



UNIVERSITY OF
Kragujevac



FACULTY OF
AGRONOMY
ČAČAK

SYMBIOTECH

2nd INTERNATIONAL SYMPOSIUM ON BIOTECHNOLOGY

14-15 March 2024

Faculty of Agronomy in Čačak, University of Kragujevac, Serbia

- PROCEEDINGS -

2nd INTERNATIONAL SYMPOSIUM ON BIOTECHNOLOGY
XXIX Savetovanje o biotehnologiji sa međunarodnim učešćem

- PROCEEDINGS -

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Print-run: 30

Printed by

MEDIGRAF - Čačak, Aleksandra Savića 42, 32000 Čačak

ISBN 978-86-87611-91-7

Year of publication: 2024

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CONTENTS

Invited Speaker

<i>Predrag Putnik, Daniela Šojić Merkulov, Branimir Pavlić, Branko Velebit, Danijela Bursać Kovačević:</i> CHEMOMETRICS IN AGRI-FOOD BUSINESS AND SUSTAINABILITY.....	19
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Section: Field, Vegetable and Forage Crops

<i>Aleksandra Stanojković-Sebić, Darko Jaramaz, Zoran Dinić, Jelena Maksimović, Aleksandar Stanojković, Radmila Pivoić:</i> SOIL SUITABILITY FOR AGRICULTURAL PRODUCTION IN THE AREA OF PROGAR (SURČIN MUNICIPALITY, BELGRADE).....	29
<i>Milomirka Madić, Dragan Đurović, Vladeta Stevović, Dalibor Tomić, Milan Biberdžić, Nenad Pavlović, Miloš Marjanović:</i> GRAIN YIELD AND YIELD COMPONENTS OF PROSPECTIVE HOMOZYGOUS WINTER WHEAT GENOTYPES.....	35
<i>Nedeljko Racić, Vladeta Stevović, Vladimir Zornić, Mirijana Petrović, Mladen Prijović, Jasmina Radović:</i> EFFECTS OF LIME ON ALFALFA CULTIVARS YIELD ON ACIDIC SOIL.....	41
<i>Jelena Stojiljković, Vera Rajičić, Nenad Đurić, Milan Biberdžić, Kristina Luković, Vladimir Perišić, Veselinka Zečević:</i> THE EFFECT OF CLIMATE FACTORS ON MAIZE YIELD OF LATE SOWING DATE.....	47
<i>Valentina Nikolić, Vesna Perić, Marijana Simić, Slađana Žilić, Danka Milovanović, Beka Sarić:</i> ADVANCING THE NEW RESEARCH PATHWAYS OF “NUTRIBREEDING” FOR HUMAN AND ANIMAL NUTRITION WITH HEALTH BENEFITS.....	55
<i>Vesna Stepić, Gorica Cvijanović, Marija Bajagić, Nenad Đurić Vojin Đukić, Zlatica Mamlić, Gordana Dozet:</i> THE INFLUENCE OF EFFECTIVE MICROORGANISMS ON SOME CHARACTERISTICS OF DIFFERENT MAIZE	63
<i>Dalibor Tomić, Vladeta Stevović, Miloš Marjanović, Milomirka Madić, Nenad Pavlović, Vesna Đurović, Mirjana Radovanović, Đorđe Lazarević, Mirjana Petrović, Vladimir Zornić:</i> COBALT FERTILIZATION IN ORDER TO PROMOTE NITROGEN FIXATION IN ANNUAL FORAGE LEGUMES.....	69
<i>Jordan Marković, Nedeljko Racić, Filip Bekčić, Đorđe Lazarević, Tanja Vasić, Sanja Živković, Bogdan Cekić:</i> LIGNIFICATION AS THE MAJOR FACTOR LIMITING RED CLOVER DM AND NDF DIGESTIBILITY.....	75
<i>Marija Gavrilovic, Biljana Veljkovic, Ranko Koprivica, Nenad Pavlovic:</i> STRATEGIES FOR OPTIMIZED FERTILIZER USE: IMPLICATIONS FOR ENERGY EFFICIENCY AND CROP PERFORMANCE.....	81

<i>Violeta Mickovski Stefanović, Predrag Brković, Dragan Božović, Stanka Pešić, Bojan Laloš, Branko Tomić, Dragan Romić: DEVELOPMENT OF WHEAT STEAM UNDER CONTAMINATION WITH HEAVY METALS.....</i>	89
<i>Nenad Pavlović, Vladimir Crepuljarević, Jelena Mladenović, Miloš Marjanović, Ljiljana Bošković-Rakočević, Dalibor Tomić, Marija Gavrilović, Jasmina Zdravković: INFLUENCE OF DIFFERENT SUBSTRATES ON THE QUALITY OF PEPPER SEEDLINGS (Capsicum annuum L.).....</i>	97
<i>Sofija Petrović, Borislav Banjac, Mirela Matković Stojšin, Teodora Feher: BREAD WHEAT FROM STRESS TO PRODUCTIVITY IN PURSUIT OF FOOD SECURITY IN RAPID CLIMATE CHANGE.....</i>	103
<i>Mihajlo Marković, Durađ Hajder, Milan Šipka, Mladen Todorović, Nery Zapata, Teresa A. Paço, Erminio E. Riezzo, Sabrija Čadro: SUSTAINABLE MANAGEMENT OF AGRICULTURAL RESOURCES IN MAIZE PRODUCTION IN BIH - H2020 SMARTWATER PROJECT.....</i>	109
<i>Ranko Koprivica, Biljana Veljković, Radmila Žugić, Marija Gavrilović, Goran Dugalić, Bojana Milenković, Dragan Terzić: THE USE OF TRACTOR AGGREGATES ON A MEDIUM-SIZED FARM IN ARABLE PRODUCTION</i>	115

Section: Pomology and Viticulture

<i>Vujović Tatjana, Anđelić Tatjana, Ružić Đurđina: LOW-TEMPERATURE STORAGE IN VITRO OF FRUIT TREE SPECIES AT THE FRUIT RESEARCH INSTITUTE, ČAČAK.....</i>	123
<i>Branislav Dudić, Alexandra Mittelman, Velibor Spalević: THE COMPARATIVE ANALYSIS OF EUROPEAN WINE INDUSTRY.....</i>	129
<i>Bojana Vasilijević, Vera Katanić, Sanja Žitković, Tanja Vasić, Stefan Kovačević, Darko Jevremović: APPLICATION OF MULTIPLEX RT-PCR FOR GRAPEVINE VIRUSES DETECTION.....</i>	137
<i>Ivan Glišić, Radmila Ilić, Tomo Milošević, Gorica Paunović: PHENOLOGY AND FRUIT CHARACTERISTICS OF AUTOCHTHONOUS APPLE CULTIVARS.....</i>	147
<i>Mlađan Garić, Ivana Radojević, Dragan Nikolić, Vera Rakonjac, Aleksandar Petrović, Zorica Ranković-Vasić, Darko Jakšić, Miloš Ristić: PRODUCTION AND TECHNOLOGICAL CHARACTERISTICS OF THE PROKUPAC WINE VARIETY IN THE NIŠ WINE-GROWING REGION.....</i>	155
<i>Zvezdana Marković, Iva Šikuten, Anita Bošnjak Mihovilović, Domagoj Stupić, Željko Andabaka, Valentina Tuščić, Ana Šišak, Ivana Tomaz, Darko Vončina, Darko Preiner: THE INFLUENCE OF SANITARY STATUS AND THE POSITION OF EXPLANTS ON THE GROWTH AND DEVELOPMENT OF IN VITRO 'PLAVAC MALI' AND 'POŠIP'.....</i>	163

<i>Tatjana Popović, Armin Kalač, Zoran Jovović, Danijela Raičević, Radmila Pajović-Šćepanović: INFLUENCE OF DIFFERENT VINEYARD WEED CONTROL METHODS ON AGROBIOLOGICAL, ECONOMICAL AND TECHNOLOGICAL CHARACTERISTICS OF VRANAC VARIETY.....</i>	169
<i>Biljana Veljković, Dušan Marković, Ranko Koprivica, Marija Gavrilović: CALCULATIONS IN RASPBERRY PRODUCTION ON FAMILY FARMS IN WESTERN SERBIA.....</i>	175

Section: Livestock Production

<i>Veselin Petričević, Miloš Lukić, Zdenka Škrbić, Vladimir Dosković, Simeon Rakonjac, Maja Petričević, Danijel Milenković: COMPARATIVE ANALYSIS OF PRODUCTION AND SLAUGHTER PARAMETERS OF FAST-GROWING BROILER HYBRIDS....</i>	183
<i>Biljana Trajkovska, Blagoja Risteski, Vesna Karapetkovska-Hristova, Kujtim Elmazi, Aleksandra Grozdanovska, Borce Petkovski: ALTERATIONS IN THE PHYSICO-CHEMICAL COMPOSITION OF MILK ACROSS UDDER QUARTERS</i>	193
<i>Bojan Stojanović, Vesna Davidović, Aleksandra Ivetić, Stamen Radulović, Blagoje Stojković: SULFUR-CONTAINING AMINO ACID SUPPLY IN ORGANIC POULTRY DIETS....</i>	201
<i>Ljiljana Samolovac, Slavča Hristov, Marina Lazarević, Nenad Mičić, Dragan Nikšić, Dušica Ostojić-Andrić, Tamara Stamenić: THE PHYSIOLOGICAL FORMS OF CALVES BEHAVIOUR IN THE ASSESSMENT OF WELFARE.....</i>	211
<i>Milun D. Petrović, Snežana Bogosavljević-Bošković, Vladan Bogdanović, Radojica Đoković, Simeon Rakonjac, Miloš Petrović: REARING SYSTEMS AND PRODUCTION IN ORGANIC POULTRY FARMING.....</i>	217
<i>Vladimir Dosković, Snežana Bogosavljević-Bošković, Zdenka Škrbić, Miloš Lukić, Simeon Rakonjac, Veselin Petričević, Dejan Beuković: THE EFFECT OF PROTEASE ENZYME ON THE MEAT CLASSES OF TWO BROILER CHICKEN HYBRIDS.....</i>	225

Section: Plant Protection, Food Safety and the Environment

<i>Aleksandra Milošević, Goran Stanišić, Milena Milojević, Suzana Knežević, Maja Došenović Marinković: REGULATORY PERSPECTIVES ON NITRATE USAGE IN ORGANIC AGRICULTURE: A FOCUS ON EU LEGISLATION</i>	233
<i>Gorica Djelic, Duško Brković, Milica Pavlovic, Vesna Veličković: BIOCHEMICAL RESEARCH OF THE SPECIES ORCHIS MORIO L. FROM ZLATAR</i>	243
<i>Ljubica Šarčević-Todosijević, Snežana Đorđević, Bojana Petrović, Vera Popović, Jelena Golijan-Pantović, Vladimir Filipović, Nikola Đorđević: BIOLOGIAL ACTIVITY OF PLANT METABOLITES.....</i>	249
<i>Marijana Ponjavić, Jelena Milovanović, Jasmina Nikodinović-Runić, Nikola Đurašković, Nedeljko Tica, Irena Živković: BIODEGRADABILITY ASSESSMENT OF CORN STOVER REINFORCED COMPOSITE MATERIALS WITH DIFFERENT MATRIX.....</i>	255

<i>Gorica Djelic, Vesna Veličković, Milica Pavlović: SESELI RIGIDUM WALDST. & KIT: SECONDARY METABOLITES AND ANTIOXIDANT ACTIVITY OF METHANOL, ETHYL ACETATE AND ACETONE EXTRACTS</i>	263
<i>Selena Dmitrović, Ivana Danilov, Vanja Vlajkov, Tatjana Dujković, Jovana Grahovac, Aleksandar Jokić, Nataša Lukić: POSSIBILITY OF USING EGG SHELL AS A FLOCCULANT TO HARVEST BIOMASS OF Bacillus sp. FOLLOWING BIOTECHNOLOGICAL TREATMENT OF FOOD SECTOR WASTEWATERS.....</i>	269
<i>Silvana Pashovska: STRATEGIC PLANNING OF TOBACCO PRODUCTION IN MACEDONIA TROUGH A SWOT ANALISIS.....</i>	277
<i>Kristina Markeljić, Aleksandra Rakonjac, Nevena Đorđević, Duško Brković, Snežana Simić: BENTHIC ALGAE AS BIOINDICATORS IN ASSESSING ECOLOGICAL STATUS OF ČEMERNICA AND DIČINA RIVERS.....</i>	289
<i>Radmila Pivić, Jelena Maksimović, Dinić Zoran, Darko Jaramaz, Tara Grujić, Mira Milinković, Aleksandra Stanojković-Sebić: INFLUENCE OF DIFFERENT SOIL USE ON VERTISOL WATER INFILTRATION.....</i>	295
<i>Dragutin Đukić, Leka Mandić, Vesna Đurović, Monika Stojanova: THE INFLUENCE OF SATURATED SOLUTIONS OF MINERAL SALTS ON SAPROPHITIC BACTERIA IN THE SOIL.....</i>	301
<i>Nela Djonovic, Sanja Kocic, Svetlana Radevic: HEALTH SAFETY OF BAKERY PRODUCTS.....</i>	309
<i>Tanja Vasić, Sanja Živković, Vera Katanić, Bojana Vasiljević, Darko Jevremović, Jordan Marković: MYCOPOPULATION ON SEED OF WEED PLANTS IN ORGANIC VEGETABLE PRODUCTION CROP.....</i>	317
<i>Duško Brković, Gorica Đelić, Snežana Branković, Kristina Markeljić: CONTRIBUTION TO THE RESEARCH OF THE FLORA AND HABITAT CHARACTERISTICS OF SP "BORAČKI KRŠ" BORAČ.....</i>	323

Section: Food Technology

<i>Zorana Miloradovic, Jovana Kovacevic, Jelena Miocinovic, Ilija Djekic, Nada Smigic: EMPOWERING SMALL-SCALE DAIRY PROCESSORS: A COMPREHENSIVE ANALYSIS OF TRAINING IMPACT AND PARTICIPANT FEEDBACK</i>	329
<i>Radoslava Savić Radovanović, Milijana Sinđić, Jelena Aleksić Radojković, Slobodanka Janićjević: MICROBIOLOGICAL SAFETY OF FOOD OF ANIMAL ORIGIN IN BELGRADE RESTAURANTS AND CATERING FACILITIES</i>	337
<i>Vesna Ružičić, Jelena Pantović: DEVELOPMENT OF THE KNOWLEDGE BASE FOR APPLICATIONS OF INFORMATION-EXPERT SYSTEMS IN THE FIELD OF FOOD TECHNOLOGY.....</i>	347

<i>Eldar Hasandić, Amila Slijepčević, Melika Trako, Aldin Tahirović, Semina Pinjić, Munevera Begić: THE INFLUENCE OF PRODUCTION TECHNOLOGY ON THE OVERALL QUALITY OF “VISOČKI SUDŽUK”</i>	353
<i>Mirjana Radovanović, Marija Jovičević, Nemanja Miletić, Marko Petković, Vesna Đurović: FORMATION OF HYDROXYMETHYLFURFURAL DURING THE INDUSTRIAL PRODUCTION OF PLUM PEKMEZ</i>	363
<i>Sanja Đurđević, Igor Tomašević, Slaviša Stajić, Dušan Živković: QUALITY OF MINCED MEAT PRODUCTS</i>	371
<i>Danka Mitrović, Nikolina Živković, Ana Milić, Ivana Ignjatović Sredović, Aleksandar Petrović: THE INFLUENCE OF MACERATION TIME ON THE CHEMICAL AND SENSORY CHARACTERISTICS OF WINES FROM THE SERBIAN AUTOCHTHONOUS VARIETY “PROKUPAC”</i>	377
<i>Enver Karahmet, Senita Isaković, Almir Toroman, Ervina Bečić, Zoran Marković: DETERMINATION OF HEAVY METALS IN FRESH FISH</i>	385
<i>Vladimir S. Kurčubić, Saša Živković, Marko Dmitrić, Slaviša Stajić, Luka V. Kurčubić: BIOACTIVE POWER OF LYOPHILIZED PLANT RAW MATERIALS: EVALUATION AND ASSESSMENT OF SUITABILITY FOR THE PRODUCTION OF NATURAL FOOD SUPPLEMENTS AND ANTIMICROBIAL DRUGS</i>	393
<i>Dragoljub Cvetković, Aleksandra Ranitović, Tara Budimac, Olja Šovljanski: EXAMINATION OF THE SURVIVAL OF <i>Lactobacillus plantarum</i> AND <i>Lactobacillus rhamnosus</i> DURING KOMBUCHA FERMENTATION</i>	409
<i>Vesna Đurović, Sofija Radenković, Leka Mandić, Mirjana Radovanović, Marijana Pešaković, Ivana Bošković, Dragutin Đukić: ANTIOXIDANT AND ANTIBACTERIAL ACTIVITIES OF ZIZYPHUS JUJUBA L. LEAF EXTRACTS</i>	415
<i>Milan P. Nikolić: COMPARASION OF THE AROMA ACTIVE COMPOUNDS IN RAW SPIRITS OBTAINED FROM DIFFERENT APPLE VARIETIES</i>	423
<i>Tomislav Trišović, Ana Trišović, Lidija Rafailović, Branimir Grgur, Zaga Trišović: AUTOMATIC CONTROL AND ARTIFICIAL INTELLIGENCE: DEVICE FOR CONTINUOUS CHLORINE RESIDUAL MEASUREMENT</i>	431
<i>Danka Milovanović, Beka Sarić, Valentina Nikolić, Marijana Simić, Slađana Žilić: QUALITY PARAMETERS OF SILAGE MAIZE HYBRIDS FOR RUMINANT FEED</i>	439

Section: Applied Chemistry

<i>Nevena Mihailović, Andrija Ćirić, Nikola Srečković, Vladimir Mihailović, Ljubinka Joksović, Samo Krefč: OPTIMIZATION OF ULTRASONIC-ASSISTED EXTRACTION OF PHENOLIC COMPOUNDS FROM <i>SALVIA VERTICILLATA</i> L. ROOT USING RESPONSE SURFACE METHODOLOGY</i>	447
--	-----

<i>Nevena Mihailović, Vladimir Mihailović, Nikola Srečković</i> : PHENOLIC CONTENT AND ANTIOXIDANT PROPERTIES OF SOME NATURAL COSMETIC CREAMS WITH PLANT-DERIVED INGREDIENTS AVAILABLE ON THE SERBIAN MARKET.....	453
<i>Jovana Cvjetković, Darko Manjenčić, Vladan Mičić, Anja Manjenčić</i> : INFLUENCE OF CONTROLLED RADIATION ON THE PROPERTIES OF BIOCOMPATIBLE SILICONE ELASTOMERS.....	459
<i>Goran Petrović, Aleksandra Đorđević, Jelena Stamenković, Marija Dimitrijević, Jelena Nikolić, Vesna Stankov Jovanović, Violeta Mitić</i> : GERANIUM MACRORRHIZUM, THE CURE IN YOUR GARDEN. NEW METHOD OF GERMACRONE ISOLATION.....	465
<i>Goran Petrović, Aleksandra Đorđević, Jelena Stamenković, Marija Dimitrijević, Jelena Nikolić, Vesna Stankov Jovanović, Violeta Mitić</i> : FATTY ACIDS CONTENT IN WATERMELON, MELON, SQUASH AND ZUCCHINI SEEDS.....	471
<i>Stefan Petrović, Denis Mitov, Aleksandar Randelović, Jelena Mrmošanin, Aleksandra Pavlović, Snežana Tošić</i> : UPTAKE OF HEAVY METALS BY WHITE CLOVER (TRIFOLIUM REPENS L.) – POT EXPERIMENT.....	477
<i>Stefan Petrović, Katarina Milenković, Denis Mitov, Milena Nikolić, Jelena Mrmošanin, Aleksandra Pavlović, Snežana Tošić</i> : THE INFLUENCE OF HEAVY METAL(OID)S SOIL CONTAMINATION ON THE CONTENT OF PIGMENTS IN PEPPER AND MAIZE LEAVES.....	483
<i>Ognjen Pavlović, Tamara Milenković, Nevena Barać, Miroljub Barać, Ivana Sredović Ignjatović</i> : PHYTOCHEMICAL CONTENT AND ANTIOXIDANT PROPERTIES OF OSMOTIC DEHYDRATED BLUEBERRY, CHERRY AND POMEGRANATE FRUIT.....	489
<i>Ivana Rašić Mišić, Jorgovanka Bojić, Emilija Pecev-Marinković, Aleksandra Pavlović, Jelena Mrmošanin, Bojan Zlatković, Tijana Jovanović</i> : HEAVY METALS DETERMINATION IN <i>ACHILLEA LINGULATA</i> AND <i>ACHILLEA DISTANS</i> BY ICP-OES.....	497
<i>Milan Mitić, Jelena Mitić, Pavle Mašković, Jelena Mašković, Goran Petrović, Jelena Nikolić, Vesna Stankov-Jovanović</i> : ENHANCING THE EXTRACTION EFFICIENCY OF CAFTARIC ACID FROM GRAPE PULP THROUGH OPTIMIZATION PROCESS.....	503
<i>Jelena Mladenović, Ivana Vranjevac, Dusko Brković, Nenad Pavlović, Milos Marjanović, Jasmína Zdravković, Nenad Đurić</i> : DETERMINATION OF THE CONTENT OF BIOACTIVE COMPONENTS IN DIFFERENT EXTRACTS OF CELERY LEAVES (<i>Apium graveolens</i> L.).....	509

<i>Igor Đurović, Miloš Petrović, Vesna Matejić: COW'S MILK IN RELATION TO DIFFERENT PLANT-BASED DRINKS: PHYSICO-CHEMICAL PROPERTIES AND NUTRITIONAL IMPORTANCE.....</i>	515
<i>Ana Milenkovic Andjelkovic, Miroslav Popovic, Jelena Mladenovic: ANALYSIS OF PHYSICOCHEMICAL PARAMETERS AND TOTAL AMOUNTS OF MICROORGANISMS IN LAKE VLASINA.....</i>	521
<i>Ivana Radojević, Edina Avdović, Dušan Dimić, Marko Antonijević, Marijana Vasić, Katarina Ćirković: ANTIMICROBIAL ACTIVITY OF HYBRIDS OF COUMARIN'S DERIVATIVES WITH NEUROTRANSMITTERS.....</i>	531
<i>Ana Obradović, Milena Vukić, Milica Paunović, Branka Ognjanović, Nenad Vuković, Miroslava Kačanićová, Miloš Matić: ANTITUMOR EFFECTS OF TANACETUM BALSAMITA ESSENTIAL OILS BY DOWNREGULATION NRF-2 AND MMP-9 IN BREAST CANCER.....</i>	537
<i>Katarina Milenković, Jelena Mrmošanin, Stefan Petrović, Bojan Zlatković, Snežana Tošić, Milan Mitić, Aleksandra Paolović: INFLUENCE OF EXTRACTION SOLVENTS ON THE PHENOLIC PROFILE OF ROSA DUMALIS BECHST. FRUIT SAMPLES.....</i>	547
<u>Section: Nutritionism</u>	
<i>Vladimir Jakovljević: EFFECTS OF STANDARDIZED ARONIA MELANOCARPA EXTRACT ON CARDIOVASCULAR SYSTEM: FROM BASIC TO APPLIED INVESTIGATION.....</i>	553
<i>Nenad Mićanović, Sanja Đurović, Nenad Naumovski, Violeta Mickovski Stefanović, Hanbing Li, Jelena Popović-Đorđević: INSIGHT INTO SELECTED QUALITY PARAMETERS OF MEDLAR (MESPILUS GERMANICA L.) FRUIT GROWN IN SERBIA.....</i>	559
<i>Anica Petrovic, Jovana Bradic, Marijana Andjic, Aleksandar Kocovic, Jovana Novakovic, Vladimir Jakovljevic: CARDIOPROTECTIVE EFFECTS OF LADY'S BEDSTRAW EXTRACT: FOCUS ON OXIDATIVE STRESS.....</i>	565
<i>Aleksandra Stojanovic, Marina Nikolic, Nevena Lazarevic, Jovana Novakovic, Nevena Jeremic, Vladimir Zivkovic, Jovana Bradic, Vladimir Jakovljevic: BENEFICIAL PROPERTIES OF TRAMETES VERSICOLOR HETEROPOLYSACCHARIDES IN A RAT MODEL OF METABOLIC SYNDROME.....</i>	571
<i>Katarina Mihajlovic, Vladimir Jakovljevic, Jovana Bradic, Maja Savic, Marina Nikolic, Jasmina Sretenovic: ASSESSMENT OF GALIUM VERUM EXTRACT SUPPLEMENTATION ON REDOX HOMEOSTASIS IN PSORIATIC RAT MODEL.....</i>	577

<i>Marijana Andjic, Jovana Novakovic, Aleksandar Kocovic, Marina Nikolic, Anica Petrovic, Vladimir Jakovljevic, Jovana Bradic: THE EFFECTS OF CHRONIC ADMINISTRATION OF ALLIUM URSINUM EXTRACT ON SYSTEMIC REDOX STATUS IN RATS.....</i>	587
<i>Aleksandra Arsić, Milica Kojadinović, Snjezana Petrović, Danijela Ristić Medić, Milena Žuža Praštalo, Vesna Vučić: EFFECTS OF POMEGRANATE JUICE ON LIPID METABOLISM IN WOMEN WITH DYSLIPIDEMIA AND METABOLIC SYNDROME.....</i>	593
<i>Snježana Petrović, Marija Paunović, Nataša Veličković, Bojana Micić, Maja Milošević, Aleksandra Arsić, Biljana Pokimica, Vesna Vučić: POLYPHENOL-RICH BLACK CURRANT JUICE AMELIORATES METABOLIC SYNDROME INDUCED BY HIGH-FAT HIGH-FRUCTOSE DIET IN RATS</i>	595

BIOLOGICAL ACTIVITY OF PLANT METABOLITES

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Abstract: As part of theoretical and applied botanical research, medicinal plant raw materials and their ingredients are studied. Certain plant species contain active substances, compounds with proven pharmacological, that is, biological activity. The mentioned compounds mainly belong to the secondary metabolites of plants.

Keywords: botany, plants, plant metabolism, biological activity.

Introduction

Given that plants have influenced the historical development of civilization, botanical research has enormous theoretical and practical importance. As part of theoretical and applied botanical research, medicinal plant raw materials are studied. The chemical structure of the most important groups of pharmacologically active compounds of plant origin, the production and cultivation of medicinal plants, as well as their pharmacological, i.e. biological action and application, are studied. Also, knowledge and skills of identification and control of natural raw materials, knowledge of phytopreparations, and possibilities of rational phytotherapy are acquired. Herbal drugs and herbal preparations contain active compounds with proven pharmacological activity. The therapeutic effect of plant species is based on active ingredients, which most often belong to the group of secondary metabolites (Jančić, 2004; Kovačević, 2004; Šarčević-Todosijević et al., 2018; Šarčević-Todosijević et al., 2023).

In this paper, the biological activity of plant metabolites is discussed.

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Materials and methods

The method of data analysis, which was collected from certain studies, was applied. Relevant scientific data, published in scientific books, papers in international and national scientific journals and scientific conferences, were used. The analyzed scientific papers belong to the categories of original and review papers.

Results and discussion

Through scientific research work in the field of biology, pharmacy and agronomy, pharmaceutical, agronomic, chemical and biological aspects of medicinal and aromatic plants are studied. Research on the quality and resources of wild plants, chemical analysis of plants and their extracts using modern analytical methods, as well as testing of biological activity in order to confirm the effectiveness of plants used in traditional phytotherapy is carried out. These researches are also carried out in order to find potential new medicinal properties of plants (Kovačević, 2004; Šarčević-Todosijević et al., 2018; Šarčević-Todosijević et al., 2023).

In living organisms, a large number of biochemical reactions, catalyzed by specific enzymes, are continuously carried out. The primary metabolism of a plant cell includes the process of photosynthesis and the subsequent transformation of glucose into polysaccharides, lipids and proteins. Secondary metabolism is a direct continuation of primary metabolic processes, and compounds of a very diverse chemical nature are formed: alkaloids, heterosides, saponosides, polyphenols, etc. The use of medicinal plants is regulated by the pharmacopoeia, which represents a collection of prescribed norms and standards for substances and the manufacture of medicines, which determine their identification, characteristics, quality, method of preparation and analysis. Herbal drugs are medicinal raw materials of plant origin, which contain pharmacologically active compounds and are used for the extraction or production of medicinal preparations (Jančić, 2004; Kovačević, 2004; Šarčević-Todosijević et al., 2019a).

Herbal drugs and herbal preparations contain compounds that have been proven to exhibit biological activity. This activity is not expressed for primary plant metabolites, carbohydrates, proteins and lipids, while secondary plant metabolites exhibit strong and specific biological activity on the human organism, as well as other organisms. In contrast to the large application in the

pharmaceutical and food industry, carbohydrates and herbal drugs containing them have a very limited therapeutic application. Because of its nutritional value, glucose is given to patients as an infusion. Plant proteins also rarely have pharmacological activity and a certain therapeutic value, except that, like glucose, amino acids mixtures are prepared and given by infusion to certain groups of patients. In addition, enzymes isolated from plant tissues are used in therapy (Kovačević, 2004, Šarčević-Todosijević et al., 2019b, Popović et al., 2021; Petrović et al., 2022).

From the aspect of lipid application in pharmacy, it is necessary to mention solid lipid nanoparticles (LNPs), as a new pharmaceutical drug delivery system. Solid lipid nanoparticles (LNPs) have been used more intensively since the end of 2020. Some COVID-19 vaccines have fragile mRNA chains coated with lipid nanoparticles as a delivery vehicle. Oral administration of LNPs is possible in the form of an aqueous dispersion or after conversion into traditional pharmaceutical forms, e.g. tablets, capsules or powders. Solid lipid nanoparticles can be transformed into a powder and added to a mixture of tableting powders. Some therapeutic problems, such as instability, low membrane permeability and drug bioavailability, can be solved by designing appropriate delivery systems based on the combination of two basic classes of ingredients: polymers and lipids (Milić et al., 2005).

The use of most biologically active substances is more recent, when their powerful medicinal or protective effects (antioxidant, antimutagenic, anticarcinogenic) were confirmed. One of the most important such compounds is a diterpene alkaloid taxol, which is produced by *Taxus brevifolia* and *Taxus baccata* plant species. It is used in the therapy of cancer metastases. Alkaloids are versatile heterocyclic nitrogen compounds, products of the secondary metabolism of plants, which exhibit a strong and specific pharmacological activity on the human and animal organisms (Kovačević, 2004; Šarčević-Todosijević et al., 2019a). Despite long-term use, there is still an interest in testing new unexplored herbal drugs, potential raw materials for the pharmaceutical industry, for more detailed testing and definition of bioactive content, as well as for the partial synthesis of new alkaloid molecules based on natural alkaloids (Tanović, 2005). Expectorants are drugs that increase pulmonary secretion. In addition to synthetic expectorants, herbal drugs with an expectorant effect are also used, especially in self-medication (Halliwell, 1997). *Ipecacuanha* root, *Ipecacuanha radix*, is the only alkaloid drug that is used as an expectorant. After oral administration, emetine irritates the mucous membrane of the stomach and through a reflex pathway, via afferent

parasympathetic fibers, stimulates the glandular cells of the bronchial mucosa and increases the secretion (Husain et al., 1987). In addition to a number of ingredients, compounds from the group of alkaloids were detected in *Achillea millefolium*, namely: achillein, achilicine, betaine. Experiments have shown that achillein detected in *Achillea millefolium* has hemostatic and antimicrobial properties. In addition to alkaloids, as biologically active ingredients, the essential oils of this plant also exhibit antioxidant and antimicrobial properties (Aryal et al., 2022). As mentioned, most secondary metabolites do not directly participate in the growth and development of plants and are not necessary for their life, but they play a major role in the interaction of plants with the environment. This group of plant metabolites also includes polyphenols, a class of natural, synthetic, and semisynthetic organic compounds. They include phenolic acids, flavonoids, coumarins, stilbenes and lignans, but also other polymerized forms, such as tannins and lignins. As natural products of the secondary metabolism of plants, they are found in fruits, vegetables, nuts and spices (Kovačević, 2004; Mattila et al., 2006; Ćetković, 2008; Spencer et al., 2008). The intake of vegetables, fruits and cereals is associated with a reduced risk of developing chronic diseases, primarily thanks to plant metabolites, which reduce oxidative stress in cells, which causes damage to biological macromolecules (DNA, lipids and proteins), which results in the appearance of degenerative diseases (Temple, 2000). Based on *in vitro* studies, it was concluded that the effect of red wine polyphenols on vascular tone is due to short-term and long-term mechanisms. Vasorelaxation is a short-term response to wine polyphenols, which act by increasing the influx of extracellular Ca and mobilizing intracellular Ca in endothelial cells. Polyphenolic compounds can also exert long-term effects, because they increase the expression of endothelial nitric oxide synthase, decrease the expression of adhesion molecules and growth factors involved in the migration and proliferation of vascular smooth muscle cells (Dell'Agli, 2004). The use of herbs is one of the most popular and common ways to reduce menopause symptoms (Geller and Studee, 2006). Numerous studies have shown that regular consumption of phytoestrogens in the diet of Asian women leads to a reduction of menopausal symptoms (Adlercreutz et al., 1992). Mohammad-Alizadeh-Charandabi et al. (2013) conducted a randomized, double-blind, placebo-controlled trial. 84 women were randomly assigned to treatment and control groups. The results of this study indicated that taking black cohosh (*Actaea racemosa*) for 8 weeks, in the form of one tablet after dinner (tablet contains 6.5 mg of extract as dry extract), reduced symptoms in early postmenopausal women compared to placebo. The

effectiveness of the treatment increased with longer use (Mohammad-Alizadeh-Charandabi et al., 2013).

Conclusion

As part of theoretical and applied botanical research, medicinal plant raw materials, their ingredients, chemical structure, production and cultivation of medicinal plants, as well as their pharmacological, i.e. biological activity and application, are studied. The most pronounced biological activity has been scientifically proven for the products of the secondary metabolism of plants.

Acknowledgement

This paper is part of the projects, Grant numbers: 451-03-9/2023-14/200032 and Project: 451-03-66/2024-03/200003.

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CIP - Каталогизација у публикацији Народна библиотека Србије,
Београд

63(082)
606:63(082)

INTERNATIONAL Symposium on Biotechnology (2 ; 2024 ; Čačak)
Proceedings / 2nd International Symposium on Biotechnology, 14–15
March 2024 ; [organizer] University of Kragujevac, Faculty of
Agronomy [in] Čačak. - Kragujevac : University, Faculty of Agronomy
in Čačak, 2024 (Čačak : Medigraf). - 595 str. : ilustr. ; 24 cm

"XXIX Savetovanje o biotehnologiji sa međunarodnim učešćem" -->
kolofon. - Tiraž 30. - Bibliografija uz svaki rad.

ISBN 978-86-87611-91-7

a) Пољопривреда -- Зборници b) Биотехнологија -- Зборници

COBISS.SR-ID 139941641

DOI: [10.46793/SBT29](https://doi.org/10.46793/SBT29)