ZBORNIK APSTRAKATA

V NAUČNO-STRUČNI SIMPOZIJUM SA MEĐUNARODNIM UČEŠĆEM

„PIVO, PIVARSKE SIROVINE I OPREMA“

Zrenjanin, Srbija
25 - 28.10.2022. godine
www.simpozijumopivu-zrenjanin.org

V NAUČNO-STRUČNI SIMPOZIJUM SA MEĐUNARODNIM UČEŠĆEM

„PIVO, PIVARSKE SIROVINE I OPREMA“

5th SCIENTIFIC-PROFESSIONAL SYMPOSIUM WITH INTERNATIONAL PARTICIPATION

"BEER, BREWING RAW MATERIALS AND EQUIPMENT"

ZBORNIK APSTRAKATA
BOOK OF ABSTRACTS

Zrenjanin, Srbija
25 – 28.10.2022. godine

IZDAVAČ
PUBLISHER

Institut za ratarstvo i povrtarstvo Novi Sad,
Institut od nacionalnog značaja za republiku Srbiju

Institute od Field and Vegetable Crops Novi Sad,
National Institute of the Republic of Serbia

ADRESA IZDAVAČA
PUBLISHER´S ADRESS

Maksima Gorkog 30, 21000 Novi Sad, Srbija
Tel: +381 21 4898 100
Fax: +381 21 4898 131

ISBN

978-86-80417-90-5

ŠTAMPA
PRINT

Školska knjiga NS doo
Živojina Ćuluma 32, Novi Sad, Srbija
Tel: +381 21 419 107

V NAUČNO – STRUČNI SIMPOZIJUM
„PIVO, PIVARSKE SIROVINE I OPREMA“

Počasni odbor

Simo Salapura, gradonačelnik Zrenjanina
Prof. dr Dušan Živković, dekan Poljoprivrednog fakulteta u Beogradu
Prof. dr Jan Kišgeci

Naučni odbor Simpozijuma

Prof. dr Viktor Nedović, predsednik,
Prof. dr Jan Kišgeci,
Prof. dr Peter Raspor,
Prof. dr Tomas Branyik,
Prof. dr Jelena Pejin,
Dr Mathias Hutzler,
Dr Deliang Wang,
Prof. dr Iztok Jože Košir,
Prof. dr Vinko Krstanović,
Prof. dr Biljana Pajin,
Prof. dr. Natalija Velić,
Prof. dr Miomir Nikšić,
Dr Ljiljana Brbaklić,
Doc. dr Kristina Mastanjević,
Doc. dr Saša Despotović,
Doc. dr Nevena Ivanović,
Prof. dr Dejan Molnar,
Dr Dimitrije Aranđelović,
Dr sc. Gordana Šimić,
Snežana Babarogić, spec. ing.tehn.,
Aleksandar Egi, B.Eng, M.Sc.,
Mr. sc. Mirela-Smajić Murtić

Organizacioni odbor Simpozijuma

Prof. dr Radovan Pejanović, predsednik,
Dr Miodrag Kovačević, potpredsednik,
Prof. dr Dragana Latković,
Dr Milorad Rančić,
Dr Ana Marjanović Jeromela,
Vladeta Dašić, generalni sekretar,
Simona Jaćimović,
Ana Bjeković,
Kristina Salapura,
Zoran Ljubotina,
Dejan Smiljanić,
Sanja Petrović

Tehnička pomoć

Daniela Baltić
Marketing služba Instituta

Kancelarija Simpozijuma

Tehnički sekretar Simpozijuma, Aleksa Radić
+381 23 565 896, tehnicki.sekretar@vts-zr.edu.rs

Pokrovitelji Simpozijuma

Grad Zrenjanin

Organizator Simpozijuma

Institut za ratarstvo i povrtarstvo Novi Sad,
Institut od nacionalnog značaja za republiku Srbiju

Suorganizatori Simpozijuma

SADRŽAJ

RECENT TRENDS ABOUT PRODUCTION AND INNOVATION IN CHINA BEER INDUSTRY

Deliang Wang

In recent years, there has been a tremendous amount of innovation and change within the brewing industry, which has resulted in a positive impact in the terms of China beer industry. The industry has seen many different trends in china beer consumer that has resulted in the industry having to pivoted in order to fit the market's demands. First, this presentation described the production statistics of recent years about China beer industry and compared the differences with the representative countries in world. Second, we discussed the ever-changing innovation of brewing technology and new product via the in China brewery.We study how certain technology trends effected beer quality in China beer industry, such as: Raw Materials, Hop Flavor, New Product, etc. In addition to these, we introduced the brief content of our department (International Joint of Research Center of Quality and Safety of Alcoholic Beverage), ie: Research Fields, International Cooperative Partners, International Cooperation Program, International Technical Forum, etc.

THE UNIVERSE OF BREWING YEAST AND FERMENTATION

Mathias Hutzler[1]

[1]*Technical University of Munich, Research Center Weihenstephan for Brewing and Food Quality, Alte Akademie 3, 85354 Freising,*

email: m.hutzler@tum.de

Saccharomyces cerevisiae and *Sacharomyces pastorianus* are the main species used in brewing. History and physiological/fermentation characteristics of those top- and bottom fermenting brewing yeasts are the main topic of this presentation. The last decade also other *Sacchromyces* species and Non-*Saccharomyces* species gained in importance for brewing. Some of those species are part of traditional beers and some were used in scientific and commercial projects. The lecture picks a few yeast as examples for such success stories and highlights their specific properties: *Saccharomyces jurei*, *Saccharomyces paradoxus*, *Torulaspora delbrueckii*, *Cyberlindnera saturnus*, *Saccharomycodes ludwigii*, *Brettanomyces bruxellensis*.The last part of the lecture demonstrates different strategies for innovative beer fermentations including mixed fermentations.

Key words: Brewing yeast, fermentation, innovative beers, *Saccharomyces*, Non-*Saccharomyces*, *Torulaspora*, *Brettanomyces*, *Cyberlindnera*, *Saccharomycodes*

STARTER CULTURES IN BEER PRODUCTION: WHY SUCCESSIVE USE OF YEAST STARTERS?

Peter Raspor[1], Nataša Kočar Mlinarič[2]

[1]*Emeritus Professor of Microbiology and Biotechnology, University of Ljubljana, Slovenia*

[2]*Pivovarna Laško Union d.o.o. Pivovarniška ulica 2. SI - 1000 Ljubljana; Slovenia,*

The production of beer includes successive repitchings (consecutive inoculation with the yeast biomass from previous fermentation batch) of a single or mixed *yeast* starter culture. During the beer production process, the yeast is exposed to several stress factors which affects the fermentation kinetics and consequently beer flavor. Pitching, single, two or more beer yeasts into the same batch is a great way to develop unique beer flavor profile. By combining yeast creation of unique yeast profiles is possible. The combination is not only the professional secret, but produces a unique signature flavor that is difficult to reproduce. Another consideration in mixing yeasts together would be matching or complimenting characteristics. Each yeast strain has its own flavors, flocculation and attenuation characteristics. But the strains should complement each other and not have competing qualities. If an incomplete fermentation happens, it represents a waste of fermentable extract and leads to a beer with higher carbohydrate levels, which might lead to a beer with an atypical flavor profile. The challenge of consecutive inoculation with the yeast biomass from previous fermentation batch will be addressed with the practical case of lager yeast *Saccharomyces pastoriaus. The results of* repeatedly used yeast culture effect the utilization dynamics of sugars in the lager beer production will be demonstrated. We monitored lager beer production, where we reused yeast culture *S. pastorianus* for twelve times. The work was done in an industrial scale, with the constant process conditions. The raw materials for the wort production was used from the same batch of malt and we also used the same brewing protocol. Primary and secondary fermentation was held under the same protocol. With the constant parameters we tried to reduced effect of other factors, which could effect the dynamics of sugar utilization from lager wort. We have concluded, that repitched or reused starter culture *S. pastorinaus* has an impact on the dynamics of sugar utilization from classical hopped wort and young beer. The efficacy of consumption or uptake of sugars is slightly higher, when the frequency of repithed brewing yeast culture is higher. It is very important that the yeast culture, which is inoculated into the wort, has a high viability. It is also important that the process parameters are highly monitored. In the end product we have not detected any residues of fermentable sugars, that could effect the quality and flavor profile of end product, lager beer.

MICROPLASTIKA U PIVU – NOVI KONTAMINAT

Kristina Mastanjević[1]
[1]*Prehrambeno-tehnološki fakultet Osijek, F. Kuhača 18, 31 000 Osijek, Croatia*

Mikroplastika u hrani i predmetima vezanim za hranu se istražuje godinama. Međutim, još uvek ne postoji propis koji bi ograničio pojavu hemikalija povezanih sa mikroplastikom ili malih delova plastike u industriji hrane i pića, uključujući pivo. Nedavne prednosti analitičkih metoda pomerile su granice detekcije kako bi se pružilo točnije i preciznije merenje jedinjenja. Pošto su ušteda vremena i novca ključni elementi, prihvatljivo je da je metod jednostavan za korišćenje, jeftin i brz. GC-MS je dokazano precizan i tačan kada je u pitanju detekcija mikroplastičnih hemikalija, kao što su ftalati. Nove tehnike kao što je FT-IR doprinele su otkrivanju novih hemikalija koje potiču od plastičnih materijala koji su u kontaktu tokom proizvodnje i skladištenja piva (naročito PET boca). FTIR se može dopuniti mikroskopskom analizom koja omogućava vizuelnu inspekciju kontaminacije. U svakom slučaju, mikroplastika je štetna hemikalija i može ozbiljno uticati na zdravlje ljudi. Trenutna istraživanja su orijentisana na analizu mikroplastike kao zagađivača životne sredine, hrane i zdravlja.

Ključne reči: pivo, mikroplastika, FT-IT, legislativa

MICROPLASTICS IN BEER - THE EMERGING CONTAMINANTS

Kristina Mastanjević[1]
[1]*Faculty of Food Technology Osijek, F. Kuhača 18, 31 000 Osijek, Croatia*

Microplastics in food and food related items has been investigated for years. However, there is still no regulation that would limit the emergence of microplastic related chemicals or micro-sized bits of plastic in food and beverage industry, including beer. Recent advantages in analytical methods pushed the boundaries of detection to deliver more accurate and precise compound measurement. Because time- and money-savings are the key elements, it is eligible that the method is easy to run, cheap and quick. GC-MS is proven to be precise and accurate when it comes to microplastic chemicals detection, such as phtalates. Novel techniques such as FT-IR have contributed to the revealing of emerging chemicals that originate from plastic materials that are in contact during beer production and storage (especially PET bottles). FTIR can be complemented with microscopic analysis which allows the visual inspection of contamination. In any case, microplastics are harmful chemicals and can affect human health gravely. Current research are oriented toward microplastics analysis as environmental, food and health contaminants.

Key words: beer, microplastics, FT-IR, legislative

PIVARSKI SEKTOR SRBIJE

Snežana Babarogić[1]

[1]*Ministarstvo poljoprivrede, šumarstva i vodoprivrede, Sektor poljopirvredne politike, Odsek za označavanje hrane, šeme kvaliteta i organsku proizvodnju*

Proizvodnja piva je veoma važan privredni segment kako u državama EU tako i u Republici Srbiji. Prihod od proizvodnje piva u Evropi iznosi više od 50 milijardi evra godišnje, od kojih preko 42 milijarde pripada poreskim prihodima. Učinak na ime akcize u 2021. godini u Srbiji je veći od 120 miliona evra na ime plaćene akcize, dok je ukupni učinak preko 280 miliona evra.U pivarskom sektoru Srbije direktno je angažovano oko 2430 zaposlenih što je za oko 10% više u odnosu na 2020 godinu, što sa aspekta broja angažovanih prredstavlja jedan vid oporavka ovog sektora. U 2021. godini proizvedeno je oko 5,5 miliona hektolitara piva ili 3% više u odnosu na 2020. godinu.

Godina 2020 ali i deo 2021. su drastično uticali na pad poslovanja pivarske industrije zbog ograničenja rada ugostiteljskih objekata, organizacije muzičkih i drugih dešavanja i zbog pada realizacije u turističkom sektoru.

Na osnovu podataka dobijenih od proizvođača piva, Republičkog zavoda za statistiku i Upravu carine možemo zaključiti da se sektor pivarstva postepeno oporavlja.

Ključne reči: proizvodnja piva, poslovanje pivarskog sektora u Srbiji na osnovu podataka dobijenih iz Registra proizvođača i uslužnih punioca piva, Republičkog zavoda za statistiku i Uprava carine.

BREWERY SECTOR OF SERBIA

Snežana Babrogić[1]
[1]*Ministry of Agriculture, Forestry and Water Management, Belgrade, Serbia; Department for Food Labelling, Quality Schemes and Organic Prodction*

Beer production is a very important economic segment both in EU countries and in the Republic of Serbia. The income from beer production in Europe amounts to more than 50 billion euros per year, of which over 42 billion belongs to tax revenues. The effect of excise duty in 2021 in Serbia is more than 120 million euros in the name of paid excise duty, while the total effect is over 280 million euros. About 2,430 employees are directly employed in the brewing sector of Serbia, which is about 10% more than in 2020, which in terms of the number of employees is one type of recovery of this sector. In 2021, were produced about 5.5 million hectoliters beer, or 3% more compared to 2020.

The year 2020, but also part of 2021, drastically affected the decline in the business of the brewing industry due to restrictions on the operation of catering facilities, the organization of music and other events, and due to the decline in realization in the tourism sector.

Based on data obtained from beer producers, the Republic Institute of Statistics and the Customs Administration, we can conclude that the brewing sector is gradually recovering.

Key words: beer production, operations of the brewing sector in Serbia based on data obtained from the Register of Beer Producers and Service Bottlers, the Statistical Office of the Republic of Serbia and the Customs Administration.

TRŽIŠNA SITUACIJA PIVARSKE INDUSTRIJE U SLOVAČKOJ

Branislav Dudić[1]

[1]*Comenius University, Faculty of Management, Bratislava, Slovak Republic, e-mail: branislav.dudic@fm.uniba.sk, and Faculty of Economics and Engineering Management in Novi Sad, Republic Serbia.*

e-mail: branislav.dudic@fm.uniba.sk

Slovaci su veliki ljubitelji piva i oduvek im je bilo omiljeno piće. Svake godine se na tržištu pojavljuju nove vrste piva ali i razne manifestacije, koje imaju za cilj promociju piva i tako privlače sve više novih korisnika ili kupaca. U Slovačkoj imamo 4 velike pivare i 64 zanatske ili kraft pivare. Mnoge male pivare su zatvorene između 2020. i 2022. godine. Proizvodnja piva u Slovačkoj se prvenstveno odvija od domaćih sirovina. Što se tiče potrošnje piva u Slovačkoj u 2021 i 2022 godine dolazi do pada zbog pandemiji korone virusa i promenjenim navikama potrošača. Kao rezultat smanjenja potrošnje, možemo smatrati i sve popularnija piva sa raznim ukusima, tzv. radleri ili piva sa nižim sadržajem alkohola. Cilj ovog rada je da prikaže trenutnu situaciju u pivarskoj industriji na teritoriji Republike Slovačke.

Ključne reči: pivarska industrija, tržište, pivo.

MARKET SITUATION OF THE BREWING INDUSTRY IN SLOVAKIA

Branislav Dudić[1]

e-mail: branislav.dudic@fm.uniba.sk

Slovaks are big fans of beer and it has always been their favorite drink. Every year, new types of beer appear on the market, as well as various events, which aim to promote beer and thus attract more and more new users or customers. In Slovakia, we have 4 large breweries and 64 craft or craft breweries. Many small breweries have closed between 2020 and 2022. Beer production in Slovakia primarily takes place from domestic raw materials. As for beer consumption in Slovakia in 2021 and 2022, there will be a decline due to the corona virus pandemic and changed consumer habits. As a result of the reduction in consumption, we can also consider increasingly popular beers with various flavors, the so-called radlers or lower alcohol beers. The aim of this work is to present the current situation in the brewing industry on the territory of the Slovak Republic.

Keywords: brewing industry, market, beer.

PREFERENCIJE POTROŠAČA I POTROŠNJA KRAFT PIVA NA TERITORIJI VOJVODINE

Dubravka Užar[1], Radovan Pejanović[1], Dragana Latković[1]
[1]*Poljoprivredni fakultet, Univerzitet u Novom Sadu*

U poslednjih nekoliko godina došlo je do značajnih promena u industriji proizvodnje piva, odnosno u velikom broju zemalja primetan je značajan rast potražnje za pivom proizvedenim u zanatskim pivarama. Dodatno, pivarska industrija nakon 80tih godina prošlog veka odgovara na preferencije i potražnju potrošača, lansiranjem novih vrsta piva, koja se znatno razlikuju od tradicionalnih. Cilj sprovedenog istraživanja jeste da pruži uvid u stavove i preferencije potrošača u pogledu učestalosti konzumiranja piva, osnovnih parametara koji utiču na potrošnju piva, razloga konzumiranja istog kao i podrške proizvodnji Zrenjaninskog kraft piva. Anketnim istraživanjem sprovedenim na uzorku od 140 slučajno odabranih ispitanika dobijeni su podaci o stavovima i preferencijama potrošača. O značaju i rastu potrošnje kraft piva, govori podatak da ispitanici u uzorku više konzumiraju kraft piva (47,1% ispitanika) u odnosu na obična, ukazujući na prisutstvo pozitivnog mišljenja od strane ispitanika i njihove okoline. Na osnovu istraživanja utvrđeno je da bolji i autentičan ukus predstavlja najznačajniji faktor prilikom kupovine Kraft piva, te se 48% ispitanika opredelilo za ovo obeležje. Rezultati istraživanja pokazuju da postoji interes potrošača za proizvodnjom Zrenjaninskog piva, odnosno velika većina (95%) smatra da u gradu Zrenjaninu treba da se proizvodi Zrenjaninsko pivo prema nekadašnoj tradicionalnoj recepturi. Najznačajniji motiv za kupovinu piva, za većinu ispitanika (46%) jeste preporuka referentnih pojedinaca i grupa, a zatim različiti podsticaji poput poklona (20%) i sniženja cena (20%). Najveći procenat ispitanika (44%) smatra da je jedna od najznačajnijih mera za povećanje potrošnje kraft piva pružanje informacija o kvalitetu i specifičnim karakteristikama putem kanala marketinških komunikacija. Dobijeni rezultati predstavljaju osnovu za kreiranje marketing strategija kompanija, ali i kreatore agrarne i lokalne politike kako bi sagledali stanje, tendencije i potencijalnu tražnju i pružili informacije potrošačima o ponudi kraft piva na tržištu.

Ključne reči: pivo, potrošnja, preferencije, potrošač, Zrenjanin

CONSUMERS' PREFERENCES AND CRAFT BEER CONSUMPTION IN THE TERRITORY OF VOJVODINA PROVINCE

Dubravka Užar[1], Radovan Pejanović[1], Dragana Latković[1]
[1]*Poljoprivredni fakultet, Univerzitet u Novom Sadu*

In the last few years, there have been significant changes in the beer production industry, i.e. a significant growth in demand for beer produced in craft breweries has been noticed in a large number of countries. Additionally, after the 80s of the last century, the brewing industry responds to consumer preferences and demand by launching species of beer, which are significantly different from the traditional ones. The research aims to provide insight into the attitudes and preferences of consumers regarding the frequency of beer consumption, the basic parameters that influence beer consumption, and support for the production of craft beer in city of Zrenjanin. The survey was conducted on 140 randomly selected respondents in order to obtain data on the consumers' attitudes and preferences. The importance and growth of craft beer consumption are indicated by the results that respondents in the sample consume more craft beer (47.1% of respondents) compared to regular beers, indicating the presence of a positive opinion on the part of the respondents and their environment. Based on the research, it was determined that a better and more authentic taste is the most important factor when purchasing craft beer, and 48% of respondents opted for this characteristic. According to the findings of the study, there is consumer interest in the production of Zrenjanin beer, with the vast majority (95%) considering that Zrenjanin beer should be produced in Zrenjanin according to the old traditional recipe. For the majority of respondents (46%), the most important reason for purchasing beer is the suggestion of reference individuals and groups, followed by other incentives such as presents (20%) and price reductions (20%). The majority of respondents (44%) consider that providing information about the quality and specific characteristics of craft beer through marketing communication channels is one of the most important measures to promote consumption. The collected data serve as the foundation for the development of company marketing strategies, as well as agricultural and local policymakers, in order to assess the situation, trends, and potential demand, and to inform consumers about the market's craft beer offerings.

Key words: beer, consumption, preferences, consumer, Zrenjanin city

SENZORNA OCENA RAZLIČITIH SVETSKIH STILOVA PIVA

Boris Gadzov[1], Rob McCaig[1], Mangethe Zwane[1], Dale Smith[1], Katia Jorge[1], Evelyne Canterranne[1], Tina Tian[1], Binod Maitin[1], Saša Despotović [2]

[1]*FlavorActiV Limited, Oxfordshire, Velika Britanija*

[2]*Institut za prehrambenu tehnologiju i biohemiju, Univerzitet u Beogradu - Poljoprivredni fakultet, Beograd – Zemun, Srbija*

Konzistentnost od šarže do šarže, konzistentnost proizvoda i visok kvalitet su od suštinskog značaja za sve proizvođače. Ukus piva nije konstantno isti; stalno se menja i zahteva senzornu i analitičku analizu u svakoj fazi. Kako bi se razumelo kako se može uticati na senzorni profil piva od ključnog značaja je razumevanje različitih faktora koji su neophodni za dobijanje konzistentnog proizvoda. Kako bi se obezbedio visoki kvalitet i stabilnost proizvoda na tržištu, neophodno je sprovesti analiza polu proizvoda i gotovog proizvoda (senzorno i analitički) kao deo dobre proizvođačke prakse. Povezivanje „*fingerprint*-a“ ukusa piva sa podacima o afinitetima potrošača, proizvođačima pruža krucijalne informacije neophodne za obezbeđivanje vodeće pozicije na tržištu. Ovde će biti prikazane uobičajene pozitivne (glavne) i tipične nepoželjne (sporedne) karakteristike u različitim stilovima piva, koje su dobijene deskriptivnom senzornom analizom u 627 različitih pivskih brendova i stilova širom sveta. Svrha ovog rada jeste prikazivanje praktičnih primera iz stvarnog svetu. Rezultati ovog istraživanja mogu se koristiti za unapređenje proizvodnje o tome kako najbolje iskoristiti dobijene senzorne i analitičke podatke, i služeći u otkrivanju pozitivnih i negativnih svojstava piva, pri čemu se mogu sprečiti i zaustaviti problemi tokom i nakon procesa proizvodnje.

Ključne reči: pivo, senzorno ocenjivanje, stilovi, konzistentnost

SENSORY EVALUATION OF DIFFERENT GLOBAL BEER STYLES

Boris Gadzov[1], Rob McCaig[1], Mangethe Zwane[1], Dale Smith[1], Katia Jorge[1], Evelyne Canterranne[1], Tina Tian[1], Binod Maitin[1], Saša Despotović [2]

[1]*FlavorActiV Limited, Oxfordshire, United Kindom*

[2]*Institute for Food Technology and Biochemistry, University of Belgrade - Faculty of Agriculture, Belgrade – Zemun, Serbia*

Batch-to-batch consistency, consistency, and high quality are essential for all producers. The beer flavor is not static; it is constantly changing, requiring human sensory and analytical analysis at each stage. Various factors are critical to delivering a consistently fresh product to understand how the beer sensory profile can be affected. Therefore, aligning pre- with post-production sensory and analytical best practices will ensure high quality and stability across the market. Linking beer flavor fingerprints with consumer preferences data provides compelling information for each producer and supports securing a leading position on the market. This study describes common positive (core) and typical off-flavors (non-core) in different beer styles, detected in descriptive sensory evaluation of 627 different beer brands and styles all around the World. The purpose of this presentation will be to show real-world practical examples. The findings can be used to advise the industry on how to use the best sensory and analytical practices, aiding in detecting positive and negative beer flavor fingerprints and preventing and stopping problems during and post-production.

Keywords: beer, sensory evaluation, styles, consistency

ZNAČAJ HIGIJENSKOG INŽENJERINGA I DIZAJNA OPREME U PROIZVODNJI PIVA

Prof dr Miomir Nikšić[1]

[1]*Katedra za tehnološku mikrobiologiju. Institut za prehrambenu tehnologiju i biohemiju. Poljoprivredni fakultet Univerziteta u Beogradu*

Iako proizvođači i prehrambena preduzeća rade u skladu sa standardima i propisima, godišnje se pojavljuju hiljade bolesti koje se prenose hranom, kao rezultat nehigijenski osmišljene opreme za preradu hrane, procesnih linija ili fabrika. Postoje dva glavna razloga za to: nedostatak praktičnih smernica-vodiča i loša edukacija

Evropsko udruženje za higijenski inžinjering i dizajn (EHEDG) osnovano je 1989. godine kao neprofitno udruženje proizvođača opreme, proizvođača hrane i dijetetskih proizvoda, dobavljača u pehrambenoj industriji, istraživačkih instituta, državnih zdravstvenih i vladinih organizacija. Misija EHEDG udruženja definisana je time da : "EHEDG omogućava proizvodnju bezbedne hrane pružajući smernice za higijenski inžinjering i dizajn ". EHEDG aktivno podržava evropske zakone, što podrazumeva da se rukovanje sa hranom, procesi pripreme i pakovanja hrane obavljaju na higijenski način, koristeći higijenske mašine u higijenskim prostorijma, a prema prehrambenoj, higijenskoj, mašinskoj i direktivi vezanoj za materijale koji su u kontaktu sa hranom.

Proces higijene igra glavnu ulogu u proizvodnji piva visokog kvaliteta.U radu su date neke preporuke i primeri kako unaprediti higijenski dizajn u proizvodnji. Stalno unapredjenje novih i poboljšanje starih materijala, završne obrade (hrapavost i topografija, materijal i dizajn zaptivki, kvalitet i mesto zaptivki, procedure čišćenja (vreme, temperatura i vrsta deterdženta) i dizajn opreme ali i pomoćne opeme kao što su pumpe , ventil i td. Različiti površinski materijali koji se upotrebljavaju u procesu proizvodnje piva razikuju se u njihovoj osetljivosti na formiranje biofilmaova. Na primer PTFE,NBR, Vitron su manje oseetljivi na formiranje biofilmova nego nerdjajuci čelik i EPDM. Neophodno je stalno pratiti interakciju dizajna opreme i načina protoka fluida kroz opremu kao i stalno smanjivati broj mrtvih uglova pri protoku fluida Mali detalji u konstrukciji ili rekonstruisanju proizvodne linije značajno utiču na kvalitet proizvoda. Mikrobiološki osetljiviji proizvod, kao što je pivo, zahteva višu sanitaciju i higijenski dizajn opreme.

Ključne reči: pivo, higijenski inžinjering i dizajn

THE IMPORTANCE OF HYGIENIC ENGINEERING AND DESIGN IN BEER PRODUCTION

Prof. Dr. Miomir Nikšić
Department of Industrial Microbiology. Institute for Food Technology and Biochemistry. Faculty of Agriculture, University of Belgrade

Although manufacturers and food businesses operators operate in accordance with standards and regulations, thousands of foodborne illnesses occur annually as a result of unsanitary designed of food processing equipment, processing lines or whole factories. There are two main reasons for this: lack of practical guidelines and poor education

The European Association for Hygienic Engineering and Design (EHEDG) was founded in 1989 as a non-profit association of equipment manufacturers, food and dietary product manufacturers, food industry suppliers, research institutes, state health and government organizations. The mission of the EHEDG association is defined as: "EHEDG enables the production of safe food by providing guidelines for hygienic engineering and design". EHEDG actively supports European laws, which means that food handling, food preparation and packaging processes are carried out in a hygienic way, using hygienic machines in hygienic rooms, and according to food, hygiene, machinery and directives related to materials in contact with food.

The hygiene process plays a major role in the production of high-quality beer. The paper gives some recommendations and examples of how to improve hygienic design in production. Constant improvement of new and improvement of old materials, finishes (roughness and topography, material and design of seals, quality and location of seals, cleaning procedures (time, temperature and type of detergent) and design of equipment, but also auxiliary equipment such as pumps, valves, etc. Different surface materials used in the beer production process differ in their sensitivity to the formation of biofilms. For example, PTFE, NBR, Vitron are less sensitive to the formation of biofilms than stainless steel and EPDM. It is necessary to constantly monitor the interaction of the equipment design and the way the fluid flows. through the equipment as well as constantly reduce the number of dead corners during fluid flow Small details in the construction or reconstruction of the production line significantly affect the quality of the product Microbiologically sensitive product, such as beer, requires higher sanitation and hygienic equipment design.

Keywords: beer, hygienic engineering and design

CIRKULARNA EKONOMIJA I EVROPSKI ZELENI PLAN U PIVARSKOM SEKTORU

Natalija Velić[1], Goran Šarić[2], Saša Despotović[3], Darko Velić[1], Mario Panjičko[4], Gregor Drago Zupančič[4]

[1]*Sveučilište u Osijeku, Prehrambeno-tehnološki fakultet Osijek, Kuhačeva 18, 31000 Osijek, Hrvatska*

[2]*Veleučilište u Karlovcu, Trg J. J. Strossmayera 9, 47000 Karlovac, Hrvatska*

[3]*Univerzitet u Beogradu, Poljoprivredni fakultet, Nemanjina 6, 11080 Beograd, Srbija*

[4]*Centar za razvoj održivih tehnologija – CROTEH d.o.o., Avenija Dubrovnik 15, 10020 Zagreb, Hrvatska*

Industrija piva i industrija slada, ali i primarna poljoprivredna proizvodnja pivarskih sirovina žitarica i hmelja, imaju značajan utjecaj na okoliš, kako zbog velike potrošnje energije i vode, tako i zbog velike količine proizvodnih ostataka koji nastaju tijekom proizvodnih procesa. Nadalje, pakiranje i transport piva također može doprinijeti negativnom utjecaju na okoliš. Uvođenje održivih praksi u proces proizvodnje piva, poput smanjenja potrošnje energije i vode ili iskorištenja proizvodnih ostataka, može igrati važnu ulogu u europskom kružnom gospodarstvu i pomoći u postizanju ambicioznih ciljeva Europskog zelenog plana. Rad daje pregled nekih mogućnosti kako povećati održivost industrije piva.

Ključne reči: industrija piva, održivost, kružno gospodarstvo, Europski zeleni plan

CIRCULAR ECONOMY AND EUROPEAN GREEN DEAL IN THE BREWING SECTOR

Natalija Velić[1], Goran Šarić[2], Saša Despotović[3], Darko Velić[1], Mario Panjičko[4], Gregor Drago Zupančič[4]

[1]University Osijek, Faculty of Food Technology Osijek, Franje Kuhača 18, Osijek, Croatia

[2]Karlovac University of Applied Sciences, Trg J. J. Strossmayera 9, 47000 Karlovac, Croatia

[3]University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11080 Beograd, Serbia

[4]Centre for the development of Sustainable Technologies Ltd. –CROTEH, Avenija Dbrovnik 15, 10020 Zagreb, Hrvatska

The beer industry and the related malt industry, as well as the primary agricultural production of grains and hops used as raw materials, have a significant impact on the environment, both because of the high consumption of energy and water and because of the large amount of production residues generated during beer production. In addition, the packaging and transportation of beer can also have an additional impact on the environment. Introducing sustainable practices in the brewing process through better management of water, energy and production residues can play an important role in the European circular economy and help to achieve the ambitious goals of the European Green Deal. The paper provides an overview of some possibilities, to make the beer industry more sustainable.

Key words: brewing, sustainable practices, circular economy, Eropean Green Deal

ČULNO ISKUSTVO NASLEĐA: OKVIR ZA KREIRANJE INOVATIVNIH PIVARSKIH PROIZVODA

Hristina Mikić, Dejan Molnar

Rad je posvećen ispitivanju međuzavisnosti između čulnog iskustva nasleđa i unapređenja proizvodnog asortimana i kulture konzumacije piva. U prvom delu rada razmatraju se koncept i dimenzije čulnog iskustva nasleđa i njihova primena u pivarstvu. Potom se diskutuje istorija čulnih iskustva u pivarstvu i istražuje veza između vizuelnog doživljaja, mirisnih praksi i ukusa i identiteta piva na nekoliko inostranih primera. Na kraju rada daju se zaključci o mogućnostima primere čulnog iskustva nasleđa u kreiranju inovativnih pivarskih proizvoda i daju preporuke kako se kroz čulno iskustvo nasleđa može kreirati dodata vrednost prozvodima pivarske industrije.

Ključne reči: čulno iskustvo, pivarstvo, kreativne industrije, konkurentnost, industrijsko nasleđe

INHERITED SENSORY EXPERIENCE: A FRAMEWORK FOR THE DEVELOPMENT OF INNOVATIVE BREWING PRODUCTS

Hristina Mikić, Dejan Molnar

The paper aims to examine the interdependence between the inherited sensory experience, product range improvement, and the culture of beer consumption. The first part of the paper deals with concept and dimensions of the inherited sensory experience and their application in brewing. The history of applying sensory experience in brewing is then discussed and the connection between visual experience, olfactory practices, taste and identity of beer is explored through several examples taken from foreign countries. Finally, the paper contains conclusions about the examples of using sensory experience and its role in the development of innovative brewing products, as well as recommendations on how an added value can be given to brewing products through the use of inherited sensory experience.

Key words: sensory experience, brewing, creative industries, competitiveness, industrial heritage

ZNAČAJ REVIZIJE I RAČUNOVODSTVENIH STANDARDA ZA KRAFT PIVARE

Jelica Eremić-Đođić[1], Vladimir Pejanović[2]
[1]*Institut internih revizora Srbije, Novi Sad*
[2]*Unverzitet u Novom Sadu, Fiakultet tehničkih nauka*

Cilj svakog pravnog lica pa tako i kraft pivara jeste dobit koja se iskazuje u finansijskim izveštajima. Vlasnici, zaposleni, poslovni partneri, poslovne banke, državne ustanove i druga javnost iskazuju veliko interesovanje za njih. Kao zakonski zastupnici odgovaramo za istinitost naših finansijskih izveštaja tvrdnjom da su fer iskazani, objektivni, tačni. Ipak, svesni smo postojanja mogućnosti nenamernih ili skrivenih rizičnih tačaka u njima. U poslovanju kraft pivara, neke od njih mogu biti: obračun porizvodnje (zalihe), obračun amortizacije, opredeljenje prilikom tretiranja troškova popravki i dr. Prilikom obezbeđivanja novčanih sredstava kraft pivare se često obraćaju poslovnim bankama. Tom prilikom se razmatra njihova imovina koja je zbog zemljišta često nerealna, potcenjena. Stoga je za rešenje problema potrebno izabrati određeni standard, primeniti odgovarajuću računovodstvenu politiku.
Sa razvojem nepravilnosti u poslovanju razvijaju se i novi oblici revizije: it revizija, forenzička revizija uvodeći savremenije načine kontrole eliminišući buduće nepravilnosti.Udruženja revizora na svetskom nivou izučavaju detektovane nepravilnosti i propisuju šeme za njih.Upotrebom šema, forenzička revizija otkriva nepravilnosti reflektovane na finansijski izveštaj.Izračunavanjem praga materijalnosti formira se konačni nalaz revizije.Uvažavajući do sada pomenuto, potrebno je na vreme primeniti sistem finansijskog upravljanja i kontrole.Na taj način, značaj revizije i računovodstvenih standarda za kraft pivare je toliko velik da njihovom primenom u poslovanju, pored ispunjavanja zakonskih obaveza oni i dodaju vrednost.

Ključne reči: revizija, računovodstveni standardi, kraft pivare

IMPORTANCE OF AUDIT AND ACCOUNTING STANDARDS FOR CRAFT BREWERIES

Jelica Eremić-Đođić[1], Vladimir Pejanović[2]
[1]*Institute of Internal Auditors of Serbia, Novi Sad*
[2]*University of Novi Sad, Faculty of Technical Sciences*

The goal of every legal entity, including craft breweries, is the profit that is shown in the financial statements. Owners, employees, business partners, commercial banks, state institutions and other public show great interest in them. As legal representatives, we are responsible for the truthfulness of our financial reports by claiming that they are fairly stated, objective, and accurate. However, we are aware of the possibility of unintended or hidden risk points in them. In the craft brewery business, some of them can be: calculation of production (inventory), calculation of depreciation, determination when treating repair costs, etc. When securing funds, craft breweries often turn to commercial banks. On that occasion, their property is considered, which is often unrealistic, undervalued due to the land. Therefore, in order to solve the problem, it is necessary to choose a certain standard, to apply the appropriate accounting policy.

With the development of irregularities in business, new forms of audit are also developing: it audit, forensic audit introducing more modern methods of control, eliminating future irregularities. Associations of auditors at the world level study irregularities that are detected and prescribe schemes for them. By using schemes, forensic audit reveals irregularities reflected in the financial report. By calculating the materiality threshold, the final audit finding is formed. Taking into account what has been mentioned so far, it is necessary to implement a system of financial management and control on time. In this way, the importance of audit and accounting standards for craft breweries is so great that with their application in business, besides meeting legal requirements, they add value as well.

Key words: audit, accounting standards, craft breweries

PRIMENA SAVREMENIH TEHNOLOGIJA U PROIZVODNJI EKSTRAKATA HMELJA

Miloš Radosavljević[1], Aleksandra Cvetanović Kljakić[1], Miha Ocvirk[2], Ksenija Rutnik[2], Izstok Jože Košir[2], Pavle Mašković[3], Branimr Pavlić[1], Nemanja Teslić[4], Marija Radojković[1], Alena Stupar[4]

[1]*Univerzitet u Novom Sadu, Tehnološki fakultet, Bulevar cara Lazara 1, 21000 Novi Sad*

[2]*Slovenački institut za hmeljarstvo i pivarstvo, Cesta Žalskega Tabora 2, 3310 Žalec, Slovenija.*

[3]*Univerzitet u Kragujevcu, Agronomski fakultet u Čačku, Cara Dušana 34, 32102 Čačak*

[4]*Univerzitet u Novom Sadu, Naučni institut za prehrambene tehnolohije, Bulevar cara Lazara 1, 21000 Novi Sad*

Potpuno iskorišćenje sirovina uz poboljšanje senzornih karakterstika finalnog proizvoda su imperativ savremene industrije piva. Prepoznatljive arome piva nastaju kao rezultat finog i suptilnog balansa između brojnih aromatičnih jedinjenja koja potiču od biljnih sirovina. Širok dijapazon savremenih tehnologija nudi mogućnost boljeg iskorišćenja sirovina kako u pogledu sadržaja bioaktivnih principa tako i u pogledu balansa aroma, što vodi ka proširenju palete piva i zadovoljenju najrazličitijih ukusa potrošača. U okviru ovog rada, izođena je ekstrakcija hmelja sorte Styrian wolf primenom različitih ekstrakcionih tehnika sa ciljem izdvajanja polarnih i nepolarnih komponenti hmelja, odnosno polifenolnih i aromatičnih komponenata. U prvom redu, ekstrakcija je izvođena superkritičnim ugljen-dioksidom (55°S, 200 bar), primenom mikrotalasne i ultrazvučne ekstrakcije koristeći 49% etanol kao rastvarač. Pored toga, sa ciljem maksimalnog iskorišćenja sirovine, rafinat zaostao nakon superkritične ekstrakcije je povrgnut ekstrakciji ultrazvukom i mikrotalasima kako bi se zaostala polifenolna jedinjenja izdvojila. Dobijeni ekstrakti su okarakterisani u pogledu biološke aktivnosti i to: antioksidativne (primenom pet različitih testova), mikrobiološke (na panelu od 8 različitih mikobnih sojeva) i citotoksične (koristeći normalnu i kancerogenu ćelijsku liniju). Ostvareni rezultati pokazuju značajno visok nivo biološke aktivnosti dobijenih ekstrakata što pruža mogućnost proizvodnje piva bogatog bioaktivnim materijama bez negativnog uticaja na aromu piva.

Ključne reči: Hmelj, savremene ekstrakcione tehnike, bioaktivna jedinjenja, biološka aktivnost

EMERGING TECHNOLOGIES APLICATION IN THE PRODUCTION OF HOPS EXTRACTS

Miloš Radosavljević[1], Aleksandra Cvetanović Kljakić[1], Miha Ocvirk[2], Iztok Jože Košir[2], Ksenija Rutnik[2], Pavle Mašković[3], Branimir Pavlić[1], Nemanja Teslić[4], Marija Radojković[1], Alena Stupar[4]

[1]*University of Novi Sad, Faculty of Technology, Bulevar cara Lazara 1, 21000 Novi Sad*

[2]*Slovenian Institute of Hop Research and Brewing, Cesta Žalskega Tabora 2, 3310 Žalec, Slovenia*

[3]*University of Kragujevac, Faculty of Agronomy in Čačak, cara Dušana 34, 32102 Čačak*

[4]*University of Novi Sad, Institute of Food Technology, Bulevar cara Lazara 1, 21000 Novi Sad*

Complete utilization of raw materials with enhancement of sensory characteristics of beer is of utmost importance for beer industry. The distinct aroma of beer is a result of very subtle balance of aromatic compounds originating from raw materials. Broad range of emerging technologies offers the possibility of greater utilization of raw materials in aspect of bioactive principles as well as in balancing the beer's aroma, leading to widening the beer selection and satisfaction of various consumers' tastes. The current research is based around the production of hops extracts from *Styrian wolf* variety using various extraction techniques in order to isolate polar and non-polar compounds, i.e. polyphenol and aromatic compound. In the first place, the extraction was performed by application of supercritical CO_2 (at 55℃ and 200 bar), followed by extraction by microwaves and ultrasound using 49% ethanol as solvent. Besides that, in order to maximize the raw material utilization and isolation of remaining polyphenols, the residual after the supercritical CO_2 extraction was exposed to ultrasound and microwave extraction. Obtained extracts were analyzed for their biological activity: antioxidant activity (using five different assays), antimicrobial activity (against 8 different bacterial and fungal strains), and cytotoxicity (applying normal and cancer cell lines). Obtained results suggest remarkably high levels of biological activity of aquired extracts which offer the possibility of production of beer rich in bioactive compound without the negative effect on beer aroma.

Key words: Hops, Emerging extraction technologies, Biolocically active compounds, Biological activity

Acknowledgment – The research is part of a bilateral project "Green extraction techniques for obtaining high-value functional additives for beer production" that is being implemented between the Republic of Serbia and the Republic of Slovenia (Project No. 337-00-21/2020-09/3).

BIOAKTIVNOS SEKUNDARNIH METABOLITA HMELJA: OD TRADICIJE DO PRIMENE

Zora Dajić Stevanović[1], Ivan Šoštarić[1], Stefan Kolašinac[1]
[1]*Univerzitet u Beogradu, Poljoprivredni fakultet, Nemanjina 6, 11080 Zemun, Srbija*

Rod *Humulus* L. (Cannabaceae) prema savremenoj klasifikaciji sadrži sedam dvodomih vrsta, među kojima je hmelj (*Humulus lupulus* L.) široko rasprostranjen i gajen, zbog svojih ženskih cvasti, za potrbe pivarske industrije ali i za dobijanje širokog spectra jedinjenja koja se koriste u farmaceutskoj, prehrambenoj i kozmetičkoj industriji. Danas postoji preko 250 varijeteta gajenog hmelja, koji se, uglavno, razlikuju po svojim fitohemijskim profilima. Mada svi delovi biljke sadrže aktivne supstance, najveći sadržaj se sintetiše u specijalnim smonim sekretornim čelijama na spoljašnjim braktejama ženskih cvasti - šišarica. Glavni smoni metaboliti su prenilovani derivati floroglucinola, alfa- i beta- kiseline, takođe poznate kao humuloni i lupuloni. Uz ove, bioaktivna jedinjenja hmelja su polifenoli, primarni flavonidi, halkoni i katehini, kao i etarska ulja, među kojima dominiraju ciklični seskviterpeni, alfa-humulen i beta-kariofilen, kao i monoterpen mikren. Etnobotanički podatci daju uvid u upotrebu hmelja kod poremećaja sna i varenja, tretman bolova, anksioznosti i povreda kože. Različiti metabolite hmelja su izolovani i opisana su njihove hemijske osobine, metabolički putevi i biološka aktivnost. Izuzetne koristi po zdravlje pokazale su se kod terpenofenola hmelja (gorke kiseline, prenilhalkoni i prenilflavonoidi), posebno kod prevencije tromboze, metaboličkog sindroma, različitih tipova kancera, ublažavanja nedostatka insulina i simptoma menopauze. Sedativni, antidepresivni i anksiolitički efekti dolaze od sposobnoti da se moduliraju GABA CNS receptor ii reguliše cirkadijalni ritam. Najnovija istraživanja su usmerena na 8-prenilnaringenin koji se smatra jednim od najpotentnijih fitoestrogena. S obzirom da se ekstrakti hmelja smatraju niski toksičnim za ljude, na tržištu su prisutni novi farmaceutski i nutriceutski proizvodi zasnovani na ekstraktu hmelja i jedinjenjima hmelja. U poslednje vreme procena kvaliteta različitih ratarskih proizvoda, ekstrakata i jedinjenja sve više se bazira na savremenim spektrskopskim metodama, uključujući Ramanovu spektroskopiju. U našem radu je razmatran tradicionalna i savremena primena metabolita hmelja sa akcentom na njihovu biološku aktivnost.

Ključne reči: etnobotanika, fitohemijski profil, prenilflavonoidi, gorke kiseline, sedativna svojstva

Autori se zahvaljuju na podršci projektu EthnoHERBS koji finansira Evropska Unija u okviru H2020-MSCA-RISE-2018 broj 823973 i projektu R-SPECT finasiran od strane Fonda za nauku Republike Srbije broj 7750160.

BIOACTIVITY OF HOP SECONDARY METABOLITES: FROM TRADITION TO APPLIATION

Zora Dajić Stevanović[1], Ivan Šoštarić[1], Stefan Kolašinac[1]
[1]*University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11080 Zemun, Serbia*

Genus *Humulus* L. (Cannabaceae) comprises seven species of dieceous plants according to the newest taxonomical reviews. Among them, the hops (*Humulus lupulus* L.) is widely cultivated for its female inflorescences used in brewing industry, but also for obtaining a range of plant bioactive molecules for use in pharmaceutical, food and cosmetic industry. Today there are more than 250 cataloged hops varieties, mainly differing in their phytochemical profiles. Although all plant parts contain specific bioactives, the most of the quantity is produced in a special resin secretory glands occurring on outer bracts of the cones. The key resin metabolites are the prenylated phloroglucinol derivatives, the alpha-and beta acids., also known as humulones and lupulones, respectively. The additional hop bioactive components are polyphenols, primarily flavonoids, chalcones and catechins, in addition to essential oil compounds, with predominance of cyclic sesquiterpenes alpha-humulene and beta-caryophyllene, and the monoterpene myrcene. Ethnobotanical data indicate the traditional use of hops for sleeping and gastric disorders, for treatment of pains, anxiety and skin injures. The different hop metabolites were isolated and described for their chemical properties, metabolic transformations and bioactivity. Promising health benefits have been shown particularly for hop terpenophenolics (bitter acids, prenylchalcones, and prenylflavonoids), especially related to prevention of thrombosis, metabolic syndrome and several types of cancer, alleviating insulin resistance, and helping with different some menopausal symptoms. The sedative, antidepressant and anxiolytic effects are attributed to ability of humulones and prenylflavonoids to modulate GABA CNS receptors and to regulate circadian rhythm. The most recent studies targeted the activity of the 8-prenylnaringenin, considered as one of the most potent phytoestrogens currently known. In general, hop extracts exhibit remarkably low toxicity to humans, and therefore novel pharmaceutical and nutraceutical products based on hops extract and hop particular components are currently available on the market. The characterization and the quality of different crop products, extracts and compounds have been recently performed by modern vibrational spectroscopy techniques, including Raman spectroscopy. In our paper, traditional and current application of hops metabolites with highlighting of their bioactivity is further discussed.

Key words: ethnobotany, phytochemical profile, prenylflavonoids, bitter acids, sedative action

Acknowledgement: Authors are grateful for support from Project EthnoHERBS funded by European Union's H2020-MSCA-RISE-2018 under grant agreement No 823973 and Project R-SPECT supported by Science Fund of the Republic of Serbia, grant No 7750160.

UTICAJ EKSTREMNIH METEOROLOŠKIH USLOVA-VISOKIH TEMPERATURA I SUŠE NA PROIZVODNJU HMELJA U VOJVODINI

Jan Kišgeci, Rastislav Struhar

Hmelj je biljka humidne klime sa visokim zahtevima prema klimatskim uslovima. Hmeljarska oblast u Vojvodini se nalazi na južnoj granici optimalnih uslova za gajenje hmelja u Evropi. Dugogodišnje iskustvo svedoči da se ta granica nalazi na 45. paraleli severne geografske širine u Evropi – između Inđije i Stare Pazove. Zbog toga nepoljni uslovi u u Sremu i Bačkoj se češće javljaju nego u drugim hmljarskim oblastima u Evropi. To nalaže da se kod zasnivanja hmeljanika posebna pažnja obrati na odabir sorata koje su manje osetlive na nepovoljne rekstremne ekološke uslove sredine.
Visoke temperature i dugotrajna suša u u leto 2022. godine neminovno nalažu da se ispita uticaj nepovoljnih meteoroloških uslova na prinos i kvalitet kod različitih sorata hmelja, koje se sada gaje i koje se pripremaju za umnožavanje za buće zasnivanje zasada.

Ključne reči: hmelj, klimatski uslovi, Vojvodina

EFFECT OF EXTREME WEATHER CONDITIONS - HIGH TEMPERATURES AND DROUGHT ON HOP PRODUCTION IN VOJVODINA

Jan Kišgeci, Rastislav Struhar

Hop plants are grown in a humid climate, under specific climate conditions. The hop growing area in Vojvodina is located on the southernmost border of the hop growing region in Europe. The long-term hop growing experience verifies the location of this border at the 45° N in Europe, between Inđija and Stara Pazova. For this reason, unfavorable conditions occur in Srem and Bačka more often than in other hop growing areas in Europe, which requires special attention to the choice of cultivars less sensitive to adverse and extreme environmental conditions when establishing hop farms.
High temperatures and long-term drought in the summer of 2022 require examination of the impact of unfavorable weather conditions on the yield and quality of different hop plants, currently cultivated and prepared for multiplication with an aim of future establishment of hop plantations.

Key words: hop, climate conditions, Vojvodina

KVALITATIVNA I KVANTITATIVNA ANALIZA ETARSKOG ULJA DOMAĆIH SORTI HMELJA

Vladimir Sikora[1], Biljana Kiprovski[1], Milica Aćimović[1], Tešević Vele[2]
[1]*Institut za ratarstvo i povrtarstvo Novi Sad, Institut od nacionalnog značaja za Republiku Srbiju*
[2]*Hemijski fakultet Univerzitet u Beogradu*

Kao jedna od najznačajnijih sirovina za proizvodnju piva, šišarice hmelja se kuvaju sa sladovinom kako bi gorke, aromatične i taninske materije prešle iz šišarica u rastvor i dale sladovini svojstven gorak ukus i prijatnu aromu. Dodavanjem hmelja se u značanoj meri određuju parametri kvaliteta piva poput ukusa, biološke stabilnosti i pene.

Domaći sortiment hmelja obuhvata staru, autohtonu sortu Bačka, kao i dve selekcionisane sorte Aroma i Robusta. Pored materija koje određuju pivarske parametre kvaliteta (sadržaj α i β-kiselina, gorkih materija, smola), šišarice domaćih sorti sadrže i etarska ulja – mirisnu, uljanu tečnost koja može da se izoluje različitim tehnikama u laboratorijskim i industrijskim uslovima. Etarsko ulje predstavlja lipofilnu smešu proizvoda sekundarnog metabolizma biljaka, koja se sastoji od više hemijskih jedinjenja izoprenoidne strukture, uključujući i njihove derivate (estre, aldehide, ketone, alkohole, itd.).

Procentualni sadržaj etarskog ulja u domaćem sortimentu hmelja značajno varira, čak i u okviru iste sorte, što je najverovatnije posledica uticaja uslova spoljne sredine, poput lokaliteta, godišnjih klimatskih uslova ili vremena berbe. Prosečni sadržaj etarskog ulja u šišaricama sorte Aroma iznosi 0,32%; kod sorte Bačka 0,60%; dok se kod sorte Robusta kreće u širokom rasponu od 0,06% - 0,77%.

Kvalitativnom GC/MS analizom etarskog ulja iz šišarica hmelja ispitivanih sorti utvrđeno prisustvo oko 30 isparljivih jedinjenja od kojih su najzastupljeniji mircen, humulen i kariofilen. Najveći relativni udeo mircena (63,0%) i humulena (36,8%) se nalazi u etarskom ulju sorte Bačka, a kariofilena (15,5%) u etarskom ulju sorte Robusta. Na osnovu GC/MS analize, najmanji relativni udeo mircena (31,2%) je zabeležen u etarskom ulju sorte Robusta, a kariofilena (9,22%) i humulena (19,5%) u etarskom ulju sorte Bačka.

Na osnovu kvantitativne ^{1}H NMR analize, najveći procentni sadržaj mircena određen je u etarskom ulju sorte Bačka (60,0%), dok je sorta Robusta imala najviši sadržaj humulena (36,1%) i kariofilena (9,0%). Najmanji procentualni sadržaj mircena se nalazi u etarskom ulju sorte Rrobusta (27,4%), humulena u etarskom ulju sorte Aroma (20,3%), a kariofilena u etarskom ulju sorte Bačka (6,1%).

QUALITATIVE AND QUANTITATIVE ANALYSIS OF ESSENTIAL OIL DOMESTIC VARIETIES OF HOPS

Vladimir Sikora[1], Biljana Kiprovski[1], Milica Aćimović[1], Tešević Vele[2]
[1]*Institute Field and Vegetable Crops Novi Sad, National Institute of the Republic of Serbia*
[2]*Faculty of Chemistry, University of Belgrade*

As one of the most important raw materials for beer production, hop cones are boiled with wort so that the bitter, aromatic and tannic substances pass from the cones into the solution and give the wort its characteristic bitter taste and pleasant aroma. The addition of hops significantly determines beer quality parameters such as taste, biological stability and foam.

The domestic assortment of hops includes the old, autochthonous variety Bačka, as well as two selected varieties Aroma and Robusta. In addition to substances that determine brewing quality parameters (content of α and β-acids, bitter substances, resins), pine cones of domestic varieties also contain essential oils - a fragrant, oily liquid that can be isolated using different techniques in laboratory and industrial conditions. Essential oil is a lipophilic mixture of products of the secondary metabolism of plants, which consists of several chemical compounds of the isoprenoid structure, including their derivatives (esters, aldehydes, ketones, alcohols, etc.).

The percentage content of essential oil in the domestic assortment of hops varies significantly, even within the same variety, which is most likely a consequence of the influence of external environmental conditions, such as locality, annual climate conditions or harvest time. The average content of essential oil in cones of the Aroma variety is 0.32%; for Backa variety 0.60%; while for the Robusta variety it ranges widely from 0.06% - 0.77%.

Qualitative GC/MS analysis of the essential oil from the hop cones of the studied varieties revealed the presence of around 30 volatile compounds, the most abundant of which are myrcene, humulene and caryophyllene. The highest relative share of myrcene (63.0%) and humulene (36.8%) is found in the essential oil of the Bačka variety, and caryophyllene (15.5%) in the essential oil of the Robusta variety. Based on GC/MS analysis, the lowest relative share of myrcene (31.2%) was recorded in the essential oil of the Robusta variety, and caryophyllene (9.22%) and humulene (19.5%) in the essential oil of the Bačka variety.

Based on quantitative ^{1}H NMR analysis, the highest percentage content of myrcene was determined in the essential oil of the Bačka variety (60.0%), while the Robusta variety had the highest content of humulene (36.1%) and caryophyllene (9.0%). The lowest percentage content of myrcene is found in the essential oil of the Rrobusta variety (27.4%), humulene in the essential oil of the Aroma variety (20.3%), and caryophyllene in the essential oil of the Bačka variety (6.1%).

ZNAČAJ OSIGURANJA ZA VEĆU PROFITABILNOST PROIZVODNJE HMELJA U SRBIJI

Radović Gordana[1], Pejanović R. Vladimir[2]
[1]*„Dnevnik-Poljoprivrednik“ AD, Novi Sad, Bulevar oslobođenja 127/5*
[2]*Fakultet tehničkih nauka, Univerzitet u Novom Sadu, Novi Sad, Trg Dositeja Obradovića 6.*

Cilj rada je analiza mogućnosti osiguranja zasada hmelja u cilju razvoja i veće profitabilnosti ove vrste poljoprivredne proizvodnje na području Republike Srbije. Autori polaze od činjenice da je značaj osiguranja poljoprivrede u tome što obezbeđuje ekonomsku zaštitu osiguranicima – poljoprivrednim proizvođačima od štetnih dejstava i poremećaja do kojih dolazi nastankom osiguranog slučaja, odnosno ostvarenjem rizika obuhvaćenog osiguranjem. U tu svrhu u radu se analizira ponuda na tržištu osiguranja poljoprivrede u Republici Srbiji, u pogledu mogućnosti osiguranja zasada hmelja sa aspekta pokrića, odnosno osiguranih rizika. Autori daju preporuke u cilju poboljšanja ekonomske zaštite, a time i razvoja i veće profitabilnosti proizvodnje hmelja u Republici Srbiji. U radu se koristi metod analize i sinteze, kao i deskriptivni metod.

Ključne reči: osiguranje poljoprivrede, osigurani rizici, profitabilnost proizvodnje hmelja, Republika Srbija

THE IMPORTANCE OF INSURANCE FOR GREATER PROFITABILITY OF HOP PRODUCTION IN SERBIA

Radović Gordana[1], Pejanović R. Vladimir[2]
[1]*”Dnevnik-Poljoprivrednik” AD, Novi Sad, Bulevar oslobođenja 127/5*
[2]*Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Trg Dositeja Obradovića 6*

The aim of the paper is to analyze the possibility of insuring hop plantations in order to develop and increase the profitability of this type of agricultural production in the territory of the Republic of Serbia. The authors start with the fact that the importance of agricultural insurance is that it provides economic protection to the insured – agricultural producers from harmful effects and disruptions caused by the occurrence of the insured event, that is, the advent of the risk covered by the insurance. For this purpose, the paper analyzes the offer on the agricultural insurance market in the Republic of Serbia, regarding the possibility of insuring hop plantations from the aspect of coverage, i.e. insured risks. The authors provide recommendations aimed at improving economic protection, and thus the development and greater profitability of hop production in the Republic of Serbia. The paper uses the method of analysis and synthesis, as well as the descriptive method.

Key words: agricultural insurance, insured risks, profitability of hop

production, Republic of Serbia.

GENOMICS OF THE LAGER YEAST STRAIN AND ITS USE FOR NEW BREWS

Neža Čadež[1]

[1]*Biotechnical faculty, University in Ljubljana, Jamnikarjeva 101, 1000, Ljubljana, Slovenia*

e-mail: neza.cadez@bf.uni-lj.si

The Lager yeast strain is a spontaneously formed hybrid between the two species - the beer-fermenting *Saccharomyces cerevisiae* and the cold-tolerant species *Saccharomyces eubayanus* recently discovered in Patagonia. Recent advances in genomics have shown that the genome of the lager strain is highly dynamic with 80 chromosomes among which internal rearrangements are frequent. To uncover these genomic changes and correlate them with the physiological responses of the lager yeast strain, we performed a laboratory experiment with 30 serial repitchings of the yeast biomass. Empirically, it has been shown that repitching can be performed six to twelve times, primarily due to phenotypic changes in the yeasts that affect beer quality. To mimic the stressors to which yeasts are exposed during industrial fermentations, we constructed a 50-ml laboratory fermenter system with the high hydrostatic and CO2 pressures of the industrial 20-m high fermenter. After each series of re-fermentations, yeast vitality/viability, degree of flocculation, and volatile aroma production were determined. Phenotypic microarray analyses were performed on the selected repitching cycles which generally showed an increase in fitness after the first cycles and later, after the 15th re-pitching, a decrease followed by fluctuations in fitness. Through genetic analyses of microsatellite regions, we detected genetic heterogeneity in the biomass. Therefore, we sequenced the whole genomes of 22 morphologically distinct clones from nine re-pitchings and mapped them to lager strain WS34/70, which was assembled into chromosomes for reference. By comparing the genetic variants along the time course, we found that the structure of the population is constantly changing and the final result (the beer) is the sum of all these differences between clones. This knowledge is now being used to construct novel beer strains adapted to new substrates for efficient conversion of sugars to ethanol. One such case will also be discussed.

Financial support: The work has been supported by Laško-Union d.d. brewery and Slovenian Research Agency (ARRS L4-8222).

PROIZVODNJA PIVA PRIMENOM NATIVNIH SOJEVA *Hanseniaspora uvarum*

Stojan Mančić[1], Sandra Stamenković Stojanović[1], Miodrag Lazić[1], Bojana Danilović[1], Ivana Karabegović[1]

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

U pivarstvu se tradicionalno koriste kvasci roda *Saccharomyces*, ali u novije vreme u fazi ispitivanja potencijalne primene u pivarstvu su mnogi ne-*Saccharomyces* kvasci. Cilj ovog rada bio je ispitivanje primene nativnih sojeva *Hanseniaspora uvarum*, izolovanih sa površine različitog voća na kvalitet i senzorne karakteristike piva. Sirovine i uslovi fermentacije bili su isti za proizvodnju svih uzoraka piva uz primenu tri različita soja *H. uvarum* (*H. uvarum* AB-1, *H. uvarum* WD-14 i *H. uvarum* WW-2). Pivo dobijeno primenom komercijalnog soja *Saccharomyces cerevisae* SafAle™ US-05 (Fermentis, Francuska) korišćeno je kao kontrolni uzorak. Sekundarna fermentacija obavljena je nakon flaširanja pomoću kvasca *S. cerevisae* Safbrew BE-256 (Fermentis, Francuska). Nakon sekundarne fermentacije izvršena su ispitivanja fizičkohemijskih parametara dobijenih piva. Senzorno ocenjivanje obavljeno je od strane devetočlanog panela, primenom deskriptivne metode bodovanja. Fermentativna sposobnost sojeva *H. uvarum* bila je dovoljna za proizvodnju piva sa standardnim sadržajem alkohola (4,5-5% v/v, sojevi AB-1, i WD-14), kao i za proizvodnju slabo alkoholnih piva (< 2,5% v/v, soj WW-2). Piva dobijena primenom nativnih sojeva *H. uvarum* imala su nižu pH vrednost i veću ukupnu kiselost, u poređenju sa kontrolnim uzorkom, ali su se vrednosti nalazile u zakonski predviđenim granicama. Primenom sojeva *H. uvarum* dobijena su piva sa jačim intenzitetom boje i sličnom koncentracijom fenolnih jedinjenja, u poređenju sa kontrolnim uzorkom. Senzorna analiza je pokazala da sojevi *H. uvarum* poboljšavaju senzorni profil piva, koja su bila okarakterisana bogatim intenzitetom mirisa i ukusa, slatkoće i izrazito istaknutim voćnim karakterom. Uzorak piva dobijen primenom *H. uvarum* WD-14 bio je najbolje ocenjen uzorak, sa najvećim ocenama za intenzitet ukusa, kompleksnost, punoću i opšti utisak u odnosu na sve ostale analizirane uzorke. Dobijeni rezultati ukazuju da se sojevi *H. uvarum* mogu smatrati dobrim kandidatima za poboljšanje senzornog profila piva.

Ključne reči: nativni izolati kvasca, *Hanseniaspora uvarum*, proizvodnja piva, senzorna analiza

PRODUCTION OF BEER USING NATIVE *Hanseniaspora uvarum* STRAINS

Stojan Mančić[1], Sandra Stamenković Stojanović[1], Miodrag Lazić[1], Bojana Danilović[1], Ivana Karabegović[1]

[1]*Faculty of Technology, University of Niš, Bulevar Oslobođenja 124, 16000 Leskovac, Serbia*

Apart from the most commonly used *Saccharomyces* yeast, in recent years many non- *Saccharomyces* yeast are being investigated for their potential use in brewing. This research aimed to investigate the effect of native strains of the yeast *Hanseniaspora uvarum* on beer quality and sensory characteristics. Raw materials and fermentation conditions were the same for the production of all beer samples using three different *H. uvarum* strains (H. uvarum AB-1, *H. uvarum* WD-14 and *H. uvarum* WW-2). Beer obtained by using the commercial strain *Saccharomyces cerevisiae* SafAle™ US-05 (Fermentis, France) was used as a control sample. After bottling, *S. cerevisiae* Safbrew BE-256 (Fermentis, France) yeast was used for secondary fermentation. After the secondary fermentation was finished, the physicochemical characteristics of the beer samples were determined. Sensory evaluation was performed by a nine-member panel, using a descriptive scoring method. Two of the *H. uvarum* strains (AB-1 and WD-14) had a fermentative capacity to produce beer with a standard alcohol content (4.5-5% v/v), while the third one (WW-2) was capable to produce low-alcoholic beer (< 2.5% v/v). Beers produced with all native *H. uvarum* strains had higher total acidity and a lower pH value than the control sample, still with the values being within the legal limits. In comparison to the control sample, the *H. uvarum* strains produced beers with higher color intensity and similar concentrations of phenolic compounds. The sensory evaluation showed that the *H. uvarum* strains enhanced the sensory profile of the beer, which was characterized by a rich intensity of smell and taste, sweetness, and a distinctly fruity character. The beer sample obtained using *H. uvarum* WD-14 had the best scores for the flavor intensity, complexity, fullness and overall impression compared to all other analyzed samples. Generally, obtained results indicate that *H. uvarum* strains can be considered as a good candidates for improving the sensory profile of a beer.

Keywords: native yeast isolates, *Hanseniaspora uvarum*, brew making, sensory analysis

INCIDENCE OF STRICTLY ANAEROBIC BACTERIA IN BREWERY BOTTLING HALLS – RISKS AND SOLUTIONS

Dagmar Matoulková[1], Tomáš Brányik[1]

[1]*Research Institute of Brewing and Malting, Lípová 511/15, 120 00 Prague, Czech Republic*

Strictly anaerobic bacteria found in connection with the brewery bottling halls and beer filling include genera *Pectinatus* and *Megasphaera*. Contamination of beer with these microorganisms is accidental, unpredictable and, in case of a massive occurrence, can be the reason for frequent complaints from the party consumers and thus causes significant financial losses to brewing operations.The presentation gives an overview of some specific features of contamination of beer by strict anaerobes, the incidence of strictly anaerobic bacteria in the brewery bottling halls, and describes the risk of beer contamination and approaches to reduce the risk of spoilage of the final product with these bacteria.

Key words: anaerobic bacteria, beer spoilage, *Pectinatus*, secondary contamination

Acknowledgment – This work was supported by the Ministry of Agriculture of the Czech Republic through the institutional support MZE-RO1918.

PIVSKI TROP: ISPITIVANJE ANTIOKSIDATIVNE AKTIVNOSTI I BIODOSTUPNOSTI POLIFENOLNIH JEDINJENJA IN VITRO

Nevena Ivanović[1], Brižita Đorđević[1]
[1]*Katedra za bromatologiju, Farmaceutski fakultet, Univerzitet u Beogradu*

Pivski trop je glavni nusproizvod proizvodnje piva. Kao izvor proteina, dijetnih vlakna i polifenola može predstavljati dobru polaznu sirovinu za formulaciju novih funkcionalnih proizvoda ili izolaciju bioaktivnih jedinjenja. Cilj ovog rada bio je da se izvrši identifikacija glavnih fenolnih jedinjena prisutnih u različitim uzorcima pivskom tropa, odredi njihova antioksidativna aktivnost, i izvrši procena njihove biodostupnosti u organizmu. Identifikacija i kvantifikacija fenolnih jedinjenja izvršena je primenom tečne hromatografije pod visokim pritiskom (HPLC/DAD/MS). Za određivanje antioksidantne aktivnosti etanolnih ekstrakta pivskog tropa korišćen je *DPPH* test. *In vitro* digestija simulirana je u tri faze, oralnoj, gastričnoj i duodenalnoj. Biodostupnost polifenolnih jedinjenja procenjena je kao odnos antioksidativne aktivnosti određene u uzorcima digestivne tečnosti dobijenih nakon potpune digestije nativnog uzorka pivskog tropa i antioksidativne aktivnosti polaznih ekstrakata pivog tropa. Antioksidativna aktivnost ekstrakata pivskog tropa se značajno razlikovala između različitih vrsta uzoraka i kretala se u rasponu od 3,11-27,14 μgTE/g uzorka. HPLC-DAD-MS/MS analiza utvrdila je prisustvo velikog broja polifenolnih jedinjenja, a polifenolni profil je zavisio od sirovine koja je korišćena za proizvodnju piva. Biodostupnost polifenola za resopciju nakon simulirane digestije *in vitro* razlikovala se između različitih uzoraka pivskog trop i kretala se u rasponu od 20-34%. U zaključku, pivski trop predstavlja značajan izvor polifenola čija biodostupnost za resopciju u organizmu može da dostigne i do 34%, što potvrđuje da je pivski trop vredan nusproizvod koji se može koristiti kao održi izvor bioaktivnih jedinjenja za formulaciju različitih funkcionalnih proizvoda.

Ključne reči: pivski trop, antioksidativna aktivnost, polifenolna jedinjenja, biodostupnost

BREWERY SPENT GRAIN: EVALUATION OF ANTIOXIDATIVE ACTIVITY AND BIOACCESSIBILITY OF POLYPHENOLIC COMPOUNDS IN VITRO

Nevena Ivanović[1], Brižita Đorđević[1]
[1]*Department of Bromatology, Faculty of Pharmacy, University of Belgrade*

Brewery spent grain (BSG) is the main by-product of beer production. As a source of protein, dietary fiber and polyphenols, it can represent a good raw material for the formulation of new functional products or the isolation of bioactive compounds. This work aimed to identify the main phenolic compounds present in different BSG samples, determine their antioxidant activity, and evaluate their bioaccessibility *in vitro*. Identification and quantification of phenolic compounds was performed using high-pressure liquid chromatography (HPLC/DAD/MS). The antioxidant activity of extracts (1:20, 60%v/v ethanol) was evaluated by the DPPH free radical scavenging method. *In vitro* digestion protocol included all three phases, oral, gastric and duodenal. The bioaccessibility of polyphenolic compounds was estimated as the ratio of antioxidant activity determined in digestion fluids (supernatants) obtained after the complete digestion of the native samples and DPPH analysis of the ethanol extracts prepared from BSG samples. The antioxidant activity of BSG extracts differed significantly between different types of samples and ranged from 3.11-27.14 μgTE/g sample. HPLC-DAD-MS/MS analysis determined the presence of a large number of polyphenolic compounds, and the polyphenolic profile depended on the raw material used for beer production. The bioaccessibility of polyphenols after stimulated *in vitro* digestion differed significantly between different BSG samples and ranged from 20-34%. In conclusion, BSG represents a significant source of polyphenols whose bioaccessibility can reach up to 34%, which confirms that BSG is a cheap and valuable by-product that can be used as a sustainable source of bioactive compounds for the formulation of various functional products.

Key words: Brewery spent grain, antioxidative activity, polyphenols, bioaccessibility

Acknowledgment – This work was supported by Cost Action CA18101 SOURDOMICS "SOURDOugh biotechnology network towards novel, healthier, and sustainable food and bIoproCesseS"

MODELING IN BREWING

Vesela Shopska[1], Rositsa Denkova-Kostova[2], **Georgi Kostov[1]**, Viktor Nedovic[3]

[1]Department „Technology of wine and beer", University of Food Technologies, 26 Maritza boulevard, 4002, Plovdiv, Bulgaria

[2]Department „Biochemistry and molecular biology", University of Food Technologies, 26 Maritza boulevard, 4002, Plovdiv, Bulgaria

[3]University of Belgrade, Faculty of Agriculture, Dept. of Food Technology and Biochemistry, Nemanjina 6, 11080 Belgrade – Zemun, Serbia

Brewing is a complex process that has existed for thousands of years, but is still evolving technologically and technically. An important stage of the production development process is the implementation of new technological solutions, and the modeling and optimization of the processes, both at the laboratory and at the industrial level, are of leading importance for this. In the present work, we will consider the methods for modeling and optimization of the main stages of beer production. For this purpose, the parameters that are essential for the main processes in beer production have been considered—development of malt blends, guaranteeing the main brewing characteristics; obtaining wort through the processes of mashing, lautering and boiling of wort; fermentation and maturation of beer. Data on the mathematical dependences used to describe the different stages of beer production (one-factor experiments, modeling of mixtures, experiment planning, description of the kinetics of microbial growth, etc.) and their limits have been presented, and specific research results of various authors teams working in this field have been cited. The independent variables as well as the objective functions for each stage have been defined. Special attention is paid to the modeling of processes with immobilized cells for beer fermentation, with a view to changing the conditions in the immobilization matrix. Some new trends in the field of beer production have been considered and possible approaches for their modeling and optimization have been highlighted. The presentation suggests a generalized approach to describe the main methods of modeling and optimization, which does not depend on the beer type produced. The proposed approaches can be used to model and optimize the production of different beer types, and the conditions for their application should be consistent with the technological regimes used in each case. The approaches for modeling and optimization of the individual processes have been supported by mathematical dependencies most typical for these stages. Some new trends in the field of beer production have been considered and possible approaches for their modeling and optimization have been highlighted.

Key words: brewing, modeling, optimization, scale-up, immobilized cells

This work was supported by the Bulgarian Ministry of Education and Science, under the National Research Programme “Healthy Foods for a Strong Bio-Economy and Quality of Life”, approved by DCM #577/17.08.2018

IMMOBILIZED YEAST – PAST OR FUTURE IN BEER PRODUCTION?

Vesela Shopska[1], Steva Lević[2], Georgi Kostov[1], Viktor Nedovic[2]
[1]*University of Food Technologies-Plovdiv, Department of Wine and beer technology, 26 Maritsa blvrd., 4002 Plovdiv, Bulgaria*
[2]*University of Belgrade, Faculty of Agriculture, Dept. of Food Technology and Biochemistry, Nemanjina 6, 11080 Belgrade – Zemun, Serbia*

Immobilization can be described as localization of intact cells to a specific region of space with the preservation of their catalytic activity. Immobilized yeast cells can be used in beer production in order to reduce the fermentation time and to increase the productivity. First attempts for implementation of immobilized cells in beer production has started in the 70s of XX century and they continued till now. The application of immobilized cells depends on not only from proper choice of carrier and bioreactor, but also on the quality of beer produced. Immobilized cells are successfully applied on industrial scale in beer maturation and in production of low alcohol and non-alcoholic beers. Unfortunately, primary beer fermentation with immobilized cells on industrial scale is an overwhelming task because of changes in yeast metabolism which leads to changes in beer flavour and aroma. Nevertheless, researchers continue their attempts to select proper yeast strain, carrier and method for its immobilization, and bioreactor design to optimize the process on laboratory and pilot scale. The aim of the study is to summarize the knowledge of the methods of yeast cells immobilization, carriers, and bioreactors that are used in beer production and to discuss how they affect the quality of beer produced. This will help us to answer the question if immobilized cells are the past or the future in beer production.

Key words: immobilized yeast, beer fermentation, beer quality

This work was supported by the Bulgarian Ministry of Education and Science, under the National Research Programme "Healthy Foods for a Strong Bio-Economy and Quality of Life", approved by DCM #577/17.08.2018 and by "Development of novel fermentation products enriched with plant and mushroom extracts" Science and Technology Development Programme – Joint Funding of Development and Research Projects of the Republic of Serbia and the People's Republic of China

ENCAPSULATION OF *S. CEREVISIAE* AND *K. MARXIANUS* YEASTS FOR THE OPTIMISATION OF ETHANOL PRODUCTION UNDER UNFAVOURABLE GROWTH CONDITIONS

Ilja Gasan Osojnik Črnivec[1], Mihaela Skrt[1], Nataša Poklar Ulrih[1,2]
[1]*Department of Food Science and Technology, Biotechnical Faculty, University of Ljubljana, Jamnikarjeva 101, SI-1000 Ljubljana, Slovenia*
[2]*The Centre of Excellence for Integrated Approaches in Chemistry and Biology of Proteins (CipKeBiP), Jamova 39, SI-1000, Ljubljana, Slovenia*

Adverse environmental conditions significantly affect efficient fermentation of raw materials. For this reason, the use of microorganisms is limited in several food systems, such as probiotic delivery and mixed-culture fermentation, where stepwise changes and/or metabolites of individual microbial groups can hinder overall growth and production.
In our study, conventional brewer's yeasts (*S. cerevisiae* ZIM 2155) or yeasts offering additional aromatic profiles and/or brewing with mixed cultures (*K. marxianus* ZIM 1868) were entrapped in an optimized (cell, alginate and hardening solution concentration, electrostatic working parameters) Ca-alginate system. Encapsulated cultures were examined for short-term survival and long-term performance under adverse growth conditions (e.g., high gravity brewing, 8-32 °P in growth media and malt extract; as well as acidified conditions in the presence of 10 g/L lactic acid (pH of 4.2)). The use of encapsulated yeasts under these conditions has not yet been investigated. Short-term batch (2-7 days) and semi-batch (4x7 days, 60% batch replacement) fermentations were performed.
Electrostatic manufacturing allowed the preparation of well-defined alginate microbeads (180-260 µm diameter), high cell entrapment (95%) and viability (90%), and uniform distribution of encapsulated cells throughout the hydrogel matrix. Based on the observed uptake and production dynamics, the optimized cross-linked alginate network did not impede the internal passage of substrates and products, providing insight into strategies for long-term or repeated use of microbeads. Under high gravity conditions, encapsulated yeasts maintained longer production activity, resulting in up to 15% higher yields and up to 10% higher final ethanol concentration. Under acidic conditions, the alginate hydrogels exhibited characteristic shrinkage and enabled unparalleled product yields compared to freely suspended cells. Our future work will focus on intraparticle diffusion, crosslinking and particle charge adjustment, and approaches to control cell growth.

Key words: encapsulation, hydrogels, yeast, ethanol production, product inhibition

POTENCIJAL SLUZI ČIJA SEMENKI ZA IMOBILIZACIJU ĆELIJA KVASCA

Andrea Bogavac[1], Steva Lević[1], Viktor Nedović[1]
[1]*Univerzitet u Beogradu-Poljoprivredni fakultet, Nemanjina 6, 11080, Beograd-Zemun*

U poslednjih nekoliko decenija došlo je do značajnih unapređenja procesa proizvodnje piva. Sa aspekta fermentacije rađeno je na uvođenju imobilisanih ćelijskih sistema i novih tipova bioreaktora. Primena imobilisanih ćelija omogućava povećanje brzine odvijanja procesa, usled prisustva velike koncentracije aktivnih ćelija i samim tim povećane produktivnosti bioreaktora. Razvijen je veliki broj kako tehnika imobilizacije ćelija kvasaca, tako i nosača za imobilizaciju. Neki od često korišćenih nosača za imbilizaciju ćelija su alginat, karagenan, celuloza i njeni derivati, čestice poroznog stakla, keramike, komadi (piljevina) drveta i dr. Našim istraživanjima smo želeli da ispitamo i dokažemo potencijal semena čije (*Salvia hispanica*) odnosno njene sluzi, koja je u literaturi opisana kao odličan izvor polisaharidnih gelova sa izuzetnim svojstvima zadržavanja vode, kao novog nosača za imobilizaciju ćelija. Na bazi preliminarnih rezultata, sprej sušena sluz semenki čije je pokazala veoma poželjne karakteristike za primenu u procesima imobilizacije kao nosač. Dodatkom inulina, dobijeni su homogeni uzorci sluz čije/inulin, mikronskih veličina. Analizom dobijenih prahova, dokazana su svojstva dobre rastvorljivosti i protočnosti i niske kohezivnosti. Niske vrednosti aktivnosti vode su pokazale da su prahovi mikrobiološki stabilni proizvodi za različite namene, a posebno kao potencijalni nosači za ćelije mikroorganizama, čime je moguće postići očuvanje vijabilnosti ćelija tokom dužeg vremenskog perioda, njihovu jaču metaboličku aktivnost, veći prinos i kvalitet finalnog proizvoda.

Ključne reči: kvasac, imobilizacija, nosač, čija seme, sluz

Ovaj rad je podržan od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije (evidencioni broj ugovora: 451-03-68/2022-14/200116).

THE POTENTIAL OF CHIA SEED MUCILAGE FOR YEAST CELL IMMOBILISATION

Andrea Bogavac[1], Steva Lević[1], Viktor Nedović[1]
[1]*University of Belgrade - Faculty of Agriculture, Nemanjina 6, 11080, Belgrade-Zemun*

In the last few decades, there have been significant improvements in the beer production process. In the field of fermentation, work has been done in introducing immobilised cell systems and new types of bioreactors. The application of immobilised cells accelerates the process due to the presence of a large concentration of active cells, thus increasing the productivity of the bioreactor. Both a large number of yeast cell immobilisation techniques and immobilisation carriers have been developed. Some commonly used cell immobilisation carries are alginate, carrageenan, cellulose and its derivatives, porous glass particles, ceramics, pieces of wood (sawdust), etc. Our research aimed to examine and prove the potential of chia seeds (*Salvia hispanica*), specifically its mucilage, which has been described in the literature as an excellent source of polysaccharide gels with exceptional water retention properties, as a new carrier for cell immobilisation. Based on preliminary results, the spray-dried chia seed mucilage shows desirable characteristics for use as a carrier in the process of immobilisation. With the addition of inulin, micron-sized homogeneous chia mucilage/inulin samples were obtained. The analysis of obtained powders proved the good properties of solubility and flowability, as well as low cohesiveness. Furthermore, low water activity showed that the powders were microbiologically stable for various purposes, especially as potential carriers for microorganisms, which makes it possible to preserve the viability of cells over a long period of time, as well as to maintain their metabolic activity, higher yield and the quality of the final product.

Key words: yeast, immobilisation, carriers, chia seeds, mucilage

PROIZVODNJA PIVA OBOGAĆENOG BIOAKTIVNIM KOMPONENTAMA CITRUSNOG VOĆA I ZAČINA U ZANATSKIM USLOVIMA

Ana Nikčević Đurđevac[1], Viktor Nedović[2], Saša Despotović[2]

[1]*Univerzitet Donja Gorica, Fakultet za prehrambenu tehnologiju, bezbjednost hrane i ekologiju, Podgorica*

[2] *Univerzitet u Beogradu, Poljoprivredni fakultet*

Zanatsko pivarstvo je poslednje dve decenije potpuno transformisalo globalno tržište piva omogućavajući veći i raznovrsniji asortiman piva. Kao potpuno prirodan i biološki uravnotežen proizvod , zbog svog relativno niskog sadržaja alkohola i prisutnih hranljivih sastojaka predstavlja odličnu osnovu za dobijanje novih proizvoda sa dodatom vrednošću. Dosadašnje studije su pokazale da je kora citrusa vredan nusproizvod. Upotrebom kore citrusa u proizvodnji piva može doći do poboljšanja fizičko-hemijskih karakteristika piva. Pivo se obogaćuje nutritivnim komponentama, bioaktivnim jedinjenjima i dolazi do poboljšanja citrusnih aroma, koje pivu daju osvežavajući karakter. Kora pomorandže i limuna sadrži veće količine vitamina C i polifenola koji pružaju antioksidativna svojstva, kao i eterična ulja, koja su bogat izvor jedinjenja kao što su flavonoidi, terpeni i karoteni. Đumbir je veoma popularan i visoko korišćen začin za korigovanje ukusa i arome, različitih prehrambenih proizvoda. Osim njegove uloge kao začina, poseduje antimikrobna, antiparazitska, antioksidativna, antiinflamatorna, analgetička i antikancerogena svojstva. Prateći zahteve potrošača u pogledu funkcionalnih piva, pivo sa citrusima i đimbirom bi moglo da nađe značajno mesto na tržištu.

Cilj ovoga rada je dobijanje specifičnog piva poboljšanih funkcionalnih svojstava. Važan izvor nutritienata i veliku količinu bioaktivnih jedinjenja sadrže ekstrakti kore pomorandže, kore limuna i đumbira koji djeluju protektivno na ljudski organizam.

Ključne reči: zanatsko pivo, pivo sa citrusima, pivo sa đumbirom

PRODUCTION OF BEER ENRICHED WITH BIOACTIVE COMPONENTS OF CITRUS FRUITS AND SPICES IN CRAFTSMAN CONDITIONS

Ana Nikčević Đurđevac[1], Viktor Nedović[2], Saša Despotović[2]

Craft brewing transformed completely global beer marketplace in the last two decades, enabling larger and more diverse beer assortments. Acting as pure natural and biologically balanced product and due to its low alcohol content and nutrients, it represents an excellent base for creating new added value products. Current studies showed that citrus peel is a valuable by-product. Citrus peel usage can improve the physical-chemical characteristics of beer and its aroma. Orange peel contains a larger portion of vitamin C and polyphenols giving antioxidant effects. In contras, citrus peel contains essential oils that are rich sources of bioactive compounds such as flavonoids, terpenes, and carotene. Ginger is a very popular and highly used spice for taste improvement and aroma. Apart from its spice role, it has therapeutic values such as antimicrobial, antiparasitic, antioxidant, anti-inflammatory, analgesic, and anticancer. Following consumer demands in terms of functional beers, a beer marketplace with citrus and ginger would improve consumers' health in general.

The purpose of this study is to obtain specific beer followed by improved functional characteristics and additional extracts of orange peel, citrus peel and ginger, which represent important source of nutrients, containing huge volume of bioactive compounds that influence human organism in protective way.

Key words: craft beer, beer with citrus, ginger beer

BEER WITH REISHI MUSHROOM

Saša Despotovc, Sonja Veljovic, Mile Veljovic, Simona Jacimovic, Ana Bjekovic, Viktor Nedovic, Anita Klaus
Faculty of Agriculture, University of Belgrade, Belgrade, Serbia
e-mail: sdespot@agrif.bg.ac.rs

Despite the fact that it isn't the oldest alcoholic beverage, beer is unquestionably one of the most widely consumed beverages in existence right now. It has grown in popularity throughout the years, not just as a refreshing beverage but also as a medically essential food. Numerous studies on the health effects of beer have been conducted in recent decades. Beer has been shown in studies to provide health benefits such as lowering the risk of cardiovascular disease, lowering blood cholesterol levels, regulating insulin, preventing osteoporosis and senile dementia, and serving as a source of vitamins, minerals, and anti-oxidants. For centuries, the health benefits and nutritional value of mushrooms have been known. For thousands of years, reishi has been utilized in Far Eastern traditional medicine. It has been done to combine beer with mushrooms to create superior nutritive beverages. Due to its sensory qualities, functional value, bioactive substance content, and anticipated cost price, it may find a niche market among consumers who are not only committed to drinking beer without alcohol but also those who are looking for food stuffs with added value that also possess superior sensory qualities in comparison to standard products.

Keywords: alcohol, beer, reishi, *Ganoderma lucidum*

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (SCIENCE AND TECHNOLOGY DEVELOPMENT PROGRAMME–RESEARCH PROJECTS OF THE REPUBLIC OF SERBIA AND THE PEOPLE'S REPUBLIC OF CHINA, Contract No.451-031206/2021-09)

IN VITRO BIOLOŠKI POTENCIJAL EKSTRAKATA *CRATAEGUS MONOGYNA* L.

Ana Ćirić[1], Marija Ivanov[1], Jovana Petrović[1], Dejan Stojković[1], Marina Soković[1]

[1]*Institut za biološka istraživanja "Siniša Stanković" – Institut od nacionalnog značaja za Republiku Srbiju, Bulevar despota Stefana 142, 11000 Beograd*

U svetu sve više raste potražnja za funkcionalnom fermentisanom hranom koja može da ispuni nutritivne potrebe i pomogne u održavanju uravnotežene ishrane, a istovremeno ima pozitivan uticaj na zdravstveno stanje ljudi. Zdrav izbor mogao bi uključivati i pića sa bioaktivnim jedinjenjima koja se mogu koristiti kao efikasna prevencija za različite bolesti. Stoga je razumevanje potencijalne upotrebe bioaktivnih jedinjenja, njihovog širokog spektra terapeutskih efekata i mogućih mehanizama delovanja od suštinskog značaja za razvoj zdravijih napitaka. Najnovije istraživanje naše grupe proučavalo je bobice gloga *Crataegus monogina* L. Tradicionalno, bobice gloga su se koristile za lečenje srčanih problema u rasponu od nepravilnog rada srca, visokog krvnog pritiska, bolova u grudima, otvrdnuća arterija i srčane insuficijencije. Antioksidantna (antioksidativna snaga koja redukuje gvožđe (FRAP)), antibakterijska, antifungalna i antibiofilm aktivnost etanolnih (70 % v/v) i vodenih ekstrakata procenjeni su *in vitro*. Dobijeni ekstrakti su pokazali obećavajući antimikrobni potencijal (minimalna inhibitorna koncentracija se kretala od 1.00-8.00 mg/mL i minimalna baktericidna/fungicidna koncentracija od 2.00-8.00 mg/mL). S druge strane, njihovo dejstvo na formiranje 48 h bioflma *Candida albicans* nije premašio 50% inhibicije. Takođe, određen je ukupan sadržaja polifenola (TPC) i ukupan sadržaja flavonoida (TFC) ekstrakata spektrofotometrijskim metodama. Rezultati su pokazali da su ovi ekstrakti bogati polifenolnim jedinjenjima (232,25 µg/g za etanolni i 103,92 µg/g za vodeni ekstrakt), ali ne sadrže visok procenat flavonoida. Ekstrakt etanola je pokazao dobar antioksidativni potencijal. Formulacija piva sa bobicama gloga mogla bi da predstavlja novi prirodni izvor polifenola, antioksidativnih i antimikrobnih jedinjenja.

Ključne reči: *Crataegus monogyna*, ekstrakti, biološka aktivnost, pivo

IN VITRO ASSAY OF BIOACTIVE POTENTIAL OF *CRATAEGUS MONOGYNA* L. EXTRACTS

Ana Ćirić[1], Marija Ivanov[1], Jovana Petrović[1], Dejan Stojković[1], Marina Soković[1]

[1]*Institute for Biological Research "Siniša Stanković"- National Institute of Republic of Serbia, University of Belgrade, Blvd. despot Stefan 142, 11000 Belgrade, Serbia*

Consumers' demand for functional fermented food that can fulfill nutritional needs and help maintain a balanced diet while also having a positive impact on one's health status is increasing all over the world. So, healthy choices could include beverages with bioactive compounds which can be used as an effective disease-prevention strategy. Thus, understanding the potential uses of bioactive compounds, the wide range of therapeutic effects, and the possible mechanisms of action is essential for developing healthier beverages. The most recent investigation of our group has studied hawthorn berries *Crataegus monogyna* L. Traditionally, hawthorn berries were used to treat heart problems ranging from irregular heartbeat, high blood pressure, chest pain, hardening of the arteries, and heart failure. Antioxidant (ferric reducing antioxidant power (FRAP)), antibacterial, antifungal, and antibiofilm activities of ethanolic (70 % v/v) and water extracts were evaluated under *in vitro* conditions. Obtaind extracts exhibited promising antimicrobial potential (minimal inhibitory concentration range 1.00-8.00 mg/mL and minimal bactericidal/fungicidal concentration 2.00-8.00 mg/mL) as determined by microdilution assay. On the other hand, their antibiofilm capacity did not exceed 50% inhibition of 48h *Candida albicans* biofilms as observed in crystal violet assay. The extracts were screened in order to determine total polyphenol content (TPC) and total flavonoid content (TFC) by spectrophotometric methods. The results showed these extracts are rich in phenolic compounds (232.25 µg/g for ethanol and 103.92 µg/g for water extracts), but do not contain a high percentage of flavonoids. The ethanol extract exhibited prominent antioxidant potential. The novel formulation of beer with *C. monogyna* could represents a new natural source of polyphenols, antioxidant, antimicrobial substances.

Key words: *Crataegus monogyna*, extracts, biological activity; beer

Acknowledgment – This work has been supported by the Serbian Ministry of Education, Science and Technological Development (Grants: 451-03-68/2022-14/200007 and Strategic projects of scientific and technological cooperation between Republic of Serbia and People's Republic of China)

MAKROMICETE - POTENCIJALNO VREDANI SASTOJCI U PROIZVODNJI PIVA

Sonja Veljović[1], Jovana Vunduk[2], Anita Klaus[3], Saša Despotović[3], Viktor Nedović[3]

[1]*Fakultet za Hotelijerstvo i Turizam, Univerzitet u Kragujevcu, Vrnjačka Banja, Serbija*

[2] *Institut za opštu i fizičku hemiju, Beograd, Serbija;*

[3]*Poljoprivredni fakultet, Univerzitet u Belgradu, Beolgrad, Serbija;*

Pivska industrija trenutno doživljava renesansu zahvaljujući novoj kategoriji kupaca koji cene inovativnost, kvalitetne sirovine i nove ukuse. Stoga, većina malih zanatskih pivara proizvodi piva sa vrhunskim i nekonvencionalnim sastojcima kako bi bila konkurentnija na lokalnom i globalnom tržištu. Pored snažnog i kompleksnijeg ukusa, dodavanjem inovativnih sirovina (npr. pečurke, voće, aromatično bilje) poboljšava se i hranljiva vrednost finalnog proizvoda. Poznate aromatične i nutritivne karakteristike makromiceta svrstavale su ih u potencijalno vredne sirovine za proizvodnju piva. Iako su neka piva od pečuraka komercijalno dostupna, istraživanja o potencijalu upotrebe gljiva u proizvodnji piva su oskudna.. Dosadašnja istraživanja su pokazala da se gljive u proizvodnji piva mogu dodati u jednoj od dve faze: tokom fermentacije ili neposredno pred flaširanje pri čemu je njihova funkcija aromatizovanje. Dve vrste jestivih pečuraka, *Tricholoma matsutake* i *Flammulina velutipes*, mogu se koristiti kao sredstva za fermentaciju jer sadrže enzim, alkohol dehidrogenazu, za transformaciju piruvata u etanol i CO_2. Kao izvor arome, makromicete se mogu dodati u formi praha osušenog plodonosnog tela, ekstrakta ili inkapsulisanog ekstrakta. Osim na aromu, dodatak pečurki se odražava i na druge parametre od značaja za finalni proizvod (sprečavanje kvarenja, produženo vreme skladištenja i bojenje). Takođe, pečurke poboljšavaju funkcionalnost piva jer ispoljavaju biološka svojstva poput antimikrobnog, antioksidativnog, antihipotenzivnog i kardioprotektivnog.

Analizirajući trenutno tržište piva, postojeća piva sa *Ganoderma lucidum, Lentunus edodes, Grifola frondosa, Craterellus cornucopioides, Pleurotus ostreatus, Inonotus obliquus*, vrstama iz roda Lactarius, Morchella i crnim tartufima, odlikuju se odličnim ukusom, teksturom, aromom. Najčešće se koristi *G. lucidum*, a preliminarni rezultati su pokazali da je pivo sa ekstraktom *G. lucidum* okarakterisano kao osvežavajuće sa prijatnom gorčinom. Uzimajući u obzir sve prednosti, može se zaključiti da makromicete imaju veliki potencijal u proizvodnji piva, a tu je još 11000 vrsta koje nisu istražene a mogu biti potencijalni nekonvencionalni sastojci u proizvodnji zanatskog piva. Imajući u vidu da zanatsko pivo ima stabilan dvodecenijski eksponencijalni rast, posebno u SAD i Kini, prostor za nova saznanja i

preporuke je dobrodošao.

Ključne reči: zanatsko pivo, sirovina, makromicete, *Ganoderma lucidum*

Ovaj rad je podržalo Ministarstvo prosvete, nauke i tehnološkog razvoja Republike Srbije (NAUKA I PROGRAM RAZVOJA TEHNOLOGIJE–ISTRAŽIVAČKI PROJEKTI REPULIKE SRBIJE I NARODNE REPUBLIKE KINE, Ugovor br.451-031206/2021-09)

MACROMYCETES - A VALUABLE INGREDIENT IN THE BEER PRODUCTION

Sonja Veljović[1], Jovana Vunduk[2], Anita Klaus[3], Saša Despotović[3], Viktor Nedović[3]

[1]*Faculty of Hotel Management and Tourism, University of Kragujevac, Vrnjačka Banja, Serbia*

[2] *Institute of General and Physical Chemistry, Belgrade, Serbia;*

[3]*Faculty of Agriculture, University of Belgrade, Belgrade, Serbia;*

Brewing industry is going through a renaissance period at the moment mainly due to an emergin class of consumers. This new category appreciates innovation, high-quality raw materials and novel tastes. Thus, the majority of craft breweries are creating beers with premium and unconventional ingredients in order to be more competitive in the local and global markets. Besides a strong and more complex flavor, the addition of novel raw materials (e.g. mushrooms, fruit, aromatic herbs) also improves the nutritive value of the final product. The well-known aromatic and nutritional characteristics of macrofungi classified them as potentially valuable raw materials for producing beers. Although some mushroom beers are commercially available, research on the potential of mushroom use in beer production is scarce. So far, the research showed that mushrooms can be added in one of two ways during fermentation or just before the bottling phase, as a flavoring agent. Two edible mushroom species, *Tricholoma matsutake*, and *Flammulina velutipes*, can be used as fermentation agents since they have enzyme, ,alcohol dehydrogenase which converts pyruvate to ethanol and CO_2. As a flavoring agent, the mushroom can be used in different forms dried fruit body powder, extract, and encapsulated extract. Besides improving flavor, the added mushrooms have additional benefits on other quality parameters of beer (preventing spoiling, prolonged storing time and coloring). Moreover, mushrooms affect the functionality of beer by expressing its numerous biological activities like antimicrobial, antioxidative, hypotensive and cardioprotective.

Analyzing the current beer market, the existing beers with *Ganoderma lucidum, Lentunus edodes, Grifola frondosa, Craterellus cornucopioides, Pleurotus ostreatus, Inonotus obliquus*, species of *Lactarius genus, Morchella*, and black truffles, offer a great variety in aroma, taste, texture, and flavor. The most researched is *G. lucidum*, and preliminary results showed that beer with *G. lucidum* extract was characterized as refreshing with a pleasant bitterness. Taking into count all benefits, it can be concluded that macromycetes have great potential for beer production and 11000 macrofungi species are still waiting to be examined and, thus, can be potential unconventional ingredients in craft beer production. Having in mind that craft beer has a steady two-decade-long exponential growth, especially in the USA and China, the room

for novel findings and recommendations is welcomed.

Key words: craft beer, raw material, macromycetes, *Ganoderma lucidum*,

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (SCIENCE AND TECHNOLOGY DEVELOPMENT PROGRAMME–RESEARCH PROJECTS OF THE REPUBLIC OF SERBIA AND THE PEOPLE'S REPUBLIC OF CHINA, Contract No.451-031206/2021-09)

POTENCIJALNI UTICAJ POLIFENOLA NA RELATIVNU DUŽINU TELOMERA I PREVENCIJU PROCESA STARENJA KOD LJUDI

Gordana Dragović[1], Božana Obradović[1], Saša Despotović[2]
[1]*Univerzitet u Beogradu, Medicinski fakultet*
[2]*Univerzitet u Beogradu, Poljoprivredni fakultet*

Starenje je biološki proces koji se ne odvija jednakom brzinom kod svih ljudi. Pored gena, na proces starenja utiče okolina, način i stilovi života, kao i ishrana. Posledica navedenog višeuzročnog procesa dovodi do činjenice da hronološka starost jedne osobe ne mora odgovarati njegovoj biološkoj starosti. Svrha biomarkera starenja je da odrede biološku dob, te da kod starijeg stanovništva pravovremeno ukažu na mogući invaliditet ili smrtnost. Danas je poznato da se dužina telomera smatra pouzdanim biološkim markerom starenja. Telomere imaju glavnu ulogu u zaštiti strukture hromozoma, one štite krajeve hromozoma od međusobnih fuzija, pa imaju ulogu „brojača deoba“, jer se sa svakom deobom ćelije one skraćuju. Kada telomere dostignu kritičnu dužinu, ćelija ulazi u permanentni zastoj ćelijskog (senescencija), Zaštitom telomera od oštećenja može se sprečiti naglo skraćivanje telomera, kao i odgoditi ulazak ćelije u proces senescencije, te su zato telomere najbitniji regulator ćelijskog starenja.
Starenje, kao i bolesti koje prate proces starenja dovode do oštećenja tkiva, kako na makromolekularnom nivou, tako i na intracelularnom nivou, poput oksidativnog stresa. U poslednjih nekoliko godina u fokusu bazičnih, ali i kliničkih istraživanja su potencijani efekti polifenola iz hrane, ali i polifenola koji ulaze u sastav pojedinih alkoholnih i bezalkoholnih pića, poput piva i vina na prevenciju i razvoj hroničnih bolesti kao što su gojaznost, dijabetes melitus tip 2, kardiovaskularna i cerebrovaskularna oboljenja, kancer, itd. Rezultati pomenutih studija nedvosmisleno ukazuju na povoljan uticaj polifenola na poboljšanje insulinske rezistencije, smanjenje rizika za razvoj dijabetes melitusa tip 2, inflamaciju i oksidativni stres, čime se sprečava prevremeni proces starenja. Konačno, unos polifenola poput EGCG (epigallocatechin-3-gallate), kurkumina, kuercetina, utiču na produženi životni vek određenih vrsta i dužinu telomera, dok upotreba rezveratrola i ganoderme nedvosmisleno pokazuju uticaj na ubrzani proces starenja određenih sistema organa.

Ključne reči: polifenoli, profilaksa, starenje, relativna dužina telomera, ćelijsko starenje.

POTENTIAL IMPACT OF POLIFENOLS ON RELATIVE TELOMERE LENGTH AND PREVENTION OF AGING PROCESS

Gordana Dragović[1], Božana Obradović[1], Saša Despotović[2]
[1]*University of Belgrade, Faculty of Medicine, University of Belgrade*
[2]*University of Belgrade, Faculty of Agriculture*

Aging is a biological process that does not progress at the same rate in every person. Genes, environment, lifestyle and diet influence aging porcess. The consequence of this multifactorial process is that chronological age does not necessarily match biological age. Thus, relative telomere lenght (RTL) is the most accurate marker of aging process. The main role of telomeres is the protection of the chromosome structure. They also protect the chromosome ends from fusions, and since they shorten with every cell division they serve as counters of population doublings. Once the telomeres reach their critical length, the cell enters permanent and irreversible cell cycle arrest called senescence which makes them the most important regulators of the cellular ageing. By protecting the telomeres we could prevent their abrrupt shortening and also postpone the cell senescence. Aging and, particularly, the onset of age-related diseases are associated with tissue dysfunction and macromolecular damage, some of which can be attributed to accumulation of oxidative damage. Recently, growing interest has emerged on the beneficial effects of dietary habits and polifenols intake with either food or alcoholic or non-alcoholic drinks such as beer or wine for the prevention of chronic diseases including obesity, diabetes, and cardiovascular and cerebrovarscular disease, cancer, etc. Several studies collectively suggests that the intake of polyphenols and their major food sources may exert beneficial effects on improving insulin resistance and related diabetes risk factors, such as inflammation and oxidative stress. They are the most abundant antioxidants in the diet, and their intake has been associated with a reduced aging in humans. Numerous lines of evidence suggest that dietary polyphenols such as resveratrol, (−)-epigallocatechin-3-gallate (EGCG), curcumin and quercetin, have the capacity to mitigate age-associated cellular damage induced via metabolic production of reactive oxygen species (ROS), which impacts relative telomere lenght, while resveratrol and ganoderma have an aimpact on preterm aging on several organ szstems within the body.

Keywords: polyphenols, prevention, aging, relative telomere length, cellular senescence.

NESLAĐENA PŠENICA KAO ZAMJENSKA SIROVINA U PROIZVODNJI PIVA

Vinko Krstanović[1], Krešimir Mastanjević[1], Gordana Šimić[2], Kristina Habschied[1]

[1]*Prehrambeno-tehnološki Fakultet Osijek, F. Kuhača 18, 31 000 Osijek, Hrvatska*

[2]*Poljoprivredni institut Osijek, Južno predgrađe 17, HR-31000 Osijek, Hrvatska*

Cilj istraživanja bio je ustanoviti utjecaj zamjene dijela slada neslađenom pšenicom (15% i 30% usipka) na fizikalno-kemijska svojstva sladovine i posljedično na senzorska svojstva gotovog piva. Međutim, senzorska i analiza fizikalno-kemijskih svojstava pokazala je da su čak i pri zamjeni od 30% slada pšenicom osjetilni utjecaji okusa nesladnih dodataka bili prihvatljiviji nego što se očekivalo. Ovo sugerira da bi se korištenje pšenice kao zamjene za dio slada u usipku bilo prihvatljivo i samo iz razloga poboljšanja senzorske prihvatljivosti gotovog piva. Nadalje, primjena pšenice kao zamjene za dio slada u usipku mijenja omjera C:N u sladovini kao i razinu ostalih mikronutrijenata. Također se mijenja odnos unutar proteinske komponente između proteinskih frakcija (proteini male, srednje i velike molekularne mase) i α-amino N, u smislu da dolazi do porasta koncentracije srednjemolekulskih proteina i smanjena koncentracija α-amino N. Pivo proizvedeno sa neslađnom pšenicom je bilo senzorski prihvatljivo kao i pivo proizvedeno iz čistog slada. Iako postoje mnogi drugi čimbenici koje treba uzeti u obzir pri formuliranju piva, kao što je koloidna stabilnost, na primjer, ovo istraživanje sugerira da korištenje neslađne pšenice u eventualnoj kombinaciji s drugim neslađnim žitaricama može pomoći u zadržavanju nekih karakteristika okusa piva od čistog slada, ako je to poželjno. Razumijevanje učinka neslađene pšenice na fizikalno-kemijska svojstva sladovine i posljedično na svojstva gotovog piva može olakšati isplativa i održiva rješenja za njezinu primjenu u pivarstvu.

Ključne reči: neslađene žitarice, neslađena pšenice, pivo

UNMALTED WHEAT AS A SUBSTITUTE RAW MATERIAL IN THE PRODUCTION OF BEER

Vinko Krstanović[1], Krešimir Mastanjević[1], Gordana Šimić[2], Kristina Mastanjević[1]

[1]*Faculty of Food Technology Osijek, F. Kuhača 18, 31 000 Osijek, Croatia*

[2]*Agricultural Institute Osijek, Južno predgrađe 17, HR-31000 Osijek, Croatia*

The aim of the research was to establish if partial replacement of malt with unmalted wheat (15% and 30% addition) would have an influence on the physical-chemical properties of wort and consequently on the sensory properties of the finished beer. However, sensory and physical-chemical analysis showed that even with a 30% substitution of malt with wheat, the sensory impact of the taste of non-malt additives was more acceptable than expected. This suggests that the use of wheat as a substitute for part of the malt in the wort would be acceptable if only for the reason of improving the sensory acceptability of the finished beer. Furthermore, the use of wheat as a substitute for part of the malt in the infusion changes the C:N ratio in the wort as well as the level of other micronutrients. The relationship within protein components between protein fractions (proteins of small, medium and high molecular mass) and α-amino N also changes, in the sense that there is an increase in the concentration of medium molecular proteins and a reduced concentration of α-amino N. Beer produced from umnalted wheat was sensorially acceptable as the beer produced from pure malt. Although there are many other factors to consider when formulating beer, such as colloidal stability, for example, this research suggests that the use of unmalted wheat in eventual combination with other unmalted grains can help retain some of the beer's flavour characteristics from pure malt, if it is desirable. Understanding the effect of unmalted wheat on the physical-chemical properties of the wort and consequently on the properties of the finished beer can facilitate cost-effective and sustainable solutions for application in brewing.

Key words: unmalted cereals, unmalted wheat, beer

PERSPEKTIVA MINI SLADARA U SRBIJI

Ljiljana Brbaklić[1], Jelena Pejin[2], Milana Pribić[2], Tanja Dražić[1], Vladimir Aćin[1], Sanja Mikić[1]

[1]*Institut za ratarstvo i povrtarstvo Novi Sad, Institut od nacionalnog značaja za Republiku Srbiju, Maksima Gorkog 30, 21000 Novi Sad, Srbija*

[2]*Tehnološki fakultet Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Srbija*

e-mail: ljiljana.brbaklic@ifvcns.ns.ac.rs

Pivarski ječam je jedna od najvažnijih sirovina za proizvodnju slada i piva. U Srbiji postoji samo jedna kompanija koja proizvodi slad od relativno malog broja sorti ječma. U poslednjoj deceniji, broj malih zanatskih pivara je u konstantnom porastu, međutim obuhvata svega oko 2% tržišta, odnosno 10 puta manje od evropskog proseka. Pored velikih i srednjih pivara, u Srbiji je do danas registrovano preko 70 malih zanatskih i veliki broj kućnih pivara. Ove male pivare uvoze skoro sve sirovine neophodne za proizvodnju zanatskog piva, samim tim i slad iz zemalja EU. Osim toga, mali broj gajenih sorti na našim poljima dovodi do smanjenja genetičkog diverziteta. Pored evidentne genetičke erozije, ukupna proizvodnja ječma je ugrožena i trenutnom političkom situacijom u Evropi, koja vodi ka globalnom narušavanju u lancu snabdevanja. Takođe, pojava visokih temeperatura i suše kao rezultat klimatskih promena negativno utiču na proizvodnju ječma ostavljajući nesagledive posledice na razvoj, pre svega malih proizvođača i održivost poljoprivrede u celini.

Jedno od mogućih rešenja je osnivanje malih sladara koje bi koristile veći broj lakše dostupnih lokalnih sorti dobrog kvaliteta, čime bi se obezbedio širi genetički diverzitet i zadovoljile različite potrebe i želje potrošača. Na taj način podstakli bi se i mali proizvođači ječma, a zatim i proizvodnja slada koji bi bili prepoznati od strane zanatske pivarske industrije. Institut za ratarstvo i povrtarstvo (IFVCNS) poseduje bogatu kolekciju ječmova sa preko 800 različitih genotipova, među kojima se nalaze stare sorte i populacije kao i moderne sorte namenjene pivarskoj industriji. Ovakav raznovrstan genetički materijal predstavlja odličnu polaznu osnovu za ispitivanje kvaliteta i prinosa starih, zapostavljenih sorti i analizu novog, aktuelnog sortimenta koji je prepoznat od strane proizvođača, ali nije dostupan malim i velikim sistemima u indutriji slada i piva.

Ključne reči: ječam, slad, mini sladare, kvalitet, industrija piva

Rad je deo projekta finansiran od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije, evidencioni broj: 451-03-68/2022-14/ 200032

PERSPECTIVE OF MICRO MALTING IN SERBIA

Ljiljana Brbaklić[1], Jelena Pejin[2], Milana Pribić[2], Tanja Dražić[1], Vladimir Aćin[1], Sanja Mikić[1]

[1]*Institute of Field and Vegetable Crops Novi Sad, National Institute of the Republic of Serbia, Maksima Gorkog 30, 21000 Novi Sad, Serbia*

[2]*Faculty of Technology Novi Sad, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia*

e-mail: ljiljana.brbaklic@ifvcns.ns.ac.rs

Brewing barley is one of the most important raw materials for the production of malt and beer. In Serbia, there is only one company that produces malt from a relatively small number of barley cultivars. In the last decade, the number of small craft breweries in Serbia constantly increases, however, they encompassing only about 2% of the market share, which is 10 times less than the Europe. In addition to large and medium-sized breweries, over 70 small craft breweries and a large number of home breweries have been registered in Serbia to date. These small breweries import almost all raw materials necessary for craft beer production, including malt from EU countries. In addition, cultivation of the relatively small number of cultivars in our fields leads to a decrease in genetic diversity. Apart from the evident genetic erosion, the overall production of barley is threatened by the current political situation in Europe, which leads to a global disruption in the global supply chain. Also, the occurrence of high temperatures and drought as a result of climate change negatively affect the production of barley, provide unexpected consequences on small producers and the sustainability of agriculture in general.

One of the possible solutions is the establishment of micro malting industry that would use a larger number of available good quality local varieties. This would ensure a wider genetic diversity and satisfy the different needs and desires of consumers. Thus, small barley producers would be encouraged to produce barley grain and malt, which would be recognized by the craft brewing industry. The Institute of Field and Vegetable Crops Novi Sad (IFVCNS) has a huge barley collection with over 800 different genotypes, including old varieties and populations as well as modern varieties intended for the brewing industry. This diverse genetic material represents an excellent starting point for testing the quality and yield of those old, neglected varieties and analysing the new, current assortment that is recognized by producers, but not available to small and large systems in the malt and beer industry.

Key words: barley, malt, micro malting, quality, beer industry

This research was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, grant number: 451-03-68/2022-14/200032

PIVSKI TURIZAM U FUNKCIJI RAZVOJA RURALNIH PODRUČJA SRBIJE

Drago Cvijanović[1], Tamara Gajić[2], Dejan Čavić[1]

[1]*Fakultet za hotelijerstvo i turizam u Vrnjačkoj Banji, Univerziteta u Kragujevcu, Vrnjačka Banja, Srbija*

[2]*Geografski institut "Jovan Cvijić", SANU, Beograd, Srbija, Institut za sport, turizam i usluge, Državni univerzitet Južni Ural, Čeljabinsk, 454080, Rusija*

Republika Srbija ima dugu i veoma interesantnu tradiciju u proizvodnji poljoprivredno-prehrambenih proizvoda a samim tim i značajne mogućnosti i spremanju različite hrane i pića, posebno autohtone hrane i pića u ruralnim područjima. Ovo je osnova za razvoj gastronomskog turizma, posebno ako se zna da je glavni motiv putovanja gastronomskih trurista upravo hrana i piće. Gastronomski turisti, spremni su da putuju u najudaljenija mesta na svetu kako bi videli, učestvovali i/ili probali određenu vrstu harne i pića. Pivo se pojavljuje kao važan razlog dolaska turista u pivare ili područja gde se pivare nalaze i/ili pak gde se služi određena vrsta piva. Pivski turizam je deo gastronomskog turizma, i sve više zauzima značajan udeo u turističkoj privredi, posebno zemalja koje su značajni proizvođači i potrošači piva. Motivi posete pivskih turista mogu biti dvojaki. U prvu grupu spadaju turisti kojima je osnovni motiv poseta mestu gde se može probati i piti određena vrsta piva. Dok u drugu grupu spadaju turisti, kojima su neki drugi razlozi u osnovi njihovog putovanja, a rado posećuju mesta gde mogu videti proizvodnju, probati i piti pivo. Srbija ima velike pivare i one male zanatske, tzv. kraft pivare, koje mogu biti povod da domaći i inostrani turisti, koji vole pivo da ih posete. Clj ovog rada je da se sagledaju mogućnosti razvoja pivskog turizma u ruralnim područjima naše zemlje, da se ukažu pravci razvoja pivskog turizma, koristeći iskustva razvijenih zemalja s jedne i zahteva pivskih turista sa druge strane.

Ključne reči: Srbija, pivski turizam, gastronomski turizam, ruralna područja

BEER TOURISM IN THE FUNCTION OF THE DEVELOPMENT OF RURAL AREAS OF SERBIA

Drago Cvijanović[1], Tamara Gajić[2], Dejan Čavić[1]

[1]*Faculty of Hotel Management and Tourism, University of Kragujevac, Vrnjačka Banja, Serbia*

[2]*Geographical Institute „Jovan Cvijic" SANU, Beograd, Srbija institute of sports, tourism and services, South Ural State University, Chelyabinsk 454080, Russia*

The Republic of Serbia has a long and very interesting tradition in the production of agricultural and food products and, therefore, significant opportunities for the preparation of various foods and beverages, especially indigenous food and beverages in rural areas. This is the basis for the development of gastronomic tourism, especially if it is known that the main motive for the travel of gastronomic tourists is precisely food and drink. Gastronomic tourists are ready to travel to the most remote places in the world in order to see, participate and/or try a certain type of food and drink. Beer appears as an important reason for tourists to visit breweries or areas where breweries are located and/or where a certain type of beer is served. Beer tourism is a part of gastronomic tourism, and it is increasingly taking a significant share in the tourism economy, especially in countries that are significant producers and consumers of beer. The motives of beer tourists can be twofold. The first group includes tourists whose main motive is to visit a place where you can taste and drink a certain type of beer. While the second group includes tourists, who have some other reasons behind their trip, and are happy to visit places where they can see production, taste and drink beer. Serbia has large breweries and small craft breweries, so-called. craft breweries, which can be a reason for domestic and foreign tourists who love beer to visit them. The aim of this work is to review the possibilities of beer tourism development in the rural areas of our country, to indicate the directions of beer tourism development, using the experiences of developed countries on the one hand and the demands of beer tourists on the other.

Key words: Serbia, beer tourism, gastronomic tourism, rural areas

IZAZOVI KONTROLE RAMULARIOZNE PEGAVOSTI JEČMA

Radivoje Jevtić[1], Vesna Župunski[1], Ljiljana Brbaklić[1], Vladimir Aćin[1]
[1]*Institut za ratarstvo i povrtarstvo-institut od nacionalnog značaja za Republiku Srbiju*

Ramulariozna pegavost ječma je prvi put preopoznata u Evropi kao ekonomski značajno oboljenje tek 80-ih godina XX veka, iako je opisana u Italiji još 1889. Prouzrokovač ramularioizne pegavosti ječma je gljiva *Ramularia collo-cygni* koja je dobila naziv na osnovu izgleda konidiofora koji podsećaju na vrat labuda. *Ramularia collo- cygni* je opisana kao ekomski značajan patogen još u Novom Zelandu, Argentini i istočnoj i zapadnoj obali Kanade. dovodeći do gubitaka prinosa i do 35 %. *Ramularia collo-cygni* se prvenstveno prenosi semenom, mada sekundarni izvor infekcije mogu činiti i spore koje se šire vazdušnim strujama. *Ramularia collo-cygni* je endofitna gljiva, i u uslovima stresa biljke dobija patogena svojstva produkcijom rubelina (A–E) od čega rubelini B i D dovode do razaranja membrane i nekroze tkiva domaćina. S obzirom da je *Ramularia collo- cygni* prouzrokovač relativno novog oboljenja i da testiranje semena ječma u prometu nije vršeno na njeno prisustvo, postoji rizik širenja ove bolesti na područja u kojima nije bila prisutna. Prvi simptomi ramularaiozne pegaovsti ječma u Srbiji primećeni su u nešto slabijem intenzitetu 2008. i 2009. godine na lokalitetu Rimski Šančevi, dok je prva jača pojava na sortama ozimog ječma zabeležena i opisana od strane Jevtića i sar. (2016) na više lokaliteta u Srbiji proizvodne 2015/2016. Imajući u vidu da pravovremena determinacija, određivanje otpornosti gajenog sortimenta i mere zaštite predstavljaju pravi izazov u kontroli ovog patogena, detaljna istraživanja koja se bave ovim aspektima pokrenuta su i u našoj zemlji. Ispitivanja mogućnosti determinacije *Ramularia collo-cygni* u različitim fenofazama ječma ukazala su da vizuelna determinacija zahteva visok nivo ekspertize ocenjivača. Nepreciznost u određivanju nivoa zaraze klasičnim vizuelnm putem može se javiti usled maskiranja simptoma sa simptoma koje stvaraju drugi patogeni kao što su: *Pyrenophora teres* f.sp. *maculata* (tačkasti tip) ili *Cochliobolus sativus*. Utvrđeno je da je primena molekularnih tehnika neophodan korak u povećanju preciznosti određivanja prisustva ovog patogena, pogotovo u ranim fazama razvoja ječma, kada je i jedina moguća. Dosadašnja istraživanja ukazalia su da je primena fungicidnih tretmana za suzbijanje ramulariozne pegavosti optimalna u fenofazama GS45-49, međutim udeo abitoičkog i biotičkog streasa u konačnim gubicima prinosa tek se moraju ispitati kako bi se ispoštovali principi integralne zaštite i održive proizvodnje ječma.

Ključne reči: *Ramularia collo-cygni,* značaj, fenofaza, suzbijanje

CHALLENGES IN RAMULARIA LEAF SPOT CONTROL

Radivoje Jevtić[1], Vesna Župunski[1], Ljiljana Brbaklić[1], Vladimir Aćin[1]
[1] *Institute of Field and Vegetable Crops Novi Sad, National Institute of the Republic of Serbia*

Ramularia leaf spot of barley was not recognized in Europe as an economically significant disease until the 80s of XX, although the causal agent *Ramularia collo-cygni* was identified as early as 1889 in Italy. The name of *Ramularia collo-cygni* is derived from the special swan neck shape of the conidiophores. *Ramularia collo-cygni* has been described as an economically significant pathogen in New Zealand, Argentina, and Canada causing yield losses of up to 35%. It is primarily considered a seed-borne pathogen, although it could also be transmitted as air-borne conidia. *Ramularia collo-cygni* is known as an endophytic fungus, but under conditions of plant stress, it gets pathogenic properties by producing rubellins (A – E), of which rubellins B and D lead to membrane destruction and host tissue necrosis. Given that *Ramularia collo-cygni* is the causal agent of a relatively new disease, and that testing of seed for the presence of *Ramularia collo-cygni* is not required as a statutory seed test, there is a risk of disease spreading in the areas where it was not present. The first symptoms of Ramularia leaf spot in Serbia were observed in 2008 and 2009 at the locality Rimski šančevi, leading to more prominent occurrences in several locations in Serbia during the 2015/2016 growing season. Bearing in mind that timely identification of the pathogen, testing for barely resistance and decisions on fungicide application is challenging, we addressed all these issues in our investigations. Testing the efficacy of methods for the determination of Ramularia leaf spot in plant tissue in different phenological phases of barley, indicated that *Ramularia collo-cygni*-driven symptoms could be masked by other pathogens such as *Pyrenophora teres* f.sp. *maculata* and *Cochliobolus sativus*. It was also indicated that the application of molecular techniques in the identification of *Ramularia collo-cygni* is a necessary step in increasing the precision of disease determination, especially in the early stages of barley development. Previous investigations have shown that the application of fungicides in the control of Ramularia leaf spot is optimal in the GS45-49 phenological phases, however, the share of abiotic and biotic stress in the final yield losses has yet to be examined in order to comply with the principles of integrated plant protection and sustainable barley production.

Key words: *Ramularia collo-cygni*, significance, fenological phase, control

OSNOVNA OCENA OSOBINA GENOTIPOVA TRITIKALE ZNAČAJNIH ZA PROIZVODNJU SLADA

Milan Mirosavljević[1], Vojislava Momčilović[1], Sanja Mikić[1], Tanja Dražić[1], Ljiljana Brbaklić[1]

[1]*Institut za ratarstvo i povrtarstvo, Novi Sad*

Iako se zanatsko pivo uglavnom pravi od tradicionalnih sastojaka kao što su slad ječma, hmelj, voda i kvasac, ponekad se koriste i netradicionalni sastojci poput drugih žitarica, voća, čokolade, začina i drugog bilja kako bi se dobila spefična prepoznatljivost ukusa. Pored toga, velike pivarske kompanije su fokusirane na smanjenje troškova, zamenjujući ječmeni slad dodacima kao što su kukuruz, pšenica, pirinač ili tritikale. U tom kontekstu, ozimi tritikale je prepoznat kao moguća delimična zamena u proizvodnji sladovine. Međutim, oplemenjivanje tritikalea za proizvodnju slada je komplikovano zbog nedostatka odgovarajuće metodologije koja omogućava brzu i istovremenu ocenu rastvorljivosti proteina i modifikacije ugljenih hidrata. S obzirom da postoje potencijalna tržišta za slad ozimog tritikalea, u Institutu za ratarstvo i povrtarstvo izvršili smo osnovnu karakterizaciju kolekcije ozimog tritikalea prema osnovnim fizičko-hemijskim osobinama zrna kako bismo identifikovali genotipove koji su pogodni za proizvodnju slada i koji se mogu dalje koristiti u oplemenjivanju. Stoga je u ovom istraživanju korišćeno 25 savremenih sorti i linija tritikalea koje su gajene na oglednom polju Instituta za ratarstvo i povrtarstvo, Novi Sad. Ispitivane su osnovne osobine zrna kao što su masa hiljada zrna, sadržaj proteina i krupnoća zrna. Masa hiljada zrna varirala je od 37,2 do 48,4 g, pri čemu je najveća masa zrna zabeležena kod sorti kao što su Odisej, NS Ignjat i nove oplemenjivačke linije NS 6-19. Sadržaj zrna prve klase je kod 15 sorti bio veći od 90%, dok je kod ostalih ispitivanih sorti sadržaj zrna prve klase varirao od 82-90%, što ukazuje na dobar kvalitet zrna sorti tritikale. Sadržaj proteina sorti tritikalea korišćenih u ovoj studiji iznosio je 12,4%, pri čemu je deset genotipova pokazalo sadržaj proteina manji od 11,5%. Dakle, genotipovi tritikalea kao što su NS Paun (11,1%) i NS Trifun (10,9%) su bili u rangu sa preporučenim sadržajem proteina ječma za industriju slada. Prema rezultatima ove analize identifikovane su četiri najperspektivnije sorte tritikalea (Odisej, NS Ignjat, NS Trifun i NS Karnak) za dalju proizvodnju slada i aktivnosti oplemenjivanja. Strateškim ukrštanjem odgovarajućih sorti tritikalea i stvaranjem de novo genetičke varijabilnosti, povećaćemo verovatnoću postizanja kumulativnog delovanja gena za dalje poboljšanje prinosa zrna, kao i svojstava slada, što će dodatno podržati upotrebu tritikalea u proizvodnji slada.

BASIC EVALUATION OF MODERN TRITICALE GENOTYPES TRAITS FOR MALT PRODUCTION

Milan Mirosavljević, Vojislava Momčilović, Sanja Mikić, Tanja Dražić, Ljiljana Brbaklić
Institute of Field and Vegetable Crops, Novi Sad, Serbia

Although craft beer is mostly made from traditional ingredients, such as malted barley, hop, water and yeast, sometimes non-traditional ingredients can be used for distinctiveness, like other cereal grains, fruits, chocolate, spices and other herbs. Moreover, big brewery companies are focused on the cost decrease, replacing barley malt with adjuncts, such as maize, wheat, rice or triticale. In this context, winter triticale has been recognized as a possible partial substitute for malt in wort production. However, triticale breeding for the malt production is difficult due to a lack of appropriate methodology that allows rapid and simultaneous screening of both protein solubilization, as well as carbohydrate modification. Since there is a potential market for winter triticale malt, we carried out basic characterization of winter triticale collection at the Institute of Field and Vegetable Crops according to main grain physicochemical properties to identify genotypes that are suited for malt production and could be further used for malting triticale breeding. Therefore, 25 modern triticale cultivars and lines were used in this study and grown at the experimental field of Institute of Field and Vegetable Crops, Novi Sad. The main grain traits such as thousand grain weight, grain protein content and grain sorting has been determined. Thousand grain weight varied from 37.2 to 48.4 g, where the highest grain weight was recorded in the cultivars Odisej, NS Ignjat and a new breeding line NS 6-19. The content of the first class grain was above 90% in 15 cultivars, while in the rest of studied cultivars the content of the first class grain varied from 82-90%, indicating good grain quality of triticale cultivars. The average protein content of triticale cultivars used in this study was 12.4%, where ten genotypes showed protein content lower than 11.5%. Therefore, triticale genotypes such as NS Paun (11.1%) and NS Trifun (10.9%) were in a range of the recommended barley protein content for malting industry. We identified four the most promising triticale cultivars (Odisej, NS Ignjat, NS Trifun and NS Paun) for further malt production investigation and breeding activities. By strategic crossing of suitable triticale cultivars and creation of *de novo* genetic variability, we will increase the probability of achieving cumulative gene action for further improvement in grain yield, as well as malting traits, that additionally will support triticale usage in malt production.

INTRINSIC CHEMICAL CHANGES IN THE INDUSTRIAL PROCESS OF WORT BOILING

Jasiu P. Lewtak[1,2], Olga de Smidt[2]
[1]*East End Brewery, Bloemfontein, South Africa*
[2]*Central University of Technology, Bloemfontein, South Africa*

Beer is a drink that is obtained by yeast fermentation of sweet wort. The process of wort preparation includes sparging, lautering, boiling and rapid cooling. Before fermentation, the wort is a complex mixture of mostly water, carbohydrates, nitrogen and sulphur compounds, minerals and salt-derived anions. Insightful comprehension of chemical changes that occur during the wort production is of the umost importance for the process control and hence, for the final beer quality. Fate and control of volatile flavour components, protein coagulation, solubilization of hop alpha-acids and rate of colour formation are some of the determinants for a historical beer style assignment. The recent increase in microbreweries number justifies the additional research in a quest of increasing a beer quality, competitiveness on the market and production cost reduction.

Key words: beer wort, brewing technology, boiling

KONTROLA I POTROŠNJA VODE ZA PROIZVODNJU PIVA

Milana Drašković, Danijela M. Jašin, Gordana Ludajić

Voda je jedna od osnovnih sirovina za proizvodnju piva. Sastav vode koja se upotrebljava za proizvodnju sladovine utiče na kvalitet piva. U prirodnoj vodi uvek postoji manja ili veća količina različitih rastvorenih soli. Mineralne materije vode ne utiču toliko neposredno na ukus piva, koliko posredno. Naime, one utiču na enzimatske i hemijske reakcije koloida, do kojih dolazi u toku tehnološkog procesa proizvodnje piva. Kvalitet vode je jedan od najvažnijih faktora koji je potrebno ispuniti da bi se postigao dobar kvalitet piva. U ovom radu analizirani su osnovni pokazatelji kvaliteta vode i njihov uticaj na kvalitet piva. Posebna pažnja usmerena je i na potrošnju vode tokom procesa proizvodnje piva uzimajući u obzir mere uštede, rekuperacije i recirkulacije vode.

Ključne reči: potrošnja vode, kvalitet vode, pivo.

CONTROL AND CONSUMPTION OF WATER FOR THE PRODUCTION OF BEER

Milana Drašković, Danijela M. Jašin, Gordana Ludajić

Water is one of the basic raw materials for beer production. The composition of the water used for the production of wort affects the quality of the beer. In natural water there is always a smaller or larger amount of various dissolved salts. The mineral substances of the water do not directly influence the taste of beer, but indirectly. Namely, they affect the enzymatic and chemical reactions of colloids, which occur during the technological process of beer production. Water quality is one of the most important factors that must be met in order to achieve good beer quality. This paper analyzes the basic indicators of water quality and their influence on the quality of beer. Special attention is also focused on water consumption during the beer production process, taking into account the measures of saving, recovery and recirculation of water.

Key words: water consumption, water quality, beer

PRIMENA MERA ENERGETSKE EFIKASNOSTI U PROIZVODNJI PIVA

Miodrag Kovačević, Matilda Lazić, Eleonora Terečik

Primena mera energetske efikasnosti nameće se kao jedan od glavnih ciljeva u procesnoj prerađivačkoj industriji. Oblasti primene obnovljivih izvora energije (OIE) pored ambicioznih ekonomskih ciljeva imaju i funkciju inženjerske integracije solarnih sistema u industrijske procese. Glavnu prepreku za efikasniju upotrebu OIE predstavljaju visoke cene primene ovih tehnologija i relativno dug period otplativosti investicije. Za primenu OIE u industrijskim sistemima potrebno je dovoljno duboko poznavanje samih industrijskih procesa gde bi obnovljive izvore energije mogli da upotrebimo. Preduzeća koja se bave energetski intenzivnim tehnologijama razvijaju novi koncept za primenu OIE u cilju smanjenja potrošnje energije iz konvencionalnih izvora energije. U pivarskoj industriji se uobičajeno kombinuju mere energetske efikasnosti i primena OIE. Ovaj rad daje pregled neki razvijenih koncepcija uključujući iskustva planiranja i ugradnje sistema OIE u cilju ostvarivanja osnovnih ciljeva održivog razvoja.

Ključne reči: energetska efikasnost, OIE, održivi razvoj.

APPLICATION OF ENERGY EFFICIENCY MEASURES IN BEER PRODUCTION

Miodrag Kovačević, Matilda Lazić, Eleonora Terečik

The implementation of energy efficiency measures is imposed as one of the main goals in the process processing industry. In addition to ambitious economic goals, the areas of application of renewable energy sources (RES) also have the function of engineering integration of solar systems into industrial processes. The main obstacle for a more efficient use of RES is the high cost of applying these technologies and the relatively long period of repayment of the investment. For the application of RES in industrial systems, a deep enough knowledge of the industrial processes where renewable energy sources could be used is required. Companies dealing with energy-intensive technologies are developing a new concept for the application of RES in order to reduce energy consumption from conventional energy sources. In the brewing industry, energy efficiency measures and the application of RES are usually combined. This paper provides an overview of some developed concepts, including the experiences of planning and installation of RES systems in order to achieve the basic goals of sustainable development.

Key words: energy efficiency, RES, sustainable development.

AMABALAŽA ZA PAKOVANJE PIVA

Danijela M. Jašin, Milana Drašković, Milada Novaković

Pivo se tradicionalno pakuje u: staklenu, metalnu i plastičnu ambalažu. Svaka od vrsta ambalaže, mora da zadovolji određene funkcije: zaštitnu, skladišnu i transportnu, upotrebnu, prodajnu i komunikacionu. U ovom radu cilj je objasniti karakteristike piva kao namirnice i zahteve koje je potrebno ispuniti, kako bi se pivo očuvalo što duže nakon pakovanja. Pored toga, opisana je ambalažu koja se koristi za pakovanje piva, njena funkcionalnost i dizajn. Poseban osvrt u radu dat je novim trendovima u pakovanju piva, kao i vrstama ambalažnih materijala koji se primenjuju. Naručito je istaknuta inovativnost i ekološki pristup, kroz sisteme aktivnog i inteligentnog pakovanja, uz primenu ekološki prihvatljive ambalaže.

Ključne reči: pivo, ambalaža, inovacije.

AMBALAGE FOR BEER PACKAGING

Danijela M. Jašin, Milana Drašković, Milada Novaković

Beer is traditional packaged in glass, metal and plastic packaging. All these types of packaging must have various functions: protection, storage and transport, convenience, sale and communication. In this work, the aim was to describe the characteristics of the beer and requirements to be met in order to preserve the beer after packagingas long as possible. In addition, the aim was to describe the package, its functionality and design. A special review in the paper is given to new trends in beer packaging, as well as the types of packaging materials used. Innovation and an ecological approach, through systems of active and intelligent packaging, with the use of environmentally friendly packaging, were highlighted.

Key words: beer, packaging, innovation.