¹, Danka DRAGOJLOVIĆ¹, Marija
MILAŠINOVIĆ ŠEREMEŠIĆ¹, Ana JEROMELA MARJANOVIĆ², Sandra CVEJIĆ²*

¹Univerzitet u Novom Sadu, Naučni institut za prehrambene tehnologije, Bulevar cara Lazara 1, 21000
Novi Sad, Srbija

²Institut za ratarstvo i povrtarstvo, Maksima Gorkog 30, Novi Sad, 21000 Srbija

E-mail: olivera.djuragic@fins.uns.ac.rs

Hrana za kućne ljubimce već godinama je jedna od najatraktivnijih industrija u svetu, a polako počinje da se razvija i dobija na značaju i kod nas. U sastav hrane za kućne ljubimce, pored sirovina animalnog porekla, sve više se poklanja pažnja funkcionalnim dodacima biljnog porekla kojima se utiče na zdravstveno stanje i dobrobit životinja. Ulja su poznata kao energetske materije za ishranu životinja ali zahvaljujući svom sastavu u pogledu esencijalnih masnih kiselina, povoljno utiču na metaboličke procese i opšte stanje organizma životinje, kao i kvalitet kože i dlake.

Trenutno se u našoj zemlji od uljanih kultura prerađuju i koriste najviše soja, suncokret i uljana repica kao i njihovi nuzproizvodi (pogače, sačme). Ostale sirovine bogate uljem kao što su lan, seme bundeve, lešnik, orah su u manjoj meri zastupljene, prerađuju se male količine i uglavnom su namenjene ishrani ljudi. Takođe, ove sirovine su znatno skuplje obzirom da proizvodnja nije masovna, da se male količine prerađuju uglavnom u pogonima malog kapaciteta čime se poskupljuje proces dobijanja. Lanik ili divlji lan (*Camelina sativa*, L. Crantz.) je uljana kultura iz porodice Brassicaceae, koja je sredinom 20. veka i u većini evropskih zemalja zamenjena drugim uljaricama. Mnoga istraživanja su pokazala da ulje lanika ima ulogu u smanjenju holesterola u organizmu i upalnih procesa zbog sadržaja α -linolenske (omega-3) i linolne (omega-6) masne kiseline, kao i bioaktivnih jedinjenja poput tokoferola i fenola. Postoji određeni broj radova koji se bave ispitivanjem uticaja ulja od lanika na ishranu pasa ali u vidu suplementa (dodatka), a ne sastojka koji je apliciran u hranu i čini njen sastavni deo (Burron et al., 2021). Sa druge strane, šafranika (*Carthamus tinctorius* L.) iz porodice Asteraceae je biljka Mediterana, poreklom iz Egipta. U 16. veku je prenesena u Englesku, a odatle se raširila i na druga područja. Ulje šafranike takođe ima izuzetna svojstva. Sastav ulja šafranike uveliko varira, ali 90% ulja čine oleinska i linolna kiselina. U industriji hrane za životinje kod nas trenutno nema proizvoda koji sadrže ulje od lanika ili šafranike, a naročito ne kombinacije ove dve vrste ulja pa je moguće proizvesti hranu za kućne ljubimce sa dodatkom ulja od lanika i šafranike koja bi kao takva mogla da se stavi na tržište.

Ključne reči: lanik, šafranika, hrana, kućni ljubimci, funkcionalni dodaci

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CAMELINA AND SAFFLOWER OIL - A FUNCTIONAL SUPPLEMENT IN THE PET FOOD

Olivera ĐURAGIĆ¹, Slađana RAKITA¹, Nedeljka SPASEVSKI¹, Danka DRAGOJLOVIĆ¹, Marija MILAŠINOVIĆ ŠEREMEŠIĆ¹, Ana JEROMELA MARJANOVIĆ², Sandra CVEJIĆ²

¹*University of Novi Sad, Institute of Food Technology, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia*

²*Institute of Field and Vegetable Crops, Maksima Gorkog 30, Novi Sad, 21000 Serbia*

E-mail: olivera.djuragic@fins.uns.ac.rs

Pet food has been one of the most attractive industries in the world for years, and it is slowly starting to develop and gain importance in our country as well. Besides the addition of raw materials of animal origin, more and more attention has been paid to functional supplements of plant origin that affect the health and welfare of animals. Vegetable oils are known as energy substances for animal nutrition thanks to their composition of essential fatty acids. They have a beneficial effect on metabolic processes and the general condition of the animal's body. They also affect the quality of skin and hair.

In our country, the most frequently used oil cultures are soybean, sunflower, and rapeseed, as well as their by-products (cakes, meals). Other raw materials rich in oil, such as flax, pumpkin seeds, hazelnuts, and walnuts, are less represented. They are produced in small quantities and are mainly intended for human consumption. Also, these raw materials are more expensive because they are processed mainly in small-capacity plants. Wild flax, or camelina (*Camelina sativa*, L. Crantz.), is an oil crop from the Brassicaceae family, which was replaced by other oilseeds in the middle of the 20th century in most European countries. Several studies have shown that camelina oil has a significant role in the human body. It can reduce inflammatory processes due to its content of α -linolenic (omega-3) and linoleic (omega-6) fatty acids, as well as bioactive compounds such as tocopherol and phenol. There are several papers explaining the effects of flaxseed oil on dog nutrition, but in the form of a supplement, not an ingredient as an integral part of pet food (Burron et al., 2021). On the other hand, safflower (*Carthamus tinctorius* L.) from the family Asteraceae is a plant of the Mediterranean that originated in Egypt. It was transferred to England in the 16th century and spread to other areas. Safflower oil also has exceptional properties. The composition of safflower oil varies greatly, but 90% of the oil is oleic and linoleic acid. In the animal feed industry, there are no products that contain camelina or safflower oil, and especially not a combination of these two types of oil, so it is possible to produce pet food with the addition of camelina and safflower oil and put it on the market.

Key words: camelina, safflower, pet food, functional components

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RESEARCH ON THE PERCEPTION OF CONSUMPTION OF COW'S CHEESE FORTIFIED WITH SPIRULINA PLATENSIS

Violeta GAGU (LEOCĂ), Mirela Gianina CALU,

„Dunărea de Jos” University of Galati, Faculty of Food Science and Engineering, 47 Domnească Street, RO-800008, Galati, Romania

E-mail: mirelacalu@yahoo.com

In order to make decisions about the choice, purchase and consumption of food, it is necessary to analyze consumer behavior. It is necessary to study the consumer's perception in order to meet his requirements. The criteria on the basis of which consumers choose foods of high biological value are elements that can be used in obtaining protein-enriched foods, respectively cow's cheese with the addition of *Spirulina platensis* in powder form. Functional foods can bring many potential health benefits. *Spirulina platensis* is used as a dietary supplement, due to its function of stimulating the immune system and due to its antiviral activity. This research analyzed the consumer's perception of the ratio of consumption of functional foods and their quality, including the consumption of innovative food cow's cheese with the addition of *Spirulina platensis*. Exploratory research has shown that there is a favorable image among consumers of foods that can also contribute to improving or maintaining health. The SAIN-LIM questionnaire and method are the tools used in exploratory marketing research.

Keywords: consumer perception, functional foods, health, quality

UTICAJ TRETMANA NETERMALNOM PLAZMOM NA KRISTALINIČNOST CELULOZE I SADRŽAJ LIGNINA U KUKURUZNOJ STABLJICI

Jovana GRBIĆ¹, Aleksandra ĐUKIĆ-VUKOVIĆ², Dragana MLADENović¹, Saša LAZOVIĆ³,
Ljiljana MOJOVIĆ²

¹*Innovation Center of Faculty of Technology and Metallurgy, University of Belgrade, 11120 Belgrade,
Karnegijeva 4, Serbia*

²*Faculty of Technology and Metallurgy, University of Belgrade, 11120 Belgrade, Karnegijeva 4,
Serbia*

³*Institute of physics Belgrade, University of Belgrade, Pregrevica 118, 11080 Belgrade, Serbia
E-mail: adjukic@tmf.bg.ac.rs*

Lignocelulozna biomasa predstavlja jeftinu sirovinu koja se može koristiti u fermentacionim procesima za dobijanje biogoriva, biogasa i drugih jedinjenja, zahvaljujući visokom sadržaju ugljenih hidrata. Složena struktura, koja uključuje celulozu, hemicelulozu i lignin, zahteva prethodni tretman biomase kojim se olakšava hidroliza do prostih šećera. Danas se biomasa samo delimično eksploatiše i generiše oko 14% energije na svetskom nivou. To je prevashodno zbog male održivosti najčešće korišćenih fizičkih, hemijskih i fizičko-hemijskih tretmana. Ovi procesi troše veliku količinu energije, imaju malu produktivnost, a toksični sporedni proizvodi koji nastaju tokom tretmana mogu ometati kasnije korake fermentacije.

Tretman biomase naprednim oksidacionim procesima ima veliki potencijal kao ekološki prihvatljiv, tzv. „zeleni“ tretman. Tokom ovog procesa dolazi do stvaranja reaktivnih vrsta (radikala, elektrona, jona i peroksida), koje napadaju celulozu, hemicelulozu i lignin. U ovom radu upoređeni su efekti tretmana kukuruzne stabljike netermalnom plazmom, Fentonovim reagensom i kombinovanog tretmana netermalnom plazmom/Fenton reagensom. Samlevena biomasa kukuruzne stabljike pomešana je sa Fentonovim reagensom i vodonik peroksidom u različitim odnosima, a zatim je podvrgnuta tretmanu netermalnom plazmom. Sadržaj celuloze i hemiceluloze je značajno smanjen u uzorcima tretiranim netermalnom plazmom i u prisustvu i u odsustvu Fe²⁺. Ipak, najveći stepen redukcije lignoceluloze je postignut pri određenom odnosu biomasa:Fe²⁺:vodonik peroksid. Primenjeni tretmani su uticali i na hemiceluloznu frakciju, ostavljajući indeks kristaliničnosti celuloze skoro nepromenjenim. Niži sadržaj lignina i manji indeks kristaliničnosti celuloze omogućavaju efikasniju enzimsku hidrolizu tretirane lignoceluloze i nove načine za valorizaciju u fermentacionim procesima.

Ključne reči: lignoceluloza, netermalna plazma, oksidacija, biorafinerija, degradacija, Fenton proces

EFFECT OF NON-THERMAL PLASMA ON CELLULOSE CRYSTALLINITY AND LIGNIN CONTENT IN CORN STALKS

Jovana GRBIĆ¹, Aleksandra ĐUKIĆ-VUKOVIĆ², Dragana MLADENović¹, Saša LAZOVIĆ³,
Ljiljana MOJOVIĆ²

¹*Innovation Center of Faculty of Technology and Metallurgy, University of Belgrade, 11120 Belgrade, Karnegijeva 4, Serbia*

²*Faculty of Technology and Metallurgy, University of Belgrade, 11120 Belgrade, Karnegijeva 4, Serbia*

³*Institute of physics Belgrade, University of Belgrade, Pregrevica 118, 11080 Belgrade, Serbia*
E-mail: adjukic@tmf.bg.ac.rs

Lignocellulosic biomass is a cheap raw material that can be used in fermentation for the production of biofuels, biogas and other compounds thanks to its high carbohydrate content. The complex structure, including cellulose, hemicellulose and lignin, requires prior biomass treatment to facilitate hydrolysis to simple sugars. Today, biomass is only partially exploited and generates about 14% of the world's energy. This is because the most commonly used physical, chemical and physicochemical treatments are not sustainable. They are energy-consuming but still low in productivity and toxic inhibitors formed during these treatments could hinder later steps of fermentation.

Treatment of biomass with advanced oxidation techniques has great potential as environmentally friendly, the so-called "green" treatment. During these processes, reactive species (radicals, electrons, ions and peroxides) are formed, and they attack cellulose, hemicellulose and lignin components. In this paper, the effects of non-thermal plasma, Fenton process and combined non-thermal plasma/Fenton treatments of corn stalks were compared. Grounded biomass of corn stalks was mixed with Fenton reagent and hydrogen peroxide in different ratios and subjected to non-thermal plasma treatment. Carbohydrate content was decreased in the samples treated by non-thermal plasma both with and without Fe²⁺. However, specific biomass:Fe²⁺:H₂O₂ ratio was needed to achieve the highest rate of lignocellulose decomposition. Cellulose and hemicellulose fractions were affected and reduced by the studied treatments but resulted in almost no changes in cellulose crystallinity index. The lower lignin content and cellulose crystallinity enable more efficient enzyme hydrolysis of treated lignocellulose and novel options for valorization in fermentations.

Key words: lignocellulose, non-thermal plasma, oxidation, biorefinery, degradation, Fenton process

DA LI CO₂ FUMIGACIJA UTIČE NA ŽIVOTNU SPOSOBNOST I KVALITET SEMENA SUNCOKRETA?

Sonja GVOZDENAC, Jelena OVUKA, Miloš KRSTIĆ, Biljana RADOVIĆ, Nadežda STOJANOV, Sandra CVEJIĆ

Institute of Field and Vegetable Crops, Maksima Gorkog 30, Novi Sad, Serbia

E-mail: sonja.gvozdenac@ifvcns.ns.ac.rs

Fumigacija ugljen-dioksidom (CO₂) je efikasna bioracionalna alternativa toksičnim hemijskim fumigantima, poput aluminijum fosfida. U širokoj je upotrebi za dezinfekciju brojnih sirovina i proizvoda, a efikasnost protiv štetnih insekata je potvrđena i dokumentovana. Međutim, ne postoje podaci o uticaju CO₂ kao fumiganta na vitalnost i kvalitet semena suncokreta. Ovaj podatak je važan, jer je seme uljarica, posebno suncokreta, podložnije smanjenju klijavosti i kvaliteta u poređenju sa žitaricama ili mahunarkama, zbog visokog sadržaja ulja i masnih kiselina. Cilj rada je da se proceni uticaj CO₂ fumigacije na vitalnost i kvalitet semena suncokreta, kao glavne uljane biljne vrste.

Devet genotipova suncokreta tretirano je različitim nivoima CO₂ (62,5, 92,0 i 96,0%) u gasnepropusnim vrećama, gde je održavana kontrolisana atmosfera, odnosno konstantan nivo fumiganta. Posle sedam dana analizirani su vitalnost semena (energija klijanja - EK i klijavost - K) i kvalitet semena (sadržaj i sastav ulja i masnih kiselina).

Fumigacija, bez obzira na koncentracije CO₂, nije pokazala štetno dejstvo na EK i K ispitivanih genotipova suncokreta. EK se kretala od 87,0 do 98,0% u svim tretmanima, u zavisnosti od genotipa, dok je u kontroli iznosila 82,0 do 97,5%. K je u svim tretmanima, uključujući i konstantinih 96,0% CO₂, bila na istom nivou značajnosti kao i kontrola (93,0 do 99%) i kretala se od 92,0 do 99,0%. Sadržaj i sastav ulja i masnih kiselina u semenu je zavisio od genotipa, ali se nije razlikovao između tretmana CO₂. Od ukupnog sadržaja ulja u semenu, detektovano je 95,98% do 98,88%, pri čemu nije uočena razlika u ovom parametru u zavisnosti od tretmana CO₂. Takođe, CO₂ nije uticao ni na sastav masnih kiselina, a razlika je postojala samo između genotipova. Međutim, i pored obećavajućih rezultata, moraju se uzeti u obzir moguće genotipske razlike u osetljivosti, pa se preporučuje da preliminarna fumigacija uzoraka semena pre fumigacije velikih razmera.

Ključne reči: ugljen dioksid, uljarice, kontrolisana atmosfera, vitalnost semena, genotipske razlike

IS THE CO₂ FUMIGATION AFFECTING VITALITY AND QUALITY OF SUNFLOWER SEEDS?

*Sonja GVOZDENAC, Jelena OVUKA, Miloš KRSTIĆ, Biljana RADOVIĆ, Nadežda STOJANOV,
Sandra CVEJIĆ*

Institute of Field and Vegetable Crops, Maksima Gorkog 30, Novi Sad, Serbia

E-mail: sonja.gvozdenac@ifvcns.ns.ac.rs

Fumigation with carbon dioxide (CO₂) is very effective biorational alternative to toxic chemical fumigants, such as aluminum phosphide. It is widely used for a variety of commodities, and the efficacy against insect pests is well documented. However, the information on its effect on the vitality and the quality of sunflower seed is not available. This information is important because oilseeds, sunflower in particular, are more difficult to store and preserve, compared to cereal grains or legumes, and are more susceptible to quality deterioration due to high content of oil and fatty acids. This work aimed to assess the efficacy of CO₂ fumigation of sunflower as a major oil crop, in relation to seed vitality and quality.

Nine sunflower genotypes were treated with different levels of CO₂ (62.5, 92.0 and 96.0%) in gas-tight bags. In bags, the controlled atmosphere was maintained, as well as the constant level of the fumigant. After seven days, seed vitality (germination energy - GE and germination - G) and seed quality (content and composition of oil and fatty acids in oil seeds) were analyzed.

The fumigation with CO₂, regardless concentrations, showed no adverse effect on GE and G of all sunflower genotypes. GE ranged from 87.0 to 98.0% in all treatments with CO₂, depending on the genotype, while in the control it ranged from 82.0 to 97.5%. In all treatments, including the highest and constant 96.0% of CO₂, G was at the same level of significance as the control (93.0 to 99%) and ranged from 92.0 to 99.0%. The detected oil content (95.98% to 98.88%), out of the total (100%) was genotype-defendant, but did not differ between the CO₂ treatments. Also, there were no differences in fatty acid composition between the CO₂ treatments, but only between genotypes. However, the possible varietal differences must be considered, thus it is recommended to perform preliminary fumigation of seed samples prior to large scale fumigation.

Key words: Carbon dioxide, oil seeds, legumes, controlled atmosphere, seed vitality, varietal differences

DA LI TVRDOĆA LJUSKE SUNCOKRETA UTIČE NA KLIJAVOST I PODLOŽNOST SEMENA SKLADIŠNIM ŠTETOČINAMA?

Sonja GVOZDENAC¹, Milivoj RADOJČIN², Miloš KRSTIĆ¹, Ivan PAVKOV², Jelena OVUKA¹, Sandra
CVEJIĆ¹

*Institut za ratarstvo i povrtarstvo Institut od nacionalnog značaja za Republiku Srbiju, Maksima
Gorkog 30, Novi Sad, Srbija*

Univerzitet u Novom Sadu, Poljoprivredni fakultet, Trg Dostieja Obradovića 3, Novi Sad, Srbija

E-mail: sonja.gvozdenac@ifvcns.ns.ac.rs

Biljna proizvodnja u velikoj meri zavisi od kvaliteta semena koje se koristi za setvu, jer je brzo i ujednačeno nicanje u polju je od presudnog značaja za ostvarivanje genetskog potencijala za prinos. Klijanje semena zavisi od mnoštva endogenih faktora poput tvrdoće ljuske i veličine semena. Naučno je potvrđeno da tvrdoća ljuske utiče na klijavost semena, međutim, veza sa podložnosti semena za napad skladišnih štetočina još nije istražena. Rad je imao za cilj da proceni uticaj tvrdoće ljuske suncokreta na klijavost divergentnih hibrida suncokreta, kao i njihovu podložnost napadu bakrenastog plamenca bršana (*Plodia interpunctella* Hubner).

Mehanička otpornost 14 hibrida suncokreta analizirana je testom probijanja igle kroz ljusku. Test je obavljen na uređaju FTC TMS-pro. Test klijavosti je postavljen prema ISTA metodologiji, a klijavost je ocenjivana svaki dan, do desetog dana. Insekatski biotest je podrazumevao veštačku infestaciju svakog genotipa suncokreta jajima bakrenastog plamenca bršana. Tokom oglada, praćena je dužina razvića kao i procenat oštećenja semena tokom života moljca.

Rezultati analize ukazuju na statistički značajne razlike u sili potrebnoj za probijanje ljuske suncokreta između 14 divergentnih hibrida. Najveću silu je ispoljilo seme Neoplante (3,83 N), a slede Romeo (2,24 N), Kiril (2,04 N) i Konstantin (2,00 N). Najmanja sila registrovana je za seme Oskara (0,62 N) i Krune (0,84 N). Klijavost prvog dana, bila je najniža za Neoplantu (9%), Ronina (17%) i Romea (28%). Međutim, drugog dana, klijavost svih genotipova bila je veća od 85%, što je minimalna klijavost propisana nacionalnom regulativom za suncokret, iako su postojale značajne razlike između genotipova. Tokom poslednje ocene, desetog dana, klijavost semena hibrida Neoplanta i Kiril ostala je najniža (91 i 93%, respektivno), dok je Kruna dostigla 100% klijavost drugog dana. U biotestu sa insekatima, nisu zabeležene statistički značajne razlike između dužine razvića insekata niti procenta oštećenja semena, koje bi se mogle povezati ili pripisati tvrdoći ljuske. Dužina razvića plamenca se kretala od 28 do 32 dana, a oštećenje semena od 18-21%, u zavisnosti od hibrida.

Imajući u vidu značaj brzog klijanja, posebno na polju, u poslednje vreme su proučavani različiti tretmani prajminga semena, jer mogu da poboljšaju klijavost posebno u prvim danima. Ovo je posebno važno za seme sa tvrdom ljuskom, pa rezultati ovog rada daju dragocene informacije o hibridima suncokreta za koje je poželjno da budu podvrgnuti prajmingu.

Ključne reči: fizičke osobine semena, sila probijanja, klijavost, napad insekata, bakrenasti plamenac bršana.

IS THE HULL HARDNESS AFFECTING SUNFLOWER GERMINATION AND SENSITIVITY TO STORED PRODUCT PESTS?

Sonja GVOZDENAC¹, Milivoj RADOIČIN², Miloš KRSTIĆ¹, Ivan PAVKOV², Jelena OVUKA¹, Sandra CVEJIĆ¹

Institute of Field and Vegetable Crops, National Institute of the Republic of Serbia, Maksima Gorkog 30, Novi Sad, Serbia

University of Novi Sad, Faculty of Agriculture, Trg Dostieja Obradovića 3, Novi Sad, Serbia

E-mail: sonja.gvozdenac@ifvcns.ns.ac.rs

Plant production largely depends on the quality of seeds, because fast and uniform germination and field emergence are crucial for the expression of genetic potential for yield. Seed germination depends on many endogenous such as hull hardness and seed size. Hull hardness has been proven to affect sunflower germination, however, its relation with seed susceptibility to stored product pests was not yet assessed. This work aimed to assess the influence of sunflower hull hardness on germination of divergent genotypes, as well as their susceptibility to Indian meal moth (*Plodia interpunctella* Hubner) attack.

Hull hardness (Newtons - N) of 14 sunflower genotypes was analyzed using needle penetration test. The test was performed on an FTC TMS-pro device. The germination test was carried out according to ISTA methodology (2022), and germination was assessed each day until the day 10. In insect bioassay, each genotype was artificially infested with *P. interpunctella* eggs, in glass jars, and the developmental duration was monitored as well as percent of seed damage after the termination of moth life cycle.

The results indicate statistically significant differences in the hull hardness between 14 different sunflower genotypes. The highest value of hull hardness, was obtained for Neoplanta (3.83 N), followed by Romeo (2.24 N), Kiril (2.04 N) and Konstantin (2.00 N). The lowest hardness was registered for Oscar (0.62 N) and Kruna (0.84 N). The lowest germination on the first day was achieved for Neoplanta (9%), Ronin (17%) and Romeo (28%). However, on the second day, germination of all genotypes was higher than 85%, which is minimal germination stipulated by national regulation for sunflower, although there were significant differences between the genotypes. During the final observation, on the day 10, germination of Neoplanta and Kiril seeds remained the lowest (91 and 93%, respectively) while Kruna reached 100% germination on the second day. In insect biotest, no statistically significant differences were recorded between the insect developmental duration or seed damage, that could be related or attributed to hull hardness. The developmental time of *P. interpunctella* ranged from 28 to 32 days and seed damages from 18-21%, depending on the genotype.

Given the importance of fast germination, particularly in field conditions, different seed priming treatments have been studied recently, as they can enhance germination, and seedling emergency especially in the first days. This is especially important for seeds with hard seedcoat or hull, thus the results of this work provide valuable information about sunflower genotypes that should be subjects to seed priming.

Keywords: seed physical traits, rupture force, germination, insect attack, Indian meal moth

UTICAJ RAZLIČITOG TIPA CITOPLAZME NA MASU 1000 SEMENA

Snežana V. JOVANOVIĆ¹, Goran TODORVIĆ¹, Miodrag TOLIMIR¹, Tanja PETROVIĆ¹, Nebojša NOVKOVIĆ², Ratibor ŠTRBANOVIĆ³, Rade STANISAVLJEVIĆ³

¹*Institut za kukuruz „ZemunPolje“, Slobodana Bajića 1, 11185 Beograd, Srbija*

²*Univerzitet u Novom Sadu, Poljoprivredni fakultet, Novi Sad, Trg Dositeja. Obradovica 8, Novi Sad, Serbia*

³*Institut za zaštitu bilja i životne sredine, Teodora Drajzera 9, 11040 Beograd, Srbija*

E-mail: jsnezana@mrizp.rs

Hibridi kukuruza dobijaju se ukrštanjem inbred linija, koje nastaju u procesu selekcije kontrolisanom samooplođnjom odabranih genotipova do postizanja homozigotnosti. U proizvodnji semena hibrida kukuruza potrebno je zakidati metlice na majčinskoj komponenti kako ne bi došlo do samooplođnje i smanjenja heterozisa hibrida F₁ generacije.

Cilj rada je bio da se utvrdi masa 1000 semena 12 inbred linija sa različitim tipom citoplazme.

Istraživanja su sprovedena na dve parcele: Školsko dobro i Selekciono polje u toku dve godine.

Ogledi su postavljeni po slučajnom blok sistemu u okviru svakog tipa citoplazme u tri ponavljanja.

Statističko-biometrijska obrada podataka se zasnivala na srednjim vrednostima po ponavljanju i obuhvatila je analizu varijanse. Na osnovu analize varijanse utvrđeno je da postoje veoma značajne razlike između inbred linija na masu 1000 semena u zavisnosti od tipa citoplazme, godine i lokacije. Najmanju prosečnu vrednost mase 1000 semena imala je inbred linija L₇ (259,5 g), a najveću inbred linija L₁ (394,0 g). Prosečne vrednosti mase 1000 semena inbred linija, veoma značajno su (P ≤ 1%) varirale u zavisnosti od godina ispitivanja i lokacija. Veća vrednost mase 1000 semena imale su inbred linije u drugoj. godini (326,58 g) u odnosu na prvu godinu (298,93 g). Na lokaciji Selekciono polje ostvarena je veća prosečna vrednost (321,62 g) mase 1000 semena u odnosu na lokaciju Školsko dobro (303,90 g). Veoma značajno (Lsd_{0,01}) veću vrednost mase 1000 semena imale su inbred linije sa citoplazmom *cms-C* tipa u odnosu na inbred linije sa fertilnom i citoplazmom *cms-S* tipa. Masa 1000 semena inbred linija po godinama veoma značajno (Lsd_{0,01}) se razlikovala kod većine linija osim L₄, L₁₀ i L₁₂ gde nije bilo razlike.

U zavisnosti od tipa citoplazme i godina ispitivanja veoma značajne (Lsd_{0,01}) razlike mase 1000 semena nisu utvrđene samo kod inbred linija L₄ i L₁₁.

Prosečne vrednosti mase 1000 semena inbred linija po lokacijama su se veoma značajno (Lsd_{0,01}) razlikovale kod inbred linija: L₁, L₂, L₅, L₈, L₉ i L₁₀ dok kod ostalih šest ispitivanih linija nisu utvrđene razlike.

Između inbred linija sa različitim tipovima citoplazme utvrđene su značajne (Lsd_{0,05}) razlike u masi 1000 semena po ispitivanim lokacijama. Linije istog tipa citoplazme dale su veću masu 1000 semena na prvoj nego na drugoj lokaciji.

Godine ispitivanja i lokacije veoma značajno su uticale na masu 1000 semena. Najveću prosečnu vrednost mase 1000 semena ostvarile su inbred linije u drugoj godini na prvoj lokaciji.

Interakcija inbred linija x godina x lokacija je bila statistički značajna (Lsd_{0,05}). Prosečna masa 1000 semena kod L₄ nije se značajno razlikovala u zavisnosti od godina i lokacija ispitivanja. Ostale ispitivane inbred linije imale su veoma značajna variranja mase 1000 semena u različitim uslovima spoljašnje sredine.

Ključne reči: citoplazmatska muškasterilnost, inbred linije, seeds

UTJECAJ RAZLIČITIH NOSAČA NA FIZIKALNA SVOJSTVA I UDIO FENOLA U ENKAPSULIRANIM EKSTRAKTIMA LISTOVA TRŠLJE

Tanja JOVIĆ¹, Ivona ELEZ GAROFULIĆ², Zrinka ČOŠIĆ², Zdenka PELAIĆ², Verica DRAGOVIĆ-UZELAC², Zoran ZORIĆ²

¹Ljekarne Zadar, Jurja Barakovića 2, Zadar, Hrvatska

²Prehrambeno-biotehnološki fakultet Sveučilišta u Zagrebu, Zagreb, Croatia

E-mail: zzoric@pbf.hr

Zbog visokog sadržaja bioaktivnih molekula (BAM) od kojih su najzastupljeniji hidroksibenzojeve kiseline te flavonoli, a koji posjeduju pozitivna biološka, fiziološka te ljekovita svojstva, tršlja (*Pistacia lentiscus* L.) se može koristiti za proizvodnju funkcionalnih proizvoda i proizvoda s dodanom vrijednošću.

S obzirom da su ovi spojevi osjetljivi na degradaciju važno je očuvati njihovu stabilnost tijekom pripreme, procesiranja i skladištenja. Enkapsulacija se pokazala kao učinkovita metoda za zaštitu BAM-a od okolišnih čimbenika kao što su temperatura, pH, enzimi i kisik. Najčešće korištena metoda enkapsuliranja je sušenje raspršivanjem (SD).

Stoga je cilj ovog istraživanja bio dobivanje prahova ekstrakta listova tršlje sušenjem raspršivanjem i istražiti utjecaj različitih nosača [β -ciklodekstrin (BCD), maltodekstrin (MD) DE 13-17 i arapska guma (GA)] na udio ukupnih fenola (TP) te fizikalna svojstva prahova dobivenih sušenjem pri 120 °C i omjeru suhe tvari i nosača 1:20.

Najveći prinos dobiven je kada se kao nosač koristila GA (55,16 % \pm 0,81), iako je u tim prahovima utvrđena najmanja količina sadržaja TP (114,05 \pm 0,18 mg/100 g praha GAE). Najveća koncentracija TP (144,02 \pm 0,70 mg/100 g praha GAE), najveći udio vlage (12%) i najmanja topljivost (35,22 \pm 0,87%) utvrđena je u prahovima dobivenim SD-om kada je kao nosač korišten BCD. Najveća nasipna gustoća određena je u prahu MD (0,35 mg/mL), a zatim BCD (0,35 mg/mL) i GA (0,31 mg/mL).

Prema dobivenim rezultatima može se zaključiti da se BCD pokazao kao najbolji nosač za dobivanje praha s najvećom količinom TP, iako su prahovi s najboljim fizikalnim svojstvima dobiveni kada su kao nosači korišteni GA i MD.

Ključne riječi: enkapsulacija, sušenje raspršivanjem, ekstrakti *Pistacia lentiscus*, fizikalna svojstva, fenoli

INFLUENCE OF DIFFERENT CARRIERS ON PHYSICAL PROPERTIES AND PHENOLIC CONTENT IN ENCAPSULATED MASTIC LEAF EXTRACT

Tanja JOVIĆ¹, Ivona ELEZ GAROFULIĆ², Zrinka ČOŠIĆ², Zdenka PELAIĆ², Verica DRAGOVIĆ-UZELAC², Zoran ZORIĆ²

¹Pharmacy Zadar, Jurja Barakovića 2, Zadar, Croatia

²Faculty of Food Technology and Biotechnology, University of Zagreb, Pierottijeva 6, Zagreb, Croatia

E-mail: zzoric@pbf.hr

Mastic tree (*Pistacia lentiscus* L.) due to the high content of bioactive molecules (BAM) mainly represented by hydroxybenzoic acids and flavonols with positive biological, physiological and medicinal effects may be used in production of functional and added-value products.

These compounds are susceptible to degradation and it is important to improve their stability during handling, processing and storage. Encapsulation has been shown as an effective method for protecting BAM's against environmental factors such as temperature, pH, enzymes and oxygen. The most commonly used encapsulation method is spray drying (SD).

Therefore, the aim of this study was to produce powders of mastic tree leaf extracts by SD and to investigate the influence of different carrier [β -cyclodextrin (BCD), maltodextrin (MD) DE 13-17 and gum arabica (GA)] on total phenolic (TP) content and physical properties of spray dried powders obtained at 120 °C and wall to core ratio of 1:20.

The highest yield was observed when GA was used as a carrier (55.16 % \pm 0.81), although in these powders the lowest amount of TP content (114.05 \pm 0.18 mg/100 g of powder GAE) was determined. The highest concentration of TP (144.02 \pm 0.70 mg/100 g of powder GAE), highest moisture content (12%) and lowest solubility (35.22 \pm 0.87%) was determined in powders obtained by SD when BCD was used as a carrier. The highest bulk density was determined in MD powder (0.35 mg/mL), followed by BCD (0.35 mg/mL) and GA (0.31 mg/mL).

According to the obtained results, it can be concluded that BCD showed as the best carrier for obtaining powders with the highest amount of TP, although powders with the best physical properties were obtained when GA and MD were used as carriers.

Key words: encapsulation, spray drying, *Pistacia lentiscus* extracts, physical properties, phenolics

ANALIZA UTICAJA METODA ZA MODELOVANJE REALNIH INDUSTRIJSKIH PROCESA U POSTUPKU PODEŠAVANJA PARAMETARA PID REGULATORA

Ilija KAMENKO, Filip KULIĆ, Vladimir BUGARSKI, Perica NIKOLIĆ

Univerzitet u Novom Sadu, Fakultet tehničkih nauka, Novi Sad, Trg Dositeja Obradovića 6

E-mail: kamenko@uns.ac.rs

Proporcionalno-integralno-diferencijalni (PID) zakon upravljanja je najčešće korišćen zakon upravljanja u industriji. PID regulatori se veoma uspešno koriste u regulaciji temperature, pritiska, brzine i protoka u tehnološkim procesima sušenja, transporta i skladištenja. PID regulator ima tri podesiva parametra, po jedan za svaki zakon upravljanja. Performanse i robusnost sistema u zatvorenoj sprezi u uskoj su vezi sa vrednošću ova tri parametra regulatora. Pored jednostavne implementacije, određivanje tri podesiva parametra nije lak zadatak. Klasične metode za podešavanje parametara PID regulatora su date u vidu jednostavnih izraza u kojima figuriraju eksperimentalno određene karakteristike dinamike procesa. Dinamika procesa se može aproksimirati korišćenjem jednostavnih modela dobijenih iz odskočnog odziva u otvorenoj sprezi. Jedan od najzastupljenijih je model opisan sistemom prvog reda sa vremenskim kašnjenjem koji ima tri parametra: K statičko pojačanje, T vremensku konstantu i L vremensko kašnjenje.

U ovom radu je dat uporedni pregled uticaja metoda modelovanja procesa na ukupne performanse u toku podešavanja parametara PID regulatora na klasičan način. Za uporednu analizu su izabrane najčešće korišćene metode odnosno metoda tangente i metoda površina. Glavna prednost metode tangente je što se može primeniti na grafiku odskočnog odziva dok je primena metode površina u tom slučaju teže primenjiva. Prednost metode površina je što se lakše implementira na realnim kontrolerima i otpornija je na uticaj šuma u tim slučajevima. Pored ovih osnovnih prednosti i mana prilikom implementacije u ovom radu je data analiza performansi i robusnosti dobijenih primenom ovih metoda za modelovanje procesa.

Obe metode za modelovanje su primenjene nad širokim skupom različitih modela realnih sistema koji se najčešće susreću u industriji u procesima regulacije temperature, pritiska, protoka i brzine. Skup uključuje modele realnih temperaturnih procesa koji imaju velike vremenske konstante kao i modele transportnih procesa koji imaju velika vremenska kašnjenja što omogućuje donošenje opštijeg zaključka na kraju. Na osnovu dobijenih modela proračunati su parametri PID regulatora koristeći istu klasičnu metodu podešavanja. Nakon toga su proračunate performanse i robusnost za tako dobijene sisteme u zatvorenoj sprezi. Uporednom analizom rezultata došlo se do zaključka da izbor metode za modelovanje utiče na ukupne performanse i robusnost. Primenom metode površina za modelovanje sistema postignute su ukupno bolje prosečne vrednosti performansi i robusnosti i to u većini usvojenih kriterijuma.

Ključne reči: PID, podešavanje parametara, regulacija, modelovanje, metoda tangente, metoda površina

MATEMATIČKO MODELOVANJE KINETIKE SUŠENJA ZAMRZAVANJEM AMERIČKE VISOKOŽBUNASTE BOROVNICE

Krstan KEŠELJ, Ivan PAVKOV, Milivoj RADOJČIN, Zoran STAMENKOVIĆ, Mladen IVANIŠEVIĆ
Univerzitet u Novom Sadu, Poljoprivredni fakultet, Trg Dositeja Obradovića 8, 21000 Novi Sad, Srbija
E-mail: krstan.keselj@polj.uns.ac.rs

Sušenje zamrzavanjem voćarskih proizvoda još uvek nije dovoljno istražena oblast. U dostupnoj naučnoj literaturi nema dovoljno radova na temu matematičkog modelovanja kinetike sušenja zamrzavanjem. Ispitivanje kinetika sušenja pomaže boljem razumevanju procesa sušenja iz čega proizilazi optimizacija procesa.

Borovnica je dobavljena od lokalnog proizvođača iz okoline Novog Sada. Nakon kupovine sveža borovnica je zamrzavana na -20 u komercijalnom zamrzivaču i na -40 °C u laboratorijskom zamrzivaču za duboko zamrzavanje. Sušenje je izvedeno u unapređenom laboratorijskom liofilizatoru proizvođača Martin Christ oznake Alpha 2-4 LDplus, kapaciteta 4kg leda. Sušenje se izvodi u dve etape, gde je prva etapa primarno sušenje ili sublimaciono sušenje i druga etapa ili etapa desorpcije. Tokom primarnog sušenja ispari se između 92 i 95 % vlage, ostala vlaga se isparava tokom etape desorpcije gde dolati do povišenja temperature materijala. Zahvaljujući unapređenju, koje se ogleda u dodavanju senzora mase i sedam sonde za merenje temperature, omogućeno je praćenje promene mase i temperature tokom sušenja. Senzor mase i temperaturne sonde povezane su sa računarnom preko akvizicije što omogućuje praćenje promena mase i temperature svake sekunde tokom merenja. Masa uzorka za svaku eksperimentalnu jedinicu iznosila je 300 ± 15 g, zamrznute borovnice. Sušenje je izvedeno pri apsolutnom pritisku od 300 Pa. Pre sušenja pokožica svake borovnice je mehanički zarezana, jer je ustanovljeno da pokožica oteževa proces sušenja. Na osnovu pregledane referentne literature odlučeno je za primenu pet matematičkih modela. Na osnovu statističkih pokazatelja R^2 , X^2 , S i RMSE dolazi se do zaključka da model Page najbolje aproksimuje kinetiku sušenja zamrzavanjem američke borovnice. Iako model Page najpreciznije odgovara eksperimentalnim podacima i drugi modeli mogu se primeniti, jer na osnovu primenjenih statističkih pokazatelja i oni odgovaraju sa visokim preciznošću.

Ključne reči: Matematičko modelovanje, američka borovnica, sušenje zamrzavanjem, kinetike sušenja

ZAHVALNICA

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**MATHEMATICAL MODELING OF FREEZE - DRYING KINETICS OF
AMERICAN Highbush BLUEBERRY**

Krstan KEŠELJ, Ivan PAVKOV, Milivoj RADOJČIN, Zoran STAMENKOVIĆ, Mladen IVANIŠEVIĆ
University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia
E-mail: krstan.keselj@polj.uns.ac.rs

Freeze-drying of fruit products is still not a sufficiently researched area. There is still not enough papers in the available scientific literature on the topic of mathematical modeling of freeze-drying kinetics. Researching the drying kinetics helps to better understand the drying process, which results in process optimization.

The blueberry was supplied by a local producer from the Novi Sad area. After that fresh blueberries were frozen at -20 in a commercial freezer and at -40 °C in a laboratory freezer for deep freezing. Drying was performed in an improved Martin Christ laboratory freeze dryer, marked Alpha 2-4 LDplus, with a capacity of 4 kg of ice. Drying is performed in two stages, where the first stage is primary drying or sublimation drying and the second stage or desorption stage. During the primary drying, between 92 and 95% of the moisture evaporates, the remaining moisture evaporates during the desorption stage, where the temperature of the material rises. Thanks to the improvement, which is reflected in the addition of a mass sensor and seven probes for measuring temperature, it is possible to monitor changes in mass and temperature during drying.

The mass sensor and temperature probes are connected to the computer via an acquisition that allows changes in moisture content and temperature to be monitored every second during the measurement. The mass of the sample for each experimental unit was 300 ± 15 g, frozen blueberries. Drying was performed at an absolute pressure of 300 Pa. Before drying, the skin of each blueberry was mechanically cut, because it was determined that the skin makes the drying process slower or unable to complete. Based on the reviewed reference literature, it was decided to apply five mathematical models. Based on statistical indicators R^2 , X^2 , S and RMSE, it is concluded that the Page model best approximates the kinetics of freezing of American blueberries. Although the Page model most accurately corresponds to experimental data, other models can also be applied, because based on the applied statistical indicators, they also correspond with high precision.

Keywords: Mathematical modeling, American blueberry, freeze drying, drying kinetics

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MONITORING OF HETEROTROPHIC BACTERIA FOR BOTTLED WATER SAFETY MANAGEMENT

Dorota KREGIEL, ANNA RYGALA

*Department of Environmental Biotechnology, Faculty of Biochemistry and Food Sciences, Lodz
University of Technology, Wolczanska 171/173, 90-530 Lodz, Poland*

E-mail: dorota.kregiel@p.lodz.pl

The quality of drinking water is a worldwide concern and has a great impact on human health. Heterotrophic plate count is a parameter that quantifies various water systems. It has been widely adopted as a standard and simple technique for microbiological testing and safety management of drinking water. The heterotrophic plate count has a long history in drinking water microbiology. At the end of the nineteenth century, it was used as an indicator of the proper functioning of water treatment systems (filtration, disinfection), and as an indirect indicator of water safety. In the twentieth century, the use of heterotrophic plate count as a safety indicator declined due to the application of fecal indicators, namely coliforms and enterococci. Nevertheless, this method measurements and limits are still included in the water regulations and guidelines of many countries. Water safety is closely related to the presence of biofilms in water networks. A biofilm is a collection of organic and inorganic, living and dead material collected on a surface. It may be a complete film or, more commonly in water systems, small patches. Biofilms in drinking water are responsible for a wide range of water quality and operational problems. Biofilms can protect pathogenic microorganisms from disinfection, and, therefore, they can present a threat to public health. Biofilms can also color water and cause taste and odor problems. Moreover, corrosion of cast iron and ductile iron pipe and biofilm formation mutually accelerate the formation of each other, contributing to aging water infrastructure. Our scientific research was focused on detection of heterotrophic bacteria present in water installation systems during drinking water treatment and evaluation of bacterial abilities to form biofilms. Since the bacteriological quality of drinking water is highly dependent on the bacterial species present, the dominant heterotrophic bacteria were identified along with their capacity for biofilm formation. Microbiological monitoring was conducted using the heterotrophic plate count method, and biofilm formation - by luminometry. To identify the bacterial isolates, we used polyphasic identification based on microbiological and biochemical tests, as well as on the molecular analysis using ribosomal RNA. The results showed that the numbers of heterotrophic bacteria were highest in the water filtration station, UV station, and the holding tank. At these critical points of the industrial process, the water was stagnant or there was poor flow. Molecular analysis identified the bacterial isolates as belonging to genera: *Acinetobacter*, *Agrobacterium*, *Aeromonas*, *Brevundimonas*, *Citrobacter*, *Enterobacter*, *Klebsiella*, *Pantoea*, and *Rhizobium*. Bacterial isolates showed various levels of biofilm formation, and the best adhesion properties were exhibited by the *Aeromonas hydrophila* and *Citrobacter freundii* isolates.

Key words: water; treatment; heterotrophic bacteria; identification, adhesion, biofilms

SELECTED MECHANICAL PROPERTIES OF THE WOOD*Lubomír KUBÍK, Viera KAŽIMÍROVÁ, Monika BOŽIKOVÁ**Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic**E – mail: Lubomir.Kubik@uniag.sk*

Mechanical properties of the wood are important parameter of the realization of the wooden skeletons in the civil engineering.

Paper dealt with the study of the structure properties of wood exposed the bending load. Wood may be described as an orthotropic material. It has unique and independent mechanical properties in the directions of three mutually perpendicular axes: longitudinal, radial, and tangential. In each fibers orientation has wood different physical and mechanical properties. Compression loading of the samples was realized in the radial direction, vertically on the longitudinal fibers orientation. The modulus of elasticity determined from bending, rather than from an axial test, may be the only modulus of elasticity available for a species. Method of the three-point bending flexural test was used for determination of the modulus of elasticity in the bending. The dependencies of the force on the flexure, modulus of elasticity on the flexure and the modulus of elasticity on the force were determined. The strain energy needed for deformation of the beam were calculated from the force on the flexure dependencies or the stress on the strain dependencies as the volume energy. The wood beams of the pine (*Pinus Sylvestris*), the oak (*Quercus robur*) and the willow (*Salix alba*) were studied. Moisture of the pine samples was 6.522 %, of oak was 4.545 % and of willow samples was 7.246 %. The beams of the rectangular cross section of the size 6x6x330 mm were loaded by the universal test equipment Andilog Stentor 1000 (Andilog Technologies, Vitrolles France). Maximal loading forces reached 150 – 200 N with maximal deflexion of the samples 4 – 6 mm.

Keywords: wood, beam, bending, modulus of elasticity, strain energy

MIKRO BIOGASNA POSTROJENJA – NEISKORIŠTEN POTENCIJAL*Filip KULIĆ, Vladimir BUGARSKI, Ilija KAMENKO, Perica NIKOLIĆ**Univerzitet u Novom Sadu, Fakultet tehničkih nauka, Trg Dositeja Obradovića 6, Novi Sad**E-mail: kulic@uns.ac.rs*

Biogas je vrsta gasovitog biogoriva koje se dobija anaerobnom razgradnjom ili fermentacijom organskih materija, uključujući đubrivo, kanalizacioni mulj, komunalni otpad ili bilo koji drugi biorazgradivi otpad (ostatak od biljne i životinjske proizvodnje i prerade, organski otpad iz industrijske proizvodnje i sl.). Praktično, svaka ljudska delatnost ima za posledicu proizvodnju određene količine organskog otpada koji može biti iskorišten kao sirovina za proizvodnju određene količine biogoriva. U ovom radu će biti analizirani potencijali malih poljoprivrednih gazdinstava i farmara u Vojvodini za proizvodnju biogasa. Posebno će biti obrađena najčešće korištena tehničko – tehnološka rešenja za konstrukciju mikro fermentora pogodnih za proizvodnju biogasa na malim poljoprivrednim gazdinstvima.

Vojvodina se nalazi u severnom delu Republike Srbije, ima površinu od 21.614 km² i u njoj živi 1.852.000 stanovnika. U Vojvodini postoji preko 127.000 poljoprivrednih gazdinstava sa prosečnom obradivom površinom od 12,4 ha. Ipak, 58% gazdinstava poseduje manje od 5 ha a 75% manje od 10 ha. Svoje energetske potrebe, pored električne energije, nafte i zemnog gasa najčešće zadovoljavaju spaljivanjem biomase dok se proizvodnjom energije iz otpadnih sirovina, uz retke izuzetke, uopšte ne bave. Biološki otpad, ostaci od poljoprivredne proizvodnje se ne zbrinjavaju, odlažu se na ekološki neprihvatljiv način, pod vedrim nebom. Na taj način se pored zagađenja životne sredine gubi i velika količina energije.

U Vojvodini oko 95.000 gazdinstava poseduje manje od 10 ha obradive zemlje, u proseku 1 govedo, 5 svinja, 2 ovce i 65 komada živine. Ukupna količina proizvedenog stajnjaka i žetvenog ostatka po jednom domaćinstvu je dovoljna za godišnju proizvodnju oko 8.000 m³ biogasa kalorijske vrednosti 38 MWh. Vidi se da je ovo značajan izvor energije koji nije uopšte iskorišten, i veoma je bitno edukovati farmere o mogućnostima zbrinjavanja i iskorištenja biološkog otpada.

Biološki otpad se može iskoristiti za proizvodnju biogasa a ostatak nakon fermentacije (supstrat) kao prirodno đubrivo. Postoji više različitih tehničkih rešenja pogodnih za proizvodnju biogasa na malim farmama. Na izbor osnovnog dizajna fermentora anaerobne digestije utiču pristupačnost tehničkog rešenja, ekonomičnost i dostupnost lokalnih materijala i sirovina.

Tri glavne vrste fermentora koje će biti obrađene su fermentor sa nepokretnom kupolom, fermentor s plutajućim bubnjem i cevasti fermentor, koji predstavljaju sisteme mokre fermentacije za kontinualni rad u mezofilnim uslovima. Ove tri vrste fermentora su relativno jeftini, jednostavni su za rukovanje, nemaju mnogo pokretnih delova i na taj način su manje podložne kvarovima. Sledeći tip fermentora, kontejnerski tip, koji se koristi kao sistem suve digestije u šaržnom režimu, će takođe biti prikazan.

Ključne reči: biogas, otpad, ruralni razvoj.

**BIOGASNE ELEKTRANE I TRŽIŠTE ELEKTRIČNE ENERGIJE U
REPUBLICI SRBIJI***Filip KULIĆ**Univerzitet u Novom Sadu, Fakultet tehničkih nauka, Trg Dositeja Obradovića 6, Novi Sad**E-mail: kulic@uns.ac.rs*

Biogasne elektrane su prema poreklu goriva, obnovljivi izvori energije. Njihovi vlasnici spadaju u povlašćene proizvođače električne energije i njihova proizvodnja je subvencionisana od strane države. Povlašćeni proizvođači imaju mogućnost da pod ekonomski povoljnim i garantovanim subvencionisanim uslovima prodaju električnu energiju „Elektroprivredi Srbije“ u dužem vremenskom periodu.

U okviru globalne inicijative za smanjenje emisije štetnih gasova i efekta staklene bašte, kao i radi očuvanja zdrave životne sredine, Vlada Republike Srbije je tokom 2009. godine usvojila čitav set propisa kojima se uređuje proizvodnja energije iz obnovljivih izvora i utvrdila feed-in tarifu koja proizvođačima električne energije iz obnovljivih izvora omogućava da pod povoljnim i garantovanim subvencionisanim uslovima prodaju električnu energiju „Elektroprivredi Srbije“, u periodu od 12 godina.

Zakon o energetici iz 2014. godine doneo čitav niz mera i propisa koji detaljno regulišu oblast obnovljivih izvora energije, uključujući i sektor biogasa. Posebna pogodnost bila je mogućnost sticanja privremenog statusa povlašćenog proizvođača električne energije. Ova mera je bila snažan podsticaj za investitore, jer je omogućila dobijanje povlašćenog statusa pre ozbiljnih investicija u tehnologiju i postrojenje.

U Zakonu o energetici iz 2021 (Sl. glasnik RS 40/2021) ova problematika se briše i postaje predmet posebnog Zakona o korišćenju obnovljivih izvora energije (ZOIE) (Sl. glasnik RS 40/2021). Zakon o korišćenju obnovljivih izvora energije (Sl. glasnik RS 40/2021) ukida feed-in tarife i uvodi sistem aukcija za energiju iz OIE. Status privremenog povlašćenog proizvođača električne energije i dalje postoji i definisan je članom 23. ZOIE.

U ovom radu je izložen istorijski pregled promena na tržištu električne energije u Republici Srbiji vezanih za obnovljive izvore električne energije u periodu od 2009. do 2021. godine. Izvršena je analiza prethodnog perioda kao i trenutnog stanja na tržištu električne energije. Na osnovu toga su izvedeni određeni zaključci o trenutnoj isplativosti investiranja u određene tehnologije za proizvodnju električne energije iz obnovljivih izvora kao što su biogas i solarna energija.

Ključne reči: biogas, električna energija, tržište.

PREGLED I PREVENCIJA NAJČEŠĆIH OBOLJENJA KOD LJUDI ZAPOSLENIH U POLJOPRIVREDNOM SEKTORU

Sofija KULIĆ, Martin MAKAJI

Univerzitet u Beogradu, Medicinski fakultet, Dr Subotića starijeg 8, Beograd

E-mail: sofijakulic4@gmail.com

Zaposleni u poljoprivrednom sektoru su svakodnevno izloženi štetnim faktorima koji utiču na njihovo zdravlje. Kroz istoriju se, poboljšanjem uslova rada, incidenca bolesti vezanih za poljoprivredne poslove smanjila. Prepreku u istraživanjima, povezivanju određenih grana poljoprivrede sa rizicima koje one nose, predstavlja heterogeni spektar ljudi koji se ovom delatnošću bave na različitim nivoima. U ovom radu će biti obrađena neka od najučestalijih oboljenja povezanih sa radom u poljoprivrednom sektoru, kroz tri sistema organa: respiratorni, centralni nervni i muskuloskeletni. Cilj ovog rada jeste podizanje svesti kod zaposlenih u ovom sektoru o rizicima po zdravlje koje ono nosi, objašnjenje patogeneze ovih oboljenja, njihovog lečenja i vidova prevencije.

Najčešća oboljenja u ovoj populaciji su oboljenja respiratornog sistema. Dovode se u vezu sa direktnom izloženošću poljoprivrednika štetnim partikulama u vazduhu različitog porekla, izduvnim gasovima i hemikalijama. Najučestalija respiratorna oboljenja u ovoj populaciji su hronična opstruktivna bolest pluća, oboljenja infektivnog tipa (bakterijska i gljivična oboljenja), bronhitis i astma. Glavni faktori rizika kod ove populacije predstavljaju prašina organskog i neorganskog porekla, bakterije, endotoksini, spore i potencijalno toksični gasovi poput hidrogen sulfida.

Poremećaji u funkcionisanju centralnog nervnog sistema mogu biti različitog porekla i simptomatologije. Mogu biti posledice trovanja različitim hemikalijama (organofosfatima i nikotinom) koje dovode do stanja poput poremećaja vida, kontrole govora, pamćenja, ubrzanog propadanja neurona, konvulzija, kome i smrti.

Povrede muskuloskeletnog sistema obuhvataju skoro svakodnevne povrede na radu, koje su učestale kod fizičkih radnika svih vrsta, tu spadaju bolovi u leđima, povrede n. ischiadicus-a, iščašenja zglobova, prelomi kostiju... Kod radnika koji se bave fizički zahtevnim poslovima dolazi do preopterećenosti kičmenog stuba, a najveći pritisak trpi lumbosakralni deo kičme. Česte su povrede pršljenova u vratnom i lumbosakralnom delu kičme koje dovode do degradacije kičmenog stuba i mogu biti praćeni posledicama koje utiču na poslovni, ali i privatni život.

Ključne reči: oboljenja, poljoprivreda, respiratorni sistem, centralni nervni sistem, muskuloskeletni sistem

PRIMENA KLASTER ANALIZE ZA ISPITIVANJE KVALITETA RAZLIČE VRSTE HRANE U ISHRANI MAGARACA

*Jasmina LAZAREVIĆ, Tatjana PEULIĆ, Bojana KOKIĆ, Danka DRAGOJLOVIĆ, Predrag
IKONIĆ, Aleksandra NOVAKOVIĆ, Viktor STOJKOV*

*Univerzitet u Novom Sadu, Institut za prehrambene tehnologije, 21000 Novi Sad, Bulevar cara
Lazara I, Srbija*

E-mail: jasmina.lazarevic@fins.uns.ac.rs

U cilju istraživanja kvaliteta različitih vrsta hrane u ishrani magaraca tokom svih godišnjih doba u toku godine primenjena je klaster analiza (CA) i analiza glavnih komponenti (PCA) koja identifikuje varijable vezane za kvalitet. Životinje su kontinuirano pasle na Valjevačkom pašnjaku Specijalnog rezervata prirode Zasavica tokom sezone uz dodatak livadskog sena i kukuruza tokom zime i deteline tokom proleća/leta. Uporedni prikaz kvaliteta pašnjaka (proleće/jesen i leto), livadskog sena, deteline i kukuruza u pogledu hemijskog i mineralnog sastava, kao i profila masnih kiselina, analiziran je tokom ishrane magaraca. Primenom CA uzorci su grupisani na način da se slične varijable nalaze u istoj klasi za različite vrste hrane za magarce.

Iz dobijenih rezultata vidljivo je da je sadržaj suve materije, proteina i masti pašnjaka u proleće/jesen veći u odnosu na leto, dok je u letnjem periodu povećan sadržaj celuloze. Iz rezultata CA mogu se uočiti tri odvojena klastera: desni klaster koji obuhvata uzorke sa pašnjaka u proleće i leto, srednji klaster koja obuhvata livadsko seno i kukuruz i desni klaster koji obuhvata uzorke dateline. Desni klaster karakterišu povećane koncentracije polinezasićenih masnih kiselina, nezasićenih masnih kiselina i minerala, a levi klaster karakterišu povećane koncentracije zasićenih masnih kiselina, odnosa zasićenih i nezasićenih masnih kiselina, kao i povećan sadržaj fosfora, kalijuma i masti. Livadsko seno je bogato mineralima kalcijumom, manganom, magnezijumom, cinkom, gvožđem i α -linoleinskom masnom kiselinom, dok je kukuruz bogat mononezasićenom, linolnom i oleinskom masnom kiselinom. Utvrđeno je da dve glavne komponente čine 81,60 % ukupne varijanse u podacima. Ovi rezultati ukazuju da CA i PCA omogućavaju razlikovanje kvaliteta različitih vrsta hrane u ishrani magaraca i odgovarajuće predviđanje vrednosti sastava na osnovu smanjenog broja parametara.

Ključne reči: ishrana magaraca, kvalitet hrane za magarce, klaster analiza, analiza glavnih komponenti

ZAHVALNICA

Ovaj rad je rezultat istraživanja sprovedenog u okviru Ministarstva prosvete, nauke i tehnološkog razvoja republike Srbije, Naučni institut za prehrambene tehnologije u Novom Sadu (br. 451-03-9/2021-14/200222).

USE OF CLUSTER ANALYSIS TO EXAMINE DIFFERENT TYPES FORAGE OF FOOD IN THE DONKEYS DIET

*Jasmina LAZAREVIĆ, Tatjana PEULIĆ, Bojana KOKIĆ, Danka DRAGOJLOVIĆ, Predrag
IKONIĆ, Aleksandra NOVAKOVIĆ, Viktor STOJKOV*

*University of Novi Sad, Institute of Food Technology, 21000 Novi Sad, Bulevar cara Lazara 1,
Serbia*

E-mail: jasmina.lazarevic@fins.uns.ac.rs

The aim of this study was to investigate the quality of different forages types in the donkey's diet during all seasons. Cluster analysis (CA) and analysis of major components (PCA) was applied, which identifies variables related to quality. The animals continuously grazed on the Valjevac pasture from Zasavica Special Nature Reserve during the season with addition of meadow hay and corn during winter and clover during spring/summer. A comparative presentation of pastures (spring/autumn and summer), meadow hay, clover and corn quality in terms of chemical and mineral composition, as well as the profile of fatty acids, was analyzed during the donkey's diet. The CA samples were grouped as follows that similar variables are found in the same class for different types forages.

From the obtained results, it is evident that the content of dry matter, protein and fat of pastures in spring/autumn is higher compared to summer, while the content of cellulose is higher in the summer. The CA shows three separate clusters: the right cluster, which includes samples from pastures in the spring and summer, the middle group, which includes meadow hay and corn, and the right cluster, which includes samples clover. Right cluster is characterized by higher concentrations of polyunsaturated fatty acids, unsaturated fatty acids and minerals and left cluster is characterized by higher concentrations of saturated fatty acids, saturated/unsaturated fatty acid ratios, minerals phosphorus, potassium and fats. Meadow hay is rich in minerals calcium, manganese, magnesium, zinc, iron and n-3 alpha-linolenic acid, while corn is rich in monounsaturated and n-6 linoleic and n-9 oleic fatty acids. It was found that two principal components account for 81.60% of the total variance in the data. These results indicate that CA and PCA enable the distinction of different forage types and appropriate prediction of the compositions value on the basis of a reduced number of parameters.

Key words: donkey diet, food quality forage, cluster analysis, principal components analysis

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**PRIMJENA BILJNE BIOFOTONIKE UTEMELJENE NA KLOROFILU U
POLJOPRIVREDI**Hrvoje LEPEDUŠ^{1,2}, Tomo TRSTENJAK³¹Filozofski fakultet Osijek, L. Jägera 9, HR-31000 Osijek, Hrvatska²Fakultet za dentalnu medicinu i zdravstvo Osijek, L. Jägera 9, HR-31000 Osijek, Hrvatska³Državni inspektorat, Ulica Hrvatske Republike 21, HR-31000 Osijek, HrvatskaE-mail: hlepedus@ffos.hr

Klorofili, zeleni pigmenti biljaka, imaju sposobnost emitiranja crvene do daleke crvene svjetlosti kad se osvijetle svjetlošću koja pokreće fotosintezu (PAR, 400 – 700 nm). *In vivo* promjene ove crvene svjetlosti moguće je utvrditi i mjeriti pomoću posebno dizajniranih fluorometara te stoga može poslužiti kao moćan alat za istraživanje fotosintetske aktivnosti biljaka. Proces fotosinteze, osim što je ključni proces u primarnom metabolizmu, uvelike je određen djelovanjem različitih okolišnih stresora te ujedno predstavlja i proces koji omogućava istraživanja utjecaja dotičnih stresora na razvoj i fiziologiju biljaka. Iako postoji nekoliko metodoloških varijanti *in vivo* mjerenja fluorescencije klorofila koje se najčešće susreću u istraživanjima, njihove zajedničke karakteristike bile bi: laka izvedba, ne-destruktivnost, jeftinoća te veliki broj bioloških informacija koje ove metode daju. Sama metoda je bazirana na mjerenju crvene fluorescencije klorofila koju emitira biljni materijal, prethodno prilagođen uvjetima tame, osvjetljen pulsom saturirajuće svjetlosti ($3200 \mu\text{molm}^{-2}\text{s}^{-1}$, maksimum na 650 nm). Primjena saturirajućeg pulsa inducira porast fluorescencije klorofila *a* od vrijednosti minimalne fluorescencije (na 50 μs , F₀, O-korak), kad su svi reakcijski centri otvoreni, do maksimalne fluorescencije (na 1 s, F_m, P-korak), kad su svi reakcijski centri zatvoreni. Nadalje, indukcijske svjetlosne krivulje pokazuju polifazni karakter porasta fluorescencije, koji se sastoji od dva koraka (J-korak na 2 ms te I-korak na 30 ms). Originalni sirovi podatci dobiveni iz mjerenja porasta fluorescencije mogu se upotrijebiti za izračun određenog broja biofizičkih parametara koji opisuju fotokemiju fotosistema II (PSII) u kloroplastima.

Različiti okolišni stresori poput povišenog osvjetljenja, temperature, vodnog režima, statusa mineralne ishrane i kemijske toksičnosti mogu imati štetan učinak na fotosintezu, posebno na PSII, a u konačnici također i na prinos usjeva. Ovdje će biti razmotrena i raspravljena biofizička pozadina mjerenja *in vivo* fluorescencije klorofila kao i nekoliko mogućih aplikacija ove metode u oplemenjivanju i poljoprivrednoj proizvodnji.

CHLOROPHYLL-DRIVEN PLANT BIOPHONICS APPLICATION IN AGRICULTURE

Hrvoje LEPEDUŠ^{1,2}, Tomo TRSTENJAK³

¹Faculty of Humanities and Social Sciences Osijek, L. Jägera 9, HR-31000 Osijek, Croatia

²Faculty of Dental Medicine and Health Osijek, L. Jägera 9, HR-31000 Osijek, Croatia

³State Inspectorate, Ulica Hrvatske Republike 21, HR-31000 Osijek, Croatia

E-mail: hlepedus@ffos.hr

Chlorophylls, plants green pigments, reveal capability of red to far-red light emission when illuminated with photosynthetically active radiation (PAR, 400 – 700 nm). The *in vivo* changes of this red light can be detected and measured by specially designed fluorimeters and can be used as a powerful tool for the investigation of plant photosynthetic activity. Since the process of photosynthesis is, besides its key role in primary plant metabolism, largely influenced by different environmental stressors it also allows study of their effects on plant development and physiology. Although there are several variants of the *in vivo* chlorophyll fluorescence measurements method that are widely represented in the current studies, their common features give us the opportunity to describe it as simple and easy to perform, non-destructive, relatively cheap and highly informative in the biological context. Method itself is based on the measurement of red chlorophyll fluorescence that is emitted by dark-adapted plant material upon a pulse of saturating red light ($3200 \mu\text{molm}^{-2}\text{s}^{-1}$, peak at 650 nm). The application of the saturating light pulse induces chlorophyll *a* fluorescence increases from minimum fluorescence (at 50 μs , F_0 , O step), when all reaction centers are open, to maximum fluorescence (at 1 s, F_m , P step), when all reaction centers are closed. Further, induction light-curves show the polyphasic fluorescence rise, consisting of two intermediate steps (J step at 2 ms and I step at 30 ms). The original data obtained from fluorescence transient can be used to calculate a certain number of biophysical parameters that describes the photochemistry of photosystem II (PSII) in chloroplasts.

Different environmental stressors such as increased irradiation level, temperature, water status, mineral nutrition status and chemical toxicity can have a detrimental effect on photosynthesis, especially on PSII, as well as on crop yield, eventually. Here will be presented and discussed biophysical background of the *in vivo* chlorophyll fluorescence measurement as well as several possible applications of the method in crop breeding and production.

**ISKUSTVA U SUŠENJU ULJARICA NA SUŠARI „POBEDA“ TIP IVSZ-9 U FU
„BANAT“ NOVA CRNJA***Neđeljko LUČIĆ, Nada GRBIĆ, Šandor BICOK, Milan ĐUKIĆ**Fabrika ulja „Banat“ AD Nova Crnja**E-mail: nedjeljkolucic@uljarabanat.rs*

U radu su prikazani rezultati sušenja suncokreta i soje u periodu 2016-2020. godine na sušari „Pobeda“. U Fabrici ulja „Banat“ instalisana je sušara Pobeda tip IVSZ-9 koja ispunjava zahteve i potrebe Silosa velikih kapaciteta prijema, sušenja i skladištenja. U toku otkupa uljarica, a naročito suncokreta, optimalno funkcionisanje sušare „Pobeda“ i povezanih tehnoloških linija predstavlja osnovni uslov za uspešan odgovor Silosa na zahteve vezane za prijem sirovine u Fabricu. Rad sadrži podatke vezane za rezultate sušenja suncokreta izražene na nivou otkupa u periodu 2016-2020 godine, kao i specifične slučajeve sušenja suncokreta i soje. Analizirani su odnosi specifične potrošnje energije i ulazne vlage pri okvirno istim uslovima sušenja. Takođe, troškovi sušenja dati su za svaki konkretan slučaj s ciljem da se prikaže odnos ekonomske i energetske efikasnosti rada sušare „Pobeda“.

Ključne reči: Suncokret, soja, sušenje, specifična energija.

**STUDIES ON THE STABILITY OF GRAIN WEIGHT PER PLANT IN
AUTUMN OAT (*AVENA SATIVA* L.)**

*Emilian MADOSA¹, Sorin CIULCA¹, Giancarla VELICEVICI¹, Adriana CIULCA¹, Lavinia SASU²,
Constantin AVADANEI¹*

*¹Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I from Romania"
Timisoara Romania,*

²Vasile Goldis" Western University Arad Romania

E-mail: madosae@yahoo.com

The aim of the study was to assess the stability of the weight of the grains per plant in the autumn oats, under the influence of climatic conditions. The study was conducted over a period of three years, examining a collection of 73 autumn oat genotypes. The experimental data were obtained by biometric measurements on representative samples. The experimental data processing was performed using several linear regression models: Finlay-Wilkinson, Hardwick-Wood, Muir and Wrike. The grains weight of the plant is a main character used in the application of the selection. The values determined varied according to the genotype and climatic conditions of the experimental year. The grain production per plant had the highest stability and the lowest interaction genotype x environment occurred in the genotypes Valiant, Solva, 4484, Emperor, Cocker 41-51. The high values of grain weight per plant are associated with good stability in the Blamouth, 834-4-1-3, PA 725-6113 genotypes. A strong influence of the interaction genotype x environment was found in the genotypes Boer, Marettos Anderson, PA 621-3274, 2032, 8276. In the use of autumn oat germplasm to improve the grains production on the plant, the genotype has a decisive role. The imperfect correlations influence the interaction genotype x environment in a proportion of 66.5%. As a result, the stability of this trait depends on the genotype.

Key words: autumn oat, grain weight per plant, stability

POREĐENJE SENZORNE I INSTRUMENTALNE METODE ODREĐIVANJA BOJE MEDA

Nikola MARAVIĆ¹, Dubravka ŠKROBOT¹, Marijana SAKAČ¹, Jelena TOMIĆ¹, Aleksandar MARIĆ¹,
Tatjana PEULIĆ¹, Aleksandra NOVAKOVIĆ¹

¹Univerzitet u Novom Sadu, Naučni institut za prehrambene tehnologije, Bulevar cara Lazara 1, 21000
Novi Sad, Srbija

E-mail: nikola.maravic@fins.uns.ac.rs

Boja meda je jedna od prvih kvalitativnih karakteristika koje ocenjuju kupci i važna senzorna karakteristika na tržištu meda. Takođe, jedan je od parametara koji ukazuje na poreklo i kvalitet meda. Za određivanje boje meda mogu da se koriste brojne instrumentalne i senzorne metode. Utvrđivanje povezanosti podataka dobijenih korišćenjem navedenih metodologija može pomoći prilikom analize i interpretacije instrumentalno dobijenih podataka i poređenja sa senzornim karakteristikama proizvoda.

U ovom radu, prikazano je poređenje dve navedene metodologije za određivanje boje meda. Uzorci meda (n=57) sakupljeni su sa planine Rtanj tokom dve sezone 2018/2019. Analiza uzoraka podrazumevala je senzornu analizu, sprovedenu od strane treniranih senzornih panelista (n=10, 6 žena i 4 muškarca) i instrumentalne analize, urađene pomoću kolorimetra Konica Minolta CR400 (Konica Minolta Co., Osaka, Japan). U senzornoj analizi, boja je vizuelno određivana uz pomoć Pfundovog dijagrama, koji predstavlja relativnu svetloću/tamnoću ćilibara na skali u milimetrima. Prilikom korišćenja instrumentalne analize, rezultati su izraženi pomoću svetloće (L*), udela crvenog/zelenog tona (a*), žuto/plavog tona (b*), saturacije (C*) i nijanse boje (h*), prema CIELab sistemu boja. Kako bi se uporedile dve navedene metodologije, rezultati instrumentalnog merenja pomoću jednačine $mmPfund = -0,631L^* + 0,840C^* - 1,026h + 155,89$ konvertovani su u Pfundovu skalu. Merenje je izvršeno u tri ponavljanja. Statistička analiza instrumentalno dobijenih podataka urađena je pomoću računarskog programa XLSTAT i analize varijansi (ANOVA, $p < 0,05$). Nakon analize varijansi korišćen je Tukijev HSD test kako bi se utvrdila značajnost razlike između uzoraka.

Rezultati dobijeni senzornom analizom treniranih panelista pokazuju da se boja meda kreće od „vodeno bele“ do „ćilibarne“, dok instrumentalni podaci pokazuju da se boja kreće od „svetlo ćilibarne“ do „tamno ćilibarne“. Najveći broj uzoraka dobijenih senzornom analizom se nalazi u ekstra svetloj ćilibarnoj zoni (59.6%), zatim u svetlo ćilibarnoj (19.3%), beloj (15.8%), vodeno beloj (3.5%) i ćilibarnoj zoni (1.8%). U slučaju instrumentalne analize, najveći broj uzoraka se nalazi u svetlo ćilibarnoj zoni (50.9%), a zatim u ćilibarnoj (43.8%) i tamno ćilibarnoj (5.3%). Na osnovu dobijenih rezultata može da se zaključi da je senzorna analiza selektivnija jer su dobijeni uzorci klasifikovani u više zona boja. Dalja istraživanja su potrebna kako bi se bolje izučila korelacija između dva ispitivana pristupa.

Ključne reči: med, boja, instrumentalne metode, senzorna analiza

ZAHVALNICA

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COMPARISON OF SENSORY AND INSTRUMENTAL METHODS IN DETERMINATION OF HONEY COLOR

*Nikola MARAVIĆ¹, Dubravka ŠKROBOT¹, Marijana SAKAČ¹, Jelena TOMIĆ¹, Aleksandar MARIĆ¹,
Tatjana PEULIĆ¹, Aleksandra NOVAKOVIĆ¹*

¹*University of Novi Sad, Institute of Food Technology, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia*

E-mail: nikola.maravic@fins.uns.ac.rs

Honey color is the first quality attribute evaluated by consumers and an important sensory characteristic in the beekeeping market. Also, it is one of parameters which can indicate botanic origin and the quality of honey. In order to determine honey color several instrumental and sensory methods can be used. Furthermore, finding connection between data obtained by these two methodologies could help in understanding and interpretation of instrumentally obtained data about key sensory characteristic of products.

In this paper, comparison of two used methodologies for honey color determination is presented. Honey samples (n = 57) were collected on the mountain Rtanj during two seasons 2018/2019. Analysis of the samples included sensory analysis, performed with trained sensory panelists (n = 10, six female and four male) and instrumental analysis, performed by using a colorimeter Konica Minolta CR400 (Konica Minolta Co., Osaka, Japan). In the sensory analysis, the color was directly estimated visually by using the Pfund diagram, which represent relative lightness/darkness of amber on a scale in millimeters. In the instrumental analysis, measured color was expressed in terms of L* (brightness/darkness), a* (redness/greenness), b* (yellowness/blueness), C* (chroma/saturation) and h (hue angle) according to CIELab system of colors. In order to compare data obtained by these two methodologies, instrumentally measured data were converted into Pfund scale as well, by using equation $mmPfund = -0.631L^* + 0.840C^* - 1.026h + 155.89$. The measurements were performed in triplicate. Statistical analysis of the instrumentally obtained data was performed by using XLSTAT software and analysis of variance (ANOVA) at the level of $p < 0.05$. Tukey's HSD test followed ANOVA in order to investigate significance of difference between samples.

Results obtained from the trained sensory panel showed that honey color ranges from "water white" to "amber", while instrumental data ranges from "light amber" to "dark amber". Most of the results obtained from sensory analysis were found in extra light amber area (59.6%), followed by light amber (19.3%), white (15.8%), water white (3.5%) and amber (1.8%). In the case of instrumental analysis, highest number of samples were light amber (50.9%), followed by amber (43.8%) and dark amber (5.3%). According to the obtained results we can assume that the sensory analysis was more selective since the samples were classified in more color areas. Further analysis must be performed in order to better understand correlation between these two approaches.

Keywords: honey, color, instrumental method, sensory evaluation

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PROCENA KVALITETA MEDA SA PODRUČJA RTANJSKIH PLANINA

Aleksandar MARIĆ¹, Pavle JOVANOVIĆ¹, Marijana SAKAČIĆ¹, Aleksandra NOVAKOVIĆ¹, Nikola MARAVIĆ¹, Radmila RADOVIĆ¹, Predrag IKONIĆ¹

¹Univerzitet u Novom Sadu, Naučni institut za prehrambene tehnologije u Novom Sadu, Bulevar cara Lazara I, Novi Sad, Srbija

E-mail: aleksandar.maric@fins.uns.ac.rs

Med je prirodni proizvod koji sadrži više od 200 različitih jedinjenja i sastoji se uglavnom od šećera, vode i drugih komponenata kao što su organske kiseline, proteini (enzimi), vitamini, minerali i fenolna jedinjenja. Kako je med hrana koja se konzumira širom planete, potrebni su određeni standardi i norme koje garantuju njegov identitet i kvalitet u cilju bezbedne konzumacije od strane potrošača. Ograničena dostupnost i relativno visoka cena ovog prirodnog proizvoda dobar su povod za krivotvorenje meda. Stoga, određivanje parametara kvaliteta meda je od izuzetne važnosti iz aspekta identifikacije markera koji potvrđuju njegovu autentičnost.

Kvalitet meda određuje se na osnovu njegovih fizičko-hemijskih karakteristika od kojih su najvažnije sadržaj vode, pH vrednost, kiselost, električna provodljivost, sadržaj pepela, sadržaj saharoze i redukujućih šećera, kao i sadržaj HMF-a.

Cilj ovog rada je bio da se odrede parametri kvaliteta (sadržaj vode, pH, ukupna kiselost i električna provodljivost) uzoraka livadskog meda sa planine Rtanj, prikupljenih u 2019. godini.

Na osnovu dobijenih rezultata određivanja parametara kvaliteta meda, koji su se kretali u rasponu: sadržaj vode (13,6 – 18,6 %), pH vrednost (3,4 – 5,3), ukupna kiselost (23,2 – 47,7 mmol/kg) i električna provodljivost (0,2 – 1,3 mS/cm), može se zaključiti da su svi uzorci bili u skladu sa propisanim nacionalnim i EU regulativama, osim u slučaju električne provodljivosti, gde je u četiri uzorka meda uočena vrednost veća od 0,8 mS/cm koja je propisana regulativama.

Povećana vrednost električne provodljivosti može se objasniti činjenicom da su uzorci prikupljeni na različitim lokalitetima i da je došlo do mešanja nektarskog meda sa medljikovcem, koji je karakterističan za šumsko područje.

Ključne reči: med; fizičko-hemijski parametri; kvalitet meda

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ASSESSMENT OF HONEY QUALITY FROM THE AREA OF RTANJ MOUNTAINS

Aleksandar MARIĆ¹, Pavle JOVANOVIĆ¹, Marijana SAKAČ¹, Aleksandra NOVAKOVIĆ¹, Nikola MARAVIĆ¹, Radmila RADOVIĆ¹, Predrag IKONIĆ¹

¹University of Novi Sad, Institute of Food Technology in Novi Sad, Bulevar cara Lazara 1, Novi Sad, Serbia

E-mail: aleksandar.maric@fins.uns.ac.rs

Honey is a natural product that contains more than 200 different compounds and consists mainly of sugar, water, and other components such as organic acids, proteins (enzymes), vitamins, minerals, and phenolic compounds. As honey is food consumed all over the planet, certain standards and norms are needed that guarantee its identity and quality to be safely consumed by consumers. The limited availability and relatively high price of this natural product are good reasons to counterfeit honey. Therefore, determining the parameters of honey quality is extremely important from identifying markers that confirm its authenticity.

The quality of honey is determined based on its physical and chemical characteristics, the most important of which are water content, pH value, acidity, electrical conductivity, ash content, sucrose content, reducing sugars, and HMF content.

The aim of this work was to determine the quality parameters (water content, pH, total acidity, and electrical conductivity) of meadow honey samples from the mountain Rtanj, collected in 2019.

Based on the obtained results of certain parameters of honey quality, which ranged from: water content (13.6 – 18.6%), pH value (3.4 – 5.3), total acidity (23.2 – 47.7 mmol/kg), and electrical conductivity (0.2 – 1.3 mS/cm), it can be concluded that all samples were in accordance with the prescribed national and EU regulations, except in the case of electrical conductivity, where four samples of honey observed value greater than 0.8 mS/cm prescribed by regulations.

The increased electrical conductivity value can be explained by the fact that samples were collected at different localities and that nectar honey was mixed with honeydew, which is characteristic of the forest area.

Key words: honey, physico-chemical parameters, honey quality

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**MODEL PREDVIĐANJA SVARLJIVOSTI SUVE MATERIJE KOD
PREŽIVARA ZA GENOTIPOVE KUKURUZA IZ SRBIJE**

Marija MILAŠINOVIC-ŠEREMEŠIĆ¹, Jelena SRDIĆ², Milica RADOSAVLJEVIĆ², Olivera ĐURAGIĆ¹, Jelena VUJETIĆ¹

¹Univerzitet u Novom Sadu, Naučni institut za prehrambene tehnologije u Novom Sadu, Bulevar cara Lazara 1, Novi Sad, Srbija

²Institut za kukuruz „Zemun Polje“, Slobodana Bajića 1, Beograd, Srbija

E-mail: marija.milasinovic@fins.uns.ac.rs

Kukuruz (*Zea mays L.*) je poznat kao glavni energetski sastojak hrane za životinje koji ima najveću konverziju suve materije u meso, mleko i jaja u odnosu na sva druga žita. Skrob je dominantni hemijski konstituent (oko 70%) u zrnju kukuruza. Zbog svoje dostupnosti skrob je glavna energetska komponenta koja se koristi u hrani za preživare. Ovaj ugljeni hidrat se često koristi za poboljšanje fermentacije buraga, optimizaciju varenja strukturalnih ugljenih hidrata, povećanje protoka proteina u tanko crevo itd. Na svarljivost zrna kukuruza utiču mnogobrojni faktori kao što su vrsta kukuruza, tip endosperma, veličina čestica itd. Zrno normalnog tipa kukuruza je veoma svarljivo zbog visokog sadržaja skroba i niskog sadržaja sirovih vlakana.

Cilj rada je bio ispitivanje fizičkih parametara kvaliteta i *in vitro* svarljivosti suve materije zrna (IVSSM) različitih genotipova kukuruza koji se gaje u Srbiji. Dalje, cilj je bio da se utvrdi odnos između pomenutih parametara kvaliteta, kao i njihov uticaj na IVSSM.

Ispitano je deset genotipova kukuruza sa različitim tipom endosperma i bojom zrna (rod iz 2018. godine).

Svi parametri kvaliteta zrna značajno su varirali kod ispitivanih genotipova kukuruza. IVSSM se kretala od 83,1-91,2%. Utvrđen je *in vitro* model predikcije IVSSM kod preživara. Fizički parametri kvaliteta kao što su hektolitarska masa (HM), apsolutna masa (AM), specifična težina ili gustina (G) i udeo tvrde frakcije endosperma (TF) su imali značajan uticaj na predviđanje svarljivosti. Na IVSSM je najviše uticala hektolitarska masa i gustina u FOP modelu ($p < 0,01$). Utvrđen *in vitro* model svarljivosti može poslužiti za skrining zrna različitih genotipova kukuruza radi procene njihove upotrebne vrednosti u industriji hrane za životinje.

Ključne reči: zrno kukuruza, fizičke osobine, *in vitro* svarljivost

ZAHVALNICA

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MODEL PREDICTION OF RUMINAL DRY MATTER DIGESTIBILITY OF SERBIAN MAIZE GENOTYPES

Marija MILAŠINOVIĆ-ŠEREMEŠIĆ¹, Jelena SRDIĆ², Milica RADOSAVLJEVIĆ², Olivera ĐURAGIĆ¹, Jelena VUJETIĆ¹

¹University of Novi Sad, Institute of Food Technology in Novi Sad, Bulevar cara Lazara 1, Novi Sad, Serbia

²Maize Research Institute, Zemun Polje, Slobodana Bajića 1, Belgrade, Serbia

E-mail: marija.milasinovic@fins.uns.ac.rs

Maize (*Zea mays* L.) has been recognised as a major energy feed ingredient giving the highest conversion of dry matter into meat, milk and eggs in relation to other cereal grains. Starch is the predominant chemical constituent (approximately 70%) in maize grain. Due to its availability starch is the main energy component used in ruminant feeds. This carbohydrate is often used to improve rumen fermentation, optimizing digestion of structural carbohydrates, increasing protein flow to the small intestine etc. The digestibility of maize grain is affected by a variety of factors such as type of maize, type of endosperm, particle size etc. Normal maize grain is highly digestible due to its high starch content and low crude fibre content.

The focus of this study is on the physical quality traits and *in vitro* dry matter digestibility (IVDMD) of various maize kernel genotypes grown in Serbia. Furthermore, the aim was to determine the relationship among these quality traits, as well as, their effects on the IVDMD.

Ten maize genotypes with different endosperm type and kernel color have been studied (2018 growing season).

All kernel traits significantly varied among selected maize genotypes. IVDMD ranged from 83.1-91.2%. *In vitro* regression model of IVDMD in ruminants was obtained. The physical quality traits such as test weight (TWt), 1000-kernel weight (KWt), density (Den) and hard endosperm portion (HE) had significant role in predicting the digestibility. The IVDMD was mostly affected by test weight and density in the FOP model ($p < 0.01$ level). The determined *in vitro* digestibility model can serve for screening various maize kernel genotypes due to estimate their utility value for feed industry.

Key words: maize grain, physical traits, *in vitro* digestibility

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TEHNIČKA EFIKASNOST KAO MERA EKONOMSKE ODRŽIVOSTI POLJOPRIVREDNIH GAZDINSTAVA REPUBLIKE SRBIJE

Aleksandar MILJATOVIĆ, Veljko VUKOJE, Dragana TEKIĆ

Univerzitet u Novom Sadu, Poljoprivredni fakultet, Novi Sad, Trg Dositeja Obradovića 8

E-mail: aleksandar.miljatovic@polj.uns.ac.rs

Cilj istraživanja je da se oceni tehnička efikasnost poljoprivrednih gazdinstava Republike Srbije i zatim utvrdi dostignuti nivo ekonomske održivosti ovih gazdinstava. Tehnička efikasnost se iskazuje odnosom ostvarenih autputa i korišćenih inputa. U radu se ovaj odnos računa pomoću neparametarske metode obavljanja podataka (engl. Data Envelopment Analysis – DEA). Ukupna vrednost proizvodnje se koristi kao autput varijabla, dok su sa druge strane korišćena četiri standardna inputa u poljoprivredi: korišćena radna snaga iskazana u godišnjim jedinicama rada, ukupno korišćeno poljoprivredno zemljište, ukupna međufazna potrošnja i vrednost ukupne imovine. Model je ulazno orijentisan sa promenljivim prinosom na obim. Ovaj model ima svoje prednosti u odnosu na model sa konstantnim prinosom na obim i primenjuje se prevashodno u uslovima nesavršene konkurencije u kojima posluju i posmatrana gazdinstva. Analiza je rađena na osnovu FADN (engl. Farm Accountancy Data Network) podataka iz 2020. godine. Iz uzorka je isključen jedan broj gazdinstava zbog ekstremnih vrednosnih pokazatelja, nakon čega je bilo 1.544 jedinica posmatranja u modelu. Tehnička efikasnost gazdinstava Srbije je na relativno niskom nivou (0,346). Ovo ukazuje na činjenicu da postoje značajne rezerve za potencijalno smanjenje korišćenih inputa, a da pritom vrednost autputa ostane ista. Posmatrano po tipovima proizvodnje najefikasnija su gazdinstva koja se bave hortikulturom (0,542), zatim slede gazdinstva koja se bave svinjarstvom i živinarstvom (0,458) i voćarstvom i vinogradarstvom (0,433), dok je najmanje efikasno mlečno govedarstvo (0,292). Primetno je da intenzivniji tipovi gazdinstava imaju bolji autput-input odnos, što ukazuje na to da ova gazdinstva dostižu i viši nivo ekonomske održivosti. Naravno, ekonomska održivost je znatno širi pojam i efikasnost, iako pouzdan indikator, nije jedini kojim se može iskazati održivost gazdinstava. S tim u vezi, dalja istraživanja bi trebala ići u pravcu jedne sveobuhvatnije analize ekonomske održivosti gazdinstava koja će pored tehničke efikasnosti uzeti u obzir i druge relevantne indikatore kao što su: profitabilnost, produktivnost, likvidnost, stabilnost. Pri tome, s obzirom na ograničenja FADN baze koja su posebno primetna kod obračuna indikatora likvidnosti i stabilnosti, potrebno je kontinuirano raditi na poboljšanju podataka i unapređenju celokupnog sistema.

Ključne reči: tehnička efikasnost, ekonomska održivost, poljoprivredna gazdinstva, DEA, FADN.

ZAHVALNICA

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**TECHNICAL EFFICIENCY AS A MEASURE OF FARM ECONOMIC
SUSTAINABILITY IN REPUBLIC OF SERBIA***Aleksandar MILJATOVIĆ, Veljko VUKOJE, Dragana TEKIĆ**University of Novi Sad, Faculty of Agriculture, Novi Sad, Trg Dositeja Obradovića 8**E-mail: aleksandar.miljatovic@polj.uns.ac.rs*

The aim of this research is to investigate farm technical efficiency in Republic of Serbia and then to determine achieved level of farm economic sustainability. Technical efficiency is evaluated as realized output and used input ratio. In this paper the ratio is calculated by applying a non-parametric data envelopment analysis (DEA) method. Total output in value is used as an output variable, while on the other hand the four standard inputs in agriculture are used: total labour input in annual work units, total utilised agricultural area, total intermediate consumption and total assets value. Model is input oriented with variable return to scale. The model has its advantages in comparison with constant return to scale and is primarily applied in imperfect competition conditions in which observed farms performs. Analysis is based on FADN (Farm Accountancy Data Network) data from 2020. Certain number of farms was excluded from the sample due to extreme value indicators, after what model had 1,544 observation units. Farm technical efficiency in Serbia is on relatively low level (0.346). This indicates the fact that there are significant reserves for potentially input reduction, without output reducing. According to types of farming the most efficient farms are the ones involved in horticulture production (0.542), followed by granivores (0.458) and vineyards and fruits (0.433), while the least efficient are dairy production (0.292). It is noticeable that more intensive types of farming have better output-input ratio, which indicates that those farms reached higher economic sustainability level. Of course, economic sustainability is wider term and efficiency, although a reliable indicator, isn't the only one for expressing farm economic sustainability. About that, further research should be focused on one comprehensive farm economic sustainability analysis which would take into consideration other relevant indicators as: profitability, productivity, liquidity, stability, next to technical efficiency. Thereby, considering FADN base limitations that are particularly noticeable when calculate liquidity and stability indicators, it is necessary to continuously work on data quality improvement and to make the whole system better.

Key words: technical efficiency, economic sustainability, farms, DEA, FADN.

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PREGLED SORPCIONIH IZOTEMSKIH MODELA*Vangelce MITREVSKI¹, Cvetanka MITREVSKA², Ljupco Trajceovski¹, Borce MITREVSKI³**¹Faculty of Technical Sciences, 7000 Bitola, Makedonska Falanga 33, Bitola, Macedonia**²Internacional Slavic University Gavriilo Romanovic Derzavin, Faculty for Safety Engineering, Sveti
Nikole, Macedonia**³Center of Energy Efficiency Bobi Turs, Bitola, Macedonia**E-mail: vangelce.mitrevski@uklo.edu.mk*

Izoterme sorpcije opisuju vezu između ravnotežnog sadržaja vlage i aktivnost vode pri konstantnim temperaturama i pritiscima. Izoterme sorpcije su važne u modeliranju procesa sušenja prehranbenih materijala, projektiranje i optimizacije opreme za sušenje, predviđanju stabilnosti i rok trajanja materijala, proračun promena vlage koje se može pojaviti za vreme skladištenja i izbor odgovarajućeg materijala za pakovanje. U naučnu i inženjersku literaturu u posljednje dve decenije sve je veći broj radova u ovom području. U nekih od ovih radova opisano je eksperimentalno određivanje sorpcione ili desorpcione izoterme materijala, temperaturna zavisnost sorpcionih izoterma, određivanje topline sorpcije i razvoj matematičkih modela za aproksimaciju eksperimentalnih podataka ravnotežnog sadržaja vlage. U zavisnosti od broja parametara, modeli mogu biti jedan, dva, tri ili više parametarski. Kod inženjerskih proračuna od velike važnosti je jednostavnost matematičkog modela, tj. model sa manjim brojem parametara. U slučaju kada je model izoterme sorpcije ugrađen u matematički model za izračunavanje procesa sušenja ili se koristi za predviđanje roka trajanja pakovanog osušenog proizvoda, aproksimacija eksperimentalnih podataka ravnotežne vlage ima veći značaj u odnosu na tačnost teorije na koja se temelji razvijeni model. U ovom radu prikazan je pregled sto devedeset i pet modela izoterme sorpcije koji se koriste za aproksimaciju ravnotežnih podataka vlažnosti prehranbenih materijala.

Ključne reči: pregled, modeli izoteme sorpcije, sto devedeset i pet.

A REVIEW OF SORPTION ISOTHERM MODELS*Vangelce MITREVSKI¹, Cvetanka MITREVSKA², Ljupco Trajcevski¹, Borce MITREVSKI³**¹Faculty of Technical Sciences, 7000 Bitola, Makedonska Falanga 33, Bitola, Macedonia**²Internacional Slavic University Gavriilo Romanovic Derzavin, Faculty for Safety Engineering, Sveti
Nikole, Macedonia**³Center of Energy Efficiency Bobi Turs, Bitola, Macedonia**E-mail: vangelce.mitrevski@uklo.edu.mk*

Moisture sorption isotherms describe the relationship between the equilibrium moisture content and the water activity at constant temperatures and pressures. For food materials sorption isotherms are important in modelling the drying process, design and optimisation of drying equipment, predicting shelf-life stability, calculating moisture changes which may occur during storage and in selecting appropriate packaging material. In scientific and engineering literature in the last two decades an increasing number of articles were reported in this area. In these articles are included the methods for determination of sorption or desorption isotherms, temperature dependence of sorption isotherms, determination of heat of sorption and development of mathematical models for approximation of moisture sorption data. Depending on the number of parameters included in the mathematical models for approximation of moisture sorption, the models may be one, two, three or more parametric. In engineering calculations, the simplicity of a mathematical model, i.e. a model with a smaller number of parameters is of great importance. In the case where the sorption isotherm model is incorporated into the mathematical model for calculating the drying processes or used to predict the shelf-life of the packaged dried product, then the approximation of the experimental data on equilibrium moisture content has a greater significance in relation to the accuracy of the theory which is based on it. The objectives of the presented article was a review of one hundred ninety-five sorption isotherm models which used to for approximation equilibrium moisture data of food materials.

Key words: *review, sorption isotherms models, one hundred ninety-five.*

KARAKTERISTIKE ĆELIJSKOG ZIDA KUKURUZNE BIOMASE NAKON OKSIDATIVNOG TRETMANA

Dragana MLADENović¹, Jovana GRBIĆ¹, Aleksandra ĐUKIĆ-VUKOVIĆ², Jelena PEJIN³, Ljiljana MOJOVIĆ²

¹Univerzitet u Beogradu, Inovacioni centar Tehnološko-metalurškog fakulteta, 11000 Beograd, Karnegijeva 4, Srbija

²Univerzitet u Beogradu, Tehnološko-metalurški fakultet, 11000 Beograd, Karnegijeva 4, Srbija

³Univerzitet u Novom Sadu, Tehnološki fakultet, 21000 Novi Sad, Bulevar cara Lazara 1, Srbija

E-mail: dmladenovic@tmf.bg.ac.rs

Najveći deo ćelijskog zida viših biljaka se sastoji od tri polimerna molekula, celuloze, hemiceluloze i lignina. Imajući u vidu zastupljenost ova tri polimera u prirodi, lignocelulozna biomasa se danas smatra važnom sirovinom za proizvodnju biogoriva i biohemikalija. U navedenim procesima prvi i najvažniji korak je narušavanje složene strukture lignocelulozne biomase i oslobađanje polisaharidnih frakcija, čime se biomasa priprema za hidrolizu do prostih šećera. Cilj ovog rada bio je ispitati na koji način oksidativni tretman primenom vodonik peroksida u alkalnim uslovima utiče na karakteristike ćelijskog zida kukuruzne biomase i da li nastale promene u sastavu i strukturi tretirane biomase dovode do efikasnije enzimske hidrolize.

Kukuruzna biomasa je tretirana alkalnim rastvorom vodonik peroksida u mikrotalasnoj pećnici u trajanju od 60 s i pri snazi od 360 W. Nakon ispiranja i sušenja, uzorci su podvrgnuti enzimskoj hidrolizi pomoću enzima Cellic[®] CTec2, kao i odgovarajućim analitičkim metodama za određivanje dostupnosti celuloze, kapaciteta adsorpcije enzima, indeksa kristaliničnosti i stepena delignifikacije. Efikasnost hidrolize tretirane i netretirane biomase je utvrđena merenjem koncentracije redukujućih šećera u dobijenim hidrolizatima. Dostupnost celuloze je ispitivana na osnovu adsorpcije boje Kongo crveno i izračunavanjem površine celuloze fitovanjem eksperimentalno dobijenih podataka sa jednačinom Lengmirove adsorpcione izoterme. Indeks kristaliničnosti je određen na osnovu vrednosti jodnog broja, a stepen delignifikacije acetil-bromid metodom. Takođe, ispitivanjem adsorpcije enzima Cellic[®] CTec2 i na osnovu konstanti Lengmirove adsorpcione izoterme utvrđen je maksimalni kapacitet adsorpcije enzima.

Dobijeni rezultati su pokazali da vodonik peroksid pri ispitivanim uslovima prvenstveno reaguje sa ligninom. Udeo lignina u tretiranoj biomasi je bio za 70% manji u odnosu na netretirani uzorak. Usled smanjenja sadržaja lignina površina celuloze tretirane biomase (186,97 m²/g) je bila značajno veća u odnosu na netretiranu (57,36 m²/g), što znači da se ispitivanim tretmanom povećava površina celuloze koja je dostupna za vezivanje celolitičkih enzima tokom hidrolize. Takođe, tretman je doveo do povećanja indeksa kristaliničnosti za 17,5%. Ispitivanjem adsorpcije enzima pokazano je da tretirana biomasa ima veći maksimalni kapacitet adsorpcije enzima u odnosu na netretirani uzorak. Konačno, hidrolizom tretirane biomase je postignuta značajno veća koncentracija redukujućih šećera (33,04 g/L) u odnosu na netretiranu biomasu (4,39 g/L). Rezultati ovog rada doprinose boljem razumevanju efekata ispitivanog tretmana i razvoju efikasnijeg procesa fracionisanja biomase, a time i bolje hidrolize dobijenih frakcija do prostih šećera, koji se dalje mogu koristiti za fermentacionu proizvodnju biogoriva i/ili biohemikalija.

Ključne reči: celuloza, lignin, enzimaska hidroliza, adsorpcija, oksidativni tretman.

**OPTIMIZACIJA PROCESA EKSTRAKCIJE ANTOCIJANA IZ SEMENJAČE
CRNE SOJE ZA PRIPREMU FUNKCIONALNE HRANE OD KUKURUZA**

*Valentina NIKOLIĆ, Slađana ŽILIC, Marijana SIMIĆ, Vesna PERIĆ,
Jelena SRDIĆ, Marko VASIĆ*

Institut za kukuruz Zemun Polje, Slobodana Bajića 1, 11185 Beograd, Srbija

E-mail: valentinas@mrizp.rs

Kukuruz (*Zea Mays* L.) je najznačajnija ratarska kultura u Republici Srbiji, koja se gaji na oko milion hektara godišnje. Soja crnog zrna (*Glycine max*) se vekovima koristila u tradicionalnoj istočnjačkoj medicini za pripremu čajeva i fermentisanih proizvoda visokog antioksidativnog kapaciteta. Semenjača crne soje ima visok sadržaj antocijanina: cijanidina, delfinidina i pelargonidina u obliku 3-O-glukozida. Antioksidativna svojstva ovih jedinjenja pozitivno utiču na regulisanje telesne mase i prevenciju dijabetesa, smanjuju rizik od obolevanja različitim bolestima kao što su ateroskleroza, rak, dijabetes, ishemijska, i neurodegenerativni poremećaji. Proizvodi obogaćeni antocijanima iz semenjače crne soje mogu pozitivno uticati na zdravlje konzumenata, dok se iskorišćenjem sojine semenjače, sporednog proizvoda iz prerade soje, dodatno se valorizuje ova sirovina.

Cilj ovog istraživanja bio je da se optimizuje proces ekstrakcije antocijana iz semenjače crne soje kako bi se konzervisani proizvodi od kukuruza dodatno obogatili bioaktivnim jedinjenjima. U eksperimentima je primenjeno nekoliko postupaka ekstrakcije: topla ekstrakcija uz zagrevanje na magnetnoj mešalici, ekstrakcija sa ultrazvučnim tretmanom, kao i hladna ekstrakcija. U eksperimentima je za ekstrakciju korišćena sirćetna kiselina koncentracije 1,6% i 0,8% uz dodatak mlečne (1 ili 1,5%) i/ili limunske kiseline (0,5 ili 1%) kao stabilizatora. Ekstrakcija uz zagrevanje – „topla“ ekstrakcija vršena je na magnetnoj mešalici na temperaturi od 50°C u trajanju od 60 minuta. Ekstrakcija bez zagrevanja – „hladna“ ekstrakcija, vršena je u tresilici kako bi se izbegla termička razgradnja bioaktivnih jedinjenja, međutim ova metoda ekstrakcije se pokazala kao najmanje efikasna. Ekstrakcija u ultrazvučnom kupatilu je primenjivana kako bi se sojina semenjača što brže razgradila i dostupnost antocijanina povećala. Ekstrakcija sa zagrevanjem se pokazala kao najpogodnija za dobijanje višeg prinosa antocijana. Najviši prinos antocijana uz optimalnu pH vrednost naliva ostvaren je primenom 1% mlečne kiseline u 0,8% sirćetnoj kiselini tokom „tople“ ekstrakcije (50°C, 1 h).

Ispitivana je mogućnost obojenja zrna kukuruza šećerom ekstraktom antocijanina. S obzirom da su nalivi sa limunskom kiselinom posle izvesnog vremena postajali zamućeni (opalescentni), u nastavku istraživanja korišćena je mlečna kiselina kao stabilizator antocijana. U zavisnosti od uslova ekstrakcije, spektrofotometrijski određen sadržaj antocijana u rastvoru varirao je od 3541,90 do 5387,70 µg CGE/g s.m., a u mariniranom zrnju kukuruza između 179,89 i 286,05 µg CGE/g s.m. Nakon sedam dana sadržaj antocijanina u zrnju nije značajno rastao, te je ovo vreme odležavanja odabrano kao optimalno za mariniranje proizvoda od kukuruza.

Ključne reči: crna soja, antocijani, kukuruz, funkcionalna hrana

OPTIMIZATION OF ANTHOCYANINS EXTRACTION PROCESS FROM BLACK SOYBEAN SEED COAT FOR THE PREPARATION OF MAIZE-BASED FUNCTIONAL FOOD

*Valentina NIKOLIĆ, Slađana ŽILIC, Marijana SIMIĆ, Vesna PERIĆ,
Jelena SRDIĆ, Marko VASIĆ*

Maize Research Institute Zemun Polje, Slobodana Bajića 1, 11185 Belgrade, Serbia

Email: valentinas@mrizp.rs

Maize (*Zea Mays* L.) is the most important field crop in the Republic of Serbia, which is grown on about one million hectares per year. Black soybean (*Glycine max*) has been used for centuries in traditional Eastern medicine for the preparation of teas and fermented products with high antioxidant capacity. Black soybean seed coat has a high content of anthocyanins: cyanidin, delphinidin and pelargonidine in the form of 3-O-glucoside. The antioxidant properties of these compounds have a positive effect on weight regulation and prevention of diabetes, reduce the risk of various diseases such as atherosclerosis, cancer, diabetes, ischemia, and neurodegenerative disorders. Products enriched with anthocyanins from black soybean seed coat can have a positive effect on the health of consumers, while the use of soybean seed coat, a by-product from soybean processing, additionally valorizes this raw material.

The aim of this study was to optimize the process of anthocyanin extraction from black soybean seed in order to further enrich canned corn products with bioactive compounds. Several extraction procedures were applied in the experiments: warm extraction with heating on a magnetic stirrer, extraction with ultrasonic treatment, as well as cold extraction. In the experiments, 1.6% and 0.8% acetic acid were used for extraction with the addition of lactic (1 or 1.5%) and/or citric acid (0.5 or 1%) as stabilizers. Heated extraction - "warm" extraction was performed on a magnetic stirrer at a temperature of 50°C for 60 minutes. Extraction without heating - "cold" extraction, was performed in a shaker to avoid thermal decomposition of bioactive compounds, but this method of extraction proved to be the least effective. Extraction in an ultrasonic bath was applied in order to decompose soybean seeds as quickly as possible and increase the availability of anthocyanins. Heated extraction has been shown to be most suitable for higher anthocyanin yields. The highest yield of anthocyanins with the optimal pH value of the brine was achieved by applying 1% lactic acid in 0.8% acetic acid during the "warm" extraction (50°C, 1 h).

The possibility of coloring sweet maize grains with anthocyanin extract was investigated. Since the brines with citric acid became cloudy (opalescent) after some time, lactic acid was used as an anthocyanin stabilizer in the continuation of the research. Depending on the extraction conditions, the spectrophotometrically determined content of anthocyanins in the solution varied from 3541.90 to 5387.70 µg CGE/g d.m., and in the marinated maize grain between 179.89 and 286.05 µg CGE/g d.m. After seven days, the anthocyanin content in the grain did not increase significantly, so this aging period was selected as optimal for marinating maize products.

Keywords: black soybean, anthocyanins, maize, functional food

**PREGLED BEZBEDNOSNIH ASPEKATA
U NADZORNO UPRAVLJAČKIM SISTEMIMA**

Perica NIKOLIĆ, Ilija KAMENKO, Vladimir BUGARSKI, Filip KULIĆ
Fakultet tehničkih nauka, Univerzitet u Novom Sadu, Trg Dositeja Obradovića 6,
21000 Novi Sad, Srbija
E-mail: npero@uns.ac.rs

Tehnološki proces savremenog proizvodnog pogona procesne industrije je nemoguće zamisliti bez nadzorno upravljačkog sistema. Savremeni nadzorno upravljački sistem se u opštem slučaju sastoji od dva osnovna elementa a to su programabilni logički kontroler (PLC) i nadzorni SCADA (engl. *Supervisory Control And Data Acquisition*) sistem. Trendovi u načinu realizacije i upotrebe nadzorno upravljačkih sistema zahtevaju da se razmotri njihova bezbednost sa stanovišta neovlašćenog pristupa ili ugrožavanja njihovog rada i na taj način ugrožavanja čitavog proizvodnog procesa. Bezbednosni rizici potiču od same realizacije sistema za upravljanje i nadzor, današnji sistem se često baziraju na IT tehnologijama koje su široko rasprostranjene tako da svi bezbednosni rizici koji se pojavljuju u IT tehnologijama predstavljaju direktno rizik i za sistem za nadzor i upravljanje. Takođe današnji trendovi u smeru komunikacije i integracije značajno povećavaju bezbednosni rizik. Pod ovim podrazumevamo trend integracije nivoa upravljanja u nivo softvera menadžmenta, zahtevi za neprekidnu daljinsku kontrolu i daljinski pristup. Ovo zahteva da se sa stanovišta bezbednosti preduzmu mere da se predupredi bilo koje neželjeno dejstvo po proizvodni proces. Potrebno je sprovesti obuku operatera i korisnika nadzorno upravljačkih sistema za korišćenje savremenih IT tehnologija, obraćajući posebnu pažnju na aktuelne bezbednosne rizike i sprovesti periodičnu dodatnu obuku u skladu sa bezbednosnim rizicima koji su aktuelni. Računari koji se koriste za nadzor i upravljanje koriste u većini slučajeva široko rasprostranjene operativne sisteme sistem i standardne softverske tehnologije te ih je potrebno obezbediti odgovarajućim softverskim rešenjima da bi predupredili ugrožavanje bezbednosti računara tj. direktno procesa koji se nadzire i upravlja. Sami zahtevi industrijske proizvodnje i njihova specifičnost nameće da često nije moguće primeniti trenutne aktuelne trendove u pogledu nadogradnje softvera i praćenja aktuelnih trendova bezbednosti. To je razlog da se dešava da sistemi postaju zastareli iz ugla IT tehnologije ali sasvim zadovoljavajući iz ugla nadzora i upravljanja. Takvi sistemi su posebno osetljivi na bezbednosne pretnje iz razloga što poseduju bezbednosne propuste koji nisu ispravljani redovnom nadogradnjom.

Bezbednosni aspekti u nadzorno upravljačkim sistemima su aspekt koji se često zaboravlja ali u današnjem svetu zahteva da se obrati posebna pažnja na njega. U većini slučajeva sam cilj ugrožavanja bezbednosti od strane napadača nije sam proces ili PLC uređaji nego deo nadzora i upravljanja koji se oslanja na IT tehnologije. Pravilnom obukom korisnika, preventivnim delovanjem na aktuelne pretnje je moguće rizike bezbednosti svesti na minimum.

Ključne reči: bezbednost, nadzorno upravljački sistem, procesna industrija, proizvodni proces

OVERVIEW OF SECURITY ASPECTS IN SUPERVISORY AND CONTROL SYSTEMS

Perica NIKOLIĆ, Ilija KAMENKO, Vladimir BUGARSKI, Filip KULIĆ

*Faculty of Technical Sciences, University of Novi Sad, Trg Dositeja Obradovića 6,
21000 Novi Sad, Srbija*

E-mail: npero@uns.ac.rs

The technological process of a modern production plant of the process industry is impossible to be imagined without a supervisory and control system. A modern supervisory and control system generally consists of two basic elements: a programmable logic controller (PLC) and a supervisory SCADA (Supervisory Control And Data Acquisition) system. Trends in implementation and use of supervisory and control system require that the safety should be considered from the point of view of unauthorized access or compromising the entire production process. Security risks come from the implementation of supervisory and control system. Today's systems are often based on IT technologies that are widespread, so all security risks that occur in IT technologies are a direct risk to the supervisory and control system. Also, today's trends in the department of communication and integration significantly increase security risk. By this we mean the trend of integration of control levels into the management software level and requirements for continuous remote control and remote access. From a safety point of view, measures should be taken to prevent any adverse effects on the production process. It is necessary to properly provide training of operators and users of supervisory and control system for the use of modern IT technologies. Special attention should be paid to current security risks and provide periodic additional training in accordance with current security risks and regular updates of it. Computers used for monitoring and control are utilizing in most cases widespread operating systems and standard software technologies, and appropriate software solutions are necessary to be provided due to prevent threats to computer security. For example for computers that directly monitor and control the process. The requirements of industrial production and their specificity dictate that it is often not possible to apply current trends in software upgrades and follow current security trends. It happens that the systems become obsolete from the point of view of IT technology, but quite satisfactory from the point of view of supervisory and control system. Such systems are especially sensitive to security threats because they have security flaws that are not corrected by regular upgrades. Security aspect in supervisory and control system is the aspect that is often forgotten, but in today's world, special attention should be paid to it. In most cases, by those who attack the system, the goal is not the process itself or PLC devices, but the part of surveillance and management that remains on IT technologies. Proper and constant training of users, preventive action on current threats can reduce security risks to a minimum.

Keywords: security, supervisory and control system , process industry, production process

ANALIZA I PREDVIĐANJE PROIZVODNO-EKONOMSKIH OBELEŽJA KUKURUZA I PŠENICE NA PODRUČJU REPUBLIKE SRBIJE

Nebojša NOVKOVIĆ¹, Nataša VUKELIĆ¹, Srboљub NIKOLIĆ², Veljko ŠARAC¹,

¹Poljoprivredni fakultet, Univerzitet u Novom Sadu, Trg Dositeja Obradovića 8, Novi Sad

²Vojna akademija, Univerzitet narodne odbrane, Veljka Lukića Kurjaka 33, Beograd

E-mail: nesann@polj.uns.ac.rs

Potreba za proizvodnjom dovoljne količine hrane za podmirenje potreba ljudi i životinja rastući je problem. Pšenica i kukuruz spadaju u najznačajnije proizvode korišćene u te svrhe. Predmet ovog istraživanja su proizvodno-ekonomska obeležja kukuruza i pšenice, kao najznačajnijih predstavnika žita u poljoprivredi Republike Srbije. Posmatrana proizvodna obeležja u radu su ostvarene površine i prinosi u periodu od 2005. do 2020. godine, a ekonomski pokazatelj su cene pšenice i kukuruza u periodu od 2002. do 2020. godine. Osnovni cilj rada jeste da se utvrde zakonitosti u kretanju posmatranih pojava, kao i da se predvide vrednosti svih analiziranih obeležja za period od 2021. do 2023. godine. Prinosi su izraženi u “t/ha”, površine posmatrane u “ha”, a cene u “EUR/kg”. Za analizu vremenske serije i utvrđivanje zakonitosti korišćeni su osnovni alati deskriptivne statistike, dok je za prognozu vrednosti obeležja korišćen optimalan ARIMA model. Izbor modela izvršen je putem naredbe “autoarima” u okviru programskog paketa “R”, a kao optimalan model za prognozu proizvodnih obeležja kukuruza pokazao se ARIMA (0,0,0) model, a za prognozu proizvodnih obeležja pšenice ARIMA (1,1,1). Primenom odgovarajuće metodologije, autori su zaključili da je prosečan prinos kukuruza u analiziranom periodu 6,24 t/ha, a pšenice 4,17 t/ha, prosečna površina pod kukuruzom iznosi 997.001 ha, a pšenice 608.345 ha. Takođe, autori u radu konstatuju da prinosi oba useva izražavaju tendenciju rasta, dok površine pod kukuruzom imaju rastuću tendenciju, za razliku od površine pod pšenicom koje beleže tendenciju pada. Apsolutna vrednost cena pšenice prosečno iznosi 0,14 EUR/kg, uz umerenu varijabilnost tokom analiziranog perioda (CV 21,06%), dok je kod kukuruza, pri takođe umerenoj varijabilnosti (CV 21,27%), prosečno iznosila 0,12 EUR/kg. Analizirajući kretanje cena pšenice i kukuruza u posmatranom period utvrđene su pozitivne godišnje stope promene, za pšenicu 1,69%, a za kukuruz 2,32%. Optimalan model za predviđanje apsolutne vrednosti pšenice je ARIMA (0,0,1), pri čemu interval varijacije podrazumeva kretanje od 0,13675-0,14075 EUR/kg. U slučaju cene kukuruza, optimalan model je ARIMA (1,0,0), a kretanje vrednosti nalazi u intervalu od 0,1243-0,1299 EUR/kg. Dobijeni rezultati predikcionog modela upućuju na zaključak da će cena u predikcionom periodu biti ispod višegodišnjeg proseka, a cena kukuruza iznad.

Ključne reči: prinos, površina, cena, analiza, predviđanje.

ANALYSIS AND PREDICTION OF MAIZE AND WHEAT PRODUCTION- ECONOMIC CHARACTERISTICS ON THE TERRITORY OF THE REPUBLIC OF SERBIA

Nebojša NOVKOVIĆ¹, Nataša VUKELIĆ¹, Srboľjub NIKOLIĆ², Veljko ŠARAC¹,

¹Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, Novi Sad

²Military Academy, University of Defence, Veljka Lukića Kurjaka 33, Belgrade

Email: nesann@polj.uns.ac.rs

The need to produce a sufficient amount of food to meet the needs of humans and animals is a growing problem. Wheat and corn are among the most important products used for these purposes. The subject of this research is the production and economic characteristics of corn and wheat, as the most important representatives of grain in agriculture of the Republic of Serbia. The observed production characteristics in the paper are the realized areas and yields in the period from 2005 to 2020, and the economic indicator are the prices of wheat and corn in the period from 2002. to 2020. The main goal of this paper is to determine the laws in the movement of the observed phenomena, as well as to predict the values of all analyzed features for the period from 2021 to 2023. Yields are expressed in “t/ha”, areas observed in “ha”, and prices in “EUR/kg” Basic descriptive statistics tools were used to analyze the time series and determine legality, while the optimal ARIMA model was used to predict feature values. The choice of the model was made by the order "autoarima" within the software package "R", and as the optimal model for the forecast of production characteristics of corn proved ARIMA (0,0,0) model, and for the forecast of production characteristics of wheat ARIMA (1,1, 1). Applying the appropriate methodology, the authors concluded that the average yield of corn in the analyzed period was 6.24 t/ha, and wheat 4.17 t/ha, the average area under corn is 997,001 ha, wheat 608,345 ha. Also, the authors state in the paper that the yields of both crops express a tendency to grow, while the areas under corn have a growing tendency, in contrast to the area under wheat which has a tendency to decrease. The absolute value of wheat prices averaged 0.14 EUR/kg, with moderate variability during the analyzed period (CV 21.06%), while in maize, with also moderate variability (CV 21.27%), it averaged 0.12 EUR/kg. Analyzing the movement of wheat and corn prices in the observed period, positive annual rates of change were determined, for wheat 1.69%, and for corn 2.32%. The optimal model for predicting the absolute value of wheat is ARIMA (0,0,1), where the variation interval implies a movement of 0,13675-0,14075 EUR/kg. In the case of the price of corn, the optimal model is ARIMA (1,0,0), and the value movement is in the range of 0.1243-0.1299 EUR/kg. The obtained results of the prediction model suggest that the price in the prediction period will be below the multi-year average, and the price of corn above.

Key words: yield, area, price, analysis, prediction.

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Nebojša NOVKOVIĆ, Nataša VUKELIĆ, Veljko ŠARAC,

Poljoprivredni fakultet, Univerzitet u Novom Sadu, Trg Dositeja Obradovića 8, Novi Sad

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Nebojša NOVKOVIĆ, Nataša VUKELIĆ, Veljko ŠARAC,

Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, Novi Sad

Email: nesann@polj.uns.ac.rs

The need to produce a sufficient amount of food to meet the needs of humans and animals is a growing problem. Wheat and corn are among the most important products used for these purposes. The subject of this research is the production and economic characteristics of corn and wheat, as the most important representatives of grain in agriculture of the Republic of Serbia. The observed production characteristics in the paper are the realized areas and yields in the period from 2005 to 2020, and the economic indicator are the prices of wheat and corn in the period from 2002. to 2020. The main goal of this paper is to determine the laws in the movement of the observed phenomena, as well as to predict the values of all analyzed features for the period from 2021 to 2023. Yields are expressed in “t/ha”, areas observed in “ha”, and prices in “EUR/kg” Basic descriptive statistics tools were used to analyze the time series and determine legality, while the optimal ARIMA model was used to predict feature values. The choice of the model was made by the order "autoarima" within the software package "R", and as the optimal model for the forecast of production characteristics of corn proved ARIMA (0,0,0) model, and for the forecast of production characteristics of wheat ARIMA (1,1, 1). Applying the appropriate methodology, the authors concluded that the average yield of corn in the analyzed period was 6.24 t/ha, and wheat 4.17 t/ha, the average area under corn is 997,001 ha, wheat 608,345 ha. Also, the authors state in the paper that the yields of both crops express a tendency to grow, while the areas under corn have a growing tendency, in contrast to the area under wheat which has a tendency to decrease. The absolute value of wheat prices averaged 0.14 EUR/kg, with moderate variability during the analyzed period (CV 21.06%), while in maize, with also moderate variability (CV 21.27%), it averaged 0.12 EUR/kg. Analyzing the movement of wheat and corn prices in the observed period, positive annual rates of change were determined, for wheat 1.69%, and for corn 2.32%. The optimal model for predicting the absolute value of wheat is ARIMA (0,0,1), where the variation interval implies a movement of 0,13675-0,14075 EUR/kg. In the case of the price of corn, the optimal model is ARIMA (1,0,0), and the value movement is in the range of 0.1243-0.1299 EUR/kg. The obtained results of the prediction model suggest that the price in the prediction period will be below the multi-year average, and the price of corn above.

Key words: yield, area, price, analysis, prediction.

BELI LUK U ORGANSKOJ PROIZVODNJI I ENDOPARAZITNA NEMATODA DITYLENCHUS DIPSACI

Violeta ORO¹, Rade STANISAVLJEVIĆ¹, Marijenka TABAKOVIĆ², Dragoslav ĐOKIĆ³

¹Institut za zaštitu bilja i životnu sredinu, 11000 Beograd, Teodora Drajzera 9, Srbija

²Institut za kukuruz „Zemun Polje“, 11185 Beograd-Zemun, Slobodana Bajića 1, Srbija

³Univerzitet u Nišu, Poljoprivredni fakultet u Kruševcu, 37000 Kruševac, Kosančićeva 4, Srbija

E-mail: viooro@yahoo.com

Beli luk je prehrambena namirnica koja je od davnina korišćena u prevenciji i lečenju različitih bolesti bakterijskog, gljivičnog i virusnog porekla i bez štetnih efekata. U starom Egiptu su beli luk davali radnicima koji su gradili piramide povećavajući na taj način njihovu izdržljivost a u staroj Grčkoj je bio hrana atletičara na Olimpijskim igrama. U Kineskoj medicini je prepisivan kao sredstvo koje pomaže u disanju i varenju, posebno za dijareju i protiv crevnih parazita. U Indiji se pre 2.000 godina koristio za lečenje srčanih bolesti i artritisa a u Engleskoj u srednjem veku je korišćen za lečenje različitih bolesti poput opstipacije, zubobolje, edema, ujeda životinja i kuge. Njegova popularnost, u tom smislu, nije ni do danas opala, štaviše brojna istraživanja dokazuju mnoge korisne osobine ove namirnice koja služi kao hrana ali i kao lek.

Proizvodnja belog luka u našoj zemlji se obavlja setvom odn. sađenjem češnjeva (ručno ili mašinski) u jesen ili u proleće na površini oko 9 000 ha. Proizvođači treba da koriste sertifikovan sadni materijal jer u protivnom može da se desi da češnjevi budu zaraženi endoparazitnom nematodom *Ditylenchus dipsaci* (Kühn) Filipjev, koja je jedna od najštetnijih nematoda jer dovodi do totalnog propadanja glavica i kompletnog gubitka prinosa. Ova nematoda je izraziti polifag, javlja se i na semenu lucerke, pasulja, deteline itd. ali i na 450 drugih domaćina gajenih biljaka i korova. U proleće, na mladom luku infekcija može da bude asimptomatska, ali kako životni ciklus traje samo 20 dana a svaka ženka može da položi i do 500 jaja, intenzivnim razmnožavanjem ubrzano raste brojnost nematoda. Simptomi se uočavaju na lukovicama odn. češnjevima u vidu braon pega koje se spajaju i zahvataju celo tkivo uz degradaciju srednje lamele ćelijskog zida i dovode do totalnog propadanja lukovica pri čemu se pojavljuje intenzivan i neprijatan miris. Nematoda može da opstane godinama u suvom materijalu a opstaje i na velikom broju korova, pa se teško može iskoreniti. Poseban problem je u organskoj proizvodnji jer nema efikasnih bio-pesticida tako da su profilaktičke mere od esencijalnog značaja. Pojava *D. dipsaci* je do sada utvrđena kod dva proizvođača iz okoline Beograda.

Da bi se utvrdilo genetičko srodstvo odn. moguće poreklo ovih izuzetno štetnih nematoda koriste se molekularne metode koje uz pomoć PCR (Lančane Reakcije Polimeraze), sekvenci i odgovarajućih kompjuterskih programa porede genetičku sličnost naših i stranih populacija. Molekularnim metodama je utvrđeno da je najbliži srodnik naših populacija ove nematode populacija iz Kine, što ukazuje da je mogao biti korišćen sadni materijal belog luka uvezen iz Kine. Novija istraživanja u Evropi su potvrdila prisustvo još opasnije nematode *D. gigas* koja je za sada otkrivena samo u Poljskoj na semenu boba.

Ključne reči: beli luk, organska proizvodnja, nematoda, endoparazit

GARLIC IN ORGANIC PRODUCTION AND ENDOPARASITIC NEMATODE *DITYLENCHUS DIPSACI*

Violeta ORO¹, Rade STANISAVLJEVIĆ¹, Marijenka TABAKOVIĆ², Dragoslav ĐOKIĆ³

¹Institute for Plant Protection and Environment, 11000 Belgrade, Teodora Drajzera 9, Serbia

²Maize Research Institute „Zemun Polje“, 11185 Belgrade-Zemun, Slobodana Bajića 1, Serbia

³University of Nis, Faculty of Agriculture in Krusevac, 37000 Kruševac, Kosančićeva 4, Serbia

E-mail: viooro@yahoo.com

Garlic is a food that has long been used in the prevention and treatment of various diseases of bacterial, fungal and viral origin and without harmful effects. In ancient Egypt, garlic was given to workers who built pyramids, thus increasing their endurance, and in ancient Greece, it was the food of athletes at the Olympic Games. In Chinese medicine, it was prescribed as an agent that helps with breathing and digestion, especially for diarrhea and against intestinal parasites. It was used 2,000 years ago in India to treat heart diseases and arthritis, and in the Middle Ages in England the garlic was applied to treat various ailments such as constipation, toothache, oedema, animal bites and plague. Its popularity, in that sense, has not declined to this day, moreover, numerous researches prove many useful properties of garlic, which serves as food but also as a medicine.

Garlic production in our country is done by sowing i.e., by planting cloves (by hand or by machine) in autumn or spring on an area of about 9,000 ha. Producers should use certified planting material, otherwise the cloves may be infected with the endoparasitic nematode *Ditylenchus dipsaci* (Kühn) Filipjev, which is one of the most harmful nematodes because it leads to total bulb decay and yield loss. This nematode is a typical polyphagous organism, it may occur on alfalfa seeds, beans, clover, etc., but also on 450 other hosts of cultivated plants and weeds. In the spring, the infection on young plants may be asymptomatic, but as the life cycle lasts only 20 days and each female can lay up to 500 eggs, the number of nematodes increases rapidly. Symptoms are observed on the bulbs or cloves in the form of brown spots that merge and capture the entire tissue followed by the degradation of the middle lamella of the cell wall and lead to the total decay of the bulbs, whereby an intense and unpleasant odor appears. The nematode can survive for years in dry material and on a large number of weeds, and it can hardly be eradicated. The nematode is a special problem in organic production because of a lack of effective bio-pesticides, so prophylactic measures are essential. The occurrence of *D. dipsaci* has been observed so far in two farms from the Belgrade area.

In order to determine the genetic relationship i.e., possible origin of these extremely harmful nematodes, molecular methods were used which, with the help of PCR (Polymerase Chain Reaction), sequences, and appropriate computer programs, compare the genetic similarity of our and foreign populations. Molecular methods have shown that the closest relative of our populations of this nematode is the population from China, which indicates that the garlic planting material may be imported from China. Recent research in Europe has confirmed the presence of the even more dangerous nematode *D. gigas*, which has only been detected in Poland in the faba bean seeds.

Key words: garlic, organic production, nematode, endoparasite

***Bacillus velezensis* – BIOKONTROLNA AKTIVNOST MIKROBIOLOŠKE BIOMASE I EKSTRACELULARNIH JEDINJENJA PROTIV *Xanthomonas* spp.**

Ivana PAJČIN¹, Vanja VLAJKOV¹, Jelena DODIĆ¹, Marta LOC², Mila GRAHOVAC², Jovana GRAHOVAC¹

¹Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Srbija

²Univerzitet u Novom Sadu, Poljoprivredni fakultet, Trg Dositeja Obradovića 8, 21000 Novi Sad, Srbija

E-mail: ivana.pajcin@uns.ac.rs

Bacillus velezensis je nova biokontrolna vrsta koja ispoljava nekoliko mehanizama biološke kontrole biljnih patogena, uključujući antibiozu, proizvodnju drugih vrsta antimikrobnih jedinjenja, kao što su isparljiva organska jedinjenja, direktnu kompeticiju u pogledu hranljivih materija i prostora za rast, kao i indukciju imunog odgovora biljaka prema patogenima. Cilj ovog istraživanja bila je procena potencijala soja *Bacillus velezensis* IP22, izolovanog iz svežeg sira i gajenog na optimizovanoj podlozi sa glicerolom kao izvorom ugljenika, za *in vitro* suzbijanje fitopatogenih sojeva roda *Xanthomonas*, izolovanih iz obolelih biljaka kupusa (*Xanthomonas campestris*) i paprike (*Xanthomonas euvesicatoria*). Ispitani su različiti potencijalni biokontrolni agensi: kultivaciona tečnost, koji sadrži biomasu *Bacillus velezensis* IP22 i proizvedene ekstracelularne metabolite, i supernatant oslobođen biomase dobijen centrifugiranjem kultivacione tečnosti (10000 rpm, 10 min), koji je sadržao samo proizvedena ekstracelularna jedinjenja. Pored toga, uzorci supernatanta su podvrgnuti termičkom tretmanu (100 °C, 15 min) da bi se utvrdilo da li u supernatantu postoje termosenzitivna ekstracelularna jedinjenja. Vakuum uparavanje na temperaturi 40 °C izvedeno je sa ciljem koncentrisanja uzoraka supernatanta, dok su dobijeni koncentracije resuspendovani u destilovanoj vodi do postizanja 25% početne zapremine uzorka kako bi se uporedio efekat veće koncentracije ekstracelularnih jedinjenja na rast patogena. Rezultati su pokazali prosečne prečnike zona inhibicije od 66,00 mm za uzorke kultivacione tečnosti, 25,67 mm za uzorke supernatanta, 10,00 mm za termički tretirane uzorke supernatanta i 43,50 mm za uzorke koncentrovanog supernatanta. Prikazani rezultati su ukazali na značajnu antimikrobnu aktivnost proizvedenih ekstracelularnih metabolita, prisustvo termosenzitivnih jedinjenja među njima, kao i značajno veću antimikrobnu aktivnost prema ispitivanim patogenima kada je u pitanju primena ekstracelularnih jedinjenja u većoj koncentraciji. Najveća antimikrobnu aktivnost je postignuta u slučaju uzoraka kultivacione tečnosti, što ukazuje na sinergistički efekat biomase *Bacillus velezensis* IP22 i proizvedenih ekstracelularnih metabolita u suzbijanju *Xanthomonas campestris* i *Xanthomonas euvesicatoria*. Dalja istraživanja u ovoj oblasti treba da obuhvate optimizaciju proizvodnih procesa u cilju maksimizacije sadržaja biomase *Bacillus velezensis* IP22 i/ili biosinteze antimikrobnih metabolita, kao i njihovu preciznu identifikaciju i karakterizaciju radi boljeg razumevanja mehanizama biokontrolne aktivnosti protiv fitopatogena *Xanthomonas* spp.

Ključne reči: antimikrobnu aktivnost, metaboliti, kultivaciona tečnost, supernatant, termički tretman, *Xanthomonas campestris*, *Xanthomonas euvesicatoria*

ZAHVALNICA

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***Bacillus velezensis* – BIOCONTROL ACTIVITY OF MICROBIAL BIOMASS AND EXTRACELLULAR COMPOUNDS AGAINST *Xanthomonas* spp.**

Ivana PAJČIN¹, Vanja VLAJKOV¹, Jelena DODIĆ¹, Marta LOC², Mila GRAHOVAC², Jovana GRAHOVAC¹

¹University of Novi Sad, Faculty of Technology Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia

²University of Novi Sad, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia
E-mail: ivana.pajcin@uns.ac.rs

Bacillus velezensis is a novel biocontrol species exhibiting several mechanisms in biological control of plant pathogens, including antibiosis, production of other types of antimicrobial compounds, such as volatile organic compounds, direct competition for nutrients and growth space, as well as induction of plant immunity towards pathogens. The aim of this study was to assess the potential of *Bacillus velezensis* IP22, isolated from fresh cheese and grown on the optimized medium with glycerol as carbon source, for *in vitro* suppression of phytopathogenic *Xanthomonas* strains, isolated from diseased cabbage (*Xanthomonas campestris*) and pepper (*Xanthomonas euvesicatoria*). Different potential biocontrol agents were investigated: the overall cultivation broth, containing biomass of *Bacillus velezensis* IP22 and produced extracellular metabolites, and biomass-free supernatant obtained by centrifugation of the cultivation broth (10000 rpm, 10 min), which contained only the produced extracellular compounds. Furthermore, supernatant samples were subjected to heat treatment (100 °C, 15 min) to assess whether there were thermosensitive extracellular compounds present in the supernatant. Vacuum evaporation at 40 °C was performed to concentrate supernatant samples, while the concentrates were resuspended in distilled water to achieve 25% of the initial sample volume in order to compare the effect of higher concentration of extracellular compounds to pathogens' growth. The results have indicated average inhibition zone diameters of 66.00 mm for the cultivation broth samples, 25.67 mm for the supernatant samples, 10.00 mm for the heat treated supernatant samples and 43.50 mm for the concentrated supernatant samples. The presented results have indicated significant antimicrobial activity of the produced extracellular metabolites, the presence of thermosensitive compounds among them, as well a significantly higher antimicrobial activity against the tested pathogens when extracellular compounds were applied in higher concentration. However, the highest antimicrobial activity was achieved in case of the cultivation broth samples, indicating synergistic effect of *Bacillus velezensis* IP22 biomass and the produced extracellular metabolites in suppression of *Xanthomonas campestris* and *Xanthomonas euvesicatoria*. Further research should include optimization of the production processes aimed at maximization of *Bacillus velezensis* IP22 biomass growth and/or biosynthesis of the antimicrobial metabolites, as well as their precise identification and characterization to better understand the mechanism(s) of biocontrol activity against phytopathogenic *Xanthomonas* spp.

Keywords: antimicrobial activity, metabolites, cultivation broth, supernatant, heat treatment, *Xanthomonas campestris*, *Xanthomonas euvesicatoria*

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FIZIČKOHEMIJSKE OSOBINE HIDROČAĐI PROIZVEDENE OD POLJOPRIVREDNE BIOMASE

Ivan PAVKOV¹, Milivoj RADOJČIN¹, Siniša BIKIĆ², Milan TOMIĆ¹, Maša BUKUROV², Krstan KEŠELJ¹, Bojana DESPOTOVIĆ²

¹Univerzitet u Novom Sadu, Poljoprivredni fakultet, Trg Dositeja Obradovića 8, 21000 Novi Sad,

²Univerzitet u Novom Sadu, Fakultet tehničkih nauka, Trg Dositeja Obradovića 6, 21000 Novi Sad,

E-mail: ivan.pavkov@polj.uns.ac.rs

U ovoj studiji, biomasa sedam različitih poljoprivrednih kultura posle žetve iskorištena je kao sirovina za proizvodnju hidročađi postupkom hidrotermalne karbonizacije (HTC), pšenična i sojina slama, kočanka i stabljika kukuruza, stabljika suncokreta, ljuska oraha i lešnika. Sirovine su različitog hemijskog sastava što je rezultiralo različitim osobinama u dobijenoj hidročađi. U literaturi mogu se pronaći podaci o karakterizaciji hidročađi dobijene od pšenične slame i silaže kukuruza (stabljika i kočanka zajedno), dok za ostale koje su obuhvaćene radom nema podataka. Cilj rada je karakterizacija suve hidročađi u zavisnosti od temperature reakcije, a zatim poređenje u odnosu na početnu sirovinu preko: HHV, atomskog odnosa H/C i O/C, sadržaja pepela, nasipne gustine, boje. U radu je urađena procena energetske (toplotne) zahteva za dobijanje suve hidročađi. Rezultati ove studije su primenljivi za praktično rešavanje valorizacije poljoprivredne biomase i ekonomska istraživanja.

Postupak HTC istraživan je na temperaturama reakcije 200 °C i 250 °C, na pritisaku 8.0 MPa i 120 minuta trajanja procesa. Primenjeni postupak hidrotermalne karbonizacije uticao je na dobijanje hidročađi boljih karakteristika kao goriva od sirovine, pšenična (WS) i sojina slama (BS), kočanka kukuruza (CC), kukurzna (CS) i suncokretova stabljika (SS), ljuska oraha (HS) i lešnika (LS). Na višoj temperaturi reakcije sirovina je više karbonizovala, povećan je sadržaj ugljenika, a smanjen sadržaj kiseonika i vodonika. Atomski odnos O:C i H:C približio se karakteristikama treseta (200 °C) i lignita (250 °C). Povećana je gornja toplotna moć i nasipna gustina kao i udeo pepela na višoj temperaturi reakcije, što je negativno. Prinos mase i energije hidročađi zavisi od sirovine i temperature reakcije, bolji odnos je ostvaren za WS, CC, CS, SS na nižoj temperaturi, a za BS, HS i LS na višoj. Temperatura procesa je uticala na boju hidročađi, koja je braon lignocelulozna (200 °C) i tamno braon boje koja prelazi u ugalj crnu (250 °C). Toplotna energija neophodna za dobijanje suve hidročađi približno je jednaka za obe temperature $\approx 2199.93 \pm 45.52$ kJ/kg_{biomass}. Dobijena hidročađ, po svojoj toplotnoj moći i elementarnoj kompoziciji, ima potencijal da se koristi u postrojenjima za sagorevanje ugljene prašine.

Ključne reči: hidrotermalna karbonizacija, hidročar, biomasa, energija.

PHYSIOCHEMICAL PROPERTIES OF HYDROCHAR PRODUCED FROM AGRICULTURAL BIOMASS

Ivan PAVKOV¹, Milivoj RADOJČIN¹, Siniša BIKIĆ², Milan TOMIĆ¹, Maša BUKUROV², Krstan KEŠELJ¹, Bojana DESPOTOVIĆ²

¹Faculty of Agriculture, University of Novi Sad, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia;

²Faculty of Technical Sciences, University of Novi Sad, Trg Dositeja Obradovića 6, 21000 Novi Sad, Serbia;

E-mail: ivan.pavkov@polj.uns.ac.rs

In this study, the biomass of seven different crops was used as feedstock in hydrothermal carbonization (HTC) to produce hydrochar: wheat straw, soybean straw, corn cob, corn stalks, sunflower stalks, walnut and hazelnuts shells. The feedstock differed in its chemical composition, which resulted in different properties of the obtained hydrochar. Literature offers hydrochar characteristics obtained from wheat straw and corn silage (stalks and cobs together); however, no data can be found on the rest of the mentioned raw materials. The objective of this paper was to determine physiochemical properties of dry hydrochars based on the reaction temperature, and then to compare them with the initial raw material based on the HHV, atomic ratios H/C and O/C, ash content, bulk density, and color. The paper also evaluates the energy (heat) requirements for obtaining dry hydrochars. The results of this study are applicable as a practical solution for the valorization of agricultural biomass and economic research.

The hydrothermal carbonization process was investigated at 200 °C and 250 °C reaction temperatures, a pressure of 8.0 MPa, and 120 minutes of process duration. The obtained dry hydrochar was characterized. Hydrochars which, as a fuel, proved to have better characteristics compared to the used feedstock: wheat straw (WS), soybean straw (BS), corn cob (CC), corn stalk (CS), sunflower stalk (SS), walnut shell (HS), and hazelnut shell (LS). The feedstock carbonized more at higher reaction temperature, the carbon content also increased, and the oxygen and hydrogen contents decreased. The atomic ratios O/C and H/C approached the characteristics of peat (at 200 °C) and lignite (at 250 °C). The higher heating value and bulk density increased, as well as the share of ash at higher reaction temperature, which is the downside. The yield of mass and energy of hydrochar depends on the raw material and the reaction temperature: a better ratio was achieved with WS, CC, CS, SS at a lower temperature, and with BS, HS and LS at a higher temperature. The temperature of the process affected the color of the hydrocarbon, which is brown lignocellulosic (200 °C) and dark brown turning into charcoal black (250 °C). The thermal energy required to obtain dry hydrochar is approximately equal for both temperatures $\approx 2199.93 \pm 45.52$ kJ/kg_{biomass}. The obtained hydrochar, according to its heating value and elemental composition, has the potential to be used in coal dust combustion plants.

Keywords: hydrothermal carbonization, hydrochar, biomass, energy.

PROCENA STABILNOSTI SADRŽAJA ULJA U ZRNU RANOSTASNIH GENOTIPOVA SOJE

Vesna PERIĆ, Mirjana SREBRIĆ, Valentina NIKOLIĆ, Marijenka TABAKOVIĆ
Institut za kukuruz „Zemun Polje”, Slobodana Bajića 1, 11185 Zemun Polje, Beograd
E-mail: vesnaperic75@gmail.com

Najvažniji parametri tehnološkog kvaliteta zrna soje su sadržaj sirovih proteina i ulja u zrnu. Prerađivačka industrija kao i individualni poljoprivredni proizvođači obraćaju posebnu pažnju na ova dva parametra, postavljajući zahteve za sortama visokog sadržaja ulja za industrijsku preradu, ili sortama visokog sadržaja proteina za dobijanje stočne hrane. Stoga je selekcionerski rad usmeren je ka stvaranju sorti ne samo visokog prinosa već i sorti poboljšanog kvaliteta zrna. Genotipovi soje koji se čuvaju u kolekciji Instituta za kukuruz Zemun Polje odlikuju se sadržajem proteina koji varira od 36.3% do 43.2%, i sadržajem ulja u rasponu od 15.6% do 22.0%. Oba svojstva su kompleksne kvantitativne prirode, determinisana kako naslednim faktorima tako i uticajem uslova spoljašnje sredine u vreme njihove akumulacije u zrnu, kao i interakcijom genotipa i spoljašnje sredine.

Cilj ovog rada bio je da se ispita vrednost interakcije genotip \times spoljašnja sredina za sadržaj ulja kod genotipova soje iz kolekcije Instituta za kukuruz Zemun Polje i otkriju stabilni izvori koji mogu poslužiti kao početni materijal za oplemenjivanje na sadržaj ulja.

Eksperimentom je obuhvaćeno 14 genotipova soje grupe zrenja 00 (veoma rane sorte). Ogledi su postavljeni u toku dve godine, na dve lokacije (Zemun Polje i Pančevo), po potpuno slučajnom blok dizajnu u tri ponavljanja. Nakon žetve, sadržaj ulja u semenu izmeren je na uređaju NIRT tehnologije „Infraneo“, Chopin Technologies. Za analizu interakcije genotipa i spoljašnje sredine za sadržaj ulja u zrnu primenjen je linearno-bilinearni AMMI-1 model.

Veliki deo varijacije (80,91%) interakcije genotipa i spoljašnje sredine za sadržaj ulja u zrnu ispitivanih genotipova soje objašnjen je prvom interakcijskom osom AMMI-1 modela. Razlike u glavnim efektima ispitivanih spoljašnjih sredina nisu bile velike, s obzirom da su sve sredine imale vrednost sadržaja ulja blizu opšteg proseka.

Četiri spoljašnje sredine imale su varijabilan uticaj na ispitivane genotipove. Za oba lokaliteta utvrđen je pozitivan interakcijski efekat u 2012. i negativan interakcijski efekat u 2011. godini, pri čemu su genotipovi ispitivani u Zemun Polju 2012. godine bili najnestabilniji, dok su genotipovi ispitivani u toku 2011. godine pokazali približno jednaku stabilnost na obe lokacije

Veći broj genotipova (Canatto, Kabott, Olima, Gi 291/70-79, Krajina, Agassiz, Maple Presto i Ljus) bio je raspoređen blizu linije stabilnosti, pri čemu posebnu pažnju zaslužuju genotipovi iznad posebnog sadržaja ulja i visoke stabilnosti (Maple Presto i Ljus) kao i genotip Agassiz, koji je imao maksimalnu prosečnu vrednost ovog parametra, i malu vrednost interakcije sa spoljašnjim sredinama. Genotipovi niskih prosečnih vrednosti sadržaja ulja (Mini Soja i Progres) imali su veoma slabu stabilnost, što se može pripisati njihovoj divergentnoj germplazmi i specifičnoj reakciji na uslove ispitivanja koji se razlikuju u odnosu na uslove regiona u kojem su ove sorte selekcionisane.

Ključne reči: soja, sadržaj ulja, AMMI-I model

**ASSESSMENT OF GRAIN OIL CONTENT STABILITY IN EARLY
MATURING SOYBEAN GENOTYPES***Vesna PERIĆ, Mirjana SREBRIĆ, Valentina NIKOLIĆ, Marijenka TABAKOVIĆ**Maize Research Institute „Zemun Polje”, Slobodana Bajica 1, 11185 Zemun Polje, Belgrade, Serbia**E-mail: vesnaperic75@gmail.com*

The most important parameters of the technological quality of soybean are the protein and oil content in the grain. The processing industry, as well as individual agricultural producers, pays special attention to these two parameters, setting requirements for varieties with high oil content for industrial processing, or varieties with high protein content for animal feed. Therefore, breeding practice is aimed at developing varieties not only of high yield but also varieties of improved grain quality. Soybean genotypes maintained in the collection of the Maize Research Institute Zemun Polje are characterized by a protein content ranging from 36.3% to 43.2%, and an oil content ranging from 15.6% to 22.0%. Both traits are of a complex quantitative nature, determined both by genetic factors and the influence of environmental conditions during their accumulation in the grain, as well as the interaction of genotype and environment.

The aim of this study was to examine the value of genotype \times environment interaction for oil content in soybean genotypes from the collection of Maize Research Institute Zemun Polje and to identify stable sources that can be utilized as starting material for breeding for oil content.

The experiment included 14 genotypes of soybean from maturity group 00 (very early varieties). The field trials were set up over two years, at two locations (Zemun Polje and Pancevo), according to a completely randomized block design with three replications. After harvest, the oil content in the grain was measured on a NIRT device "Infraneo", Chopin Technologies. The linear-bilinear AMMI-1 model was applied to analyze the genotype \times environment interaction for grain oil content.

A large part of the variation (80.91%) of the genotype \times environment interaction for the grain oil content in soybean genotypes was explained by the first interaction axis of the AMMI-1 model. The differences in the main effects of the examined environments were not large, since all environments had a value of oil content close to the general average.

Four environments had a variable influence on the examined genotypes. For both locations, a positive interaction effect was found in 2012 and a negative interaction effect in 2011, with the genotypes tested in Zemun Polje in 2012 being the most unstable, while the genotypes tested in 2011 showed approximately equal stability at both locations.

A number of genotypes (Canatto, Kabott, Olima, Gi 291 / 70-79, Krajina, Agassiz, Maple Presto and Luso) were distributed close to the stability line. Genotypes with above the average oil content and high stability (Maple Presto and Ljuso) deserved special attention, as well as the Agassiz genotype, which had the maximum average value of this parameter, and a small value of interaction with environments. Genotypes of low average values of oil content (Mini Soybeans and Progress) had very poor stability, which can be attributed to their divergent germplasm and specific response to environmental conditions that differ from the conditions in the region of their origin.

Key words: soybean, oil content, AMMI-I analysis

POTROŠAČKI TEST RANGIRANJA U OCENI ATRAKTIVNOSTI PIĆA NA BAZI NADES EKSTRAKATA

Mladenka PESTORIĆ¹, Dubravka ŠKROBOT¹, Milca POJIC¹, Anamarija MANDIĆ¹, Nemanja
TESLIĆ¹, Branimir PAVLIĆ², Aleksandra MIŠAN¹

¹Univerzitet u Novom Sadu, Institut za prehrambene tehnologije, Bulevar cara Lazara 1, 21000 Novi
Sad, Srbija

²Univerzitet u Novom Sadu, Tehnološki fakultet, Bulevar cara Lazara 1, 21000 Novi Sad, Srbija
E-mail: mladenka.pestoric@fins.uns.ac.rs

Da bi se zadovoljila rastuća globalna potražnja za nutraceutskim i farmaceutskim proizvodima, neophodno je koristiti nedovoljno iskorišćene nusproizvode industrije voća za obnavljanje vrednih bioaktivnih jedinjenja. Istovremeno, potrebno je razvijati nove i održive procese ekstrakcije, kao što su NADES – *Natural Deep Eutectic Solvents* - prirodni eutektički rastvarači umesto korišćenja visoko toksičnih organskih rastvarača štetnih po životnu sredinu.

Međutim, tokom razvoja novih voćnih napitaka važno je ne samo obezbediti adekvatnu količinu bioaktivnih jedinjenja, već i povoljan senzorski profil koji će zadovoljiti delikatne hedonske potrebe potrošača. Uključivanje potrošača u proces razvoja novog prehrambenog proizvoda jedan je od pokretačkih alata u okviru efikasne strategije za postizanje boljeg prihvatanja i uspeha proizvoda na tržištu.

Sprovedeno istraživanje imalo je za cilj da proceni prihvatljivost potrošača prema voćnim napicima na bazi NADES ekstrakata.

Potrošačkim testom rangiranja bilo je obuhvaćeno 5 sličnih napitaka, od kojih su tri uzorka bila komercijalno dostupna na tržištu: ledeni čaj sa aromom breskve (IT1), ledeni čaj sa aromom zove (IT2) i ledeni čaj sa aromom šumskog voća (IT3). Druga dva testirana uzorka imala su sledeće karakteristike: jedan napitak u koji je dodato 0,5 g NADES ekstrakta maline (NR) i drugi u koji je dodato 2 g NADES ekstrakta timijana (NT). Testiranje je sprovedeno u Novom Sadu, Srbija, u okviru Festivala „Noć istraživača“, velikog kulturnog događaja u Srbiji. Korišćen je panel od 93 potrošača koji su bili posetioци ove kulturne manifestacije. Spremnost da učestvuju u testu rangiranja, kao i bez averzije prema sastojcima pića i poznatih alergija na hranu, bili su osnova da potrošači uzmu učešća u testiranju.

Za statističku anлізу podataka i anлізу utvrđivanja značajnih razlika između uzorka korišćeni su Excel i XLSTAT 2012.2.02 (Addinsoft, NI, SAD) softveri. Podaci o rangju analizirani su korišćenjem Fridmanovog neparametrijskog testa, kao i metod višestrukih poređenja zasnovanih na sumi rangovima, praćena LSD testom pri nivou značajnosti od 0,05.

Bolja preferencija potrošača postignuta je u odnosu na uzorke IT1, IT2 i IT3, ukazujući da su preferencije između njih bile značajno različite u pogledu slatkoće, arome i opšte privlačnosti. Ovo nas navodi da verujemo da kad god nema dovoljno vremena za obuku deskriptivnog panela, može se razmotriti upotreba panela potrošača i sprovesti test rangiranja kako bi se brzo steklo mišljenje potrošača i pružio uvid u postojanje jaza potrošača u sklonostima za određene attribute unutar senzorskog profila proizvoda.

Ključne reči: voćni ledeni čajevi, NADES ekstrakti, potrošačka prihvatljivost, test rangiranja

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CONSUMER RANKING TEST IN ASSESSING THE ATTRACTIVENESS OF BEVERAGES BASED ON NADES EXTRACTS

Mladenka PESTORIĆ¹, Dubravka ŠKROBOT¹, Milca POJIĆ¹, Anamarija MANDIĆ¹, Nemanja
TESLIĆ¹, Branimir PAVLIĆ², Aleksandra MIŠAN¹

¹University of Novi Sad, Institute of Food Technology, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia

²University of Novi Sad, Faculty of Technology

E-mail: mladenka.pestoric@fins.uns.ac.rs

In order to meet the growing global demand for nutraceutical and pharmaceutical products, it is necessary to use the underutilized by-products of the fruit industry to recover valuable bioactive compounds. At the same time, it is necessary to develop new and sustainable extraction processes, such as NADES - *Natural Deep Eutectic Solvents* instead of using highly toxic organic solvents harmful to the environment.

However, during the development of new fruit drinks it is important not only to provide an adequate amount of bioactive compounds, but also to provide a favourable sensory profile to meet the delicate hedonic needs of consumers. Involving consumers in the development process of a new food product is one of the driving tools within an effective strategy to achieve better acceptance and success in the market.

The conducted research was aimed at assessing the acceptability of consumers towards fruit drinks based on NADES extracts.

The consumer ranking test included 5 similar beverages, of which three samples were commercially available on the market: peach-flavoured iced tea (IT1), black elder-flavoured ice tea (IT2), and forest fruit-flavoured ice tea (IT3). The other two tested samples had the following characteristics: one beverage in which 0.5 g of NADES raspberry extract was added (NR) and the other in which 2g of NADES thyme extract was added (NT). The testing was conducted in Novi Sad, Serbia, as part of the "Researchers' Night" Festival, a large cultural event in Serbia. A panel of 93 consumers were used as visitors to this cultural event. They took part in the ranking test based on their willingness to participate in it, as well as without aversion to the ingredients of the drink and known food allergies.

Excel and XLSTAT 2012.2.02 (Addinsoft, NY, USA) software were used for data statistics and significant difference analysis. Rank data were analysed using Friedman's nonparametric test and multiple comparisons methods based on sum ranks. Following statistically significant effects ($p < 0.05$), a post hoc LSD test was used to compare products.

Better consumer preference was achieved over samples IT1, IT2 and IT3, indicating that the preference between them was significantly different in terms of sweetness, flavour and general appeal. This leads us to believe that whenever there is not enough time to train a descriptive panel, the use of a consumer panel can be considered and a ranking test conducted to quickly gain consumer opinion and provide insight into the existence of a consumer gap in liking for certain attribute within sensory profile of the food product.

Keywords: fruit iced teas, NADES extracts, consumer acceptability, ranking test

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**ANALIZA TRENDA U PROCESU ISPITIVANJA MASE 1000 SEMENA
PRIMENOM BROJAČA**

*Tanja PETROVIĆ, Jasna VUJINOVIĆ, Marija MILIVOJEVIĆ, Dragana BRANKOVIĆ-RADOJČIĆ,
Radmila VUKADINOVIĆ*

Institut za kukuruz „Zemun Polje“, Slobodana Bajića 1, 11185, Zemun, Beograd, Srbija

E-mail: ptanja@mrizp.rs

Praćenje i kontrola rada laboratorijske opreme je jedan od zahteva standarda za laboratorije za ispitivanje semena. Period i način kontrole zavise od učestalosti korišćenja opreme, njene starosti itd. U Laboratoriji za ispitivanje semena Instituta za kukuruz „Zemun Polje“, brojač semena koristi se u ispitivanju mase 1000 semena radi ubrzanja procesa rada i jednom godišnje se redovno proverava njegova tačnost brojanja. Međutim, u dosadašnjoj praksi nije se obraćala pažnja da li prilikom rada brojača dolazi do selektivnog izbora semena koje se broji. Preciznost i slučajni izbor semena kod ispitivanja mase 1000 semena u laboratoriji je od velike važnosti kako bi se obezbedila reprezentativnost uzorka i ispravno donela odluka o daljem procesu pakovanja. Određivanje mase semena prema ISTA Pravilima se može izvesti na dva načina: brojanjem cele frakcije čistog semena i brojanje ponavljanja od po 100 semena. U oba slučaja brojanje se može izvesti ručno ili korišćenjem brojača. Cilj ovog istraživanja je provera da li laboratorijski brojač semena u toku svog rada, u zavisnosti od brzine, selektuje seme po obliku i veličini i da li postoji trend. U radu je ispitivano 10 vrsta različite krupnoće semena (*Capsicum annuum*, peletirano seme *Beta vulgaris*, *Brassica napus*, *Medicago sativa*, *Raphanus sativus*, *Sinapis alba*, *Triticum aestivum*, *Helianthus annuus*, *Glycine max* i *Zea mays*). Brojač je podešen na dve brzine brojanja (maksimalna brzina automatski zadata i 50% od maksimalne brzine). Brojano je 10 ponavljanja po 100 semena. Posle svakog ponavljanja izbrojanog na brojaču, ručno je proveravan broj semena i merena je masa. Analizom dobijenih rezultata utvrđeno je da brojač precizno broji, a na osnovu rezultata izmerene mase uočeno je da se na maksimalnoj brzini pojavljuje trend prilikom rada brojača kod vrsta *Capsicum annuum* i *Glycine max* (selektovanje semena od sitnijeg ka krupnijem). Kod semena *Medicago sativa* i peletiranog semena *Beta vulgaris*, uočen je trend selektovanja semena od krupnijeg ka sitnijem. Prilikom sporijeg brojanja (50% od maksimalne brzine), ne pojavljuje se trend prilikom rada brojača, kod gore navedenih vrsta semena. Za ostale vrste nije uočen trend (proseci mase 1000 semena za obe posmatrane brzine su skoro identični). Rezultati ovih analiza ukazuju na važnost provere opreme kako u smislu tačnosti brojanja tako i selektovanja semena u cilju dobijanja tačnih rezultata ispitivanja mase 1000 semena.

Ključne reči: trend, masa 1000 semena, brojač semena

TREND ANALYSIS IN 1000 SEED WEIGHT TESTING USING A COUNTER

Tanja PETROVIĆ, Jasna VUJINOVIĆ, Marija MILIVOJEVIĆ, Dragana BRANKOVIĆ RADOJČIĆ,
Radmila VUKADINOVIĆ

Maize Research Institute Zemun Polje, Slobodana Bajića 1, 11185, Zemun, Belgrade, Serbia

E-mail: ptanja@mrizp.rs

Monitoring and control of laboratory equipment is one of the requirements of the standard for seed testing laboratories. The period and method of control depends on the frequency of use of the equipment, its age, etc. In Seed Testing Laboratory of the Maize Research Institute Zemun Polje, seed counter is used to speed up the testing of 1000 seeds weight, and its counting accuracy is regularly checked once a year. However, in the practice so far, no attention has been paid whether the seed selection occurs during the operation of the counter. Accuracy and random selection of seeds when testing the 1000 seeds weight in the laboratory is of great importance in order to ensure the representativeness of the sample and precise information for further packaging process. According to the ISTA Rules 1000 seed weight can be determined by two methods: by counting the whole fraction of pure seed and by counting replications of 100 seeds. In both cases, the counting can be performed manually or by counter. The aim of this research was to check whether the laboratory seed counter selects seeds by shape and size and whether there is a trend during operation at maximum and reduced speed. Ten species of different seed sizes (*Capsicum annuum*, pelleted seed *Beta vulgaris*, *Brassica napus*, *Medicago sativa*, *Raphanus sativus*, *Sinapis alba*, *Triticum aestivum*, *Helianthus annuus*, *Glycine max* and *Zea mays*) were used. The counter is set to two counting speeds (maximum speed set automatically and 50% of maximum speed). Ten replications of 100 seeds were counted. After each replicate counted by counter, the number of seeds was manually checked and the weight measured. The analysis of the obtained results showed that the counter is precise, but weight results showed trend in *Capsicum annuum* and *Glycine max* (selection of seeds from smaller to larger) at maximum speed operation of the counter. In case of *Medicago sativa* seeds and pelleted *Beta vulgaris* seeds, a trend of seed selection from larger to smaller was observed. During slower counting (50% of the maximum speed), there was no trend during the operation of the counter, with the above-mentioned types of seeds. No trend was observed for other species (1000 seed weight mean, for both observed speeds were almost identical). The results of these analyses indicate the importance of checking the equipment both in terms of accuracy of counting and selection of seeds in order to obtain accurate test results for the 1000 seed weight.

Keywords: trend, 1000 seed weight, seed counter

INOVACIONA PODNJAČE KOŠNICE NAMENJENE PRIHVATU KOLEKTORA ZA SKUPLJANJE PČELINJEG OTROVA

Ivan PIHLER¹, Miroslava POLOVINSKI-HORVATOVIĆ¹, Saša DRAGIN¹, Denis KUČEVIĆ¹, Ksenija
ČOBANOVIĆ¹, Hadži Zoran JOVANOVIĆ²

¹Poljoprivredni fakultet – Univerzitet Novi Sad

²Pčelarski klaster “Panonian bee”

E-mail: ivan.pihler@stocarstvo.edu.rs

Sinonim za proizvodnju u pčelarstvu je svakako med, međutim i drugi pčelinji proizvodi kao što su matična mleč, propolis, polen, pčelinji vosak i pčelinji otrov, predstavljaju jednu riznicu lekovito-profilaktičkih materija. Možda se još uvek najmanje zna o lekovitom delovanju pčelinjeg otrova, ali poslednjih 20 godina njegova primena je neverovatno raširena od lečenja virusnih oboljenja i upala do blagotvornih kozmetičkih tretmana (Wehbe et al. 2019). Apiterapija je grana alternativne medicine koja se zasniva upravo na upotrebi pčelinjih proizvoda i najviše pčelinjeg otrova u terapijske svrhe (Fratellone 2015). Upravo ovako raširena primena pčelinjeg otrova i njegovo dokazano delovanje je učinilo ovaj proizvod pčela vrlo dragocnim, a interesovanje pčelara za njegovim sakupljanjem postala sve veća (Serrinha et al., 2019).

Većina kolektora za sakupljanje pčelinjeg otrova je koncipirana tako da se on fiksira na leto košnice kako bi pčele sletale na njega i bile izložene elektrošokovima. Problem se javlja jer su ovakvi kolektori i sakupljen otrov na njima izloženi sunčevoj svetlosti i drugim vremenskim uticajima. Da bi smo ovo izbegli potrebno je na neki način promeniti konstrukciju dela košnice gde se nalazi kolektor za sakupljanje pčelinjeg otrova tako da sakupljen otrov na kolektoru bude zaštićen od nepovoljnog uticaja vremenskih prilika.

Izradom podnjače u koji se unutar košnice može postaviti kolektor za sakupljanje pčelinjeg otrova, kombinujemo više pozitivnih stvari kod sakupljanja pčelinjeg otrova:

- Pčelinji otrov na kolektoru je zaštićen od štetnog uticaja sunčeve svetlosti,
- Specijalna konstrukcija podnjače sprečava kontaminaciju pčelinjeg otrova sa prljavštinom iz košnice (vosak, polen, nektar...)
- Kolektor za sakupljanje pčelinjeg otrova sa nalazi na ulasku pčela u košnicu, gde se prirodno očekuje eventualni napad na košnicu, te pčele brže i i intenzivnije reaguju na kolektor.

Ključne reči: Pčelarstvo, košnice, podnjače, pčelinji otrov

UV-LED IRRADIATION PROCESS: IMPACT ON PECTOLYTIC ACTIVITY AND QUALITY PARAMETERS IN TOMATO (*SOLANUM LYCOPERSICUM*) JUICE

Sebastián PIZARRO-OTEÍZA, Fernando SALAZAR

Escuela de Alimentos, Pontificia Universidad Católica de Valparaíso, Av. Waddington 716, Valparaíso, Chile.

E-mail: sebastian.pizarro@pucv.cl

The treatments "Hot and Cold break" are used to control pectinases activities in tomatoes. The research aim was to analyze the pectolytic activities (pectinmethylesterase "PME" and polygalacturonase "PG") and quality features of tomato juice treated by UV-LED and Hot Break (HB) and Cold break (CB) processes. The tomato juice treated by UV-LED for 5 min obtained a PME residual activity similar to CB and 28.3 % lower than HB ($p < 0.05$) when the tomato juice was treated by UV-LED for 15 min. Besides, the effect of UV-LED on PG activity was similar to HB and 49 % lower than CB ($p < 0.05$). Furthermore, the UV-LED process generated a decrease of pH, total acidity and soluble solids, but significant increase in total lycopene content. Also, the antioxidant activity and viscosity were similar to CB, and total polyphenol content was similar to HB ($p < 0.05$). Therefore, this study provides promising applications of UV-LED technology on the control of enzymatic activity of tomato juice as an alternative to heat treatments.

Keywords: UV-LED irradiation process, Pectolytic activities, Hot-Cold break, Tomato (*Solanum lycopersicum*) juice.

MOLECULAR DETECTION OF FUSARIUM INFECTIONS IN WHEAT - A MEASURE OF QUALITY ASSESSMENT

Sorina POPESCU, Oana-Maria BOLDURA, Aurica BOROZAN, Emilian MADOSA

Banat University of Agricultural Sciences and Veterinary Medicine “King Michael I from Romania”
Timisoara, Romania

Email: sorinapopescu@usab-tm.ro

The genus *Fusarium* is considered the most important group of pathogenic fungi due to its diversity, wide spread and especially their involvement in many plants diseases. Their importance is primarily related to the phytopagenicity of certain species that cause large losses in the production of major crops, but also the contamination with their toxins, reducing the market value. The presence of toxins makes impossible the introduction of contaminated grains in the food chain both for humans and animals. The most important classes of mycotoxins are trichothecenes, fumonisins, and zearalenones.

The presence of toxins is usually determined by biochemical ELISA (*Enzyme-Linked Immunosorbent Assay*) and HPLC (*High Performance Liquid Chromatography*) methods. But the progress of DNA analysis set up to the development of PCR (Polymerase Chain Reaction)-based methods in order to screen the fungal early infection, chemotype identification and even accurate species identification using specific gene sequencing.

In this study 50 wheat samples collected from different western Romanian locations were analyzed. The mycotoxin were determined by ELISA test and the DNA screening was done based on PCR amplification with primers specific for *Fusarium graminearum*, *Fusarium culmorum*, *Fusarium proliferatum* and *Fusarium verticillioides*. Of these, 32 samples were positive when they were amplified with *Fusarium graminearum* primers and the production of the DON (deoxynivalenol) toxin was detected in all of them. To confirm the identity of this fungal species several samples (10) were subjected to the barcoding procedure namely the sequencing of the translation elongation factor 1- α gene which is known as a taxonomic marker for fungi. The species identity was confirmed for all the analysed samples. For other 9 fungal samples the production of fumonisin was identified. Of these, five samples were *Fusarium proliferatum*, confirmed both by PCR and sequencing. The others were negative for PCR tests but were confirmed by sequencing as *Fusarium verticilloides*, *Fusarium andyaze*, *Fusarium solani* and *Fusarium subglutinans*. Another 9 samples were negative in terms of both mycotoxins and molecular analysis.

Considering that in Romania the prevalence of *Fusarium graminearum* infections is the most important, it can be stated that the screening with primers specific to fungal species ensures a preliminary test for fungal infection identification.

Key words: wheat, *Fusarium*, PCR analysis, barcoding

OCENA KVALITETA SEMENA RAZLIČITIH PARTIJA KUPUSA TOKOM STARENJA

Dobrivoj POŠTIĆ¹, Ratibor ŠTRBANOVIĆ¹, Zoran BROČIĆ², Marijenka TABAKOVIĆ³, Nenad ĐURIC⁴, Nenad PAVLOVIĆ⁵, Rade STANISAVLJEVIĆ¹

¹*Institut za zaštitu bilja i životnu sredinu, Beograd, Teodora Drajzera 9*

²*Poljoprivredni fakultet, Beograd, Nemanjina 6*

³*Institut za kukuruz, Zemun Polje, Slobodana Bajića 1*

⁴*Institut za povrtarstvo, Smederevska Palanka, Karađorđeva 71*

⁵*Agronomski fakultet, Čačak, Cara Dušana 34*

E-mail: pdobrivoj@yahoo.com

Proizvodnja povrća u Republici Srbiji odvija se na oko 130.000 ha, što predstavlja približno 3,5% od ukupne biljne proizvodnje. Kupus zajedno sa keljom na osnovu zasnovanih površina dolazi odmah iza krompira, paradajza i paprike sa 12,534 ha u 2019. godini, što predstavlja oko 9,5% od ukupnih površina pod povrćem prema podacima Republičkog zavoda za statistiku.

Cilj istraživanja je bio da se izvrši ocena uticaja godine i partije semena na najznačajnije pokazatelje kvaliteta semena kupusa. Dobijeni rezultati treba da daju doprinos razumevanju opadanja vrednosti pokazatelja kvaliteta visoko hibridnog semena kupusa tokom starenja.

Ispitivanje kvaliteta semena devet različitih partija kupusa Potomak F1, izvedena su tokom tri godine (2019, 2020 i 2021) u Laboratoriji za ispitivanje kvaliteta semena i sadnog materijala Instituta za zaštitu bilja i životnu sredinu. Seme devet partija kupusa hibrida Potomak F1 uveženo je 2019. godine u Republiku Srbiju.

Analiza energije klijanja, ukupne klijavosti, nenormalnih klijanaca i mrtvog semena kupusa pokazala je visoko značajne razlike ($p < 0,01$) pod uticajem faktora godina (A) i partija semena (B), kao i njihove interakcija ($A \times B$).

Prosečna ukupna klijavost ispitivanih partija u 2019. godini bila je (97%), u 2020. (85%), odnosno (55%) u 2021. godini. Vrednosti ukupne klijavosti semena kupusa u proseku veoma značajno opadaju tokom starenja u 2020. godini za 12%, odnosno u 2021. za 42%, u poređenju sa prosečnom ukupnom klijavosti zabeleženoj u 2019. godini. U prvoj godini zabeležena je značajna korelacija ($r = 0.84779$, $p < 0.01$) između energije klijanja i ukupne klijavosti, odnosno u drugoj godini ($p \leq 0.05$), dok je u trećoj godini izostala. Visoka negativna međuzavisnost dobijena je između ukupne klijavosti i mrtvog semena ($r = -0.94363$, $p < 0.001$) i nenormalnih klijanaca ($r = -0.78019$, $p < 0.05$). Takođe, negativna korelacija utvrđena je između energije klijanja i mrtvog semena ($r = -0.80000$, $p < 0.01$) i nenormalnih klijanaca ($r = -0.66144$, $p < 0.05$).

Dobijeni rezultati ukazuju da se ukupna klijavost visoko hibridnog konvencionalnog semena kupusa veoma značajno smanjuje tokom starenja, kao direktna posledica vrlo značajnog povećanja broja nenormalnih klijanaca.

Key words: kupus, klijavost, partija semena, nenormalni klijanci

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UTICAJ RAZLIČITIH UDELA TRITIKALEA SORTE ODISEJ NA KVALITET PIVA

Milana PRIBIĆ¹, Saša DESPOTOVIĆ², Sunčica KOCIĆ-TANACKOV¹, Jelena PEJIN^{1*}

¹Univerzitet u Novom Sadu, Tehnološki fakultet, Bulevar Cara Lazara 1, 21000 Novi Sad, Srbija

²Univerzitet u Beogradu, Poljoprivredni fakultet, Nemanjina 6, 11 080 Beograd, Srbija

E-mail: jpejin@uns.ac.rs

Tehnologija piva je jedna od najstarijih biotehnoških procesa u kojem se tokom niza faza od početnih sirovina proizvodi finalni proizvod - pivo. Ječmeni slad je glavna sirovina tradicionalne tehnologije piva. Međutim, zbog složene prirode procesa sladovanja, koji je energetski intenzivan i koristi velike količine vode, upotreba nesladovanih žitarica u proizvodnji piva postala je praksa. Istraživanja pokazuju da cena procesa sladovanja iznosi oko 3,5% od ukupnih troškova proizvodnje piva. Shodno tome, upotreba nesladovanih žitarica predstavlja način uštede troškova, smanjuje uticaj na životnu sredinu, a doprinosi i razvoju novih tipova piva. Međutim, važan faktor predstavlja činjenica da nesladovane žitarice uglavnom imaju manju aktivnost amilolitičkih enzima, što zahteva dodatak komercijalnih enzima tokom proizvodnje piva.

Kao nesladovane žitarice najčešće se koriste ječam, pšenica, kukuruz, pirinač, tritikale... Ove žitarice su uglavnom bogate skrobom, sa smanjenom enzimskom aktivnosti, ali žitarica poput tritikalea je izuzetak. Tritikale ima nisku temperaturu klajsterizacije i visoku enzimsku aktivnost, što ukazuje na njegovu sposobnost razgradnje sopstvenog skroba efikasnošću jednakoj efikasnosti ječmenog slada, tako da ne zahteva dodatnu termičku obradu. Međutim, upotrebom tritikalea umesto ječmenog povećava se koncentracija β -glukana i arabinoksilana u komini, što dovodi do povećanja viskoznosti komine, samim tim i sporije filtracije piva.

Cilj ovog istraživanja je procena mogućnosti primene tritikalea kao delimične zamene za ječmeni slad u proizvodnji piva. Tritikale, sorte Odisej, korišćen je u različitim udelima u proizvodnji sladovine (10, 30 i 50%) sa ili bez dodatka komercijalnog enzima za smanjenje viskoznosti sladovine - Shearzyme. Sa povećanjem sadržaja tritikalea u usipku, povećavala se i viskoznost, koja je smanjena dodatkom komercijalnog enzima. Najveća viskoznost određena je u sladovini proizvedenoj iz 50% tritikalea bez dodatka enzima (1,903 mPa·s) koja je smanjena na 1,462 mPa·s uz dodatak enzima. Najveći sadržaj etanola dobijen je u pivu sa 10% sadržaja tritikalea (2,89%), bez dodatka enzima. Sa povećanjem sadržaja tritikalea u usipku, smanjivao se sadržaj ekstrakta dobijenih sladovina i ohmeljenih sladovina. Dodatkom enzima uspešno je smanjena viskoznost sladovina, posebno u slučaju korišćenja većih udele tritikalea u usipku. Zamena ječmenog slada tritikaleom nije imala negativan uticaj na fermentaciju piva, čak ni pri najvećem udelu tritikalea u usipku (50%). Dobijeni rezultati ukazuju da tritikale sorte Odisej ima dobre tehnološke parametre i da se može koristiti kao delimična zamena ječmenog slada u proizvodnji piva.

Ključne reči: sladovina, pivo, tritikale, nesladovane sirovine

THE EFFECT OF DIFFERENT RATIOS OF TRITICALE VARIETY ODISEJ ON THE BEER QUALITY

Milana PRIBIĆ¹, Saša DESPOTOVIĆ², Sunčica KOCIĆ-TANACKOV¹, Jelena PEJIN^{1*}

¹University of Novi Sad, Faculty of Technology, Bulevar Cara Lazara 1, 21000 Novi Sad, Serbia

²University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11 080 Belgrade, Serbia

E-mail: jpejin@uns.ac.rs

Brewing is one of the world's oldest biotechnological process that employs a number of operations in processing raw materials to the final product - beer. Malted barley is the main raw material in the traditional brewing. However, due to the complex nature of the malting process, which is being energy intensive and uses large volumes of water, the use of unmalted cereals in brewing process has become more realistic. Some reports show that the cost of malting process is approximately 3.5% of total beer production costs. Consequently the use of unmalted cereals instead of malt became an interesting way to save costs, to reduce environmental impact and to produce unique beers. However, it is important to consider that unmalted cereals mainly have amylolytic enzyme deficit, which requires the addition of commercial enzymes during the brewing process.

The most common choices for unmalted cereals are barley, wheat, corn, rice, triticale... Typically, these unmalted cereals contribute starch, with no enzyme activity, but cereal like triticale is an exception. Triticale has a low gelatinization temperature and high enzymatic activity, which indicates its capability of degrading its own starch with efficiencies equal to those of barley malt, so it doesn't require additional thermal process. However, usage of triticale instead of barley malt increases the presence of β -glucans and arabinoxylans in the mash. This can lead to higher mash viscosities and therefore slower beer filtration.

The objective of this study was to evaluate the possibility of triticale application as a partial substitute for barley malt in beer production. Triticale variety Odisej was used in a different proportions in wort production (10, 30, and 50%) with or without addition of commercial enzyme for wort viscosity reduction - Shearzyme. With an increase in triticale content in the grist, viscosity increased, which was corrected with the addition of commercial enzyme Shearzyme. The highest value of this parameter was obtained in wort produced from 50% triticale content in the grist without enzyme addition (1.903 mPa·s) which was reduced to 1.462 mPa·s with enzyme addition in the wort. The highest ethanol content was obtained for beer produced with the 10% of triticale in the grist (2.89%), without enzyme addition. Extract contents of obtained worts and boiled was were decreased with an increase in triticale content in the grist. Enzyme addition decreased wort viscosity, especially when higher triticale ratios in grist were used. Replacement of the barley malt with native triticale did not have a negative impact on beer fermentation, even at the highest triticale content in the grist (50%). The obtained results indicate that triticale variety Odisej has good technological parameters and could be used as a partial substitute for barley malt in beer production.

Key words: wort, beer, triticale, adjuncts

HIBRIDNI KUKURUZA BELOG ZRNA FAO GRUPA ZRENJA 500 I 600 - SVOJSTVA I SASTAV

Milica RADOSAVLJEVIĆ¹, Marija MILAŠINOVIĆ-ŠEREMEŠIĆ², Dušanka TERZIĆ¹, Života JOVANOVIĆ¹, Valentina NIKOLIĆ¹, Mile SEČANSKI¹

¹Institut za kukuruz „Zemun Polje“, Slobodana Bajića 1, Beograd, Srbija

²Naučni institut za prehrambene tehnologije u Novom Sada, Bulevar cara Lazara 1, Novi Sad, Srbija

E-mail: rnilica@mrizp.rs

Pod kukuruzom belog zrna se smatra onaj tip kukuruza čiji endosperm ima jasnu belu boju, bez primesa pigmenta žute boje. Značaj kukuruza belog zrna se vremenom menjao u raznim zemljama i kulturama. Ako se ima u vidu globalna rasprostranjenost kukuruza belog i žutog zrna, zapaža se da kukuruz žutog zrna ima u svetu apsolutno dominantnu ulogu. Korišćenje kukuruza belog endosperma značajno se promenilo u poslednjih nekoliko decenija. Praktično prestala je njegova upotreba u ishrani domaćih životinja, dok je istovremeno povećano njegovo korišćenje za dobijanje specijalnih proizvoda za ljudsku ishranu i u mlinskoj preradi. Zbog toga su svojstva kvaliteta zrna postala jako važna i u selekcionom procesu poklanja im se ista pažnja kao i samom prinosu zrna.

Cilj ovog rada bio je da se izvrši karakterizacija hibrida kukuruza belog zrna u pogledu morfološke građe, različitih fizičkih svojstva i osnovnog hemijskog sastava zrna kao pokazatelja njihove upotrebne vrednosti i kvaliteta. Pored toga, u radu su ispitivane i fizičke karakteristike klipa. Za ispitivanja je odabrano je pet zemunpoljskih hibrida kukuruza (tri hibrida belog i dva hibrida žutog zrna FAO grupa zrenja 500 i 600).

Dobijeni rezultati su pokazali da se zrno ispitivanih hibrida kukuruza belog endosperma u proseku sastoji od 6,11% perikarpa, 79,24% endosperma i 14,65% klice. Prosečne vrednosti hektolitarske mase, mase 1000 zrna, gustine, indeks flotacije, otpornosti na mlevenje i udela tvrde frakcije endosperma bile su 273,16 g, 778,60 kg/m³, 1,28 g/cm³, 27,70%, 12,85 s i 56,26%, redom. U proseku zrno hibrida belog endosperma sadrži 70,55% skroba, 9,38% proteina, 6,31% ulja, 2,31% sirove celuloze i 1,35% pepela. U odnosu na hibride žutog zrna ispitivani hibridi belog zrna su u proseku imali veći udeo klica i tvrde frakcije endosperma, viši sadržaj ulja i višu otpornost na melvenje, a manju masu 1000 zrna, indeks flotacija, masu klipa i masu zrna na klipu.

Ključne reči: hibridi kukuruza, zrno, klip, svojstva, sastav.

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WHITE MAIZE HYBRIDS OF THE FAO MATURITY GROUPS 500 AND 600 - TRAITS AND COMPOSITION

Milica RADOSAVLJEVIĆ¹, Marija MILAŠINOVIĆ-ŠEREMEŠIĆ², Dušanka TERZIĆ¹, Života JOVANOVIĆ¹, Valentina NIKOLIĆ¹, Mile SEČANSKI¹

¹Maize Research Institute, Zemun Polje, Slobodana Bajića 1, Belgrade, Serbia

²Institute of Food Technology in Novi Sad, Bulevar cara Lazara 1, Novi Sad, Serbia

E-mail: rmilica@mrizp.rs

White maize is maize with the endosperm of clear white colour, without the addition of the yellow pigment. The importance of white maize has changed over time in various countries and cultures. The comparison of the global distribution of white and yellow maize shows that the latter one has an absolutely dominant role in the world. The use of maize with the white endosperm has changed significantly in the last few decades. Its use in livestock feeding has practically ceased, while at the same time its use for obtaining special products for human consumption and in mill processing has increased. Therefore, the grain quality traits have become very important and they are given the same attention as the grain yield itself in the breeding and selection process.

The aim of this study was to characterize white maize with respect to the morphological structure, different physical traits and basic chemical composition as a parameter of the use value and quality of grain. In addition, physical traits of ears were observed. Five ZP maize hybrids (three with white and two with yellow kernels of the FAO maturity groups 500 and 600) were selected for testing.

The obtained results showed that the grain of observed white maize hybrids consisted, on average, of 6.11% pericarp, 79.24% endosperm and 14.65% germ. The average values of test weight, 1000-kernel weight, density, flotation index, milling response and the proportion of hard endosperm fractions amounted to 273.16 g, 778.60 kg/m³, 1.28 g/cm³, 27.70%, 12.85 s and 56.26%, respectively. On average, the grain of white hybrids contains 70.55% starch, 9.38% proteins, 6.31% oil, 2.31% crude fibres and 1.35% ash. Compared to yellow hybrids, the observed white hybrids had on average a higher proportion of germs and hard endosperm fraction, higher oil content and higher milling resistance, while 1000-kernel weight, flotation index, ear weight and kernel weight on the ear were lower.

Key words: maize hybrids, grain, ear, traits, composition.

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PROCENA NUTRITIVNE VREDNOSTI SEMENA LANIKA (CAMELINA SATIVA L. CRANTZ)

Sladana RAKITA¹, Nedeljka SPASEVSKI¹, Olivera ĐURAGIĆ¹, Viktor STOJKOV¹, Ana JEROMELA MARJANOVIĆ², Sandra CVEJIĆ², Federica ZANETTI³

Univerzitet u Novom Sadu, Naučni institut za prehrambene tehnologije, Bulevar cara Lazara 1, 21000 Novi Sad, Srbija

Institut za ratarstvo i povrtarstvo, Maksima Gorkog 30, Novi Sad, 21000 Srbija

Department of Agricultural and Food Sciences (DISTAL), Università di Bologna - Alma Mater Studiorum, Viale G. Fanin 44, 40127 Bologna, Italy

E-mail: sladjana.rakita@fins.uns.ac.rs

Lanik ili kamelina (*Camelina sativa* (L.) Crantz) je uljarica iz porodice Brassicaceae koja je privukla ogromnu pažnju zbog brojnih pozitivnih karakteristika koje je izdvajaju od ostalih uljanih kultura. Lanik je veoma adaptibilna kultura i može se gajiti u različitim klimatskim uslovima i zemljištima. Pored toga, zahtevi za njen uzgoj su minimalni i ekološki prihvatljivi jer joj je potrebno malo đubriva i vode, i ne zahteva upotrebu pesticida ili herbicida u poređenju sa drugim uljaricama, što ovu kulturu čini pogodnom za gajenje na manje plodnim zemljištima. Lanik je relativno otporan na sušu i hladnoću međutim, jedino ograničenje za uzgoj su teška glinovita tla. Lanik je obećavajuća alternativna uljana kultura jer ima veliki potencijal primene. Sa nutritivnog spektra, dragocen je izvor proteina, masti, vlakana, esencijalnih masnih kiselina, naročito omega-3 masnih kiselina, tokoferola, fitosterola, i fenolnih jedinjenja.

U ovom istraživanju, dve sorte lanika (NS Zlatka i NS Slatka) registrovane u Republici Srbiji su ispitane u pogledu nutritivnih svojstava, što je podrazumevalo analizu hemijskog i mineralnog sastava, sastava masnih i amino kiselina, sadržaja liposolubilnih vitamina. Takođe, ispitana je mikrobiološka bezbednost. Utvrđeno je da se obe sorte lanika odlikuju visokim sadržajem proteina, masti i vlakana (oko 27, 38 i 18%, respektivno). NS Slatka je imala veći sadržaj kalijuma, kalcijuma, magnezijuma i gvožđa, ali niži sadržaj glukozinolata u odnosu na NS Zlatku. Obe sorte su bile mikrobiološki ispravne, iako je NS Zlatka imala duplo veći broj mikroorganizama. Seme lanika je bilo bogato polinezasićenim masnim kiselinama (57%), od kojih je najdominantnija bila alfa-linolenska kiselina, čineći oko 37% ukupnih masnih kiselina. Seme lanika je bilo bogato γ -tokoferolima koji su bili zastupljeni u koncentraciji oko 19 mg/100g. Leucin, lizin i valin su bile najzastupljenije esencijalne amino kiseline u zrnu lanika, dok su od neesencijalnih najzastupljenije bile glutaminska kiselina, arginin, asparagniska kiselina, prolin i glicin. Dobijeni rezultati istraživanja su pokazali značajnu nutritivnu i funkcionalnu vrednost lanika, što ukazuje da seme lanika i njegovi nusproizvodi imaju veliki potencijal primene u prehrambenoj industriji i industriji hrane za životinje, pri čemu treba uzeti u obzir dozvoljeni sadržaj antinutritivnih materija prisutnih u laniku.

Ključne reči: uljarica, glukozinolati, omega-3 masne kiseline, tokoferoli, amino kiseline

ZAHVALNICA

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EVALUATION OF NUTRITIVE VALUE OF CAMELINA SEED (*CAMELINA SATIVA L. CRANTZ*)

Sladana RAKITA¹, Nedeljka SPASEVSKI¹, Olivera ĐURAGIĆ¹, Viktor STOJKOV¹, Ana JEROMELA MARJANOVIĆ², Sandra CVEJIĆ², Federica ZANETTI³

University of Novi Sad, Institute of Food Technology, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia

Institute of Field and Vegetable Crops, Maksima Gorkog 30, Novi Sad, 21000 Serbia

Department of Agricultural and Food Sciences (DISTAL), Università di Bologna - Alma Mater Studiorum, Viale G. Fanin 44, 40127 Bologna, Italy

E-mail: sladjana.rakita@fins.uns.ac.rs

Camelina sativa (L.) Crantz, an oilseed crop that belongs to *Brassicaceae* family, has gained enormous attention due to its numerous positive characteristics that make it distinctive among oilseed crops. Camelina is very adaptable crop, and it can be cultivated in different environmental regions and lands. Apart from that, its requirements for cultivation are minimal and environmental friendly as it needs low fertilizer, water and require no pesticides/herbicides compared to other oilseeds which makes this crop suitable for growing on less productive soils. The only limitation for camelina cultivation is heavy clay and organic soils. However, it is relatively resistant to drought and cold. Owing to its multiple feed and industrial applications, camelina is being considered a very promising alternative oilseed crop. From the nutritional point of view, it is a valuable source of proteins, fats, fibres, essential polyunsaturated fatty acids, particularly omega-3 fatty acids, tocopherols, phytosterols, and phenolic compounds.

In this research, two varieties of camelina seed (NS Zlatka and NS Slatka), registered in Serbia, were evaluated with regard to nutritional properties, which included assessment of chemical and mineral composition, fatty acid and amino acid profile and content of liposoluble vitamins. Microbiological safety was also assessed. It was determined that both camelina seed varieties were characterized by high content of crude protein, fat and fiber (around 27, 38 and 18%, respectively). NS Slatka was characterized by higher content of potassium, calcium, magnesium and iron, but lower level of glucosinolates than NS Zlatka. Both varieties were safe in terms of microbiological parameters although NS Zlatka had two fold higher total bacteria count. Regarding fatty acids, camelina seeds were rich in polyunsaturated fatty acids (57%), of which the most dominant was alpha-linolenic accounting for approximately 37%. Camelina is a rich source of tocopherols, especially γ -tocopherols which was distributed in camelina seeds in the concentration of around 19 mg/100g. Leucine, lysine and valine was the major essential amino acids found in camelina seeds, while glutamic acid, arginine, aspartic acid, proline, and glycine was the most dominant non-essential amino acids. The obtained results pointed out that camelina has a substantial nutritional and functional value indicating that camelina seed and its by-products have enormous potential for the application in food and animal feed industry, whereas the level of antinutritive factors present in camelina should be taken into consideration.

Keywords: oilseed, glucosinolates, omega-3 fatty acids, tocopherols, amino acids

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ANTIOKSIDATIVNA I ANTIBAKTERIJSKA SVOJSTVA MEDA SA TERITORIJE SRBIJE, KOSOVA I BOSNE I HERCEGOVINE

Marijana SAKAČ¹, Pavle JOVANOVIĆ¹, Aleksandar MARIĆ¹, Aleksandra NOVAKOVIĆ¹,
Dragana PLAVŠIĆ¹, Dubravka ŠKROBOT¹

¹Univerzitet u Novom Sadu, Naučni institut za prehrambene tehnologije u Novom Sadu,
Novi Sad, Bulevar cara Lazara 1

E-mail: marijana.sakac@fins.uns.ac.rs

Med je prirodni zaslađivač koji proizvode pčele koristeći nektar. Koristi se ne samo u ishrani, već i u terapijske svrhe. U sastavu meda dominiraju ugljeni hidrati, glukoza i fruktoza (85–95%). Pored šećera, med sadrži i oko 200 supstanci u malim količinama, uključujući minerale, proteine, enzime, amino kiseline, organske kiseline, vitamine, polifenole i druga fitojedinjenja.

Vrsta meda određena je vrstom polena, odnosno nektara, izlučevinama insekata, kao i klimatskim uslovima i sastavom zemljišta.

Zdravstvene dobrobiti meda, korišćene vekovima u terapeutse svrhe, proizilaze iz njegove antioksidativne prirode, antimikrobne i antiproliferativne aktivnosti.

Antioksidativni kapacitet meda prvenstveno zavisi od fenolnog profila meda, koji je uslovljen botaničkim i geografskim varijacijama. Antibakterijska aktivnost meda proizilazi iz visokog osmolariteta i kiselosti meda, kao i prisustva vodonik peroksida i fenolnih jedinjenja.

Sa ciljem da se proceni antioksidativni kapacitet i antibakterijska aktivnost različitih vrsta meda karakterističnih za region, ispitano je devetnaest uzoraka (bagrem, lipa, vriješak, suncokret, facelija, bosiljak, anis, žalfija, kesten, glog, heljda, lavanda i livadski) prikupljenih sa različitih lokacija u Republici Srbiji, Kosovu i Bosni i Hercegovini. Uzorci meda su ispitani i u pogledu fizičko-hemijskih parametara (vlaga, pH, električna provodljivost, slobodna kiselost i HMF) kako bi se osiguralo da ispunjavaju uslove za kvalitet meda.

Na osnovu dobijenih rezultata fizičko-hemijskog profila meda zaključeno je da su svi ispitani uzorci bili su u skladu sa propisima nacionalne i EU regulative.

Antioksidativni potencijal uzoraka meda je procenjen određivanjem ukupnog sadržaja fenola (TPC) i procenom antiradikalske aktivnosti na difenilpikrilhidrazil radikale (DPPH·).

Najveći sadržaj fenola utvrđen je u medu od bosiljka ($101 \pm 2,72$ mg GAE/100 g), dok je najmanji registrovan u medu od uljane repice ($11,5 \pm 0,70$ mg GAE/100 g). Uzorci meda od vriješka, anisa, facelije, žalfije, kestena i lavande takođe su bili bogati TP ($80\text{--}100$ mg GAE/100 g). Antiradikalske aktivnost na DPPH· varirala je među uzorcima i bila je najveća za med od lavande ($IC_{50} = 88,2 \pm 2,11$ mg/mL), a najniža za med od uljane repice ($IC_{50} = 646 \pm 8,72$ mg/mL).

Antibakterijska aktivnost je procenjena *in vitro* testom, odnosno mikrodilucionom metodom je određena minimalna inhibitorna koncentracija (MIC). Među ispitivanim sojevima bakterija utvrđene su sledeće rezistentne potencije: *E. coli* > *E. coli* ATCC 8739 > *E. faecalis* > *Proteus mirabilis* > *S. aureus* > *S. epidermidis*. Fruškogorski lipov med (vrednosti MIC od 3,12% i 6,25% prema *S. aureus* i *S. epidermidis*) i med od facelije (vrednosti MIC od 6,25% i 3,12% prema *S. aureus* i *S. epidermidis*), respektivno. Ispoljili su najjaču antibakterijsku aktivnost.

Ključne reči: med, antioksidativna aktivnost, antibakterijska aktivnost

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ANTIOXIDATIVE AND ANTIBACTERIAL PROPERTIES OF HONEY FROM SERBIA, KOSOVO AND BOSNIA AND HERZEGOVINA

Marijana SAKAČ¹, Pavle JOVANOVIĆ¹, Aleksandar MARIĆ¹, Aleksandra NOVAKOVIĆ¹,
Dragana PLAVŠIĆ¹, Dubravka ŠKROBOT¹

¹University of Novi Sad, Institute of Food Technology,
Novi Sad, Bulevar cara Lazara 1

E-mail: marijana.sakac@fins.uns.ac.rs

Honey is a natural sweetener produced by honeybees using nectar. It has been used not only for food, but also for therapeutic purposes. Carbohydrates, primarily glucose and fructose (85-95%), dominate in honey composition. In addition to sugars, honey contains about 200 substances present in small amounts, including minerals, proteins, enzymes, amino acids, organic acids, vitamins, polyphenols and other phytochemicals.

The type of honey is determined by the type of pollen, i.e. nectar, insect secretions, as well as climatic conditions and soil composition.

The health benefits of honey, used for centuries for therapeutic purposes, derive from its antioxidant nature, antimicrobial and antiproliferative activity.

The antioxidant capacity of honey primarily depends on the phenolic profile of honey, which is conditioned by botanical and geographical variations. The antibacterial activity of honey results from the high osmolarity and acidity of honey, as well as the presence of hydrogen peroxide and phenolic compounds.

With the aim to assess the antioxidant capacity and antibacterial activity of different types of honey characteristic for the region, nineteen samples (acacia, linden, heather, sunflower, phacelia, basil, anise, sage, chestnut, hawthorn, buckwheat, lavender and meadow) were collected from different locations in the Republic of Serbia, Kosovo and Bosnia and Herzegovina and examined. Honey samples were also tested for physicochemical parameters (moisture, pH value, electrical conductivity, free acidity and HMF) to ensure that they meet the requirements for honey quality.

Based on the obtained results of honey physicochemical profile, it was concluded that all tested samples were in accordance with the regulations of national and EU regulations.

The antioxidant potential of honey samples was assessed by determining the total phenol content (TPC) and evaluating the antiradical activity on diphenylpicrylhydrazyl radicals (DPPH·).

The highest phenol content was found in basil honey (101 ± 2.72 mg GAE/100 g), while the lowest was registered in rapeseed honey (11.5 ± 0.70 mg GAE /100 g). Samples of heather, anise, phacelia, sage, chestnut and lavender honey were also rich in TP ($80\text{--}100$ mg GAE/100 g). Scavenging activity on DPPH· varied among samples and was highest for lavender honey ($IC_{50} = 88.2 \pm 2.11$ mg/mL) and lowest for rapeseed honey ($IC_{50} = 646 \pm 8.72$ mg/mL).

Antibacterial activity was estimated *in vitro* using agar diffusion tests and measuring minimal inhibitory concentration (MIC). Among investigated bacterial strains following resistant potencies were determined: *E. coli* > *E. coli* ATCC 8739 > *E. faecalis* > *Proteus mirabilis* > *S. aureus* > *S. epidermidis*. The linden honey from Fruška Gora (MIC values of 3.12% and 6.25% against *S. aureus* and *S. epidermidis*, respectively) and phacelia honey (MIC values of 6.25% and 3.12% against *S. aureus* and *S. epidermidis*, respectively) showed the strongest antibacterial activity.

Keywords: honey, antioxidant activity, antibacterial activity

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INNOVATION AND SOCIO-ECONOMIC DEVELOPMENT IN ROMANIA FOLLOWING THE EUROPEAN UNION INTEGRATION

*Cosmin SALASAN, Iasmina IOSIM, Carmen DUMITRESCU, Cosmina TOADER, Tabita ADAMOV,
Raul PASCALAU*

*Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael Ist of Romania",
Faculty of Management and Rural Tourism, Calea Aradului no. 119, RO-300645 Timisoara, Romania*

E-mail: cosminsalasan@usab-tm.ro

The accession of Romania to the European Union was packed since the early negotiations with a specific need to boost up the market integration of the research sector. The expected transformations induced by the transition to a market economy and the structural adjustments required to ease the process were demanding more targeted efforts towards a closer integration of research, development and innovation. Efforts were made and specific sectoral and trans-sectoral strategies were designed and implemented to direct and facilitate the future investments effort towards quantified targets, particularly in terms of innovation. After fifteen years of integrating efforts, we can read the first results of these efforts and their outcomes. The analysed period, as later highlighted in the analysis, covers two unfavourable periods: the financial crisis at the end of the first decade of this century and more recently the slowdown of the global economy due to the public health crisis induced by the COVID-19 pandemic. As observations and data indicate both shocks were relatively of low relevance for the evolution and changes of the RDI activities with particular emphasis on the innovation. The datasets screened for the analysis are encompassing the average monthly nominal gross earnings and the employees in research and development at the end of each year as reference for the economic wealth. To complete the analysis the turnover from innovation as share from total turnover by economic sector is added to the data series. The innovative enterprises having placed on the market new or significantly improved products as number together with the total research and development expenditure as share of GDP are completing the analysis frame. These elements also part of the general innovation index are further completed with relevant indicators helping the observer note that although the general economic development was progressively and systematically improved the innovative part of the economy continue to decline despite a dedicated diversified and consistent public funding support for all sectors. The perspective of the bioeconomy development in the region might resuscitate the research activities particularly in the public-funded research institutions and universities considering all present and future incentives. The programmed development as part of the programming cycles of the EU is now supplemented consistently with the recovery and resilience funding available already as post-COVID recovery financial instruments expected to accelerate the innovation and innovative processes moreover with a flavour of green and digital.

Key words: innovation, socio-economic development, research expenditure

UTICAJ TEHNIKE HLADNOG PRESOVANJA I SOKSLET EKSTRAKCIJE NA FIZIČKO-HEMIJSKA SVOJSTVA ULJA SEMENA KAMELINE (*CAMELINA SATIVA L.*)

Ivana M. SAVIĆ GAJIĆ¹, Ivan M. SAVIĆ¹, Slađana RAKITA², Nedeljka SPASEVSKI², Jasmina LAZAREVIĆ², Danka DRAGOJLOVIĆ², Viktor STOJKOV

¹Univerzitet u Nišu, Tehnološki fakultet u Leskovcu, Bulevar oslobođenja 124, 16000 Leskovac, Srbija

²Univerzitet u Novom Sadu, Naučni institut za prehrambene tehnologije u Novom Sadu, Bulevar cara Lazara 1, 21101 Novi Sad, Srbija

E-mail: savicivana@tf.ni.ac.rs; vana.savic@yahoo.com

Kamelina pripada porodici *Brassicaceae* čije seme sadrži 30-50% ulja. Visoka nutritivna vrednost ulja kamine prvenstveno je povezana sa njegovim profilom masnih kiselina. Ulje je obogaćeno tokoferolima, karotenoidima, hlorofilom i fosfolipidima. Zbog prisustva ovih jedinjenja ulje je stabilno i otporno na procese oksidacije. Magnezijum je najzastupljeniji mineral u ulju. Poznato je da ulje blagotvorno deluje na kardiovaskularni sistem, kožu, hormonsku ravnotežu, dijabetes i dr. Cilj ovog istraživanja bio je da se analizira efekat tehnika ekstrakcije na fizičko-hemijska svojstva ulja dobijenog iz semena kamine genotipa NS Zlatka uzgajane u Srbiji. Sokslet ekstrakcija je pokazala veći prinos ulja (26,7%) u poređenju sa hladnim presovanjem (26,0%). Uočene su značajne varijacije u gustini, pH vrednosti, kiselinskom i saponifikacionom broju, dok se sadržaj vlage, viskozitet i indeks prelamanja nisu razlikovali između ulja kamine dobijenih obema metodama. Dobijeni podaci su pokazali da postoje značajne razlike u sastavu masnih kiselina. Za Sokslet ekstrakciju zabeležen je sadržaj 9,99% zasićenih, 32,82% nezasićenih i 57,19% polinezasićenih masnih kiselina. U slučaju hladnog presovanja, procenat zasićenih (9,23%) i nezasićenih masnih kiselina (32,12%) ide u prilog velikim količinama polinezasićenih masnih kiselina (58,65%). Kod oba postupka ekstrakcije, ulje semena kamine je sadržalo visoke procenat α -linolenske (C18:3n3), linolne (C18:2n6c) i eikozenske kiselina (C20:1n9). Sadržaj β -karotena i fenolnih jedinjenja (118,96 mg/kg i 26,0 mg GAE/100 g) u ulju dobijenom Sokslet ekstrakcijom bio je veći od hladno ceđenog ulja (89,43 mg/kg i 7,3 mg GAE/100 g, respektivno). Ulje dobijeno Sokslet ekstrakcijom imalo je bolje nutritivne karakteristike u poređenju sa hladno presovanim uljem. Uopšteno, ulja izolovana ovim metodama mogu se koristiti kao visokokvalitetna ulja u prehrambenim i medicinskim formulacijama. Takođe, se mogu koristiti kao ekološki rastvarači za prirodne proizvode.

Ključne reči: kamelina; ulje semena; ekstrakcija; masne kiseline, kvalitet.

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EFFECT OF COLD-PRESSING AND SOXHLET EXTRACTION TECHNIQUES ON THE PHYSICO-CHEMICAL PROPERTIES OF CAMELINA (*CAMELINA SATIVA* L.) SEEDS OIL

Ivana M. SAVIĆ GAJIĆ¹*, Ivan M. SAVIĆ¹, Slađana RAKITA², Nedeljka SPASEVSKI², Jasmina LAZAREVIĆ², Danka DRAGOJLOVIĆ², Viktor STOJKOV

¹University of Nis, Faculty of Technology in Leskovac, Bulevar oslobodjenja 124, 16000 Leskovac, Serbia

²University of Novi Sad, Institute of Food Technology in Novi Sad, Bulevar cara Lazara 1, 21101 Novi Sad, Serbia

E-mail: savicivana@tf.ni.ac.rs; vana.savic@yahoo.com

Camelina belongs to the *Brassicaceae* family whose seeds contain about 30-50% of oil. The high nutritional value of camelina oil is primarily related to its fatty acid profile. The oil is enriched with tocopherols, carotenoids, chlorophyll, and phospholipids. Due to the presence of these compounds, the oil is stable and resistant to oxidation processes. Magnesium is the most abundant mineral in oil. It is known that the oil has beneficial effects on the cardiovascular system, skin, hormonal balance, diabetes, *etc.* The aim of this study was to analyze the effect of the extraction techniques on the physico-chemical properties of oil obtained from camelina seeds of genotype NS Zlatka cultivated in Serbia. Soxhlet extraction showed a higher oil yield (26.7%) compared to cold pressing (26.0%). There were significant variations observed in density, pH value, acid value, and saponification value, whereas, moisture content, viscosity, and the refractive index did not differ between camelina oils produced by both methods. The obtained data showed that there were significant differences in the fatty acid composition. The content of 9.99% of saturated, 32.82% of unsaturated, and 57.19% of polyunsaturated fatty acids was noticed for the Soxhlet extraction. In the case of cold pressing, the percentage of saturated (9.23%) and unsaturated fatty acids (32.12%) is in favor of large amounts of polyunsaturated fatty acids (58.65%). In both extraction procedures, the camelina seeds oil contained high percentages of α -linolenic (C18:3n3), linoleic (C18:2n6c), and eicosenoic acids (C20:1n9). The content of β -carotene and phenolic compounds (118.96 mg/kg and 26.0 mg GAE/100 g, respectively) in the oil obtained by the Soxhlet extraction was higher than the cold-pressed oil (89.43 mg/kg and 7.3 mg GAE/100 g, respectively). The oil obtained using Soxhlet extraction had superior nutritional characteristics compared to the cold-pressed oil. Generally, the oils isolated using these methods could be used as high-quality oils in food and medicinal formulations. They are also can be used as eco-friendly solvents for natural products.

Key words: camelina; seed oil; extraction; fatty acids, quality.

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UTICAJ PRED TRETMANA I TEMPERATURE NA KLIJAVOST PARTIJA SEMENA FESTULOLIUMA

Rade STANISAVLJEVIĆ¹, Ratibor ŠTRBANOVIC¹, Dobrivij POŠTIĆ¹, Marijenka TABAKOVIĆ², Dragoslav ĐOKIĆ³, Dragoljub BEKOVIĆ⁴, Jasmina MILENKOVIĆ⁵

¹Institut za zaštitu bilja i životnu sredinu, Teodora Dražera 9, Beograd

²Maize Research Institute, Zemun Polje, Slobodana Bajića 1, 11185 Belgrade-Zemun, Serbia.

³University of Nis, Faculty of Agriculture in Krusevac, 37000 Kruševac, Kosančićeva 4, Serbia

⁴University of Priština, Faculty of Agriculture, bb 38219 Lesak, Serbia

⁵Institute of Forage Crops, Globoder bb, 37000 Krusevac, Serbia,

E-mail: stanisavljevicrage@gmail.com

Sedamdesetih godina prošlog veka se počelo intezivno raditi na ukrštanja između vrsta krmnih trava. Tako je rađeno ukrštanje između roda: *loliuma* x *festuca* i na taj način stvorena vrsta pod nazivom Fesulolium. Sledio je period ispitivanja Fesulolium-a sa aspekta genetike i oplemenjivanja, semenarsta, tehnologije gajenja i korišćenja. Međutim do današnjih dana naučno-stručno znanje o kvalitetu semena Fesulolium-a je sa mnogo nepoznanica.

Kako bi smo imali više saznanja o kvalitetu semena Fesulolium-a odlučili smo da sprovedemo ispitivanja uticaja pred tretmana: i) hlađenje na temperaturi 5-7 oC u trajanju 3 danana, ii) primena KNO₃ na podlozi za naklijavanje semenu i) i ii) pred tretman su pobavezni za ispitivanje kvaliteta semena ove vrste po važećem pravilniku o ispitivanju kvaliteta semena (47/87) što je uskladu sa ISTA pravilima (ISTA 2020). I treći pred tretman je bio bez primene ičega iii). Nakon pred tretmana (i, ii, iii) seme je stavljeno u kljajalište na temperaturi I) 20 oC u mraku, II). neizmenoj temperaturi 20 svetlost-dan/30 mrak-noć oC (temperature koje se mogu koristiti po pravilniku o kvalitetu semena), i III. 30 oC u mraku. Ispitivanja su sprovedena na četiti partije semena sorte Peron, u četitri ponavljanja. Ova sorta je nastala ukrštanjem *Festuca pratensis* x za *Festuca pratensis*.

Po našem pravilniku o kvalitetu semena za Fesuloliuma nema kao vrste pa se na osnovu prakse uzimaju najsirodnije vrste (*Festuca pratensis* i *Lolium multiflorum*). Međutim ove dve vrste se razlikuju: energija klijanja se za *festuca pratensis* očitava 7-dmog dana, za *lolium multiflorum* 5-og dana, ukupna klijavost se za obe vrste očitava 14-tog dana. Mi smo energiju klijanja za Fesulolium očitali 5-og i 7-og dana, ukupnu klijavost 14-tog dana kada je očitano i mrtvo seme i nenormalni kljajanci. Seme svih partija ispitivano na 30 oC imalo je značajno nižu $p \leq 0.001$) energiju klijanja 5 i 7 dana i ukupnu klijavost od temperatura 20-30 oC i 20 oC bez obzira na primenjeni pred tretman, dok uticaj temperatura 20 oC ili 20-30 oC na ispitivani parametri kvaliteta semena je bio sličan. Pred tretman na semenu KNO₃ se pokazao najefikasniji na svim partijama i temperaturama ispitivanja. Očitavanje 7-mog dana je dalo značajno višu energiju klijanja u svim varijantama.

Ključne reči; Fesulolium, kvalitet semena, metode ispitivanja

**INFLUENCE OF PRE-TREATMENT AND TEMPERATURE ON
GERMINATION OF *FESTULOLIUM* SEED LOTS**

Rade STANISAVLJEVIĆ¹, Ratibor ŠTRBANOVIĆ¹, Dobrivij POŠTIĆ¹, Marijenka TABAKOVIĆ²,
Dragoslav ĐOKIĆ³, Dragoljub BEKOVIĆ⁴, Jasmina MILENKOVIĆ⁵

¹ Institute for Plant Protection and Environment, 11000 Beograd, Teodora Drajzera 9, Serbia

² Maize Research Institute, Zemun Polje, Slobodana Bajića 1, 11185 Belgrade-Zemun, Serbia.

³ University of Nis, Faculty of Agriculture in Krusevac, 37000 Kruševac, Kosančićeva 4, Serbia

⁴ University of Priština, Faculty of Agriculture, bb 38219 Lesak, Serbia

⁵ Institute of Forage Crops, Globoder bb, 37000 Krusevac, Serbia,

E-mail: stanisavljevicrade@gmail.com

A species called *Festulolium* was created in the middle of the last century by crossing two genus: *Lolium* and *Festuca*. This was followed by a period of research on *Festulolium* from the aspect of genetics and breeding, seed production, cultivation technology and use. However, to this days, scientific and professional knowledge about the quality of *Festulolium* seeds is insufficient. We conducted various pre-treatment impact studies on *Festulolium* seeds: i) cooling at 5-7 oC for 3 days, ii) application of KNO₃ on seed germination medium.

The third pre-treatment (iii) was control, without pre-treatment. Pre-treatments are mandatory for testing the quality of seeds of this species according to the current regulations on seed quality testing in the Republic of Serbia, and in accordance with ISTA rules (ISTA 2020). After pre-treatment (i, ii, iii), seed germination have examined at the following temperature regimes (provided by the seed quality regulations): 20 oC/ dark; alternately 20o/ 30o (light /dark); and 30 oC/ dark.

The tests were performed on four seed lots of the variety Peron, in four replicates. In Serbian rulebook on seed quality, *Festulolium* is not mentioned as a species, so the most related species (*Festuca pratensis* and *Lolium multiflorum*) are used for seed testing methods. Considering the germination energy have predicted to read on day 7 for *Festuca pratensis* and day 5 for *Lolium multiflorum*, we read the germination energy for *Festulolium* on both days, 5 and 7.

Total germination, dead seed and abnormal seedlings were evaluated at day 14. Significantly lower ($p \leq 0.001$) germination energy, as well as total germination was achieved at the temperature 30 oC/ dark for both days of evaluation (5th and 7th). But, there was no significant difference in the examined seed germination parameters between the other two germination temperatures, regardless of the pre-treatment applied. Pre-treatment of seeds with KNO₃ proved to be the most effective in all seed lots and tested temperatures. Evaluating on day 7 gave significantly higher germination energy in all tested variants.

Key words: *Festulolium*, pre-treatment, seed quality, test methods.

ANTIMICROBIAL ACTIVITY OF SELECTED PLANT EXTRACTS AGAINST POTATO PHYTOPATHOGENS

Aleksandra STEGLIŃSKA¹, Alina KUNICKA-STYCZYŃSKA², Dorota KRĘGIEL¹, Krzysztof ŚMIGIELSKI¹, Beata GUTAROWSKA¹,

¹Department of Environmental Biotechnology, Faculty of Biochemistry and Food Sciences, Lodz University of Technology, Wólczanska 171/173, 90-950 Lodz, Poland

²Department of Sugar Industry and Food Safety Management, Lodz University of Technology, Wólczańska 171/173, 90-950 Łódź

E-mail: aleksandra.steglinska@dokt.p.lodz.pl

The potato (*Solanum tuberosum* L.) is one of the most important crop in the world, after wheat and rice. It is characterized by wide availability, high nutritional value and significant productivity per unit area. However, phytopathogens which are attacking potato crops more and more recently, generate significant losses to potato producers. Currently used synthetic fungicides are poorly biodegradable, toxic to humans and inconsistent with the growing eco-friendly trend. Plant extracts can therefore provide an interesting alternative to these synthetic fungicides.

The aim of this research was to evaluate the antimicrobial properties of water plant extracts against seed potato phytopathogens and to select the most effective agent for potato protection. The scope included assessment of antimicrobial activity of 15 plant extracts against 5 fungal potato phytopathogens from the genera: *Alternaria*, *Fusarium*, *Colletotrichum*, *Rhizoctonia* and *Phoma* by agar-well diffusion method, determination of the Minimal Inhibitory Concentration (MIC) and Minimal Fungicidal Concentration (MFC). In addition, the chemical profiles of extracts by Gas Chromatography – Mass Spectrometry (GC-MS) and *in vivo* application tests on seed potatoes were conducted.

Allium sativum L. (garlic) water extract and *Caryophyllus aromaticus* L. (clove) exhibited antimicrobial activity *in vitro* against all tested potato phytopathogens. MIC values ranged from 6.3 to 12.5 mg/mL for garlic water extract and from 3.1-6.3 mg/mL for clove water extract. The main compound of garlic extract was 5-hydroxymethylfurfural, and eugenol was the main component of clove extract. *In vivo* tests, garlic extract was found to be much more effective than clove extract.

The obtained results showed that selected garlic extract may be used as environmentally friendly biopesticide for potato protection against phytopathogens.

Keywords: potato, plant extracts, phytopathogens, biopesticide

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UTJECAJ PRIMJENE BIOSTIMULATORA NA SADRŽAJ BJELANČEVINA U ZRNU PŠENICE

B. ŠIMIĆ¹, M. DOMAČINOVIĆ², Ivana PRAKATUR², H. PLAVŠIĆ¹

¹Poljoprivredni institut Osijek,

Agricultural Institute Osijek

²Fakultet agrobiotehničkih znanosti Osijek,

Faculty of Agrobiotechnical Sciences Osijek

E-mail: branimir.simic@poljin.hr

Pravilnim odabirom genotipa, optimiziranom agrotehnikom i primjenom biostimulatora smanjuje se rizik proizvodnje a povećava se prinos i kvaliteta proizvedenog zrna. Sadržaj proteina u zrnu pšenice nije u korelaciji s prinosom, tako da je željeni udio proteina obično povezan s manjim prinosom zrna. Proizvodnja proteina kreće se od 900-1300 kg/ha, kada tu količinu dodamo ukupnom prinosu po ha, dobivamo sadržaj proteina koji čini klasu pšenice i utječe na otkupnu cijenu pšenice. Kako bi se realizirao genetski potencijal sorte, tla i vremenskih uvjeta te proizvelo kvalitetno zrno s visokim sadržajem proteina provode se mikro, makro i proizvodni pokusi. Na temelju rezultata pokusa vrši se odabir sorti pšenice i ciljane agrotehnike za pojedina proizvodna područja s obzirom na tlo i klimatske uvjete. Poznato je da je za visoki sadržaj proteina u zrnu pšenice najznačajniji je odabir genotipa i primijenjena agrotehnika. Tlo je također vrlo važno jer na strukturni tlama bogatim humusom koja nisu jako kisela moguće je postići vrlo dobre rezultate sa sortama koje nemaju izražen genetski potencijal za visoki sadržaj proteina u zrnu, a kod sorti za koje znamo da imaju taj potencijal postižu se najbolji rezultati, zrno klase Premium. U cilju postizanja maksimalnog sadržaja proteina u zrnu pšenice provedeno je istraživanje utjecaja folijarne primjene biostimulatora na sadržaj proteina u zrnu pšenice. U tri proizvodne godine (2019., 2020. i 2021.) testirano je pet sorti pšenice Poljoprivrednog instituta Osijek (Kraljica, Vulkan, Tika-Taka, Silvija, EL Nino) na pet lokaliteta u Republici Hrvatskoj (Vukovar, Nemetin, Budrovci, Gundinci, Čajkovci). U poljskom pokusu primjena je uobičajena agrotehnika i gnojidba u proizvodnji pšenice i varijanta tretmana uz uobičajenu agrotehniku primjena biostimulatora (3l/ha, u vlatanju i pri završetku oplodnje). Najveći sadržaj proteina u svim godinama istraživanja utvrđen je kod sorte pšenica Kraljica, bez biostimulatora u prosjeku 13,12% a sa biostimulatorom 14,87% uz prosječan prinos zrna od 8,65 t/ha bez biostimulatorom a sa primjenom biostimulatora 9,58 t/ha.

Ključne riječi: pšenica, folijarna prihrana, biostimulatora, sadržaj proteina

ZAHVALNICA

Projekt "Značaj odabira sorti i optimizacija primjene zaštite i biopreparata u proizvodnji pšenice za povećanje profitabilnosti OPG " sufinanciran od Brodsko-posavske županije.

INFLUENCE OF BIOSTIMULATOR APPLICATION PROTEIN CONTENT IN WHEAT GRAIN

B. ŠIMIĆ¹, M. DOMAČINOVIĆ², Ivana PRAKATUR², H. P LAVŠIĆ¹

¹Poljoprivredni institut Osijek,

Agricultural Institute Osijek

²Fakultet agrobiotehničkih znanosti Osijek,

Faculty of Agrobiotechnical Sciences Osijek

E-mail: branimir.simic@poljin.hr

Proper selection of genotypes, optimized agricultural techniques and the use of biostimulators reduces the risk of production and increases the yield and quality of grain produced. The protein content of wheat grain does not correlate with yield, so the desired protein content is usually associated with lower grain yield. Protein production ranges from 900-1300 kg / ha, when we add this amount to the total yield per ha, we get the protein content that makes up the wheat class and affects the purchase price of wheat. In order to realize the genetic potential of the variety, soil and weather conditions and to produce a quality grain with a high protein content, micro, macro and production experiments are carried out. Based on the results of the experiment, wheat varieties and targeted agricultural techniques are selected for individual production areas with regard to soil and climatic conditions. It is known that for the high protein content in wheat grain, the most important is the choice of genotype and applied agronomic techniques. Soil is also very important because on structural soils rich in humus that are not very acidic it is possible to achieve very good results with varieties that do not have a pronounced genetic potential for high protein content in grain, and varieties that we know have that potential have the best results. premium grade grain. In order to achieve the maximum protein content in wheat grain, a study of the effect of foliar application of biostimulants on the protein content in wheat grain was conducted. In three production years (2019, 2020 and 2021), five wheat varieties of the Agricultural Institute Osijek (Kraljica, Vulkan, Tika-Taka, Silvija, EL Nino) were tested at five localities in the Republic of Croatia (Vukovar, Nemetin, Budrovci, Gundinci , Tchaikovsky). In the field experiment, the application of common agrotechnics and fertilization in wheat production and a variant of treatment in addition to the usual agrotechnics is the application of biostimulators (3 l / ha, in weeding and at the end of fertilization). The highest protein content in all years of research was found in the wheat variety Kraljica, without biostimulator on average 13.12% and with biostimulator 14.87% with an average grain yield of 8.65 t / ha without biostimulator and with the use of biostimulator 9.58 t / Ha.

Key words: wheat, foliar supplementation, biostimulants, protein content

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**PRIMENA METODE DOMINANTNIH SENZACIJA U FUNKCIJI VREMENA
ZA DEFINISANJE PROFILA MIRISA KISELOG TESTA**

Dubravka ŠKROBOT¹, Jelena TOMIĆ¹, Tamara DAPČEVIĆ-HADNAĐEV¹, Nikola MARAVIĆ¹, Pavle JOVANOVIĆ¹, Miroslav HADNAĐEV¹

¹Univerzitet u Novom Sadu, Institut za prehrambene tehnologije, Bulevar cara Lazara 1, 21000 Novi Sad, Srbija

E-mail: dubravka.skrobot@fins.uns.ac.rs

Kiselo testo je testo koje se dobija mešanjem brašna i vode uz fermentaciju prirodno prisutnim ili odabranim bakterijama mlečne kiseline i kvascima. Proces fermentacije zavisi od prirode makrobiote, vrste i sastava brašna, vode i temperature na kojoj se proces odvija. Reakcije i procesi koji se odvijaju tokom fermentacije (zakišeljavanje, proteoliza, aktivacija enzima, sinteza metabolita mikroflora) doprinose ne samo unapređenju nutritivnih i funkcionalnih svojstava već i razvoju karakteristične arome i mirisa gotovog proizvoda. U cilju praćenja razvoja i promene profila mirisa tokom aktivacije startera kiselog testa, primenjena je metoda dominantnih senzacija (Temporal Dominance of Sensations – TDS) u funkciji vremena.

TDS je metoda koja se primenjuje u senzorskoj analizi i omogućava karakterizaciju čitavog senzorskog profila kompleksnih matriksa u kratkom vremenskom periodu. Ovaj pristup ima za cilj da više puta beleži dominantne senzacije koje se opažaju tokom senzorske ocene. Za potrebe izvođenja eksperimenta sa starterom kiselog testa, u senzorskoj analizi su učestvovali trenirani senzorski ocenjivači (n = 12, osam učesnika ženskog i 4 učesnika muškog pola, starosti od 25 do 45 godina). Uzorci startera kiselog testa od integralnog pšeničnog brašna ocenjivani su na svakih sat vremena od početka aktivacije startera tokom šest sati, koliko je trajao period fermentacije i stabilizacije. Uzorci su dostavljani panelistima u staklenim teglama sa poklopcem. U trenutku kada su otvorili teglu i skinuli poklopac, panelisti su bili zamoljeni da stisnu dugme „START“ na ekranu kako bi započeli evaluaciju i aktivirali softver da beleži vreme. Tokom senzorske ocene panelisti su bili zamoljeni da pritisnu taster sa nazivom mirisa koji je dominantan u tom trenutku, a čim se dominantan miris promeni da ponovo pritisnu taster sa nazivom drugog mirisa. Postupak se ponavljao sve do momenta kada ni jedan miris nije bio dominantan, i tada je trebalo da se pritisne taster „KRAJ“. Pred panelistima se na ekranu nalazilo deset prethodno odabranih atributa mirisa: na mekinje, brašno, testo, kvasac, sircetnu kiselinu, mlečnu kiselinu, kiselo mleko, jogurt, sir i voćno. Na osnovu prikupljenih podataka kreirani su grafici odnosa zastupljenosti dominantnog mirisa (y-osa) u funkciji od vremena kada su uočeni (x-osa).

Rezultati jasno ukazuju na promenu profila mirisa koji se javlja tokom perioda aktivacije i stabilizacije startera za kiselo testo. Na početku procesa, u mirisu startera dominantne su bile note na mekinje, brašno i testo. Međutim, tokom vremena fermentacije ove note su imale mali doprinos ukupnom profilu mirisa u kojem su dominirale oštrije note mirisa poput onih na kiselo mleko, sir, jogurt i sircetnu kiselinu. Tokom procesa fermentacije miris startera je postao kompleksniji što ukazuje i na složenost biohemijskih procesa koji se odvijaju u ovakvom sistemu.

Ključne reči: kiselo testo, senzorske karakteristike, dominantne karakteristike mirisa, fermentacija

ZAHVALNICA

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APPLICATION OF TEMPORAL DOMINANCE OF SENSATIONS IN SENSORY PROFILING OF SOURDOUGH STARTER ODOUR

Dubravka ŠKROBOT¹, Jelena TOMIĆ¹, Tamara DAPČEVIĆ-HADNAĐEV¹, Nikola MARAVIĆ¹, Pavle JOVANOVIĆ¹, Miroslav HADNAĐEV¹

*¹University of Novi Sad, Institute of Food Technology, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia
E-mail: dubravka.skrobot@fins.uns.ac.rs*

Sourdough is one of the oldest examples of natural starters, obtained from the mixture of cereal flour and water, fermented with naturally occurring or selected lactic acid bacteria (LAB) and yeasts. Fermentation process depends on naturally occurring microbiota, type of flour, flour composition, additional ingredients, tap water, and temperature. During fermentation, acidification, proteolysis and activation of a number of enzymes, as well as the synthesis of microbial metabolites, influence not only the nutritional/functional quality of baked goods but also contribute to development of odour and flavour of starter and final product. In order to describe the evolution of the sourdough odour during starter activation, the method of temporal dominance of sensations is performed.

Temporal Dominance of Sensations (TDS) is method used in sensory analysis which enables characterization of an entire profile of complex food in a short time. This approach is aimed at repeatedly recording the dominant sensations perceived during the tasting period. For the presented study experienced sensory panellists (n = 12, eight female and four male, 25 – 45 years old), used to participate in sensory profiling, were recruited. Whole grain wheat sourdough starter samples were collected and evaluated for each 1 h within six hours from the start of the sourdough activation. Samples were delivered to the panellists in a glass jars with a lid. The panellists were instructed that once they remove the lid, they have to click on the “START” button on the screen to begin the evaluation and to activate software. During an evaluation, the panellists had to select dominant odour sensation from ten simultaneously presented odour attributes (brans, flour, dough, yeast, acetic acid, lactic acid, sour milk, yoghurt, cheese, and fruity). When panellists noticed that one dominant odour perception changed, they had to score new dominant sensation. If none attribute was perceived as dominant sensation, panellists had to click the “End” button. TDS was performed for all samples within three replicate sessions by all panellists. TDS data was collected by Excel, while with XLSTAT software collected data was calculated and presented by curves showing dominance rate (Axis Y) for each 0.2 s step during the 1 min period (Axis X).

TDS curves clearly showed changes in odour profile during period of sourdough starter activation. At the beginning of the activation process, flour-like, brans-like and dough-like attributes were dominant odour characteristics. However, during the time, these odour characteristics had little contribution to the overall odour profile since they became masked with more sharp odour notes reminiscent of sour milk, cheese, yoghurt and acetic acid. Over time, odour profile became more complex indicating complexity of biochemical processes.

Keywords: dominant sensation, sensory analysis, odour, sourdough starter, sensory profiling

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UTICAJ DODATKA EKSTRAKATA MAJČINE DUŠICE NA OKSIDATIVNU STABILNOST BARENH KOBASICA SA SMANJENIM SADRŽAJEM NITRITA

Branislav ŠOJIĆ, Branimir PAVLIĆ, Vladimir TOMOVIĆ, Snežana ŠKALJAC, Marija JOKANOVIĆ
Univerzitet u Novom Sadu, Tehnološki fakultet Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Srbija

E-mail: sojic@tf.uns.ac.rs

Natrijum i kalijum nitrit su jedni od najznačajnijih aditiva u izradi proizvoda od mesa. Oni se široko koriste kao antioksidanti i antimikrobni agensi. Pored velikog broja benefita, poznato je da nitriti imaju neka neželjena dejstva po zdravlje čoveka. Stoga, jedan od najvećih izazova u savremnoj industriji mesa je pronalaženje funkcionalnih supstituenata za nitrite. Biljni ekstrakti sadrže više različitih grupa bioaktivnih jedinjenja (npr. polifenoli, terpeni) sa poželjnim svojstvima po zdravlje čoveka. Ekstrakti dobijeni iz sporednih tokova proizvodnje majčine dušice (*Thymus serpyllum* L.) sadrže različita jedinjenja (flavonoidi, tanini, terpenoidi) sa visokom bioaktivnosti: antioksidativna, antitumorna, antimikrobna aktivnost. Superkritična ekstrakcija sa ugljen-dioksidom je označena kao “zelena” i “čista” tehnologija za dobijanje ekstrakata iz različitog biljnog materijala, bez negativnih efekata na životnu sredinu. Cilj ovoga rada je da se ispita uticaj dodatka superkritičnog ekstrakta dobijenog iz sporednih tokova proizvodnje majčine dušice kao alternative za nitrite u proizvodnji barenih kobasica.

Pet šarži barenih kobasica sa dva nivoa natrijum nitrita (100 i 50 mg/kg) proizvedeno je u industrijskom objektu za preradu mesa. U kobasice proizvedene sa 50 mg/kg natrijum nitrita, dodate su različite koncentracije ekstrakata majčine dušice (SFE1 i SFE 2). Šarže su označene kao: T1, kobasice proizvedene sa 100 mg/kg natrijum nitrita; T2, kobasice proizvedene sa 50 mg/kg natrijum nitrita; T3, kobasice proizvedene sa 50 mg/kg natrijum nitrita i 0,150 µL/g ekstrakta SFE1; T4, kobasice proizvedene sa 50 mg/kg natrijum nitrita i 0,150 µL/g ekstrakta SFE2; T5, kobasice proizvedene sa 50 mg/kg natrijum nitrita, 0,075 µL/g ekstrakta SFE1 i 0,075 µL/g ekstrakta SFE2. Oksidativna stabilnost barenih kobasica izražena je preko TBARS testa (mg MDA/kg). Kobasice su skladištene na 4 °C tokom 60 dana. Sve vrednosti izražene su kao srednja vrednost sa standardnom devijacijom (± SD). Korišćena je analiza varijanse (ANOVA) sa intervalom poverenja od 95% (P<0,05). Vrednosti su poređene preko Dankanovog višestrukog testa intervala.

Na početku skladištenja TBARS vrednost se kretala u intervalu od 0,10 (T3) do 0,21 (T2) mg MDA/kg. Kao što je i očekivano, tokom skladištenja došlo je do porasta TBARS vrednosti (P<0,05). Dodatak oba tipa ekstrakta (SFE1 i SFE2) dovelo je do smanjenja oksidacije lipida; TBARS vrednost je bila manja od 0,5 mg MDA/kg tokom celokupnog skladištenja.

Na osnovu dobijenih rezultata može se zaključiti da dodatak oba ekstrakta (0,150 µL/g), pogotovo SFE2 dovodi do smanjenja oksidacije lipida u barenim kobasicama. Ovi rezultati ukazuju da superkritični ekstrakti majčine dušice mogu poslužiti kao delimični supstituenti za nitrite u proizvodnji barenih kobasica.

Ključne reči: majčina dušica, superkritični ekstrakti, natrijum nitrit, barene kobasice.

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THE EFFECT OF WILD THYME BY-PRODUCT EXTRACTS ON THE OXIDATIVE STABILITY OF COOKED SAUSAGES WITH REDUCED LEVEL OF SODIUM NITRITE

Branislav ŠOJIĆ, Branimir PAVLIĆ, Vladimir TOMOVIĆ, Snežana ŠKALJAC, Marija JOKANOVIĆ
University of Novi Sad, Faculty of Technology Novi Sad, Bulevar Cara Lazara 1, 21000 Novi Sad,
Serbia

E-mail: sojic@tf.uns.ac.rs

Sodium and potassium nitrite are important food additives in cured meat products. They are broadly used as antioxidants and antimicrobials. Despite the advantages of nitrites, it is well known that usage of these additives show some negative effects for human health. Hence, one of the main challenges for the meat industry is to find a functional replacement for nitrites in cured meat products. Plant extracts and ingredients contain various types of nutraceuticals and bioactive compounds (e.g. phenolics, terpenes) that are beneficial to human health. Wild thyme (*Thymus serpyllum* L.) by-product extracts include various bioactive compounds: flavonoids, tannins, terpenoids and other compounds with antimicrobial, antioxidant, antitumor, hypoglycemic and hematological effects. Supercritical fluid extraction (SFE) has been particularly recognized as the “green” and clean technique for recovering extracts from different plant material, without negative environmental impact. Thus, the aim of this study was to assess the effect of wild thyme (*Thymus serpyllum* L.) by-product extracts obtained by SFE as an alternative for sodium nitrite in cooked sausages.

Supercritical fluid extraction (SFE) was used as green and environmentally-friendly procedure for preparation of wild thyme by-product extracts. Five batches of cooked sausages were manufactured with two levels of sodium nitrite (50 and 100 mg/kg) and with the addition of wild thyme by-product extracts (SFE1 and SFE2). The batches were marked as: T1, batch produced with 100 mg/kg of sodium nitrite; T2, batch produced with 50 mg/kg of sodium nitrite; T3, batch produced with 50 mg of sodium nitrite and 0.150 µL/g of SFE1; T4, batch produced with 50 mg/kg of sodium nitrite and 0.150 µL/g of SFE2; T5, batch produced with 50 mg/kg of sodium nitrite and 0.075 µL/g of SFE1 and 0.075 µL/g of SFE2. Oxidative stability of cooked sausages was expressed by TBARS test (mg MDA/kg). Sausages were stored at 4 °C during 60 days. Variance analysis (ANOVA) was performed, with a confidence interval of 95 % (P<0.05). Means were compared by Duncan’s multiple range test.

At the beginning of storage TBARS values ranged in an interval from 0.10 mg MDA/kg (T3) to 0.21 mg MDA/kg (T2). As predictable, TBARS values in all five treatments significantly increased (P<0.05) during the storage period, representing the progression of lipid oxidation. The addition of both, SFE1 and SFE2 as natural antioxidants significantly (P<0.05) inhibited lipid oxidation during the storage. All treatments, except (T2) maintained TBARS values below 0.5 mg MDA/kg over storage period, which is marked as acceptable sensory limit for revealing rancid flavour which clearly shows potential for natural additive in meat industry.

In conclusion, these results exhibited a respectable antioxidative potential of SFE1 and particularly SFE2, which displayed the maximum inhibitory activity against lipid oxidation at concentration of 0.150 µL/g. These data strongly suggest that supercritical wild thyme by-product extracts could be used as natural antioxidants and potential partial replacements for sodium nitrite in cooked sausages.

Key words: wild thyme by-product, supercritical fluid extraction, sodium nitrite, cooked sausages;

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REMOVAL OF TEMBOTRIONE (AGRICULTURAL HERBICIDE) FROM WATER BY USING SUSTAINABLE NANOTECHNOLOGY: CHEMOMETRIC EVALUATION OF DIFFERENT PHOTOCATALYTIC PARAMETERS

Daniela ŠOJIĆ MERKULOV¹, Marina LAZAREVIĆ¹, Predrag PUTNIK²

¹University of Novi Sad Faculty of Sciences, Department of Chemistry, Biochemistry and Environmental Protection, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia;

²University North, Department of Food Technology, Trg dr. Žarka Dolinara 1; 48000 Koprivnica, Croatia

E-mail: daniela.sojic@dh.uns.ac.rs

Nowadays, the use of herbicides is common practice for increasing the yield of cultivated crops. As a consequence, in some cases the extensive use of pesticides leads to contamination of natural waters in agricultural areas. Tembotrione is a relatively new triketon herbicide introduced on the market in 2007 by Bayer CropScience as commercial formulation Laudis[®]. This herbicide is used for post-emergence application on all varieties of maize. Although it is mainly used on maize cultivation fields, there are potential applications on other fields such as poppy, sorghum, and millet, which are still investigated. Due to confirmed effectiveness, the global demand of tembotrione is increasing, for instance in the 2013 there were 267.4 tons in sales of this herbicide with market value of about US\$21.7 million. By 2020 it is estimated that it would exceed a double market value or US\$51.2 million. As a consequence of the extensive use and high potential for runoff, surface waters may be contaminated. Moreover, investigation on microorganism *Vibrio fischeri* revealed increased toxicity with chlorination of tembotrione. Another study indicates the possible cytogenetic effects which tembotrione can pose to HepG2 cells at low concentrations.

Due to hazardous effects which herbicides may manifest in the environment, scientists are trying to find possible sustainable solutions for water decontamination. In this study, fractional multivariate design of experiments with seven factors was used to chemometrically evaluate adsorption of tembotrione on the surface of catalyst, efficiency of photocatalytic degradation of tembotrione, and removal efficiency. For adsorption, the experiments revealed two significant main effects (loading of TiO₂ and concentration of KBrO₃) and two interactions (loading of TiO₂ × purging of O₂ and loading of TiO₂ × stirring during and 5 min before irradiation). Model for efficiency of photocatalytic degradation of tembotrione revealed three significant main effects (concentration of KBrO₃, purging of O₂, and stirring during and 5 min before irradiation), while overall removal efficiency had four significant main effects (concentration of KBrO₃, purging of O₂, loading of TiO₂, and stirring during and 5 min before irradiation) and one two factor interaction (loading of TiO₂ × concentration of KBrO₃). The optimal removal yield of tembotrione was achieved 99.5% at TiO₂ loading of 1.25 mg/mL, KBrO₃ concentration of 4.33 mM, β-cyclodextrin with Au in the ratio 2:1, 3 mL/min O₂ purging, and stirring before and during irradiation.

Key words: herbicide, chemometrics, photocatalysis, adsorption, removal efficiency

SVEOBUHVAJNI PREGLED PRIMENE PROCENE ŽIVOTNOG CIKLUSA U SEKTORU AMBALAŽE ZA POLIMERNE I BIOPOLIMERNE MATERIJALE

*Danijela ŠUPUT, Senka POPOVIĆ, Jovana UGARKOVIĆ, Nevena HROMIŠ
Tehnološki Fakultet Novi Sad, Bulevar Cara Lazara 1, 21 000 Novi Sad, Srbija*

E-mail: suput.danijela@gmail.com

Među mnogim važnim zahtevima za ambalažne materijale, ekološka prihvatljivost je nešto što je postalo neophodno za svaki materijal koji može biti konkurentan na tržištu. Analiza životnog ciklusa (LCA) je analitički instrument koji obezbeđuje okvir za analizu uticaja proizvoda i usluga na životnu sredinu, odnosno pruža razumevanje i mogućnost poređenja različitih proizvoda. Glavni cilj uticaja je da se identifikuju i uspostave veze između životnog ciklusa proizvoda i usluga i potencijalnih uticaja na životnu sredinu. LCA proučava ekološke aspekte i moguće uticaje na životnu sredinu tokom čitavog životnog ciklusa proizvoda od ekstrakcije sirovina, kroz proizvodnju, upotrebu i tretman na kraju životnog veka, reciklažu i konačno odlaganje („od klevke do groba“). To je sistematski pristup i uključuje četiri najvažnije faze: fazu definisanja cilja i obima, fazu inventara životnog ciklusa, fazu procene uticaja životnog ciklusa i fazu tumačenja rezultata. Serija standarda ISO 14040 uspostavlja fleksibilan okvir pod kojim se LCA studija sprovodi na praktičan i tehnički pouzdan način. Ne postoji jedinstvena metoda za sprovođenje LCA studije. Organizacijama je obezbeđena fleksibilnost u sprovođenju LCA studije, što zavisi od specifičnosti aplikacije i zahteva korisnika.

Ovaj rad će dati pregled rezultata LCA analiza različitih komercijalnih polimernih ambalažnih materijala, kao i rezultata LCA analiza biopolimernih materijala. Polimerni materijali se u najvećem procentu (38%) koriste u proizvodnji ambalaže, što je više nego u građevinarstvu, automobilskoj industriji, elektroenergetici i elektronicima. Široka upotreba polimera za proizvodnju ambalažnih materijala je u velikoj meri posledica dobrih fizičko-mehaničkih i barijernih svojstava, ali je njihov dug životni vek najveća mana, posebno u pogledu zaštite životne sredine. Kada se uzme u obzir uticaj na životnu sredinu, ovi materijali su se u mnogim kategorijama pokazali lošijima u poređenju sa biorazgradivim polimerima (emisija CO₂), ali su u nekim kategorijama postigli bolje rezultate (manja potrošnja energije).

Ideja upotrebe ambalažnih materijala na bazi biopolimera iz obnovljivih izvora je da zatvore prirodni ciklus, pri čemu kraj jednog ciklusa znači početak sledećeg ciklusa. Biopolimeri su relativno novi na tržištu u poređenju sa njihovim sintentskim polimerima dobijenim iz naftnih derivata. Ipak, ova industrija je ostvarila značajne dobitke u kratkom vremenskom periodu. Pretpostavka da su biopolimeri u skladu sa održivim razvojem mora i dalje biti podržana relevantnim naučnim činjenicama. Dostupne LCA studije i ekološke procene snažno podržavaju dalji razvoj biopolimera, jer u poređenju sa sintetičkim polimerima, oni imaju prednosti, na primer, manju potrošnju fosilnih goriva i nižu stopu emisije gasova staklene bašte iz celog životnog ciklusa.

Ključne reči: ambalaža, analiza životnog ciklusa, polimeri, biopolimeri

COMPREHENSIVE REVIEW OF THE APPLICATION OF LIFE CYCLE ASSESSMENT IN THE PACKAGING SECTOR FOR POLYMER AND BIOPOLYMER MATERIALS

*Danijela ŠUPUT, Senka POPOVIĆ, Jovana UGARKOVIĆ, Nevena HROMIŠ
Faculty of Technology Novi Sad, Bulevar Cara Lazara 1, 21 000 Novi Sad, Serbia*

E-mail: suput.danijela@gmail.com

Among many important requirements for packaging materials, environmental friendliness is property that has become necessary for any material that can be competitive in the market. Life Cycle Analysis (LCA) is an analytical instrument that provides a framework for analyzing the impact of products and services on the environment, ie provides an understanding and the possibility of comparing different products. The main objective of the impact is to identify and establish links between the life cycle of products and services and potential environmental impacts. The LCA studies environmental aspects and possible environmental impacts, throughout the entire life cycle of raw material extraction products, through production, use and end-of-life treatment, recycling and final disposal ("from the cradle to the grave"). It is a systematic approach and includes four most important phases: the Goal Definition and Scoping Phase, the Life Cycle Inventory Phase, Life Cycle Impact Assessment Phase and the Interpretation Phase. The ISO 14040 series of standards establishes a flexible framework under which the LCA study is conducted in a practical and technically reliable manner. There is no single method for conducting an LCA study. Organizations are provided with flexibility in conducting the LCA study, which depends on the specifics of the application and user requirements.

This paper will provide an overview of the results of LCA analyzes of various commercial polymeric packaging materials, as well as the results of LCA analyzes for biopolymer materials. Polymeric materials are used in the largest percentage (38%) in the production of packaging, which is higher than in construction, automotive industry, electricity and electronics. Widespread use of polymers for the production of packaging materials is largely due to the good physico-mechanical and barrier properties of such products, but their long life is their biggest drawback, especially in terms of environmental protection. When the impact on the environment is taken into account, these materials have proven to be worse in many categories compared to biodegradable polymers (CO₂ emissions), but in some categories they have achieved better results (lower energy consumption).

The idea of biopolymers from renewable sources is to close the natural cycle, where the end of one cycle means the beginning of the next cycle. Biopolymers are relatively new to the market when compared to their petroleum counterparts. Still, this industry has made significant gains over a short period of time. The assumption that bio-polymers are consistent with sustainable development must continue to be supported by relevant scientific facts. The available LCA studies and environmental assessments strongly support the further development of biobased polymers, since when comparing them with synthetic polymers, they have advantages, e.g., lower consumption of fossil fuels and lower emission rate of greenhouse gases from the whole life cycle.

Key words: packaging, life cycle analysis, polymers, biopolymers

**ZAJEDNIČKI I DIREKTNİ EFEKTI GENOTIPA I EKOLOŠKIH USLOVA
SREDINE NA PRINOS HIBRIDNOG SEMENA KUKURUZA**

Marijenka TABAKOVIĆ¹, Vesna DRAGIČEVIĆ¹, Milena SIMIĆ¹, Rade STANISAVLJEVIĆ², Dobrivoj POŠIĆ², Milan BRANKOV¹, Violeta ORO²

¹Institut za kukuruz “Zemun Polje”, Zemun Polje, Slobodana Bajića 1, 11185 Beograd-Zemun, Srbija

²Institut za zaštitu bilja i životne sredine, Teodora Drajzera 9, 11040 Beograd, Srbija

E-mail: mtabakovic@mrizp.rs

U treći za obezbeđivanjem dovoljno hrane za rastuće stanovništvo, stvaraju se novi hibridi kukuruza koji treba da zadovolje savremene društvene potrebe. Polednjih decenija pored gentske osnove, za dobijanje visokih prinosa posvećuje se pažnja različitim sistemima gajenja, kao odgovor na klimatske promene. Nestabilni vremenski uslovi upućuju nas na stalno preispitivanje efekata genotip - ekološki uslovi sredine. Cilj ovog rada bio je da se oceni uticaj uslova sredine i genotipa na prinos tri linije kukuruza i morfološke osobine klipa. U radu je korišćeno seme tri linije kukuruza, proizvedene u Institutu za kukuruz ZemunPolje, u dvogodišnjem ogledu 2018 i 2019 godine, na jednoj lokaciji. Parametri koji su posmatrani bili su prinos, apsolutna masa semena, zapremina, dužina klipa i debljina klipa. Iz dobijenih rezultata efekat godine je bio značajan za sve osobine. Prosečan prinos za sve linije u prvoj godini bio je 6,13 a u drugoj 4,66t/ha. Značajan efekat ekoloških uslova bio je I na apsolutnu masu semena 327,56 u prvoj godini I 251,77 u drugoj godini. Ovako velika razlika u masi semena odrazila se I na ukupan odnos sitne I krupne frakcije semena na klip. U prvoj godini odnos SF/KF bio je 18,47/78,49%. Druga godina po pitanju krupnoće semena bila je mnogo ujednačenija sa odnosom SF/KF 45,15/40,08%. Na varijabilnost mase semena, zapremine, gustine, odnos frakcija godina proizvodnje je imala značajnog uticaja ($p \leq 0,05$). Genotip je značajno delovao na varijabilnost mase, gustine, Sf, Kf, dužine klipa I prinosa ($p \leq 0,05$). Interakcija dva faktora bila je značajna samo za odnos frakcija. Kvalitativna zavisnost prinosa I morfoloških osobina klipa I semena, iznosila je R^2 0.514. Sve morfološke osobine semena međusobno značajno koreliraju na oba nivou značajnosti ($p \leq 0,01$, $p \leq 0,05$).

Praćenje i analiza vremenskih promena na lokalnom nivou, modeliranje temperaturnih uslova vazduha i zemljišta, kao i padavina, od presudnog su značaja za uspostavljanje novih sistema gajenja ratarskih proizvoda.

Ključne reči: genotip, prinos, kvalitet semena, klip.

JOINT AND DIRECT EFFECTS OF GENOTYPES AND ENVIRONMENT CONDITIONS ON YIELD OF HYBRID MAIZE SEED

Marijenka TABAKOVIĆ¹, Vesna DRAGIČEVIĆ¹, Milena SIMIĆ¹, Rade STANISAVLJEVIĆ², Dobrivoj POŠIĆ², Milan BRANKOV¹, Violeta ORO²

¹Maize Research Institute, Zemun Polje, Slobodana Bajića 1, 11185 Belgrade-Zemun, Serbia

²Institute for Plant Protection and Environment, Teodora Drajzera 9, 11040 Belgrade, Serbia

E-mail: mtabakovic@mrizp.rs

In the competition to provide enough food for a growing population, new maize hybrids are being created to meet nutritional needs. In recent decades, regarding to the genetic basis, in order to obtain high yields, attention has been given to various cultivation systems in response to climate change. Unstable weather conditions lead to constant re-examination of the effects of genotypes × environment interaction. This study aimed to evaluate the influence of environmental conditions and genotype on the yield of three maize lines and the morphological properties of cobs and seeds. Three hybrid maize lines conducted at the Maize Research Institute were used as material in the study. Experiment included two years (2019-2018) and one location (Zemun Polje). The following parameters were monitored: 1000-seed weight, seed volume, bulk density, cob length, cob thickness, fraction content and grain yield. All examined parameters were mainly under the influence of the year on. The average grain yield for all three lines in the first and the second year was 6.13 t ha⁻¹ and 4.66 t ha⁻¹, respectively. A significant impact of environment was noticed on 1000 seed weights in both years (2018 and 2019), 327.56 g and 251.77 g, respectively. These great variations, in the 1000-seed weight, were also reflected on the proportion of the seed fraction in the cob. In 2018 proportion of small fraction and large fraction SF/KF was 18.47/78.49% (p≤0.05). In the second year, the seed weight it was more uniform, so SF/KF relation, was 45.15/40.08%. Significant effect of year was also noticed on seed volume, and seed bulk density. Genotype has a significant effect on 1000 seed weight, bulk density, SF, KF, cob length and grain yield (p≤0.05). The interaction genotype × environment was significant only for the proportion of the seed fraction. Qualitative dependence of yield and morphological characteristics of cobs and seeds, which expressed through the coefficient of determination was R² 0.514. All morphological characteristics of seeds significantly correlated each with other, at both levels of significance (p≤0.01, p≤0.05).

Monitoring and analysis of weather changes at the local level, including air and soil temperature conditions, as well as precipitation, are crucial for the establishment of new systems of cropping practices.

Key words: genotype, yield, seed quality, cob.

EKOLOŠKI SOLARNI KLIMA UREĐAJ U PREHRAMBENOJ INDUSTRIJI*Momir TABAKOVIĆ¹, Michal MASARYK²*¹*FH Technikum Wien, Giefinggasse 6, 1210 Wien, Austria*²*Slovak University of Technology in Bratislava, Vazovova 5, 81243 Bratislava**E-mail: momir.tabakovic@technikum-wien.at*

Mnoge ruralne zemlje sa slabom električnom mrežom se suočavaju sa velikom potražnjom za rashladnom energijom uslovljenih klimatskim promenama. Hlađenje se koristi ne samo da obezbedi hlađenje prostora, već i da obezbedi hlađenje / čuvanje hrane. Kada je električna mreža preopterećena u letnjim mesecima, uglavnom zbog sistema za klimatizaciju, opterećenja se isključuju kako bi se sprečio prekid napajanja električnom energijom. Sistemi za skladištenje hrane se isključuju na nekoliko sati da bi se električna mreža očuvala stabilnom. Ako se problem ne otkrije odmah, prekid napajanja električnom energijom se može produžiti. Tokom proizvodnje, skladištenja i transporta hrane, konstantne temperature se moraju održavati u celom hladnom lancu između 5-7 °C. Ovo ne samo da obezbeđuje kvalitet proizvoda, već i štiti zdravlje potrošača i poštovanje propisa. Temperaturne fluktuacije nisu dobre za hranu i mogu biti štetne za proizvod.

Toplota se umesto električne energije koristi kao pogonska energija u dve vrste rashladnih mašina – u poznatim (ali komplikovanim i skupim) apsorpcionim rashladnim mašinama i u ejektorskim rashladnim sistemima. Mašine za hlađenje sa ejektorima su jednostavni, pouzdani i jeftini sistemi – bez skupih mehaničkih delova kao što su kompresori. Odlična su alternativa za proizvodnju rashladne energije – ako ima relativno dovoljno prostora za ugradnju i dosta izvora toplote (čak i niskotemperaturna toplota iz otpadne toplote dolazi u obzir).

Prethodno opisani problem spada u oblast skladištenja i delimično logistike, a njegovo rešenje rezultira i osiguranjem kvaliteta. Pomoću ejektorskog sistema za hlađenje može se ostvariti hlađenje namirnica, bez opterećenja električne mreže. Postoji čak i mogućnost da pumpa (cca. 300W) rashladne mašine sa baterijom, fotonaponskim izvorom ili agregatom za hitne slučajeve radi nezavisno od mreže.

Ejektorski sistem za hlađenje doprinosi energetske efikasnosti, kao i obezbeđivanju samoodrživosti. Sprečava se eventualno nastajanje otpada uzrokovano kvarenjem hrane i obezbeđuje očuvanje njenog kvaliteta. Uz pretpostavku da sistem radi 12 časova dnevno i da je cena električne energije 0,12 €/kWh, ostvaruje se ušteda od cca. 2.800 kWh, što je ekvivalentno približno. 2.000 € godišnje i ušteda u emisiji od 3.300 tCO₂ sa inovativnim rashladnim postrojenjem ovog tipa od 20 kW. Za Evropu, FAO studija (Food and Agriculture of the United Nations) procenjuje godišnji gubitak hrane po glavi stanovnika od 280 do 300 kilograma u celom lancu snabdevanja. U Evropi i Severnoj Americi baca se između 95 i 115 kilograma hrane godišnje po domaćinstvu.

Ključne reči: solarna klima, niska emisija, nezavisna od mreže

ENVIRONMENTAL FRIENDLY SOLAR AIR-CONDITIONER IN FOOD INDUSTRY

Momir TABAKOVIĆ¹, Michal MASARYK²

¹*FH Technikum Wien, Giefinggasse 6, 1210 Wien, Austria*

²*Slovak University of Technology in Bratislava, Vazovova 5, 81243 Bratislava*

E-mail: momir.tabakovic@technikum-wien.at

The challenge is in many rural countries with a weak power grid but a high demand for cooling due to climatic conditions. The cooling is used not only to provide space cooling but also to ensure food refrigeration/storage. When the electrical network is overloaded in the summer months, primarily by air-conditioning systems, loads are switched off to prevent a power failure. Food storage systems are shut down for a few hours to keep the grid stable. If the problem is not detected immediately, power outages can be prolonged. During food production, storage, and transport, constant temperatures must be maintained throughout the cold chain between 5-7 °C. This ensures the quality of the products and protects consumer health and regulatory compliance. Temperature fluctuations are not suitable for food and can be detrimental to the product.

Heat instead of electric power is used as powering energy in two cooling machines – is well-known (but complicated and expensive) absorption cooling machines and ejector cooling systems. Ejector cooling machines are simple, reliable, and cheap systems – without expensive mechanical parts as compressors are. They are an excellent alternative for the production of air-conditioning cold – if there is relatively enough space for installation and plenty of heat sources (even a low-temperature heat from waste heat).

The problem falls into the area of storage and partly logistics and also results in quality assurance. The cooling for foodstuffs can be generated through the ejector cooling system without burdening the electrical network. There is even the possibility of the cooling machine's pump (approx. 300W) with a battery, PV, or emergency generator, thus working independently of the grid.

This would enable food refrigeration in countries and our industrial spheres. The ejector cooling system will contribute to energy efficiency and ensure self-sufficiency. Possible waste due to spoilage will be prevented, and quality is assured. Assuming 12 working hours per day and an electric price of 0,12 €/kWh, we have savings of approx. 2800 kWh, which is the equivalent of approx. 2000 € per year and savings of 3300 tCO₂ with a 20 kW innovative refrigeration plant of this type. For Europe, the authors of the FAO study (Food and Agriculture of the United Nations) estimate an annual per capita loss of 280 to 300 kilograms of food over the entire value chain. Europeans and North Americans throw away between 95 and 115 kilograms per year at home.

Key words: solar air condition, low emission, network independent

CENTRIFUGAL PUMPS AND NON-NEWTONIAN FLUIDS*Slobodan TAŠIN¹, Vladan MITROVIĆ¹, Maša BUKUROV¹, Siniša BIKIĆ¹**¹University of Novi Sad, Faculty of Technical Sciences Novi Sad, Trg Dositeja Obradovića 6**[E-mail: tasholi@uns.ac.rs](mailto:tasholi@uns.ac.rs)*

Performance characteristics of centrifugal pumps $H(Q)$, $P(Q)$, $\eta(Q)$, provided by manufacturers in catalogues, technical sheets and test reports, commonly refer to clean water at a temperature between 4 °C and 20 °C. If a pump has to operate with a fluid that has different physical properties than water at a given temperature, especially in case of density and viscosity, its performance characteristics could be more or less different from the characteristics that refer to water. If a particular fluid differs from water only in density, the expected pump performance characteristics can be estimated with acceptable accuracy from the performance characteristics for water by using affinity laws for turbo-machinery. If the viscosity of a fluid significantly differs from the viscosity of water, the procedures for assessing the performance characteristics are much more complex. In practice, several methods have been developed for this purpose by specialized research centres or pump manufacturers. Most of these methods refer to Newtonian fluids, i.e., fluids that exhibit a linear correlation between viscous stresses τ and the velocity gradient dv/dy , or the shear rate $\dot{\gamma}$.

On the other hand, many industries require pumping of fluids whose behaviour differs from such linear dependence, for example, the rubber industry, chemical and pharmaceutical industry, food industry, industry of paints and varnishes, etc. Although all fluids that do not exhibit Newtonian behaviour are commonly referred as non-Newtonian, different non-Newtonian fluids may achieve completely different flow patterns for the same boundary conditions. Depending on the form of functional dependence between viscous stresses and shear rate, non-Newtonian fluids can be divided into several groups such as dilatant, pseudoplastic, viscoelastic, viscoplastic, thixotropic and rheopectic. Besides, many materials may exhibit a combined behaviour of two or more types of non-Newtonian fluids.

All the above-mentioned non-Newtonian fluids have different impacts on the operation of a centrifugal pump, namely on its performance characteristics. As experiments show, pump performance characteristics may increase or decrease when a pump pumps a non-Newtonian fluid instead of water but may also decrease at lower flow rates and increase at higher flow rates, or vice versa, depending not only on the non-Newtonian fluid type but also on the pump rotational speed. Useful methods for estimating pump performance characteristics have been developed for a very limited number of non-Newtonian fluids, e.g., for wood pulp. For most other non-Newtonian fluids, the only reliable way to determine the performance characteristics of a centrifugal pump is to measure the actual operating parameters when pumping particular fluid or fluid that has the most similar rheological properties.

This paper presents an overview of the available results of testing performance characteristics of centrifugal pumps when working with different non-Newtonian fluids. The presented results could be used as a basis for a qualitative assessment of performance characteristics of a particular centrifugal pump when pumping a particular non-Newtonian fluid.

Key words: non-Newtonian fluids, centrifugal pumps, performance characteristics

DETERMINANTE PROFITABILNOSTI MLINSKIH PREDUZEĆA IZ VOJVODINE

Dragana TEKIĆ, Beba MUTAVDŽIĆ, Dragan MILIĆ, Tihomir NOVAKOVIĆ, Milana POPOV, Zlata MIHAJLOV

Poljoprivredni fakultet, Trg Dositeja Obradovića 8, 21000 Novi Sad, Srbija

E-mail: dragana.tekic@polj.uns.ac.rs

Profitabilnost preduzeća predstavlja jedan od osnovnih pokazatelja uspešnosti poslovanja, za koju su zainteresovane sve strane u biznisu. Profitabilnost, u praktičnom smislu odražava sposobnost preduzeća da generiše profit. Pored ocene profitabilnosti, potrebno je utvrditi i faktore koji na nju utiču. Predmet ovog istraživanja su mala i srednja mlinska preduzeća koja su poslovala na teritoriji Vojvodine. Cilj istraživanja jeste da se ocene stopa prinosa na imovinu (ROA) i stopa prinosa na kapital (ROE), kao i faktore koji utiču na ove pokazatelje. Na osnovu uzorka od 23 preduzeća male i srednje veličine koja su u 2019. godini poslovala pod šifrom delatnosti 1061-proizvodnja mlinskih proizvoda, sprovedena je kvantitativna analiza. Najpre su izračunati osnovni pokazatelji deskriptivne statistike (medijana, kvartili, koeficijent interkvartilne razlike), a zatim su za utvrđivanje uticaja različitih determinant na profitabilnost formirani modeli višestruke linerne regresije. Na osnovu izračunatih pokazatelja deskriptivne statistike utvrđeno je da je medijalna vrednost stope prinosa na imovinu iznosila 2.58%, a medijalna vrednost stope prinosa na kapital iznosila je 5.56%. U regresionim modelima, kao zavisno promenljive posmatrani su pokazatelji profitabilnosti (stopa prinosa na imovinu i stopa prinosa na kapital), a kao nezavisno promenljive posmatrani su pokazatelji: likvidnosti, zaduženosti, solventnosti i produktivnosti. Značajnost formiranih modela testirana je primenom analize varijanse regresije i utvrđeno je da je samo model koji sadrži stopu prinosa na imovinu statistički značajan. Takođe, je utvrđeno da od svih posmatranih nezavisno promenljivih samo zaduženost statistički značajno utiče na profitabilnost.

Ključne reči: profitabilnost, mlinska preduzeća, regresiona analiza, Vojvodina

PROFITABILITY DETERMINANTS OF MILL COMPANIES IN VOJVODINA

Dragana TEKIĆ, Beba MUTAVDŽIĆ, Dragan MILIĆ, Tihomir NOVAKOVIĆ, Milana POPOV, Zlata MIHAJLOV

Faculty of Agriculture, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia

E-mail: dragana.tekic@polj.uns.ac.rs

The profitability of the company is one of the basic indicators of business success, in which all parties in the business are interested. Profitability, in practical terms, reflects the company's ability to generate profit. In addition to assessing profitability, it is necessary to determine the factors that affect it. The subject of this research are small and medium-sized mill companies that operated in the territory of Vojvodina. The aim of the research is to assess the rate of return on assets (ROA) and the rate of return on capital (ROE), as well as the factors influencing these indicators. Based on a sample of 23 small and medium-sized companies that operated in 2019 under the activity code 1061 - production of mill products, a quantitative analysis was conducted. First, the basic indicators of descriptive statistics (median, quartiles, coefficient of interquartile difference) were calculated, and then multiple linear regression models were formed to determine the influence of different determinants on profitability. Based on the calculated indicators of descriptive statistics, it was determined that the median value of the rate of return on assets was 2.58%, and the median value of the rate of return on capital was 5.56%. In regression models, profitability indicators (rate of return on assets and rate of return on capital) were observed as dependent variables, and indicators of liquidity, indebtedness, solvency and productivity were observed as independent variables. The significance of the formed models was tested by applying regression variance analysis and it was determined that only the model containing the rate of return on assets, as dependent variable, is statistically significant. Also, it was found that of all the observed independently variables, only indebtedness statistically significantly affects profitability.

Key words: profitability, mill companies, regression analysis, Vojvodina

**PRIMENA SAVREMENIH IDENTIFIKACIONIH TEHNOLOGIJA U
PROCESIMA PRAĆENJA PROIZVODNJE PREHRAMBENIH PROIZVODA***Vladimir TODORVIĆ**Naučno tehnološki park Novi Sad, Univerzitet u Novom Sadu**E-mail: vladimir.todorovic@uns.ac.rs*

Bezbednost hrane, sledljivost proizvodnje, kao i praćenje prehrambenih proizvoda uopšte, jedan su od većih izazova u teoriji organizacije proizvodnje. Sistemska rešenja, protokoli postupanja i/ili adekvatna softverska rešenja na dosadašnjem nivou tehnike još uvek ne postoje, kada je u pitanju kompletna sledljivost prehrambenih proizvoda. Naime, postoji veliki broj partikularnih rešenja, preporuka, pilot projekata (čak i na nacionalnom nivou, kao što je to slučaj u Kini), ali suštinski pristup koji bi bio propisan na međunarodnom nivou nažalost još uvek ne postoji. Strategija *Farm to Fork* je prvi značajan korak u tom pravcu i nalazi se u srcu evropskog *Green deal-a* sa ciljem da sistemi proizvodnje i distribucije hrane budu pravedni, zdravi i ekološki prihvatljivi. Još jedan od izazova je pokazao da sistemi proizvodnje hrane ne mogu biti otporni na krize kao što je pandemija COVID-19 ako nisu održivi.

Put koji prolazi jedan gotov prehrambeni proizvod od samog uzgoja, prerade, do konačnog dolaska na mesto konzumiranja je izuzetno složen i zahteva strogo praćenje kako bi se izbegle neželjene situacije. Naime, čak i u zemljama sa razvijenom svešču, pravnom regulativom i procedurama iz oblasti praćenja hrane i obezbeđivanja njenog odgovarajućeg kvaliteta, dolazilo je do problema koji su ugrožavali kompletne pojedine grane poljoprivrede, jer su se dešavale situacije da nakon, čak i pojedinačnih, slučajeva trovanja hranom dođe do straha kupaca koji je, u današnje vreme razvijenih komunikacionih kanala, nemoguće kontrolisati i sprečiti. Da bi se ovakve situacije mogle držati pod kontrolom, ili u potpunosti preduprediti, potrebno je omogućiti sledljivost proizvoda, odnosno dovesti do toga da kupac ima mogućnost da konačan proizvod proveri samostalno, pre same kupovine, i time se uveri u poreklo i procese kroz koje je proizvod prošao tokom proizvodnje i distribucije.

Na osnovu navedenih problema i jasno identifikovane i definisane neophodnosti i potrebe za sledljivošću proizvoda, u radu će biti predstavljen model razvoja i strukturisanja sistema sledljivosti zasnovanog na trenutno raspoloživim tehnologijama koje je moguće koristiti za navedeni problem kao što su RFID (engl. Radio Frequency Identification) tehnologija, NFC (Near Field Communication), QR kod sistem obeležavanja, ali i čuvanje podataka primenom Blockchain tehnologije. Ovaj model bi se prvenstveno primenjivao u sistemima prerade, proizvodnje i distribucije prehrambenih proizvoda.

Ključne reči: Radio frekventna identifikacija, sledljivost, sigurnost, hrana, bar kod, QR kod, lanac distribucije, NFC

UTICAJ SUPSTITUCIJE PŠENIČNOG BRAŠNA KISELIM TESTOM I PROTEINIMA SURUTKE NA KVALITETNA SVOJSTVA BISKVITA

Jelena TOMIĆ¹, Dubravka ŠKROBOT¹, Tamara DAPČEVIĆ-HADNAĐEV¹, Nikola MARAVIĆ¹,
Miroslav HADNAĐEV¹

¹Univerzitet u Novom Sadu, Naučni institut za prehrambene tehnologije, Bulevar cara Lazara 1, 21000
Novi Sad, Srbija

E-mail: jelena.tomic@fins.uns.ac.rs

Preferencije potrošača usmerene ka konzumiranju obogaćenih i/ili funkcionalnih prehrambenih proizvoda uslovile su pojavu trenda obogaćivanja ili potpune zamene rafinisanog pšeničnog brašna integralnim žitima ili drugim alternativnim sastojcima. Redizajn tradicionalne hrane u cilju kreiranja proizvoda optimalnog nutritivnog kvaliteta postaje uobičajena praksa, pri čemu se potrošačima nudi širi i zdraviji izbor prehrambenih artikala. Ugradnja proteina i/ili vlakana različitog porekla u formulacije hrane predstavlja jedan od najčešće korišćenih pristupa. Postupak proizvodnje kiselog testa postaje ponovo aktuelan jer njegova primena u kreiranju proizvoda na bazi žita obezbeđuje niz funkcionalnih i zdravstvenih prednosti kao što su poboljšanje teksture i ukusa proizvoda, stabilizacija ili povećanje nivoa različitih bioaktivnih jedinjenja, smanjenje glikemijskog indeksa proizvoda i poboljšanje bioraspoloživosti minerala.

U ovom radu ispitan je uticaj zamene pšeničnog brašna kiselim testom od integralnog pšeničnog brašna (20% i 30%) i koncentrata proteina surutke (10%) na kvalitet biskvita. Karakterizacija biskvita obuhvatala je procenu hemijskog sastava, specifične zapremine, boje i teksturnih svojstava. Senzorska analiza je izvedena na uzorcima biskvita od strane deset obučених senzorskih ocenjivača ispitivanjem sledećih svojstava: nepravilnost oblika, gustina, ujednačenost pora, kohezivnost, elastičnost, adhezivnost, mrvljivost, miris (ukupni intenzitet, miris na jaja), aroma (ukupni intenzitet, aroma na jaja), ukus (slatko i gorko) i naknadni sladak ukus. Za ispitivanje značajnosti razlike između uzoraka korišćena je analiza varijanse (ANOVA) praćena Tukey's HSD testom pri nivou značajnosti od 0,05.

Rezultati ukazuju da hemijski sastav i boja biskvita u velikoj meri zavise od sirovina korišćenih u formulaciji. Prisustvo proteina u formulaciji biskvita rezultiralo je kreiranjem proizvoda koji se može označiti kao izvor proteina jer više od 12% ukupne energetske vrednosti proizvoda potiče od proteina. U poređenju sa kontrolnim uzorkom, supstitucija pšeničnog brašna kiselim testom i proteinima surutke izazvala je značajno smanjenje specifične zapremine, dok su vrednosti čvrstoće ispitivanih uzoraka bile značajno veće. Rezultati senzorske analize pokazali su da uzorci sa kiselim testom i proteinima poseduju znatno gušću strukturu sa većom neujednačenošću pora. Supstitucija pšeničnog brašna kiselim testom i proteinima surutke uticala je na gubitak gorkog ukusa, arome i mirisa na jaja, dok je slatkoća za ove uzorke bila značajno izražena u poređenju sa kontrolnim uzorkom. Na osnovu dobijenih rezultata može se zaključiti da korišćene sirovine poseduju potencijal visokovrednih alternativnih sastojaka u kreiranju proizvoda sa dodatom vrednošću pri čemu su neophodna dalja istraživanja u smislu modifikacije formulacija ili proizvodnog postupka kako bi se minimizirali negativni uticaji na teksturna svojstva i specifičnu zapreminu proizvoda.

Ključne reči: kvalitet biskvita, kiselom testom, proteinski koncentrat surutke, tekstura, senzorska svojstva

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**EFFECT OF SUBSTITUTION OF WHEAT FLOUR BY SOURDOUGH AND
WHEY PROTEINS ON THE PROPERTIES OF SPONGE CAKE**

*Jelena TOMIĆ¹, Dubravka ŠKROBOT¹, Tamara DAPČEVIĆ-HADNAĐEV¹, Nikola MARAVIĆ¹,
Miroslav HADNAĐEV¹*

*¹University of Novi Sad, Institute of Food Technology, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia
E-mail: jelena.tomic@fins.uns.ac.rs*

As a result of consumer preferences, including the demand for healthier and high protein and high dietary fibre plant-based food, there is a trend towards fortifying or completely replacing refined wheat flour with whole grains or alternative ingredients. Redesign of traditional foods in order to create optimal nutritional value becomes a common practice thus offering consumers a wider and healthier choice. Incorporation of proteins and/or fibres from different sources in food formulations present one of the most used approaches. Recently, the application of sourdough technology has gained research interest due to its complexity as well as its ability to promote beneficial modifications on sensory, technological and nutritional properties of bakery products. The technological application of sourdough can offer several advantages such as improving texture and palatability of cereal based products, stabilizing or increasing levels of various bioactive compounds, retarding starch bioavailability and improving mineral bioavailability.

This study aims to investigate the effects of substitution of wheat flour by sourdough from whole wheat flour (at levels 20% and 30%) and whey protein concentrate (at level 10%) on the quality of sponge cakes. The characterization of sponge cakes included the evaluation of chemical composition, specific volume, colour and texture properties. The sensory evaluation of sponge cake samples was carried out by a panel of ten trained sensory assessors who evaluated following attributes: shape irregularity, density, pores uniformity, cohesiveness, elasticity, adhesiveness, crumbliness, odour (overall intensity, on eggs), flavour (overall, on eggs), taste (sweet and bitter) and sweet aftertaste. All experimental data were subjected to one-way analysis of variance (ANOVA). To the aim, a Tukey's honestly significant difference (Tukey's HSD) test was carried out to determinate significance differences ($P < 0.05$) between samples.

Regarding the proximate composition and colour measurements, results were, as expected, strongly dependent on the raw materials used in the formulation. Generally, the incorporation of proteins resulted in creation of product which can be labelled as protein source since more than 12% of their energy value is provided by protein. Compared to the control sample, reduction of wheat flour by sourdough and whey proteins caused a significant decrease in specific volume while values of hardness of tested samples were significantly higher. Regarding the sensory analysis, samples with sourdough and proteins exhibited much denser structure with a noticeable number of non-uniform large pores. Reduction of wheat flour by sourdough and whey proteins caused the loss of bitter taste, flavour and odour on eggs while the sweetness for these samples was significantly pronounced. The results indicate that this combination of used ingredients have a potential to be considered as an alternative value-added food ingredients for bakery products but further research should be conducted in this area.

Keywords: sponge cakes quality, sourdough, whey protein concentrate, textural properties, sensory properties

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DEVELOPMENT OF FINGERPRINT-BASED SORTING MODELS TO DETERMINE THE RIPENESS OF DIFFERENT STONE FRUITS

Flora VITALIS, Juan-Pablo AGUINAGA BÓSQUEZ, Zoltan GILLAY, Marietta FODOR, Zoltan KOVACS

Hungarian University of Agriculture and Life Sciences, Institute of Food Science and Technology, H-1118 Budapest, Somlói street 14-16.

E-mail: vitalis.flora@phd.uni-mate.hu

Stone fruits are an essential part of the human diet that are consumed primarily for energy and health, but can also be a source of pleasure. For the Hungarian and international gastronomy and food industry, cherries, sour cherries and plums are consumed both fresh and processed. The advantageous nutritional, organoleptic and techno-functional properties of these fruits are combined with considerable market importance. The quality of the products is determined by the complex changes that occur during ripening, harvesting, storage and processing, which greatly depend on the environmental conditions. Fruits can be harvested at different ripeness, depending on their climacteric ripening potential and the purpose of their use.

The optimal harvest time of fruit is typically determined by empirical techniques or destructive tests. The sorting of fruit for sale or for processing is often done manually to remove non-compliant fruits. These are very subjective, costly and time-consuming. Due to the modernisation of agriculture and the miniaturisation of rapid analytical methods, the use of near-infrared spectroscopy-based fingerprint methods are becoming more widespread in fruit production as well. This research aimed to develop non-destructive near-infrared (NIR) spectroscopy-based models for the classification of cherry, sour cherry and plum samples of different ripeness. Additionally, qualitative models were built for the prediction of some of the main quality indicators of the tested fruits.

Different varieties of cherries, sour cherries and plums harvested in different stages of maturity (from green to fully ripe) were collected from the Satu Mare region (Hungary). The fruits were evenly sorted according to their visible colour, then ripeness clusters were formed. The colour values, the dry matter, the soluble solid, the acid and the anthocyanin content of the fruits were measured. Five fruits per sample group were analysed with a hand-held NIR spectrometer. The spectra were recorded on the unripe and ripe sides of the fruit in the wavelength range of 900-1700 nm with three consecutive scans. After pre-processing the spectral data, linear discriminant analysis was applied to classify samples based on their ripeness. Partial least squares regression models were fitted to predict the physicochemical properties of the fruits.

The sorting models built for each variety classified the fruits according to their ripeness with high accuracy. The predictive models, also built per variety, generally estimated the physicochemical properties with acceptable accuracies. The accuracy of the models was determined by whether they were built on the data recorded on the ripe, unripe or both sides of the fruits. These preliminary developments could serve as a basis for determining the optimal harvest, and could be potential input for a fruit sorting system, allowing the best use of fruit according to its current and predicted quality.

Key words: stone fruits, ripeness, fingerprint method, NIR spectroscopy, chemometrics

ESTABLISHMENT OF TEMPERATURE REGIMES FOR STORAGE OF MARINATED MUSHROOMS

Zinaida YEGOROVA

Belarusian State Technological University, Sverdlov str., 13a, 220006, Minsk, Belarus

E-mail: egorovaze@tut.by

To determine the storage conditions of canned foods, it is recommended to use an integrated approach, one of the components of which can be the method of accelerated shelf life testing (ASLT), in particular kinetic modeling, in which the most popular is the use of a unit acceleration factor, for example, ambient temperature. In Belarus, the requirements for the storage temperature of canned mushrooms, which should not exceed 15°C, are established in GOST 28649 and STB 1427. It should be noted that a number of canneries producing marinated mushrooms are interested in increasing the storage temperature from 15 to 25°C, by analogy with canned fruits and vegetables, which have a pH similar to marinated mushrooms. Considering the above, the purpose of our work was to justify the increase in the temperature regimes for storing marinated mushrooms.

The objects of the study were samples of marinated mushrooms, made in industrial conditions, packed in glass jars III-82-450 and sterilized in a vertical autoclave, as well as 2 strains (non-spore-forming and spore-forming) of bacteria from the working collection of microorganisms of the Department of PCMCP. The subject of the study is microbiological (mesophilic aerobic, facultative anaerobic and anaerobic bacteria, lactic acid microorganisms, yeasts and molds) and physicochemical (pH, titratable acidity, water activity and redox potential) indicators, which were determined by standard test methods. Samples of marinated mushrooms (control) were stored under the following temperature conditions: 25±1°C; 30±1°C and 37±1°C for 8 months. To determine the possible development of spoilage microorganisms in the objects of study, artificial contamination of samples with test strains was carried out in an amount from hundreds to tens of hundreds of CFU per g of product. The contaminated samples were stored at 6°C and 30°C for one and a half months.

As a result of the research, the following conclusions were obtained. During storage of control samples for 8 months. under different temperature regimes, viable microorganisms were not detected, i.e., canned food remained industrially sterile. Non-spore-forming bacteria artificially introduced into samples of pickled mushrooms and cultivated in a home refrigerator (6°C) and optimal temperature conditions for their development (30°C) died within 6 days, regardless of the storage temperature of the products. The number of spore-forming bacteria artificially introduced into samples of marinated mushrooms and cultivated in a home refrigerator (6°C) and optimal temperature conditions for their development (30°C) decreased by 2-3 orders of magnitude during 2 months of the experiment. At the same time, storage at a temperature of 30°C caused a more intensive death of these test microorganisms.

Our data indicate the possibility of increasing the upper limit of the storage temperature of marinated mushrooms from 15°C to 25°C.

Key words: marinated mushrooms, storage temperature, survival of microorganisms

RADIONUCLIDES IN FOOD ADDITIVES FOR SAUSAGE PRODUCTS*Zinaida YEGOROVA¹, Olga GMYRAK²**¹Belarusian State Technological University, st. Sverdlov, 13a, 220006, Minsk, Belarus**²Minsk Meat Processing Plant, st. Kazinets, 46, 220099, Minsk, Belarus,**E-mail: egorovaze@tut.by*

Recently, in the production of meat products and sausages, the use of food additives, including complex food additives used to impart certain taste characteristics to products, has become increasingly important. Vegetable components (dried and chopped root crops, vegetable greens, spices and herbs) are often introduced into the composition of complex food additives. Taking into account the consequences of the accident at the Chernobyl nuclear power plant, the possible uncontrolled use of potash fertilizers, as well as the requirement of the international standard ISO 22000:2018, studies devoted to assessing the likelihood of food contamination with radioactive substances are relevant.

The purpose of this work was to study the radionuclides Cs-137, Sr-90 and K-40 in complex food additives. The objects of the study were 19 samples of complex food additives produced in Belarus (4 types), Poland (4 types), Russia (7 types) and Germany (4 types) and used in the production of sausages at the Minsk Meat Processing Plant. The studies were carried out in an accredited production laboratory of the enterprise using a standard method using a gamma-beta radiometer MKS AT 1315.

The research results showed the following. The specific activity of the radionuclide cesium-137 in 84% of the studied samples did not exceed 20 Bq/kg, and in the remaining 16% of complex food additives it reached 85÷115 Bq/kg, which is more than 2 times lower than the permissible level (AL - 370 Bq/kg). The level of specific activity of strontium-90, not exceeding 20 Bq/kg, was found in 6 samples of complex food additives, in the same number of studied samples, the specific activity of this radionuclide exceeding 40 Bq/kg was found, in the remaining 37% samples of complex food additives, the specific activity of strontium was in the range from 20 to 40 Bq/kg. Since there are no established acceptable levels for these food ingredients, it is not possible to judge their safety. Interesting data were obtained by us in the study of the specific activity of K-40. In almost 50% of the studied samples, the specific activity of potassium-40 did not exceed 100 Bq/kg, in others it varied from 180 to 770 Bq/kg. A comparison of our data with those available in the literature for raw vegetables and fruits, grains, pulses and cereals showed an excess of 2.5 to 100 times, which is most likely due to the fact that dried ingredients are used in food additives.

Thus, the analysis of the data obtained by us indicates the expediency of a deeper study of radionuclides, in particular, potassium-40 for a reliable risk assessment for this indicator.

Key words: complex food additives, cesium-137, strontium-90, potassium-40.

PROMENE KVALITETA SEMENA ODABRANIH SORTI PAPIRIKE U TROGODIŠNJEM PERIODU

Ivana ŽIVKOVIĆ¹, Radiša ĐORĐEVIĆ¹, Slađan ADŽIĆ¹, Milan UGRINOVIĆ¹, Dobrivoj POŠTIĆ²,
Ratibor ŠTRBANOVIĆ², Jelena DAMNJANOVIĆ¹

¹Institut za povrtarstvo, Karađorđeva 71, 11420 Smederevska Palanka, Srbija

²Institut za zaštitu bilja i životne sredine, Teodora Drajzera 9, Beograd, Srbija

E-mail: izivkovic@institut-palanka.rs

Paprika (*Capsicum annuum* L.) kao komercijalna vrsta obuhvata veliki broj različitih sorti koje su popularne širom sveta. Prema zvaničnim podacima Organizacije za hranu i poljoprivredu, 2016 godišnja proizvodnja paprike dostiže približno 3.9 miliona tona. Dobar kvalitet semena je jedan od glavnih uslova postizanja visokih i stabilnih prinosa. Promene kvaliteta semena autohtonih sorti semena paprike: Palanačko čudo, Župska rana i Kobra praćene su u trogodišnjem periodu (2019-2021) u Laboratoriji za ispitivanje kvaliteta semena u Smederevskoj Palanci.

Kvalitet semena procenjen je standardnim laboratorijskim analizama (energija i ukupna klijavost, vlaga i zdravstvena ispravnost). Kvalitet semena odabranih sorti paprike testiran je u skladu sa Pravilnikom o kvalitetu semena poljoprivrednog bilja (47/87) koji je uskladu sa ISTA pravilima (2020). Uzorci odabranih sorti paprike, 100 semena u četiri ponavljanja postavljeni su u petri šolje, obložene filter papriom i natopljene sa KNO₃. Postavljeni uzorci ostavljeni su na inkubaciju 7 i 14 dana na 23 °C. Zdravstvena ispravnost semena Palanačko čudo, Župska rana i Kobra testirana su na *Alternaria* spp. i *Fusarium* spp.

Ukupna klijavost za Kobru u 2019. godini iznosila je 88 %, energija 72 %, dok su *Alternaria* i *Fusarium* su bili prisutni u 1 %. Klijavost (2020) je iznosila 77 %, a energija 65 %, primećen je značajan porast *Alternaria* 5 %, dok *Fusarium* nije bio prisutan. U 2021 godini parametri kvaliteta su značajno smanjeni ($p < 0.05$), 66 % (klijavost) i 50 % (energija), prisutnost *Alternaria* je 4 % i *Fusarium* 3 %.

Za sortu paprike Palanačko čudo 2019 godine ukupna klijavost iznosila je 89 %, energija 79 %, i detektovano je 4 % *Alternaria*. Nije primećeno značajno opadanje ($p > 0.05$) ukupne klijavosti (2020), dok je pad u energiji klijanja iznosio 71 % ($p < 0.05$). Detektovana je *Alternaria* 3 %. U periodu treće godine (2021) parametri nisu značajno promenjeni ($p > 0.05$) za ukupnu klijavost (84 %) i energiju (69 %). Detektovana je *Alternaria* iznosila 5 %.

Župska rana je imala najbolju klijavost 2019. godine (95 %) u odnosu na Palanačko čudo i Kobru ($p < 0.05$). Energija klijanja je značajno viša u odnosu na druge odabrane sorte, 89 % ($p < 0.05$). Prisutnost je *Alternaria* je 3 % i *Fusarium* 1%. Primećeno je značajno opadanje ukupne klijavosti 2020 u odnosu na 2019 godinu ($p < 0.05$) i iznosila je 83 %, shodno tome i energija klijavosti je opala. Nisu detektovane fitopatogene gljive u uzorku Župske rane. Ukupna klijavost i energija značajno su opale u odnosu na predhodne dve godine ($p < 0.05$). Ukupna klijavost iznosila je 75 %, a energija 60 %. *Alternaria* i *Fusarium* su detektovane 1 %. Prilikom analize parametra kvaliteta 2021 godine uočena je najmanja promena kvaliteta kod sorte Palanačko čudo. Primećen je značajan pad u klijavosti Župske rane u periodu 2019 – 2021 godine. Najmanji procenat fitopatogenih gljiva u trogodišnjem periodu detektovan je kod Župske rane.

Ključne reči: župska rana, kobra, palanačko čudo, parametri kvaliteta