

BOOK OF PROCEEDINGS



*XII International Scientific
Agriculture Symposium
"AGROSYM 2021"
October 7-10, 2021*



BOOK OF PROCEEDINGS

**XII International Scientific Agriculture Symposium
“AGROSYM 2021”**



Jahorina, October 07 - 10, 2021

Impressum

XII International Scientific Agriculture Symposium „AGROSYM 2021“

Book of Proceedings published by

University of East Sarajevo, Faculty of Agriculture, Republic of Srpska, Bosnia
University of Belgrade, Faculty of Agriculture, Serbia
Mediterranean Agronomic Institute of Bari (CIHEAM - IAMB) Italy
International Society of Environment and Rural Development, Japan
Balkan Environmental Association (B.EN.A), Greece
Centre for Development Research, University of Natural Resources and Life Sciences (BOKU),
Austria
Perm State Agro-Technological University, Russia
Voronezh State Agricultural University named after Peter The Great, Russia
Tokyo University of Agriculture
Faculty of Agriculture, University of Western Macedonia, Greece
Faculty of Bioeconomy Development, Vytautas Magnus University, Lithuania
Enterprise Europe Network (EEN)
Faculty of Agriculture, University of Akdeniz - Antalya, Turkey
Selçuk University, Turkey
University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania
Slovak University of Agriculture in Nitra, Slovakia
Ukrainian Institute for Plant Variety Examination, Kyiv, Ukraine
National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine
Valahia University of Targoviste, Romania
National Scientific Center „Institute of Agriculture of NAAS“, Kyiv, Ukraine
Saint Petersburg State Forest Technical University, Russia
University of Valencia, Spain
Faculty of Agriculture, Cairo University, Egypt
Tarbiat Modares University, Iran
Chapingo Autonomous University, Mexico
Department of Agricultural, Food and Environmental Sciences, University of Perugia, Italy
Higher Institute of Agronomy, Chott Mariem-Sousse, Tunisia
Watershed Management Society of Iran
Institute of Animal Science- Kostinbrod, Bulgaria
Faculty of Economics Brcko, University of East Sarajevo, Bosnia and Herzegovina
Biotechnical Faculty, University of Montenegro, Montenegro
Institute of Field and Vegetable Crops, Serbia
Institute of Lowland Forestry and Environment, Serbia
Institute for Science Application in Agriculture, Serbia
Agricultural Institute of Republic of Srpska - Banja Luka, Bosnia and Herzegovina
Maize Research Institute “Zemun Polje”, Serbia
Faculty of Agriculture, University of Novi Sad, Serbia
Institute for Animal Science, Ss. Cyril and Methodius University in Skopje, Macedonia
Academy of Engineering Sciences of Serbia, Serbia
Balkan Scientific Association of Agricultural Economics, Serbia
Institute of Agricultural Economics, Serbia

Editor in Chief

Dusan Kovacevic

Technical editors

Sinisa Berjan
Milan Jugovic
Noureddin Driouech
Rosanna Quagliariello

Website:

<http://agrosym.ues.rs.ba>

CIP - Каталогизација у публикацији
Народна и универзитетска библиотека
Републике Српске, Бања Лука

631(082)(0.034.2)

INTERNATIONAL Scientific Agriculture Symposium "AGROSYM" (12 ;
Jahorina ; 2021)

Book of Proceedings [Електронски извор] / XII International
Scientific Agriculture Symposium "AGROSYM 2021", Jahorina, October 07
- 10, 2021 ; [editor in chief Dusan Kovacevic]. - Onlajn izd. - El. zbornik. -
East Sarajevo : Faculty of Agriculture, 2021. - Ilustr.

Sistemski zahtjevi: Nisu navedeni. - Način pristupa (URL):
http://agrosym.ues.rs.ba/article/showpdf/BOOK_OF_PROCEEDINGS_2021_FINAL.pdf. - El. publikacija u PDF formatu opsega 1465 str. - Nasl. sa naslovnog ekrana. - Opis izvora dana 15.11.2021. - Bibliografija uz svaki rad. - Registar.

ISBN 978-99976-787-9-9

COBISS.RS-ID 134751233

**XII International Scientific Agricultural Symposium “AGROSYM 2021”
Jahorina, October 07-10, 2021, Bosnia and Herzegovina**

HONORARY COMMITTEE

Prof. dr Boris Pasalic, Minister of Agriculture, Water Management and Forestry of Republic of Srpska, Bosnia and Herzegovina
Mr Srdjan Rajcevic, Minister of Scientific-Technological Development, Higher Education and Information Society of Republic of Srpska, Bosnia and Herzegovina
Prof. dr Mario T. Tabucanon, President of the International Society of Environment and Rural Development, Japan
Prof. dr Milan Kulic, Rector of the University of East Sarajevo, Bosnia and Herzegovina
Prof. dr Dusan Zivkovic, Dean of the Faculty of Agriculture, University of Belgrade, Serbia
Dr. Maurizio Raeli, Director of the Mediterranean Agronomic Institute of Bari, Italy
Prof. dr Metin Aksoy, Rector of the Selcuk University, Turkey
Prof. dr Aleksey Andreev, Rector of the Perm State Agro-Technological University, Russia
Prof. dr Antanas Maziliauskas, Rector of the Vytautas Magnus University Agriculture Academy, Lithuania
Prof. dr Alexey Yu. Popov, Rector of the Voronezh State Agricultural University named after Peter The Great, Russia
Prof. dr Barbara Hinterstoisser, Vice-Rector of the University of Natural Resources and Life Sciences (BOKU), Austria
Prof. dr Sorin Mihai Cimpeanu, Rector of the University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania
Doc. Ing. Klaudia Halászová, Rector of the Slovak University of Agriculture in Nitra, Slovakia
Prof. dr Calin D. Oros, Rector of the Valahia University of Targoviste, Romania
Prof. Dr Katerina Melfou, Dean of the Faculty of Agriculture, University of Western Macedonia, Greece
Prof. dr Amr Ahmed Mostafa, Dean of the Faculty of Agriculture, Cairo University, Egypt
Prof. dr José Sergio Barrales Domínguez, Rector of the Chapingo Autonomous University, Mexico
Prof. dr Davut Karayel, Dean of Faculty of Agriculture, University of Akdeniz - Antalya, Turkey
Prof. Dr EGUCHI Fumio, Rector of the Tokyo University of Agriculture, Japan
Prof. Dr Zeki Bayramoğlu, Dean of Faculty of Agriculture, University of Selçuk- Konya, Turkey
Dr Chokri Thabet, the General Director of the High Agronomic Institute of Chott Mariem, Sousse, Tunisia
Prof. dr Ivan Yanchev, Director of the Institute of Animal Science- Kostinbrod, Bulgaria
Prof. dr Seyed Hamidreza Sadeghi, Professor at Tarbiat Modares University and the President of the Watershed Management Society of Iran, Iran
Prof. dr Francesco Tei, Director of the Department of Agricultural, Food and Environmental Sciences, University of Perugia, Italy
Prof. dr Viktor Kaminskyi, Director of National Scientific Center „Institute of Agriculture of NAAS“, Kyiv, Ukraine
Prof. dr Mirza Dautbasic, Dean of the Faculty of Forestry, University of Sarajevo, Bosnia and Herzegovina
Prof. dr Bozidarka Markovic, Dean of the Biotechnical Faculty, University of Podgorica, Montenegro
Prof. dr Rade Jovanovic, Director of the Institute for Science Application in Agriculture, Serbia
Prof. dr Lazar Radovanovic, Dean of the Faculty of Economics Brcko, University of East Sarajevo, Bosnia and Herzegovina
Prof. dr Vojislav Trkulja, Director of Agricultural Institute of Republic of Srpska - Banja Luka, Bosnia and Herzegovina
Dr. Branka Kresovic, Director of the Maize Research Institute “Zemun Polje”, Serbia
Dr Svetlana Balesevic-Tubic, Director of the Institute of Field and Vegetable Crops, Serbia
Prof. dr Nedeljko Tica, Dean of the Faculty of Agriculture, University of Novi Sad, Serbia
Prof. dr Rodne Nastova, Director of the Institute for Animal Science, Skoplje, Macedonia
Prof. dr Sasa Orlovic, Director of the Institute of Lowland Forestry and Environment, Serbia
Prof. dr Jonel Subic, Director of the Institute of Agricultural Economics, Serbia
Prof. dr Branko Kovacevic, President of the Academy of Engineering Sciences of Serbia, Serbia
Prof. dr Radovan Pejanovic, President of Balkan Scientific Association of Agricultural Economics, Serbia

SCIENTIFIC COMMITTEE

Chairman: Academician Prof. dr Dusan Kovacevic, Faculty of Agriculture, University of Belgrade, Serbia
Prof. dr Machito Mihara, Tokyo University of Agriculture, Japan
Prof. dr John Brayden, Norwegian Agricultural Economics Research Institute (NILF), Norway
Prof. dr Steve Quarie, Visiting Professor, School of Biology, Newcastle University, United Kingdom
Prof. dr Andreas Melcher, CDR, University of Natural Resources and Life Sciences (BOKU), Vienna, Austria
Prof. dr Dieter Trautz, University of Applied Science, Germany
Prof. dr Sergei Eliseev, Vice-Rector for Research and Innovations, Perm State Agro-Technological University, Russia
Prof. dr Dani Shtienberg, full professor, Department of Plant pathology and Weed Research, ARO, the Volcani Center, Bet Dagan, Israel

Prof. dr William Meyers, Howard Cowden Professor of Agricultural and Applied Economics, University of Missouri, USA

Prof. dr Markus Schermer, Department of Sociology, University of Innsbruck, Austria

Academician Prof. dr Novo Przulj, Faculty of Agriculture, University of Banjaluka, Bosnia and Herzegovina

Prof. dr Thomas G. Johnson, University of Missouri – Columbia, USA

Prof. dr Fokion Papatthanasiou, School of Agricultural Sciences, University of Western Macedonia, Greece

Prof. dr Sabahudin Bajramovic, Faculty of Agriculture and Food Sciences, University of Sarajevo, Bosnia and Herzegovina

Prof. dr Hiromu Okazawa, Faculty of Regional Environment Science, Tokyo University of Agriculture, Japan

Prof. dr Tatiana Sivkova, Faculty for Veterinarian Medicine and Zootechny, Perm State Agro-Technological University, Russia

Prof. dr Aleksej Lukin, Voronezh State Agricultural University named after Peter The Great, Russia

Prof. dr Matteo Vittuari, Faculty of Agriculture, University of Bologna, Italy

Prof. dr Seyed Mohsen Hosseini, Faculty of Natural Resources, Tarbiat Modares University, Iran

Prof. dr Ardian Maci, Faculty of Agriculture and Environment, Agricultural University of Tirana, Albania

Prof. dr Regucivilla A. Pobar, Bohol Island State University, Philippines

Prof. dr Sudheer Kundukulangara Pulissery, Kerala Agricultural University, India

Prof. dr EPN Udayakumara, Faculty of Applied Sciences, Sabaragamuwa University, Sri Lanka

Prof. dr Vladimír Smutný, full professor, Mendel University, Faculty of agronomy, Czech Republic

Prof. dr Franc Bavec, full professor, Faculty of Agriculture and Life Sciences, Maribor, Slovenia

Prof. dr Jan Moudrý, full professor, Faculty of Agriculture, South Bohemia University, Czech Republic

Prof. dr Stefan Tyr, full professor, Faculty of Agro-biology and Food Resources, Slovakia

Prof. dr Natalija Bogdanov, Faculty of Agriculture, University of Belgrade, Serbia

Prof. dr Richard Barichello, Faculty of Land and Food Systems, University of British Columbia, Canada

Prof. dr Francesco Porcelli, University of Bari Aldo Moro, Italy

Prof. dr Vasilije Isajev, Faculty of Forestry, University of Belgrade, Serbia

Prof. dr Elazar Fallik, Agricultural Research Organization (ARO), Volcani, Israel

Prof. dr Junaid Alam Memon, Pakistan Institute of Development Economics, Pakistan

Prof. dr. Jorge Batlle-Sales, Department of Biology, University of Valencia, Spain

Prof. dr Pandi Zdruli, Land and Water Resources Department; IAMB, Italy

Prof. dr Mladen Todorovic, Land and Water Resources Department; IAMB, Italy

Dr. Hamid El Bilali, Mediterranean Agronomic Institute of Bari, Italy

Prof. dr Maksym Melnychuk, National Academy of Agricultural Science of Ukraine, Ukraine

Prof. dr Borys Sorochnykyi, Ukrainian Institute for Plant Variety Examination, Kyiv, Ukraine

Dr. Lorenz Probst, CDR, University of Natural Resources and Life Sciences (BOKU), Vienna, Austria

Prof. dr Mohsen Boubaker, High Institute of Agronomy of Chott Meriem, Sousse, Tunisia

Dr. Nouredin Driouech, Coordinator of MAIB Alumni Network (FTN), Mediterranean Agronomic Institute of Bari, Italy

Prof. dr Ion Viorel, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania

Prof. dr. Chuleemas Boonthai Iwai, Faculty of Agriculture, Khon Kaen University, Thailand

Prof. dr Wathuge T.P.S.K. Senarath, Department of Botany, University of Sri Jayewardenepura, Colombo, Sri Lanka

Dr. Hamada Abdelrahman, Soil Science Dept., Faculty of Agriculture, Cairo University, Egypt

Prof. dr Maya Ignatova, Agricultural Academy – Sofia, Bulgaria

Prof. dr Ioannis N. Xynias, School of Agricultural Technology & Food Technology and Nutrition, Western Macedonia University of Applied Sciences, Greece

PhD ing. Artur Rutkiewicz, Department of Forest Protection, Forest Research Institute - IBL, Poland

Prof. dr Mohammad Sadegh Allahyari, Islamic Azad University, Rasht Branch, Iran

Dr. Lalita Siri wattananon, Faculty of Agricultural Technology, Rajamangala University of Technology Thanyaburi (RMUTT), Thailand

Prof. dr Konstantin Korlyakov, Perm Agricultural Research Institute, Russia

Dr. Mohammad Farooque Hassan, Shaheed Benazir Bhutto University of Veterinary & Animal Sciences Sakrand, Sindh, Pakistan

Dr. Larysa Prysiashniuk, Ukrainian Institute for Plant Variety Examination, Kyiv, Ukraine

Prof. dr Oksana Kliachenko, National University of Life and Environmental Science of Ukraine, Ukraine

Prof. dr Ivan Simunic, Department of amelioration, Faculty of agriculture, University of Zagreb, Croatia

Dr. Abid Hussain, International Centre for Integrated Mountain Development (ICIMOD), Nepal

Dr. Amrita Ghatak, Gujarat Institute of Development Research (GIDR), India

Prof. dr Naser Sabaghnia, University of Maragheh, Iran

Dr. Karol Wajszczuk, Poznan University of Life Sciences, Poland

Prof. dr Penka Moneva, Institute of Animal Science - Kostinbrod, Bulgaria

Prof. dr Mostafa K. Nassar, Animal husbandry Dept., Faculty of Agriculture, Cairo University, Egypt

Prof. dr Márta Birkás, full professor, St. Istvan University, Godollo - Hungary

Prof. dr Andrzej Kowalski, Director of the Institute for Agricultural and Food Economy, Warszawa-Poland

Prof. dr Yalcin Kaya, The Director of the Plant Breeding Research Center, University of Trakya, Turkey

Prof. dr Sanja Radonjic, Biotechnical Faculty, University of Montenegro, Montenegro
Prof. dr Ionela Dobrin, Department for Plant Protection, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania
Prof. dr Inocencio Buot Jr., Institute of Biological Sciences, College of Arts and Sciences, University of the Philippines Los Banos, Philippines
Prof. dr Monica Paula Marin, Department for Animal Husbandry, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania
Prof. dr Nedeljka Nikolova, Institute for Animal Science, Ss. Cyril and Methodius University in Skopje, Republic of Macedonia
Prof. dr Mohammad Al-Mamun, Department of Animal Nutrition, Bangladesh Agricultural University, Bangladesh
Prof. dr Anucha Wittayakorn-Puripunpinyoo, School of Agriculture and Co-operatives, Sukhothai Thammathirat Open University, Nonthaburi, Thailand
Dr. Redouane Choukr-Allah, International Center for Biosaline Agriculture (ICBA), United Arab Emirates
Prof. dr Ignacio J. Díaz-Maroto, High School Polytechnic, University of Santiago de Compostela, Spain
Prof. dr Nidal Shaban, University of Forestry Sofia, Bulgaria
Prof. dr Mehdi Shafaghati, Faculty of Geography, Tarbiat Moalem (kharazmi) University, Iran
Prof. dr Youssif Sassine, Lebanese University Beirut, Lebanon
Prof. dr Cafer Topaloglu, Faculty of Tourism, Mugla Sitki Kocman University, Turkey
Prof. dr Seyed Hamidreza Sadeghi, Faculty of Natural Resources, Tarbiat Modares University, Iran
Prof. dr Mohsen Mohseni Saravi, University of Teheran and Member of WMSI Management Board, Iran
Prof. dr Branislav Draskovic, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
Prof. dr Mahmood Arabkhedri, Soil Conservation and Watershed Management Research Institute and Member of WMSI Management Board, Iran
Prof. dr Ataollah Kavian, Sari Agricultural Science and Natural Resources University and Member of WMSI Management Board, Iran
Prof. dr Tugay Ayasan, Department of Organic Farming Business Management, Osmaniye, Applied Science School of Kadirli, Osmaniye Korkut Ata University, Turkey
Prof. dr Sakine Özpınar, Department of Farm Machinery and Technologies Engineering, Faculty of Agriculture, Çanakkale Onsekiz Mart University, Çanakkale, Turkey
Prof. dr Sherein Saeide Abdelgayed, Faculty of Veterinary Medicine, Cairo University, Cairo, Egypt
Prof. dr Zohreh Mashak, Islamic Azad University, Karaj Branch, Iran
Dr. Khalid Azim, National Institute of Agriculture Research, Morocco
Dr. Mario Licata, Department of Agricultural, Food and Forest Sciences, University of Palermo, Italy
Prof. dr Srdjan Lalic, University of East Sarajevo, Bosnia and Herzegovina
Prof. dr Zeljko Vasko, Faculty of Agriculture, University of Banja Luka, Bosnia and Herzegovina
Dr. Edouard Musabanganji, School of Economics/CBE, University of Rwanda, Rwanda
Prof. dr Kubilay Baştaş, Department of Plant Protection, Faculty of Agriculture, Selçuk University, Turkey
Dr. Branka Kresovic, Director of the Maize Research Institute “Zemun Polje”, Serbia
Dr. Nenad Delic, Maize Research Institute “Zemun Polje”, Serbia
Dr. Milan Stevanovic, Maize Research Institute “Zemun Polje”, Serbia
Dr. Svetlana Balesevic-Tubic, Institute of Field and Vegetable Crops Novi Sad, Serbia
Dr. Ana Marjanovic Jeromela, Institute of Field and Vegetable Crops Novi Sad, Serbia
Prof. dr Tatjana Krajisnik, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
Prof. dr Aleksandra Govedarica-Lucic, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
Prof. dr Desimir Knezevic, University of Pristina, Faculty of Agriculture, Kosovska Mitrovica - Lesak, Kosovo i Metohija, Serbia
Dr. Snezana Mladenovic-Drinic, Maize Research Institute “Zemun Polje”, Serbia
Prof. dr Nebojsa Momirovic, Faculty of Agriculture, University of Belgrade, Serbia
Prof. dr Osman Mujezinovic, Faculty of Forestry, University of Sarajevo, Bosnia and Herzegovina
Prof. dr Dalibor Ballian, Faculty of Forestry, University of Sarajevo, Bosnia and Herzegovina
Prof. dr Velibor Spalevic, Faculty of Philosophy, Geography, University of Montenegro
Prof. dr Zoran Jovovic, Biotechnical Faculty, University of Montenegro, Montenegro
Prof. dr Danijel Jug, Faculty of Agriculture, University of Osijek, Croatia
Prof. dr Milan Markovic, Biotechnical Faculty, University of Montenegro, Montenegro
Prof. dr Zeljko Dolijanovic, Faculty of Agriculture, University of Belgrade, Serbia
Dr Dejan Stojanovic, Institute of Lowland Forestry and Environment, Serbia
Dr Dobrivoj Poštić, Institute for plant protection and environment, Belgrade, Serbia
Dr Srdjan Stojnic, Institute of Lowland Forestry and Environment, Serbia
Dunja Demirović Bajrami, Research Associate, Geographical Institute “Jovan Cvijić,” Serbian Academy of Sciences and Arts, Belgrade, Serbia

ORGANIZING COMMITTEE

Chairperson: Prof. dr Vesna Milic, Dean of the Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
Dr Marko Gutalj, Vice rector of the University of East Sarajevo, Bosnia and Herzegovina
Dr Jelena Kronic, Vice rector of the University of East Sarajevo, Bosnia and Herzegovina
Dr. Maroun El Moujabber, Mediterranean Agronomic Institute of Bari, Italy
Mrs. Rosanna Quagliariello, Mediterranean Agronomic Institute of Bari, Italy
Prof. dr Aleksandra Despotovic, Biotechnical Faculty Podgorica, University of Montenegro, Montenegro
Dr. Nouredin Driouech, Coordinator of MAIB Alumni Network (FTN), Mediterranean Agronomic Institute of Bari, Italy
Dr Milic Curovic, The journal "Agriculture and Forestry", Biotechnical Faculty Podgorica, University of Montenegro, Montenegro
Dr. Tatiana Lysak, International Relations Office, Voronezh State Agricultural University named after Peter The Great, Russia
Dr. Oksana Fotina, International Relations Center, Perm State Agro-Technological University, Russia
Prof. dr Fokion Papathanasiou, School of Agricultural Sciences, University of Western Macedonia, Greece
Dr Ana Marjanović Jeromela, Institute of Field and Vegetable Crops, Serbia
Dr. Anastasija Novikova, Faculty of Bioeconomy Development, Vytautas Magnus University, Lithuania
Prof. dr Engr. Teodora Popova, Institute of Animal Science - Kostinbrod, Bulgaria
Prof. dr Mehmet Musa Ozcan, Faculty of Agriculture, Selçuk University, Turkey
Dr. Abdulvahed Khaledi Darvishan, Faculty of Natural Resources, Tarbiat Modares University, Iran
Prof. dr Nikola Pacinovski, Institute for Animal Science, Ss. Cyril and Methodius University in Skopje, N. Macedonia
MSc. Erasmo Velázquez Cigarroa, Department of Rural Sociology, Chapingo Autonomous University, Mexico
Dr. Ecaterina Stefan, University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania
Dr. Jeeranuch Sakkhamduang, The International Society of Environmental and Rural Development, Japan
Dr. Raoudha Khanfir Ben Jenana, High Institute of Agronomy of Chott Meriem, Sousse, Tunisia
Dr. Hamada Abdelrahman, Soil Science Dept., Faculty of Agriculture, Cairo University, Egypt
Dr. Dragana Sunjka, Faculty of Agriculture, University of Novi Sad, Serbia
MSc. Vedran Tomic, Institute for Science Application in Agriculture, Serbia
Dr. Milan Stevanovic, Maize Research Institute "Zemun Polje", Serbia
Dr. Andrej Pilipovic, Institute of Lowland Forestry and Environment, Serbia
Dr. Sc. Morteza Behzadfar, Tarbiat Modares University, Tehran, Iran
Dr. Larysa Prysiazhniuk, Ukrainian Institute for Plant Variety Examination, Kyiv, Ukraine
Dr. Diana Bilić-Šobot, Faculty of Agriculture, University of Niš, Serbia
Doc. dr Sead Ivojevic, Faculty of Forestry, University of Sarajevo, Bosnia and Herzegovina
Dr. Nenad Markovic, Enterprise E. N. (EEN) Coordinator, University of East Sarajevo, Bosnia and Herzegovina
Mrs Branislavka Boroja, Agricultural Institute of Republic of Srpska - Banja Luka, Bosnia and Herzegovina
MSc. Milan Jugovic, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
Prof. dr Sinisa Berjan, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
MSc. Milena Stankovic, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
Dr. Stefan Stjepanovic, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
Doc. dr Dejana Stanic, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
MSc. Stefan Bojic, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
MSc. Tanja Jakisic, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
MSc. Tijana Banjanin, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
MSc. Boban Miletic, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
MSc. Todor Djorem, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
Dr. Igor Djurdjic, Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina, General Secretary

ANTIOXIDANT ACTIVITY ESTIMATION OF INNER AND OUTER SEED FRACTIONS OF THE LEGUMES *VIGNA RADIATA* L. AND *GLYCINE MAX* L.

Dragana BARTOLIĆ*, Miloš PROKOPIJEVIĆ, Ksenija RADOTIĆ

Institute for Multidisciplinary Research, University of Belgrade (IMSI), Belgrade, Serbia

*Corresponding author: dragana.bartolic@imsi.rs

Abstract

Legumes have multiple functions in sustainable agriculture, but also are a favourable ingredient of functional nutrition. Antioxidants in legumes have several beneficial physiological properties and provide protection against chronic diseases. In this study, we compared the antioxidant activities of the seed fractions (outer and inner) for two different legumes: mung bean (*Vigna radiata* L.) and soybean (*Glycine max* L.). The antioxidant activity was estimated using a modified DPPH (2, 2-diphenyl-1-picrylhydrazyl) assay in a 96-well microplate. We showed that mung bean hulls possessed significantly higher ($p < 0.05$) DPPH free radical scavenging activity ($80.80 \% \pm 0.19$) compared to their inner fraction ($10.94 \% \pm 0.23$), as well as to both fractions of the soybean. On the other hand, the soybean seeds' inner fractions ($21.00 \% \pm 0.32$) exhibited a significantly ($p < 0.05$) higher activity than the hulls ($8.78 \% \pm 0.71$) and the inner fraction of the mung bean. The obtained results indicated that in each of the two analysed legume species, inner and outer seed fractions exhibited different antioxidant activities regarding to the elimination of the free radicals. The obtained results indicate that antioxidant capacity may be a useful indicator in the estimation of the quality of legume seeds as food and feed.

Keywords: *Antioxidant activity, Soybean, Mung bean, DPPH, Food quality.*

Introduction

Leguminous seeds are considered as significant source of nutrients (proteins, essential amino acids, starch, fibers, minerals, vitamins) but they also, depending on the biological variety of the plants and their origin, contain different bioactive substances including phenolics. Secondary metabolites are involved in protection of the seeds against plant pathogens, wounds caused by insect pests and herbivores, UV radiation and other biotic and abiotic stress conditions (Yusnawan et al. 2019). Antioxidant activity of various phenolic compounds from legume seeds (flavonoids, alkaloids, tannins, phenolic acids) is important both from nutritional and technological points of view (Amarowicz and Pegg 2008). Legumes are excellent functional food ingredients and a great dietary source of antioxidants due to their nutrient composition (Ganesan and Xu, 2018). Health benefits related to antioxidants contained in edible food sources include reduced risk and prevention of developing major chronic diseases such as cancer, diabetes or cardiovascular diseases (Singh et al. 2017). Phenolic antioxidants and polyphenols, that protect the seeds against the harmful effect of oxygen free radicals, are typically present in high content in seed hulls. Mung bean seeds are consumed as a whole or after separation the hulls while soybean seed hulls are usually discarded as a byproduct. This biowaste has a high polyphenol content which could be extracted and used as nutraceuticals, a source of natural antioxidants, or used as animal feed (Singh et al. 2017).

Mung bean (*Vigna radiata* L.), a summer cultivated legume widely distributed and consumed throughout Asia, has a high nutrient value comparable to that of soybean (*Glycine max* L) (Shi et al. 2016; Orak et al. 2018). Mung bean also contains bioactive food components and polyphenols which possess a high antioxidant capacity (Orak et al. 2018). Soybean is an annual self-pollinated diploid leguminous plant, predominantly grown for use in human and animal diet and as a major source of protein and oil (Gaonkar and Rosentrater 2019). Aside from the nutritional value, soybean contains isoflavones and certain phenolic compounds (Wang and Komatsu 2017). The antioxidant potential of soybean has also proven to have health benefits, especially in their seed coat (Peiretti et al. 2019).

In the present study, differences in antioxidant capacity between two seed fractions (inner and outer) of the two different legume species, soybean and mung bean, were examined. Aqueous-ethanol extracts of both seeds and hulls were examined for their respective radical scavenging activity with DPPH (2,2-Diphenyl-1-picrylhydrazyl) reagent. In a reaction with antioxidants, DPPH is reduced to DPPH-H while the color changes from purple to yellow and the decrease in absorbance maximum at 517 nm is spectrophotometrically detected (Khan et al. 2017).

Material and Methods

Sample preparation

Soybean and Mung bean were purchased from the local market in Belgrade, Serbia. Seed hulls have been separated from the seed endosperm before homogenization, and considered as outer fractions. The rest of the seed (endosperm and embryo) was the inner fraction. Both fractions of the seed were grinded separately in a mill. The samples were further powdered in a mortar with pestle with liquid nitrogen and stored in the dark at 5 ± 3 °C until use.

DPPH Assay

Antioxidant activity (AA %) of both legumes (mung bean and soybean) seeds and hulls, was carried out separately using DPPH (Sigma-Aldrich, St. Louis, MO, USA) test (Khan et al. 2017). Compared to the original method, described by Khan et al. 2017, the procedure was modified in terms of absorbance measurement; smaller sample volumes were required since a microplate reader was used instead of UV/VIS Spectrophotometer. This method enables rapid analysis and possibility of screening a large number of samples.

Powdered samples (8 mg) were extracted with 3 ml of 70 % ethanol. To each sample, 1 ml of freshly prepared 0.4 mM DPPH solution in 96 % ethanol was added to a final concentration of 0.1 mM. After 30 minutes of incubation with constant shaking in the dark, 200 µl aliquots were taken and absorbance at 517 nm was measured using a UV-VIS microplate reader (Tecan Infinite M Nano+, Switzerland). Blank consisted of pure deionized water without any additions. Control contained 0.1 mM DPPH in 96 % ethanol solution. Antioxidant activity was calculated using the following equation (Khan et al. 2017):

$$A \% = 100 - \left(\frac{A_{sample} - A_{blank}}{A_{control}} \right) \times 100$$

The results were presented as a percentage of depleted DPPH-reagent. Readings were carried out in four replicates for each analysed seed fraction and, based on obtained data, the standard error was calculated. Mann-Whitney sum rank test has been used for statistical analysis of the obtained results.

Results and Discussion

Images of mung bean and soybean seeds are shown in Figure 1. The obtained results indicate that mung bean seed coats possessed significantly higher ($p < 0.05$) DPPH radical scavenging activity, according to Mann-Whitney test ($p = 0.021$), $80.80 \% \pm 0.19$, compared to their inner fraction of the seed being only $10.94 \% \pm 0.23$ (Figure 2). Our results are consistent with previously reported studies showing that mung bean hull contained higher antioxidant capacity compared to the inner fraction of the seed (Singh et al. 2017). Pigmented grain such as mung bean contains a higher concentration of secondary metabolites especially in the seed coat. These phytochemicals contributing to antioxidant activity, such as phenolic acids and flavonoids (flavones, flavonoids, isoflavone, and isoflavonoids), are distributed unevenly through the seed fractions (Yusnawan et al. 2019). Some of the major polyphenols (caffeic acid, syringic acid, chlorogenic acid, ferulic acid and *p*-coumaric acid) have been detected in mung bean (Singh et al. 2017). Furthermore, water-soluble polysaccharides (containing mannose, rhamnose, and galactose) from mung bean hulls exhibit high DPPH radical-scavenging activities (Ganesan and Xu, 2018).



Figure 1. Image of mung bean (left) and soybean (right) seeds.

Figure 2 shows antioxidant activity (AA %) of both inner and outer fractions of soybean. Soybean seeds' inner fraction showed a significantly higher antioxidant activity compared to the soybean seed coats, $21.00 \% \pm 0.32$ and $8.78 \% \pm 0.71$, respectively. These results are in accordance with Lim et al. (2021), who showed higher antioxidant activity in cotyledon compared to the seed coat.

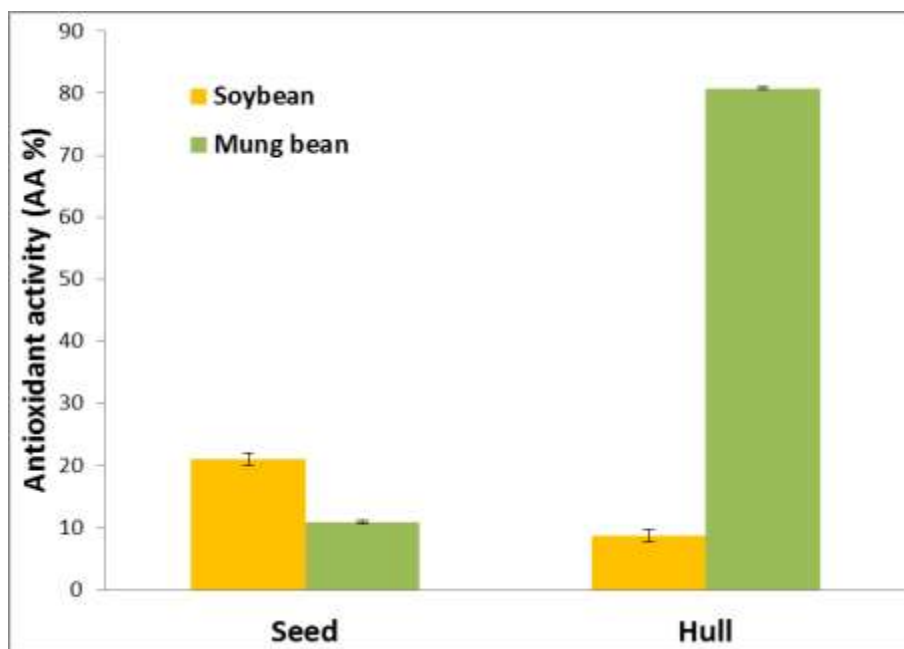


Figure 2. Antioxidant activity (AA %) of both inner and outer fractions of soybean and mung bean. Each value is expressed as the means out of 4 replicates with standard error.

Conclusions

The obtained results indicate that comparing the two analysed legumes, the highest antioxidant capacity was exhibited in the mung bean hulls, almost 10 times higher than the activity of the same seed fraction of soybean. Each of the analysed legume seed fractions had a different antioxidant capacity. Antioxidant activity may be a reliable indicator of seed quality. Efficient radical scavenging activity of the outer fraction of the mung bean suggests that this legume may be evaluated as a functional food ingredient. The seeds possessing higher antioxidant potential could be suggested as a better food source due to their health benefits. The growing interest in the functional properties of mung bean and soybean has focused the attention of research studies towards bioactive compounds and their health benefits.

Acknowledgement

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, by the grant number 451-03-9/2021-14/200053.

References

- Amarowicz R, Pegg RB (2008). Legumes as a source of natural antioxidants, *European Journal of Lipid Science and Technology*, 110 (10), 865-878.
- Ganesan K, Xu B (2018) A critical review on phytochemical profile and health promoting effects of mung bean (*Vigna radiata*), *Food Science and Human Wellness*, 7, 11-33.
- Gaonkar V, Rosentrater KA (2019). Chapter 4: Soybean, *Integrated Processing Technologies for Food and Agricultural By-Products*, Elsevier Inc. 73-104.