ИЗБОРНОМ ВЕЋУ
ПОЉОПРИВРЕДНОГ ФАКУЛТЕТА
УНИВЕРЗИТЕТА У БЕОГРАДУ

У складу са Законом о науци и истраживањима ("Службени гласник РС" бр. 49/2019) и Правилником о стицању истраживачких и научних звања ("Службени гласник РС" бр. 159/2020 и 14/2023) и на основу одлуке Изборног већа Пољопривредног факултета Универзитета у Београду бр. 400/5-8, 27.02.2025. године именовани смо у Комисију за спровођење поступка стицања звања, подношење извештаја и оцене научноистраживачког рада кандидаткиње Ане Тодоровић, мастер инжењера технологије, за избор у звање истраживач сарадник у области биотехничких наука, грана – прехрамбено инжењерство, научна дисциплина – прехрамбена биотехнологија, ужа научна дисциплина – биохемијско инжењерство.
На основу увида у достављену документацију, Комисија у саставу: др Виктор Недовић, редовни професор, Пољопривредног факултета Универзитета у Београду, др Стева М. Левић, ванредни професор Пољопривредног факултета Универзитета у Београду и др Верица Ђорђевић, доцент Технолошко-металуршког факултета у Београду, подноси следећи:

ИЗВЕШТАЈ

Биографски подаци

Ана (Борисав) Тодоровић, рођена је 04.04.1998. године у Београду, Република Србија. Основну и средњу школу (Прва београдска гимназија, природно-математички смер, и СМШ „Др Војислав Вучковић", одсек клавир) завршила је у Београду. Основне академске студије на Пољопривредном факултету Универзитета у Београду, смер Прехрамбена технологија, модул Технологија конзервисања и врења, уписала је 2016. године, а завршила 2020. године са просечном оценом 9,75 и оценом 10 на дипломском испиту. Мастер академске студије уписала је 2020. године на истом факултету, смер Прехрамбена технологија, модул Хемија и биохемија хране, а завршила 2021. године са просечном оценом 10,00 и одбрањеним мастер радом на тему „Карактеризација инкапсулата екстракта европске боровнице (*Vaccinium myrtillus* L.)", такође са оценом 10. Докторске академске студије на Пољопривредном факултету, смер Прехрамбена технологија, уписала је 2021. године.

За време основних и мастер студија била је стипендиста Министарства науке, технолошког развоја и иновација, а од 2022. године ангажована је на Пољопривредном факултету Универзитета у Београду као истраживач приправник на Катедри за хемију и биохемију у оквиру уговора о реализацији и финансирању научно-истраживачког рада између Пољопривредног факултета у Београду и Министарства науке, технолошког развоја и иновација Републике Србије (евиденциони број уговора за 2025. годину: 451-03-137/2025-03/200116).

Веће научних области биотехничких наука је одлуком број 61206-67/2-25 дало сагласност на одлуку Наставно-научног већа Пољопривредног факултета Универзитета у Београду о прихватању теме докторске дисертације кандидаткиње, под називом: „Екстракција антоцијана из тропа дивље боровнице (*Vaccinium*

myrtillus L.) применом дубоких еутектичких растварача и инкапсулација добијених екстраката у полимерне честице и филмове“ (Прилог 1).

Током досадашњег рада на факултету са својим колегама је објавила један научни рад и остварила учешће на различитим међународним конференцијама и стручним усавршавањима. У 2022. години је са својим тимом освојила прво место на такмичењу „Challenge Labs 2022“ усмереном ка решавању изазова из различитих области привреде, а финансираном од стране компаније Делта Аграр и организације *EIT food*. У више наврата је помагала на свечаностима и у промоцији факултета и била је члан организационог одбора националног такмичења Екотрофелија Србија 2023.

Као учесник *CEEPUS* програма мобилности студената (фондација *Tempus*) 2021. године обавила је једномесечни студијски боравак на Биотехничком факултету Универзитета у Љубљани, у оквиру којег је радила истраживања за свој мастер рад. Студијски боравак у Љубљани у оквиру истог програма реализовала је и 2024. године, када је у периоду од априла до јула изводила експерименте за своју дисертацију на Националном хемијском институту, Институту за целулозу и папир, и Биотехничком факултету.

Поред енглеског (ниво C1 – *APTIS General Test*), служи се и италијанским и немачким језиком (ниво B1 – *Deutsches Sprachdiplom – DSD*).

Научноистраживачки рад

Кандидаткиња Ана Тодоровић је до сада показала велику склоност ка научноистраживачком раду, са нагласком на екстракцију и инкапсулацију полифенолних једињења, развој функционалних материјала за паковање и детекцију кварења хране, као и искоришћење нуспроизвода прехрамбене индустрије. Ангажована је у Централној лабораторији Катедре за конзервисање и врење Пољопривредног факултета Универзитета у Београду, где ради на изради своје докторске дисертације и са својим колегама спроводи истраживања из горенаведених области.

Са својим колегама из Србије и Словеније објавила је један научни у категорији М22 и пет саопштења на међународним конференцијама (М34) (Прилог 2).

Закључак и предлог

На основу поднете документације и анализе научноистраживачког и стручног рада истраживача приправника Ане Тодоровић, мастер инжењера технологије, Комисија закључује да је кандидаткиња постигла запажен успех у научном раду. Резултати, усвајање метода научноистраживачког рада, као и залагање и ентузијазам у погледу научног напредовања квалификују је за избор у више истраживачко звање. Оваквим приступом она се развија у перспективног научног радника из области прехрамбене технологије.

Комисија је јединствена у оцени и закључку да истраживач приправник **Ана Тодоровић**, мастер инжењер технологије, испуњава све потребне услове дефинисане Законом о науци и истраживањима (“Службени гласник РС” бр. 49/2019) и Правилником о стицању истраживачких и научних звања (“Службени гласник РС” бр. 159/2020 и 14/2023) и у складу са тим предлаже Изборном већу и Декану Пољопривредног факултета Универзитета у Београду да Ану Тодоровић, мастер инжењера технологије, изабере у звање **истраживач сарадник** у области биотехничких наука, грана − прехрамбено инжењерство, научна дисциплина − прехрамбена биотехнологија, ужа научна дисциплина − биохемијско инжењерство.

Београд – Земун
Дана 28.02.2025. год.

ЧЛАНОВИ КОМИСИЈЕ

_____
др Виктор Недовић, редовни професор
Универзитет у Београду – Пољопривредни факултет
(ужа научна област: Биохемија)

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др Стева М. Левић, ванредни професор
Универзитет у Београду – Пољопривредни факултет
(ужа научна област: Биохемија)

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др Верица Ђорђевић, доцент
Универзитет у Београду – Технолошко-металуршки факултет
(ужа научна област: Хемијско инжењерство)

Прилог 1.

УНИВЕРЗИТЕТ У БЕОГРАДУ

Адреса: Студентски трг 1, 11000 Београд, Република Србија
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ВЕЋЕ НАУЧНИХ ОБЛАСТИ
БИОТЕХНИЧКИХ НАУКА

Београд, 21. јануар 2025. године
02-08 Број: 61206-67/2-25
МЦ

На основу члана 48 став 5 тачка 3 Статута Универзитета у Београду („Гласник Универзитета у Београду", бр. 201/18, 207/19, 213/20, 214/20, 217/20, 230/21, 232/22, 233/22, 236/22, 241/22, 243/22, 244/23, 245/23, 247/23, 251/23 и 258/24) и члана 32 Правилника о докторским студијама на Универзитету у Београду („Гласник Универзитета у Београду", бр. 191/2016, 212/2019, 215/2020, 217/2020, 228/21, 230/21 и 241/22), а на захтев Пољопривредног факултета, бр. 32/3-5.1. од 25. децембра 2024. године, Веће научних области биотехничких наука, на електронској седници одржаној 21. јануара 2025. године, донело је

О Д Л У К У

ДАЈЕ СЕ САГЛАСНОСТ на одлуку Наставно-научног већа Пољопривредног факултета о прихватању теме докторске дисертације АНЕ ТОДОРОВИЋ, под називом: „Екстракција антоцијана из тропа дивље боровнице (*Vaccinium myrtillus* L.) применом дубоких еутектичких растварача и инкапсулација добијених екстраката у полимерне честице и филмове" и одређивању проф. др Виктора Недовића и проф. др Стеве Левића за менторе.

П Р Е Д С Е Д Н И Ц А В Е Ћ А
проф. др Мирјана Оцокољић

Доставити:
- Факултету
- архиви Универзитета

Прилог 2. Списак саопштених и објављених научних и стручних радова кандидаткиње

Рад у истакнутом међународном часопису (M22=5):

1. **Todorović, A.**, Šturm, L., Salević-Jelić, A., Lević, S., Osojnik Črnivec, I. G., Prislan, I., Skrt, M., Bjeković, A., Poklar Ulrih, N., Nedović, V. (2022): Encapsulation of Bilberry Extract with Maltodextrin and Gum Arabic by Freeze-Drying: Formulation, Characterisation, and Storage Stability. Processes 10(10): 1991. https://doi.org/10.3390/pr10101991

Саопштење са међународног скупа штампано у изводу (M34=0,5)

1. **Todorović, A.**, Salević-Jelić, A., Milinčić, D., Lević, S., Pešić, M., Nedović, V. (2022): Encapsulation of Polyphenols – Tehniques and Applications in Food Products. 2nd International Conference on Advanced Production and Processing, October 20–22, Novi Sad, Serbia. Book of Abstracts, pp. 97. ISBN 978-86-6253-160-5.

2. **Todorović, A.**, Lević, S., Nedović, V. (2023): Utilization of Spent Brewer's Yeast for Encapsulation of Food Bioactives. VI Scientific-expert symposium with international participation: "Beer, brewing raw materials and equipment", October 25–27, Zrenjanin, Serbia. Book of Abstracts, pp. 28–29. ISBN 978-86-80417-93-6.

3. **Todorović, A.**, Bajčetić, N., Bundalo, J., Lević, S., Mirković, M., Nedović, V. (2023): Plasmolyzed Yeast Cells as Potential Wall Material for Probiotic Bacteria. International Conference on Biochemical Engineering and Biotechnology for Young Scientists ICBEB-YS, December 7-8, Belgrade, Serbia.
https://aspace.agrif.bg.ac.rs/handle/123456789/6716

4. **Todorović, A.**, Sežun, M., Kapun, T., Vicente, F., Osojnik Črnivec, I. G., Lević, S., Salević-Jelić, A., Nedović, V. (2024): Bilberry Pomace Powder and Ethanolic Extract as Active Paper Colourants: Properties and Colour Stability. 5th International Congress "Food Technology, Quality and Safety – FoodTech 2024", October 16–18, Novi Sad, Serbia. Book of Abstracts, pp. 290. ISBN 978-86-7994-063-6.

5. Belošević, S., Marjanović, S., Marković, J., **Todorović, A.**, Lević, S., Salević-Jelić, A., Stanković, M., Marković, Z., Nedović, V. (2024): Aquaponic System in the Cultivation of Microgreens and Sprouts: A Review. Aquaponic System in the Cultivation of Microgreens and Sprouts: A Review. SimTerm 2024 – 21st International Conference on Thermal Science and Engineering of Serbia, October 22–25, Niš, Serbia. Book of Abstracts, pp. 52. ISBN 978-86-6055-191-9.

Прилог 3.

processes

MDPI

Article

Encapsulation of Bilberry Extract with Maltodextrin and Gum Arabic by Freeze-Drying: Formulation, Characterisation, and Storage Stability

Ana Todorović [1], Luka Šturm [2], Ana Salević-Jelić [1], Steva Lević [1], Ilja Gasan Osojnik Črnivec [2], Iztok Prislan [2], Mihaela Skrt [2], Ana Bjeković [1], Nataša Poklar Ulrih [2,*] and Viktor Nedović [1,*]

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Abstract: Anthocyanins are polyphenolic plant pigments associated with antioxidant and health-promoting properties. However, their application in the food industry is limited due to their poor stability. The purpose of this study was to encapsulate anthocyanin-rich bilberry (*Vaccinium myrtillus* L.) extract by freeze-drying and to investigate the effects of different wall materials and extract contents on the physicochemical and bioactive properties of the obtained encapsulates. Ethanolic bilberry extract was encapsulated with the use of maltodextrin (16.5–19.5 DE) (MD), gum Arabic (GA), and their combination in a 1:1 *w/w* ratio (MIX). Bilberry solids to wall material ratios were examined at 20:80, 30:70, and 40:60. All encapsulates showed an attractive red colour and low water activity values ($a_w \leq 0.3$) that indicated a low risk of microbial spoilage. In general, the biggest losses of total phenolic compounds and anthocyanins during three-week storage in the dark and at room temperature (20 ± 2 °C) were detected in the case of encapsulates with a higher content of bilberry extract (MIX30 and MIX40, and GA30 and GA40, respectively). The use of maltodextrin provided the best protection to bilberry anthocyanins during forced storage. Overall, the obtained encapsulates show suitable potential for the development of food products with added nutritional benefits.

Keywords: encapsulation; bilberry; polyphenols; anthocyanins; freeze-drying; maltodextrin; gum Arabic; food colourants

check for updates

Citation: Todorović, A.; Šturm, L.; Salević-Jelić, A.; Lević, S.; Osojnik Črnivec, I.G.; Prislan, I.; Skrt, M.; Bjeković, A.; Poklar Ulrih, N.; Nedović, V. Encapsulation of Bilberry Extract with Maltodextrin and Gum Arabic by Freeze-Drying: Formulation, Characterisation, and Storage Stability. *Processes* **2022**, *10*, 1991. https://doi.org/10.3390/pr10101991

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1. Introduction

Over the past decades, there has been a growing demand for food products that not only fulfil basic nutritional demands but also provide functional benefits to consumers. Food that, apart from providing necessary nutrients, prevents or reduces the consequences of nutrition-related diseases and increases the physical and mental well-being of consumers is commonly known as functional food [1].

Polyphenols are secondary plant metabolites associated with many health-promoting benefits, mainly because of their antioxidant, anti-inflammatory, and antimicrobial properties [2]. In addition to their biological activities, anthocyanins, a class of polyphenols, are natural pigments responsible for the red, blue, and purple colour of various fruits, vegetables, and flowers [3]. When consumed at normal dietary intake levels, anthocyanins have been shown to have no negative effects on consumers' health [4]. This makes them a promising alternative to artificial food dyes, which have been linked to allergic reactions and neurobehavioural effects in children [5,6].

European blueberry (*Vaccinium myrtillus* L.), also known as bilberry, is a deciduous shrub from the Ericaceae family. It is native to northern and central Europe, but is also found in some parts of North America and Asia [7]. Bilberries are rich in anthocyanins,

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ENCAPSULATION OF POLYPHENOLS - TECHNIQUES AND APPLICATIONS IN FOOD PRODUCTS

Ana Todorović, Ana Salević-Jelić, Danijel Milinčić, Steva Lević, Mirjana Pešić, Viktor Nedović

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Over the past decades, polyphenolic compounds have received a lot of attention in both the scientific community and the food industry. The potential health benefits make these compounds interesting for food fortification. However, due to low stability and unpleasant taste at higher concentrations, the use of polyphenols in food products is limited. Encapsulation, a process based on forming a physical barrier around an active substance, is a promising way of overcoming these problems. The number of research studies and reviews focusing on polyphenol encapsulation is on the constant rise. Polyphenol encapsulates tend to display greater stability during processing and storage compared to non-encapsulated polyphenols and, therefore, have a high potential for application in foods. However, papers focusing on the practical application of encapsulated polyphenols are scarce. For that reason, the aim of this work was to present possible applications of such encapsulates in foods, as well as to summarize the most popular techniques used for this purpose. Encapsulated polyphenols can be applied as functional food ingredients and/or food colorants in various products, such as milk products, bakery products, and confectionery. The most commonly employed techniques for polyphenol encapsulation include spray drying and freeze-drying, as well as ionic gelation, complex coacervation, and liposome entrapment. In terms of limitations, the increased cost of industrial production and the low bioavailability of polyphenols and their encapsulates should be further investigated.

Keywords: Polyphenols, Encapsulation, Food application, Food fortification, Food colorants

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ISKORIŠĆENJE OTPADNOG PIVSKOG KVASCA ZA INKAPSULACIJU BIOAKTIVNIH KOMPONENATA HRANE

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Otpadni pivski kvasac (OPK) (engl. Spent brewer's yeast, SBY) drugi je najvažniji nusproizvod industrije piva nakon pivskog tropa. Premda se neki kvasci mogu koristiti više puta za fermentaciju sladovine, nastala biomasa se na kraju proizvodnog procesa odbacuje, što dalje uzrokuje finansijske i ekološke probleme. U cilju smanjenja otpada ovog nusproizvoda agroindustrije, OPK se uglavnom koristi kao stočna hrana i kao takav ima nisku komercijalnu vrednost. Međutim, zbog svoje visoke nutritivne vrednosti, visoke dostupnosti i niske cene, OPK ima potencijal za profitabilnije primene, između ostalog, i za inkapsulaciju bioaktivnih jedinjenja. Sastav ćelijskog zida kvasca omogućava inkapsulaciju i hidrofilnih i lipofilnih bioaktivnih supstanci, dok njegova mehanička svojstva pružaju zaštitu od spoljnih faktora tokom obrade, skladištenja i konzumiranja. Proces inkapsulacije primenom otpadnog pivskog kvasca je jednostavan i rezultuje visokom efikasnošću inkapsulacije, koja se dodatno može poboljšati različitim predtretmanima kvaščevog materijala. Jedinjenja do sada uspešno inkapsulirana u OPK i materijale dobijene iz OPK uključuju polifenole, vitamine, ulja, pa čak i probiotike. U pogledu mogućih primena, OPK inkapsulati imaju veliki potencijal za upotrebu u prehrambenoj industriji; mogu se koristiti u formulaciji funkcionalne hrane ili kao zdrava zamena za sintetičke konzervanse i/ili boje. Ipak, povišeni troškovi proizvodnje i, u nekim slučajevima, gorčina inkapsulata mogu predstavljati izazov kada je u pitanju šira primena ove tehnologije i stoga bi trebalo da budu u fokusu budućih studija.

Ključne reči: otpadni pivski kvasac, nusproizvod, inkapsulacija, nosač

UTILIZATION OF SPENT BREWER'S YEAST FOR ENCAPSULATION OF FOOD BIOACTIVES

Ana B. Todorović, Steva M. Lević, Viktor A. Nedović
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Spent brewer's yeast (SBY) is the second most important by-product in the brewing industry after spent grain. Although some yeasts can be used multiple times to ferment wort, the resulting biomass is discarded at the end of the production process, causing financial and environmental problems. To reduce the waste of this agro-industrial by-product, SBY is mainly used as animal feed and, as such, it has low commercial value. However, due to its high nutritional value, high availability, and low cost, SBY has the potential for more profitable applications, including the encapsulation of bioactive compounds. The composition of the yeast cell wall allows for the entrapment of both hydrophilic and lipophilic bioactives, while its mechanical properties provide protection from external factors during processing, storage, and consumption. The process of encapsulation with spent brewer's yeast is simple and leads to high encapsulation efficiency, which can be further improved by various pretreatments of the yeast material. Compounds that have been successfully encapsulated in SBY and SBY-derived materials to date include polyphenols, vitamins, oils, and even probiotics. In terms of possible applications, SBY encapsulates have great potential for use in the food industry; they can be used to develop functional foods or as healthy substitutes for synthetic preservatives and/or colorants. However, higher production costs and, in some cases, the bitterness of the encapsulates may pose a challenge to wider application of this technology and should therefore be the focus of future studies.

Keywords: spent brewer's yeast, by-product, encapsulation, carrier material

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Belgrade, 2023

PLASMOLYZED YEAST CELLS AS A POTENTIAL WALL MATERIAL FOR PROBIOTIC BACTERIA

Ana B. Todorović, Nikola D. Bajčetić, Jovana R. Bundalo, Steva M. Lević, Milica M. Mirković, Viktor A. Nedović[1]

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The beneficial effects of probiotics are severely limited due to their low stability during production and storage. Encapsulation of probiotic cells remains the main strategy to overcome this problem, and in this regard, the use of yeast cells may have potential. Viable, sonicated and thermally treated yeast cells as well as yeast cell wall polymers have been shown to promote the growth and survival of probiotic bacteria; however, the effects of plasmolyzed yeast have not yet been investigated. Therefore, the aim of this work was to evaluate the potential of plasmolyzed yeast cells for maintaining the viability of probiotic bacteria. Plasmolysis of *Saccharomyces uvarum* yeast cells was performed using a 10% NaCl solution (55 °C, 48 h). The cells were then washed, spray-dried and mixed with a previously prepared *Lactiplantibacillus plantarum* 299v culture (DSM 9843) in two ratios (1:1 and 2:1, w/w). Finally, the mixtures were freeze-dried. The viability of the probiotic cells was assessed after encapsulation and every two weeks during three months of storage under refrigerated conditions using the plate count method. In addition, water activity and morphology analyses were performed and the auto/coaggregation properties of the cells were investigated. After storage, the number of viable cells in both formulations remained above 7 log CFU/g, i.e. above the minimum required for probiotic benefits. The obtained powders showed satisfactory water activity, while optical microscopy and aggregation assays indicate that the protective effect of the yeast may be due to direct cell-to-cell contact. The results suggest that plasmolyzed yeast cells have the potential to serve as wall material for probiotic bacteria by maintaining their viability during freezing and storage. Further studies are needed to gain a better insight into the properties of the encapsulates under gastrointestinal conditions and in food matrices.

Key words: yeast cells; plasmolysis; probiotic bacteria; encapsulation; wall material.

Acknowledgments: This study was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Contract number: 451-03-47/2023-01/200116).

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On behalf of organizing committee, we would like to confirm that Abstract entitled „Plasmolyzed yeast cells as a potential wall material for probiotic bacteria" co-authored by Ana B. Todorović, Nikola D. Bajčetić, Jovana R. Bundalo, Steva M. Lević, Milica M. Mirković, Viktor A. Nedović was accepted and presented in form of poster presentation at International Conference on Biochemical Engineering and Biotechnology for Young Scientists – ICBEB-YS that was held in Belgrade from 7-8. December 2023. The abovementioned abstract was mistakenly omitted from the book of abstracts by the publisher, however, all information about the Abstract and co-authors can be found at our official Conference web page (https://icbeb-ys.com/papers-abstracts/).

Sincerely,

Prof. Dr. Dejan Bezbradica
TwinPrebioEnz project coordinator

Dr. Milica Simović
Chair of ICBEB-YS Committee

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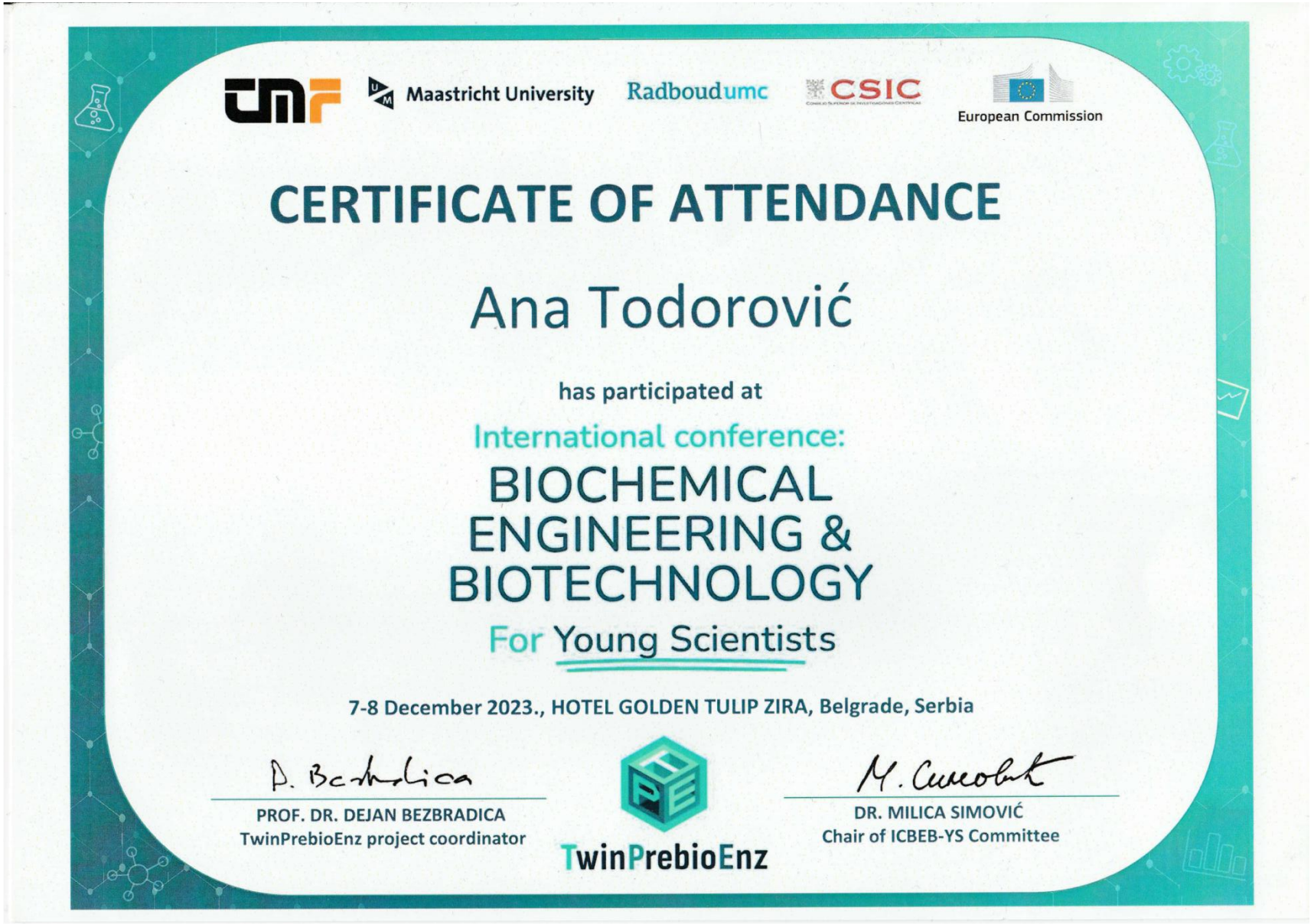
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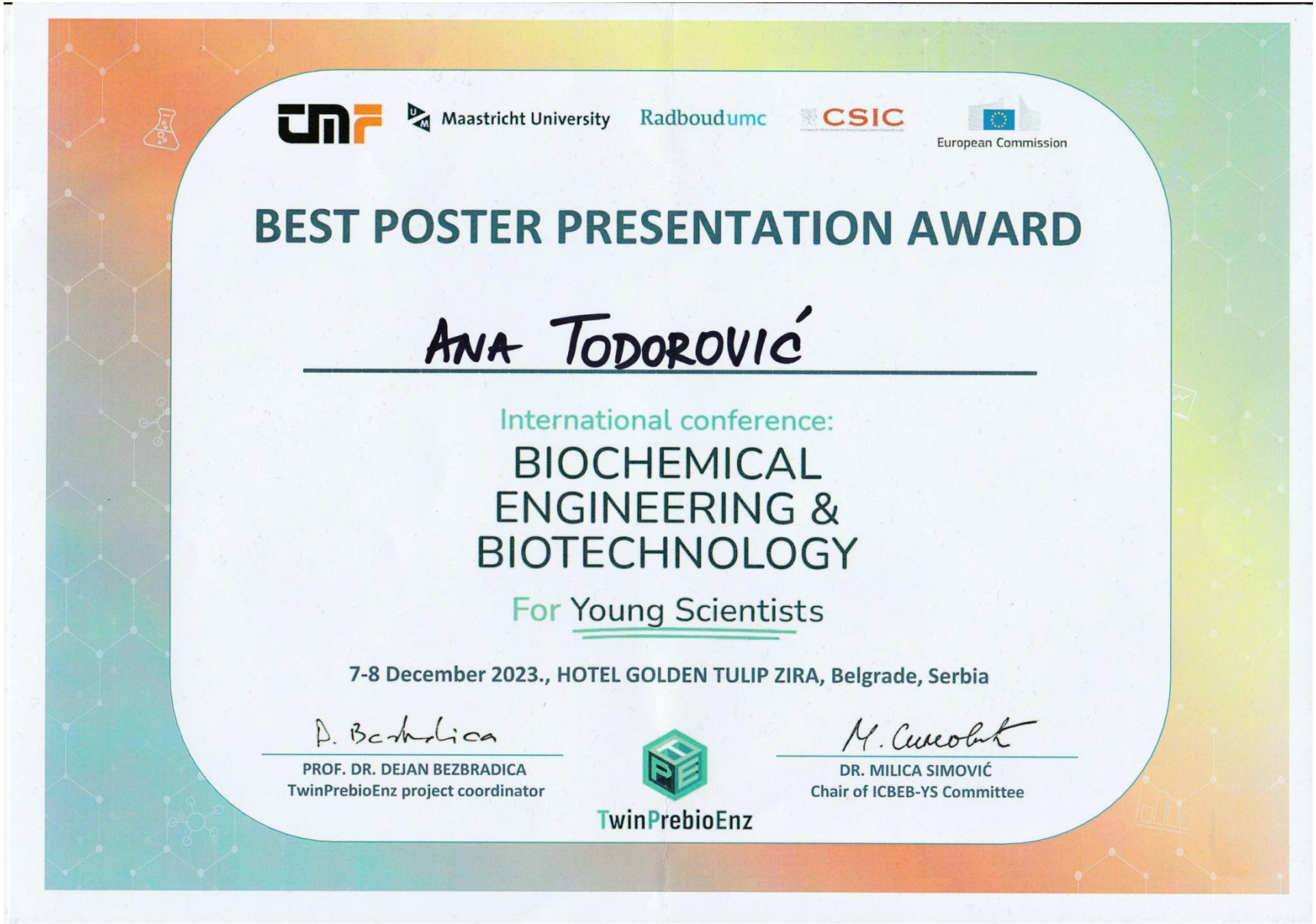
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BILBERRY POMACE POWDER AND ETHANOLIC EXTRACT AS ACTIVE PAPER COLOURANTS: PROPERTIES AND COLOUR STABILITY

Ana Todorović[1]*, Mija Sežun[2], Tea Kapun[2], Filipa Vicente[3], Ilja Gasan Osojnik Črnivec[3],Steva Lević[1], Ana Salević-Jelić[1], Viktor Nedović[1]*

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Bilberry pomace is a fruit processing by-product that is rich in lignocellulosic fibres and polyphenols, especially anthocyanins. Anthocyanins are natural pigments whose colour changes with the pH of the environment, making them a promising pH-responsive colourant. Our study investigated bilberry pomace powder and its ethanolic extract as potential paper colourants/pH indicators by evaluating their mechanical, optical, and colour-changing properties. For paper production, the bilberry pomace powder and the acidified ethanolic extract were added to pulp mixtures in three different concentrations. The mechanical and optical properties of the produced papers were measured according to ISO standards. Colour stability was evaluated during a 6-week storage period under daylight and dark conditions, and colour change was tested using a range of buffers (pH 3.0-10.0). All formulations with pomace extract showed better mechanical properties than those with pomace powder; however, both additions resulted in poorer performance compared to the commercial paper. The samples with added powder had a darker and more intense colour, but were also more susceptible to change during storage. For all samples, the overall colour changes (ΔE) were more pronounced in daylight than in the dark. The pH response was only recognisable in an acidic environment, which is probably due to the basic nature of the paper. Nevertheless, the colour change in the acidified samples was reversible, so that alkaline conditions could also be detected. Overall, all prepared materials are suitable for use as specialty papers, and their appealing colour and reactivity to different pH values enable rapid monitoring of various liquid products. To improve the mechanical and colour stability, optimisation of the colourant ratio and the addition of stabilising additives/coatings will be investigated.

Keywords: bilberry pomace, anthocyanins, paper colourants, pH indicators, by-product utilisation

Acknowledgements: This study was financially supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Grant No. 451-03- 65/2024-03/200116) and the national research program Chemical Reaction Engineering (P2-1052, Slovenian Research and Innovation Agency).

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AQUAPONIC SYSTEM IN THE CULTIVATION OF MICROGREENS AND SPROUTS: A REVIEW

Spasoje Belošević, Stefan Marjanović, Jovana Marković, Ana Todorović, Steva Lević, Ana Salević-Jelić, Marko Stanković, Zoran Marković and Viktor Nedović

Abstract: Aquaponics is a novel system for the simultaneous cultivation of plants and fish, developed in response to the uncontrolled use of chemical fertilizers in plant production and the waste generated by aquaculture. In this closed-loop system, ammonia-rich fish waste is converted into nutrients by nitrifying bacteria, serving as fertilizer for plants, while the plants help purify water for the fish by removing waste products and excess nutrients. Through waste reduction and maximized resource efficiency, aquaponics exemplifies the circular economy in agriculture and food production. Microgreens and sprouts are young seedlings that only need a few weeks to grow in different substrates and systems. They are appreciated for their appearance, flavor, and higher concentrations of bioactive compounds compared to mature plants. Their short growing time and low nutrient requirements make them ideal for cultivation in all modern agricultural practises, including aquaponics. This review focuses on the application of aquaponics for cultivating microgreens and sprouts. So far, only one study has investigated the cultivation of microgreens in aquaponics, compared to more extensive research on hydroponics and sprouts. Growing arugula microgreens in an aquaponics system with goldfish positively impacted microgreens' growth rates, while sprout production exhibited higher levels of vitamin C, protein, and soluble sugars, as well as improved germination rates, weight, and height. Lettuce and rocket were successfully grown using trout wastewater as a nutrient source, enhancing yield and quality while promoting water efficiency and fertilizer savings compared to conventional production. The main limitation of the aquaponics system for growing small plants such as microgreens, sprouts, and baby leaves is the potential microbial contamination from the recirculating nutrient water. Overall, the aquaponics system is an emerging technology for growing microgreens with reduced use of natural resources while positively influencing growth parameters and phytochemical content.

Keywords: *Aquaponics, Circular economy, Microgreens, Plant and fish cultivation, Sprouts.*
CA: Viktor A. Nedović, e-mail: vnedovic@agrif.bg.ac.rs


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