th International Scientific Online Conference

DOI: https://doi.org/10.15414/2021.9788055224015

AGROBIODIVERSITY FOR IMPROVING THE NUTRITION, HEALTH, QUALITY OF LIFE AND SPIRITUAL HUMAN DEVELOPMENT



Slovak University of Agriculture in Nitra Institute of Plant and Environmental Sciences Excellent Centre for the Conservation and Sustainable Use of Agrobiodiversity Research Centre AgroBioTech



M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine Kyiv, Ukraine Department of Fruit Plants Acclimatization

Book of Abstracts

of the

5th International Scientific Conference

Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and Spiritual Human Development

November 3rd 2021

DOI: https://doi.org/10.15414/2021.9788055224015

Co-organizers

LIFE SCIENCES

kademia

Pomorska v Słupsku

Instytut Biologii i Nauk o Ziemi Arboretum and Institute of Physiography in Bolestraszyce, Poland

National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine

Uzhhorod National University, Uzhhorod, Ukraine

Institute of Rice of National Academy of Agrarian Sciences of Ukraine, Antonivka, Ukraine

University of Life Sciences in Lublin, Poland

Pomeranian Academy in Słupsk, Poland

Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland

Botanical Garden of Slovak University of Agriculture in Nitra, Slovak Republic

N.V. Tsitsin Main Botanical Garden of Russian Academy of Sciences, Moscow, Russian Federation

Agrogenofond, Nitra, Slovakia

SaveBees: Save Endangered Bees to Improve Nutrition, Health and Life Quality of Human

Foundation of Women Beekeepers

"BeesAgro" Controlled Pollination Association

Bio Bee Clinic, Bačko Novo Selo, Republic of Serbia

Health Complex, Dudince, Slovakia

Spa Dudince, Slovakia

DOI: https://doi.org/10.15414/2021.9788055224015

Institutions and experts were actively involved in the organization of the 5th International Scientific Conference

Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and **Spiritual Human Development**

in the framework of

AgroBioNet

International Network within the implementation of the International Program

'Agrobiodiversity for Improve the Nutrition, Health and Quality of Life'

in the form of implemented research, educational and development projects and research stays at the international conference in lectures Authors and author collectives present posters and publications as well as results and knowledge from

Research Projects ITEBIO ITMS 26220220115 ECOVA ITMS 26220120015 **ECOVA plus** ITMS 26220120032 AGROBIOTECH ITMS 26220220180 **TRIVE** ITMS 26110230085 **BIOPOTRAVINY** ITMS 25 110 320 104

Research Programs from research stay of participants with financial support from the Agencies and the EU program

Ministry of Education, Science, Research and Sport of the Slovak Republic - Bilateral Agreements

> Slovak Academic Information Agency (SAIA) Visegrad Fund (V4) **ERASMUS World UNESCO**



Funded by the European Union V



Ministry of Education, Science, Research and Sport of the Slovak Republic



Title: Book of Abstracts of the 5th International Scientific Conference Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and Spiritual Human Development

Editor: Ján Brindza Managing Editor: Olga Grygorieva Associate Editors: Svitlana Klymenko, Olena Vergun, Vladimíra Horčinová Sedláčková Reviewers: Tünde Juríková, Alla Kuklina Author of e-environment design, graphic design: Olga Grygorieva, Radovan Ostrovský Cover designed: Olga Grygorieva, Marina Kors Publication place: Nitra Publication date: 2021 Language: English Edition: AgroBio*Net* Publisher: Slovak University of Agriculture in Nitra

The publication in electronic form was approved by the Rector of the Slovak University of Agriculture in Nitra assoc. Prof. Klaudia Halászová, PhD. on 2nd November, 2021 as Proceedings of Scientific Abstracts from the International Conference.

In the Book of Abstracts, prepared with minor editing, corresponding co-authors are responsible for the accuracy of their submitted abstracts.

Copyright © 2021 Authors

Copyright © 2021 Slovak University of Agriculture in Nitra

This work is published under the license of the Creative Commons Attribution-NonCommercial 4.0 International Public License (CC BY-NC 4.0)

https://creativecommons.org/licenses/bync/ 4.0/legalcode



ISBN 978-80-552-2401-5

DOI: https://doi.org/10.15414/2021.9788055224015



Dear Participants

The Slovak University of Agriculture in Nitra, Slovakia, in active cooperation with the M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine (Kyiv), within the common established AgroBio*Net* International Network, has already prepared the 5th International Conference entitled Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and Spiritual Human Development. Unfortunately, due to the unfavourable pandemic situation in the world, this conference will take place online.

The international conference was prepared by the Organizers in a non-traditional form as several interconnected conferences on specific topics. The first conference will take place on November 3, 2021. It will be an opening conference with the complex of other conferences.

The first – introductory conference aims to open some new current topics, which form an important part of the issue of conservation and sustainable use of biodiversity – agrobiodiversity and the plant kingdom – by man and humankind. These are topics related to the development of humankind and the practical use of the natural wealth of this planet. Unfortunately, in a relationship – man and humankind – did not understand the very essence of the existence of life on this planet. This is reflected in the degradation of biodiversity and nature, however that international organizations such as the UN, FAO, EU and national governments have adopted many laws and programs to protect biodiversity and nature.

For this reason, the organizers orient the focus of the 5th International Conference, in addition to solving traditional current problems of conservation and use of agrobiodiversity, also on a very specific topic, namely the spiritual development of man, humankind, civilization.

Many conference participants may consider this issue to be inappropriate for the scientific community because the prevailing view is that the issue of spirituality belongs to the religious community. But the spiritual development of man does not only mean the relationship of man to any religion. The life of man and society is built on the principle of unity of the spiritual and material worlds in all areas. The state of energy in a person is manifested through three essentially different contents: body (matter), soul and spirit. According to Einstein, the matter is condensed energy. And the word "energy" means, like the word "function" – the ability to act.

Man cannot dematerialize and exist only as the spiritual essence. The material principle forms an important part of the human personality as well as of society. This is evident especially nowadays when the material world is experiencing a period of unlimited growth. The current standard of living is very high. Humans and humankind have the technique and technology to solve many extremely complex problems. But on the contrary, the spiritual principle of man and humankind is experiencing a period of the almost total decline.

Man's spirituality means his respect for universal human values while respecting the basic spiritual values of man. The basis of a person's spirituality are his moral qualities and values for life, responsibility not only to his partner, children, family, his work, work team, co-workers, the law but also to the nature, to all forms of life with respect for the principles of ethics. A person's spiritual culture is manifested in his good relations with other people, in his upbringing, behaviour, helping people in misery, showing humanity, positive thinking and acting in all his areas of activity without spreading pride, anger, hate, slandering, harassment in the family and the workplace.

The moral character of each working team, society is determined by the level of spirituality of all its members. This truth has been known since ancient times and has not lost its significance today. Spirituality is associated with the development of society. These are two interdependent categories. The French philosopher Denis Diderot put it very simply: "A human without spirituality cannot be a poet, a philosopher or a thinking man, he simply cannot be a human."

Human and humankind, in general, has so far proved and demonstrated admirable achievements in various sciences, technologies, but at the same time proved and demonstrated all inhuman forms of evil, war, crime, human abuse by modern weapons, organ harvesting, the spread of poverty, hunger, devastating nature and other drastic forms.

5th International Scientific Conference Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and



Russian naturalist and thinker Vladimir Vernadsky is the creator of the concept of the noosphere as part of the biosphere of our planet. In this recognized concept, Vernadsky respects the spread of conscious activity of people on our planet Earth in interaction with nature (biosphere). The basis of these relationships is a reasonable approach as the main condition for human survival. It connects the purpose of the noosphere in the harmonization of relations between man and nature. This relationship is already seriously disrupted by the developing technosphere as a complex of technical systems of today's consumer society, which is dominated by artificial material means of human activity. This means that society's harmony with nature is seriously disturbed. The spirituality of humankind is in decline. Proof of this is the growing number of natural disasters in all countries of the world.

Nature rebels and proves to humanity that it no longer tolerates such exploitation. The idea that the Earth is not just a pile of stones, but a living being has been proved by many important thinkers and scientists. But humans and humankind still do not realize it. In fact, concerning nature, a human appears as a kind of virus that parasitizes on his body, penetrates everywhere, multiplies at an increased speed and spoils it with its waste.

But despite the technical and technological sophistication of human civilization, humanity is not able to solve many problems. An illustrative example is the coronavirus pandemic, which has spread in all countries of the world. The solution to the given problem is dominated by the helplessness of humankind, the scientific and medical community. Are we convinced that repeated vaccinations could stop this threat to humanity?

Not only anthroposophical (gr. Anthroposophy – human and wisdom) doctors but also quite conventional scientists prove that the disease is only a way to point out to the body a spiritual problem that one does not want to solve. In his books "Disease as the Language of the Soul" and "Disease like the Way", the German physician Rudiger Dalke shows how some diseases relate to a person's mental state. Therefore, doctors who develop old forms of treatment for people with a new approach at the level of holistic medicine, functional medicine, psychosomatic medicine or other new forms of therapy and rehabilitation are successful.

In the context of a pandemic, "biophilia" is spreading significantly to humans. The term began to be actively used in the late 20th century when the American biologist Edward O. Wilson pointed out the consequences of the separation of man and humankind from nature. In his publication in 1984, Wilson wrote that biophilia means "the innate emotional connection between humankind and other living organisms." Quarantine, home working and the isolation of people during a pandemic in an artificial background without the presence of greenery and the natural environment have significantly increased people's environmental stress and its negative consequences. A study published last year in the journal Nature shows how air pollution and isolation from nature are associated with a significant decline in people's cognitive abilities and, in addition, contributes to their respiratory, cardiovascular diseases and others. Research from the University of Exeter (EU) found that employees in contact with nature were 15 % more productive and motivated than those who worked in a sterile background. The report entitled The Global Impact of Biophilic Design in the Workplace notes a 15 % increase in creativity among people working in natural plant environments; it is estimated that in a room with an adequate number of plants, the number of bacterial colonies will be reduced by 60%; headaches were observed to be reduced by 24% and eve irritation by 52%. Isolation of people at home for a long time during a pandemic has resulted in a sharp upwards of the houseplants purchase in many countries around the world. This trend also points to biophilia (https://www.biophiliccities.org/nature-pandemic-resources).

Humankind is destroying the biosphere at all levels. Drastic civilizational impacts on the environment have left about a million species of animals and plants threatened with extinction. This emerges from a report by the IPBES Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (1919). According to the report's authors, about 25% of the planet's animal and plant species are currently threatened with destruction (https://www.bbc.com/russian/features-48174756).



The global population tripled in the 20th century, and water use increased sixfold. Up to 2050, water consumption is expected to increase by 400 % in production and by 130 % in domestic use. Drought can aggravate the plenty of water. Drought will affect more people than any other natural disaster. At the beginning of this century, the average annual crops area under drought increased from 11.6 million hectares to 25.1 million hectares, representing an increase of 116 %. As many as 90 % of all disasters are water-related, and floods have been the most common global natural disasters in the last two decades. Up to 2050, the number of floods with adverse material consequences will increase significantly in many countries of the world due deforestation, wetland to climate change. loss and rising seas (https://www.cdc.gov/healthywater/global/wash statistics.html, https://inweh.unu.edu/wp-content/uploads/2017/11/Global-Water-Crisis-The-Facts.pdf).

Food security is one of the world's major problems. The problem has many contradictions. According to FAO statistics from 2020, almost 795 million people went hungry worldwide – 10 million more than in 2018 and almost 60 million more than five years ago. The report also predicts that the COVID-19 pandemic could increase the number of hungry people by more than 130 million people. According to the latest UNEP report, 1/3 of food and agricultural products are discarded each year without reaching the table of customers and consumers. Mankind discards more than \$1 billion worth of food each year. In the US, about 40 % of food ends up in waste. In Europe, more than 100 million tonnes of food are discarded each year.

According to the FAO forecast, humankind will have to increase food production 1.5–2.0 times up to 2050 to ensure food security for 9 billion people, which has already been difficult to achieve today. If this is ensured, CO2 emissions into the atmosphere will increase by 12–20 %, thus climate change will be affected.

The forests condition is related to food security. The world forest area decreased by 178 million hectares between 1990 and 2020. Of the 60,000 different tree species, about 17 500 are already on the Red List of Threatened Species according to the International Union for Conservation of Nature's (IUCN) <u>https://www.iucnredlist.org/resources/sowt</u>. Worldwide, more than 1 billion people are dependent on wild plant and animal products, such as wild meat, edible insects, edible plant products, fungi and fish, which often contain high levels of essential micronutrients. The value of forest foods as a nutritional resource is not limited to low- and middle-income developing countries. More than 100 million people in the European Union (EU) regularly consume wild foods. About 2.4 billion people in cities and the countryside use wood energy for cooking (The State of the World's Forests 2020 – ReliefWeb).

Human health and well-being are closely associated with forests. At present, more than 28,000 wild species are registered in forest ecosystems, which are used in traditional but also in modern therapy, cosmetics and other purposes. Visits to the forest environment have a proven positive impact on human physical and mental health. In many countries of the world, health is improved by already organized visits to forests ("swimming" in the forest air), building healing ecosystems, agroforest parks, healing meadows and other forms for improving the environment, especially in cities but also in rural areas.

We do not mention in this very brief overview other world's problems because of intimidation. These are real problems that are directly and indirectly related to both biodiversity and agrobiodiversity. The possibilities of the scientific community in each country are so limited that it is not possible to solve these problems.

This international conference aims to create more space and conditions for a broader discussion and search for all available solutions for the conservation and use of agrobiodiversity within the possibilities that research teams in individual countries and workplaces have. Research teams usually focus only on solving a specific biological problem of a plant species. That's right. But it would be appropriate for research teams to go beyond the research barriers and connect research results to practical applications, conditions and current societal challenges not only to improve nutrition, health and quality of life, but also to areas related to spiritual human development, and of humankind.

Therefore, the conference organizers included in the program lectures focused on ethics in biological research, the use of plant species and nature for human healing, the use of agroforestry systems for food production with the current solution of adverse climate change, practical use of plants for new therapy and rehabilitation of humans and other specific and unusual areas.

Founders of the international network AgroBio*Net* strive for more than 250 registered members of the international network and other participants to use the organized conferences in 2022 on various specific and unusual topics to create a discussion platform for learning new knowledge from new areas with the progressive integration of information into scientific fields and new possibilities for the practical use of biodiversity and agrobiodiversity. New and unusual topics include areas such as the use of plants in functional medicine, plant neurobiology, biophilia, quantum biology, communication with plants, the use of synergistic effects of plants, new methods of plants in rehabilitation and therapy, therapeutic landscape, bioregulators and biopesticides, ethics in biological research, water and plant energy, anthroposophy in biology, the economic value of less-used and less-known plants, the hemp (*Cannabis sativa* L.) and many others.

Conferences on specific topics will be organized progressive. Each conference will be organized one day with a presentation of selected 5–7 lectures after will be a discussion and exchange of knowledge and information of participants.

The organizers of the international conference expect further proposals as well as critical comments from the members of the international network AgroBio*Net* as well as other participants on the submitted concept of organizing further conferences.

Our scientific journal is available for the publication of original scientific works, short communications or reviews of researchers, PhD students and students "Agrobiodiversity for Improving Nutrition, Health and Life Quality" <u>https://agrobiodiversity.uniag.sk/scientificpapers</u>/.

Ján Brindza

Olga Grygorieva

on behalf of participants of the 5th International Scientific Conference Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and Spiritual Human Development

COMMITTEES

Honorary Committee

Assoc. Prof. **Klaudia Halászová** – Rector of Slovak University of Agriculture in Nitra, Slovak Republic

Prof. Dr. **Nataliia Zaimenko** – Director of M.M. Gryshko National Botanical Garden of the National Academy of Science of Ukraine, Kyiv

President of Scientific Committee

Assoc. Prof. Peter Ondrišík – Faculty of Agobiology and Food Resources, SUA, Slovakia

International Scientific Committee

Ukraine

Prof. **Svitlana Klymenko** – M.M. Gryshko National Botanical Garden of the National Academy of Science of Ukraine, Kyiv

Prof. Dr. **Dzhamal Rakhmetov** – M.M. Gryshko National Botanical Garden of the National Academy of Science of Ukraine, Kyiv

Prof. Dr. **Valeriy Brovarskiy** – National University of Life and Environmental Sciences of Ukraine in Kyiv

Assoc. Prof. **Andriy Prokopiv** – Botanical Garden of the Ivan Franko National University of Lviv Assoc. Prof. **Roman Ivannikov** – M.M. Gryshko National Botanical Garden of the National Academy of Science of Ukraine, Kyiv

Assoc. Prof. **Leonora Adamchuk** – National University of Life and Environmental Sciences, Kyiv **Liudmyla Svydenko**, PhD. – State Enterprise 'Experimental Farm Novokakhovsky' of Institute of Rice of the National Academy of Agrarian Sciences, Plodove

Olga Grygorieva, PhD. – M.M. Gryshko National Botanical Garden of the National Academy of Science of Ukraine, Kyiv

Olena Vergun, PhD. – M.M. Gryshko National Botanical Garden of the National Academy of Science of Ukraine, Kyiv

Poland

Dr. **Narcyz Piórecki** – Arboretum and Institute of Physiography in Bolestraszyce Prof. **Alicja Kucharska** – Wrocław University of Environmental and Life Science, Wrocław

Prof. **Halyna Tkachenko** – Pomeranian University in Słupsk

Prof. **Anna Bieniek** – University of Warmia and Mazury in Olsztyn

Agata Antoniewska, PhD. – Warsaw University of Life Sciences, Warsaw

Bulgaria

Assoc. Prof. **Tatyana Yoncheva**, Institute of Viticulture and Enology, Pleven, Bulgaria

Serbia

Emeritus prof. **Ján Kisgeci** – University of Novi Sad Ing. **Jozef Gašparovski** – President of Center for Organic production, Selenca

Czech Republic

Assoc. Prof. Andriy Synytsya – University of Chemistry and Technology, Prague

Russia

Prof. Dr. **Yulia Vinogradova** – Tsytsin Main Moscow Botanical Garden of Academy of Sciences, Moscow

Dr. **Olga Shelepova** – Tsytsin Main Moscow Botanical Garden of Academy of Sciences, Moscow Dr. **Svetlana Motyleva** – Federal Horticultural Research Center for Breeding, Agrotechnology and Nursery, Moscow

5th International Scientific Conference Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and Spiritual Human Development

Turkey

Prof. **Sezai Ercisli** – Department of Horticulture, Faculty of Agriculture, Ataturk University, Erzurum

Slovak Republic

Prof. Ing. **Marián Brestič**, CSc. – Institute of Plant and Environmental Sciences, Slovak University of Agriculture in Nitra

Assoc. prof. Ing. **Ján Brindza**, PhD. – Institute of Plant and Environmental Sciences, Slovak University of Agriculture in Nitra

Ing. **Ján Gažo**, PhD. – Institute of Plant and Environmental Sciences, Slovak University of Agriculture in Nitra

Ing. **Marián Miko**, PhD. – Institute of Plant and Environmental Sciences, Slovak University of Agriculture in Nitra

Assoc. prof. Ing. **Pavol Eliáš**, PhD. – Institute of Plant and Environmental Sciences, Slovak University of Agriculture in Nitra

Assoc. prof. Ing. **Ľuba Ďurišová**, PhD. – Institute of Plant and Environmental Sciences, Slovak University of Agriculture in Nitra

Ing. **Vladimíra Horčinová Sedláčková**, PhD. – Institute of Plant and Environmental Sciences, Slovak University of Agriculture in Nitra

Ing. **Katarína Fatrcová Šramková**, PhD. – Institute of Nutrition and Genomics, Slovak University of Agriculture in Nitra

Assoc. prof. Ing. **Ľuboš Vozár**, PhD. – Institute of Agronomic Sciences, Slovak University of Agriculture in Nitra

Ing. **Peter Hric**, Ing.Paed.IGIP, PhD. – Institute of Agronomic Sciences, Slovak University of Agriculture in Nitra

Ing. **Peter Kovár**, Ing.Paed.IGIP, PhD. – Institute of Agronomic Sciences, Slovak University of Agriculture in Nitra

Ing. **Petra Verešová**, PhD. – Institute of Agronomic Sciences, Slovak University of Agriculture in Nitra

Assoc. prof. **Dagmar Hillová**, PhD. – Botanical Garden, Slovak University of Agriculture in Nitra Assoc. prof. **Jarmila Eftimová**, CSc. – University of Veterinary Medicine and Pharmacy in Košice Ing. **Martin Gálik**, PhD. – Research Institute of Plant Production, Gene bank, Piešťany

TABLE OF CONTENTS

Aboimova O., Levon V.	19
BIOLOGICAL, ECOLOGICAL, ANATOMICAL-MORPHOMETRIC FEATURES OF	
REPRESENTATIVES OF THE GENUS <i>JUGLANS</i> L.	
Aboimova O., Levon V.	20
HISTORY OF STUDY, DISTRIBUTION, AND USE SPECIES OF THE GENUS JUGLANS L.	
Andrusyshyna I., Golub I., Lampeka O.	21
SAFETY ASSESSMENT OF NATURAL NUTRACEUTICALS AS AN IMPORTANT SOURCE OF	
TRACE ELEMENTS	
Antoniewska A., Brindza J., Klymenko S., Shelepova O.	22
FATTY ACID COMPOSITION OF CORNELIAN CHERRY (CORNUS MAS L.)	
Bieniek A., Grygorieva O., Bielska N.	23
BIOCHEMICAL CHARACTERIZATION OF FRUITS OF BLUE HONEYSUCKLE (LONICERA	
CAERULEA L.): A REVIEW	
Bilko A., Adamchuk L.	24
SOME FORGOTTEN, LITTLE-KNOWN, AND LESS USED PLANT SPECIES	
Bohdanovych T., Matvieieva N.	25
COMPARISON OF TECHNOLOGICAL PARAMETERS OF IN VITRO GROWTH OF ARTEMISIA	
VULGARIS L. AND CICHORIUM INTYBUS L. "HAIRY" ROOTS IN A MEDIUM WITH	
DIFFERENT SUCROSE CONTENT	
Borzova N., Gudzenko O.	26
DERHAMNOSILATION OF FLAVONOIDS BY α -L-RHAMNOSIDASE <i>PENICILLIUM TARDUM</i>	
Brovarskiy V., Brindza J., Turdaliev A., Mirzakhmedova G., Velichko A.	27
HONEYBEES IN THE CONDITIONS OF CLIMATE CHANGE	
Bukharina I., Islamova N.	28
STUDY OF FUSARIUM EQUISETI METAL RESISTANCE TO CHROME AND COPPER	
Bulyhina T., Brovarska O.	29
PHYTOTOXICITY OF NATIVE AND MODIFIED LIPOPOLYSACCHARIDES OF PANTOE	
AGGLOMERANS, PSEUDOMONAS PUTIDA, P. CHLORORAPHIS SUBSP. CHLORORAPHIS AND	
ESCHERICHIA COLI	
Buyun L., Tkachenko H., Kurhaluk N., Gyrenko O., Kovalska L.	30
IN VITRO ASSESSMENT OF ANTIMICROBIAL ACTIVITY OF ETHANOLIC EXTRACTS	
OBTAINED FROM THE LEAVES AND PSEUDOBULBS OF <i>COELOGYNE TOMENTOSA</i> LINDL.	
Buyun L., Tkachenko H., Kurhaluk N., Opryshko M., Kovalska L., Gyrenko O.	31
EVALUATION OF ACID-INDUCED HEMOLYSIS OF EQUINE ERYTHROCYTES EXPOSED TO	
EXTRACTS FROM LEAVES OF SOME <i>COELOGYNE</i> SPECIES LINDL. (ORCHIDACEAE)	
Buyun L., Tkachenko H., Kurhaluk N., Opryshko M., Maryniuk M., Gyrenko O.	32
ASSESSMENT OF LIPID PEROXIDATION IN THE HUMAN BLOOD AFTER IN VITRO	
TREATMENT BY LEAF EXTRACTS OBTAINED FROM SOME AGLAONEMA SPECIES	
Buyun L., Tkachenko H., Kurhaluk N., Opryshko M., Maryniuk M., Gyrenko O.	33
OXIDATIVE STRESS BIOMARKERS IN THE HUMAN ERYTHROCYTE SUSPENSIONS	
EXPOSED TO EXTRACTS OBTAINED FROM <i>COELOGYNE ASPERATA</i> LINDL. LEAVES	24
Спеграк U., Спеграк M.	34
CUMPAKATIVE PHYTOCHEMICAL RESEARCH OF STELLARIA HOLOSTEA L. AND	
SIELLAKIA MEDIA L. Chiaolitan O. Chiaolitan N. Dochlin A. Effermente N. Tofor E. Loore A. Doctor C.	0 F
UNISENISU U., UNISENISU N., BESINIU A., EJREMOVU N., 10JAN E., LOZAN A., BOORTSEVA S., Dunga M	35
DYI SU M. INELLENCE OF MANNODOTEIN DEDADATION OPTAINED FROM THE MICROPIAL	
INFLUENCE OF MANNOFKUTEIN FREFARATION OBTAINED FROM THE MICKUBIAL	
WASTE OF THE DEEV INDUSTATION TRITICALE SEEDS	

Chisnicean L.	36
INTRODUCTION OF IRONWORT SPECIES IN THE COLLECTION OF AROMATICS PLANTS	
Chyniaieya Yu., Adamchuk I.,	37
DEVELOPMENT OF APISERVICE IN UKRAINE	0.
Corcimaru S., Mereniuc L., Sitnic F.	38
MICROBIOLOGICAL TOOLS FOR EFFECTIVE ASSESSMENT AND PREDICTION OF THE	
IMPACT OF SOIL MANAGEMENT ON SOIL ORGANIC MATTER	20
RHODIOLA ROSEAL – A VALUABLE SOURCE OF ADAPTOGENS FOR MEDICINE AND	39
BIOSTIMULATORS FOR AGRICULTURE	
Dascaliuc A., Călugăru-Spătaru T., Parii Ya., Parii Yu.	40
IN VIVO AND IN VITRO CONTROL OF RHODIOLA ROSEA L. PLANTS GROWTH AND	
ACCUMULATION OF SECONDARY METABOLITES	
Deineko L., Kyshnirenko U. $(A \cap B) = (A \cap B)$	41
Didvk N., Ivanvtska R., Ivsenko T.	42
CALCIUM SILICATE AND γ -AMINOBUTYRIC ACID REDUCE ADVERSE EFFECTS OF	
SIMULATED ACID RAIN ON CORN AND WHEAT	
Duplij V., Matvieieva N.	43
INFLUENCE OF CONCENTRATION OF AQUEOUS-ETHANOL SOLUTION ON EXTRACTION	
OF FLAVONOIDS FROM "HAIRY" ROOTS OF MEDICINAL PLANTS Dwkaliuk R Adamchuk I	ЛЛ
NEW APPROACH TO DEFINING THE TYPE (KIND) OF PROPOLIS	тт
Dvykaliuk R., Adamchuk L.	45
OVERVIEW OF TYPES (KINDS) OF PROPOLIS COLLECTED BY APIS MELLIFERA	
Eftimová J., Petrovič V., Vodhanel V.	46
EFFECT OF ALGINITE ON SUBSTANCES OF GENUS MENTHA REPRESENTATIVES AND	
Flisovetcaja D. Ivanova R. Simkova I. Brindza I.	47
STUDY OF SOME BIOLOGICAL EFFECTS OF ALGINITE ON PLANT AND INSECTS	17
Ershova I.	48
TOCOPHEROLS IN THE FRUITS OF ALTAI SEA BUCKTHORN CULTIVARS	
	49
HUMULUS LUPULUS L. SEED REPRODUCTION OF PLANTS IN TRANSCARPATHIA	50
MICROBIOLOGICAL CHARACTERISTICS PHYSIOLOGICAL AND BIOCHEMICAL	30
PROPERTIES OF ENDOPHYTIC BACTERIA OF BEAN PLANT NODULES	
Garkava K., Tymoshenko U., Pavlyuk R., Michailova I.	51
OSMOTIC RESISTANCE OF ERYTHROCYTES OF DIFFERENT BLOOD GROUPS UNDER THE	
INFLUENCE OF CHAMERION ANGUSTIFOLIUM (L.) SCOP.	F 0
GINS M., GINS V., GINS E. Amaranth flour usace at rakery wares production	52
Gniezdilova V.	53
ARBORETUM OF IVANO-FRANKIVSK MEDICAL COLLEGE	
Goncharovska I., Kuznetsov V.	54
MORPHOMETRIC PARAMETERS OF VEGETATIVE ORGANS OF DIFFERENT CULTIVARS	
UF LRABAPPLE Crigoroug O	FF
DESIGN PRINCIPLES FOR FARM FORESTRY	33
Grygorev I.	
FOREST PLANTATIONS AS THE BASIS OF AGROFORESTRY	56

Grygorieva O., Klymenko S., Vinogradova Yu., Bieniek A.A., Antoniewska A., Fatrcová-	57
Sramková K., Brindza J.	
AMINO ACID PROFILE OF LEAVES OF NON-TRADITIONAL FRUIT PLANTS	-
Gumeniuk I., Levishko A., Tsvigun V., Botsula O., Demyanyuk O., Sherstoboeva O.	58
STUDY OF CULTIVATION CONDITIONS OF BRADYRHIZOBIOM JAPONICUM STRAINS	F 0
HUSUNOV J.H., MIFZUXMEUOV SN.D., SUIIKNOV SN.I.	59
SUREW PRESSED FLAX (LINUM USITATISSIMUM L.) UIL	60
ANTIRACTEDIAL ACTIVITY OF ETHANOLIC EVTDACTS OFTAINED FOOM LEAVES OF	00
SOME THVMUSI (LAMIACEAE MARTINOV) REPRESENTATIVES ACAINST ESCHERICHIA	
COLI	
Horčinová Sedláčková V Mňahončáková F Goncharovska I Brindza I	61
SCANNING ELECTRON MICROSCOPY STUDY OF POLLEN MORPHOLOGICAL	UI
CHARACTERS OF <i>MALUS DOMESTICA</i> BORKH.	
Hrabovetska O.	62
DIOSPYROS L. – PROSPECTIVE FRUIT CULTURE IN UKRAINE	
Hrvhorenko A., Koval I.	63
ROBINIA PSEUDOACACIA L. AS AN INTRODUCED PLANT INTO NATALIYIVSKYI PARK	
AND ITS APPLICATIONS	
Hudz N., Horčinová-Sedláčková V., Šimková J., Svydenko L., Brindza J., Wieczorek P.P.	64
DEVELOPMENT OF THE ANALYTICAL PROCEDURE OF THE DETERMINATION OF TOTAL	
FLAVONOID CONTENT IN THE HERB OF MONARDA FISTULOSA L.	
Ivanišová E., Granátová L., Grygorieva O.	65
BIOCHEMICAL CHARACTERIZATION AND SENSORY PROPERTIES OF BEETROOT (BETA	
VULGARIS SSP. VULGARIS VAR. RUBRA L.)	
Ivanova R., Casian I.	66
MAHONIA AQUIFOLIUM (PURSH) NUTT. AS A SOURCE OF NUTRITIONAL AND	
PHYTOCHEMICAL COMPOUNDS	
Ivanova R., Elisovetcaia D., Borovskaia A.	67
DIVERSITY OF NATURAL REGULATORS OF PLANT GROWTH AND THEIR POTENTIAL	
BIOLOGICAL ACTIVITY	
Ivanytska B., Didyk N., Rositska N., Zaimenko N.	68
EFFECT OF SILICEOUS MINERALS AND CHLORELLA VULGARIS BEIJER. ON PEPPER	
(CAPSICUM ANNUUM L.)	
Kabachevskaya A., Niescier G.	69
CHOICE OF METHOD FOR RNA EXTRACTION FROM TISSUES OF FOUR PLANT SPECIES	
RICH IN BIOLOGICALLY ACTIVE SUBSTANCES	= 0
Kabusheva I., Sak N.	70
RUSE PRODUCTIVITY IN GREENHOUSE CONDITIONS OF THE CENTRAL BUTANICAL	
GARDEN OF THE NATIONAL ACADEMY OF SCIENCES OF BELARUS	71
Kalista M., Kovalenko U.	/1
MURPHULUGICAL INVESTIGATION ON UNDERGROUND ORGANS OF GERANIUM	
SIDIRICUM L. Kharkhota I. Domkovich F.	77
ΚΠΟΓΚΠΟΙΟ Δ., DEΠΙΚΟΥΙCΗ Ε. DDODACATION OF CODNIIS BY CDAFTING IN THE CONDITIONS OF THE STEDD	12
Kilish I Kovalchuk I Fodoruk P	72
CONTENT OF MINERAL FLEMENTS IN TISSUES OF HONEV REES UNDER FEEDING	13
CITRATE CO AND CE	
Klimova E Fesenko I	74
A NEW ARTIFICIAL BUCKWHEAT SPECIES FAGOPYRIIM HYRRIDIIM AS A SOURCE OF	<i>'</i> T
THE RAW MATERIAL FOR WHOLE-GRAIN FLOUR PRODUCTION	

<i>Klymenko S.</i> CULTIVARS OF CORNELIAN CHERRY (<i>CORNUS MAS</i> L.) OF UKRAINIAN SELECTION IN EURASIA	75
<i>Klymenko S., Ilyinska A.</i> BIOMETRIC CHARACTERISTICS OF <i>CHAENOMELES</i> SPP. CULTIVARS AND VARIETIES, INTRODUCED IN M.M. GRYSHKO NATIONAL BOTANICAL GARDEN OF UKRAINE	77
Kobza M., Ostrovský R. NATURALLY OCCURRING DIRECT CURRENT IN TREES AS THE OVERALL TREE VITALITY	78
Kosenko I., Opalko O., Hrabovyi V., Opalko A. WOODY DI ANTS SPECIMEN'S CONSERVATION IN THE NDD "SOFIVIVKA"	79
Kosogolova L., Kuznietsova O. INFLUENCE OF ELECTROMAGNETIC RADIATION ON OPTIMIZATION OF FLAVONOID EXTRACTION FROM DANDELION FLOWERS (<i>TARAXACUM OFFICINALE</i> (L.) WEBB EX E.H.WIGG)	80
<i>Kovalchuk I., Tsap M., Androshulik R., Kroh A.</i> VIABILITY OF BEES UNDER CONSUMPTION OF DIFFERENT DOSES OF MAGNESIUM CITRATE	81
<i>Kovalenko O., Senchuk T., Senchylo O.</i> DISTRIBUTION OF INSECT-POLLINATED SPECIES IN THE FLORA OF NATIONAL NATURAL PARK "PYRYATYNSKYI" (UKRAINE)	82
<i>Kozub N., Sozinov I., Bidnyk H., Demianova N., Sozinova O., Blume Ya.</i> DIVERSITY OF HIGH MOLECULAR WEIGHT GLUTENIN SUBUNIT ALLELES CONSERVED IN THE <i>EX-SITU</i> COLLECTION OF <i>AEGILOPS BIUNCIALIS</i> VIS.	83
<i>Kryvyi M., Dikhtiar O., Lisohurska D., Brindza J.</i> ANTIOXIDANT PROPERTIES OF DRY SUBSTANCE OF FLOWERS MEDICINAL PLANT	84
<i>Kuznetsova E., Bychkova T., Alhusseini H.</i> BIOCHEMICAL AND ANTIMICROBIAL PROPERTIES OF <i>SCHIZANDRA CHINENSIS</i> (TURCZ.) BAILL. FRUIT POMACE EXTRACT	85
<i>Kuznetsova E., Nasrullaeva G., Kuznetsova E.</i> BREAD TECHNOLOGY FROM A MIXTURE OF WHEAT AND SPELT GRAINS	86
<i>Kvitko M., Savosko V.</i> PERSPECTIVES AND USING WOODY ARTIFICIAL PLANTATIONS FOR HARMONIZATION OF THE NATURAL ENVIRONMENT IN KRYVYI RIH	87
<i>Kyrylenko O., Ferreira R.S.Jr.</i> POSSIBLE THERAPEUTIC PROPERTIES OF THE COMPONENTS OF BEE VENOM <i>Kyslynska A</i> Tsekhmister H	88 89
LOCALIZATION OF SAPROTROPHIC FUNGUS <i>CHAETOMIUM COCHLIODES</i> IN HEALTHY TISSUES OF AGRICULTURAL PLANTS	07
<i>Laguta I., Stavynska O., Kuzema P., Ivannikov R., Anishchenko V., Linnik O.</i> WASTES FROM VEGETABLE OIL PRODUCTION AS A SOURCE OF BIOACTIVE SUBSTANCES	90
<i>Lastochkina O., Garshina D., Shpirnaya I., Ibragimov A.</i> POSSIBLE MECHANISMS OF <i>BACILLUS SUBTILIS</i> AND SALICYLIC ACID-MEDIATED REDUCTION OF POSTHARVEST DISEASES IN TUBERS OF <i>SOLANUM TUBEROSUM</i> L.	91
<i>Levon V., Golubkova I.</i> DYNAMICS OF CYANOGENIC GLYCOSIDES ACCUMULATION IN <i>PRUNUS SPINOSA</i> L. SPROUTS	92
<i>Levon V., Zhurba M.</i> CONTENT OF ANTHOCYANINS IN THE ABOVEGROUND ORGANS OF PLANTS <i>AKEBIA</i> <i>QUINATA</i> (HOUTT.) DECNE	93

5th International Scientific Conference Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and Spiritual Human Development

Lisohurska O., Lisohurska D., Furman S., Kryvyi M.	94
NATUKAL LANDS OF HONEY PLANTS IN UKRAINIAN POLISSYA	05
REPRODUCTIVE DEVELOPMENT AND PHENOLOGY PECHLIARITIES OF LEONID	95
SHUGIN'S PRECOCIOUS PERSIAN WALNUT VARIETIES	
Lukash O.	96
LOCAL RESOURCE OF THE PRUNUS MAHALEB L. RAW IN POLISSYA	
Maltsov I., Gurnenko I., Marynyuk M.	97
STUDY OF LEAF SURFACE BY SCANNING ELECTRON MICROSCOPY	~~
Mammadova A.	98
RELATIONSHIP OF PRODUCTIVITY OF ZEA MAYS L. HYBRIDS WITH ACTIVITY OF	
NULLEIL ALID SINIHESIS Matuiojova N. Shutava H. Tuchinskava I. Skakovsky F.	00
AMINO ACIDS ACCUMULATION IN CICHORIUM INTURIIS I "HAIRY" ROOTS	"
Mysholov A., Konovalova O., Hurtovenko I., Gudzenko O., Hudzenko N.	100
INVESTIGATION OF POLYPHENOL EXTRACT COMPOSITION OF GREAT BURNET	100
(SANGUISORBA OFFICINALIS L.) FROM THE CARPATHIAN RESERVE FOR CREATION	
PHYTOPOLYMER COATING	
Opryshko M., Maryniuk M., Gyrenko O., Buyun L., Tkachenko H., Kurhaluk N.	101
IN VITRO HEMOLYSIS ASSESSMENT OF THYME ESSENTIAL OIL AND ITS PROTECTIVE	
EFFECT ON OXIDATIVE DAMAGE OF HUMAN ERYTHROCYTES	
Opryshko M., Maryniuk M., Gyrenko O., Tkachenko H., Kurhaluk N., Buyun L.	102
ANTIMICROBIAL ACTIVITIES OF THREE ESSENTIAL OILS DERIVED FROM	
GYMNUSPERM TREE SPECIES AGAINST STAPHYLOLOLUUS AUREUS STRAIN	100
EVALUATION OF THE DOSE DEDENDENT EFFECTS OF TEA TOFE OIL ON THE	103
HEMOLYSIS OF HIMAN FRYTHROCYTES	
Opryshko M., Tkachenko H., Buyun I., Kurhaluk N., Maryniuk M., Gyrenko O.	104
ANTIBACTERIAL ACTIVITY OF ETHANOLIC EXTRACTS FROM AGLAONEMA	101
COMMUTATUM SCHOTT AND ITS CULTIVARS AGAINST ENTEROCOCCUS FAECALIS	
Palamarchuk O., Dzhurenko N., Sokol O., Butko A.	105
VOLATILE COMPOUNDS OF THE SECONDARY METABOLISM OF MEMBERS OF THE	
FAMILY ASTERACEAE BERCHT. & J.PRESL	
Pavliuchenko N., Grygorieva O., Klymenko S.	106
ALLELOCHEMICALS FROM ROOT ENVIRONMENT OF <i>DIOSPYROS VIRGINIANA</i> L.	
Petrina R., Zahorodnia D., Kniazieva K., Shved O., Lubenets V.	107
DEVELOPMENT OF BIOTECHNOLOGICAL METHOD OF DELPHINIUM ELATUM L.	
COLITIVATION Potrokhov A. Ouchgranko O	108
ANTIOXIDANT ACTIVITY OF TRANSGENIC PETIINIA HYBRIDA VILM WITH	100
HETEROLOGOUS ZRNASE II GENE AFTER TOBACCO MOSAIC VIRUS INFECTION	
Rakhmetov D., Veraun O., Fishchenko V., Rakhmetova S.	109
PAULOWNIA TOMENTOSA (THUNB.) STEUD. AS PERSPECTIVE ENERGETIC PLANT IN	
UKRAINE	
Rodionova E., Grushko M., Kanieva N.	110
INFLUENCE OF SOIL CHARACTERISTICS ON THE GLYCYRRHIZIC ACID ACCUMULATION	
DYNAMICS IN LIQUORICE ROOTS	
Snelepova U., Volkova U., Delneka V. Deddies de six species de consededdy (dides L) as a source de functional	111
DERRIES OF SIA SPECIES OF GOUSEBERKT (<i>KIBES</i> L.J AS A SOUKCE OF FUNCTIONAL INCREDIENTS	
Shymanska O., Veraun O., Rakhmetov D., Rondarchuk O., Rakhmetova S.	112
MORPHOMETRIC PARAMETERS OF <i>CRAMBE</i> SPP. FLOWERS AND FRUITS	~ • •

5th International Scientific Conference Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and Spiritual Human Development

<i>Simeonov I., Belberova Y., Yoncheva T.</i> RESPONSE AND ABILITY OF THE VINES OF STORGOZIA CULTIVAR TO RECOVER AFTER HAIL DAMAGE	113
<i>Solgajová M., Paulovičová Z., Mareček J.</i> EVALUATION OF MILLING AND BAKING QUALITY CHARACTERISTIC OF SELECTED WHEAT CULTIVARS	114
<i>Stefanowski N., Tkachenko H., Kurhaluk N.</i> ANTIBACTERIAL ACTIVITY OF ETHANOLIC EXTRACTS OBTAINED FROM ROOTS AND STALKS OF <i>CHELIDONIUM MAJUS</i> L. AGAINST <i>ENTEROCOCCUS FAECALIS</i> STRAINS	115
<i>Stefanowski N., Tkachenko H., Kurhaluk N.</i> ANTIOXIDANT EFFECTS OF EXTRACTS DERIVED FROM ROOT AND STALK OF <i>CHELIDONIUM MAJUS</i> L. COLLECTED FROM URBAN AND RURAL AREAS USING THE MODEL OF EQUINE ERYTHROCYTES	116
Suberliak S., Tepla Yu., Fedorova O., Havryliak V., Skorochoda V., Petrina R. BIOTECHNOLOGY METHOD OF OBTAINING BIOMASS OF MEDICINAL PLANTS FOR MEDICAL AND COSMETIC PURPOSES IN UKRAINE	117
<i>Sukhaveyeva S., Kabachevskaya A.</i> PARTICIPATION OF PHYTOHORMONES OF ETHYLENE AND BRASSINOSTEROIDS IN CONTROL OF GRAVITROPIC REACTIONS OF PLANT LEAVES	118
<i>Svydenko L., Hudz N., Hlushchenko L.</i> STUDY OF BIOLOGICAL AND BIOCHEMICAL PECULIARITIES OF <i>THYMUS STRIATUS</i> VAHL	119
<i>Svydenko L., Markovska O., Stetsenko I.</i> CREATION OF NEW PERSPECTIVE CULTIVARS OF <i>LAVANDULA ANGUSTIFOLIA</i> MIIL. FOR GROWING OF AREA OF UKRAINIAN SOUTH	120
<i>Svydenko L., Vergun O., Fatrcová-Šramková K., Ivanišová E., Brindza J.</i> ANTIOXIDANT ACTIVITY OF ETHANOL EXTRACTS OF <i>HYSSOPUS OFFICINALIS</i> L. <i>Tamrazov T</i>	121 122
STUDY OF THE MAIN PHYSIOLOGICAL INDICATORS OF PRODUCTIVITY FORMATION IN THE STUDIED GENOTYPES OF DURUM AND BREAD WHEAT	122
WALNUT KERNELS PELLICLE (<i>JUGLANS REGIA</i> L.) – A GOOD SOURCE OF GALLIC, ELLAGIC ACIDS, CATECHIN AND THEIR DERIVATIVES FOR FUNCTIONAL FOODS	123
<i>Tiras Kh.</i> NEW, DIGITAL BIOLOGY OF THE 21 st CENTURY: THROUGH DIGITALIZATION TO VIRTUALIZATION	124
<i>Tkach Ye., Pylypchuk T., Lobova O., Bunas A., Starodub V.</i> ECOLOGICAL ASSESSMENT OF WINTER WHEAT GROWING TECHNOLOGIES IN THE CENTRAL FOREST-STEPPE OF UKRAINE	125
<i>Tkachenko H., Buyun L., Kurhaluk N., Belayeva Ya.</i> <i>IN VITRO</i> ANTIBACTERIAL ACTIVITY OF THE CRUDE ETHANOLIC EXTRACTS FROM THE LEAVES OF SOME <i>BEGONIA</i> SPP. AGAINST <i>ENTEROCOCCUS FAECALIS</i> ISOLATE	126
Tkachenko H., Buyun L., Kurhaluk N., Góralczyk A., Honcharenko V., Prokopiv A. <i>IN VITRO</i> EVALUATION OF ANTIMICROBIAL EFFICACY OF ETHANOLIC EXTRACTS FROM LEAVES OF <i>EICUS TINCTORIA</i> G. FORST	127
Tkachenko H., Buyun L., Kurhaluk N., Honcharenko V., Prokopiv A. IN VITRO ANTIOXIDANT RESPONSE OF THE EQUINE BLOOD TREATED BY EXTRACT OBTAINED FROM FICUS DRUPACEA THUNB LEAVES (MODACEAE)	128
<i>Tkachenko H., Buyun L., Kurhaluk N., Maryniuk M.</i> ANTIBACTERIAL ACTIVITY OF <i>SANSEVIERIA AETHIOPICA</i> THUNB. LEAF EXTRACT	129

<i>Tkachenko H., Buyun L., Kurhaluk N., Opryshko M., Maryniuk M., Gyrenko O.</i> <i>IN VITRO</i> ESTIMATION OF TOTAL ANTIOXIDANT CAPACITY OF THE MUSCLE TISSUE OF RAINBOW TROUT (<i>ONCORHYNCHUS MYKISS</i> WALBAUM) EXPOSED TO LEAF EXTRACTS OF <i>SANSEVIERIA SUFFRUTICOSA</i> N.E.BR.	130
<i>Tkachenko H., Buyun L., Kurhaluk N., Opryshko M., Maryniuk M., Gyrenko O.</i> <i>IN VITRO</i> STUDIES OF ANTIOXIDANT POTENTIAL OF EXTRACT DERIVED FROM THE LEAVES OF <i>BEGONIA FOLIOSA</i> KUNTH IN HUMAN ERYTHROCYTE SUSPENSION	131
<i>Tkachenko H., Buyun L., Kurhaluk N., Opryshko M., Maryniuk M., Gyrenko O.</i> ANTI-HEMOLYTIC EFFECTS OF EXTRACTS OBTAINED FROM LEAVES OF VARIOUS <i>BEGONIA</i> L. SPECIES ON THE EQUINE ERYTHROCYTE MEMBRANES	132
Tkachenko H., Kurhaluk N., Buyun L., Kharchenko I., Opryshko M., Maryniuk M.,	133
<i>Gyrenko O.</i> TOTAL ANTIOXIDANT CAPACITY IN THE MUSCLE TISSUE OF THE RAINBOW TROUT (<i>ONCORHYNCHUS MYKISS</i> WALBAUM) AFTER <i>IN VITRO</i> INCUBATION WITH EXTRACTS DERIVED FROM LEAVES OF VARIOUS CULTIVARS OF CAMELLIA JAPONICA L.	
<i>Tkachenko H., Kurhaluk N., Buyun L., Opryshko M., Maryniuk M., Gyrenko O.</i> CHANGES IN OXIDATIVE STRESS BIOMARKERS IN THE EQUINE BLOOD TREATED <i>IN</i> <i>VIT</i> RO BY EXTRACT DERIVED FROM <i>SANSEVIERIA PARVA</i> N.E.BR.	134
Tkachenko H., Kurhaluk N., Kharchenko I., Buyun L., Opryshko M., Maryniuk M.,	135
Gyrenko O.	
FROM LEAVES OF CAMELLIA JAPONICA L. CULTIVARS AGAINST STAPHYLOCOCCUS AUREUS STRAIN	
Tkachuk N., Okulovich I.	136
TEST-INDICATORS OF <i>LEPIDIUM SATIVUM</i> L. SEEDLINGS UNDER THE INFLUENCE OF MICELLAR WATER	40.5
FORMATION AND PRESERVATION OF COLLECTIONS OF GENETIC RESOURCES OF	137
LEGUMES AND GRUATS CRUPS Tseig I Kohets M Kohets Vu Malining N Ibrahimova O Filintsova O	138
ANALYSIS OF DOSAGE FORMS OF FIRST AID MEDICINES FOR INFANTS	150
Tsekhmister H., Kopilov E., Nadkernychna O., Kyslynska A.	139
ANTAGONISTIC ACTIVITY OF TRICHODERMA VIRIDE 017 TO PATHOGENS OF ROOT ROT	
Valková V., Dúranová H., Ivanišová E., Kravárová A., Hillová D., Gabriny L. INFLUENCE OF VARIETY ON TOTAL POLYPHENOLS CONTENT AND ANTIOXIDANT ACTIVITY IN APPLE FRUITS (<i>MALUS DOMESTICA</i> BORKH.)	140
Vergun O., Ivanišová E., Vinogradova Yu., Shelepova O., Brindza J.	141
DYNAMIC OF POLYPHENOL COMPOUND CONTENT OF SYMPHYTUM SPP.	4.40
Vergun O., Rakhmetov D., Fishchenko V., Rakhmetova S. I ICNIN AND SUCADS CONTENT IN THE DAM OF SELECTED DOACEAE DADNHADT	142
Vergun O., Rakhmetov D., Rakhmetova S., Bondarchuk O., Fishchenko V.	143
Veraun O., Shvmanska O., Ivanišová E., Brindza I.	144
ANTIOXIDANT ACTIVITY OF ETHANOL EXTRACTS OF SELECTED ASTERACEAE BERCHT. & J. PRESL REPRESENTATIVES	
<i>Vergun O., Shymanska O., Rakhmetov D., Brindza J., Ivanišová E.</i> ESTIMATION OF ANTIOXIDANT ACTIVITY OF <i>TRIFOLIUM AMBIGUUM</i> M. BIEB AND <i>T.</i> <i>RUBENS</i> L.	145
Vinogradova Yu., Shelepova O.	146
PHYTOCHEMISTRY AND FLOWER'S MORPHOLOGY OF INVASIVE <i>SOLIDAGO</i> L. SPECIES – VALUABLE LATE AUTUMN MELLIFERS	_

Varoshko () Matviejeva N	147
TUI USHKU U, MULVICICVU N. TDANCIENT EVDDECCION OC UIDA CENE IN DUVCALIC DEDUVIANA L AND DUVCALIC	14/
IRANSIENT EXPRESSION OG UIDA GENE IN PHYSALIS PERUVIANA L. AND PHYSALIS	
IXOCARPA BROTH.	
Zaimenko N., Didyk N., Rositska N., Ivanytska B.	148
EFFECT OF CHLORELLA VULGARIS BEIJERINK AS A BIOFERTILIZER ON SOLANUM	
LYCOPERSICUM L.	
Zaimenko N., Rositska N., Ivanytska B.	149
INFLUENCE OF TALAROMYCES RUBER ON SEED GERMINATION OF ZEA MAYS L.	
Zhila A., Tymchenko O., Anishchenko V., Boyko O., Ivannikov R.	150
PHYTOCHEMICAL COMPOSITION OF BULBOUS OXALIS (OXALIS L.) OF SOUTH	
AMERICAN ORIGIN IN THE M.M. GRYSHKO NATIONAL BOTANICAL GARDEN OF THE NAS	
OF UKRAINE	
Zhurba M., Gurnenko I., Motyleva S.	151
POLLEN MORPHOLOGY OF SOME SPECIES OF THE GENUS LYCIUM L.	
Zhurba M., Hudz N., Ivanišová E., Bieniek A.A., Antoniewska A.	152
AMINO ACID COMPOSITION OF LEAVES, FLOWERS, PEDICEL, FRUITS, AND SEEDS OF	
SCHISANDRA CHINENSIS (TURCZ.) BAILL.	
Zhurba M., Ilyinska A., Gurnenko I.	153
CHARACTERISTICS OF THE STOMATAL APPARATUS OF THE LEAVES OF VARIETIES	
AND CULTIVARS OF <i>LYCIUM</i> SPP.	

BIOLOGICAL, ECOLOGICAL, ANATOMICAL-MORPHOMETRIC FEATURES OF REPRESENTATIVES OF THE GENUS JUGLANS L.

Oleksandra Aboimova, Volodymyr Levon

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine Kyiv, Ukraine; E-mail.: <u>aboimovaaleksandra@gmail.com</u>

The introduction study of plants involves the attraction of new species from different floristic regions of the Earth. Species of the genus *Juglans* L. are of Holarctic origin. The natural range of the genus is located in the countries of Asia, America, and Europe. *J. nigra* L., *J. cinerea* L. originated from the Boreal sub-kingdom, the Atlantic-North American floral region. *J. ailanthifolia* var. *cordiformis* Max. belongs to the Boreal Kingdom. *J. mandshurica* Maxim., *J. ailanthifolia* Carr. originated from the East Asian floristic region. The Madrean sub-kingdom includes *J. major* Torr., *J. microcarpa* Berland., of the Madrean floristic region. From the Ancient Mediterranean sub-kingdom (Iran-Turan floristic region) originated *J. regia* L., *J. regia* L. f. *fertillis* Petzet Kirch.

The research aims to investigate the water regime, anatomical and morphometric features of plant leaves of species of the genus *Juglans* in connection with their drought resistance.

According to the results of studies of drought resistance, no significant signs of wilting were revealed in plants of the species of the genus *Juglans* in the conditions of the Right-Bank Forest-Steppe of Ukraine. It was found that the indicators of drought resistance of plants of the genus *Juglans* were 3–4 points in representatives of the East Asian (Japanese-Chinese) floral region (*J. ailantifolia* var. *cordiformis*, *J. ailantifolia*, *J. mandshurica*). Drought resistance of plants *J. regia* f. *fertillis, J. regia* (Iran-Turan floristic region) it was 5 points. According to the visual scale, the indicator of drought resistance of plants from the Atlantic-North American (*I. nigra, J. cinerea*) and Madrean floristic regions (*I. microcarpa* and *I. major*) was estimated at 5 points. It was found that for 24 hours after collecting the leaves, the water loss (*J. ailanthifolia*) was 27.0 ±1.21 % of the initial raw mass, J. mandshurica – 2.5 ±2.91 %. The lowest water loss was recorded in plants from the Iran-Turan floristic region (J. regia 20.6 ±0.74 %). The determination of the total water in the leaves showed that its content was highest in *I. regia* $(34.6 \pm 0.67 \%)$. This indicator was the lowest in plants from the Japanese-Chinese floristic region (*J. ailantifolia*) – 27.8 ±0.47 %. The water deficiency was highest in the leaves of plants from the Japanese-Chinese floristic region in *J. ailanthifolia* (11.8 ±0.12 %). The lowest indicator was recorded in plants from the Iran-Turan floristic region (*J. regia*) – 10.0 ±0.32 %.

It was found that the resistance to drought in plants of the genus Juglans is due to the anatomical and morphological structure of the leaf. The stomatal apparatus of the leaves of the studied species is the anomocytic. A correlative relationship between the size of stomata and the parameters of drought resistance is established. The smallest stomatal area was noted in the leaves of the more drought-resistant species *J. regia* 245.52 ±10.34 mm²; in the less drought-resistant species *J. ailanthifolia* this indicator was 305,01 ±7,61 mm². The studied species of the genus *Juglans* are characterized by the presence of trichomes that are placed on the abaxial and adaxial surfaces of the leaves, which is a manifestation of xeromorphy. The parameters of the thickness of the spongy parenchyma were established, which ranged from 61.92 ±1.1 (*J. regia*) to 73.70 ±1.5 microns (*J. mandshurica*). A decrease in the thickness of the parenchyma is a manifestation of the xeromorphy of plants.

Anatomical and morphological parameters of the leaves of the studied species indicate that they are ecologically plastic and can adapt to arid growth conditions.

Keywords: Juglans, drought resistance, leaves, xeromorphy, parenchyma.



Oleksandra Aboimova, Volodymyr Levon

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine Kyiv, Ukraine; E-mail.: <u>aboimovaaleksandra@gmail.com</u>

The introduction of nut plants in Ukraine began with *Juglans regia* L., which is one of the oldest fruit plants. It has been grown here since the times of Kievan Rus. *J. regia* f. *fertillis* L. f. *fertillis* Petzet Kirch. introduced to Ukraine in the 50s of the last century from Uzbekistan. J. nigra has more than two centuries of cultivation history. It was first introduced into the planting of the Krasnokutsky Arboretum in 1809, from where it spread by seeds throughout Ukraine and far beyond its borders. *J. microcarpa* Berland. and *J. major* Torr., introduced to Ukraine in the 30s of the last century from the Nikitsky Botanical Garden. East Asian species of the genus *Juglans* (*J. ailanthifolia* Carr., *J. mandshurica* Maxim. and the variety *J. ailanthifolia* var. *cordiformis* Max.) were introduced to Ukraine with the beginning of the development of introduction studies in botanical gardens at the end of the 19th century. *J. regia* and *J. regia* f. *fertillis* are cultivated in more than 60 countries around the world, mainly the United States, Asian and European countries, including Ukraine. The modern centers of cultivation and distribution of *J. nigra* are the USA, Europe, Russia, Ukraine, Central Asia, Transcaucasia.

J. cinerea is cultivated in the USA, Europe, Russia, and Ukraine. Plants of *J. microcarpa* and *J. major* are common in the USA and in European and Asian countries they have been cultivated since the second half of the XIX century, as ornamental trees with an original crown. East Asian species of the genus *Juglans* (*J. mandshurica, J. ailanthifolia, J. ailanthifolia* var. *cordiformis*) is used in the food industry, medicine, and landscaping.

Different parts of *Juglans* plants such as leaves, bark, fruits, and roots are used in medicine, pharmacology, and the food industry. Raw materials of *Juglans* species contain various chemical components, including juglone, diarylheptanoids, quinones, polyphenols, flavones, and terpenes.

J. regia is one of the oldest fruit plants in Ukraine. The nutritional value of the fruits, favorable natural conditions, ease of tree care, and increased demand for them contributed to the spread of the *J. regia* culture first in the Western and South-Western regions of the country (XII-XIX centuries), and later – in the Central and South-Eastern (XX century). In Ukraine and the world, *J. regia* cultivars are in great demand, their number is constantly increasing. However, *J. regia* began to acquire industrial significance in Ukraine only from the 19th century. Now Ukraine ranks first among European countries in the production of *J. regia* fruits, for the period 1992–2018. Although the high demand and export potential for *J. regia* fruits contribute to the development of varietal culture and new commercial plantings, the mass reproduction of new cultivars and their laying of industrial plantations in areas where these varieties have not been previously tested sometimes leads to the freezing of plantings, and their owners often experience significant material damage due to ignorance. The cultivars *J. nigra, J. cinerea, J. ailantifolia* var. *cordiformis* are in great demand in the world.

Thus, the species of the genus *Juglans* can be widely used in medicine and the food industry in Ukraine. Also, many-years investigations with different species and genotypes of these plants showed that Ukrainian conditions are good for deep selective work for further use in different branches of agriculture.

Keywords: Juglans, fruit crops, industrial plantations, ornamental trees.



SAFETY ASSESSMENT OF NATURAL NUTRACEUTICALS AS AN IMPORTANT SOURCE OF **TRACE ELEMENTS**

Irvna Andrusyshyna, Inna Golub, Olena Lampeka

SI "Kundiiev Institute of Occupational Health of NAMS of Ukraine", Kyiv, Ukraine; E-mail.: andrusyshyna.in@gmail.com

Today, the majority of scientific researchers believe that it is impossible to address the microelementosis problem through correct diet only, so it is extremely timely today to identify a safe and reliable source of minerals for the human body. In many countries all over the world, targeted micronutrients have already been used for many years, and special programs have been launched to develop functional foods. The monitoring of modern human nutrition profile indicates a chronic deficiency in essential food components. At the International Conference on Nutrition held in Rome in 1992, micronutrient deficiencies were recognized as a major problem that could lead to a crisis in the nutrition of the world's population in the XXI century. Therefore, a person's diet must meet his/her physiological needs for nutrients and biologically active substances, micronutrients. Biologically active supplements (dietary supplements) became available in Ukraine about ten years ago. Currently, more than 200 companies producing biologically active supplements offer their products to the population of Ukraine.

The main components of dietary supplements include herbal extracts, bee products, minerals (colloidal metal solutions), fermentation products, and, in recent years, nanotechnology products. In some cases, dietary supplements can play the role of natural sorbents.

In the SI "Kundiiev Institute of Occupational Medicine of the National Academy of Medical Sciences", the methods for the prevention of heavy metal poisoning have been a research topic for many years. The Institute has been successfully cooperating with international health and safety organizations (WHO) and with labor organizations (ILO) and has been participating in the projects run by the International Chemical Safety Program (UNEP Chemicals, UN). An internationally acknowledged experience has been acquired not only in the comprehensive assessment of working conditions in various production fields (industrial production, agriculture, etc.) but also in the prevention of occupational and environmental diseases, chronic and acute poisoning. The search for new preventive methods is continued.

Based on the above mentioned, it appeared relevant to assess the possibility for safe use of pectins and bee products (honey, bee bread, and pollen) in this context. In order to determine the content of 13 chemical elements in the samples of such products, a microwave method for sample mineralization and a method for multi-elemental analysis, namely optical emission spectrometry with inductively coupled plasma on PerkinElmer OPTIMA 2100 DV, were applied. Our researches on elemental content in pectins and bee pollen resulted in the following findings. High levels of Zn $(34.49 \,\mu\text{g/g})$, Fe $(398.5 \,\mu\text{g/g})$, and Mg $(1.49 \,\text{mg/g})$ in pectins make it possible to use them as sorbents or immunomodulating agents. High levels of Ag (1.15 μ g/g), Cu (7.50 $\mu g/g$), Se (0.61 $\mu g/g$), and Zn (46.41 $\mu g/g$) in bee pollen may be useful for people with inflammatory diseases and immune system disorders.

Thus, modern dietary supplements are safe since they do not produce any toxic, carcinogenic, mutagenic, or other adverse effects on the human body when they are consumed in generally approved reasonable amounts. Their safety is warranted by established and observed standard levels of related chemical substances in these products. Tangible success in problem solutions responding to dietary micronutrient deficiency in the general population relies on the implementation of and search for new methods for correcting micronutrient imbalance in the human body.

Keywords: occupational risk, trace elements, micronutrients.



Agata Antoniewska¹, Jan Brindza², Svitlana Klymenko³, Olga Shelepova⁴

¹Warsaw University of Life Sciences, Warsaw, Poland; E-mail.: <u>agata_antoniewska@sggw.edu.pl</u> ²Slovak University of Agriculture in Nitra, Slovak Republic ³M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine

⁴N.V. Tsitsin Main Botanical Garden of Russian Academy of Sciences, Moscow, Russian Federation

The cornelian cherry (Cornus mas L.) is one of the most valuable fruit plants known in garden cultivation for 4000 years. The cornelian cherry fruits are distinguished by attractive ruby-red color, sour taste, valuable composition and health-promoting properties. The composition of bioactive compounds, including ascorbic acid, organic acids (mainly malic acid), pectins, phenolic acids (gallic and ellagic, and derivatives of hydroxycinnamic acids), flavonoids (anthocyanins, flavonols), triterpenoid (ursolic acid) and recently identified iridoids (loganic acid, cornuside, loganin, sweroside) was reported in *Cornus mas* fruits. Ample studies have shown *Cornus mas* fruits to play a remarkable role in the maintenance of human health exhibit antiscorbutic, antibacterial, anti-inflammatory, antioxidant, tonic, astringent, temporary hypotensive, and diuretic properties. Morover, *Cornus mas* fruits were used in folk medicine for treatment of various fever-related diseases (flu, sore throat, malaria) and gastrointestinal disorders. Generally, fruits are not known as a good source of lipids. However, some fruits revealed to be a good source of lipids and beneficial fatty acids. Thus, determination of lipid content and fatty acid composition of cornelian cherry plant is of a great importance. The aim of this study was to determine the fatty acid compositions of leaves, flowers, fruits, and seeds of *Cornus* mas; samples of the candidate genotype *Cornus mas* grown in the M.M. Gryshko National Botanical Garden (Kyiv, Ukraine). The fatty acid methyl esters were analyzed by gas chromatography using an Agilent 7820A instrument equipped with a flame-ionization detector (Agilent, California, USA).

The lipid contents in leaves, flowers, fruits, and seeds were 4.37, 5.69, 1.68, and 4.42% of plant material dry weight, respectively. The fatty acid composition differed significantly depending on the part of the Cornus mas plant. The contents of saturated fatty acids (SFAs) of the leaves, flowers, fruits and seeds were 43.48, 27.69, 38.99, and 12.44 g/100 g, while unsaturated fatty acid composition of the leaves, flowers, fruits and seeds were 15.2, 5.53, 12.79, and 22.0 g/100 g, respectively. Polyunsaturated fatty acids (PUFAs) were 25.05, 51.17, 34.67, and 64.42 g/100 g. The major PUFA in the seeds was linoleic acid C18:2 9*c*12*c* (62.71 g/100 g); accounting for 63.43 % of the total fatty acid content. Half as much linoleic acid was identyfied in the fruits (26.38 g/100 g) and flowers (20.31 g/100 g). Palmitic acid C16:0 was the most abundant from the SFAs in all studied parts of the plant. The highest palmitic acid content was identyfied in leaves – 32.80 g/100 g and fruits pulp – 30.44 g/100 g, while 20.52 g/100 g was identyfied in flowers, and only 9.02 g/100 g in seeds. Among PUFAs, small amounts (<0.5 g/kg) were found in fruits, namely: trans-oil; trans-9,12-linoleic; cis-9, trans-12-linoleic; trans-9, cis-12-linoleic; trans-9, trans-12,15-linolene; trans-9,12, cis-15 + trans-9, cis-12, trans-15-linolenic acid; cis-9, trans-12,15-linolene; cis-9,12, trans-15-linolene; cis-9, trans-12, cis-15-linolenic. Only trans-9, cis-12,15-linolene was identyfied in the fruits pulp (0.8 g/100 g).

Based on these results, the lipid content and fatty acid compositions of leaves, flowers, fruits and seeds of *Cornus mas* may be nutritionally important for human health.

Keywords: Cornelian cherry, fatty acids, leaves, flowers, fruits pulp, seeds.

Acknowledgments

The publication was prepared with the active participation of researchers in International network AgroBio*Net*, and supported by the Visegrad Fund (Slovak Republic).

BIOCHEMICAL CHARACTERIZATION OF FRUITS OF BLUE HONEYSUCKLE (LONICERA CAERULEA L.): A REVIEW

Anna Bieniek¹, Olga Grygorieva², Natalia Bielska¹

¹University of Warmia and Mazury in Olsztyn , Poland; E- mail:<u>anna.bieniek@uwm.edu.pl</u> ²M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine Kyiv, Ukraine; E-mail.: <u>olgrygorieva@gmail.com</u>

Species belonging to the genus *Lonicera* such as *Lonicera caerulea* var. *edulis*, *L. caerulea* var. kamtschatica, L. caerulea var. altaica, L. caerulea var. byarnikovae and L. caerulea var. *emphyllocalyx*, as well as their hybrids, collectively known as *Lonicera caerulea* L., also known as blue honeysuckle, haskap, honeyberry, sweet berry honeysuckle or edible honeysuckle, are representative of such plants. The berries of blue honeysuckle containing a significant amount of biologically active substances can be included in the group of so-called 'superfruits'. Haskap is a deciduous berry shrub, growing to 1.5-2.0 m tall, bearing a type of blue-berried honeysuckle about 1 cm in diameter. Blue honeysuckle plants have been used for ages in Asia for their medicinal properties. According to the available literature, fruits of the honeyberry are a valuable source of vitamins, minerals, and secondary metabolites with bioactive properties that are important for maintaining proper human health. A high total polyphenolic content and antioxidant activity are typical of blue honeysuckle berry and determine the edible value and health benefits of this plant. The chemical composition of berries varies depending on genetic factors (cultivar), climate, weather conditions, as well as agronomic practices. Fully ripened fruits contain between 12.4 and 20.3 % of dry matter, with a predominance of fructose and glucose. The noteworthy among bioactive compounds are anthocyanins. The most abundant anthocyanin is cyanidin-3-glucoside (79-92%), whereas cyanidin-3,5-diglucoside, peonidin-3glucoside, cyanidin-3-rutinoside, peonidin-3-rutinoside, and pelargonidin-3-glucoside occur in smaller amounts. The other group of chemical compounds identified in the fruits of blue honeysuckle is phenolic acids, flavonoids, flavan-3-ols, flavons, flavanols, organic acids, and iridoids. Blue honeysuckle berries are characterized by a high content of vitamin C, which can reach up to 187 mg/100 g fresh weight. In addition, they also contain the mineral components, potassium is dominant, followed by phosphorus and calcium, magnesium and iron in smaller amounts, and trace amounts of manganese, copper, and zinc. They are characterized by a high content of organic acids, among which citric acid is the most dominant and constituted 47 % of all organic acids, among which malic, phytic, oxalic, quinic, and shikimic acids were also present. Health-promoting properties of the haskap berries include protective effects against cardiovascular and neurodegenerative diseases, osteoporosis, type 2 diabetes, anemia, as well as antimicrobial, anticarcinogenic, and anti-inflammatory activity. Therefore, they can be successfully used in the production of functional food and dietary supplements, and even medicinal products.

Keywords: Lonicera caerulea, fruits, cultivars, biochemical composition.

Acknowledgments. The publication was prepared with the active participation of researchers in the international network Agrobio*Net.* The authors are grateful to Visegrad Fund and SAIA (Slovak Republic).



Anastasiia Bilko, Leonora Adamchuk

National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>bilkoanastasia@gmail.com</u>

The flora of our planet is very diverse and unique. Plants have been studied, described, and recorded as species gradually. Subsequently, mankind has learned to use plants for medicinal, traditions, and nutritional purposes. Thus, plants have assumed an important role in human life. With the development of technology and the chemical industry, this trend has lost its relevance. This has led to a reduction in the number of plants used by humans, which may later lead to the extinction of some species, the disruption of biocoenosis, and, consequently, to greater environmental problems. Today many plants are forgotten or little-known and that is important for the national economy and the maintenance of human health.

The goal was to highlight the rarely used, forgotten plant species that played an important role in the lives of people in some regions of Ukraine.

Among the rarely used plants of the Ukrainian Carpathians were the following species: elder-flowered orchid (*Dactylorhiza sambucina* (L.) Soó); creeping buttercup (*Ranunculus repens* L.); common nettle (*Urtica dioica* L.); yarrow (*Achillea millefolium* L.); chamomile (*Matricaria chamomilla* L.) and others. In books on traditional medicine from the 40–50s of the last century, these plants were used by women in domestic life for skincare, infant bathing, and supplementing to drinks or meals.

Among the forgotten species of plants that were previously used in Slobozhanshchyna include rowan (*Sorbus aucuparia* L.); common gromwell (*Lithospermum officinale* L.); perforate St John's-wort (*Hypericum perforatum* L.); three-part beggarticks (*Bidens tripartita* L.); broadleaf plantain (*Plantago major* L.); southern globe thistle (*Echinops ritro* L.); coleus (*Coleus decurrens* L.); cannabis (*Cannabis sativa* L.) and others.

Most of these plants were previously used intensively for traditional medicine, food, and domestic purposes. They treated many illnesses, including gastrointestinal inflammation, neurosis, common cold, and gynecological disorders, and they were used as wound-healing and bactericidal agents. With the development of the pharmaceutical, textile, and food industries, these plants have become less popular, and their numbers have fallen sharply.

Honeysuckle and shadbush were among the little-known plants of the Forest-steppe, as they are less and less used as fruit plants. Blue honeysuckle (*Lonicera caerulea* L.) is a small shrub that fruits in the form of small, oblong blueberries. The berries have many microelements, vitamin A and C, fructose, and glucose. Also, tinctures of flowers, bark, and leaves have such useful effects on the human organism: choleretic, diuretic, antioxidant; antiphlogistic; antipyretic actions. Juneberry (*Amelanchier lamarckii* L.) is a large shrub or a fruit tree. It is used as a medicinal, fruit, and ornamental plant. Juneberry berries contain iron, vitamins C and E, calcium, magnesium. They can be consumed, both raw and made as jam.

By neglecting the plant species that were previously used, we lose the traditions, values, and knowledge of our ancestors. Therefore, the flora of our planet should be explored, stored, and restored, and the knowledge should be imparted to the descendants.

Keywords: little-known species, forgotten species, traditional medicine.



COMPARISON OF TECHNOLOGICAL PARAMETERS OF *IN VITRO* GROWTH OF *ARTEMISIA VULGARIS* L. AND *CICHORIUM INTYBUS* L. "HAIRY" ROOTS IN A MEDIUM WITH DIFFERENT SUCROSE CONTENT

Taisa Bohdanovych, Nadiia Matvieieva

Institute of Cell Biology and Genetic Engineering of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>bogdanovych_tais@ukr.net</u>

Artemisia vulgaris L. and *Cichorium intybus* L. are herbaceous plants used for centuries in traditional medicine and known for their antioxidant, hepatoprotective, antispasmolytic, antibacterial, and antifungal effects. *A. vulgaris* was even called "the mother of herbs" for its wide use, and *C. intybus* is a dietary supplement, coffee substitute, and sweetener. Those properties are caused by the high content of bioactive secondary metabolites. To increase their production in the plant, cocultivation with *Agrobacterium rhizogenes* bacteria is used. This process leads to the formation of "hairy" roots with altered metabolism and thus boosted production of bioactive substances.

The study aimed to investigate technological parameters of *in vitro* growth of "hairy" root cultures in a liquid half-strength MS medium with different content of sucrose (20 and 40 g/l), and also the analysis of the accumulation of flavonoids with antioxidant properties. Determination of root mass gain overtime was done by direct weighing, after which extracts of roots (in 70 % ethanol) were prepared and analyzed for flavonoid content by the standard method with aluminum chloride.

The results of the study showed that the mass gain after 3 weeks of cultivation for A. *vulgaris* was higher when cultivating in the liquid medium with 40 g/L of sucrose comparing to 20 g/L: 1.24 \pm 0.16 g comparing to 0.47 \pm 0.03 g. A similar effect was obtained in the case of *C*. *intybus* cultivation: 24.34 ±2.88 g comparing to 20.40 ±2.71 g. The coefficient of the mass gain (ratio of m₂ to m₀) for *A. vulgaris* was 4.98 (40 g/L of sucrose) and 2.11 (20 g/L of sucrose) and for *C. intybus* correspondingly 52.54 and 40.22. Flavonoid content in the ethanol extract of *A. vulgaris* after cultivation was 1.51 ±0.28 mg RE/g FW (20 g/L of sucrose). The total content of flavonoids for the absolute mass increase was 1.36 mg RE/ Δ m (20 g/L of sucrose). The output of flavonoids synthesis (how much flavonoids can be obtained from 1 g of initial mass) thus was 3.16 mg RE. In the case of *C. intybus*, flavonoid content in the ethanol extract after cultivation was 1.07 ± 0.24 mg RE/g FW (40 g/L of sucrose) and 0.65 ± 0.14 mg RE/g FW (20 g/L of sucrose). The total content of flavonoids for the absolute mass increase was 26.47 mg RE/ Δ m (40 g/L of sucrose) and 13.51 mg RE/ Δ m (20 g/L of sucrose). The output of flavonoids synthesis thus was 56.32 mg RE and 26.47 mg RE correspondingly. As it is seen from the data, flavonoid content per 1 g of fresh weight is slightly higher for *A. vulgaris*, but the mass growth rate is considerably higher for *C. intybus*, which results in a much bigger output of secondary metabolites over time. However, both species showed similarity in the growth rate increased with higher content of sucrose in medium, which concludes that the most efficient cultivation of "hairy" roots of common mugwort and chicory in terms of product output is with the content of sucrose 40 g/L.

Keywords: "hairy" roots, *Artemisia vulgaris, Cichorium intybus*, technological parameters, flavonoids.

Acknowledgments. This research was financially supported by the National Academy of Sciences of Ukraine, grant No. 34 (II-2-21).



DERHAMNOSILATION OF FLAVONOIDS BY α -L-RHAMNOSIDASE *PENICILLIUM TARDUM*

Nataliia Borzova, Olena Gudzenko

Zabolotny Institute of Microbiology and Virology of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail: <u>nvb.imv@gmail.com</u>

Plants are the major source of flavonoids in the human diet. These natural substances with variable phenolic structures have various biological properties: anti-inflammatory, antioxidant, antimutagenic, antiproliferative, and antiatherogenic, and therefore are applicated in the treatment of neurodegenerative and cardiovascular diseases. Removing the carbohydrate component of flavonoids (rhamnose, glucose, rutinose, hesperidose) often increases their activity and efficacy, both as medicines and as dietary supplements. For enzymatic hydrolysis of glycosides, α -L-rhamnosidase, an enzyme that cleaves terminal L-rhamnose residues from a wide range of glycoconjugates, can be used.

This work aimed to study the substrate specificity of the purified α -L-rhamnosidase from *Penicillium tardum*, and to evaluate the potential of the enzyme for use in the pharmaceutical and food industries. Gel filtration on Toyopearl HW-60 and ion-exchange chromatography on DEAE Toyopearl 650m were used for purification of the enzyme from micromycetes cultural liquid. Naringin, rutin, neohesperidin, hesperidin and narirutin (0.5-1 mM), and synthetic *p*-nitrophenyl (*p*-NP) substrates *p*-NP- α -L-rhamnose, *p*-NP- β -D-glucose, *p*-NP- β -D-galactose, and *p*-NP-N-acetyl- β -D-glucosamine (1 mM) were used to assay the α -L-rhamnosidase substrate specificity. The changes in the concentration of substrates were measuring by HPLC. Hydrolysis efficiency (%) is the residual concentration of substrates after enzymatic hydrolysis. The hydrolysis. The maximum rate (V_{max}) and Michaelis constant (K_m) were calculated according to Dixon as well as to Lineweaver-Burk at 37 °C at the pH 5.0.

The high affinity of α -L-rhamnosidase *P. tardum* toward natural and synthetic rhamnoglycosides has been shown. Thus α -L-rhamnosidase effectively hydrolyzed naringin, neohesperidin, hesperidin, rutin, narirutin, and p-NP- α -L-rhamnose. α -L-Rhamnosidase P. tardum exhibits a higher affinity for the synthetic substrate p-NP- α -L-rhamnose compared to the natural flavonoid naringin (K_m 0.7 and 1.34 mM, respectively). The hydrolysis efficiency of substrates containing α -1,2-linked rhamnose was maximal under experimental conditions (98 % for naringin and 97 % for neohesperidin). The rate of hydrolysis of narirutin and hesperidin was slightly lower (65 and 70 %, respectively), and the least efficient α -L-rhamnosidase P. tardum was hydrolyzed rutin (10 %). However, it should be remembered that the aglycone part of flavonoids is also important in determining the selectivity of the enzyme to natural substrates.

Thus, the high hydrolyzing ability of α -L-rhamnosidase P. tardum to plant flavonoids was shown, and it's open up broad prospects for using this enzyme in the medicine and food industry.

Keywords: *Penicillium tardum*, α-L-rhamnosidase, flavonoids, derhamnosilation.

HONEYBEES IN THE CONDITIONS OF CLIMATE CHANGE

Valeriy Brovarskiy¹, Jan Brindza², Avazbek Turdaliev³, Gulhae Mirzakhmedova³, Aleksandr Velichko¹

¹National University of Bioresources and Natural Resources of Ukraine, Kyiv, Ukraine; E-mail.: <u>vbrovarskiy@ukr.net</u> ²Slovak University of Agriculture in Nitra, Slovak Republic ³Fergana State University, Fergana, Uzbekistan

Due to the rise in ambient temperature, it is important to conduct researches on the interconnection between the plant diversity of ecosystems and their pollinators – the honey bees. The purpose of our researches was related to the adaptability of bees to high ambient temperatures. The task of the research was to investigate the effect of high temperatures on the secretion of nectar by plants in various ecosystems; as well as to analyze the ethology of bees under the influence of various ambient temperatures.

The areas with entomophilous agricultural and wild plants were defined near the apiary. Over the period of three years, the timing of flowering of plants was recorded. During the heat period, the activity of bees visiting flowers was recorded from 8 a.m. to 8 p.m. with an interval of 2 hours. The photo-fixation of the ethology of bees in the zone of hive entrance block was carried out at ambient temperatures from 24 °C and above.

It has been found that *Aesculus hippocastanum*, *Robinia pseudoacacia*, *Tilia cordata* bloom 7–15 days earlier than usual. This is due to warm winters and lack of soil freezing that leads to the simultaneous vegetation of plants with different root systems.

The bees worked in the field with different intensities depending on the type of plant, the duration of the drought and at different ambient temperatures. The moisture-loving plant species stopped secreting nectar at temperatures from 24 to 30 °C. Forbs (weeds) produced nectar even at 35–38 °C of heat.

It is confirmed that in the heat, when nectar is excreted, the bees work in the field. With the termination of its excretion, the bees interrupted their flight activity. Upon returning to the nests, the number of bees on the combs increased significantly, which contributed to an increase in temperature. The increase in the air temperature of the nest forces the family to stabilize the microclimate by ventilation, bee bearding and water evaporation.

The bees carry out ventilation of the nest until the ambient temperature does not exceed 35 °C. As the temperature rises, some of the bees leave the nest and concentrate on the external structures of the hive. With a further increase in temperature, the bees cover the entrance holes with their bodies, preventing the penetration of hot air into the nest.

Global warming is negatively affecting plants and bees. It has been found that at high ambient temperatures, the vegetation of plants is disturbed, the timing of their flowering is shifted, the flight activity of bees decreases, which endangers the preservation of entomophilous vegetation and pollinator insects.

Keywords: global warming, temperature, plants, bees, ethology.



STUDY OF FUSARIUM EQUISETI METAL RESISTANCE TO CHROME AND COPPER

Irina Bukharina, Nadezhda Islamova

Udmurt State University, Izhevsk, Russian Federation; E-mail.: <u>buharin@udmlink.ru</u>

Soil pollution with heavy metals (HM) changes the composition and nature of the life of microbial communities, disrupts metabolism and reduces the growth and reproduction of plants. Hence, the issue of restoring disturbed lands becomes relevant, and phytoremediation is the most promising in this regard. However, the efficiency of phytoremediation is largely increased due to the interaction of plants with microorganisms that are beneficial to them (especially endophytes), which allow them to change the absorption, mobility and bioavailability of metal ions. It is known that some endophytic fungi isolated in media with an increased HM content have increased metal resistance and are able to increase the resistance to metals of host plants.

Purpose: to study the endurance limits of endophytic fungi isolated from the root system of woody plants growing in conditions of technogenic pollution to the action of copper and chromium.

The endophytic fungus *Fusarium equiseti* isolated from the root system of tree plantations growing on the territory of the sanitary protection zone of the "Izhstal" industrial enterprise, which is one of the main pollutants in the city of Izhevsk (the Udmurt Republic), was chosen as the object of the study. *F. equiseti* is a naturally occurring root endophyte that is cosmopolitan and has the ability to colonize the roots of non-host plants. The fungus has been long considered pathogenic, but has recently attracted attention for its ability to acts as a biocontroller in the fight against root pathogens. The species of the fungus was established by molecular DNA analysis in the laboratory of the Leibniz Institute for Vegetable and Ornamental Crops (Berlin). The mushrooms were cultivated on an agar medium consisting of dextrose broth, agar-agar and distilled water, with the addition of different concentrations of copper and chromium: Cu – 50; 100; 150 mg/l; Cr – 2.5; 5; 10 mg/l. There was also a test case. The diameter of the colonies of filamentous fungi and their growth rate were measured. The peculiarities of the response of fungi to stress conditions were assessed by the content of malondialdehyde (MDA), which is a product of lipid oxidation. The content of MDA was estimated by the degree of accumulation of the product of its reaction with thiobarbituric acid (TBA), determining the optical density of the solution on a spectrophotometer at a wavelength of 532 nm.

The chromium content in the medium influenced the growth of *F. equiseti*. The mushroom showed great resistance to copper. The diameter of its colony in the variants Cu 50 and Cu 100 mg/l exceeded the values of the control. Nevertheless, at all studied concentrations of metals, the growth of the fungus continued.

The MDA content in many variants significantly exceeded the control values. However, when *F. equiseti* was grown on a substrate with chromium, the excess of MDA content was not as significant as when copper was applied.

Fusarium equiseti has a high metal resistance to chromium and copper. The synthesis of MDA and an increase in its concentration in the mycelium of the fungus is a response to an increase in the concentration of HM ions in the substrate. These results also show the possibility of using *F. equiseti* endophyte in bioremediation technologies for soils contaminated with HM salts.

Keywords: metal resistance, endophytes, micromycetes, resistance, inoculation.

Acknowledgments

This work was supported by the RFBR grant "Postgraduates" $\ensuremath{\mathbb{N}}\xspace{\ensuremath{\mathbb{P}}}$ 19-316-90003.



PHYTOTOXICITY OF NATIVE AND MODIFIED LIPOPOLYSACCHARIDES OF PANTOE AGGLOMERANS, PSEUDOMONAS PUTIDA, P. CHLORORAPHIS SUBSP. CHLORORAPHIS AND ESCHERICHIA COLI

Tetiana Bulyhina, Oksana Brovarska

D.K. Zabolotny Institute of Microbiology and Virology of the National Academy of Science of Ukraine, Kyiv, Ukraine; E-mail.: <u>dascaliuca@yahoo.com</u>

When studying the interaction of plants with associative and pathogenic microflora, an important issue is the role of surface structures of microorganisms in their recognition of the host plant and interaction with plant cells. Lipopolysaccharides (LPSs) are one of the main components of the outer membrane of cells of gram-negative bacteria involved in their interaction with other organisms. A number of studies have shown that they can act as an agent of innate plant immunity and can induce such reactions of plant cells as oxidative burst, NO synthesis, the influx of calcium ions into cells, changes in the cell wall with deposition of calose and phenolic compounds, induction or inhibition of hypersensitivity reactions. The effect of LPSs preparations on plants is also associated with their direct toxic effect, which is mainly due to the ability of the LPSs molecule to easily bind with various cells of the microorganism.

It is known that the biological activity of LPSs largely depends on the method of their isolation, chemical structure, and conformation of the molecule. A change in the biological properties of LPSs as a result of chemical treatment is associated with a change in the conformation of LPSs molecules. The research aimed to investigate changes in the phytotoxic activity of native and modified LPSs.

Phytotoxicity was determined on the seeds of salate, calculating the root and pagon index (test indicators). To reveal the effect of LPSs on germination energy, lettuce seeds were soaked for 2 hours in solutions of native and modified LPSs (1 mg/ml). LPSs modification was carried out by succinylation and two LPSs (*Pseudomonas putida* and *Pantoea agglomerans* 7460) were modified using succinic acid and germanium.

It was found that the studied native and modified LPS both stimulated and suppressed the growth of roots and sprouts. Thus, three modified LPSs had a stimulating effect on roots and/or sprouts, while three other native LPSs had an inhibiting effect on the growth of both roots and sprouts. In addition, not all modified LPSs had a stimulating effect on the root and sprout index.

An interesting fact is that the modified LPS of *Pseudomonas chlororaphis* subsp. *chlororaphis* UKM-106 (+10 $^{\circ}$ C – temperature of cultivation) had a more stimulating effect on the growth of roots and sprouts (by 7 and 12 %, respectively) than native LPS. In turn, the modified LPS of *Pantoea agglomerans* 7460 had the greatest stimulating effect on root growth, and modified LPS *Pseudomonas chlororaphis* subsp. *chlororaphis* (+28 $^{\circ}$ C – temperature of cultivation), even compared to native LPS (\approx 31 and 18 %, respectively).

Modification of *E. coli* 2890, 2892 LPSs had almost no effect on the phytotoxicity; it's even slightly increased the negative effect on root growth, although it had a small stimulating effect on sprouts growth.

Thus, the results obtained indicate that the studied native and modified LPSs during seed treatment are characterized by different effects on the development of seedlings, depending on the strain from which they are isolated and the method of modification.

Keywords: *Pantoea agglomerans, Pseudomonas putida, P. chlororaphis* subsp. *chlororaphis, Escherichia coli*, succinylated lipopolysaccharide, phytotoxicity.

IN VITRO ASSESSMENT OF ANTIMICROBIAL ACTIVITY OF ETHANOLIC EXTRACTS OBTAINED FROM THE LEAVES AND PSEUDOBULBS OF *COELOGYNE TOMENTOSA* LINDL.

Lyudmyla Buyun¹, Halyna Tkachenko², Natalia Kurhaluk², Oleksandr Gyrenko¹, Lyudmyla Kovalska¹

¹M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine; E-mail.: <u>buyun@nbg.kiev.ua</u>

 $^{2}\mbox{Institute}$ of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland

Although the antimicrobial activity of many orchid species, including *Coelogyne* species, has been effectively established against a wide spectrum of microorganisms, bacterial drug resistance continues to be a worldwide public health issue, thereby stimulating the search for new alternatives with fewer side effects. The present study was aimed to determine the antibacterial activity of *Coelogyne tomentosa* Lindl. against *Escherichia coli* strains, clinically important bacteria, which are indicator organisms commonly used in various projects to monitor antibiotic resistance.

The leaves and pseudobulbs of *C. tomentosa* plants cultivated under glasshouse conditions were sampled at M.M. Gryshko National Botanical Garden (Kyiv, Ukraine). Freshly sampled leaves and pseudobulbs were washed, weighed, crushed, and homogenized in 96 % ethanol (in proportion 1:19) at room temperature. For this study, *Escherichia coli* (Migula) Castellani and Chalmers (ATCC®25922[™]) and *E. coli* (Migula) Castellani and Chalmers (ATCC®35218[™]) were used. The antimicrobial susceptibility testing was undertaken on Muller-Hinton agar by the disc diffusion method. Inhibition zone diameters were evaluated and averaged.

The ethanolic extract obtained from leaves of *C. tomentosa* resulted in considerable growth suppression of *E. coli* strains. Leaf extract displayed high antibacterial potency against *E. coli*, i.e. the mean values of inhibition zone diameters were (17.85 ±1.25) and (13.33 ±1.12) mm for *E. coli* (ATCC® 25922TM) and *E. coli* (ATCC®35218TM), respectively. Also, *E. coli* exhibited similar susceptibility for the impact of the ethanolic extract obtained from pseudobulbs of *C. tomentosa*. The mean of inhibition zone diameters was (16.58 ±1.03) and (15.76 ±1.24) mm for *E. coli* (ATCC®25922TM) and *E. coli* (ATCC® 35218TM), respectively. Moreover, the ethanolic extracts obtained from the leaves and pseudobulbs of *C. tomentosa* revealed significant antibacterial activity against studied strains compared to control samples (96 % ethanol). A statistically significant increase (p<0.05) in inhibition zone diameters for growth of *E. coli* ATCC®35218TM estrain was also observed (by 48 and 76 % for leaf and pseudobulb extracts, respectively).

To conclude, the present study has revealed that ethanolic extract derived from the leaves and pseudobulbs of *C. tomentosa* exhibited significant antibacterial activity against *E. coli*. More impressive results were observed for *E. coli* ATCC[®] 25922^M and for pseudobulb extracts. Overall, our analysis suggests that screening of *Coelogyne* species for other biological activities including antioxidant and antibacterial activities is essential and may be effective for searching the preventive agents to be used in the pathogenesis of some metabolic and infectious diseases.

Keywords: *Coelogyne tomentosa*, leaves, pseudobulbs, antibacterial efficacy, disc diffusion technique, ethanolic extracts.

Acknowledgments

This study was carried out during the Scholarship Program supported by The Visegrad Fund in the Department of Zoology and Animal Physiology, Institute of Biology and Earth Sciences, Pomeranian University in Słupsk (Poland). We thank The Visegrad Fund for supporting our study.

EVALUATION OF ACID-INDUCED HEMOLYSIS OF EQUINE ERYTHROCYTES EXPOSED TO EXTRACTS FROM LEAVES OF SOME *COELOGYNE* **SPECIES LINDL. (ORCHIDACEAE)**

Lyudmyla Buyun¹, Halyna Tkachenko², Natalia Kurhaluk², Maryna Opryshko¹, Lyudmyla Kovalska¹, Oleksandr Gyrenko¹

¹M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine; E-mail.: <u>buyun@nbg.kiev.ua</u>

²Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland

In the present study, by using equine erythrocytes as an *in vitro* model, the membranedisruptive effects of extracts obtained from leaves of the *Coelogyne* genus have been explored to gain fresh insight into the extract toxicology. The leaves and pseudobulbs of orchids, i.e. *C. flaccida* Lindl., *C. huettneriana* Rchb.f., *C. speciosa* (Blume) Lindl., *C. fimbriata* Lindl., *C. tomentosa* Lindl., *C. ovalis* Lindl., *C. cristata* Lindl., *C. viscosa* Rchb.f., *C. asperata* Lindl., *C. pandurata* Lindl., *C. assamica* Linden & Rchb.f., *C. brachyptera* Rchb.f., *C. rochussenii* de Vriese cultivated under glasshouse conditions, were sampled at M.M. Gryshko National Botanical Garden (Kyiv, Ukraine). Freshly collected leaves were washed, weighed, crushed, and homogenized in 0.1 M phosphate buffer (pH 7.4) (in proportion 1:19, w/w) at room temperature. Blood was drawn from the jugular vein of the animals. A volume of 0.1 ml of the plant extract was added to 1.9 ml of equine erythrocytes. For positive control, phosphate buffer was used. After incubating the mixture at 37 °C for 60 min with continuous stirring, it was centrifuged at 3,000 rpm for 5 min. The acidic resistance of erythrocytes was induced by 0.5M HCl, and erythrocyte hemolysis was measured spectrophotometrically.

According to the results from the protective effect of extracts obtained from leaves of selected *Coelogyne* species, the incubation time of 1 h was chosen for assessing the HCl-induced hemolysis in the equine erythrocyte suspension. At 1 h of incubation, the maximum percent of hemolyzed erythrocytes of untreated erythrocytes comprised (8.3 ±0.64 %). The results indicated that all extracts led to an increase in hemolysis percentage (ranged from 21.7 to 73.5 %, respectively). When erythrocytes were incubated with *C. flaccida* and *C. pandurata* extracts, the hemolysis level was maximal (73.5 and 67.5 %, respectively) compared to the untreated control. In the meantime, the treatment of C. assamica and C. tomentosa extracts caused a nonsignificant increase in the formation of hemolyzed erythrocytes by approximately 21.7–24.1 %, respectively. However, C. asperata, C. viscosa, C. fimbriata, C. ovalis, and C. cristata had a significant increase in hemolysis level in the extract-treated erythrocytes (ranged 49 to 59 %, p<0.05). The current results are in agreement with our previously obtained data, including assessment of antioxidant activity of extracts obtained from leaves and pseudobulbs of selected species from the Coelogyne genus. Further, our results suggest that high doses of extracts might be a good candidate for inducing oxidative stress in cells, e.g., for targeting the diverse forms of tumor cells, while low doses of extracts could exhibit antioxidant properties. Future dosedependent studies will be performed to determine the optimal dose for an exhibition of antioxidant properties of these extracts. Moreover, it is well evidenced that there is a significant discrepancy between data obtained in vitro and in vivo experiments. Nevertheless, the results obtained from in vitro bioassay could be considered as a predictor of in vivo response.

Keywords: *Coelogyne*, leaves, extracts, HCl-induced hemolysis, equine erythrocytes.

Acknowledgments

We are grateful to the Polish National Commission for UNESCO for supporting our study. Since 1999 the whole collection of tropical and subtropical plants (including orchids), maintained both *ex situ* and *in vitro*, has the status of a National Heritage Collection of Ukraine and is supported through State funding.

ASSESSMENT OF LIPID PEROXIDATION IN THE HUMAN BLOOD AFTER *IN VITRO* TREATMENT BY LEAF EXTRACTS OBTAINED FROM SOME *AGLAONEMA* SPECIES

Lyudmyla Buyun¹, Halyna Tkachenko², Natalia Kurhaluk², Maryna Opryshko¹, Myroslava Maryniuk¹, Oleksandr Gyrenko¹

¹M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine; E-mail.: <u>buyun@nbg.kiev.ua</u>

²Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland

This study aimed to evaluate the antioxidant activity of water extracts obtained from leaves of *Aglaonema commutatum* Schott, *A. nitidum* (Jack) Kunth, *A. simplex* (Blume) Blume, and *A. modestum* Schott ex Engl. plants. The effect of the extract on cellular oxidative damage was evaluated using *in vitro* bioassays by 2-thiobarbituric acid reactive substances (TBARS) formation as a lipid peroxidation biomarker in human erythrocytes.

The leaves of *Aqlaonema* plants, cultivated under glasshouse conditions, were sampled at M.M. Gryshko National Botanical Garden (NBG), National Academy of Science of Ukraine (Kyiv, Ukraine). Freshly collected leaves were washed, weighed, crushed, and homogenized in 0.1M phosphate buffer (pH 7.4) (in proportion 1:19, w/w) at room temperature. The extracts were then filtered and used for analysis. The extracts were stored at -20 °C until use. Blood (10-20 ml) was obtained from normal volunteers via venipuncture (4 males and 5 females aged 28-53-years old). The Research Ethics Committee of Regional Medical Hospital in Gdańsk (Poland) approved the study (KB-31/18). An erythrocyte suspension at 1 % hematocrit was incubated with 4 mM phosphate buffer (pH 7.4) (control) and pre-incubated with the extracts (5 mg/mL) at 37 °C for 60 min. This reaction mixture was shaken gently while being incubated for a fixed interval at 37 °C. For positive control, phosphate buffer was used. Erythrocyte aliquots were used in the study. The level of lipid peroxidation was determined by quantifying the concentration of 2-thiobarbituric acid reacting substances (TBARS) with the Kamyshnikov (2004) method for determining the malonic dialdehyde (MDA) concentration. The µmol of MDA per L was calculated using $1.56 \cdot 10^5$ mM⁻¹ cm⁻¹ as the extinction coefficient. The mean ± S.E.M. values were calculated for each group to determine the significance of the intergroup difference. The significance of differences between the values (significance level, p<0.05) was examined using the Kruskal-Wallis H test with Statistica 8.0 software (StatSoft, Krakow, Poland).

Our results revealed, that the treatment by extracts obtained from various plants of the *Aglaonema* genus in a dose of 5 mg/mL increased the TBARS level when compared to untreated erythrocytes. The most potent prooxidative effect was demonstrated by the *A. nitidum* and *A. commutatum* compared to phosphate buffer as control samples (an increase of TBARS content by 85.3 and 30.2 %, p<0.05, respectively). On the contrary, the minimum increase of TBARS content in human erythrocyte suspensions was induced by *A. simplex* and *A. modestum* extracts (by 42.8-and 35.2 %, p<0.05, respectively). In conclusion, the most potent prooxidative effect was demonstrated by the *A. nitidum* and *A. commutatum* compared to phosphate buffer as a control sample. The minimum increase of TBARS content in human erythrocyte suspension was induced by *A. modestum* extract. Further research is needed to determine the effects of the active compounds of various plants belonging to the *Aglaonema* genus on oxidative damage in human erythrocytes.

Keywords: *Aglaonema*, leaves, lipid peroxidation, 2-thiobarbituric acid reactive substance, erythrocytes.

Acknowledgments

This study was carried out during the Scholarship Program supported by The Visegrad Fund in the Institute of Biology and Earth Sciences, Pomeranian University in Słupsk (Poland). We thank The Visegrad Fund for supporting our study.

OXIDATIVE STRESS BIOMARKERS IN THE HUMAN ERYTHROCYTE SUSPENSIONS EXPOSED TO EXTRACTS OBTAINED FROM *COELOGYNE ASPERATA* LINDL. LEAVES

Lyudmyla Buyun¹, Halyna Tkachenko², Natalia Kurhaluk², Maryna Opryshko¹, Myroslava Maryniuk¹, Oleksandr Gyrenko¹

¹M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine; E-mail.: <u>buyun@nbg.kiev.ua</u>

²Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland

In the current study, crude water extracts derived from the leaves of epiphytic orchid *Coelogyne asperata* Lindl. were assessed for antioxidant activities using the oxidative stress biomarkers (2-thiobarbituric acid reacting substances) as a biomarker of lipid peroxidation, carbonyl derivatives as biomarkers of protein oxidative modification) in the human erythrocyte model.

The leaves of *Coelogyne asperata* cultivated under glasshouse conditions were sampled at M.M. Gryshko National Botanical Garden (Kyiv, Ukraine). Freshly collected leaves were washed, weighed, crushed, and homogenized in 0.1M phosphate buffer (pH 7.4) at room temperature. Blood (10–20 ml) was obtained from normal volunteers via venipuncture. An erythrocyte suspension at 1 % hematocrit was incubated with 4 mM phosphate buffer (pH 7.4) (control) and pre-incubated with the extracts (0.5 and 5 mg/mL) at 37 °C for 60 min. For positive control, phosphate buffer was used. The level of lipid peroxidation was determined by quantifying the concentration of 2-thiobarbituric acid reacting substances (TBARS) with the Kamyshnikov (2004) method. The rate of protein oxidative destruction with 2,4-dinitrophenylhydrazine (DNFH) as described by Levine et al. (1990) and as modified by Dubinina et al. (1995).

The extract influence during incubation with erythrocyte suspension in a dose of 0.5 mg/mL caused a non-considerable decrease of TBARS level (by 11.6 %, p>0.05), while extract in dose 5 mg/mL induced lipid peroxidation (increased TBARS level by 15.5 %, p<0.05) compared to the control samples. Content of aldehydic derivatives of oxidatively modified proteins was increased after treatment by extracts in doses of 0.5 and 5 mg/mL (by 6.9 %, p>0.05, and 26 %, p<0.05, respectively) compared to control samples. On the other hand, ketonic derivatives of oxidatively modified proteins were decreased after treatment by extracts in doses of 0.5 and 5 mg/mL (by 6.3 %, p>0.05, and 5.8 %, p>0.05, respectively) compared to control samples.

The results of the current research indicated that crude extract obtained from *C. asperata* leaves in a dose of 0.5 mg/mL possessed an effective antioxidant effect after the treatment of a suspension of human erythrocytes. The protective effect of *C. asperata* extract is evident by the suppression of lipid peroxidation biomarker (TBARS level), as well as ketonic derivatives of oxidatively modified proteins. Extract of *C. asperata* leaves in a dose of 5 mg/mL exhibited prooxidative effect increasing lipid peroxidation and protein oxidation. It should be taken into consideration that the potential antioxidant function of a plant extract *in vivo* cannot be directly extrapolated from *in vitro* assays, since they do not take into account the metabolic transformations and interactions that affect the bioavailability and biological action of polyphenols.

Keywords: *Coelogyne asperata*, leaves, lipid peroxidation, 2-thiobarbituric acid reactive substance, erythrocytes.

Acknowledgments

This study was carried out during the Scholarship Program supported by The Visegrad Fund in the Institute of Biology and Earth Sciences, Pomeranian University in Słupsk (Poland). We thank The Visegrad Fund for supporting our study.



COMPARATIVE PHYTOCHEMICAL RESEARCH OF STELLARIA HOLOSTEA L. AND STELLARIA MEDIA L.

Oksana Cherpak, Michael Cherpak

Danilo Halytsky Lviv National Medical University, Lviv, Ukraine; E-mail.: <u>oksanacherpak@gmail.com</u>

The aim of the study was a comparative phytochemical study of *Stellaria holostea* L. and *Stellaria media* L. grass, in particular, qualitative and quantitative determination of polyphenolic compounds, ascorbic acid, chlorophylls, and carotenoids, which show anti-inflammatory, antimicrobial, antioxidant, antifungal, and reparative.

Objects – dried raw materials of *Stellaria holostea* L. and *Stellaria media* L. herb. Detection of the main groups of biologically active substances of medicinal plant raw materials using qualitative reactions is carried out by the generally accepted methods of the received water and water-alcohol extracts. Quantitative determination of polyphenolic compounds included: determination of the content of the sum of oxidizable phenols – in aqueous extracts and determination of the content of flavonoids – in ethanolic extracts. Quantitative determination of the content of spectrophotometric method. Quantitative determination of ascorbic acid in the studied samples is performed by titrimetric method with sodium 2,6-dichlorodiphenolindophenolate according to the method presented in the SPU (State Pharmacopoeia of Ukraine, 2001). Quantitative determination of carotenoid content was determined by the spectrophotometric method.

The content of tannins, saponins, anthocyanins, and flavonoids was established by phytochemical study of water and water-alcohol grass extracts of *Stellaria holostea* and *Stellaria media*. Identification reactions and chromatography in a thin layer of sorbent revealed the presence of ascorbic acid in the aqueous extracts of both study objects (Rf = 0.40–0.44). The titrimetric method established the quantitative content of ascorbic acid in the grass of the *Stellaria media* 48.25 mg%, which is 1.3 times higher than its content in the herb of the *Stellaria holostea* 37.42 mg%. The quantitative content of the sum of oxidizable phenols in the *Stellaria holostea* herb is 3.82 % slightly higher than the average *Stellaria media* herb 3.63 %. The content of the amount of flavonoids in the *Stellaria holostea* herb was 0.88 %, which is 1.2 times higher than their content in the *Stellaria media* herb 0.74 %. The content of *Stellaria holostea* herb 21 mg%.

Stellaria holostea and *Stellaria media* herb are a source of polyphenolic compounds – tannins and flavonoids, ascorbic acid and carotenoids, is a valuable medicinal plant raw material for further use both independently and as a component in combined phytomedicines with antimicrobials, antimicrobials, antifungal, hepatoprotective action.

Keywords: Stellaria holostea, Stellaria media, phytochemical research.

INFLUENCE OF MANNOPROTEIN PREPARATION OBTAINED FROM THE MICROBIAL WASTE OF THE BEER INDUSTRY ON TRITICALE SEEDS

Oleg Chiselitsa, Natalia Chiselitsa, Alina Beshliu, Nadejda Efremova, Elena Tofan, Ana Lozan, Svetlana Boortseva, Maxim Byrsa

IP Institute of Microbiology and Biotechnology Chisinau, Republic of Moldova; E-mail.: <u>chiselita.natalia@gmail.com</u>

Climate change, frequent droughts, abrupt changes in weather conditions during the season, as well as in connection with this the growth of phytopathogenic diseases, have become significant problems for the cultivation of grain crops. One of the methods that allow withstanding adverse weather conditions is the treatment of seeds before planting. It is directed not only at increasing and accelerating germination, but also at obtaining a high and qualitative harvest.

Currently, various methods of seed processing are known using natural biologically active microbial preparations, especially from yeasts. Results about the influence of preparations of levurian origin on the indices of plant growth and development are described in the literature, but specifically about the effect of mannoprotein preparations in this regard, data have not been found.

In this context, the research aimed to test the mannoprotein preparation LB-MP in the concentration of 10 mg/mL at the ability to stimulate seed germination, growth, and development of *Triticosecale* Wittm plants, Ingen 40 variety.

The biologically active preparation based on yeast biomass from brewing waste from the Kellers brewery, Budeshti was obtained through several stages: autolysis of yeast biomass with sodium phosphate buffer, subsequent processing of the remaining biomass with 1N NaOH for 2 hours at a temperature of +80 \pm 5 °C, obtaining the alkaline extract and sedimenting the mannoproteins with ethyl alcohol.

The seeds were treated with LB-MP mannoprotein preparation in the concentration of 10 mg/mL and its distilled water solutions of 0.33; 0.5; 1; 2 and 10 %/V. Distilled water was served as a control. The experiments were performed at room temperature +23–24 °C, in three repetitions. Three days after germination, the following parameters were evaluated: the formed number of roots, the length of the roots and stem, the dry mass of the roots and stem of each plantule.

The obtained results indicate that the treatment of seeds with LB-MP bio preparation in the concentration of 10 mg/mL increases the number of roots by 6 %, the length of the roots by 10 %, the dry mass of roots and stems by 4-11 % compared to the control sample.

The stimulating effect was also established in the case of seed processing with the aqueous solution of the LB-MP preparation in the concentration of 0.5 %. The results indicate a 10 % increase in the number of roots, a 5 % increase of stem length, a dry mass of roots and stems by 6-10 %, compared to the control variant. The other concentrations of the preparation had a neutral influence, the values of the studied indices oscillating at the control level or had a negative effect.

Thus, taking into account the established effect and the fact that the preparation can be obtained at a convenient price from the waste of the beer industry, research on the use of yeast preparations as stimulants of crop plants is perspective.

Keywords: brewer's yeast, mannoproteins, stimulator, *Triticosecale*, seeds.

Acknowledgments

The results were obtained within Project 20.80009.5107.16. "New biologically active microbial preparations for increasing the reproductive and productive potential of animals of zootechnical interest", funded by ANCD.


INTRODUCTION OF IRONWORT SPECIES IN THE COLLECTION OF AROMATICS PLANTS OF THE INSTITUTE OF GENETICS, PHYSIOLOGY AND PLANT PROTECTION

Lilia Chisnicean

Institute of Genetics, Physiology and Plant Protection, Chișinău, Republic of Moldova; E-mail.: <u>lilia.chisnicean@igfpp.md</u>

Ironwort (*Sideritis* spp.) belongs to the genus *Sideritis* L., which consists of annual or perennial plants of the Lamiaceae family. The plants have a pleasant aroma and multiple health benefits. In the Mediterranean Basin and Crimea, ironwort inflorescences and leaves are used for the preparation of herbal tea. Both types of ironwort, in the folk medicine of their native countries, are considered natural immunomodulators. The plants have hypotensive, antipyretic, diuretic effects, support wound healing, show antitumor activity. Besides, they show antibacterial, antiprotozoal, and repellent activity. They also possess gastroprotective and antiulcer properties.

A study was started to introduce two valuable species: *Sideritis scardica* Griseb. and *Sideritis taurica* Steph. ex Willd., as two other subspecies grow in Moldova – *Sideritis montana* L. and *Sideritis comosa* (Rochel ex Benth) Stankov.

Two methods of propagating the above-mentioned species were used – by seedlings obtained from seeds and by rooted cuttings taken from annual shoots, applying rooting stimulants such as Kornevin. The propagation of the plants by seedlings was performed using 100 seeds. The seedlings emerged in 12–15 days, with two pairs of uneven, gray-green leaves. When transplanting the seedlings in open ground, were planted into a permanent place.

Another method of propagating the plants was the vegetative one, using 100 cuttings taken from annual shoots. Both species of ironwort, *Sideritis scardica* and *S. taurica*, have taken root well, forming a strong, healthy root system. The best results in rooting cuttings were observed in the propagation material harvested in early spring, with a rooting success of 89–90 %. Both methods of propagation are effective, except that the seeds are easier to store, without the risk of frost or drying to which the plants are subjected in open ground.

The propagation of the species *Sideritis scardica* and *S. taurica* by different methods was performed with good results, the species being recommended as spicy, aromatic, and medicinal plants.

Keywords: Sideritis scardica, S. taurica, medicinal plant, reproduction, species, spice.

Acknowledgments

Research was carried out within the project of the State Program 20.80009.5107.07 "Reducing the consequences of climate change by creating, implementing varieties of medicinal and aromatic plants drought, frost, winter, disease resistant, which ensures sustainable development of agriculture and guarantees high quality raw material predestined to the perfumery, cosmetics, pharmaceuticals and food industry", financed by the National Agency for Research and Development.

DEVELOPMENT OF APISERVICE IN UKRAINE

Yuliia Chyniaieva¹, Leonora Adamchuk^{1,2}

¹Community Organization Foundation of Women Beekeepers, Vyshneve, Ukraine; E-mail.: <u>bee.women.fundacia@gmail.com</u> ²National University of Life and Environmental Sciences of Ukraine, Kviv, Ukraine

The goal of the research was to identify the target audience and conditions for the provision of services for health improvement using beekeeping products and apihouses. The observation was carried out during the beekeeping season 2019–2021. The main trends in the development of apiservice include the following: the appearance of a consumer profile of services; the division of consumers into two main groups; the need for psychological and physiological comfort at the place of services' provision; the growth of demand for services, as a kind of outdoor recreation. By apiservices we mean visiting the locations where bees live in hives or apihouses, with the possibility of health improvement through the rest above bees (special beds) or consumption of bee products, massages, apitoxin therapy. That is, it is a combination of apitourism and apitherapy in various combinations. Consumers of apiservice live in a large city. They have a rush pace of life, which exhausts them physically and mentally. These are the professions most exposed to stress factors (e.g., firefighters, ambulance drivers), in other words, they are in constant need of regeneration of vital energy and frequent solitude. Staying in the apihouses allows restoring the harmony of physical and emotional state effectively. The first group of service consumers is a category that is interested in a healthy lifestyle, takes care of their physical condition, is active, productive, and positive. They travel a lot and look for new experiences for themselves. They are curious, outer-directed, loyal, and friendly. The second group is the category of people with health problems who want to treat them. These people are looking for an expert or a guide who will help to orient in new experiences, provide preliminary information, highlight the advantages of a naturopathic approach to health improvement. And who will also be there for support? Certainly, for each of the groups, it is necessary to create an approach and program of stay in the apiary with the use of health improvement in apihouses. These categories require different levels of consultation and accommodation. The need for psychological and physiological comfort is an important condition for the customer's stay in the place where the service is provided. The main tasks of the api-consultant include the following: the readiness of the service consumer to find his or her time (one day off); a small company (2-3 persons); the convenience of transport link to the place where the service is provided, or its provision; availability of facilities (toilet, water, a rest area, solitude); availability of a program for attention (a presentation, consultation, degustation, an excursion, a master class); an emphasis on the peculiarity of the area (cultural, recreational, historical, natural or created objects). Despite the migration of the population to large cities, the demand for outdoor recreation is increasing. At the same time, people's interest in a healthy lifestyle is growing, promoting the development of places for combining rest and health improvement. In the last two years, we have also seen the development of infrastructure and quality of the service. One of the peculiarities of the apiservice consumers is that they always come back. Once people have experienced physical and spiritual recovery, they use the energy of bee colonies constantly. Prospects for apiservice development are the setting of service places in already existing facilities for public visits/recreation. Certainly, the correspondence of the terrain with the natural needs of bees should be considered. Therefore, apihouses can be placed in urban parks, botanical gardens. This approach will make apiservice available even when the visitor/consumer has not planned this kind of service for health improvement.

Keywords: apiservices, apitourism, apitherapy, sleep above bees.



Serghei Corcimaru, Lilia Mereniuc, Feodora Sitnic

Institute of Microbiology and Biotechnology, Chisinau, Republic of Moldova; E-mail.: <u>sergheicorcimaru@hotmail.com</u>

Efficient tools for the assessment and prediction of impacts on soil organic matter (SOM) are necessary for the development of sustainable management practices aimed at maintaining and enhancing soil biodiversity. The usefulness of direct SOM measurements in these matters is constrained by the impossibility of establishing experimentally verifiable changes within a relatively short time. Soil microbial biomass (SMB) is among the most promising tools for timely detection and prediction of changes in SOM induced by soil management. The purpose of this work was to make use of the advantages of long-term field experiments to identify microbial parameters that could be used as an effective tool for SOM-related assessments and predictions. The long-term field experiments of the study included 2 soil types (the moderately and the poorly humified Typical chernozems), 6 traditional (10-field) and 5 ecological (7-field) crop rotations with and without alfalfa, mineral fertilizers and/or farmyard manure; continuous black fallow and 5 continuous crops with and without mineral fertilizers with farmyard manure. Soil samples were collected in the springtime from a depth of 0-20 cm; passed through a 2 mm sieve and plant material, stones and visible organisms removed manually; adjusted to 40 percent water holding capacity and pre-incubated for 10 days at 25°C. in the dark, in aerated plastic bags with periodic adjustment of moisture. SOM was determined by dichromate oxidation followed by back titration of the excess dichromate. SMB was determined by substrate-induced respiration and/or fumigation-extraction. Basal respiration was determined by using IRGA or gas chromatography. Metabolic quotient was calculated as basal respiration expressed per unit of SMB carbon, and microbial quotient was expressed as the percentage of SMB carbon to the total soil organic carbon.

Significant correlations between SOM and soil microbial parameters (SMB, and/or basal respiration, and/or metabolic quotient) were observed in the moderately and poorly humified Typical chernozems of the studied long-term field experiments. These correlations demonstrated that with time-specific relationships between SOM and SMB related parameters are reached in the chernozem soils of Moldova, relationships that remain the same across a wide range of experimental variants with different levels of SOM and SMB, and are conditioned by peculiarities of soil management. These correlations as well as the difference in the turnover rates between SMB and SOM permit a practical possibility of using SMB as a tool for SOM-related assessments and predictions. Once a new soil management practice is introduced and SMB is allowed sufficient time (comparable to the SMB turnover rates) to approach the new equilibrium determined by peculiarities of this practice, the quantitative prediction of the future SOM level becomes predictable from the new microbial parameters and the established correlational relationship (assuming that given enough time SOM will tend to fit the same correlational relationship that was observable in the long-term field experiments). These predictions may be beneficial in such important fields as protection and enhancement of soil quality and biodiversity, carbon sequestration, development/assessment of sustainable soil management practices, and others. The implementation of the possibility will provide farmers with better opportunities for investing in soil quality/biodiversity and will contribute to solving problems related to climate change and others.

Keywords: soil microbial biomass, soil organic matter, soil biodiversity, soil quality prediction.

Acknowledgments

The results were partially obtained within a research project with financial support awarded by the Global Soil Partnership of the Food and Agriculture Organization of the United Nations.



Alexandru Dascaliuc, Tatiana Călugăru-Spătaru

Institute of Genetics, Physiology and Protection of Plants, Chisinau, Moldova; E-mail.: <u>dascaliuca@yahoo.com</u>

We focused our research on testing the assumption that the response of biological systems to stressors depends on the general or similar effects of various adaptogens on the viability and health of humans, animals, and plants due to the available mechanisms of response to factors inherited during evolution. We present the results obtained in studying the influence of biostimulators, extreme temperatures, and ultraviolet radiation on the accumulation of secondary metabolites in *Rhodiola rosea* L., cultivated in conditions in vivo and in vivo.

In research, we used golden root plants collected from the Carpathian Mountains or artificially grown in vivo and in vitro. In laboratory and field conditions, we determined the influence of different physical and chemical factors on the growth, accumulation, and composition of secondary metabolites in the in vivo and in vitro culture of the golden root. In parallel, tested the influence of substances with the property's characteristic for adaptogens on the resistance and productivity of higher plants to the action of extreme temperatures and gamma radiation.

We developed and adjusted the conditions for multiplying and obtaining golden root biomass from plants cultivated in vivo and the callus growing in vitro. The content of secondary metabolites in rhizomes and callus biomass was lower than in plant rhizomes collected in the mountains. After introducing un culture medium the precursors of secondary metabolite, or biostimulators with adaptogen properties, the accumulation of secondary metabolites in callus cells of the golden root increased. Short-term exposure of callus to low temperatures and ultraviolet radiation assured a similar beneficial effect on the accumulation of secondary metabolites. The treatment with biostimulators that demonstrate adaptogen properties of the seeds and different species of plants by vegetation lead the increasing plants primary and adaptive resistance to heat, frost, and gamma radiation. The use of biostimulators to treat wheat seeds before sowing, depending on the conditions of the year and variety, ensured the harvest increased by 0.2–1.2 tons per hectare.

The modification plants' response to the action of abiotic stresses using biostimulators and adaptogens is similar. Developing efficient cultivation methods and accumulation of secondary metabolites by golden root plants grown in vitro or in vivo opens new possibilities for obtaining raw materials in sufficient quantities for the large-scale and economically advantageous implementation of adaptogens in medicine and organic agriculture.

Keywords: system biology, adaptogens, biostimulators, golden root.

Acknowledgment

The research was carried out partially in the frame of State Programs 20.80009.7007.07 by the financial support of the National Agency for Research and Development of the Republic of Moldova.

IN VIVO AND *IN VITRO* CONTROL OF *RHODIOLA ROSEA* L. PLANTS GROWTH AND ACCUMULATION OF SECONDARY METABOLITES

Alexandru Dascaliuc¹, Tatiana Călugăru-Spătaru¹, Yaroslav Parii², Yulia Parii²

¹Institute of Genetics, Physiology and Plant Protection, Chisinau, Moldova; E-mail.: <u>dascaliuca@yahoo.com</u> ²All Ukrainian Institute of Plant Breeding, Kyiv, Ukraine

Our research aimed to determine the effect of some physical and chemical factors on the synthesis and accumulation of secondary metabolites in *Rhodiola rosea* L. plants grown *in vivo* and *in vitro*. To achieve this goal, we have identified the following objectives: 1. To elaborate on the agrotechnical regime of *R. rosea* plants growth during cultivation artificially and in the field; 2. To determine the heterogeneity of *R. rosea* plants by analyzing morphological, physiological, and biochemical parameters; 3. To analyze the influence of UV radiation and other physical and chemical factors on the accumulation of secondary metabolites in *R. rosea* plants grown in the laboratory, greenhouse, and field conditions in Moldova.

We have collected seeds from *R. rosea* plants grown in the Carpathian Mountains and elaborated optimal conditions for their cultivation *in vitro* and *in vivo*. We developed sensitive HPLC methods for quantitative and qualitative analysis of secondary mнекуцйetabolites.

We performed experiments with the *R. rosea* plants obtained from seeds collected in the Carpathian Mountains and with the plants propagated *in vitro*. The results showed that the received plants differ by their morphology and growth rate. The content of secondary metabolites in rhizomes from plants cultivated in the greenhouse and field conditions was lower than that of those collected in the mountains. After periodic illumination of plants with ultraviolet radiation and their treatment with the biostimulator Reglalg, the content of secondary metabolites in rhizomes increased to a level comparable to those in rhizomes collected in the culture medium, and the exposure of *R. rosea* callus in the logarithmic growth phase at 4°C, during 12 hours, stimulated the accumulation of secondary metabolites in callus biomass. We selected a vigorous clone of plant induced from the cells of *R. rosea* callus and transferred it for propagation *in vivo*. The generative descendants of this clone served as initial material for the selection of the *R. rosea* cultivars Tatiana, certified in Ukraine.

The research conducted allowed elucidating and optimizing the combined influence of the main factors that determine the growth and accumulation of secondary metabolites in the *in vitro* and *in vivo* culture of *R. rosea*. More promising results were obtained with the plants cultivated under *in vivo* conditions. Currently, using accumulated information, we are developing economically advantageous technologies for artificially large-scale cultivation of the *R. rosea* plants that contain high levels of secondary metabolites in their rhizomes.

Keywords: Rhodiola rosea, in vivo, in vitro, secondary metabolites.

Acknowledgment

Research was carried out partially within the project of the State Program "20.80009.7007.07" "Determining the parameters that characterize the resistance of plants with the different level of organization to the action of extreme temperatures in order to reduce the effects of climate change.", financed by the National Agency for Research and Development.

INDUSTRY 4.0 TECHNOLOGY AND BIODIVERSITY

Liudmyla Deineko, Oksana Kyshnirenko

Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>kushnksena@gmail.com</u>

A characteristic feature of the current days is the technological challenges, related to Industry 4.0. These include the widespread dissemination of digital technologies in manufacturing and services, including everyday life, work, and leisure. Technological changes of the Industry 4.0 are characterized by the global integration of digital networking technologies into day-to-day life. It established new rules and priorities, changed forms of behavior, and set the parameters of the impact on the environment and biodiversity, propelling the world into modernity. It is not a matter of the local application of technologies, but about their merger, integration into a network, which entails profound structural transformations that are manifested at the global level. Prior to the emergence of Industry 4.0 all organisms have been evolving within the natural selection processes, but industrial development advances have brought the loss of biodiversity (from 10 to 50 % of well-studied higher taxonomic groups are endangered, including 23 % of mammalian species, 12 % of birds, 25 % – conifers), triggering food and water insecurity. The latest technologies make it possible to carry out a rational design of biological development. Such biological intervention may have serious risks if the effects of such intervention are not sufficiently studied.

In the light of the above mentioned, the goal of the research is to improve the conceptual approaches for explaining the causes of environmental transformations and determining the patterns of their impact on biodiversity, to prevent the destructive impact of industrial and innovative transformations brought by the Industry 4.0. That, in turn, will allow developing new approaches to the prospects of further socio-economic development and will help to adapt to the challenges of the future.

Both general and special scientific methods were used in the study. To determine the impact of technological innovations of Industry 4.0 on the environment, particularly on biodiversity, a systematic approach was applied. The main research methods used in the work are abstract-logical (for theoretical generalization of the results of the scientific research and formation of conclusions); economic and statistical – time series, analytical grouping (to identify trends in detecting the influence of factors on biodiversity), monographic (to clarify individual concepts – "industry 4.0", "biodiversity", etc.).

Through compiling and synthesizing existing scientific approaches to Industry 4.0's technologies, it has been determined that they could be both a source of future environmental problems and a basis for the new promising environmental technologies. The identification of transformational forces, that will affect future development, making it possible to systematize the factors influencing industry 4.0 technologies on biodiversity and the state of the environment. The measures for the prevention of such risks are substantiated, of which the authors distinguish: intimate understanding of the mechanics of the rational management of natural resources with the use of appropriate innovative ecologically oriented nanotechnologies; enhancing the development of a circular economy; stimulating sustainable practices in the manufacturing, retail and service provision; promoting sustainable consumption and the transition to healthy diets; reduction of industrial waste; reduction of emissions and the transition to a state of "low-carbon industries"; support of the ecological transport development and the creation of appropriate infrastructure; the dissemination of environmentally friendly resource-efficient innovations, development of "green" businesses.

This paper considered the issue of the Industry 4.0 influence on biodiversity and the state of the environment. With the development of Industry 4.0, the demands of society to protect the interests of each person and the environment are growing.

Keywords: Industry 4.0, biodiversity, risks, transhumanism.

CALCIUM SILICATE AND γ-AMINOBUTYRIC ACID REDUCE ADVERSE EFFECTS OF SIMULATED ACID RAIN ON CORN AND WHEAT

Natalia Didyk¹, Bogdana Ivanytska¹, Tetiana Lysenko²

¹M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine; Kyiv, Ukraine; E-mail.: <u>nataliya_didyk@ukr.net</u>

²Educational and Scientific Center "Institute of Biology and Medicine", Taras Shevchenko National University of Kyiv, Ukraine

One of the dangerous consequences of anthropogenic emissions of sulfur and nitrogen compounds into the atmosphere is an increase in precipitation acidity. The greatest damage acid precipitations cause to vegetation. The yield of most crops is declining worldwide. Acid precipitations intervene with the main physiological processes such as photosynthesis, respiration, nutrition, and water balance. Inhibition of photosynthesis and nutrition hampers plant growth and resistance to other stress factors. Traditional farming technologies are not able to compensate for the losses of agriculture from abiotic stresses. Therefore, recently, much attention of researchers is focused on the development of new, environmentally sound antistress technologies for crop production. In this regard, the most promising are natural substances with high adaptogenic potential such as biologically active silicon and allelochemicals.

The effect of CaSiO₃, γ -aminobutyric acid and their mixtures on the adaptation of testplants of wheat (*Triticum aestivum* L. cv. Smuglyanka) and corn (*Zea mais* L. cv. Kadr 267 MB) to simulated acid rain was studied in the model pot experiments. The acid precipitations were imitated by double watering with distilled water acidified with sulfuric acid to pH = 2: the day and 3 days after sowing the seeds. Test plants were grown in a phytochamber under controlled conditions of light, temperature, and soil moisture for three weeks. At the end of the experiments, morphometric growth parameters (shoot height, root length, leaf area, dry weights of shoots and roots), the content of photosynthetic pigments, flavonoids, and proline in leaves were determined. For maize, the content of anthocyanins in shoots and roots was also evaluated. Characteristics of soil pH, electrical conductivity, redox potential, contents of NO₃⁻ and HCO₃⁻ were also measured.

The test-plants exposed to simulated acid rain had stunted growth, reduced content of photosynthetic pigments in leaves as compared to plants grown in the control treatment (without acid rain simulation). While the content of metabolites, known to be stress markers (i.e. proline, flavonoids, anthocyanins) increased. Application of all studied amendments to soil completely compensated the negative influence of the simulated acid rain on the studied physiological processes in wheat and corn test plants. The mixture of calcium silicate and γ -aminobutyric acid was the most effective. Test plants treated with this mixture prior to simulated acid rain displayed better growth and biomass accumulation as compared to test plants in the control treatment (without simulated acid rain).

In addition, the application of the studied amendments to the soil contributed to the increase of electrical conductivity and content of NO₃⁻ and HCO₃⁻ anions. This restoration of HCO₃⁻ to the control level (without simulated acid rain) after application of a mixture of CaSiO₃ and γ -aminobutyric acid indicated normalization of the carbonate-calcium soil buffering system.

Thus, a mixture of $CaSiO_3$ and γ -aminobutyric acid is promising for the elaboration of innovative environmentally safe technologies to protect crops against acid precipitations.

Keywords: *Triticum aestivum, Zea mais,* calcium silicate, γ-aminobutyric acid, acid precipitations, abiotic stress, adaptive reactions.



INFLUENCE OF CONCENTRATION OF AQUEOUS-ETHANOL SOLUTION ON EXTRACTION OF FLAVONOIDS FROM "HAIRY" ROOTS OF MEDICINAL PLANTS

Volodymyr Duplij, Nadiia Matvieieva

Institute of Cell Biology and Genetic Engineering of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>joyna56@gmail.com</u>

Plants have been used by mankind since ancient times for the treatment and prevention of various diseases. However, mass collection of plant raw materials can pose a threat to natural populations. In addition, contamination of the environment with toxicants sometimes makes it impossible to collect plants that grow naturally. The use of biotechnological approaches, in particular, *Agrobacterium*-mediated transformation, allows obtaining "hairy" roots of medicinal plants. Such roots are a promising source of a complex of bioactive compounds, as they can synthesize compounds inherent in plants, and their number may be many times higher than that in control plants. In addition, the roots grown in bioreactors are not exposed to negative natural factors that reduce the content of valuable compounds, in particular, flavonoids, as they are cultivated under standardized conditions (medium composition, temperature, humidity, etc.). However, the extraction conditions of the compounds synthesized in "hairy" roots are an important technological factor that must be taken into account. In this work, we analyzed the features of extraction of flavonoids using a water-ethanol mixture with different ethanol content. "Hairy" roots of *Cichorium* intybus L. (2 samples) and Artemisia vulgaris L. (2 samples) were grown under standard conditions (Murashige and Skoog nutrient medium), collected, lyophilized, and crushed. Extraction was performed at + 25 °C for 24 h using 40 %, 70 % and 96 % aqueous-ethanol mixture. The total flavonoid content was determined by reaction with aluminum chloride per 1 gram of dry weight (DW).

It was found that the studied root samples differed significantly in the content of flavonoids after extraction with a water-ethanol mixture of different concentrations. Thus, in the *A. vulgaris* sample Nº1 the largest amount of flavonoids was detected by extraction with 40 % ethanol – $63.5 \pm 1.25 \text{ mg/g}$ DW. When 70 and 96 % ethanol were used, the amount of flavonoids was 25.2 ±0.28 and 35.18 ±2.15 mg/g DW, respectively. At the same time, the detected content of flavonoids in sample Nº2 of the same species was 55.49 ±3.34, 67.78 ±7.03, and 73.08 ±4.28, respectively, using 40 %, 70 %, and 96 % ethanol.

Two samples of *C. intybus* differed from the above-described extracts because a higher content of flavonoids was detected using 70 % ethanol. Thus, flavonoid content was 74.82 ± 1.56 , 89.35 ± 1.32 , and 84.48 ± 3.12 in the line Nº1, as well as in the line Nº2 it was 71.34 ± 1.79 , 93.99 ± 1.51 , and 88.34 ± 1.31 mg/g DW when used respectively 40 %, 70 %, and 96 % ethanol.

Such features can be explained by the different qualitative compositions of flavonoids. This is due to the solubility of glycosylated flavonoids (preferably extracted with a waterethanol mixture with a lower ethanol concentration) and aglycones, which are extracted with a mixture with a high concentration of ethanol. The obtained data indicate a probably higher content of aglycones in two samples of chicory "hairy" roots in comparison with the wormwood sample Nº1. Thus, when optimizing the method of extraction of flavonoids, it is necessary to conduct preliminary testing using an aqueous-ethanol mixture of different concentrations for maximum extraction f the target compounds.

Keywords: Cichorium intybus, Artemisia vulgaris, "hairy" roots, flavonoids.

Acknowledgments

The work was supported by a grant № II-2-21of the National Academy of Sciences of Ukraine.

NEW APPROACH TO DEFINING THE TYPE (KIND) OF PROPOLIS

Roman Dvykaliuk, Leonora Adamchuk

National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>leonora.adamchuk@gmail.com</u>

The goal of our work was to substantiate a new approach to the definition of the type of propolis. Scientific information sources on propolis research over the past 10 years have contained a variety of inconsistent types of propolis. This uncertainty complicates the scientific search, considering the different languages of the publication, the commercial activities of propolis producers, the educational process, and the systematization and generalization of the results of existing research. Consequently, new technologies and regions with potentially «new» types of propolis are overlooked.

Our observations on the behavior of honeybees during the carrying of plant resin in the 2019–2021 beekeeping seasons confirm the results of Isidorov et al. (2016) and Bankova et al. (2019). We have observed bees with different colours of plant resin. However, not only the tendency of bees to visit different sources of propolis is the basis for the formation of «Mixed propolis types». We have found that the way the propolis is collected in apiaries plays an important role in the formation of the type of propolis. The propolis was collected from 25 apiaries in different regions of Ukraine using special meshes in the 2020 beekeeping season. Considering the obtained results, we have determined the factors that influence the formation of mixed or monofloral propolis. These include the presence of various botanical sources (plant species) that secrete plant resin simultaneously; the method of selection of propolis from hives; the frequency of rotation of meshes' areas to which bees have access for laying propolis; propolis collection period; method of cleaning the tools for collecting propolis (parts of the hive or special devices). We have proved that within the same climatic zone, at the same way of collecting propolis in the same period, colour, smell, taste of propolis differ. This is probably due to the specific location of the collection and the flora within the range of productive flight of the bees, genetics, and the state of the colony (strength, presence of the honey harvest, development, etc.).

In our opinion, it is not advisable to link the propolis type name to a particular geographical region because its origin is primarily due to the species from which the bees collected the plant resins. The distribution of plant species is not always limited to geographical regions. For example, *Populus spp.* is common in most of the world. Considering the common practice in beekeeping, the type of propolis should be based on the genus name of the plant (botanical source of its origin). Varieties of honey are similarly identified by botanical origin. Today it is known that in different regions, at least 7 species of the genus *Populus spp.* are sources of propolis. Subsequently, the propolis obtained and identified from the individual plant species should be classified under the subtype. Depending on the presence of one or more sources in the propolis, the type of propolis should be named by the dominant source, with additional sources also mentioned in the name. The adoption of a common approach to the names of propolis types will promote good research and scientific practice, popularize the product to consumers and provide a basis for the development of common standards and product quality for the improvement of human health.

Keywords: propolis, botanical origin, type.



Roman Dvykaliuk, Leonora Adamchuk

National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>leonora.adamchuk@gmail.com</u>

Different approaches in the propolis type (kind) names are primarily due to the complexity of their definition and the identification of the botanical source (plant resin), which is the basis of the formation of bee glue. Most often, a new type of propolis is first identified organoleptically in the nest (colour, smell, taste, consistency, quantity) and then physicochemical investigations of its composition and properties are carried out. The identification of the plant source of propolis is a complex study. This requires the analysis of a significant number of candidate plants within the productive flight of bees from which propolis is selected. The goal of our work was to analyze the known types of propolis, their names, and botanical sources.

The author Anton C. de Groot (2013) denotes the types of propolis: «Poplar» plant source - Populus spp., «Green (alecrim) Brazilian» - Baccharis spp., «Birch» - Betula spp., «Red propolis» – Dalbergia spp., «Mediterranean» – Cupressaceae spp., «Clusia» – Clusia spp., «Pacific» – *Macaranga* spp. Bankova et al., (2019) define the types of propolis: «Poplar type propolis» – Populus spp., «Aspen type propolis» – Populus tremula L., «Brazilian green propolis» - *Baccharis dracunculifolia* DC., «South American red propolis» - *Dalbergia ecastophyllum* (L.) Taub., «Mediterranean type propolis» - Cupressus sempervirens L., «Pacific type propolis» -Macaranga tanarius (L.) Müll.Arg., «Mangifera indica type propolis» – Mangifera indica L., Mixed propolis types – the source of which is two or more species of plants. Salas et al. (2020) defined «Zuccagnia-type Propolis» in Argentine, which originates from *Zuccagnia punctata* Cav. Bloor & Mitchell (2021) identify propolis the source of which is *Populus spp*. as «European-type propolis». Park et al., (2002) and Hodel et al., (2020) divided propolis from different regions of Brazil into 13 types by colour, texture, and chemical composition. Propolis whose source is Macaranga tanarius (L.) Müll.Arg. is called «Taiwanese green propolis (Su et al., 2014; Chen et al., 2019; Hsieh et al., 2019; Vo et al., 2021) or «Pacific type» (Trusheva et al., 2017). Jiang et al., (2019) reported a new type of propolis in Changbai Mountains area (China). They concluded that the source of the propolis was *Populus davidiana* Dode and *Populus simonii* Carrière. There is also a discrepancy between the type names of propolis «Mediterranean propolis» to its plant source Cupressus sempervirens L. (El-Guendouz et al., 2019; Svečnjak et al., 2020; Ardjoum et al., 2021; Popova et al., 2012). According to the results of a study of 56 samples of propolis from Croatia (Saftić et al., 2019), it has been proved that «European-type propolis» (Populus spp.) is obtained on the mainland and getting closer to the coast the substances that are specific to «Mediterranean propolis» are identified. According to authors (Bankova et al., 2002; Trusheva et al., 2011) «Mixed propolis types» is a type that is formed by the natural predisposition of bees to accumulate resin from different plants in their nests. Isidorov et al. (2016) confirm the presence of mixed types of propolis in European countries with a temperate climate. Two or more sources of plant resins (plant species) are identified in their composition.

Despite different approaches to the typology of propolis and contradictions in its classification, there is a need to create a single identifier that can be used internationally.

Keywords: propolis, type, species, plant resin.



Jarmila Eftimová, Vladimír Petrovič, Vladimír Vodhanel

Department of Pharmaceutical Technology, Pharmacognosy and Botany, University of Veterinary Medicine and Pharmacy in Košice, Slovak Republic; E-mail.: jarmila.eftimova@uvlf.sk

The experimental work aimed to compare the influence of different application forms of alginite on the amounts of substances in *Mentha species* "*Erdbeerminze*" and *Mentha species* "*Schokominze*" and their toxicity on freshwater invertebrates of the genus *Daphnia* spp.

We determined the content of total polyphenols, phenolic acids, and antioxidant activity by spectrophotometric methods. The highest content of total polyphenols converted to coffee acid equivalent was determined in the aqueous extract of a sample of *Mentha species* "*Schokominze*" in the control variant 3.37 mg CAE/100 g of dry drug. The lowest in the sample of *Mentha species* "*Erdbeerminze*" variant powdered alginite, 1.01 mg CAE/100g of the dried drug had the statistically lowest content.

The highest antioxidant activity determined by the method with DPPH radical was observed in the methanol extract of *Mentha species* "*Schokominze*" in the variant with powdered alginite 40.52 % and in the dressing with alginite 39.87 %. The differences between the alginite and control variants are statistically insignificant. The highest antiradical activity (as Trolox equivalent) was shown by the methanol extract of *Mentha* "*Schokominze*" variant alginite powder, namely 119.5 mg TEAC/100 g of dry drug.

The content of phenolic acids in the ethanol extracts of the sample *Mentha species* "*Schokomize*" was determined in the range from 1.52–1.57 mg CAE/100 g of dried drug. No statistical differences in phenolic acid content were observed between variants within one species.

Results of a 48-hour ecotoxicological experiment on *Daphnia sp.* indicate that the contents of the extracts from the sample of *Mentha species* "*Schokominze*" had approximately 10 times higher EC₅₀ values than in all samples of *Mentha species* "*Erdbeerminze*", regardless of the form of alginite application. The results showed that the extract from *Mentha species* "*Schokominze*" in the control variant was for invertebrates *Daphnia sp.* the most toxic.

Keywords: *Mentha*, essential oil, menthol, Erdbeerminze, Schokominze, alginite.

STUDY OF SOME BIOLOGICAL EFFECTS OF ALGINITE ON PLANT AND INSECTS

Dina Elisovetcaia¹, Raisa Ivanova¹, Jana Simkova², Jan Brindza²

¹Institute of Genetics, Physiology and Plant Protection, Chisinau, Republic of Moldova; E-mail.: <u>dina.elis.s@gmail.com</u> ²Slovak University of Agriculture in Nitra, Slovak Republic

Alginite is an organic-bituminous rock, rich in macro- and microelements. Due to its unique chemical composition, alginite improves the soil, affects the growth and development of plants, and increases yield and productivity. The purpose of our work was to study the effect of alginite of Slovak origin on germination of tomato seeds, growth, and development of plants, as well as to evaluate the biological activity of alginite against insect pests.

The research was carried out by standard methods in the laboratory and greenhouse during 2020. Tomato seeds with low germination capacity (60.0 %) were treated by immersion in alginite solutions of concentration 0.0001, 0.001, 0.01 and 0.1 %. Alginite solutions with concentrations of 0.1–5.0 % were used for testing against insects.

The application of alginite solutions significantly increases the germination of tomato seeds in laboratory conditions by 9.2–13.0 % (LSD_{0.05}=8.82, p≤ 0.05). The highest seed germination (81.3 %) was observed in the variant with the alginite concentration of 0.001 %, the lowest (77.5 %) – in 0.1 % concentration. In addition, there was a significant increase in the length of seedlings by 1.87 and 2.98 cm (LSD_{0.05}=1.61, p≤0.05) in variants treated with 0.01 and 0.1 % alginite solutions, respectively. An increase in root length by 2.22, 3.54, and 4.51 cm was observed in three variants of treatment with alginite solutions of 0.001, 0.01, and 0.1 %, respectively (LSD_{0.05}=1.55, p≤0.05). Thus, the alginite solutions lead to both a significant stimulation of the germination of tomato seeds and to the growth of seedlings and roots.

In a greenhouse, the germination of pre-sowing treated seeds in all variants exceeded the control by 8.3–33.2 %. However, a significant difference (LSD_{0.05}=20.5, p≤0.05) was noted only in the variant where the seeds were treated with 0.001 % alginite solution. Monitoring of plant height showed that a month after the emergence of the first seedlings the average plant height was significantly higher in the variant 0.001 % alginite solution and reached 11.41 cm (LSD_{0.05}=2.63, p≤0.05). The average plant height in the rest of the tested variants was at the control level (8.21 cm). The yield in the variants treated with alginite solutions significantly exceeded the control by 316.53–327.71 g per one tomato bush.

It was found that alginite solutions at a concentration of 0.1–1.0 % had low ovicidal (2.73– 13.19 %) and insecticidal (5.0–33.3 %) effects against insects belonging to different orders – *Leptinotarsa decemlineata* (Coleoptera), *Galleria mellonella* (Lepidoptera) and *Halyomorpha halys* (Hemiptera). Alginite solutions did not have contact insecticidal activity; the death of insects was caused mainly by the consumption of treated feed. At the same time, a high antifeedant effect was revealed from 45.0 to 85.0 % against adults and larvae of 2–3 instars of *L. decemlineata* and larvae of 2–3 instars of *G. mellonella*. To conclude, the application of alginite contributed to an increase in seed germination and plant productivity, and it did not have a significant negative effect on the insect.

Keywords: alginite, seeds germination, plant growth, yield, insect biological activity.

Acknowledgments

The authors are grateful to the Ministry of Education, Science, Research and Sport of the Slovak Republic for supporting by two grants the researcher's mobility within the Bilateral scholarship program for 2019–2020.



Inessa Ershova

Federal Altai Scientific Centre of Agro-Biotechnologies, Barnaul, Russian Federation; E-mail.: <u>inessers@yandex.ru</u>

Tocopherols (Vitamin E) are characterized by unique biological properties and high antioxidant activity. The fruits of sea buckthorn (*Hippophaë rhamnoides* L.) serve as a highly valuable source of natural Vitamin E, thus, it is important to study tocopherol content in the fruits of this crop, aiming to identify and create new cultivars and varieties with high content of this type of biologically active substances. Altai cultivars of sea buckthorn have high potential in this regard.

The present research aims to study the content of tocopherols in the fruits of nine sea buckthorn cultivars with high economic and biochemical potential: Chuiskaya, Elizaveta, Zlata, Inya, Ognivo, Chechek, Chulishmanka, Essel, and Ethna. The material of the research consisted of freshly harvested fruits, frozen in the freezer at -25 °C. The extraction of tocopherols was performed by the modified method equivalent to the I.K. Murry method of extraction of carotenoids. Ethanol 96 % and benzol were used as extractants. The sample weight was 5 g. 10 ml of finite benzol fraction was a vacuum- concentrated by 20 times at the temperature of 35 °C and used for chromatographic analysis. The chromatography was performed with liquid chromatograph Agilent LC 1260 Infinity, using column Zorbax Eclipse Plus C18, size 2.1*50 mm, sorbent grain – 1.8 microns. The conditions of chromatography were: sample volume – 0.25– 0.5 microliters, mobile phase – water-acetonitrile (5 % H₂O, 95 % ACN), flow rate – 0.2 ml/min, time – 30 minutes. Mass spectrums of the samples were registered by mass spectrometer Agilent 6530 QTOF. Quantitative analysis was based on the analysis of MRM transition 430,3795 \rightarrow 165,0912, the voltage of collision cell being 20 V in positive ionization mode. A calibration curve was built on a standard sample of Vitamin E («Aldrich»).

The research shows a rather high level of tocopherol content that, however, differs substantially in the fruits of the abovementioned cultivars of sea buckthorn. The average tocopherol quantity is 96.1 mg/100 g, with a variation range 71.8–126.0 mg/100 g in wet weight. Cultivar Chuiskaya , known for the high content of biologically active substances in its fruits, also takes one of the leading positions in this research. The quantity of Vitamin E in this variety is 116.9 mg/100 g, which is higher than average in other varieties and very substantial for this crop. Red-fruited cultivar Ognivo has the highest tocopherol content: 126.0 mg/100 g. The enhanced content of Vitamin E is also remarked in cultivar Chechek (99.7 mg/100 g) and sweet-fruited cultivar Essel (92.9 mg/100 g). The rest of the cultivars, according to the literature data, are also considered high in Vitamins. The corresponding variation range for the mis 71.8–88.4 mg/100 g. In this group cultivar Chulishmanka deserves attention, as it has the highest content of tocopherols in the fruits – 88.4 mg/100 g, and, like cultivar Chyiskaya, it is characterized by the high content of biologically active substances. The high content of Vitamin E is remarked in red-fruited cultivars and forms of sea buckthorn.

Keywords: sea buckthorn, cultivars, fruits, tocopherols.

HUMULUS LUPULUS L. SEED REPRODUCTION OF PLANTS IN TRANSCARPATHIA

Iryna Feketa

Uzhhorod National University, Uzgorod, Ukraine; E-mail.: <u>irynabiogeo@gmail.com</u>

Global climate change on the planet is forcing scientists to pay attention to high-quality and competitive plant varieties.

Humulus lupulus L. is used in the food, medical and pharmaceutical industries. *Humulus lupulus* is important for the development of the hop industry in Ukraine.

It is important to study the features of seed propagation of *Humulus lupulus* in Transcarpathia. Although it is propagated vegetatively in the production of *Humulus lupulus*, the study of this issue is of great importance for selective work and for understanding the relationships between plants in natural communities. *Humulus lupulus* is a dioecious plant, for pollination, it is necessary to take into account the relative position of plants of both sexes and the distance between them.

Humulus lupulus is a common perennial herbaceous vine with a fleshy rhizome. Plants have aboveground and underground parts, only the underground part is perennial. The terrestrial part consists of annual shoots that grow annually from buds, which during the growing season go through a full cycle of development, and die in winter. The stem curls to the right, seated with small spines, the leaves are long petiolate, opposite, with two stipules. Male flowers are collected in panicles and placed in the axils of the leaves. Females are covered with a wrapper and form inflorescences similar to cones. The most valuable part of hops is cones due to the presence of a complex of specific resins, polyphenolic compounds, essential oils, and biologically active substances that have not only flavor and aroma, but also antibiotic, antioxidant, and medicinal properties.

To characterize seed productivity, the following indicators were taken: potential seed productivity (PNP), which is defined as the number of seed germs per individual or generative shoot; and actual seed productivity (TNP) is the number of ripe undamaged seeds. Studies were conducted on plants in Transcarpathia. It was found that individuals have a lower TNF than PNP. This is due to the fact that plants during budding, flowering, and maturation of the plant are affected by weather conditions, insect pests, and various diseases.

Another important characteristic of seed propagation is seed germination. There is a low ability to germinate seeds in the first year of harvest. In the second year, seed germination is better, especially in stratified. The weak germination of non-stratified seeds is due to the fact that it is covered with a hard shell, which is impregnated with resinous substances. This prevents water from entering the seeds and delays their germination. After stratification, the seed coat collapses and germination conditions improve.

Humulus lupulus has high additional productivity, but the seeds are characterized by low germination, so when sowing it is necessary to carry out additional stratification.

Keywords: *Humulus lupulus*, seeds, reproduction, productivity, stratification.



Svetlana Garipova^{1,2}, Oksana Markova¹, Natalya Ivanchina¹, Ramil Khairullin³

¹Bashkir State University, Ufa, Russian Federation; E-mail.: <u>garipovasetlana@gmail.com</u> ²Bashkir Research Institute of Agriculture, Subdivision of the Ufa Federal Research Centre of the Russian Academy of Sciences, Ufa, Russian Federation

³Institute of Biochemistry and Genetics – Subdivision of the Ufa Federal Research Centre of the Russian Academy of Sciences, Ufa, Russian Federation

Any plant can be considered as a macro-symbiont that organizes mutualistic connections with beneficial microorganisms, complementing the adaptive potential of a macro-organism due to its ability to synthesize a variety of physiologically active substances. Root nodules of legume plants are the nutrient-rich niche that can contain both rhizobia and endophytic bacteria (EB). Analysis of their metabolic activity indicates that their existence inside a plant organism can be beneficial to the host. The purpose of this work was a screening of EB from nodules of *Phaseolus vulgaris* with plant growth-promoting traits influencing the seed productivity.

Bacteria were isolated from superficially sterilized nodules on bean-glucose agar, pure cultures of strains were obtained, their morphological, cultural, tinctorial properties and 16S rRNA gene sequence were studied. Sterilized plant seeds were inoculated with bacterial suspension at a density of 10^7 cells/seed and were germinated on wet filters in the dark at 20-22 °C. Morphometric parameters of sprouts were assessed on 3^d and 7th days. The production of cytokinins (CK) by EB was determined by the method of biotests for the preservation of chlorophyll in barley leaves calibrated by 6-benzylaminopurine equivalent. The conditions of the 3 field experiments in 2010 were extremely drought and in 2015 they were optimal. The bean plants were sown at a rate of 15 seeds/m with a row spacing of 45 cm. The accounting plots area for sowing was 3 m². The plots were placed randomly in 4 replicates. Statistical analysis was carried at *p* < 0.05.

In addition to Rhizobium leguminosarum, the isolated from the nodules of bean plants EB were spore-forming gram-positive rods. Based on a complex of morphological, cultural, and biochemical properties, the "satellites" of rhizobia were identified as *Bacillus megaterium* and *B. subtilis*. The taxonomic affiliation of the promising strain 522 (SG12) to the *B. subtilis* species was confirmed based on the analysis of the 16S rRNA gene sequence. Depending on straincultivar combination both intensification and inhibition of the growth of the axial organs of the seedling, shoot/root ratio, and seed germination energy were observed compared to noninoculated control. CK production was 600–800 ng/ml. This level was 1.5 times higher than the production of this hormone by the reference strain *R. leguminosarum* 1078. As a result of field trials of EB, a promising strain *B. subtilis* 522 (collection name of strain SG12) was selected. It contributed to a twofold increase in comparison with control of the biomass of the shoot and the number of beans of the Ufimskaya cultivar plants under conditions of an extremely dry 2010 and increased the seed yield of Zolotistaya cultivar plants by 1.5 times compared to noninoculated control in relatively in favorable 2015. An increase in the productivity of plants inoculated with this strain was accompanied by an increase in shoot mass, the setting of a larger number of beans, and the formation of a larger number of seeds, as well as a greater resistance of plants to root rot compared to the control. This strain can be further recommended for production and wider testing.

Keywords: Phaseolus vulgaris, endophytes, PGP-bacteria, Bacillus megaterium, Bacillus subtilis.



Kateryna Garkava¹, Ulyana Tymoshenko², Raisa Pavlyuk², Irina Michailova¹

¹National Aviation University, Kyiv, Ukraine; E-mail.: <u>immunolog@ukr.net</u> ²Government Agency «Institute of Hematology and Transfusiology National Academy of Medical Sciences of Ukraine» Kyiv, Ukraine

In recent decades, scientists have looked at the link between blood types and the risk of developing certain diseases. Thus, it is believed that people with blood group 0 (I) are more prone to the peptic ulcer of the stomach and duodenum, gastritis as well as hip dysplasia. Persons with A (II) – to obliterating atherosclerosis, endarteritis of the lower extremities, rheumatic diseases, coronary heart disease, bronchial asthma, allergies, leukemia, cholecystitis, and gallstone disease. Carriers of the B (III) group are more likely to suffer from pneumonia, radiculitis, and joint disease. Individuals with AB (IV) blood type are prone to SARS, sore throat, sinusitis, and heart disease. Almost all of these diseases are based on erythrocyte dysfunction.

The use of medicinal plants to replenish the body with biologically active compounds to improve its adaptive capacity is necessary and timely in current days. *Chamerion angustifolium* (L.) Scop., which has antitumor, anti-inflammatory, and antianemic properties, attracts special attention. In this regard, this study aimed to investigate the effect of *Chamerion angustifolium* on the osmotic resistance of erythrocytes of different blood groups of donors.

To reduce the destruction of erythrocytes, they were treated with 0.1 % water-salt extract from *Chamerion angustifolium*. To obtain a water-salt extract a solution of 0.15 mol/L NaCl was used. Erythrocyte resistance was determined by the percentage of hemolysis in buffered isotonic sodium chloride solutions of different concentrations from 1.0 to 0.1 % after treatment with the test plant.

Erythrocyte membranes were a model for studying the level of free radical processes, the state of the body's antioxidant systems, and its adaptive capabilities. The erythrocytes that were not treated with the test plant were the control group.

The results showed that *Chamerion angustifolium* increased the osmotic resistance of erythrocytes 0 (I) of blood group by 28 %, A (II) by 56 %, and B (III) by 35 %.

Thus, the osmotic resistance of erythrocytes A (II) blood group was higher by 29 % compared with 0 (I) blood group and 21 % compared with B (III) blood group, indicating a higher tropism of *Chamerion angustifolium* to erythrocytes A (II) groups, than to 0 (I) and B (III) blood groups. Due to this fact, the individual need, taking into account also blood groups, the use of medicinal plants to improve the adaptive capacity of the organism is beneficial.

Keywords: *Chamerion angustifolium*, blood groups, erythrocytes, medicinal plants.



Murat Gins¹, Valentina Gins¹, Ekaterina Gins²

¹Federal Scientific Center of Vegetable Growing, Moscow, Russian Federation; E-mail.: <u>anirr@bk.ru</u> ²Laboratory of Cell and Genomic Technologies, Russian Potato Research Center, Lyubertsy, Russian Federation

Nowadays in the confectionery industry of Russia, large attention is paid to the production of goods enriched with functional ingredients and biologically active components. There are the collected data about the successful usage of 5...20 % of the flour from amaranth seeds at bakery wares, confectionery, and paste goods production as well as fermented dairy products.

The amaranth of Valentina cultivar is a plant with leaves of deep red color. They are rich in vitamins C, E, carotene, mineral substances (K, Ca, P, Mg, and Fe), they also contain a pigment of red-purple color – amaranthine that allows producing natural red-purple food colorant. The amaranth of Valentina cultivar is used at "Phytotea Amatantyl" production. The amaranth of Krepysh cultivar is a plant of green color with white seeds, the flour from its seeds that is characterized with higher content of proteins and lipids in comparison with wheat flour (proteins – till 19.0 %, lipids – till 8.5 %) is used in cookery, bakery and confectionery industry in combination with wheat flour. The processed product of amaranth seeds is amaranth flour.

The flour from amaranth seeds of Valentina cultivar is characterized with higher content of protein (18.82 %), which is 8.5 % higher than in the wheat flour and 2.0 % higher in comparison with the flour from the amaranth seeds of Krepysh cultivar. On the whole, in the flour from amaranth seeds, the content of fats is almost 7 times higher than in the wheat flour, and the content of amylum and available carbohydrates is lower. The flour from the Krepysh cultivar is characterized by a high content of K (1500 mg%) that is 600 mg% higher than in Valentina cultivar and 1388 mg% higher than in the wheat flour. The flour from amaranth seeds of both cultivars is characterized by a significantly higher content of Fe, Ca, and Mg than the wheat flour, and their physical parameters are very similar. In comparison with the wheat flour, the flour from amaranth seeds is characterized with the higher content of saturated acids: 21.39 % against 18.42 %; significantly higher concentration of monounsaturated fatty acids: 38.28 % against 14.42 %, mostly oleic acid (36.99 %), but less amount of polyunsaturated fatty acids: linolic acid – on 23.9 %, alpha-linolenic acid – on 3.45 %.

The whole meal flour from amaranth seeds is an interesting research object for the development and verification of recommendations for the production of bakery confectionery goods of higher nutritional value and better quality. The addition of the flour from amaranth seeds into the formulation increases the nutritional value of the ready goods, improves their structural-mechanical properties. The optimal proportion of the flour from amaranth seeds of Krepysh and Valentina cultivars at the combined presence is 8.0 and 4.0 % relatively. The prime cost of a wafer sheet with higher nutritional value increases the prime cost of a traditional sheet by almost 50%. However, the ready goods on the base of amaranth flour will be in demand with the population because they possess improved nutritional value and are the goods for healthy nutrition.

Keywords: Amaranth, cultivars, leaves, seeds, biochemical composition.

ARBORETUM OF IVANO-FRANKIVSK MEDICAL COLLEGE

Victoria Gniezdilova

Vasyl Stefanyk Precarpathian National University, Ivano-Frankivsk, Ukraine; E-mail.: <u>viktoria.gniezdilova@pnu.edu.ua</u>

Ornamental plantations play a very important role in urban construction and improvement of settlements. They are one of the most effective ways to improve the living conditions of residents. In 1971 the arboretum with an area of 2 ha was established in Ivano-Frankivsk. Planting planning was done in such a way as, on the one hand, to decorate the building of the Ukrainian Research Institute of Mountain Forestry, and on the other hand – to place next to it a collection of the most important forest-forming species. Therefore, the arboretum was divided into two parts: front, decorative, and rear, collectible, with a scientific purpose. But in 1988 the arboretum changed its owner. Without proper care, many species and forms of valuable introduced species died and fell out of the flora of the arboretum.

The purpose of our study was to conduct an inventory of plantations, systematic, biomorphological and dendrofloristic analysis. For this purpose, the generally accepted methods of floristic research were used. During the study of dendroflora, a list of species was compiled, which were determined by "Dendrology". Systematic taxa were accepted by Takhtadzhyan (1968). As a result of the research, 73 species, 1 hybrid, 5 ornamental forms of woody plants were identified. These species and hybrid belong to 43 genera, grouped into 24 families. Analysis of life forms showed that of the total number of species and hybrids, trees account for 69.1 %, shrubs - 29.6 %, lianas - 1.3 %. Among the representatives of the arboretum, the share of deciduous tree species predominates – 76.9 %, and evergreen plants make up 23.1 %. Systematic analysis of introduced tree species revealed 6 leading families. The largest number of species has *Rosaceae* family, which includes 10 genera and 16 species. In second place – the family *Pinaceae* – 6 genera and 11 species. The composition of 4 families includes four species. Five families include 3 species (Betulaceae, Aceraceae, Magnoliaceae, *Tiliaceae, Caprifoliaceae*). Such families, as *Platanaceae, Oleaceae, Bignoniaceae*, have 2 species. According to the floristic division of the world, representatives of the introduced dendroflora of the arboretum naturally grow in the Holarctic kingdom. A total of 73 species originate from 7 floristic areas. These species can be divided into 3 groups. The first group consists of 54 species, whose habitats are within certain floristic areas. Of these, the largest number comes from the North American Atlantic Region - 41.1 %. 24.6 % of the total number of species originate from the Eastern Asiatic Region (Larix leptolepis Gord.; Acer ginnala Maxim.; Ginkgo biloba L. and other). Some species (6.8 %) (Sorbus intermedia (Ehrh.) Pers.; Picea omorica (Panc.) Purkyne and other) come from the Circumboreal region. The second group consists of 15 species, whose habitats are within the two floristic areas (Circumboreal and Eastern Asiatic, Circumboreal and Iran-Turan, Circumboreal and North American Atlantic Regions). The third group consists of 4 species, whose natural habitats are within the three floristic areas. *Taxus* baccata L. and Ginkgo biloba L. are the relict species in the arboretum.

Students and teachers of the Medical College have established a garden of medicinal plants on the territory of the arboretum, where valuable species of herbs are grown. Today, the Arboretum of Ivano-Frankivsk Medical College is a valuable dendrological object. Students have the opportunity to get acquainted with introduced species, which have proven their suitability for widespread use in landscaping and forestry. Further work will be carried out with the involvement of students in the arrangement of arboretum plantations, as well as to study the ecological properties of the main introduced species.

Keywords: Arboretum, species, floristic areas, life forms.



MORPHOMETRIC PARAMETERS OF VEGETATIVE ORGANS OF DIFFERENT CULTIVARS OF CRABAPPLE

Inna Goncharovska, Volodymyr Kuznetsov

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>Inna Lera@ukr.net</u>

Since the end of the XVIII century in Canada on Ottawa in America at South Dakota research stations from crossing a cherry-like Siberian apple tree imported from Russia with cultivated cultivars, as well as by repeated crossing of a large number of Canadian and American apple trees – Crabapples. The apple tree got its name from English gardeners, who divided the apples into good-tasting and bitter or "Crabapples". However, the main distinguishing feature of crabapples from ordinary apple trees is the size of the fruit. Crabapples fruit is less than or equal to 5.1 cm (2 inches) in diameter. Apples are fruits with a diameter of more than 5.1 cm (2 inches).

This study aimed to identify the best phenotypes from our apple tree collections, in particular crabapples, which could be successfully grown and used in industrial gardens as plants that produce large amounts of pollen, and the introductory collection will contribute to successful breeding with these fruit crops in the future in programs for improved fruit biochemical composition. The objects of the study were 8-year-old apple plants (Crabapples), grafted on the rootstock 54–118, the number of 15 phenotypes of *Malus* spp. collection of the M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine (NBS), on their morphological characteristics and the content of anthocyanins in fruits.

The fruits were harvested at full maturity (October). Cultivar samples differ in weight, shape, size, color of fruits and seeds. Pomological characteristics were performed in four replicates on 30 fruits of each genotype. Only one plant (tree) was used in the study for each sample cultivar. The following parameters were measured: fruit weight (FW) in g, fruit length (FL) in mm, fruit width (FW) in mm and seed weight (SW) in g, seed length (SL) in g, seed width (SW) mm, seed thickness (SW), mm, number of seeds in 1 fruit (NS). The data we work with has been tested in a normal distribution. The amount of anthocyanins was determined spectrophotometrically at a wavelength of 530 nm, using alcohol extraction from the homogenate of vegetable raw materials, acidified with 3.5 % hydrochloric acid.

Morphometric parameters were as follows: Crabapples fruit weight from 1.49 g (cv. Adirondack) to 20.56 g (cv. Era), length from 12.87 mm (cv. Van Ezeltin) to 25.11 mm (cv. Ola), diameter from 12.0 mm (cv. Butterball) up to 26.74 mm (cv. Rayka Pink), number of seeds in 1 fruit from 1.0 (cv. Era) to 5.5 (cv. Everest), fruit diameter from 11.88 (cv. Royalty) to 42.56 (cv. Era) mm. Fruit shape index ranges from 0.8 (cv. Ola) to 1.1 (cv. King Beauty).

According to the results of anthocyanin content, it was found that the highest content of the cultivar Royalty – 311.64 mg/100 g, and the lowest in the cultivar White Jade – 31.8 mg/100 g of dry matter.

The introductory collection of apple trees, collected in the M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine (NBS) has sufficient potential for successful selection work. Increased susceptibility may be the result of genetic variability within a cultivar or species.

Keywords: Malus, fruit, morphometric parameters, anthocyanins.

DESIGN PRINCIPLES FOR FARM FORESTRY

Olga Grigoreva

Department of Forestry, Federal State Budget Education Institution of Higher Education "Saint-Petersburg state forest technical University named after S.M. Kirov", Saint-Petersburg, Russian Federation; E-mail.: <u>grigoreva o@list.ru</u>

The article deals with agroforestry systems that offer new ways to meet the needs of wood, food, and renewable energy sources. In particular, the inclusion of several vertical levels of crop production in the same space, the cultivation of wood crops with a high content of cellulose for biomass.

To familiarize Russian specialists in the field of forestry, an overview of general methods of agroforestry has been made. In the modern view, forest management, in most cases, is a special type of land use, in which one type of phytoproduct – wood is grown for a long duration of time (the turnover of logging). The key difference between forest plantations and traditional agricultural crops is the duration of crop cultivation, its size, as well as the fact that a wide range of useful products can be obtained in forest plantations during the turnover of logging, the processes of "production" of which go in parallel and do not interfere with each other. This specific of the forest has been known to mankind for a long time, for example, the spring collection of tree juices, the collection of mushrooms and berries during summer and autumn seasons, etc. In recent years, such a type of forest business as the collection and processing of forest food products, mushrooms, and berries has been dynamically developing in Russia. But all this regards naturally grown phytoproducts. In large agricultural areas, one field is occupied only with wheat, and the other with corn and only apples are grown in the garden, for example. But small landowners can observe how vegetables are grown under apple trees, and late agricultural crops are planted in the middle of seedbeds with early products. In that case, the land is used more rationally, but the mechanization of the process of cultivation of agricultural products is very difficult and requires a large amount of manual labor. Such a method of management, in which each plot of land is used most rationally, will not be used in the practice of huge timber enterprises in the foreseeable future. But, for example, when planning farming on the «Far Eastern hectare», the practice of agroforestry can be very useful.

Combining tree cultivation with agricultural activities can create additional sources of income, distribute agricultural labor throughout the year and increase agricultural productivity – along with soil and water protection. Such systems of "agroforestry" include alleying (cultivation of crops along alleys), forest pastures, windbreaks, forestry of non-wood products, and coastal buffer strips. Agroforestry is a complex forest-agricultural system that combines agricultural crops or livestock, or both with tree and shrub vegetation. A well-designed agroforestry system provides many advantages, including diversified sources of income, increased biological production, improved water, and soil quality, and habitat.

As a result, it can be noted that the most promising systems of agroforestry are: the inclusion of several vertical levels of production, agricultural crops in the same space; as well as the cultivation of perennial crops.

Keywords: agroforestry, forest farming, forest plantations.

FOREST PLANTATIONS AS THE BASIS OF AGROFORESTRY

Igor Grygorev

Arctic State Agrotechnological University, Department of Technology and Equipment of the Forest, Yakutsk; Voronezh State University of Forestry and Technologies named after G.F.

Morozov, Voronezh, Russian Federation; E-mail.: <u>silver73@inbox.ru</u>

In the conditions of negative climate changes, environmental pollution, growing overpopulation, frequent droughts and crop failures, shortages of food and clean drinking water, military-political conflicts and climatic anomalies, migration processes gaining momentum in this regard, the problem of rational and efficient land use are becoming increasingly urgent.

The Russian Federation, so far, does not face this problem as much as small European or overpopulated Asian countries. Moreover, the scale of Russia, so far, allows us to treat such wealth as fertile lands in many ways carelessly. Suffice it to say that in 2021, 60 million hectares of farmland in Russia are overgrown with forest growth, which is a rather serious problem. This is due to the fact, that in Russia the Federal Forestry Agency is part of the Ministry of Natural Resources, and in many foreign countries, similar departments are part of the Ministry of Agriculture. That is, their forest lands are considered as a kind of agricultural land, allowing receiving a variety of products, depending on the developing situation.

Without taking into account, for the time being, the global ecological significance of forests, as well as their social significance, we note that the fundamental difference between plantations and traditional crops is the duration of crop cultivation, its size, as well as the fact that a wide range of useful products can be obtained in plantations for logging turnover, the processes of "production" of which go in parallel and do not interfere with each other. This property of the forest has been known to mankind for a long time, for example, the spring collection of tree juices, summer and autumn collection of mushrooms and berries, etc.

The purpose of creating artificial plantations, usually, is the cultivation of monoculture, for a period determined by the purpose of the final product – wood. Its further direction of use can be energy, technological chips, lumber, etc.

It should be noted that planting not only woody and shrubby plants can be used for the production of "green" energy. The optimal choice of rational use of land depends on the specific natural and industrial situation.

In Russia, in our opinion, energy plantations (plantations) will not be relevant in the coming years, due to large reserves of hydrocarbons, falling prices for them, the active development of the country's gasification program, the extinction of villages and small rural settlements, which is why the demand for wood falls annually. But, in our opinion, balance-sheet plantations have very good prospects in Russia. This is due to the fact, which ripe affordable operational forests have been cut down in many regions. There is almost no construction of forest roads, and the sawmill was destroyed in the last years of the USSR. This leads to a rapid increase in the shoulder of the export of harvested wood, an increase in its cost, and, ultimately, an increase in the cost of the final products of wood processing, which means a decrease in the competitiveness of the domestic forestry complex.

For the cultivation of balance wood, it is not necessary to wait for the age of ripeness to be reached by the plantation. Moreover, in the initial period, the growth of planting occurs exponentially, which means that it is possible to significantly reduce the turnover of logging, increase the efficiency of land use under cuttings that are currently overgrown with blackwood. Overgrowing of cuttings with weedy tree species is associated with a sharp drop in the volume of logging, which, in turn, is due to the fact, that the forest user cannot get two turns of logging during the lease period. And when creating and operating forest plantations, this is quite possible.

Keywords: agroforestry, forest plantations, bioenergy.

AMINO ACID PROFILE OF LEAVES OF NON-TRADITIONAL FRUIT PLANTS

Olga Grygorieva¹, Svitlana Klymenko¹, Yulia Vinogradova², Anna Adriana Bieniek³, Agata Antoniewska⁴, Katarína Fatrcová-Šramková⁵, Ján Brindza⁵

¹M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>olgrygorieva@gmail.com</u>

²N.V. Tsitsin Main Botanical Garden of Russian Academy of Sciences, Moscow, Russian Federation
³University of Warmia and Mazury in Olsztyn, Poland
⁴Warsaw University of Life Sciences, Warsaw, Poland
⁵Slovak University of Agriculture in Nitra, Slovak Republic

Amino acids have important functions in both nutrition and health: regulate protein synthesis, breakdown and consequently protein deposition, which corresponds to the balance between the two processes; cell signaling molecules, regulators of gene expression and the protein phosphorylation cascade; key precursors for syntheses of hormones and low-molecular weight nitrogenous substances of high biological importance.

To the best of the authors knowledge, amino acids composition of leaves of many nontraditional fruit plants is lacking. Thus, the aim of the study was to determine amino acid profiles of leaves of selected non-traditional fruit plants: *Amelanchier alnifolia* (Nutt.) Nutt., *Asimina triloba* (L.) Dunal, *Cornus mas* L., *Diospyros kaki* L., *Diospyros lotus* L., *Diospyros virginiana* L., *Hippophaë rhamnoides* L., *Chaenomeles japonica* (Thunb.) Lindl. ex Spach, *Ziziphus jujuba* Mill. grown in the M.M. Gryshko National Botanical Garden (Kyiv, Ukraine).

Amino acid profile was analyzed by ion-exchange chromatography using an AAA-400 Amino Acid Analyzer (Ingos, Czech Republic) equipped with a column (370×3.7 mm filled with an Ostion LG ANG ion exchanger, Ingos, Czech Republic) and were detected by reaction with ninhydrin at 570 nm.

The differences in the total amino acids content between studied non-traditional fruit plants were remarkable. *Hippophaë rhamnoides* leaves were distinguished by the highest content of total amino acids (176.9 g/kg of dry weight), whereas *Chaenomeles japonica* with 83.8 g/kg of dry weight by the lowest. Asparagine (25.1 g/kg of dry weight) was the major component of non-essential amino acids of *Hippophaë rhamnoides* leaves, followed by glutamine (21.4 g/kg of dry weight). It should be pointed out that the content of asparagine, as a precursor of lysine and a donor of amino groups in the biosynthesis of non-essential amino acids, is of a great interest. In turn, *Amelanchier alnifolia* leaves proved to be rich in leucine (17.4 g/kg of dry weight) among the essential amino acids. The leucine content should be highlighted, due to the impact on accumulation of diterpene glycosides in the process of ontogenesis.

In conclusion, leaves of non-traditional fruit plants proved to be of high nutritional value, as indicated by a significant share of amino acids. The leaves of selected species may be regarded as a novel source of some amino acids in human diet.

The Institute of Biodiversity Conservation and Biosafety at the Slovak University of Agriculture in Nitra and the M.M. Gryshko National Botanical Garden (Kyiv, Ukraine) cooperate in the promising project regarding the study of biochemical composition of non-traditional fruit plants. It should be highlighted that presented results are only a small part of multidisciplinary research.

Keywords: non-traditional fruit plants, leaves, amino acids.

Acknowledgments

The authors are grateful SAIA and Visegrad Fund (Bratislava, Slovakia). Experimental activities were realized in the laboratories of the Excellent Center for the Conservation and Use of Agrobiology at the Faculty of Agrobiology and Food Resources, Slovak Agricultural University in Nitra.



Iryna Gumeniuk, Alla Levishko, Viktoria Tsvigun, Oleksandr Botsula, Olena Demyanyuk, Olena Sherstoboeva

Institute of Agroecology and Environmental Management of National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>gumenyuk.ir@gmail.com</u>

Soybean is a unique plant, it can be called a natural factory, thanks to a successful combination of two important processes: photosynthesis and biological nitrogen fixation. It helps to improve the nitrogen balance of the soil, is a good precursor for other crops, provides clean products. The phenomenon of soybeans is a high content of protein and fat in the seeds, a rare and diverse combination of enzymatic and vitamin composition.

Inoculation of soybean seeds by nodule bacteria is an integral part of its cultivation technology. The use of bacterial fertilizers can improve the conditions of nitrogen nutrition of this crop, increase its yield, the protein content in the seeds and reduce the number of mineral nitrogen fertilizers. The result of legume-rhizobial symbiosis (LRS) is a sharp increase in plant production without the need to add mineral fertilizers. It should be noted, that the value of this symbiosis is also in ensuring the control of weeds, pathogens, and insects during harvesting in the agricultural system. In a symbiotic association with *Bradyrhizobium japonicum*, soybean plants can fix up to 200 kg/ha of molecular nitrogen, reducing the need for expensive and potentially harmful nitrogen fertilizers. Therefore, the creation of highly efficient *B. japonicum* nitrogen-fixing systems – has great theoretical significance and practical value.

The study aimed to investigate and determine the components and their concentrations for the nutrient medium that would be most suitable for the cultivation of soybean bacteria *Bradyrhizobium japonicum*.

It is known that yeast-mannitol agar (YMA) of the following composition is used for growing the rhizobia (g/l): mannitol – 10.0; yeast extract – 1.0; sucrose – 3.0; $(NH_4)_2SO_4 - 0.5$; $K_2HPO_4 - 0.35$; $KH_2PO_4 - 0.5$; $MgSO_4 - 0.2$; pH 7.2. Our task was to modify this medium to obtain a significant increase in the biomass of soybean rhizobia.

The growth activity of *B. japonicum* strains, which were given the name BR-1 and BR-2, in aYMA medium, which included sources of various nutrients, was studied. We set the following levels of medium components: molasses: 8.0: 16.0: 21.0 g/dm^3 : fodder 5.0 g/dm^3 ; phosphates (1:1)(KH₂PO₄ veast: 2.5; 3.5; + K_2HPO_4): 0.2; 0.3; 0.4 g/dm³. Cultivation was performed in 250 ml Erlenmeyer flasks, under conditions of constant stirring using an orbital shaker 180 rpm, a temperature of 28 ±2 °C. The optimal environment was determined at different periods of bacterial growth using a ULAB 102UV Spectrophotometer at maximum absorption (600 nm) and built growth curves. It was found that the maximum effect of molasses for the growth of BR-2 strain was obtained at its concentration of 21 g/dm³, concerning the BR-1 isolate – at a concentration of 15 g/dm³. The maximum effects on yeast extract exposure were observed using a component concentration of 3.5 g/dm³ for both isolates. In the study of the effect of different content of phosphoric acid salts on the growth of *B. japonicum*, the greatest effect was obtained using the minimum concentration of this component – 0.2 g/dm^3 .

Therefore, according to the growth rates of *B. japonicum* strains, it was found that the optimal ratio of components and concentrations are: molasses: 18.0 g/dm^3 ; fodder yeast: 3.5 g/dm^3 ; phosphates (1:1) (KH₂PO₄ + K₂HPO₄): 0.2 g/dm^3 . The optimized medium promotes the growth of biomass of isolated strains – the formation of a significant amount of exopolysaccharides, which will further contribute to the formation of effective LRS.

Keywords: nodule bacteria, *Bradyrhizobium japonicum*, soybean, legume-rhizobial symbiosis, exopolysaccharides.



Jahongir Hikmatilloevich Hasanov¹, Sherzod Dilmurotovich Mirzaxmedov², Shavkat Ismoilovich Salikhov¹

¹Institute of Bioorganic Chemistry of Academy of Sciences of Uzbekistan, Tashkent, Uzbekistan; E-mail.: <u>hasanovjahongir1980@gmail.com</u> ²Tashkent State Technical University Named After Islam Karimov, Tashkent, Uzbekistan

Essential fatty acids (EFA) play key roles in the normal development and functioning of the brain, central nervous system, linoleic acid (omega-6) and α -linolenic acid (omega-3) may convert to arachidonic acid (ARA) and eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) respectively. Flax (*Linum usitatissimum* L) oil is one of the main sources of essential fatty acids that can be produced functional oil. It includes 40 % of oil and fatty acids composition such as α -linoleic acid (~53 %), oleic acid (~19 %), linoleic acid (~17 %), palmitic acid (~5 %), and stearic acid (~3 %). The higher temperature in pressing is used to faster extraction and increase the oil's yield, but this may lead to thermal degradation of oils, especially those with a higher percentage of polyunsaturated fatty acids. Moreover, oils with higher omega-3 content should be processed with extra care at the lowest temperatures possible to avoid oil deterioration and to prolong oil stability. Due to the abovementioned circumstances, should be used proper processing technologies avoiding oil deterioration and oxidation. Some technologies can be chosen to apply the production of functional oils. Screw pressing is an appropriate technology for producing flax oil even though some disadvantages.

The aim of our study is the determination of moisture content of flax by keeping in mind the quality and quantity of the produced oil. Initial oil and moisture content of the flax seed determined by following AOCS Official Method Af 2.3–54. Samples of flaxseed were weighted using a balance (Scout Pro SPS602F, max weight 600 g) and divided into 6 groups (each mass of the seed is 0.5 kg). The first group of (2*0.5 kg) moisture content of flax seeds was left without changing and remained seed groups were conditioned for the desired moisture content.

Our study shows higher flax seed oil recovery from 24.89 to 40.99 % at lower moisture content ranges as between $5.55 \sim 9.56$ % w.b, when moisture contents increased oil recovery by pressing diminished. The observed trend can be explained by the high moisture contents and humidity of seeds that might be used as a lubricant and result in lower friction inside of the press. In addition, the plasticity of the seeds rises and the pressure inside of the press may decrease. However, solid tiny particles in oil demonstrated controversial results. The sediment content of oil increased from 6.07 to 19.2 %, when the moisture content decreased from 15.57 to 5.55 %. Moreover, the effect of moisture contents of flaxseed on the quality parameters of oil such as acid value, peroxide value, and free fatty acids were studied as well. The acid value of oil represents a downward trend 2.65 \sim 1.47 (mg KOH/g) with increasing the moisture content from 5.55 to 11.05 % w.b. However, acid values increase was observed (1.79, 1.905 mg KOH/g) at the moisture content of 11.05 % w.b. from 1.33 to 0.74 %. The highest peroxide value was 4.25 meq/kg at a moisture content of 5.55 % w.b, and the lowest 1.62 meq/kg at 14.62 % w.b. moisture content.

The overall picture of our research shows that the quality of the raw material is a crucial factor that can influence oil quality and quantity.

Keywords: flaxseed oil, degradation, temperature, screw press.

Acknowledgments

Work was supported by internal grants of Institute of Bioorganic Chemistry of Academy of Sciences of Uzbekistan, the authors acknowledge for daily support of laboratory members of Chemistry of Proteins and Peptides.



Vitaliy Honcharenko¹, Viktor Nachychko^{1,2}, Andriy Prokopiv^{1,2}, Halyna Tkachenko³, Natalia Kurhaluk³, Anna Góralczyk³

¹Ivan Franko National University of Lviv, Lviv, Ukraine; E-mail.: <u>vherbarium@ukr.net</u> ²Botanic Garden of Ivan Franko National University of Lviv, Lviv, Ukraine ³Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland

The current study aimed to verify the antibacterial effects of four species and one interspecific hybrid of the *Thymus* L. genus (*Thymus serpyllum* L. emend. Mill., *T. pannonicus* All., *T. × porcii* Borbás, *T. pulegioides* L., *T. alpestris* Tausch ex A. Kern.) sampled in the western part of Ukraine against *Escherichia coli* (Migula) Castellani and Chalmers ATCC[®]25922[™].

Leaves of *T. serpyllum* were collected among the grass on sandy soil in the edge of a pine forest (Baymaky village, Bilohirva district, Khmelnytsky region, Ukraine; N 50°03'58,9'', E 26°13′37,5″, 257 m a.s.l.). Leaves of *T. pannonicus* were harvested among the grass on the roadside between the two cultivated fields (Syvky village, Bilohirya district, Khmelnytsky region, Ukraine; N 50°02′09,6″, E 26°13′19,2″, 283 m a.s.l.). Leaves of T. pulegioides were collected among grass nearby land parcels (Syvky village, Bilohirya district, Khmelnytsky region, Ukraine; N 50°02′02,8′′, E 26°14′13,9′′, 306 m a.s.l.). Leaves of Th.× porcii (a hybrid between *T. pannonicus* and *T. pulegioides*) were sampled in the grass stand, on the side of the footpath of the race track (Medovoi Pechery Str., Lviv, Ukraine; N 49°49'15.1", E 24°05'12.5", 348 m a.s.l.). Leaves of *Th. alpestris* were harvested on the side of the road below the stream, in mountain valley Shumneska (Kvasy village, Rakhiv district, Zakarpattia region, Ukraine; N 48°09'32.3", E 24°21'26.4", 1259 m a.s.l.). Plant samples were thoroughly washed to remove all the attached material and used to prepare ethanolic extracts. Fresh leaves were washed, weighed, crushed, and homogenized in 96 % ethanol (in ratio 1:19, w/w) at room temperature. Antimicrobial activity was determined using the agar disk diffusion technique. Isolates of bacteria were then incubated at 37 °C for 24 h. The plates were then observed for the zone of inhibition produced by the antibacterial activity of various ethanolic extracts obtained from leaves of *Thymus* representatives. Zone diameters were determined and averaged. Statistical analysis of the data obtained was performed by employing the mean ± standard error of the mean (S.E.M.).

The current study has shown that ethanolic extracts obtained from leaves of *Thymus* species inhibited mild activity against *E. coli*. The mean diameter of inhibition zone for *T. serpyllum* was (10.57 ±0.82 mm), for *T. pannonicus* – (11.59 ±0.75 mm), for *T. x porcii* – (10.80 ±0.69 mm), for *T. pulegioides* – (10.15 ±0.71 mm), and for *T. alpestris* – (9.82 ±0.64 mm). The highest antimicrobial effect was recorded for *T. x porcii*, *T. pannonicus* and *T. serpyllum*. It should be noted that the most antimicrobial effective plant against *E. coli* was *T. x porcii* (mean diameter of inhibition zone was 10.80 ±0.69 mm).

The biological activities of *Thymus* plants and essential oils depend on their chemical composition, which is determined by the genotype and influenced by environmental conditions. Nowadays, thymol and thyme present a wide range of functional possibilities in the pharmacy, food, and cosmetic industry due to several studies that have evaluated the potential therapeutic uses of this compound for the treatment of disorders affecting the respiratory, nervous, and cardiovascular systems. Moreover, this compound also exhibits antimicrobial, antioxidant, anticarcinogenesis, anti-inflammatory, and antispasmodic activities, as well as a potential as a growth enhancer and immunomodulator.

Keywords: *Thymus* species, leaves, antibacterial efficacy, disc diffusion technique, ethanolic extracts.



SCANNING ELECTRON MICROSCOPY STUDY OF POLLEN MORPHOLOGICAL CHARACTERS OF MALUS DOMESTICA BORKH.

Vladimíra Horčinová Sedláčková¹, Erika Mňahončáková¹, Inna Goncharovska², Ján Brindza¹

¹Institute of Plant and Environmental Sciences, Slovak University of Agriculture in Nitra, Slovak Republic; E-mail.: <u>vladimira.sedlackova@uniag.sk</u>

²M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine

The complex of morphological characteristics and ultrastructure of pollen grains allows determining the differences or similarities between the same species. External variables such as extreme climatic changes, but also mineral nutrition and many internal factors (e. i. number of chromosomes) may contribute to the variability of pollen morphological features, especially pollen grain size.

The aim of the study was general characteristics and significant morphological traits of pollen grains of domesticated apple (*Malus domestica* Borkh.) obtained from seven genotypes cultivated in Slovakia. Analyses were studied at the Institute of Biodiversity Conservation and Biosafety using the scanning and transmission electron microscopy. The morphometric parameters were carried out on 50 pollen grains from each genotype using the AxioVision Rel. 4.8.2.0. The length of the polar axis (P) and the equatorial diameter (E) of grains, P/E ratio were measured and compared among studied samples, structure of pollen grain surface was described.

The pollen grains are medium-sized, as we can classify them in the 25–50 μ m category. The smallest pollen grains from the tested genotypes were recorded at the Md-1/4 genotype (31.85 μ m) and the largest at the Md-11/2 genotype (42.85 μ m). The coefficient of variation indicates a certain degree of variability of the mentioned traits – the average length of the polar axis (6.05–10.68 %) and the equatorial axis (4.05–10.18 %). The genotype with the smallest pollen grains was characterized by the greatest variability in the mentioned traits. Shape index varied from 1.44 to 1.87.

Based on the type and number of apertures pollen grains of *Malus domestica* are tricolporate, and according to the location of the apertures zonocolpate. This means that the elongated apertures – colps are distributed equidistantly – at the same distance on the surface of pollen grains with the center in the equatorial plane. They are traditionally tapered towards poles. The place of narrowing of the ridges at the pole (apocolpium) has an average of 7.2–8.0 μ m. The mesocolpium or intercolpium is widest at the equator, i. e. at the same distance from both poles. The average width of the mesocolpium at the equator ranged from 15.0 to 25.2 μ m. In the middle of the mesocolpium, we can observe the ridge of exina above the surface of the pollen grain.

The colour of pollen grains is also a taxonomic feature and tends to be different, mostly yellow in different shades. The colour of the pollen depends on the content of the type of plant dyes. The selected pollen grains were yellow with a shade of brown.

It was noted that diversity of surface sculpturing of pollen grains in combination with shape and sizes of them enables to use complex of thin morphologic signs for *Malus domestica* pollen identifications.

Keywords: Malus domestica, pollen, SEM, morphology.

Acknowledgments

Co-authors is grateful to SAIA and Visegrad Fund for the scholarship for the research during which the presented knowledge were obtained.

DIOSPYROS L. – PROSPECTIVE FRUIT CULTURE IN UKRAINE

Olha Hrabovetska

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine Kyiv, Ukraine; E-mail.: <u>olgagrabovetskay@ukr.net</u>

Persimmon's culture as a fruit plant has been known in Ukraine since the last century, now it is represented by three deciduous species (Caucasian, Virgin, Oriental), as well as hybrids of persimmon and Oriental, which give edible fruit and are widely used in southern and subtropical horticulture.

The introduction of new plant species in combination with an integrated system of agricultural technology will make it possible to minimize the use of pesticides and obtain environmentally friendly products.

Delicious and nutritious persimmon fruits are rich in vitamins and polyphenolic substances, carotenoids, as well as organic compounds of potassium, iron, and calcium. Distinctive and very useful quality of persimmon fruit – high iodine content and low acidity. Fresh fruit pulp contains 13 organic acids, including citric, malic, carotene, dyes, and tannins, 25 macro-and micronutrients, nine of which are essential for the human body. Among them Cu, Zn, Mn, Mo.

The purpose of our work is to assess the success of the introduction and adaptation, to establish the prospects for the cultivation of persimmons (*Diospyros* L.) in the south of Ukraine.

The material of our research was the varietal diversity of persimmons, which originates from three countries (Japan, Georgia, and the USA), as well as obtained as a result of selection work in Ukraine, in the collection plantations of the State Enterprise "Research Farm Novokakhovske "Rice Institute NAAS ".

The experience of growing *Diospyros* outside the southern coast of Crimea shows that the weather and climatic conditions of the Kherson region are fully consistent with their biological characteristics and they, with proper farming techniques, are suitable for cultivation in backyards, cottages, amateur and farm gardens.

Years of research have shown that persimmon plants in the Kherson region during the growing season go through all stages of seasonal development and tie the fruit, which fully ripens and gives similar seeds.

Studies of the biological characteristics of persimmons have been conducted since 1999, its collection was formed on the farm with the support of the NBS-NSC since the late 1980 s. Today in the collection of SE "DG" Novokakhovske" and Rice NAAS" there are about 60 samples. Most of which are samples that were obtained by us as a result of selection work. They show much higher winter hardiness than cultivars *Diospyros kaki* L., can withstand temperatures down to -20–25 °C.

According to the results of many years of research, for the first time in Ukraine we have registered in the National Center for Plant Genetic Resources of Ukraine a Designable Collection of Persimmons based on distinction, samples are presented here by three countries of the world: Japan, Georgia, the USA, and also, received as a result of selection work in Ukraine, including own.

Keywords: *Diospyros*, fruits, cultivars, collection.



ROBINIA PSEUDOACACIA L. AS AN INTRODUCED PLANT INTO NATALIYIVSKYI PARK AND ITS APPLICATIONS

Alla Hryhorenko¹, Inna Koval²

¹State Ecology Academy of Postgraduate Education and Management, Kyiv, Ukraine; E-mail.: <u>alla_gr@ukr.net</u>

² M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine

The introduction of woody plants has a long history. Thanks to it, the enrichment of floristic resources took place. Moreover, the introduction has both positive and negative consequences.

Robinia pseudoacacia L. as an intoroducent, a melliferous plant with medicinal properties, that naturalized on the territory of the Nataliyivskyi park, a monument of gardening art of national importance (the village of Volodymyrivka, Krasnokutsk district of Kharkiv oblast).

An analytical review of literary sources on the generalization of data on introduction, economically valuable qualities of the plant, and its use in various industries is carried out. The composition of the species and cultivars of the park was established by the method of route surveys. Plant names are based on WFO (2021).

Robinia pseudoacacia is a representative of the genus *Robinia* L. of the *Fabaceae* Juss family. It is a North American kenophyte, ergasiophyte with a high adaptive potential to unfavorable abiotic, biotic, and anthropogenic factors.

The natural habitat of the genus *Robinia* is various ecotopes of the Appalachian and Rocky Mountains. Thanks to the French botanist Jean Robin, *Robinia pseudoacacia* came from North America to the Paris gardens in 1601 and spread rapidly throughout Europe.

R. pseudoacacia in Ukraine first appeared in 1780 in the garden of A.K. Razumovsky. On the territory of the Left-Bank forest-steppe of Ukraine, it appeared thanks to I.N. Karazin, who, traveling in the USA and Canada, in 1809, brought it to the Osnovyansky Acclimatization Garden. And from there this plant got into the neighboring park-estate of I.G. Kharitonenko – Nataliyivka, which was created in 1884.

Due to its high drought resistance and soil-strengthening ability, *R. pseudoacacia* was widely used in steppe afforestation. Beekeepers have noticed the high melliferous qualities of this plant. *R. pseudoacacia* honey is almost colorless, transparent, with a floral aroma, high fructose (up to 45 %), glucose (36 %), slowly crystallizes. According to French scientists, the use of *R. pseudoacacia* honey is quite useful for people suffering from cardiovascular diseases and colds. Scientists have studied the various parts of *R. pseudoacacia* for medicinal properties. Today, the official raw material is flowers, which contain an essential oil (0.08–0.12 %) used in cosmetology and aromatherapy. Decoctions and infusions of flowers have antipyretic and antispasmodic effects. One of the most abundant *R. pseudoacacia* flavonoids is robinin, which has hypoazotemia activity and is used to make flaronin.

Thus, *Robinia pseudoacacia* is a very interesting plant as a honey plant for beekeepers and also as a medicinal plant for the pharmaceutical industry. At the same time, thanks to monitoring studies by biologists, this species is one of the most common invasive species in the world. What we observed in the territory of Nataliyivskyi Park, where there were changes in landscapes and tree plantations, where the self-seeding *Robinia pseudoacacia* captures disturbed areas of the landscape. Therefore, the use of this species in plantations needs control.

Keywords: Robinia pseudoacacia, introduction, Nataliyivskyi Park, flavonoids.

DEVELOPMENT OF THE ANALYTICAL PROCEDURE OF THE DETERMINATION OF TOTAL FLAVONOID CONTENT IN THE HERB OF MONARDA FISTULOSA L.

Nataliia Hudz¹, Vladimira Horčinová-Sedláčková², Jana Šimková², Liudmyla Svydenko³, Ján Brindza², Piotr Paweł Wieczorek⁴

¹Department of Drug Technology and Biopharmacy, Danylo Halytsky Lviv National Medical University, Lviv, Ukraine; E-mail.: natali gudz@ukr.net

²Institute of Biological and Environmental Sciences, Slovak University of Agriculture in Nitra, Slovakia ³Sector of Mobilization and Conservation of Plant Resources of the Rice Institute of the NAAS, Plodove, Ukraine

⁴Department of Analytical Chemistry, University of Opole, Poland

Monarda fistulosa L. is to a promising new plant raw material. Essential oil of this species exhibits bactericidal action against many microorganisms. The M. fistulosa herb contains flavonoids of different groups (luteolin-7-0-glucoside, apigenin-7-0-glucoside, apigenin-7-0rutinoside, luteolin, apigenin, rutin, hesperidin, diosmin, guercetin, naringenin, catechin, quercetin, etc.). According to Dmitrienko et al., the content of quercetin determined by high pressure liquid chromatography is 0.6 mg per 1 g of the *M. fistulosa* leaves. The total flavonoid content (TFC) in *M. fistulosa* herb is about 2 % and depends on a particle size of the herb, ethanol concentration and place of growing. Therefore, this plant could be considered as a raw material for the preparation of herbal products rich in flavonoids.

The herb of *M. fistulosa* was collected during the flowering period at the Sector of Mobilization and Conservation of Plant Resources of the Rice Institute in 2020. Two tinctures of the *M. fistulosa* herb were prepared by remaceration at the ratio of the herbal substance to a final product was approximately 1 to 9 (tincture 1) and 1 to 4.5 (tincture 2) at a particle size of 0.5 to 3 mm (70 % ethanol). The TFC was evaluated by the developed analytical technique of aluminum chloride method.

The analytical procedure of the determination of TFC was elaborated. 25 µL of the developed tinctures were diluted with 50 % ethanol up to 1000 µL and were mixed with 1000 µL of 1.1 % solution of aluminum chloride. The mixtures were mixed. The incubation was at room temperature for 85 \pm 10 min. 50 μ L of the stock solution of rutin trihydrate (1032 mg/L) or quercetin hydrate (400 mg/L) were diluted with 50 % ethanol up to 1000 µL. 1000 µL of 1.1 % aluminum chloride in 50 % ethanol were added to the obtained dilutions of rutin trihydrate or quercetin hydrate and mixed. After incubation at room temperature for 85 ± 10 min the spectra of the reaction mixtures were measured in the range of 360 nm to 440 nm using the spectrophotometer (Photometry Hitachi U-2810). The volume of 1.1% aluminum chloride in 50 % ethanol was substituted by the same volume of 50 % ethanol in the blanks for tinctures and solutions of rutin trihydrate or quercetin hydrate. The results were expressed as mg eqrutin/L and mg eq-quercetin/L of a tincture and mg eq-rutin/g and mg eq-quercetin/g of the *M. fistulosa* herb. The TFC was the following: tincture 1 – 1547.6 mg eq-rutin/L (14.3 mg eqrutin/g) and 563.3 mg eq-quercetin/L (5.2 mg eq-quercetin/g); tincture 2 – 1789.4 mg/L (8.2 mg eq-rutin/g) and 584.3 mg eq-quercetin/L (2.7 mg eq-quercetin/g). These results point to richness of the *M. fistulosa* herb in flavonoids. For instance, the TPC of the herbs of *Satureja* montana and Satureja hortensis, grown on the same plots, ranged from 5.15 to 9.47 eq-rutin/g and 6.67 to 7.98 eq-rutin/g, respectively.

The herb of *M. fistulosa* of Ukrainian origin is rich in flavonoids and could be used as a raw material for the preparation of herbal preparations with antioxidant, antimicrobial, immunostimulated properties.

Keywords: Monarda fistulosa, herb, total flavonoid content, flavonoids.

Acknowledgments

Co-authors thanks SAIA and Visegrad Fund for the scholarships for the research performed at the Slovak University of Agriculture in Nitra (Slovakia), 2021.

5th International Scientific Conference Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and Spiritual Human Development

BIOCHEMICAL CHARACTERIZATION AND SENSORY PROPERTIES OF BEETROOT (BETA VULGARIS SSP. VULGARIS VAR. RUBRA L.)

Eva Ivanišová¹, Laura Granátová¹, Olga Grygorieva²

¹Department of Technology and Quality of Plant Products, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture in Nitra, Slovakia; E-mail.: <u>eva.ivanisova@uniag.sk</u>

²M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine Kyiv, Ukraine

Modern pharmacology shows that beetroot extracts exhibit antihypertensive and hypoglycaemic activity as well as excellent antioxidant activity. The promising results of their phytochemicals in health protection suggest the opportunity for their use in functional foods.

This study aimed to evaluate the biochemical profile (total ash and crude protein content, total polyphenols and betalains) and sensory properties (5 points hedonic scale) of beetroot cultivars (Taunus, Boro, Gesche) obtained from a private producer from Austria (bio-agriculture).

The crude protein content in evaluated beetroots ranged from 1.3 % (cv. Boro) to 2.09 % (cv. Gesche). Ash content ranged from 0.58 % (cv. Boro) to 0.65 % (cv. Gesche). The total polyphenols were the highest in cultivar Gesche – 2.94 mg GAE.kg⁻¹ (GAE – gallic acid equivalent). Betalains were determined and calculated as red-violet betacyanins and yellow betaxanthins. The betacyanins ranged from 5.94 mg.kg⁻¹ (cv. Taunus) to 8.09 mg.kg⁻¹ (cv. Gesche). The betaxanthins ranged from 2.95 mg.kg⁻¹ (cv. Boro) to 5.39 mg.kg⁻¹ (cv. Gesche). Sensory properties (appearance, color, consistency, aroma, taste) of determining beetroot varieties were evaluated overall as good with the best score in a taste and overall appearance in cultivar Boro.

Beetroot is a very good source of bioactive compounds, but much more studies are needed in the future to make effective use of the potential of beetroot as raw material and food, and to reduce the potential risks (heavy metals, pesticide, and herbicides residues) associated with it, especially in the food industry.

Keywords: red beet, ash, protein, polyphenols, betalains.

Acknowledgments

This work was supported by grants Visegrad Fund (52110301) and SAIA (Slovak Republic). The publication was prepared with the active participation of researchers in the International network AgroBio*Net*, as a part of the International Program "Agricultural Biodiversity to Improve Nutrition, Health and Quality of Life".



Raisa Ivanova¹, Igor Casian²

¹Institute of Genetics, Physiology and Plant Protection, Chisinau, Republic of Moldova; E-mail.: <u>ivanova_raisa@yahoo.com</u>

²Scientific Centre for Medicines, "Nicolae Testemitanu" State University of Medicine and Pharmacy, Chisinau, Republic of Moldova

Mahonia aquifolium (Pursh) Nutt. is an evergreen shrub harvested from the wild in China and North America for local use as food and medicine. All parts of this plant could be utilized that are predetermined by phytochemical constituents. The leaves, the bark of the stem, and roots as popular remedy in modern herbalism; the leaves and berries as a source of green, violet, and dark blue-purple dyes; flowers are eaten. Mahonia berries are consumed in fresh and dried forms in jams, beverages, and confections; oil from seeds is rich in γ -tocotrienol, omega-6, and omega-3. However, in the Republic of Moldova, the *Mahonia aquifolium* is used only as an ornamental plant. In this regard, the purpose of the study was to analyze some phytochemical constituents of mahonia berries and determine their nutritional value as antioxidants.

The frozen berries were homogenized with a 70 % hydroalcoholic solution in a ratio of 1:2, centrifuged, and filtered through a paper filter. The total phenolic content was determined by the Folin-Chocalteu procedure. The individual phenolic constituents were analyzed by the HPLC method using a DAD detector in the range of 200–600 nm. Standard substances are detected at the following wavelengths: 280 nm – gallic acid and (+) catechin; 328 nm – chlorogenic acid; 360 nm – rutin, 528 nm – cyanidin chloride. The radical scavenging activity (RSA) was a taste *in vitro* by a potentiometric method using 2,2'-azobis (2-amidinopropane) dihydrochloride as a generator of free peroxyl radicals. The RSA evaluation of standard substances was carried out according to the concentration values, which scavenged 50 % of free radicals (IC₅₀, mg/L). The RSA of berries extracts was expressed as vitamin C equivalent antioxidant capacity (VCEAC, μ Mol/g).

Mahonia berries extracts contained in dry residue 3.55–5.39 % of polyphenolic substances, which predetermined their RSA. Experimentally, a significant direct correlation was found between the total phenolic content and RSA of tested berries extracts; Pearson's coefficient of correlation was equal to 0.8723. VCEAC indexes of Mahonia berries extracts varied in limits from 36.07 to 70.52 μ Mol/g of dry residue. The content (mg/L) of individual constituents in extracts of Mahonia berries can be shown as follows: chlorogenic acid (203.0) > anthocyanins, recalculated by cyanidin chloride (190.5) > rutin (168.0) > quercetin (47.1) > catechin (17.5) > hydroxycinnamic acids (17.0) > derivatives of gallic acid (8.35).

Putting forward the hypothesis that individual constituents of the extracts, such as chlorogenic acid or cyanidin chloride, have the same RSA in the extract composition as in their pure form, we tried to evaluate the contribution of each constituent to the RSA of extracts. It was determined that the standard substances scavenged 50 % of free radicals at the concentrations: gallic acid – $6.88 \pm 0.48 \text{ mg/L}$, quercetin – $13.66 \pm 0.33 \text{ mg/L}$, (+) catechin – $14.18 \pm 0.76 \text{ mg/L}$, cyanidin chloride – $23.83 \pm 1.04 \text{ mg/L}$, chlorogenic acid – $23.88 \pm 0.48 \text{ mg/L}$, rutin – $118.45 \pm 2.97 \text{ mg/L}$. The most important antioxidants in Mahonia berries were chlorogenic acid and anthocyanins, their contribution to the total RSA of extracts was 34.67 and 32.60 %, respectively. Thus, Mahonia berries can be consumed as a functional food due to the high content of antioxidant constituents, especially anthocyanins, which are also natural dyes.

Keywords: *Mahonia aquifolium,* berry, extract, phenolic constituent, antioxidant activity.



DIVERSITY OF NATURAL REGULATORS OF PLANT GROWTH AND THEIR POTENTIAL BIOLOGICAL ACTIVITY

Raisa Ivanova, Dina Elisovetcaia, Alla Borovskaia

Institute of Genetics, Physiology and Plant Protection, Chisinau, Republic of Moldova; E-mail.: <u>ivanova raisa@yahoo.com</u>

Bioregulators are natural chemical compositions that induce biological responses in plant tissues. Screening of bioactive compounds showed that the wide range of natural products might contain constituents – potential regulators of physiological processes in a plant, namely whole or selective extracts from medicinal and weed plants, seaweeds, microorganisms, insects, shale ore, and bituminous rocks. The large diversity of natural regulators is predetermined by wide chemical classes that possess biological activity. Protein hydrolysates (peptides, polypeptides, amino acids), polysaccharides, polyphenols, terpenoids, steroids, saponins, vitamins, phytohormone-like substances, volatile oils, microelements were tested as growth regulators, immunomodulators, antioxidants, and biostimulants. Biologically active substances synthesized by higher plants during secondary metabolism perform important regulatory functions in the plant cells and are able, even in nano amounts, to normalize many vital processes.

This review focuses on plant secondary metabolites, which are considered bioregulators, their biological effects, and possible mechanism of action. Special attention was paid to steroid, iridoid, and flavonoid glycosides, practices for their obtaining and application. Recent studies carried out in laboratories, greenhouses and open field experiments demonstrated that applications of bioregulators increase the seeds germination, growth of root and seedlings, plants development, rise yield, and nutritive value of crops. Many studies reported positive effects of bioregulators on the growth and yield increasing of cereal and vegetable crops through seeds pre-sowing treatment. To noted, that after the application of bioregulators the market quality of crops, biochemical compositions, and nutritive value of tomatoes, onions, white cabbage, and carrot were also positive changed. Moreover, seeds treatment with bioregulators and subjected to moderate thermal stress, retained their germination capacity, while untreated seeds were injured by temperatures.

Diverse effects of bioregulators are elicited depending on the times and mode of their application, concentrations, species, and state of plants and environmental conditions. For example, iridoid and flavonoid glycosides acted variety-specific inside the same plant species. Modern analysis of the microarray data showed that the treatment with bioregulators is able to modulate the expression level of about 4,000 genes in tomatoes plant, which is involved in several biological processes like stress responses, protein, and secondary metabolism transport, and antioxidant defense. However, the molecular mechanisms of their effects remain to be fully elucidated. In conclusion, since bioregulators are multifunctional and numerous, a comprehensive preliminary study is necessary for the correct choice of product.

Keywords: natural bioregulator, secondary metabolites, biological activity, action mechanism.

Acknowledgments

The research was carried out in the frame of the State program nr. 20.80009.7007.07 "Determining the parameters that characterize the resistance of plants with the different level of organization to the action of extreme temperatures in order to reduce the effects of climate change" by the financial support of the National Agency for Research and Development of the Republic of Moldova (www.ancd.gov.md).



EFFECT OF SILICEOUS MINERALS AND CHLORELLA VULGARIS BEIJER. ON PEPPER (CAPSICUM ANNUUM L.)

Bogdana Ivanytska, Natalia Didyk, Nadiia Rositska, Natalia Zaimenko

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>ivanytskabo@ukr.net</u>

The pepper (*Capsicum annuum* L.) is a high-yielding vegetable plant grown in many countries in the world for culinary and medicine.

Recently, the use of natural growth stimulants, which activate resistance of plants in unfavorable weather conditions, to increase the yield of vegetable crops is relevant. Our research was focused on the effect of natural silicon mineral analcite mixed with peat, and the culture medium of *Chlorella vulgaris* Beijer. on growth processes and photosynthetic activity of sweet pepper plants *Capsicum annuum*, cv. Bilozerka. This cultivar has broad environmental tolerances to weather conditions and phytopathogens but is very sensitive to soil drought. This cultivar is also good for long storage and suitable for canning and cooking.

Experimental work was carried out in the Department of Allelopathy M.M. Gryshko National Botanical Garden of NAS of Ukraine in 2020-2021. The pepper plants were grown in 0.7 L plastic pots filled with soil substrate under laboratory conditions (temperature – 23–29 °C, humidity – 65–80 %, natural sunlight, soil humidity – 50–80 % of field capacity). We tested the effect of the application of (1) culture medium of Chlorella vulgaris Beijer. (10 ml); (2) mixture of analcite (500 mg) with peat (1.5 g); (3) mixture of the culture medium of Chlorella vulgaris with analcite (500 mg) and peat (1.5 g) on the growth and photosynthesis of the pepper test plants. The control treatment was without any amendments. The duration of the experiment was 6 months. Each treatment has 6 replicates. The length of pepper plants (shoot and root) treated with Chlorella was 1.2-fold as much as the one in test plants in control. The leaf area of the former was also 1.7-fold as large as that in the control treatment. The test plants treated with the mixture of peat and analcite have 1.4-fold higher root and shoot growth characteristics than the test plants grown in control The highest growth parameters were observed in plants exposed to the combined application of Chlorella culture medium, analcite, and peat: root length was 1.7-fold as high as in control and 1.5-fold as high as in the treatment with culture medium of Chlorella alone. There was a noticeable increase in plant stem thickness (1.6-fold), the number of leaves, flowers, and fruits per plant. The photosynthetic pigments content (in particular the content of chlorophyll a) in the leaves was the highest after the combined application of the microalgae with the siliceous mixture. This indicates the intensity of growth processes.

Thus, the combined application of *Chlorella vulgaris*, analcite, and peat is promising as an effective biostimulant of pepper plants' growth and productivity.

Keywords: pepper, Capsicum annuum, Chlorella vulgaris, siliceous minerals, analcite, peat.

Acknowledgments

This project was performed with the support of priority for the state scientific research and scientific and technical (experimental) developments Department of General Biology of the National Academy of Sciences of Ukraine.



Alena Kabachevskaya, Grazhyna Niescier

Institute of Biophysics and Cell Engineering of the National Academy of Sciences of Belarus, Minsk, Belarus; E-mail.: <u>kabachevskaya@lab.ibp.org.by</u>

Tissues of medicinal and aromatic plants are characterized by a high content of various secondary metabolites, which often interfere with the RNA extraction from plant cells. Meanwhile, high-quality RNA is the basis of molecular biological, genetic, physiological, etc. plant research. There are a lot of protocols for RNA isolation from plant tissues, but most of them involve the use of volatile toxic substances, which makes these methods not very practical for everyday usage. This work aimed to select effective methods for the RNA extraction from leaves of some plant species rich in biologically active substances, as well as to reduce the use of toxic reagents. Both well-known medicinal and aromatic species (*Echinacea purpurea* (L.) Moench, Ocimum basilicum L.) and the representatives of traditional medicine with antiproliferative, antitumoral, or cytotoxic potential (Plectranthus amboinicus (Lour.) Spreng., Plectranthus scutellarioides Blume) were investigated. The following methods of RNA extraction were used: 1) with Tri-reagent (according to the Sigma protocol); 2) 2 % CTAB (cetyl trimethyl ammonium bromide, 1.4 M NaCl, 20 mM EDTA, 100 mM Tris-HCl, 2 % polyvinylpyrrolidone (PVP)), isopropanol 100 %, DTT (DL-dithiothreitol), SDS (sodium dodecyl sulfate), 70 % ethanol, DNase. 3) 100 mM Tris-HCl, 20 mM EDTA, 2 M NaCl, 2 % CTAB, 1 % PVP, 2 % 2-mercaptoethanol, 24:1 chloroform: isoamyl alcohol, LiCl, 80 % ethanol. 4) Modified method No. 3, in which 2-mercaptoethanol, chloroform, and isoamyl alcohol are replaced by dithiothreitol and 1-bromo-3-chloropropane, that allows reducing the volume of volatile toxic substances used in the work.

For each investigated plant species an optimal RNA extraction method was revealed: for basil, the trizol method turned out to be the most optimal, for Echinacea – method No. 2, for the most difficult to isolate RNA plant material, *Plectranthus* spp. – methods 3 and 4, and it should be noted that since method 4 involves the use of fewer volatile toxic substances, it is preferable for use in work. Method No. 2 is also characterized by reduced use of solvents, however, the yield and purity of RNA from plants of the genus *Plectranthus* are not high.

So, the high content of biologically active substances in medicinal and aromatic plants, as well as the use of highly toxic reagents when working with these species, is a key problem in the study and analysis of gene expression at the earliest stages of work. The methods described in our work represent a solution to eliminate these problems and make it possible to carry out further larger-scale experiments.

Keywords: Echinacea purpurea, Plectranthus amboinicus, Plectranthus scutellarioides, Ocimum basilicum, RNA extraction.

Acknowledgments

We are grateful for providing useful information on method 3 of RNA extraction from *Plectrantus amboinicus* to Prof. Madya Dr. Janna Ong Binti Abdullah, Faculty of Biotechnology & Biomolecular Sciences UPM and Mohd Hairul Ab Rahim, Lecturer Faculty of Industrial Sciences & Technology, Universiti Malaysia Pahang, Malaysia.



Iryna Kabusheva, Natallia Sak

Central Botanical Garden of the National Academy of Sciences of Belarus, Minsk, Belarus; E-mail.: <u>I.Kabusheva@cbg.org.by</u>

Currently, the rose is one of the leading cut crops in the industrial floriculture of Belarus. Among the wide diversity of rose cultivars created to date by breeders, it is necessary to select the most highly productive ones of an intensive type suitable for year-round cultivation.

The purpose of the study is to identify the most productive and high-quality flower-cut rose cultivars in greenhouses based on the investigation of morphological characteristics.

The objects of the research were three-year-old plants of the following hybrid tea rose cultivars: Anastasia, Avalanche, Jumilia, Red Naomi, Kimberly, and Talea. Test plots were laid in the second decade of January 2021 in the greenhouse of the Central Botanical Gardens of the National Academy of Sciences of Belarus planting 610 specimens on an area of 73 m² with a planting density of 8.36 plant/m². The following temperature and light conditions were observed. The air temperature was +8 °C during the laying of the experimental plots and then it was weekly increased by 2 °C, up to +20 °C. Additional illumination with LEDs was used in the period 15.02.2021-15.04.2021 gradually increasing the intensity from 50 to 100 % and additional illumination time from 12.5 h to 14.5 h. Morphological observations and accounting of cut flower yield were carried out on the 90th day of planting. The quality of cut flowers was determined according to GOST 18908.1-2019. Our studies have shown that the period from planting to flowering was 68-84 days for different rose cultivars: Jumilia – 68 days, Anastasia and Kimberly – 73 days, Avalanche and Talea – 74 days, and Red Naomi – 84 days. The number of stems on a plant ranged from 2.4 to 7.4 in different cultivars. The stem length reached an average of 22.6-45.5 cm. The most powerful plants were observed in 'Red Naomi' with 6.0 stems per plant and stem length is on average 37.8 cm. 'Kimberly' and 'Talea' tended to form a rather large number of stems (5.6 and 7.4 respectively) with a small stem length (only 24.9 cm and 22.6 cm respectively). The cut flowers obtained from the first wave of flowering satisfied in quality to the first ('Red Naomi', 'Avalanche', 'Anastasia') and second grade ('Talea', 'Jumilia', 'Kimberly') according to the received morphological data. The average vield was 2.3–3.8 flowers per plant or 19.2–31.3 flowers/m² in cultivated rose cultivars. 'Kimberly' (31.3 flowers/m²), 'Red Naomi' (22.4 flowers/m²), 'Jumilia' (21.3 flowers/m²) and 'Talea' (20.7 flowers/m²) were the most productive, and 'Red Naomi' were the best considering the quality of the obtained flower cut.

Consequently, the initial tests of six rose cultivars in greenhouse conditions of the Central Botanical Gardens of the National Academy of Sciences of Belarus revealed the most productive 'Red Naomi' which can be recommended for obtaining import-substituting cut flowers.

Keywords: rose cultivars, cut flowers, yield, greenhouse.

MORPHOLOGICAL INVESTIGATION ON UNDERGROUND ORGANS OF GERANIUM SIBIRICUM L.

Mariia Kalista, Oleksii Kovalenko

National Museum of Natural History of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>crambe@ukr.net</u>

Geranium sibiricum L. is a biannual or perennial summer green herbaceous species of the Geraniaceae family. This plant contains a considerable amount of biologically active substances such as phenolic compounds, represented by flavonoids, coumarins, phenol carboxylic acids, tannins, as well as nitrogen-containing compounds, carbohydrates, organic acids, triterpene compounds, carotenoids, fatty acids, essential oil, and mineral compounds. There why it is possible to use this plant as medicinal and especially due to the fact that it is widely spread as invasive and there is a sufficient source base in Ukraine. This is also facilitated by the absence of insect damage and diseases.

Geranium sibiricum herb and rhizomes with roots are used as medicinal raw materials in medicine. However, there is no unambiguous definition in the description of its underground organs: as an indistinct rhizome or short rhizome with a system of additional roots and even taproot system that is not combined with rhizome at all as with the biennial type of life form monocarpic life cycle. Besides in the literature sources, this plant shoot formation model is given as a semi-rosette sympodial or monopodial. So accordingly, morphological features of *Geranium sibiricum* life form: shoots (particularly underground) and roots are poorly studied and there is no single opinion on this, therefore, this study is of particular interest. The aim of this study was a morphological investigation of underground organs of *Geranium sibiricum* using methods of investigation of the types of biomorph according to morphogenesis process and the manifestation of morphological disintegration, the concepts of architectural models, and the concept of the variety of caudexes and their difference from other structural formations according to Nukhimovskyi Ye. L. Plant materials were taken in several local populations in Ukraine in 2019–2021.

We found that of individuals biomorph of the studied species is characterized by polyvariance and is represented by one main and two additional types. The main one is mostly biennial conode taproot monocarpic with sympodial branching type. Occasionally, *Geranium* sibiricum individuals have such types of biomorph: 1) caudex taproot oligocarpic with the sympodial type of branching (for perennial plants that have a connection of the perennial stem with the taproot); 2) basiphis fibrousroot oligocarpic with sympodial type of branching. We have also confirmed the data that in the process of ontogenesis the root system of this species individual can be taproot, mixed and fibrous. In plants with conode, the taproot is preserved throughout life. Taproot system or mixed root system with a distinct main root was observed in caudex plants of different levels of vitality after the first flowering period. A fibrous root system was indicated for basiphis plants, while the main root becomes indistinct (but does not die). So, in our opinion, Geranium sibiricum does not have rhizomes at all. The caudex is similar to rhizomes functionally (nutrient storage, vegetative renewal) and morphologically (thickening and shortening of internodes, perennial), however, unlike rhizomes, caudexes do not die in the basal part and together with the primary root system of the plant remains throughout life.

Therefore, we have identified a typical *Geranium sibiricum* type of biomorph as mostly biennial conode taproot monocarpic with sympodial branching type and two varieties. And according to morphological peculiarities medicinal raw materials of underground organs of *Geranium sibiricum* are definitely not rhizomes with roots, but conode, caudex, or basiphis.

Keywords: Geranium sibiricum, underground organ, conode, caudex, basiphis.


Lyudmila Kharkhota, Evgeny Demkovich

Donetsk Botanical Garden, Donetsk, Ukraine; E-mail.: <u>ludmilaharhota@yandex.ru</u>

Cornus mas L. (Cornelian cherry) is a valuable fruit, medicinal and ornamental plant native to the west of Ukraine, Crimea, the Caucasus, Central and Southern Europe, West Asia. In the Donetsk region, *C. mas* is not popular yet, its fruits coming to the regional trade networks mainly from the Crimea.

Since 1993, four C. mas cultivars, namely Vydubetskyi, Korallovyi, Nikolka, Elegantnyi, selected at the M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine (Kyiv), along with the seedlings from free pollination, have been introduced and trialed in the collection of woody plants of the Donetsk Botanical Garden (abbreviated as DBG). Our research staff has selected three promising breeding forms among free-pollination seedlings. Investigation of biological characteristics of their growth and development has shown good prospects for this species under complex climatic and technogenic conditions of our region. Since 2012, research has been conducted in the DBG on the efficient reproduction methods and seedling growth technology of *C. mas* cultivars to obtain planting material of local origin. According to the results of our long-term research on *C. mas* reproduction by stem cuttings, the species is classified in plant group with low regenerative capacity, as their green and lignified stem cuttings do not take root without growth stimulant treatment. The experiments have demonstrated that the optimal stem-cutting term is the phase of active shoot growth (under the regional conditions it is the 1st decade of June), the most effective growth stimulator is an aqueous solution of indole butyric acid with 100 mg/l concentration at 5-hours exposure. Stemcuttings take root in a greenhouse with artificial air humidification within 26–34 days, rooting rate being 43-95 %. However, the percentage of planting material obtained from rooted cuttings is low – no more than 20 %. Therefore, since 2016, research has been underway on the *C. mas* reproduction by grafting. The purpose of our work is to determine the optimal grafting terms and methods for cultivars and breeding forms of *C. mas* to obtain local planting material. Two-year-old dogwood seedlings were used as a stock, the most popular methods were used – grafting and budding. Whip-graft and cleft-graft turned to be inefficient. The survival rate of plate-budding in the early spring period (April) depended on the scion condition and was 75-80 % for all cultivars and breeding forms. Grafted trees reach a height of 30–60 cm by the end of the first growing season and in autumn they can be transplanted in a field on permanent growth place. The highest (up to 100 %) survival rates of bark-budding were observed in the second half of July. Fruitage in grafted trees starts in the 3rd year after inoculation. Climatic conditions of the region are characterized by the rapid onset of heat and drought, starting from the 1st-2nd decade of May, which interfere normal development of trees, grafted in early spring. Therefore, the most optimal for the steppe conditions is budding for the bark in the summer, namely in the second half of July. The staff of DBG has issued recommendations on the growing and reproduction techniques of dogwood. The sale of seedlings of *C. mas* cultivars is carried out. A certain amount of documentation and planting material of the selection forms have been amassed.

Keywords: Cornus mas, reproduction, cuttings, grafting, seedlings.

CONTENT OF MINERAL ELEMENTS IN TISSUES OF HONEY BEES UNDER FEEDING CITRATE CO AND GE

Igor Kikish¹, Iryna Kovalchuk², Rostyslav Fedoruk¹

¹Institute of Animal Biology National Academy of Agrarian Sciences of Ukraine, Lviv, Ukraine; E-mail.: <u>irenakovalchuk@ukr.net</u>

²Lvivskyy National University of Veterinary Medicine and Biotechnology named S.Z. Hzhytskoho, Lviv, Ukraine

The study of the biological effects of microelements on the honey bees colony and their interaction with other elements in the application of mineral additives will allow finding optimal and safe methods for stimulating the resistance of the organism of bees and their productivity.

The research was conducted in the spring in a private apiary in the Lviv region on 4 groups of bee families, three bee families in each. Control group (I) was fed with sugar syrup (300 ml/week/bee colony), experimental group II - under similar conditions received sugar syrup with the addition of 30 μ g of Co in the form of citrate, III experimental group - under similar conditions received 60 μ g of Ge and IV 30 μ g Co citrate and 60 μ g Ge citrate. The duration of the watering citrate syrup and Co and Ge is 4 weeks. Trace elements were added to sugar syrup in the form of citrates obtained from LLC "Nanomaterials and Nanotechnologies" in Kyiv and made by the method of nanobiotechnology. To study tissue samples were taken specific anatomical parts (head, chest, and abdomen) bee colonies from the control and experimental groups. In samples of tissue homogenates of bees, the content of individual trace elements was determined on an atomic absorption spectrophotometer SF-115PK. The digital data were processed statistically using the computer program Microsoft EXCEL with the determination of the mean values of M, their deviations \pm m, and the degree of probability of intergroup differences using the Student's ratio (p).

According to the results of the study, it was found that feeding with sugar syrup Co in the form of citrate was characterized by an increase in Fe content in the homogenate of head tissues of honey bees II and IV groups, as well as in thoracic tissues of bees, respectively 1.2 and 1.1 times (p < 0.05). The highest level of Cu (p < 0.05) was observed in all tissues of bees of the experimental groups, which indicates the possible greater assimilation of copper from the syrup into the organisms of bees and their transformation into the tissues of these departments. Significantly higher Zn content was observed in the head tissues in the II and III experimental groups against the background of lower content in the IV (p < 0.01) groups compared to the control. The lowest level of this element was found in the tissues of the abdomen of bees II, III, IV (p < 0.05) compared to the experimental group control. The antagonistic effect of Co and Ge citrates in metabolic processes on the accumulation of Pb decreased in the homogenate of head and abdominal tissues of the II and III experimental groups, compared to the control. However, it should be noted that the antagonistic effect on Pb and Cd was more pronounced in the tissues of the head and abdomen of the IV experimental group.

Thus, experimental studies indicate the relationship between the content of Co and Ge in the body of honey bees with other trace elements. The detected changes in the content of microelements in the body of bees show tissue specificity and depend on the dose of feed additives of citrate Co and Ge. Feeding of Co and Ge citrates with sugar syrup had a corrective effect on the content of trace elements such as Fe, Cu, Zn, as well as Pb and Cd of the main, thoracic and abdominal anatomical parts of honey bees, which indicates a dose-dependent effect of Co and Ge citrates in metabolic processes of mineral nutrition of their body in the spring. This allows us to assert power a decisive impact on honey bees optimization parameters of mineral metabolism in different anatomical parts of the body of bees.

Keywords: bees, tissues of bees, head, chest, abdomen, citrate Co and Ge.



A NEW ARTIFICIAL BUCKWHEAT SPECIES *FAGOPYRUM HYBRIDUM* AS A SOURCE OF THE RAW MATERIAL FOR WHOLE-GRAIN FLOUR PRODUCTION

Elena Klimova¹, Ivan Fesenko²

¹Orel State University named after I.S. Turgenev, Orel, Russian Federation; E-mail.: <u>kl.e.v@yandex.ru</u> ²Federal Scientific Center of Grain Legumes and Groats Crops, Orel, Russian Federation

Fagopyrum hybridum, a new artificial buckwheat species, was resulted from a long-term experiment including interspecific cross *F. tataricum* $(4x) \times F.$ *giganteum* followed re-sowing of the hybrid lineages and selection of the samples most suitable for agriculture. Accession of the species gave 2.8 t/ha on experimental plots. Therefore, it can be considered as a possible cultivated species. An objective of this work was to evaluate the grain of *F. hybridum* as a raw material for the production of whole-grain flour.

We used a lineage of *F. hybridum* which shown maximal yield ability in variety testing. For comparison, it was taken the grain of common buckwheat, *F. esculentum*, a buckwheat species widely cultivated in Russia, and one of *F. tataricum* (an accession k-108 producing grain morphologically similar with one of *F. hybridum*). The samples of grain were milled and the milling fragments were analyzed using a microscope. Also, both the thousand-grain weight and share of the hull were evaluated.

Grain characteristics of *F. hybridum* are typical for tetraploid tartary buckwheat which was one of the parental forms in the interspecific cross that resulted in *F. hybridum*, with several differences. So, thousand grains weight of the new species is up to 40 g versus up to 25 g typical for tetraploid *F. tataricum*; share of the hull in the grain is about 30 % for *F. hybridum* and up to 35 % for tetraploid *F. tataricum*, despite the hull of *F. hybridum* seed is thicker compared to one of tetraploid *F. tataricum*. Production of whole-grain flour requires some peculiarities of the grain, including specific features of shell which must be fragmented into fragments that are not harmful to consumers. We compared the hull fragments of *F. tataricum*, *F. esculentum* and *F. hybridum*. Fragments of *F. esculentum* husk grinding had sharp edges, often with acute angles. In addition, a significant number of large hull fragments were observed. Fragments of *F. hybridum* hull milling were smaller and did not have acute angles. It appears to be related to the structure of the hull. It can be assumed that the hull structure of *F. hybridum* is looser, which contributes to better results of grinding the whole grain.

So, due to some peculiarities of the hull structure resulting in optimal characteristics of its milling fragments the grain of *F. hybridum* looks like the best raw material for the production of whole-grain buckwheat flour.

Keywords: Fagopyrum hybridum, whole-grain flour, buckwheat.



CULTIVARS OF CORNELIAN CHERRY (CORNUS MAS L.) OF UKRAINIAN SELECTION IN EURASIA

Svitlana Klymenko

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine Kyiv, Ukraine; E-mail.: <u>cornusklymenko@gmail.com</u>

Cornus mas L. (cornelian cherry) belongs to the subgenus Cornus L.s.str. (genus Cornus, family Cornaceae Bercht. & J.Presl). Subgenus Macrocarpium, which has fragmented areal on the globe, is represented by four species: Cornus mas L. - in the west of the mainland, C. *officinalis* Sieb. et Zucc. – in Japan, China and Korea, *C. chinensis* Wanger. – in the central region of China and *C. sessilis* Toor. – in North America. Some species of the subgenus *Cornus* belong to ancient fruit and medicinal plants. In the northern Black Sea region (Moldova), the fruits of C. mas were used even in the Neolithic period. In Ukraine, C. mas plants were cultivated already in Kievan Rus. Fruits and other parts of the plant are used as an active antimicrobial remedy for various ailments due to the high content in them of biologically active substances. Fruits and drugs of them (decoctions, tinctures, teas, concentrates of fresh and dried raw materials) exhibit antiscorbutic, general health-improving, tonic, astringent, temporary hypotensive, diuretic effect. Fresh fruits (10–12 g/day) are recommended for neurasthenia, common weakening, joint pains, infectious hepatitis, and others. From the pulp of the fruits is prepared for centuries well-known antiscorbutic cornelian paste, that contains 50–55 mg% of ascorbic acid and does not lose the healing properties within 2 years. One hundred grams of this paste contains a daily dose of ascorbic acid. The fruits of cornelian cherry – a rich source of pectin, which can bind radioactive isotopes of strontium, calcium, cobalt, as well as pectins hardly digested in the human digestive tract, then with them excreted most of these isotopes. A large amount of pectin in the fruits of the cornelian cherry also determines their value to the canning industry. The leaves of cornelian cherry have a high content of biologically active substances throughout the growing season and can be a source of cheap raw materials for the creation of preventive vitamin phytocompositions. Of the endocarp (stone) cornelian cherry isolated lipid fraction is an oily, colorless liquid with a characteristic odor. The composition and proportion of fatty acids determine their biological activity.

In modern gardening, *C. mas* is a relatively young culture, at the same time it meets the requirements of today. The main biological characteristics of the *C. mas*: there is no periodicity in fruiting, the biological productivity in favorable conditions is 30–100 kg per tree depending on age. The duration of the productive period is 100–150 years. Plants are practically not damaged by pests and diseases and don't need pest-killers treatment. *C. mas* yields abundant and stable crops in culture with large juicy fruits, while not demanding through care, its cultivation is very paying.

Still used the local varieties, and the fruits are collected in natural populations, squares which is very reduced as soon as their natural habitats, as well as productivity, were significantly reduced the demand in fruits are no satisfy. Besides, the forest forms of cornelian cherry don't bear fruits regularly enough, yield small dry fruits, especially in draughty years. The crop makes up 2.8–4.8 kg per bush; under sufficient light and moistening crop capacity grows considerably and makes 5–10 kg per bush.

Systematic selection of *C. mas* has not been done for a long time, in areas where it has long been grown, used selected local forms. In Ukraine, work on the revival of *C. mas* culture began 60 years ago at the M.M. Gryshko National Botanical Garden in Kyiv (NBG). Cornelian cherry has not been included in the State Register of Sorts of Ukraine until 1990. The blank has been filled up by the work of the NBG. For the first time, 14 cultivars of *C. mas* were entered in the State Register. The gene pool of *C. mas* of the NBG differs by the rich variety of biological and economic signs.

More than 50 promising cultivars were created as a result of analytical (Grenader, Lukianivskyi, Mriia Shaidarovoi, Nikolka, Nizhnyi, Olena, Oryhinalnyi, Priorskyi, Semen, Suliia,



Yantarnyi), synthetic (Elehantnyi, Koralovyi Marka, Kostia, Radist, Starokyivskyi, Volodymyrskyi, Vydubetskyi, Yevheniia) and clone selection (Ekzonytchnyi, Svitliachok).

Now there are no genotypes with yellow fruits in nature. We have five the some, three of which are of particular interest – Alosha, Nizhnyi and Yantarnyi and have been prepared for the State-cultivar-testing.

In addition to the registered cultivars, there is a great potential for hybrid cultivars of *C. mas*, with a variety of biological, environmental properties and economic value. Cultivars such as: Koralovyi, Kozerih, Nartsyz, Nespodivanyi, Priorskyi, Suliia, Vytivka Svitlany, Yantarnyi, Yuvileinyi Klymenko are prepared for the state test. Created cultivars of *C. mas* with oval, round, pear-shaped, bottle-shaped fruits of red, cherry, dark red, almost black, yellow, and pink. The average weight of the fruit in different cultivars is 5.0–8.0 g, maximum 9.0–10.0 g; it varies from year to year depending on weather conditions. In our best cultivars, the stone is 7.5–10.0 % by weight of the fruit, in other cultivars, this figure is 11.0–12.0 % (in wild forms, the stone is 12.0–19.0 % by weight fetus).

The first stage was the analytical selection when we used the results of the spontaneous selection. As a result of the second stage – synthetic selection (cultivated varieties of *C. mas* of diversified origin were used) there have been developed cultivars characterized by steady annual fructification, with various biochemical properties and practical – valuable characteristics (mass, shape, color fruit, ripening and other), high productivity, and frost resistance under the conditions of the Forest-Steppe.

The fruits contain 8.0 to 11.0 % of sugars; 1.3–1.9 % of organic acids; 101.0–193.0 mg% of the vitamin C; 670.0–850.0 mg% of anthocyanin the skin, and 36.0–121.3 mg% – in the pulp.

The genetic pool of *C. mas* in Ukraine is formed mainly by the cultivars selected by the NBG. The cultivars of our selection have become widespread not only in Ukraine but also in European countries (Poland, Austria, Greece, Serbia, the Netherlands, Belgium, Bulgaria), the United States, and Japan. Breeding with *C. mas* in Ukraine was the impetus for such work and the spread of *C. mas* cultivars of Ukrainian selection in other countries.

As a result of breeding work, winter-hardy, highly productive cultivars of *C. mas* were created that are promising for industrial and farming crops in the Forest-Steppe and Polissia, as well as in the steppe regions of Ukraine (under irrigation conditions). Industrial plantations of *C. mas* can function for many decades. We have developed the technology of vegetative propagation – the yield of planting material is 85–90 %. In calculating complex of arrangements aimed at establishing the plantation we proceed from the following data: an average number of plants per hectare – 500, 625, 835, and 1000 (feeding area 5 x 4, 4 x 4, 4 x 3, 4 x 2.5 m) pieces, the average productivity of one plant – 30–80 kg, stones make 10 % of the mass of the fruits, a number of stones per one tree – 20.0–24.0 thousands, crop per 1 hectare – 200–250 centner.

The technology of vegetative reproduction of the cornelian cherry has been worked out. The main method is budding, resulting in 90–98 % output; other methods are also being effective: by offsets – with 85–90 % output, by green grafts – with 75–78 %. Seedlings serve as stock for inoculation.

Special cornel gardens, both in Ukraine and abroad, are extremely rare. However, in recent years in many European countries – Austria, Azerbaijan, Armenia, Bulgaria, Hungary, Germany, Georgia, Poland, Serbia, Slovakia, they revive the cornel culture.

At present, the *C. mas* culture has been revived in Ukraine. Farmers' and private gardens are being laid, and we hope that industrial gardens will also be created.

Keywords: Cornus mas, cultivars, selection analytical, synthetic, State Register.



Svitlana Klymenko, Antonina Ilyinska

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>cornusklymenko@gmail.com</u>

East Asian genus *Chaenomeles* Lindl. includes four species, three hybrid groups, and more than 500 cultivars. *Chaenomeles* species have been cultivated since ancient times, mostly as ornamental plants. In the middle of the 20th century, the species of chenomeles were included among the new economically important and ecologically clean potential fruit crops, due to its valuable biochemical composition and high antioxidant activity of fruits combined with high yields, annual fruiting, long-term storage of fruits, and as well as a wide range of plant adaptability, their resistance to diseases and pests and simple cultivation techniques. The actual direction of modern selection is to obtain large-fruited cultivars and forms with a high content of pulp, the small size of the seed chamber and a large thickness of the mesocarp, and a high content of biologically active substances.

We investigated the biometric parameters (length, diameter, and weight) of fruits of genotypes of 29 cultivars and forms of *Chaenomeles* spp., which were grown in M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine (Kyiv), in 2018. In 2018, the largest in average size (length and diameter) and weight were the fruits of cultivars of Ukrainian selection: *Ch. japonica* (Thunb.) Lindl. ex Spach 'Chudovvv Ol'hv' (65.2 mm; 61.9 mm; 132.0 g, respectively), *Ch. japonica* x *Ch. speciosa* (Sweet) Nakai 'Yan' (55.6 mm; 56.0 mm; 94.6 g, respectively), 'Vyshukanyy Svitlany' (47.4 mm; 58. 1mm; 78.8 g respectively). The average fruit weight of Ch. x superba (Frahm) Rehder 'Nicoline' was 72.8 g. A significant part of the studied forms and cultivars had fruits weighing more than 50 g, for example, *Ch. japonica* 'Tsytrynovyy' (67.1 g), *Ch. speciosa* 'Nivalis' (62.4 g), form *Ch. x superba* 'Amphora' (58.5 g), form *Ch. japonica* x *Ch. speciosa* 'Svyatkovyy' (57.7 g), *Ch.* x *superba* 'Crimson and Gold' (57.4 g), etc. The smallest fruits in size and weight were cultivars of *Ch. japonica* 'Karavayevs'kyy' (42.4 mm; 27.0 mm; 19.9 g, respectively) and *Ch.* × superba 'Pink Trail' (31.3 mm; 36.1 mm; 23.3 g, respectively). The level of fruit size variability in all studied cultivars and forms was very low (V < 7%) or low (V = 7-12%). The weight of the fruits, in contrast to their size, varied in a much wider range. The level of its variability ranged from very low to high. The weight of the fruits of the cultivar *Ch. speciosa* 'Yukigoten' was the most stable (V = 5.8 %), and in *Ch.* x superba 'Crimson and Gold' – the most variable (V = 33.2 %). Our results showed that the most suitable for use in the food industry are large-fruited varieties-forms of Ukrainian selection *Ch. japonica* 'Chudovyy Ol'hy' Ch. japonica x Ch. speciosa 'Jan' and 'Vyshukanyy Svitlany'. Cultivars with an average fruit size > 50 g, for example, *Ch.* x *superba* 'Nicoline', *Ch. japonica* 'Tsytrynovyy' (67.1 g), *Ch.* x superba 'Amphora' (58.5 g) and *Ch. japonica* x *Ch. speciosa* 'Svyatkovyy' (57.7 g), etc. also deserve attention as a raw material for useful dietary products.

Keywords: *Chaenomeles* spp., cultivars, fruits, biometric indicators, introduction, selection.



NATURALLY OCCURRING DIRECT CURRENT IN TREES AS THE OVERALL TREE VITALITY INDICATOR

Marek Kobza, Radovan Ostrovský

Institute of Forest Ecology of the Slovak Academy of Sciences, Department of Plant Pathology and Mycology Nitra, Slovakia; E-mail.: <u>marek.kobza@ife.sk</u>

The aim of the work was the vitality evaluation of trees in urban greenery by the method of the direct current measurement. Naturally occurring direct current (geo-phyto electrical current) running between an entire tree and the earth was measured. The measurable intensity of the current makes it possible to determine the health state of the tree with great precision, starting from the onset of their physiological weakening, before the appearance of the first external visible symptoms of the disease. The intensity of the direct current is "species-specific" worldwide, depending on trunk diameter, active canopy area, and other parameters (weather condition, temperature, and humidity).

Variation of measured current was determined periodically every four weeks during the research period from January 2015 to December 2017. In the territory of city Nitra, a total of 44 visually healthy trees of various trunk diameters of four species (*Pinus sylvestris, Fraxinus excelsior, Betula pendula, Platanus x hispanica*) were included in the trial. During the measurement, maximal values of direct current and voltage between cambial tissue and the earth were determined using a standard multimeter and inox probes, one penetrated trunk base (1–3 cm deep) and the second penetrated approx. 0.3 m deep into the soil in the distance of approximately 5 m from the tree.

Based on the measured data, trees were divided into five groups according to maximal current divided by the diameter of the tree trunk (C/D). The highest C/D values, the better the health state of the tree. The maximum values for completely healthy trees of each examined species examined were used as a basis for comparison (100%). The reduction of this value by various influences coincides regularly with a deterioration in the health state of the tree. During the three-year growing period of trial, the highest currents were recorded from 24th to the 39th week of the year. During this period, the highest currents were recorded for Scots pine 87 μ A, for European ash 281 μ A, for Silver birch 265 μ A, and London Plane tree 377 μ A. Minimal values were recorded during winter for all evaluated species.

Measurement of direct current is a fast, economical, and reliable method for the relatively precise determination of tree vitality; however, further research of all parameters influencing this current in trees is necessary.

Keywords: direct current, tree vitality, health state of tree, urban greenery.

Acknowledgments

The authors would like to thank Alena Magušinová for her help during fieldwork. This research was funded by the Scientific Grant Agency of the Ministry of Education of the Slovak Republic and of the Slovak Academy of Sciences, grant number VEGA 2/0062/18 and VEGA 2/0077/18.

WOODY PLANTS SPECIMEN'S CONSERVATION IN THE NDP "SOFIYIVKA"

Ivan Kosenko, Olga Opalko, Volodymyr Hrabovyi, Anatoly Opalko

National Dendrological Park "Sofiyivka" of the National Academy of Sciences of Ukraine, Uman, Ukraine; E-mail.: <u>opalko_a@ukr.net</u>

The value of the wild relatives of cultivated fruit, ornamental and technical woody plants for horticulture, food industry, feed production, and pharmacy makes it necessary to increase our efforts to develop integrative conservation approaches of these plants within their natural habitats and their conservation and reproduction *ex situ* being that they can be valuable sources of initial material for breeding. Although now, botanical gardens and dendrological parks devote their resources to the study and *ex situ* conservation of plants, and nowadays "Sofiyivka" has the status of a research institute of the NAS of Ukraine; however, in September 1796 Polish magnate Stanislaw Potocki founded "Sofiyivka" not for scientific purposes but as a romantic garden. I.e., historically, exotic plants in "Sofivivka" as in other botanical gardens were introduced with the medicinal aims or for displays of single specimens of vegetal curiosities, but not to reflect the genetic diversity of the species. At present, "Sofiyivka" devote their resources to the study and *ex situ* conservation of plants, as well as making the world's plant species diversity known to the public. However, studying the morphological features of some woody plants from the collection of "Sofiyivka" and analysis of the effectiveness of theirs interspecific hybridization revealed their differences from the data given in the literature sources. Because of this reason were initiated our researches.

Study of species-specific features of woody plants, hybridization, progeny analysis, clonal selection, propagation of selected seedlings, and generalization of the observations were performed using commonly used methods.

At present, "Sofiyivka" plant collections have about 4,000 taxa of living plants, with almost 1,000 trees, more than 1,500 shrubs, more than 110 vines, and more than 1,200 herbaceous and aquatic plants. Comparison of morphological features of some woody plants specimen's (Corylus spp., Malus spp., Picea spp., Pinus spp., and Pyrus spp.) imported from the different botanical gardens and their vegetative descendants with descriptions and photos given in the online database founded by the Royal Botanic Gardens Kew (Great Britain), showed the similarity and deviations of features of leaves, inflorescence, bark, trunk, and other specifications. It may indicate a hybrid origin of the introduced plants. Although now, "Sofiyivka" devote their resources to the study and *ex situ* conservation of plants, as well as making the world's plant species diversity known to the public. However, the number of species that can be genetically conserved in "Sofiyivka" or any botanical garden is limited because of the available land plot areas deficit, and it would be prohibitively expensive at their expansion. In addition, namely, very few individuals of each species can be held. Therefore, it severely restricts the range of genetic diversity found in the wild that is protected. The modern plant collections created at "Sofiyivka" support the implementation of scientific research related to monitoring the condition and conservation of the plant world of the Forest-Steppe zone of Ukraine; as well as for biotechnology, genetics, breeding, and reproductive plant biology; and not only ensured the preservation of the historical core and development of the park but also contributed to the creation of new horticultural cultivars.

Keywords: genetic diversity, horticulture, interspecific hybridization, plant collection.

Acknowledgments

This material is partly based on the work supported by the National dendrological park "Sofiyivka" of the NAS of Ukraine "Theoretical fundamentals of hazelnut breeding using molecular genetic markers for identification of species belonging of initial materials and hybrids generated" (SRN 0120U103133) in compliance with the thematic plan of the research work.

INFLUENCE OF ELECTROMAGNETIC RADIATION ON OPTIMIZATION OF FLAVONOID EXTRACTION FROM DANDELION FLOWERS (*TARAXACUM OFFICINALE* (L.) WEBB EX F.H.WIGG)

Lyudmila Kosogolova, Olena Kuznietsova

National Aviation University, Kyiv, Ukraine; E-mail.: <u>ekyznec@ukr.net</u>

In recent years, functional foods have become increasingly popular, the daily consumption of which promotes good health. The feature of the composition of these products is the presence of physiologically important compounds in them: vitamins, macro- and microelements, and fibers. Particular attention is paid to plants with centuries of use in folk medicine, which include dandelion (*Taraxacum officinale* (L.) Webb ex F.H.Wigg) – a perennial herbaceous plant of the family Asteraceae Bercht. & J.Presl. 45 biologically active compounds were identified in dandelion flowers, including amino acids, flavonoids, sugars, tocopherols, sterols, and coumarins. The most valuable biologically active compounds are flavonoids, which have Pvitamin activity, reduce the harmful impact of toxic substances, have antimicrobial and antihistamine effects, and in combination with ascorbic acid have anti-inflammatory and antiallergic effects on the capillary system. In addition, flavonoids act as strong antioxidants, protecting against oxidation and damage by free radicals.

Therefore, it was important to optimize the process of extraction of flavonoids in dandelion flowers. Vegetable raw materials of dandelion were collected in the spring during the period of mass flowering, it is known that during this period the most biologically active compounds accumulate in the flowers. Drying of raw materials was performed according to conventional methods.

The degree of grinding is of great importance for the extraction of extractives from plant material, which allows increasing the interfacial surface of vegetable raw materials, thereby influencing the dynamics of extraction. The choice of extractant depends on the hydrophilicity of biologically active compounds contained in dandelion flowers. Most biologically active compounds of dandelion flowers are hydrophilic, so it is advisable to use water as an extractant. The extraction was performed with distilled water at a temperature of (20 ± 2) °C for 30 min, the ratio of raw material and extractant was 1:20 and the degree of grinding was about 2 mm. To optimize the extraction process electromagnetic radiation was used. Irradiation of dandelion flower extract was performed under standard conditions. Treatment with electromagnetic radiation was performed at extremely high frequency (57–68 GHz) and ultrasound (800–860 kHz) for 5, 10, 15, 20, 25 minutes. Control samples were under the same conditions without irradiation. Determination of flavonoids was performed according to standard methods.

It was found that with increasing time of irradiation there was an increase in the content of flavonoids. It was found that at an extremely high frequency (57–68 GHz) the greatest effect was found at 15 minutes of irradiation of dandelion flowers, the number of flavonoids in this mode increased by 2 times compared to the control. Ultrasonic treatment showed the best result at 20 minutes of irradiation and the amount of flavonoids increased 2.5 times compared to the control sample.

It is proposed to use electromagnetic radiation at an extremely high frequency (57–68 GHz) for 15 minutes to optimize the process of extraction of flavonoids from dandelion flowers.

Keywords: Taraxacum officinale, flavonoids, extraction, electromagnetic radiation.



VIABILITY OF BEES UNDER CONSUMPTION OF DIFFERENT DOSES OF MAGNESIUM CITRATE

Iryna Kovalchuk¹, Maria Tsap², Ryslan Androshulik², Anastasia Kroh¹

¹Lvivskyy National University of Veterinary Medicine and Biotechnology named S.Z.Hzhytskoho, Lviv, Ukraine; E-mail.: <u>irenakovalchuk@ukr.net</u>

²Institute of Animal Biology National Academy of Agrarian Sciences of Ukraine, Lviv, Ukraine

It is known that the resistance of honey bees and the reproductive function of queen bees largely depend on both genetic and biological and nutritional factors, including the level of mineral nutrition. It is known that Mg and other mineral elements maintain the osmotic pressure in the cell, provide transport of inorganic ions through their membranes, affecting metabolic processes at the level of tissues, organs, and systems, which determines the resistance of the organism. Therefore, the study of separate and combined use of mineral elements, the introduction of a sugar syrup such as Mg citrate in feeding bees, their impact resistance of the organism are relevant.

The research was conducted on four groups of bees 25–30 each. Bees isolated in the control group (I) were fed 1 ml of 50 % sugar syrup (CA) and 1 ml of H₂O daily; Group II (experimental) – 1 ml of sugar syrup with the addition of 1 ml of Mg citrate containing 0.04 mg Mg / l; Group III (experimental) – similarly with the addition of 1 ml of Mg citrate (0.02 mg Mg / l); Group IV (experimental) – similarly with the addition of 1 ml of Mg citrate (0.01 mg Mg / l). The bees of the control and experimental groups were kept in similar conditions of the laboratory thermostat TS-80M-3 with micro ventilation at a temperature of 30.00C for 30 days of research. During the study period, daily control of the number of live and dead bees, their motor and forage activity was performed. On the 30th day, journal records were compared with the actual number of live and dead bees and the daily dynamics of survival and life expectancy were determined.

According to the results of the study, positive dynamics of bee survival were observed for 10 days with 100 % in the III and IV experimental groups, against the background of lower preservation for the II experimental group compared to the control. On day 10, the number of live bees was lower and was 97.3 % in the second experimental group and remained at this level for up to 20 days. After 30 days from the beginning of the experiment, the number of live bees fluctuated, in particular in group II was 91.9 %; III – 97.7 %; IV – 97.9 % against control – 94.9 %. Not set bee death within 10 days in the first - control, III, and IV research groups. In group II, 2.7 % of bee deaths were established, maintaining this value until the 20th day. However, on the 30th day, there was an increase in mortality from 2.7 (20 days) to 8.1 % in the second experimental group compared to the control. The third experimental group observed lower levels of bee deaths within 30 days – 2.3 % against 5.1 % in the control group. The number of dead bees in the experimental group IV at 30 days was 2.1 % and was lower than in the control group during this period of the experiment. Life expectancy for bees III and IV research groups was fed sugar syrup with the addition of Mg citrate at a dose of 0.02 mg and 0.01 Mg / I was 29.8 and 30.0 c.u. in accordance. Lower results in life expectancy (29.1) Bee marked the second experimental group that received Mg citrate at a dose of 0.04 mg Mg / l compared to 29.7 c.u. in control.

Therefore, a more pronounced positive effect of Mg citrate on the viability and resistance of bees was observed for III and IV experimental groups, which received before feeding sugar syrup citrate Mg in doses of 0.02 and 0.01 mg Mg / l.

Keywords: bees, citrate Mg, viability, resistance.

DISTRIBUTION OF INSECT-POLLINATED SPECIES IN THE FLORA OF NATIONAL NATURAL PARK "PYRYATYNSKYI" (UKRAINE)

Oleksii Kovalenko¹, Tetiana Senchuk², Oleksandr Senchylo²

¹National Museum of Natural History of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>corydalis.kovalenko@gmail.com</u>

²Educational and Scientific Centre "P.I. Prokopovych Institute of Beekeeping" Kyiv, Ukraine

Insects, and especially members of Hymenoptera order, have an important functional role in natural, semi-natural, rural, and agricultural ecosystems. The success of the reproductive strategy of many species of any flora depends on insects as pollination vectors. Valuating their role in biodiversity supporting and providing ecosystem services are the important task of modern ecology.

Current work aims to study the differentiation of insect-pollinated species in the flora of National Natural Park "Pyryatynskyi" (Ukraine).

Studies of the flora of national park were conducted during 2008–2020 using floristic, phytosociological, statistical, and population-biological methods. The flora of National Natural Park "Pyryatynskyi" includes 1174 species of higher vascular plants from 509 genera, 122 families, 55 orders, 16 subclasses, and 9 classes belonging to 6 divisions of the plant kingdom. Each plant species was analyzed according to its type of pollination and attribute to the fractions of flora and coenoflora.

Entomogamy is the dominant type of pollination in the flora of the national park. Insects are an important vector of pollen transfer for 838 species of angiosperms (71.3 %). The number of species with anemogamy (313; 26.6 %) in the flora is significantly lower. There are 11.1 % (135 species) of species with autogamy. Water-pollinated species are a minor component of the flora (44; 3.7 %). Similar relationships between species by type of pollination were obtained for the flora of the Carpathian Highlands, Danube Biosphere Reserve, the natural flora of Central Asia, and are characteristic features of the flora of the Holarctic floristic kingdom.

Native and non-native components of the flora are almost indistinguishable according to the differentiation of species with a different type of pollination. Among alien species, hydrogamy is almost completely absent (2; 0.9 %), but the role of self-pollinated plants is increasing (31; 14.9 % compared to 104; 10.7 % for the aboriginal flora fraction).

Entomogamy is an equally important method of pollination in both the adventive (154; 74.0 %) and an aboriginal fraction of flora (684; 70.7 %). However, significant deviations from these proportions are fixed in coenofloras.

Thus, in the coenofloras of the classes *Lemnetea*, *Littorelletea uniflorae*, *Potametea*, *Phragmito-Magnito-Caricetea*, and *Scheuchzerio-Caricetea nigrae* the ratio of the species with anemogamy and entomogamy is almost 1:1.

In communities of the class *Bolboschoenetea* the relative number of insect-pollinated species is even smaller than a number of species with anemogamy.

The role of insect-pollinated plants in the communities of the classes *Trifolio-Geranietea*, *Carpino-Prunetea*, *Festuco-Brometea*, and the order *Galietealia veri* is especially high.

Entomogamy is the leading type of pollination in the flora of NPP "Pyriatynsky", its aboriginal and adventitious faction. The study of the taxonomic structure of pollinators is an important task for the conservation of vegetation of nature reserves.

Keywords: flora, entomogamy, insect-pollinated species, National Natural Park "Pyryatynskyi".

DIVERSITY OF HIGH MOLECULAR WEIGHT GLUTENIN SUBUNIT ALLELES CONSERVED IN THE *EX-SITU* COLLECTION OF *AEGILOPS BIUNCIALIS* VIS.

Natalia Kozub^{1,2}, Igor Sozinov¹, Hanna Bidnyk^{1,2}, Natalia Demianova^{1,2}, Oksana Sozinova^{1,2}, Yaroslav Blume²

¹Institute of Plant Protection of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine; E-mail: <u>natalkozub@gmail.com</u>

²Institute of Food Biotechnology and Genomics of the National Academy of Sciences of Ukraine, Kyiv,

Ukraine

Aegilops biuncialis Vis. belongs to the tertiary gene pool of wheat and is a promising source of new genes for wheat improvement. It is a tetraploid species with the genomic formula UUMM. *Ae. biuncialis* is widespread in southeastern Europe, the Cis- and Transcaucasus regions, on the western arc of the Fertile Crescent. The northern part of the *Ae. biuncialis* area resides in the Crimean Peninsula. For enriching the common wheat gene pool, *Ae. biuncialis* may provide new alleles for high molecular weight (HMW) glutenin subunits, which directly determine breadmaking quality. The study aimed to conserve *ex situ* the diversity of *Ae. biuncialis*, mainly from populations from the Crimean Peninsula, concerning HMW glutenin subunit alleles.

Ae. biuncialis samples collected in different regions of the Crimea in 1995–2012 served as the material for investigation. The samples represented 15 populations (5 from the western and eastern regions of the Crimean Peninsula. 4 from the southern part, and 1 from the southwestern region – from the Tauric Chersonese National Reserve). For propagation, single spikes from natural populations were sown on the experimental plot (Kyiv region). SDS electrophoresis according to Laemmli was performed to identify alleles at the *Glu-U1* and *Glu-M^b1* loci. The previously compiled catalogue of HMW glutenin subunits encoded by different *Glu-U1* and *Glu-M^b1* alleles was used for allele identification (Kozub et al., 2011). As a result of analysis of 1200 *Ae. biuncialis* samples from the Crimean natural populations, this catalogue was supplemented by new allelic variants. Samples with different storage protein alleles were selected for further propagation. The collection was made in accordance with the M-strategy of establishing a core collection (van Hintum et al., 2000).

In the current collection of the propagated 40 samples, there are 8 different alleles at the locus *Glu-U1* (*a-g*, and *k*) and 14 alleles at *Glu-M^b1* (*a-i*, *m-o*, *q*, and *s*). All these alleles at *Glu-U1* encode two HMW glutenin subunits (both x- and y-subunits), whereas at *Glu-M^b1* five alleles are encoding only one subunit: the alleles *e*, *f*, *n*, and *s* encode only the y-subunit and the allele *Glu*-*M*^b1*i* encodes only the x-subunit. The alleles encoding only one subunit are private alleles for a Crimean population or a region. The collection diversity at the *Glu-U1* and *Glu-M^b1* loci represents 80 and 74 %, respectively, of the allele diversity, revealed among 1200 Ae. biuncialis samples from the natural populations of the Crimean Peninsula. Of them, 24 samples have been registered in the National Center of Plant Genetic Resources of Ukraine (NCPGRU, Kharkiv), representing 60 and 47 % of the revealed genetic diversity at the *Glu-U1* and *Glu-M^b1* loci, respectively. Samples carrying seven new alleles have been propagated for further registration in NCPGRU. The registered accessions of *Ae. biuncialis* are available for use in wide crosses with wheat to transfer novel HMW glutenin subunits into the wheat gene pool. The geographical differentiation of *Ae. biuncialis* by the flowering rate was revealed: the earliest are samples from the eastern part of the area of the species in the Crimean Peninsula. Such samples are the most convenient for interspecific hybridization with cultivated wheat.

Keywords: Aegilops biuncialis, high molecular weight glutenin subunits, alleles, bread-making quality.



ANTIOXIDANT PROPERTIES OF DRY SUBSTANCE OF FLOWERS MEDICINAL PLANT

Mykhailo Kryvyi¹, Olena Dikhtiar¹, Dina Lisohurska¹, Jan Brindza²

¹Polissya National University, Faculty of Technology, Zhytomyr, Ukraine; E-mail.: <u>olena.dikhtiar@gmail.com</u>

²Institute of Biological Conservation and Biosafety, Slovak University of Agriculture in Nitra, Slovak Republic

The biological value of flowers of medicinal plants is determined by their total antioxidant activity, which is due to the content of biologically active substances, phenolic compounds, flavonoids, localized in various vegetative organs of plants.

Our research aimed to determine and compare the total antioxidant activity of methanol and aqueous extracts of dry matter of flowers of medicinal plants for their further use in beekeeping.

Plant raw materials of echinacea purpurea (*Echinacea purpurea* L.), oregano (*Origanum vulgare* L.), sage (*Salvia officinalis* L.), tansy (*Tanacetum vulgare* L.), hyssop (*Hyssopus officinalis* L.), tarragon (*Artemisia dracunculus* L.), wormwood. (*Artemisia absinthium* L.), veronica longifolia (*Veronica longifolia* L.), canadian goldenrod (*Solidago canadensis* L.), heather (*Calluna vulgaris* (L.) Hull), which were used for analysis were obtained in conditions Polissya, Zhytomyr region.

To date, several methods are known to assess the antioxidant potential of plants, one of which is a spectrometric method with a stable chromogen radical DPPH (2,2-diphenyl-1-picrylhydrazyl). According to the method, methanol and distilled water were used as extractants. Before research, flowers with a dry matter content of 15–16 % were ground and extracted in solvents. The solutions were constantly stirred on the shaker for 12 hours. We added 3.9 ml of phenolic DPPH solution to the filtered extracts for further studies. We prepared the solution for photometric studies immediately before the analysis. The antioxidant activity of the dry matter of flowers was determined using a spectrophotometer Genesis-20. For calculations, we measured the optical density of the radical solution and the optical density with the sample 10 minutes after preparation. Experimental data were processed by the method of mathematical statistics in Microsoft Excel, calculated the average value (M), its standard error (m), and the coefficient of variation (V).

We found a high level of antioxidant action of plant extracts in methanol solution (71.1– 76.1 %); in particular, we found the highest potential is in *Calluna vulgaris, Solidago canadensis, Hyssopus officinalis, Tanacetum vulgare, Artemisia absinthium.* In an aqueous solution, the antioxidant effect of the extracts was in the range of 23.5–71.8 %. High values of antioxidant capacity of aqueous extracts of flowers had *Calluna vulgaris, Tanacetum vulgare, Veronica longifolia.* On the contrary, the lowest antioxidant capacity in aqueous extracts of *Echinacea purpurea, Origanum vulgare* has been found. Coefficients of variation of antioxidant activity of extracts of medicinal plants in methanol solutions range from 0.5 to 4.0 %, and in aqueous from 1.3 to 15.6 %. The most consolidated values of the coefficients of variation in methanol solutions were obtained in *Echinacea purpurea* and *Tanacetum vulgare*, and in aquatic – *Solidago canadensis, Hyssopus officinalis.*

The obtained data of studies of flowers of medicinal plant extracts testify to their indisputable antioxidant properties. Therefore, they can potentially be used for bee colonies in early spring.

Keywords: plant, extract, methanol, water, antioxidant activity.



BIOCHEMICAL AND ANTIMICROBIAL PROPERTIES OF SCHIZANDRA CHINENSIS (TURCZ.) BAILL. FRUIT POMACE EXTRACT

Elena Kuznetsova¹, Tatyana Bychkova², Houssam Alhusseini¹

¹Orel State University named after I.S. Turgenev, Orel, Russian Federation; E-mail.: <u>elkuznetcova@yandex.ru</u>

²Razumovsky Moscow State University of Technology and Management, Moscow, Russian Federation

Schizandra chinensis (Turcz.) Baill. – it is a plant species well known in traditional Chinese medicine. Considering the pharmacology of the fruits of *Schisandra chinensis*, first of all, researchers pay attention to antihepatotoxic, antioxidant, and anti-tumor activities. *Schizandra chinensis* on the territory of Russia grows in the Far East region. The presence of rich chemical composition in the fruits of the plant allows it to be used to obtain preparations of biologically active substances intended for use in food technologies.

The study aims to obtain extracts from the pomace of *Schizandra chinensis* fruits and to study their properties.

To obtain the marc, the fruit pressing operation was carried out. The pulp and some of the cellular juice from the skin passed into the juice, and most of the membrane contents remained in the pomace. Rational extraction methods have been established experimentally. *Schizandra chinensis* fruit pomace was crushed, poured with water (hydro module 1:30), the temperature was brought to 85 °C and kept at this temperature for 20 minutes, cooled, stirred with a magnetic stirrer for 1 time. Then, centrifugation was performed at 4500 rpm for 10 minutes and the liquid phase was separated. To determine the biochemical and antimicrobial properties of the extract, standard research methods were used.

It was found that the aqueous extract obtained from the pomace of the fruits of *Schizandra chinensis* contained 6.9 % of dry matter. The extract contained reducing sugars in an amount of 16.5 %, organic acids – 3.2 %, ascorbic acid – 12.6 mg%, flavonoids – 7.0 %, anthocyanins – 5.2 %. It is known that organic acids, flavonoids, and anthocyanins are substances that determine the antioxidant and antimicrobial properties of the product. Research results show that the aqueous extract of the pomace of the fruit of *Schisandra chinensis* is rich in minerals. The extract found calcium – 120.1, magnesium – 60.0, phosphorus – 104.3, potassium – 130.1, iron – 8.72, zinc – 3.86 mg/kg. The extract satisfies man's daily requirement for 15 % magnesium, 87.2 % iron, 32.16 % zinc.

The antioxidant activity of the aqueous extract was 47.2 % inhibition of the DPPH radical.

Studies were carried out on the antimicrobial properties of the extract obtained against test cultures of *Staphylococcus aureus* and *Escherichia coli*. The diameters of the non-growing areas of *Staphylococcus aureus* were found to be 8.8 \pm 0.2 and that of *Escherichia coli* to 10.1 \pm 0.2 mm. These values indicate high antimicrobial activity against the bacteria studied.

Thus, the studies carried out have shown that the extract of fruit pomace of *Schisandra chinensis* contains biologically active substances responsible for antioxidant and antimicrobial properties against *Staphylococcus aureus* and *Escherichia coli*, and also has a rich mineral composition. The resulting extract can be used in the production of syrups and carbonated drinks with prophylactic properties.

Keywords: Schisandra chinensis, fruit pomace, properties.

BREAD TECHNOLOGY FROM A MIXTURE OF WHEAT AND SPELT GRAINS

Elena Kuznetsova¹, Gyunesh Nasrullaeva², Elena Kuznetsova¹

¹Orel State University named after I.S. Turgenev, Orel, Russian Federation; E-mail.: <u>elkuznetcova@yandex.ru</u> ²Azerbaijan State Economic University, Baku, Azerbaijan

Recently, people have become more and more interested in natural and organic foods. In this regard, the older wheat varieties *Triticum monococcum*, *Triticum dicoccum* and *Triticum spelta* have been discovered for use in food technology. The nutritional value of the grain of *Triticum dicoccum* is mainly due to the high protein content (18–23 %), the total proportion of essential amino acids in the protein and the high degree of digestibility of the protein compounds. An increased concentration of antioxidants has been found in the grain of *Triticum dicoccum*. Grain starch is mainly represented by persistent fractions, resulting in slower absorption of carbohydrates. Non-digestible resistant starch is one of the factors that increase the functionality of food products. The low glycemic index makes the grain of *Triticum dicoccum* particularly valuable for diabetic nutrition. However, *Triticum dicoccum* grain has been found to have lower β -carotene values than traditional wheat varieties. A higher concentration of phytic acid has been found in the grain of *Triticum dicoccum* compared to traditional raw materials in the bakery industry.

The work aims to develop a technology from whole unshelled wheat and spelt grains growing on the territory of the Republic of Azerbaijan.

In bread-baking technology, a dry complex enzymatic preparation was used, including cellulase, β -glucanase and xylanase (produced by *Penicillium canescens*). To increase the microbiological safety of the grain, extract *Thymus serpyllum L.* was prepared using a succinic acid buffer at pH 4.6 and an enzyme preparation was dissolved in this extract. Theoretically sound and experimentally related rational doses of the enzyme preparation. The grain of the wheat and spelt were kept in the extract for 8 hours, then dispersed and the bread was prepared by the straight dough method.

Using a scanning electron microscope, data were obtained on the changes of the morphology and microstructure of wheat and spelt under the action of enzyme preparation. The use of succinic acid in the buffer composition accelerates the hydrolysis process of the polysaccharides.

The sensitivity of test microorganism cultures of strains typical of *Bacillus, Lactobacillus, Micrococcus, Penicillium, Aspergillus, Mucor, Rhizopus* to the action of a succinic acid-based buffer solution and *Thymus serpyllum L.* is extracted. A solution based on succinic acid of pH 4.6 inhibits the development of microorganisms typical of cereal microflora. The diameter of the growth inhibition zone of the cultures to be tested in the experiment was determined to vary from 8.0 to 14.5 mm.

The physicochemical and sensory characteristics of grain bread developed, its antioxidant and antimicrobial activity were studied. The developed bread had quality indicators comparable to the control variant prepared according to GOST 25832, had an antioxidant activity of 25.5 % inhibition of the DPPH radical.

Conducted research indicators on the nutritional value and safety of bread made from wheat and spelt. It is established that the essential amino acid content increases by 7.9~% in vitamins – by 43.2~%, in mineral substances – by 22.1~% compared to control.

The crafted bread can replenish the range of specific dietary products.

Keywords: technology, grain bread, spelt, properties.



Maxim Kvitko, Vasyl Savosko

Kryvyi Rih State Pedagogical University, Kryvyi Rih, Ukraine; E-mail.: <u>kvitko.max@gmail.com</u>

There is increasing attention of scientists to the social aspects of forest use in modern cities, as well as the role of forests in the green economy.

The research aimed to study artificial woody plantations as a significant factor in improving the ecological environment for their further use, adhering to the paradigm of sustainable development in the Kryvyi Rih mining and metallurgical region.

During 2015–2020, we studied the natural forest ecosystems and the artificial forest plantations, which are located in contrast to environmental conditions. A forest woodland inventory was made a random sampling scheme. The 34 research plots (25*25 m) were established in natural forest ecosystems and artificial woody plantations.

It was established that at Natural forest ecosystems of the Gurivsky forest the values of stand density varied from 1100 to 1300 trees ha⁻¹, stem heights were 17–19 m, stem diameters were from 19 to 21 cm, stand basal area was from 44 to 48 m² ha⁻¹, stand volume was from 500 to 550 m³ ha⁻¹. It should be noted, that the vitality of the stand was very high and indicated to healthy forests of these ecosystems. In general, the characteristics of the Gurivsky forest were typical for the floodplain forests of Ukraine.

Instead, the values of stand density in plantations in areas with the most environmentally unfavorable areas varied. The most ecologically polluted territory includes forest protection zones of PJSC "ArcelorMittal Kryvyi Rih" and urban protected forests (city protection forests (Lisove and Sotsmisto forest tracts) are located in an ecologically unfavorable zone. These tree plantations develop mainly on relatively fertile soils with a low level of moisture and a high level of air pollution by gas and dust.

It was established that at these woody plantations the values of stand density varied from 1400 to 1500 trees ha⁻¹, stem heights varied from 10 to 12 m, stem diameters varied from 14 to 16 cm, stand basal area varied from 26 to 32 m² ha⁻¹ and stand volume varied from 150 to 250 trees m³ ha⁻¹. These values are very different from the control (F>Fcritical, p<0.05).

The viability of the stand with the most unfavorable environmental conditions was very low and indicated a partially healthy condition of these stands.

In our opinion, the biogeochemical parameters of each seasonal fallen tree leaves can be considered one of the promising markers that determine the viability, or in other words, the health of tree species, and predict the development of artificial woody plantations.

Keywords: forest plantations, analysis of the forest condition, woody plants of Kryvyi Rih district.



Olga Kyrylenko¹, Rui Seabra Ferreira Jr²

¹PHEI Kyiv Medical University, Kyiv, Ukraine; E-mail.: <u>o.kyrylenko@kmu.edu.ua</u> ²Center for Study of Venoms and Venomous Animals, Botucatu Medical School, São Paulo State University, Botucatu, Brazil

Human health is currently threatened by diseases that cannot be treated with existing drugs. Moreover, they often result from the usage of common drugs and disinfectants. The causes of outbreaks of such diseases are microorganisms resistant to antibiotics (CRE, C. difficile, MRSA, N. gonorrhoeae, MDR/XDR tuberculosis) or disinfectants, including disinfectants of drinking water (Cryptosporidium spp, viruses), or disinfectant-resistant toxins of microorganisms (Shiga toxin of *E. coli* 0157:H7 or 0104:H4), also viruses, including emerging, such as SARS-CoV-2. Since effective anti-viral drugs have never been found. Therefore, novel types of antibiotics need, as well as disinfectants. Both enzymes (proteases, phosphatases, etc.) and protease inhibitors capable of cleaving / inhibiting vital pathogenic proteins and nucleic acids may be useful. Animal venoms are offered as a source of such enzymes, potential novel drugs. Bee venom (BV) is one of the best candidates because it is not directed against mammals, but against bee enemies, such as arthropods and parasites, as well as against bacteria, protozoa, viruses, fungi, from which the bee protects itself by sprinkling its venom. Our study aimed to find the BV components responsible for such a broad antimicrobial activity of bee venom, for therapeutic purposes and as disinfectants.

We divided the bee venom into fractions by chromatography (HPLC) and analyzed the fractions of the chromatographic peaks in the polyacrylamide gel to determine the fractions containing proteins (enzymes) and their biological activity in human blood, mainly their effect on blood clotting and prevention of such coagulation, which is often affected by the infection. In addition, we interpreted the found proteins (enzymes) using mass spectrometry.

We obtained interesting data on protease as well as a protease inhibitor, which were previously found in bee venom, but have not yet been well studied. Our data suggest that both BV protease and protease inhibitor may be more potent than many viral, bacterial, or parasitic proteases and protease inhibitors, and therefore might be used to destroy them or their activity; for example, to cleave (protease) or inhibit (protease inhibitor) the proteases of coronavirus SARS-CoV-2, known to be critical for viral spread. Due to the same ability, they also might be potent disinfectants. In addition, we observed a significant decrease of blood coagulation via inhibition of tissue factor by BV protease inhibitor. This suggests that BV protease inhibitor can inhibit the extrinsic pathway of blood coagulation, which is known to activate as a result of tissue damage along with the release of cytokines leading to thrombosis. Such mechanism of thrombosis has also been shown in Covid-19 pathophysiology. We also observed that bee venom Phospholipase, already used in human therapy but potentially toxic to human cells, is included in a complex with other proteins that might prevent its toxicity.

Keywords: emerging diseases, novel drugs, bee venom protease inhibitor, blood coagulation.



Anna Kyslynska, Hanna Tsekhmister

Agricultural Microbiology and Agro-Industrial Production Institute of Agrarian Sciences National Academy, Chernihiv, Ukraine; E-mail.: <u>a.s.kyslynska@gmail.com</u>

It is well-known that endophytic fungi can stay in plant tissues for a long time without any sign of their presence and only be active under adverse environmental conditions. The study of diversity, ecological niches, and metabolism products of endophytic microorganisms, their usage to improve the growth and development of the plants, the macroorganism protection from adverse environmental factors – all that are important aspects of applied microbiology in agricultural production.

The study aimed to investigate the ability of *Chaetomium cochliodes* Palliser 3250 fungus to penetrate healthy tissues of agricultural crop roots was determined.

Localization of the endophytic fungus mycelium within the macroorganism is revealed by histological methods. Seeds of wheat, barley, rye, triticale, buckwheat, maize, sunflower, soybean, and flax were inoculated with the saprotrophic fungus *C. cochliodes* and grown in the vegetation experiment. *C. cochliodes* 3250 is a strain of the marsupial antagonist fungus that was obtained from a collection of beneficial soil microorganisms from the Agricultural Microbiology and Agro-Industrial Production Institute of Agrarian Sciences National Academy of Ukraine Thin sections of the roots and plant root hairs were painted with an aniline blue lactic acid solution, which allowed the visualization of fungal mycelium and, in some cases, spores.

As a result of microscopy of root hairs and roots cross-sections of the investigated plants, it is established that the saprotrophic fungus *C. cochliodes* 3250 actively develops in the root zone of the studied crops and forms fruiting bodies on the roots of wheat, rye, triticale, maize, sunflower, soybean, and buckwheat. Fruit bodies of *C. cochliodes* 3250 formed mainly on the secondary and tertiary lateral roots of plants. Some small hyphae were found inside the rhizodermal cells, with larger hyphae being observed both between the rhizodermal cells and in the spaces of the mesoderm parenchymal cells. The penetration of *C. cochliodes* 3250 hyphae into the root and root hairs of the studied plants was also detected. Localization of fungus spores on the plant's root hairs and samples with sections of mesoderm parenchymal cells is evidence of endophytic associative system formation. Micromycetes penetration of *C. cochliodes* 3250 did not inhabit flax roots. We did not observe any fruit bodies on the roots of this culture, nor hyphae penetration inside the flax root hairs.

Thus, the fungus *C. cochliodes* 3250 forms fruiting bodies on the roots and penetrates the root cells of wheat, barley, rye, triticale, buckwheat, corn, sunflower, and soybeans. Accordingly, the localization of fungal structures in healthy root tissues of cereals, legumes, and industrial crops indicated the ability of the saprotrophic fungus *C. cochliodes* 3250 to form endophytic symbiotic systems.

Keywords: agricultural plants, *Chaetomium cochliodes*, fungal endophytes.

Acknowledgments

The work was performed within the state task of basic research No. 0116U003068.

WASTES FROM VEGETABLE OIL PRODUCTION AS A SOURCE OF BIOACTIVE SUBSTANCES

Iryna Laguta¹, Oksana Stavynska¹, Pavlo Kuzema¹, Roman Ivannikov², Victor Anishchenko³, Oksana Linnik¹

¹Chuiko Institute of Surface Chemistry of NAS of Ukraine, Kyiv, Ukraine ²M.M. Gryshko National Botanic Garden of NAS of Ukraine, Kyiv, Ukraine ³L.M. Litvinenko Institute of Physical-Organic and Coal Chemistry of NAS of Ukraine, Kyiv, Ukraine; E-mail.: <u>icvmtt34@gmail.com</u>

Since the wastes from vegetable oil products contain a large amount of valuable biologically active substances, the bioprocessing concept involving the consistent use of all biomass components is one of the promising areas of research within the new European Union initiative "European Green Course", which helps to protect the environment and to increase human biosafety. Especially valuable are biowastes containing polyphenolic compounds with antioxidant / reducing properties, which can be used, for example, in medicine (as pharmacological agents with antioxidant and antimicrobial properties), in "green" synthesis of metal nanoparticles (as reducing agents), in the energy industry (as stabilizers of biodiesel to prevent its degradation during storage), etc.

This work aimed to investigate the composition and antioxidant properties of extracts obtained from vegetable oil production biowastes. Pomaces from seeds of the grape, ryegrass, flax, hemp, pumpkin, mustard, carduus marianus, and sunflower were selected for the study.

The extraction was performed in two stages: first, oil residues were removed from 10 grams of crushed pomace for 6 hours using hexane (500 ml); then extracts of phenolic compounds were obtained by treatment with 96 % ethanol (500 ml) for 6 hours.

The composition of extracts was investigated using HPLC and MALDI MS methods while antiradical activity was tested in the reactions with DPPH• radicals; total polyphenol content was determined using Folin-Ciocalteu assay. All the extracts were found to contain mostly flavonoids (~20 mg per 1 g of raw material), oxycinnamic acids and their derivatives (~17 mg/g); the basic aglycones of flavonoid derivatives were quercetin and kaempferol, and oxycinnamic acids were represented mainly by coumaric, caffeic and sinapic acids. The results of antioxidant studies have shown that six of the eight examined extracts demonstrate high antiradical activity, inhibiting even in the diluted form up to 90 % of radicals. Pumpkin and flax waste extracts are relatively less active, although even these extracts, diluted by 10 times, inhibit about 20 and 50 % of DPPH radicals, respectively. The data on the antiradical activity of the extracts correlate with the results of the Folin-Ciocalteu test: extracts from pumpkin and flax waste are characterized by a total phenolic index of 0.5 and 1, while for other extracts this index is 3–10.

The high content of antioxidants and high activity of extracts from vegetable oil production wastes show promise for the use of waste materials to extract effective antioxidants of natural origin.

Keywords: natural antioxidants, vegetable oil production wastes, antioxidant properties.

Acknowledgements

This work was financially supported by National Research Foundation of Ukraine (Project No 2020.01/0136 "Efficient use of renewable plant resources and photocatalytic conversion of biomass as eco-innovative approaches for environmental protection and human biosafety").

POSSIBLE MECHANISMS OF *BACILLUS SUBTILIS* AND SALICYLIC ACID-MEDIATED REDUCTION OF POSTHARVEST DISEASES IN TUBERS OF *SOLANUM TUBEROSUM* L.

Oksana Lastochkina¹, Darya Garshina², Irina Shpirnaya³, Almaz Ibragimov³

¹Institute of Biochemistry and Genetics – Subdivision of the Ufa Federal Research Centre of the Russian Academy of Sciences, Ufa, Russian Federation; E-mail.: <u>oksanaibg@gmail.com</u> ²Bashkir Research Institute of Agriculture – Subdivision of the Ufa Federal Research Centre of the Russian Academy of Sciences, Ufa, Russian Federation ³Bashkir State University, Ufa, Russian Federation

Potato (*Solanum tuberosum* L.) is a major food crop worldwide due to its nutritional value and health-promoting properties. Postharvest diseases lead to significant food and economic losses. The application of eco-friendly and bio-safe approaches plays an important role in the control of postharvest decay. Earlier we demonstrated that endobacteria *Bacillus subtilis* (strains 104, 26D) and their compositions with natural signal molecule salicylic acid (SA) reduced (up to 30–50 %) the incidence of dry rot and late blight in stored potatoes, caused by *Fusarium oxysporum* and *Phytophthora infestans*, respectively. It was suggested that such action of *B. subtilis* may be linked to their ability to produce compounds with antifungal activity including lipopeptides (LPs).

In this study, we isolated and identified metabolites produced by *B. subtilis* 104 and 26D, grown in Luria-Bertani broth (LB) and Medium Optimal for Lipopeptide Production (MOLP), as well as assess their antifungal activity using classical and modern methods of microbiological and biochemical analysis.

The obtained results of *in vitro* assays showed *B. subtilis* 10-4 and 26D exerts antagonistic activity against phytopathogenic fungus F. oxysporum and Ph. infestans. The microscopic observation showed the mycelia structure was well organized in the absence of the bacterial cells, while numerous gaps of mycelia appeared in the presence of the *B. subtilis*. The results showed the efficiency of the extracts of *B. subtilis* 104 and 26D metabolites for the inhibition of *F. oxysporum* and *Ph. infestans* growth in Petry dishes. It was identified that tested strains *B. subtilis* 104 and 26D produce LPs surfactins C13, C14, and C15, as well as bacillomicin D (C16) for *B. subtilis* 26D was detected. Obviously, produced LPs make an important contribution to *B.* subtilis (104, 26D)-induced suppressing of *F. oxysporum* and *Ph. infestans* growth as well as in potatoes' systemic resistance induction. With that, likely the spectrum of synthesized metabolites is not limited only to detected LPs and may exist other components with antifungal activity, for example, such as hydrolases capable to induce potatoes defense mechanisms. Also, it was revealed *B. subtilis* (104, 26D) and especially compositions of *B. subtilis* (strain 104)+SA contribute to the reduction of pathogens (F. oxysporum and Ph. infestans) – caused vitamin C and starch destruction in stored potatoes. Thus, obtained results indicate that the detected LPs produced by *B. subtilis* 104 and 26D can contribute to the formation of resistance of potato tubers to dry rot and late blight diseases during long-time storage while maintaining their quality and appearance.

Keywords: Solanum tuberosum, postharvest diseases, Bacillus subtilis, salicylic acid, antifungal activity.

Acknowledgments

The research was supported by the grant of the Russian Science Foundation (№ 18-76-00031) and partially carried out within the framework of the state assignment of Russia (registration number AAAA-A21-121011990120-7) with using the instrument park of the RCCU "Agidel" and "KODINK" of the UFRC RAS.

DYNAMICS OF CYANOGENIC GLYCOSIDES ACCUMULATION IN *PRUNUS SPINOSA* L. SPROUTS

Volodymyr Levon, Iryna Golubkova

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>vflevon@gmail.com</u>

Currently, among the large variety of *Prunus* species, the thorn (*Prunus spinosa* L.) is of considerable interest, which is characterized by high productivity, frost and winter hardiness, resistance to pests and diseases, and is a valuable breeding material for further study.

For the majority of introduced fruit plants, the Forest-Steppe of Ukraine is the northern border of successful fruiting. A certain number of forms and species of different types of fruit plants, especially of southern origin, have undergone strict natural and artificial selection over several generations. But all of them are damaged to a certain extent by critical temperatures in winter and spring frosts, are affected by fungal diseases, as well as other negative factors of biotic and abiotic origin. The resistance of the plant organism to various stressful situations is determined by its adaptive potential. An important role in the adaptation processes is played by secondary metabolites that take part in the biochemical adaptation of plants.

The cyanogenic glycoside prunasin is one of the characteristic elements of the metabolism of stone fruits, and its accumulation is associated with certain phases or stages of plant development. Prunasin itself is a non-toxic compound, but when plant tissues are destroyed, such as when eaten by animals, it interacts with specific enzymes, resulting in the formation of benzaldehyde and prussic acid. Prussic acid, as a result of its high toxicity, protects the plant organism from pests and damage by pathogenic fungi and bacteria.

This work aims to establish the relationship between the content of prunasin in *P. spinosa* sprouts and the processes of vital activity in certain periods. By tracking the quantitative changes in prunasin during the annual cycle, it is possible to analyze the level of adaptation of the plant to natural and climatic conditions.

For the quantitative determination of prunasin, the method of its hydrolysis to prussic acid was used, which was then distilled with water vapor and captured with a certain amount of mercury (II) nitrate. The excess mercury (II) nitrate was titrated with ammonium rhodanide. For complete hydrolysis of prunasin, the crushed sample was filled with water for 1 day in the presence of a small amount of thymol as a fixing agent and diethyl ether to separate the organic phase from the inorganic one.

The study of the dynamics of prunasin accumulation in *P. spinosa* sprouts showed that the maximum accumulation of prunasin occurs at critical moments of plant life: April-May-the active beginning of the growing season; June-July – the first wave of growth (the largest growth of sprouts); August-September – the second wave of growth; November – preparation for winter. In winter, there is a decrease in the content of prunasin. This can be explained by a decrease in all the functions of the plant organism at low temperatures, a state of rest when cyanogenesis also slows down.

The experimental data obtained indicate that cyanogenesis plays an important role in the physiology of the protective reactions of *P. spinosa* plants. Therefore, further study of the mechanism of cyanogenesis for this culture is an urgent task.

Keywords: Prunus spinosa, sprouts, cyanogenic glycosides, cyanogenesis.

CONTENT OF ANTHOCYANINS IN THE ABOVEGROUND ORGANS OF PLANTS AKEBIA QUINATA (HOUTT.) DECNE

Volodymyr Levon, Mykhailo Zhurba

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine Kyiv, Ukraine; E-mail.: <u>vflevon@gmail.com</u>

Currently, an urgent task is to find new plants that can be used in medicine for kidney and bladder diseases. A promising plant in this regard is *Akebia quinata* (Houtt.) Decne., which has palmate-compound leaves and delicious inflorescences that are chocolate-scented. Due to this fact, the plant was named chocolate vine.

A. quinata native to China, Japan, and Korea, naturalized and invasive in New Zealand, USA, Belgium. It is used as a diuretic and has a beneficial effect on the functioning of the kidneys and, accordingly, the bladder. *A. quinata* will also help to relieve inflammation and helps to fight colds and infectious diseases. In addition, such an interesting fruit helps to get rid of swelling on the throat and reduces the temperature, fights fever. They are used in folk medicine not only the fruit of the vine itself but also the leaves, as well as the stems. They are used to make decoctions and teas, which in turn have a tonic effect on the human body.

It is known that the stems of akebia contain betulin, hederagenin, inositol, oleanolic acid, akebosides, stigmasterin, sucrose, daukosterol, potassium salts. The fruits of the plant contain vitamins B1, B2, and B6, ascorbic acid, vitamin E, iron, zinc, phosphorus, manganese, potassium, sodium, palmitic, oleic, and linoleic acids.

The purpose of our work was to study the content of anthocyanins in the aboveground organs of *Akebia*, since there are no data on these studies in the literature.

The objects of research are cultivars and varieties of *A. quinata*, namely, Ametyst, Shirobana, Silver Bells, Rosea, AQ-02, AQ-03, AQ-04. The samples were taken at the beginning of the growing season, during flowering and fruiting. Stems, leaves, flowers, and fruits were collected from the plants of collection of Department of Acclimatization of Fruit Plants in M.M. Gryshko National Botanical Garden (Kyiv, Ukraine) during 2019–2020.

When studying the content of anthocyanins in the bark, leaves, and flowers of *Akebia quinata* genotypes, it was found that the highest content of anthocyanins is in the leaves (435–870 mg/100 g DM). The content of anthocyanins in the flowers of *A. quinta* genotypes is quite wide (147–696 mg/100 g DM). The highest content of anthocyanins in the leaves and flowers of *A. quinata* is the variety AQ-03, 810, and 696 mg/100 g DM, respectively. The bark of *A. quinata* plants has a significantly lower content of anthocyanins than leaves and flowers: 55–225 mg/100 g DM.

It is interesting to note the fact that there is a significant difference between the content of anthocyanins in creeping and ordinary sprouts of *A. quinata*. In creeping sprouts, the content of anthocyanins is significantly higher than in climbing shoots, the difference is in the range of 31–91 %. We explain this by the fact that the creeping sprouts are exposed to more intense solar radiation, which can cause more active biosynthesis of anthocyanins.

When studying the content of anthocyanins in the fruits of varieties and forms of *Akebia quinata* plants, it was found that the content of anthocyanins is within fairly wide limits. The highest content of anthocyanins is found in the fruits of variety AQ-04 (88 mg/100 g DM) and cultivar Ametyst (72 mg/100 g DM).

Studies have shown that the aboveground organs of *A. quinata* plants have a high content of anthocyanins. This indicates that the studied plants are of interest to the food and pharmaceutical industries and can serve as raw materials for the production of P-vitamin preparations.

Keywords: Akebia quinata, aboveground organs, anthocyanins.

NATURAL LANDS OF HONEY PLANTS IN UKRAINIAN POLISSYA

Olha Lisohurska, Dina Lisohurska, Svitlana Furman, Mykhailo Kryvyi

Polissia National University, Zhytomyr, Ukraine; E-mail.: <u>lisogurskaya2016@gmail.com</u>

Polissya is a zone of mixed forests, located in the North of Ukraine. It stretches from North to South to 150–200 km and occupies about 20 % of the territory. It includes 9 regions. The melliferous flora of Polissya is characterized by great biological diversity (there are 759 species, 300 of which are the most valuable). But over the past decades, it has undergone significant anthropogenic changes and needs research, which became the goal of our research.

The object of the research was the area of honey plants of Zhytomyr Polissya. Statistical data on the number of bee families and the availability of land plots (2012-2017), which were grouped into natural and cultural melliferous lands, were used for the research. Natural ones included forests, parks, and protective plantings, swamps, pylons, hayfields, pastures, and disturbed soils. Forest, swamp, field, and meadow forbs are widespread on these lands. Cultivated ones are gardens and berrying grounds and the main agricultural entomophilous plants are common sunflower (*Helianthus annuus* L.), winter and spring rape (*Brassica napus* L.), and common buckwheat (*Fagopyrum esculentum* Moench). Land that is not practical for beekeeping (land without plant cover and open water reservoirs) is defined separately. For the calculation of the honey stock, literature data of the honey production was used: forest forbs – 25, marsh forbs – 12, field and meadow forbs – 15, gardens and berrying grounds – 25 kg/ha, sunflower – 40, buckwheat – 90, winter rape – 80, spring rape – 100. It was planned 130 kg of honey per year for one bee family.

Zhytomyr Polissya is an area of intensive agricultural production. Over the past thirty years, the structure of crops, of the main entomophilous crops, in particular, has changed significantly. The area under *Helianthus annuus* grew 900 times, under *Brassica napus* – 6 times, under *Fagopyrum esculentum* – 2 times. The total area of these crops increased 10 times. But despite this, the natural habitats of honey plants now cover the vast majority of the total area – 91.2 %.

It was determined that the honey stock in the Polissya Zhytomyr region, which bees use, is 15807.8 thousand tons. Of these, 94 % belong to natural honey plants.

This honey stock can provide a full honey flow for 121.6 thousand bee families. At present, there are 80.3 thousand bee colonies in this region with a honey production of 41.7 kg. The obtained results prove that natural honey plants play a key role in the beekeeping of the Polissya Zhytomyr region. With the rational use of them, you can increase the number of bee families and increase their productivity. Due to the high proportion of nectar of natural honey plants in this region, one of the factors (cultivating single crops) is leveled out, which leads to the death of bees.

Keywords: honey plants, melliferous lands.



Svitlana Los, Vladislava Shugina, Tetyana Ryzhenko

Ukrainian Research Institute of Forestry and Forest Melioration named after G.M. Vysotsky, Kharkiv, Ukraine; E-mail.: <u>mailto:svitlana_los@ukr.net</u>

One of the most important characteristics of Persian walnut (*Juglans regia* L.) cultivars is the peculiarities of reproductive development. When creating walnut orchards, it is advisable to select the cultivars so that the female flowers blossoming of some of them coincide with the time of pollen flight for others. It is believed that protogenic walnut trees are more productive.

The research aimed to determine the peculiarities of reproductive development of precocious Persian walnut cultivars obtained by Leonid Shugin.

Phenological observations of 27 cultivars were carried out every 7–10 days from May to September 2020 and 2021. The studied cultivars are precocious and are represented by hybrids of several generations from crosses of Uzbek precocious Kalmykov's cultivars with local frost-resistant precocious forms and Kocherzhenko's precocious cultivars, as well as with Sadko's lateral fast-growing ones. Reproductive development of female (\bigcirc), male (\bigcirc) and bisexual ($\bigcirc \bigcirc$) inflorescences was assessed on a 5-point scale. The type of dichogamy and the presence of secondary flowering were determined.

The analysis of the obtained data showed that half of the examined cultivars (54 %) are protogenic, a third (32 %) are homogamous and only 14 % are protandric. Despite the significant differences in weather conditions in 2020 and 2021, the beginning of flowering of both O and O inflorescences in most cultivars was fixed in the late first decade of May. At the same time, flowering in cooler conditions in 2021 was several days longer. One week after the end of the first flowering, the appearance of secondary inflorescences was noted in some cultivars. Both years in a row, the beginning of secondary flowering occurred in the late third decade of May. The number of trees with secondary male flowering was slightly higher than with the female one. Secondary flowering was noted for 70.3 % of observed cultivars.

10 cultivars are forming secondary bisexual inflorescences (female flowers at the base, male flowers at the top, and bisexual flowers in the middle part of the inflorescence), in particular the 'Sadko', 'Bomba', 'Bagryany', 'Petliura', 'Turnyk', 'Shukhevych' cultivars. Three cultivars form a significant number of such inflorescences throughout the summer, even in early September. Some researchers consider such manifestations to be developmental abnormalities. On some trees, secondary inflorescences are observed annually, and on others – only as an episodic phenomenon. Our research shows that each cultivar is characterized by the formation of certain types of inflorescences in certain periods of vegetation, but the intensity of their formation varies in different years.

Secondary inflorescences are formed on shoot tops from axils buds. We can assume that these buds are not dipped dormant until the spring of next year, as is the case with classic cultivars, and continue to develop, forming shoots with inflorescences. Their number to a certain extent depends on the number of ovaries formed from the first flowering. When the number of ovaries is small, secondary flowering is more abundant. Probably the secondary flowering is a kind of adaptive mechanism that promotes the formation of fruit yields in adverse conditions of the growing season.

Thus secondary flowering is a fairly common phenomenon among the Shugin's walnut cultivars. Features of their reproductive biology, in particular the phenomena of secondary flowering and precocious, require more detailed study and application in further breeding.

Keywords: phenology, dichogamy, secondary flowering, precocious.



Oleksandr Lukash

T. Shevchenko National University "Chernihiv Collegium", Chernihiv, Ukraine; E-mail.: <u>lukash2011@ukr.net</u>

Prunus mahaleb L. (mahaleb cherry) produces highly pigmented small-stone fruits that have an astringent and sour taste. Mahaleb fruits have a high content in anthocyanins. According to C. Gerardi et al. (2015), the concentrated extract has a high content of anthocyanins, flavonols, and coumarin and a strong antioxidant capacity. Mahaleb seed and its powder are fragrant and have a taste comparable to bitter almonds with cherry notes. They are used in small quantities to sharpen sweet foods in Turkey, Armenia, and Greece. Moreover, mahaleb fruit is used in liqueur, wine, and vinegar production in the food industry. So the *Prunus mahaleb* fruits are the perspective of a new natural colorant and as an ingredient in the formulation of functional foods.

The most remote locality outside the *Prunus mahaleb* natural range is in Polissya (the city of Chernihiv, Ukraine). According to I. Popescu & G. Caudullo (2016) the natural range of the *Prunus mahaleb* covers Central and Southern Europe, extending to Spain, and through Gibraltar to the tip of Northwest Africa, from the Balkans eastwards to Ukraine, Western and Central Asia. It can be found from the lowlands to above 1 000 m elevations in the South Carpathians, Caucasus, and Tien Shan Mountains (Central Asia). It has been introduced and is considered potentially invasive in South America, introduced, naturalized, and invasive in North America, as well as Australia, and New Zealand. The mahaleb cherry is a thermophile and pioneer species, growing on warm, sunlit, and dry slopes at middle elevations. It tolerates the Mediterranean and temperate dry climates with annual precipitation of 500-600 mm. It is not sensitive to frost. It grows better on calcareous soils with pH 5.5, in stony and rocky sites. This species thrives in open woods, at the margins of temperate oak forests, and also in bluffs and riverbanks.

The South-East slope of the Boldin hills (the Desna river pine-forest terrace) is occupied by the *Prunus mahaleb* communities. The general area of the communities is about 1,5 ha. The age of the *Prunus mahaleb* trees is over 50 years. They have a height of up to 5 m, flowering, fruiting. The fruit production is controlled and proximal flowers (first to open) have advantages in maternal resource capture; the first fruits to develop have an advantage over the later developing fruits. *Prunus mahaleb* formed the shrub layer (the projective cover is up to 20 %). It creates a community together with other thermophile species such as *Crataegus fallacina* Klokov *Euphorbia cyparissias* L., *Elytrigia intermedia* (Host) Nevski, *Stipa capillata* L., *Hylotelephium polonicum* (Błocki) Holub., etc.

Prunus mahaleb is slightly shading tolerant only at young stages; when mature it is a high light-demanding species. The juvenile individuals are often under adult plants in the Polissya habitate.

An aromatic spice is produced, having a taste similar to almond seeds. This spice was used for centuries in the Middle East and North Africa to flavour bread, cakes, cheese, cookies, etc. It is possible to experience the use of spices in the confectionery and food industry in the Polissya region.

Known for its strong roots, the Chernihiv mahaleb can be used in horticulture as a frostresistant rootstock for *Prunus avium* and *Prunus cerasus* that are resistant to Polissya climate. This species has an important ecological role. An increase in the areas of slopes that will be planted by the plant will prevent the erosion processes of the Boldin hills and other slopes in Chernihiv city.

Keywords: Prunus mahaleb, fruits, Polissya, plant communities.

STUDY OF LEAF SURFACE BY SCANNING ELECTRON MICROSCOPY

Igor Maltsov, Ivan Gurnenko, Myroslava Marynyuk

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>maltsov@yandex.ru</u>

The micro-morphology of the leaf surface is valuable for the study of leaf development and functions. Scanning electron microscopy is an ideal technique for the investigation of plant surfaces including leaf surfaces. Sample preparation with dehydration is still an important aspect of the microscope study. This study represented many-years development of the methodology of leaf surface study.

Investigations were conducted in the Tropical and Subtropical plants Department of the M.M. Gryshko National Botanical Garden of the NAS of Ukraine. Leaves of the middle formation were collected and material took from the central part of the lamina. Contaminated material processed with solution HCl (1N) during 10–25 seconds, after that was used ultrasound during 30–60 seconds. The fixation of the leaf surface was conducted in a 4 % solution of glutaraldehyde. The dehydration of plant tissues for scanning electron microscopy poses distinctive challenges. Many methods can be employed to overcome difficulties arising from plant tissue characteristics, but none of them are universal. Washing of material carried out with buffer solutions (I-III) (pH=7) three times 15 minutes (every buffer). Next, was conducted the dehydration of material with the use of mixtures of tert-butanol with concentration increasing: mixture I – 1 hour (20 %), mixture II – 1.5 hours (35 %), mixture III – 2 hours (60 %), mixture IV – 1 hour (75 %), mixture V – 1.5 hours (100 %), mixture VI – left tonight (100 %), mixture VII – 2 hours (100 %).

After the dehydration procedure, the material in a solution of tert-butanol 100 % was put in aluminum bottles with 1 ml volume and frozen on a copper plate on the freezing camera at - 6 °C during 15–20 min. For the drying procedure, the material carried over on pre-chilled to - 5°C ceramic. The working volume pumped out with a regime of pre-vacuum till 3.99 Pa (3*10–2 mm Hg). Dried samples were glued on metal tables and were used carbon spraying in the regime of the thermal evaporation and rotation of vacuum universal post VUP-5M (SELMI, Ukraine). For obtaining quality photos we recommend spraying samples with platinum in the regime of ion-plasma mode.

The examination and result documentation of obtained material were conducted with the use of a scanning microscope JSM-6700F (JEOL, Tokyo, Japan).

Despite the fact that it does not exist the universal method for plant tissue processing for scanning electron microscopy, this study can be used as a method of study of the leaf surface. Furthermore, this algorithm was successfully used in the study of different plant species.

Keywords: leaf surface, scanning microscopy.



RELATIONSHIP OF PRODUCTIVITY OF ZEA MAYS L. HYBRIDS WITH ACTIVITY OF NUCLEIC ACID SYNTHESIS

Afet Mammadova

Institute of Genetic Resources of the National Scientific Academy of Azerbaijan, Baku, Azerbaijan; E-mail.: <u>afet.m@mail.ru</u>

The problem of productivity is closely related to the phenomenon of hybrid strength, which manifests itself in an increase in the degree of development of individual traits, and, perhaps, never directly affects the organization as a whole.

The effect of heterosis seems to be based on the activation of a gene or a complex of genes and belongs to the category of phenomena directly or indirectly related to the mechanisms of genetic regulation of the development of traits in ontogenesis.

The greatest effect in the study of heterosis has been achieved in maize. Power, yield, and most of the economically important traits of corn are quantitative in nature and are controlled by a large number of genes.

High-yield maize hybrids and their parental varieties were selected as the object of research. The total content of nucleic acids in plant material was determined by the spectrometric method; the method of stepwise fractional extraction was used to isolate DNA fractions.

The study of the content of nucleic acids in corn leaves showed the activation of DNA and RNA synthesis in high-yielding hybrids in comparison with parents. For example, analysis of the data in the study of the Bi 73 x MK 22 hybrid showed the activation of both types of nucleic acids: the DNA content was at the level of the best parental form in this indicator, the RNA content was 24.75 higher than the average of both parents. In hybrid GB 2501 x MK 22, the total DNA content was 15.2 % higher than the average indicator of the initial forms, RNA – by 47 %.

The structural state and functional activity of the DNA of the cell nucleus is heterogeneous. Part of it is in a labile state in the composition of dispersed chromatin – euchromatin and is functionally more active. Most of the DNA is tightly bound to histones and is a component of less active chromatin. An insignificant part of DNA is bound in chromatin due to packing in structures containing, in addition to proteins, RNA, and lipids.

Determination of the fractional composition of DNA showed a significant difference between hybrids and parents in the functional state of DNA. In the studied productive maize hybrids GB 2501 x MK 22, MK 22 x OK 18, Bi 73 x OK 18, Bi 73 x MK 22, an increase in total DNA was accompanied by activation of labile DNA. For example, the amount of labile DNA in the GB 2501 x MK 22 hybrid increased by 7.3% in comparison with the average indicator of the parental forms. In the maize hybrid MK 22 x OK 18, the amount of the labile DNA fraction was 7.5 mg%, in the maternal form – 7.2, and the paternal form – 5.8 mg. Labile chromatin (chromatin containing labile DNA) is associated mainly with metabolic processes occurring in growing cells or differentiated cells with active physiological function. The factors that stimulate growth and metabolic processes in the body contribute to chromatin labilization.

Thus, in our studies, heterotic maize hybrids exceeded the parental forms in the activity of nucleic acid synthesis. An increase in the total DNA content in hybrids is accompanied by the activation of the synthesis of the labile DNA fraction. The activation of the synthesis of nucleic acids in productive hybrids in comparison with the parental forms indicates an increase in the physiological lability and functional activity of the genetic apparatus. Studying the activity of nucleic acid synthesis makes it possible to identify high-yielding maize hybrids at the early stages of ontogenesis.

Keywords: Zea mays, yield, nucleic acids.



Nadiia Matvieieva¹, Hanna Shutava², Ljudmila Tychinskaya³, Eugenij Skakovsky³

¹Institute of Cell Biology and Genetic Engineering of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; Email: <u>joyna56@gmail.com</u>

² Central Botanical Garden of the National Academy of Sciences of Belarus, Minsk, Belarus ³Institute of Physical Organic Chemistry of the National Academy of Sciences of Belarus, Minsk, Belarus

Agrobacterium rhizogenes-mediated transformation is a well-known method for plant genetic transformation. After plant parts (leaves, stems, cotyledons, etc.) cocultivation with soil bacteria "hairy" roots growth can be initiated. These roots are of practical interest because of the synthesis of different compounds including the chemicals which can be used in medicine. Polyphenols, sugars, amino acids, essential oils can be synthesized in the cells of "hairy" roots. The level of the accumulation of the compounds in root clones can differ because of the effect of the site of incorporation of bacterial genes (*rol* genes) in the plant genome (independent transformational events).

In the case of "hairy" roots using for the creation of pharmaceuticals, it is important to maximize the identification of all groups of biologically active compounds that can be extracted during extraction. These metabolites include amino acids, which have a number of valuable pharmaceutical properties. However, there is no information about their accumulation in chicory "hairy" roots. In this work, we compared the content of amino acids in two "hairy" root clones cultivated *in vitro*.

"Hairy" roots of *Cichorium intybus* L. were grown under standard conditions on solidified Murashige and Skoog nutrient medium supplemented with 20g/L sucrose, collected, lyophilized, and crushed. The content of amino acids was studied by Nuclear magnetic resonance spectroscopy. To prepare the extracts, 0.07 g of each of the samples was added to 10 ml glass containers and 2 ml of deuterated water (D₂O, degree of deuteration – 99.8 %) was added. Samples in closed containers were kept at room temperature with periodic stirring for 24 hours. Then the extracts were filtered and made into ampoules for the subsequent recording of NMR spectra. The spectra on 1H and 13C nuclei were recorded on an AVANCE-500 NMR spectrometer (Bruker, Germany) with operating frequencies of 500 and 125 MHz for 1H and 13C nuclei, respectively, at a temperature of 293 K.

Differences in the content of the amino acid of root clones No1 and No2 were found (5.83 and 8.84 %, respectively). Glutamine, Asparagine, Alanine and Arginine HCl and Threonine content was greater in the root clone No2 compared clone No1 (1.59 and 0.55 %; 2.68 and 1.78 %; 0.2 and 0.08 %; 3.45 and 2.72 %; 0.21 and 0.09 %, respectively). At the same time, there were no differences in the content of Isoleucine, Valine, Leucine, Lysine didn't differ in studied root clones.

So, differences in the content of the amino acids were found in two Chicory "hairy" root lines. These differences can be explained by the effect of the position of bacterial genes transferred in the plant genome after the *Agrobacterium*-mediated transformation.

Keywords: *Cichorium intybus*, "hairy" roots, *Agrobacterium rhizogenes*-mediated transformation, amino acids.

Acknowledgments

The work was partially supported by a grant N $^{\circ}$ II-2-21 of the National Academy of Sciences of Ukraine and N $^{\circ}$ B21-UKRG-005 of BRFFR.



INVESTIGATION OF POLYPHENOL EXTRACT COMPOSITION OF GREAT BURNET (SANGUISORBA OFFICINALIS L.) FROM THE CARPATHIAN RESERVE FOR CREATION PHYTOPOLYMER COATING

Anastasiia Mysholov, Olena Konovalova, Irina Hurtovenko, Oleg Gudzenko, Nataliia Hudzenko

Private Higher Educational Establishment "Kyiv Medical University", Department of Pharmaceutical and Biological Chemistry, Pharmacognosy; Kyiv, Ukraine; E-mail.: <u>a.mysholov.st@kmu.edu.ua</u>

Nowadays the development of medicinal phytopolymer coatings of "phytocoating" targeted action is a promising direction. From this point of view, the development of phytopolymer coating with biologically active plant substance based on extract Great Burnet is of scientific and practical interest.

This work aimed to analyze the qualitative and quantitative composition of polyphenol compounds extracted from Great Burnet and their application in the creation of phytocoating.

The object of research: roots and rhizomes of Great Burnet (*Sanguisorbae radix* et *rhizoma*), collected in the Carpathian Reserve in autumn 2018.

Identification of polyphenol compounds was carried out by chemical reactions, in particular, flavonoids – by Bryant cyanidin reaction and detection of phenolic hydroxyl by reaction with FeCl₃; tanning agents – were detected by reaction with ammonium iron sulfate. The phytopolymer coating was synthesized from polyethers and isocyanates in two stages.

The high-performance liquid chromatography (HPLC) method was used to determine the content of flavonoids and catechins on Agilent Technologies 1200 liquid chromatography. Acetonitrile (A) and 0.1 % water solution of formic acid (B) were used as the mobile phase for flavonoids. Separation was carried out on the chromatographic column Zorbax SB-C18 (3.5μ m, 150 x 4.6 mm) (Agilent Technologies, USA), the flow rate through column 0.25 ml/min temperature of thermostat 30 C, the volume of injection 4 μ l. The detection was carried out using a diode-matrix detector with a signal recording at 280 nm and a fixed absorption spectrum at 210–700 nm. Methanol (A) and 0.1 % water solution of formic acid (B) was used as the mobile phase for catechins. The detection was carried out using a diode-matrix detector with a signal recording at 210–700 nm. The quantitative content of the material under investigation was found to be dominated by neogesperydin (112.17 mg/100 g), rutin (83.55 mg/100 g), and pyrotechquine (87.46 mg/100 g).

The extract of the Great Burnet was used as the carrier of medicinal substances for filling in the synthesis of the phytopolymer coating. The hemostatic effect on the blood of the white rats was investigated. The research was done with a microscope and a stopwatch. Blood coagulation was observed after some time caused by phenol compounds released from phytocoating.

Thus, the qualitative composition and quantitative content of flavonoids and catechins have been investigated by the HPLC method. The predominant content of neogesperydin, rutin, and pyrotechyn was established. The synthesized phytopolymer coating with the filling based on Great Burnet extract allows suggesting that such coatings with hemostatic action will have an important place in medicine. The obtained results testify to the perspectives of further investigation of the hemostatic effect of the obtained "phytocoating" with extract of *Sanguisorba officinalis*.

Keywords: *Sanguisorba officinalis,* flavonoids, high-performance liquid chromatography, hemostatic effect, phytopolymer coating.

IN VITRO HEMOLYSIS ASSESSMENT OF THYME ESSENTIAL OIL AND ITS PROTECTIVE EFFECT ON OXIDATIVE DAMAGE OF HUMAN ERYTHROCYTES

Maryna Opryshko¹, Myroslava Maryniuk¹, Oleksandr Gyrenko¹, Lyudmyla Buyun¹, Halyna Tkachenko², Natalia Kurhaluk²

¹M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine; E-mail.: <u>maryna.opryshko@meta.ua</u>

²Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland

As the hemolytic activity of any compounds is considered as an indicator of general cytotoxicity toward normal healthy cells, the main objective of this study was to evaluate the dose-dependent hemolytic/antihemolytic potential of thymus essential oil (TEO) using a human erythrocyte model.

The venous blood (10–20 ml) was obtained from normal volunteers *via* venipuncture (7 females aged 23–36-years old). The Research Ethics Committee of the Regional Medical Commission in Gdańsk (Poland) approved the study (KB-31/18). Human erythrocytes from citrated blood were isolated by centrifugation at 3,000 rpm for 10 min and washed two times with 4 mM phosphate buffer (pH 7.4) and then re-suspended using the same buffer to the desired hematocrit level. The blood sample was incubated with TEO (Etja, Elbląg, Poland), respectively (final concentrations were 20 and 10 μ g/mL) for 15 min at 25 °C. Samples were removed at 20 min of storage for analysis. The untreated erythrocyte samples were used as the control sample. The osmotic-induced hemolysis of erythrocytes was measured spectrophotometrically with different 0.1–0.9 % NaCl solutions. The assay is based on the measuring of the percent of erythrocytes disintegration into hemolytic reagent action (0.1–0.9 % NaCl). The absorbance was read at 540 nm. The disintegration of erythrocytes (%) at different NaCl solutions was expressed as a curve.

It was observed that, TEO in final concentration 20 µg/mL caused a significant increase of hemolysis in the samples with 0.9–0.5 % NaCl solutions: 13.3 % vs. 4.1 % (0.9 % NaCl), 15.4 % vs. 4.3 % (0.8 % NaCl), 16.7 % vs. 5.6 % (0.7 % NaCl), 17.8 % vs. 5.7 % (0.6 % NaCl), and 58 % vs. 18.2 % (0.5 % NaCl). The increase of hemolysis was 3.3-fold (0.9 % NaCl), 3.6-fold (0.8 % NaCl), 3-fold (0.7 % NaCl), 3.1-fold (0.6 % NaCl), 3.2-fold (0.5 % NaCl), respectively. On the contrary, after incubation in solutions of 0.4-0.1 % NaCl, adding of TEO to the human erythrocytes caused the decrease of hemolysis (by 14.9 %, 10.5 %, 7.1 %, and 4.7 %, respectively). Treatment of the human erythrocytes by TEA in final concentration 10 µg/mL caused a statistically significant increase of hemolysis in the samples with 0.9-0.6 % NaCl solutions: 5.8 % vs. 1.2 % (0.9 % NaCl), 6.9 % vs. 1.2 % (0.8 % NaCl), 9.3 % vs. 1.5 % (0.7 % NaCl), and 13.3 % vs. 2 % (0.6 % NaCl). The increase of hemolysis was 4.8-fold (0.9 % NaCl), 5.6-fold (0.8 % NaCl), 6.4-fold (0.7 % NaCl), and 6.8-fold (0.6 % NaCl), respectively. In the sample with 0.5–0.1 % NaCl, a difference between the percentage of hemolysis in samples after adding TEO to the erythrocytes suspension compared to the untreated samples was nonsignificant (decrease of hemolysis by 2.5 %, 3.3 %, 2.9 %, and 0.1 %). In the sample with 0.5-0.1 % NaCl, TEO added to human erythrocyte suspension in final concentration of 10 µg/mL exhibited anti-hemolytic activity. Thus, TEO screened in this study possessed good antihemolytic activities using the human erythrocytes model. The interest in the formulation of pharmaceuticals, nutraceuticals, and cosmeceuticals based on thymol is due to several studies that have evaluated the potential therapeutic uses of this compound for the treatment of disorders affecting the respiratory, nervous, and cardiovascular systems. Moreover, this compound also exhibits antimicrobial, antioxidant, anti-carcinogenesis, anti-inflammatory, and antispasmodic activities, as well as a potential as a growth enhancer and immunomodulator.

Keywords: hemolysis, erythrocytes, thymus essential oil, antioxidants.



ANTIMICROBIAL ACTIVITIES OF THREE ESSENTIAL OILS DERIVED FROM GYMNOSPERM TREE SPECIES AGAINST *STAPHYLOCOCCUS AUREUS* STRAIN

Maryna Opryshko¹, Myroslava Maryniuk¹, Oleksandr Gyrenko¹, Halyna Tkachenko², Natalia Kurhaluk², Lyudmyla Buyun¹

¹M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine; E-mail.: <u>maryna.opryshko@meta.ua</u>

²Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland

Essential oils obtained from conifer needles and bark have been widely used for treating a wide range of disorders, including neuralgia, infectious, rheumatic, and some aging-related chronic diseases. In the present research, the antibacterial properties of commercial essential oils (fir oils and cedar oil) derived from three conifer tree species, namely Silver fir (*Abies alba* Mill.), Siberian fir (*Abies sibirica* Ledeb.) (*Pinaceae* family, *Abietoideae*), and Virginia cedarwood (*Juniperus virginiana* L.) (*Cupressaceae* family) against *Staphylococcus aureus* strain have been evaluated. The name of gymnosperm plant species are given by Integrated Taxonomic Information System (ITIS).

Essential oils were provided by a Polish essential oils manufacturer (Etja, Elbląg, Poland). The investigated samples did not contain additives or solvents and were confirmed to be natural by the manufacturers. The samples were stored in resalable vials at 5 °C in the dark but were allowed to adjust to room temperature before investigation. Geographical origins were excluded as information was mostly not available. For this study, the *Staphylococcus aureus* subsp. *aureus* Rosenbach (ATCC®25923TM) (mecA negative) strain was used. Cultures were grown aerobically for 24 h at 37 °C. The cultures were later diluted with a sterile solution of 0.9 % normal saline to approximate the density of 0.5 McFarland standard. Muller-Hinton agar plates were inoculated with 200 µl of standardized inoculum (10⁸ CFU/mL) of the bacterium and spread with sterile swabs. Sterile filter paper discs impregnated by sample were applied over each of the culture plates, 15 min after bacteria suspension was placed. The antimicrobial susceptibility testing was done on Muller-Hinton agar by the disc diffusion method (Kirby-Bauer disk diffusion susceptibility test protocol). The diameters of the inhibition zones were measured in millimeters. Each test was repeated six times.

Our study demonstrated that the fir oil derived from Silver fir *Abies alba* showed considerably more activity than the cedar oil and fir oil derived from Siberian fir *Abies sibirica*. Maximum antibacterial activity was shown by essential oil of silver fir with the inhibition zone diameter (27.0 ±1.8) mm, compared to the cedar oil with the inhibition zone size (16.9 ±1.5) mm, while Siberian fir essential oil showed less activity with (16.5 ±0.9) mm of clear inhibition zone against *S. aureus* strain.

In summary, this study provides insight into the *in vitro* antibacterial activity of a wide variety of essential oils derived from many different plant genera against the *Staphylococcus aureus* strain. The data contributes to the ongoing scientific investigation regarding the application of essential oils as natural antibacterial agents. After benchmarking essential oils from plants belonging to the subfamily *Abietoideae*, Silver fir essential oil is identified as a promising candidate concerning possible applicability in the prevention of bacterial growth. Further, the chemical compositions of essential oil, derived from Silver fir *A. alba* (Silver fir) should be studied by gas chromatography-mass spectrometry (GC–MS).

Keywords: *Abies alba, Abies sibirica, Staphylococcus aureus,* Kirby-Bauer disk diffusion susceptibility test.

Acknowledgments

We are grateful to The Visegrad Fund for supporting our study.



EVALUATION OF THE DOSE-DEPENDENT EFFECTS OF TEA TREE OIL ON THE HEMOLYSIS OF HUMAN ERYTHROCYTES

Maryna Opryshko¹, Myroslava Maryniuk¹, Oleksandr Gyrenko¹, Halyna Tkachenko², Natalia Kurhaluk², Lyudmyla Buyun¹

¹M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine; E-mail.: <u>maryna.opryshko@meta.ua</u> ²Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland

Plant-derived alternative medicines such as tea tree (*Melaleuca alternifolia* (Maiden & Betche) Cheel, Myrtaceae) oil have become increasingly popular in recent decades. Therefore, the objectives of this study were to evaluate and compare the effects and three doses (final concentrations were 20 and 10 μ g/mL) of tea tree oil (TTO) on the hemolysis parameters of human erythrocytes, as the step towards possible application as the anti-hemolytic agent.

The venous blood (10–20 ml) was obtained from normal volunteers *via* venipuncture. The Research Ethics Committee of the Regional Medical Commission in Gdańsk (Poland) approved the study (KB-31/18). The blood sample was incubated with TTA, respectively (final concentrations were 20 and 10 μ g/mL) at 25 °C for 15 min. The osmotic-induced hemolysis of erythrocytes was measured spectrophotometrically with different 0.1–0.9 % NaCl solutions (Mariańska et al., 2013). The assay is based on the measuring of the percent of erythrocytes disintegration into hemolytic reagent action (0.1–0.9 % NaCl). The assay mixture contained 2.5 mL of NaCl solutions and 0.05 mL of 1 % erythrocyte suspension. The absorbance was read at 540 nm. The disintegration of erythrocytes (%) at different NaCl solutions was expressed as a curve.

Treatment of the human erythrocytes by TTA in final concentration 20 µg/mL caused a statistically significant increase of hemolysis in the samples with 0.9–0.5 % NaCl solutions: 20.2 % vs. 4.1 % (0.9 % NaCl), 26.4 % vs. 4.3 % (0.8 % NaCl), 27.5 % vs. 5.6 % (0.7 % NaCl), 32.9 % vs. 5.7 % (0.6 % NaCl), and 36.8 % vs. 18.2 % (0.5 % NaCl). The increase of hemolysis was 4.9fold (0.9 % NaCl), 6.1-fold (0.8 % NaCl), 4.9-fold (0.7 % NaCl), 5.8-fold (0.6 % NaCl), 2-fold (0.5 % NaCl), respectively. In the sample with 0.4–0.1 % NaCl, a difference between the percentage of hemolysis in samples after adding TTO to the erythrocytes compared to the untreated samples was non-significant (83.7 %, 88.1 %, 91.9 %, and 94.6 % vs. 98.4 %, 98.5 %, 99 %, and 99.3 %). In the sample with 0.4–0.1 % NaCl, TTO in final concentration 20 µg/mL exhibited antihemolytic activity after the treatment of human erythrocytes. TTO in final concentration 10 µg/mL caused a significant increase of hemolysis in the samples with 0.9–0.5 % NaCl solutions: 8.3 % vs. 1.23 % (0.9 % NaCl), 12.6 % vs. 1.23 % (0.8 % NaCl), 16.6 % vs. 1.5 % (0.7 % NaCl), 20.9 % vs. 1.97 % (0.6 % NaCl), and 24.2 % vs. 22.7 % (0.5 % NaCl). The increase of hemolysis was 6.7-fold (0.9 % NaCl), 10.2-fold (0.8 % NaCl), 11.3-fold (0.7 % NaCl), 10.7-fold (0.6 % NaCl), 1.1-fold (0.5 % NaCl), respectively. After incubation in solutions of 0.4-0.1 % NaCl, adding of TTO to the human erythrocytes caused the decrease of hemolysis (by 1.2 %, 4.3 %, 3.9 %, and 1.6 %, respectively).

Thus, based on the results from the hemolysis assay, it followed that TTO could affect the human erythrocytes hemolysis in a dose-dependent manner. In particular, TTO seems to be well tolerated by human erythrocytes down to a concentration of 5 μ g/mL; higher quantities of this TTO determined increasing impairment in a concentration-dependent manner as shown by the results of the erythrogram models. This trend strengthens the necessity to test the toxic effects of exogenous compounds directly on the erythrocytes when the aim is to use them in the biological membrane model. The overall findings regarding the effects of the essential oil derived from *M. alternifolia* are similar to the ones reported for human monocytes and polymorphonuclear neutrophils.

Keywords: hemolysis, erythrocytes, tea tree essential oil, antioxidants.

ANTIBACTERIAL ACTIVITY OF ETHANOLIC EXTRACTS FROM AGLAONEMA COMMUTATUM SCHOTT AND ITS CULTIVARS AGAINST ENTEROCOCCUS FAECALIS

Maryna Opryshko¹, Halyna Tkachenko², Lyudmyla Buyun¹, Natalia Kurhaluk², Myroslava Maryniuk¹, Oleksandr Gyrenko¹

¹M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine; E-mail.: <u>maryna.opryshko@meta.ua</u>

²Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland

Aglaonema Schott (Araceae Juss.) is one of the most beautiful foliage plants, as are many members of these monocotyledonous flowering plants in which flowers are borne on a type of inflorescence called a spadix. Aglaonema includes many cultivars that are important ornamental plants due to their tolerance to drought and low light and low relative humidity levels encountered under interior conditions. Aglaonema plants have been widely used in recent years because of their anti-aging and longevity properties, natural anti-allergic and anti-inflammatory properties. The current study aimed to evaluate the antibacterial activity of ethanolic extracts obtained from leaves of Aglaonema commutatum Schott and its cultivars (Malay Beauty, Silver Queen, and Silver King), cultivated under glasshouse conditions at M.M. Gryshko National Botanic Garden (NBG), National Academy of Science of Ukraine against *Enterococcus faecalis* (Andrewes and Horder) Schleifer and Kilpper-Balz ATCC

The leaves of *A. commutatum* and its cultivars, cultivated under glasshouse conditions, were sampled at M.M. Gryshko National Botanic Garden (NBG), National Academy of Science of Ukraine. Freshly sampled leaves were washed, weighed, and homogenized in 96 % ethanol (in proportion 1:19) at room temperature. The extracts were then filtered and investigated for their antimicrobial activity. The testing of the antibacterial activity of the plant extracts was carried out *in vitro* by the Kirby-Bauer disc diffusion technique. The susceptibility of the test organisms to the plant extracts was indicated by a clear zone of inhibition around the holes containing the plant extracts and the diameter of the clear zone was taken as an indicator of susceptibility. The following criteria for interpretation of inhibition zone diameter were used to assign susceptibility or resistance of bacteria to the phytochemicals tested: Susceptible (S) \geq 15 mm, Intermediate (I) = 10–15 mm, and Resistant (R) \leq 10 mm.

The ability of the selected ethanolic plant extracts obtained from leaves of *A. commutatum* and its cultivars to inhibit *E. faecalis* growth was determined in this study. The results revealed that four extracts exert antibacterial activity against this microorganism. However, the extracts from variety *A. commutatum* and cultivar *A. commutatum* 'Silver Queen' exhibited higher inhibitory activity than the extracts from cultivars Melay Beauty and Silver King. Maximum *in vitro* inhibition was scored by 'Silver Queen', followed by variety *A. commutatum*, cultivars Malay Beauty, and Silver King, which presented inhibition zones of (14.52 ± 1.07) mm, (14.34 ± 0.98) mm, (13.71 ± 1.10) mm, and (13.29 ± 1.16) mm, respectively. In the case of the positive controls, 96 % ethanol possesses a mild anti-*C. freundii* effect, which presented inhibition zones of (9.15 ± 0.99) mm. In conclusion, the ethanolic extracts obtained from the leaves of *Aglaonema commutatum* and its cultivars (Malay Beauty, Silver Queen, and Silver King) has the potential for use as natural antimicrobial agents. Further *in vivo* and *in vitro* antimicrobial, phytochemical and toxicological studies are required to evaluate the chemotherapeutic effect of the plant.

Keywords: *Aglaonema commutatum*, leaves, ethanolic extract, antimicrobial activity, disk diffusion method.

Acknowledgments

We are grateful to The Visegrad Fund for supporting our study.

VOLATILE COMPOUNDS OF THE SECONDARY METABOLISM OF MEMBERS OF THE FAMILY ASTERACEAE BERCHT. & J. PRESL

Olena Palamarchuk¹, Nadiya Dzhurenko¹, Oksana Sokol¹, Alina Butko²

¹M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>pastinacase@gmail.com</u> ²O O. Bogomolets National Medical University, Kyiv, Ukraine

²O.O. Bogomolets National Medical University, Kyiv, Ukraine

The last decades are characterized by a clear tendency of widespread use in the medical practice of natural active substances (NAS), the advantage of which is low toxicity, milder action, and a wide range of pharmacological activity. Modern research has proven the high efficiency of an important and sometimes predominant source of raw materials – plants from the arsenal of folk and traditional medicine, which determine the value of species for pharmacy and medical practice. The rational ratio and composition of NAS components, similar to bioactive compounds of the body or products of its vital activity (metabolites), provide a harmonious relationship and interdependence of physiological and biochemical processes, which determine the diversity and widespread use of plants. A special group is represented by organic substances volatile organic compounds (VOC) – a wide class of natural metabolites that perform important biological and biochemical functions in livingorganisms, the relevance of the study of which has significantly increased in recent years.

This work aimed to study the specific biochemical characteristics of the VOC composition of the underground part of the introduced species of the Asteraceae Bercht &J.Preslfamily of the genetic collection of the M.M. Gryshko National Botanical Garden of the NAS of Ukraine and to assess the potential of bioactive ingredients. They preferred large burdock (*Arctium lappa* L.), common chicory (*Cichorium intybus* L), medicinal dandelion (*Taraxacum officinale* Wigg), spread grindelia (*Grindelia squarrosa* (Pursh) Dun), and common Georgina roots (*Dahlia single* L). VOC was obtained by a modified method of hydrodistillation, followed by gas chromatography-mass spectrometric analysis (GC-MS) of their component composition, the quantitative content of which was calculated by the normalization method.

The VOC of the roots of the species under study refers to alcohols, aldehydes, saturated and unsaturated hydrocarbons, esters, etc (%). Chicory has 40 VOCs, 31 were identified. Ethyl palmitate (25.43) and ethyl linoleate (48.15) dominate. Borneol, bornyl acetate, cadinene alcohol, tetradecane, ethyltetradecanoate are characteristic of this species. For burdock, out of 45 substances, 40 were identified, the main of which are 1,11,15-heptadecatriene (25.34), 1,11,13heptadecatetraene (108.93), hexanol (49.31). Ethyl palmitate, cis-, trans-2, 4-decadienal, pentadecene-1, paracymene-8-ol, furfural were found to be a marker. Dandelion was identified of 47 substances. Heptadecene, ethylphenyl acetate were found to be specific VOCs. In dahlia tubers 55 VOCs. Major 1,3,5-tridecatriene-1-triine (37.13) were identified. Specific components no more than 1%. Grindelia had 76 VOCs (%), 31 with a predominance of alcohols (%): borneol (15.53), verbenol (8.22). Basic alkanes (28.35), terpenes (8.28) – germacrene B, characteristicmethylgrindelate. Special attention is paid to the presence of unsaturated carbon squalene - a powerful immunostimulant, the high level (%) of which is characteristic of the aerial part of dandelion (5.62), burdock (6.27), chicory (17.33), which determines their prospects for the creation of anticancer drugs. The specificity of the component composition of VOCs suggests the possibility of developing diagnostic features to determine the species of the considered plants under consideration, as well as using their raw material potential to create multifunctional medicinal products.

Keywords: Asteraceae spp., volatile organic compounds.



Nataliia Pavliuchenko, Olga Grygorieva, Svitlana Klymenko

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>npavliuch@gmail.com</u>

American persimmon (*Diospyros virginiana* L., Ebenaceae family) is a valuable fruit and ornamental plant. Under natural conditions persimmon is widespread in the eastern part of North America. *D. virginiana* is grown in Ukraine mainly in botanical gardens, but recently it has become increasingly popular as a food crop. American persimmon fruits are considered dietary and can be used both fresh and as jams, pastilles, syrups, beer, and other processed products. All parts of the plant contain biologically active substances that determine its medicinal properties. At the same time, these organic compounds can manifest themselves as allelopathic agents through accumulation in the root environment. The allelopathic factor is essential for the successful cultivation of plants. The work aimed to analyze the allelopathic properties of the root environment of *D. virginiana* plants of different ages.

The object of research was the root environment of *D. virginiana* from orchard plots of M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine. Plants were divided into the following age groups: a) young plants (2–4 years old); b) plants of the middle age (7–9 years old); c) the old plants (15–17 years old). Rhizosphere soil samples were collected at 0–30 cm layer. The fallow soil was used as a control. Allelopathic and biochemical analyzes of the root environment of *D. virginiana* were conducted in dynamics during the growing season. Allelopathic activity of the root environment was studied by the direct bioassay method. The redox potential (Eh) was measured in soil suspension modeling soil solution at the soil to distilled water ratio as 1:1 by potentiometric technique. Phenolic compounds were extracted from the soil by desorption method using an ion exchanger KU-2-8 (H⁺).

Allelopathic activity of the root environment fluctuated during the growing season, significantly increasing towards its end. The root environment of the old plants was characterized by the highest phytotoxicity.

The biochemical state of the root environment was assessed by redox potential values. Weakly oxidizing conditions in the control were detected. The Eh values of the root environment of *D. virginiana* were lower than the control. The redox status of the root environment varied from weak to highly reducing soil conditions during the growing season. The lowest soil Eh values for the old plants were observed.

The content of phenolic allelochemicals in the root environment of *D. virginiana* was higher than control. The accumulation of phenolic compounds in the root environment increased with the age of the plants.

Thus, the concentration of allelochemicals in the root environment of *D. virginiana* depended on the age of the plants. The soil phytotoxicity increased along with the duration of plant cultivation, which was caused by the disturbance of redox processes and the accumulation of phenolic allelochemicals.

Keywords: *Diospyros virginiana*, root environment, allelopathic activity, phenolic compounds, redox conditions.

Acknowledgments

The publication was prepared with the active participation of researchers in the International Network AgroBio*Net*, as a part of the international program "Agricultural Biodiversity to Improve Nutrition, Health and Quality of Life". This work was supported by grants Visegrad Fund and SAIA (Slovak Republic).



DEVELOPMENT OF BIOTECHNOLOGICAL METHOD OF *DELPHINIUM ELATUM* L. CULTIVATION

Romana Petrina, Diana Zahorodnia, Kateryna Kniazieva, Olha Shved, Vira Lubenets

Lviv Polytechnic National University, Lviv, Ukraine; E-mail.: <u>romanna.o.petrina@lpnu.ua</u>

Species that belong to the family *Delphinium* are interesting representatives of the plant kingdom that have a practical use. This is caused by the fact that they contain diterpene alkaloids, which show analgesic, anti-inflammatory, antimicrobial, anticancer, antiarrhythmic activity. Also, they contain phenolic compounds, which show antibacterial, antifungal, immune-stimulating, analgesic, antioxidant activity. *Delphinium elatum* L. contains diterpene alkaloids, that show cytotoxic activity against the cell lines of nasopharynx cancer, they are resistant to cell lines of lungs, prostate, and nasopharynx cancer. Information about *D. elatum*, which grows in Ukrainian Carpathians and is included in the Ukrainian Red Book, is limited, there are no publications about its composition and application.

The plant tissue culture method has advantages over classical harvesting of medicinal plants and growing plants in the field. The use of *in vitro* technology allows to regulate plant cells' growing and secondary metabolites accumulation by optimizing culture medium contain and cultivation conditions. Callus biomass produces an infinite amount and can be used as a raw material for medical purposes because it is ecologically clean. Moreover, it is not contaminated by chemicals, pesticides and herbicides.

We used for our experiment *D. elatum* seeds that had previously been soaked in water for 24 hours. The seeds were sterilized using 30 % hydrogen peroxide solution and 70% ethanol solution. Then it was rinsed three times with sterile distilled water. The seeds were introduced into the culture medium *in vitro* accommodation and sterile plants were obtained.

Leaves and stems of the plants were used as explants for callus genesis induction in the Murashige-Skuga culture medium with adding of phytohormones. 0.1-3.0 mg/l auxin – indole acetic acid (IAA), α -naphthyl-1-acetic acid (NAA) in various combination and 0.5 mg/l 6-aminopurine (kinetin) were used as phytohormones. The culture medium also contained 8–9 g/l agar, pHwas 5.7. Cultivation was performed with a photoperiod of 16/8 hours (light/dark), illumination 2000 Lux, temperature 26 ±2 °C, relative humidity 60–70 % for 50 days (2 passages). All experiments were performed in 3 replicates and the results were statistically processed. The influence of phytohormones and explant type on culture growth rate has been studied. The highest intensity of callus genesis was found in the case of leaf explants use and the culture medium with 1.0 mg/l NAA and 2.0 mg/l IAA as phytohormones.

All explants formed a callus. The obtained biomass was light yellow and had fluffy consistency. The best percentage of callus genesis was observed for leaves explants (84 %), then for steams explants (72 %). The frequency of callus genesis was determined as the ratio of the explants with callus number to the total explants number in percent every 3 weeks of cultivation.

The cultivation conditions *in vitro* of *D. elatum* were selected. The influence of concentration and phytohormones contain in culture medium on callus biomass growth rate was studied. The biotechnological method of biomass production was developed to preserve plant biodiversity. The ecologically clean raw material was obtained to identify its secondary metabolites.

Keywords: *Delphinium elatum,* cultivation, biotechnological method, callus genesis, explants, phytohormones.


Andrii Potrokhov, Olga Ovcharenko

Institute of Cell Biology and Genetic Engineering, Kyiv, Ukraine; E-mail.: <u>AlexGSMster@gmail.com</u>

Petunia hybrida Vilm. is gradually becoming a new model for research in virology and genetics. Petunia plants with *ZRNase II* gene encoding endoribonuclease were obtained earlier. Transgenic plants were characterized by increased resistance to the *Tobacco mosaic virus* (TMV). This study aimed to evaluate the degree of stress reactions in transgenic petunia plants with the *ZRNase II* gene after their infection with TMV. Lipid peroxidation and antioxidant activity were used as indicators of stress reactions.

Independent transgenic Petunia hybrida lines were obtained based on two separate commercial clones. Lines TM1.1 and TM1.2 are derivatives M1 clone, while lines TP5.1, TP5.2, and TP5.3 belong to P5. Plants were transformed previously with a genetic vector carrying the heterologous ZRNaseII gene from Zinnia elegance. The plants with confirmed transgenic nature were propagated in vitro and used for further *ex vitro* investigations. The experimental plants were grown in neutral peat substrate TS1 (Klasman, Latvia) at a temperature of +24 °C and 16hour light. The transgenic and control plants were infected with virus (TMV) containing material by mechanical inoculation of leaf blades. Lipid peroxidation was evaluated by measuring diene conjugates. Plant material (leaves) was triturated in 0.1 M phosphate buffer (pH 7.4), and the pellet was resuspended. A mixture of heptane with isopropyl alcohol 1:1 was added. The resulting mixture was centrifuged for 10 minutes at 4000 g and 1/10 volume of distilled water was added, the solution was stirred, 1 ml of heptane phase was taken, 5 ml of ethyl alcohol was added. The optical density was measured at 233 nm. To determine malonic dialdehyde, the resulting homogenate was precipitated with 5 % trichloroacetic acid and centrifuged for 10 minutes at 4000 g. The supernatant was transferred to test tubes and 0.8 % thiobarbituric acid was added and heated. The optical density was measured on a spectrophotometer at 532 nm. To determine the total antioxidant activity, 0.2 ml of 10 mM 2deoxyribose solution, 0.2 ml of 0.1 mM Fe_{2 +} / EDTA solution and 0.2 ml of 30 % H2O2 were added to the homogenate. The resulting solution was adjusted with phosphate buffer to a volume of 2 ml. The mixture was incubated for 4 hours. at + 37 °C. After incubation, 1 ml of 2.8 % trichloroacetic acid solution and 1 ml of 1 % thiobarbituric acid solution in 50 mm NaOH solution were added. The mixture was heated for 10 minutes at 100 °C. Optical density measurements were performed at a wavelength of 532 nm.

In the transgenic lines obtained based on M1 clone, the level of diene conjugates (DC) didn't overrun the control, while in the line TM1.2 it was even lower than control. It was found that the content of DC in the transgenic lines obtained from P5 petunia clone exceeded that in the control. There was no significant difference in the content of MD in transgenic and control lines of M1 petunia clone. While in transgenic plants of P5 petunia clone the amount of MD was significantly higher than that in control. After infection with TMV, it was shown that antioxidant activity in the transgenic M1 lines was at the same level as control or even exceeded it in the case of TM1.2 line. In all infected transgenic plants of the P5 petunia clone, it was observed a significant increase of AOA compared to control. The largest difference with control was in lines TP5.2, TP5.3 and exceeded up to 50–53 %. Moreover, previously the line TP5.3 was determined as the most resistant to viral damage.

The development of stress reactions in infected transgenic petunia plants with the *ZRNase II* gene was studied. As a result, it was found that transgenic lines TP5.2, TP5.3, both with TM1.2 line were much more resistant to the biotic stress caused by TMV infection than control wild-type lines.

Keywords: Petunia hybrida, ZRNase II gene, Tobacco mosaic virus, antioxidant activity.

November 3rd 2021



PAULOWNIA TOMENTOSA (THUNB.) STEUD. AS PERSPECTIVE ENERGETIC PLANT IN UKRAINE

Dzhamal Rakhmetov, Olena Vergun, Valentyna Fishchenko, Svitlana Rakhmetova

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>olenavergun8003@gmail.com</u>

Plants of *Paulownia tomentosa* (Thunb.) Steud. have had a scientific interest for the last decades and they are known as ornamental and medicinal cultures. Leaves, wood, and fruits are used in traditional Chinese medicine for the treatment of tonsillitis, bronchitis, asthmatic attack, etc. It was detected pharmacological activity of *P. tomentosa* such as anti-inflammatory, antispasmodic, antioxidant, vasorelaxant. But the most interesting last time connecting with energetic properties. Bioenergetic plants have interest due to their ability to produce a large amount of lignocellulosic biomass. *P. tomentosa* is one of the fast-growing wood species in some countries. Stem, branch, bark, leaves, and roots had a high heating value. Bioenergy characteristics of this plant depending on investigated plant part. *Paulownia* is a tree species distributed nowadays in more than 40 countries, very adaptable, and extremely fast-growing.

This study was aimed to demonstrate the energetic potential of *P. tomentosa* plants. The research used genotypes of *P. tomentosa* from the collection of M.M. National Botanical Garden of the NAS of Ukraine (NBG) in 2018–2019: f. PB, f. PO, f. PO (1st year), and cultivar sample. The content of dry matter was determined by drying raw to constant weight at 105 °C. The content of ash was detected by combustion at 800 °C in the muffle oven. The heating value was measured on calorimeter IKA C-200.

Plants of this genus were introduced from North America to Europe and Asia in the second part of the 19th century. In the NBG *P. tomentosa* has been studied since 2011 and is concerning with high productivity energetic plants (Rakhmetova et al., 2021). Results showed that the content of ash was from 1.05 to 2.27 %, dry matter was from 64.38 to 92.96 %, and heating value from 15.99 to 16.62 MJ/kg depending on genotypes. Also, we found a very strong correlation between investigated parameters: dry matter and ash (r = 0.982), heating value and dry matter (r = 0.945), and ash and heating value (r = 0.877).

Primary investigations showed that *P. tomentosa* is a promising energetic plant in Ukraine. These plants can compete with other tree and herbaceous plant species well-known in the world. By the way, the Ukrainian state register of varieties included cultivars of the energetic plant species from genera *Salix, Miscanthus, Panicum,* etc., some of which were created in NBG. Also, it is necessary to conduct selective work with these plants considering their biological, ecological, and biochemical properties to create new forms with stress tolerance in different growing conditions.

Keywords: Paulownia, use, energetic plant.

INFLUENCE OF SOIL CHARACTERISTICS ON THE GLYCYRRHIZIC ACID ACCUMULATION DYNAMICS IN LIQUORICE ROOTS

Ekaterina Rodionova, Maria Grushko, Nuria Kanieva

Astrakhan State Technical University, Astrakhan, Russian Federation; E-mail.: mgrushko@mail.ru

Liquorice *Glycyrrhiza glabra* L.) is one of the oldest medicinal plants that have not lost their relevance to this day.

Liquorice root contains substances belonging to various classes of chemical compounds, the most pharmacologically valuable of them are triterpene and flavonoid substances. The greatest interest among triterpene compounds of Liquorice root is given to glycyrrhizic acid. It is known that natural conditions have a direct impact on the dynamics of the accumulation of biologically active substances in medicinal plants.

This work aims to carry out a comparative analysis of the biochemical composition of Liquorice from different districts of the Astrakhan region. One more aim is to establish the influence of soil characteristics on the dynamics of glycyrrhizic acid accumulation in plant roots.

The object of the study is the roots of *Glycyrrhiza glabra* and soil samples from different districts of the Astrakhan region which were taken at the end of the growing season in September and October of 2019. Determination of the content of glycyrrhizic acid in the selected samples was carried out using a liquid chromatograph *an Agilent 1220 Infinity LC System*. Besides the content of heavy metals (lead, cadmium, copper, manganese) in samples of these Liquorice roots was determined by the atomic absorption method for toxic elements determination. Some soil sample (samples were taken in the previously mentioned districts of the Astrakhan region) characteristics such as the content of organic matter, acidity, the concentration of chloride ions, bicarbonate ions, sulfate ions, mass fractions of the same metals (lead, cadmium, copper, manganese) were determined. The samples of plant roots were tested on the same criteria.

The results of determining the glycyrrhizic acid content in the Liquorice roots samples taken from various regions of the Astrakhan region, namely, Kharabalinsky (Kharabali), Kamyzyak (Samosdelka), Krasnoyarsk (Lanchug) and Astrakhan (Leninsky district) showed that the glycyrrhizic acid content varies from 1.68 to 4.41 %. The highest rate of glycyrrhizic acid is noted for plants sampled in the Kharabalinsky region (Kharabali town) – 4.41 %.

During the biochemical tests, a positive correlation was found between the content of glycyrrhizic acid and such soil characteristics as the content of organic matter (r = 0.6), acidity (r = 0.3), mass fraction of bicarbonate ions (r = 0.5).

Manganese, cadmium, lead and copper were found in the soils of all these regions inadmissible concentrations. It was found that the soils of the Kharabalinsky region have the lowest levels of lead concentration (0.9 mg/kg), while the indicators of manganese (96.0 mg/kg), copper (6.7 mg/kg) and cadmium (0.28 mg/kg) are the highest in comparison with other tested areas. But, the concentration of these metals in the roots of the plant is one of the lowest – 2.816 mg/kg; 1.461 mg/kg; 0.078 mg/kg, respectively.

It has been established that the best growing conditions have developed in the Kharabalinsky district (Kharabali town), where the lowest indicators of chloride (0.105 %) and sulfate salinization (0.02 %); the optimal level of acidity (pH 6.62), the content of organic substances (4.4 ± 0.67 %) and metals.

Keywords: *Glycyrrhiza glabra*, glycyrrhizic acid, Astrakhan region.



BERRIES OF SIX SPECIES OF GOOSEBERRY (*RIBES* L.) AS A SOURCE OF FUNCTIONAL INGREDIENTS

Olga Shelepova¹, Olga Volkova¹, Viktor Deineka²

¹N.V. Tsitsin Main Botanical Garden of Russian Academy of Sciences, Moscow, Russian Federation; E-mail.: <u>shelepova-olga@mail.ru</u>

²Belgorod State National Research University, Belgorod, Russian Federation

In recent years, scientists' attention has been drawn to comprehensive plant research to identify new highly effective sources of nutrients and vitamins. It is known that the human body is not capable of the necessary complex of antioxidants, therefore, a significant part of them must come from food rich in antioxidant compounds. Natural antioxidants include a variety of fruit and berry plants, in particular gooseberries. Gooseberry (*Ribes* L.) belongs to the family *Grossulariacea* and is one of the most widespread shrubs in the world. The gooseberry culture appeared in Europe in France in the middle of the 15th century, since the end of the 16th century, gooseberry has become the most favorite fruit crop in England. In Germany, interest in this berry increased markedly at the end of the 18th century. In our country, gooseberries began to grow already at the beginning of the 16th century, and our ancestors called it "kryzh", "bersen" or "agryz". Gooseberry berries are in deserved demand, as they have therapeutic, prophylactic, and dietary properties. According to the recommendations of the Nutrition Institute of the Academy of Medical Sciences, the annual consumption rate of these berries should be at least 1.7 kg. Fruits Gooseberries contain a complex of important biologically active substances. The main food nutrients in fruits are digestible carbohydrates, indigestible carbohydrates are pectins and fiber. Gooseberry fruits are rich in almost all vitamins; P-active capillarystrengthening substances (anthocyanins) also accumulate. Anthocyanins, a member of the flavonoid group, are widespread in fruits and berries. They endow plants with vital biological functions, with the recent interest in anthocyanins in fruits and vegetables focusing on their antioxidant capacity and potential health benefits such as reducing the risk of cancer, cardiovascular disease, improving vision, and other pathologies.

In our work, we studied six gooseberry species grown in the Main Botanical Garden RAS (Moscow, Russia) to evaluate the best species as potential sources of bioactive compounds (anthocyanins). Anthocyanins were characterized by HPLC-ESI-MS / MS coupled with a diode array detector in six species of Gooseberry. In all studied species (*Ribes oxyacanthoides* L., *R. nivea* (Lindl.) Spach, *R. missouriensis* (Nutt.) Coville & Britton, *R. succirubra* (Zbl.) Los., *R. rusticum* Jancz., *R. cynosbati* (L.) Mill.) cyanidin-3-glucoside and cyanidin-3-rutinoside predominated in the complex of detected anthocyanins. The content of cyanidin-3-glucoside was maximum in *R. cynosbati* and amounted to 85.7 % of the total content of anthocyanins, and the minimum (36.7 %) in *R. succirubra*. The content of cyanidin-3-rutinoside was maximum in *R. oxyacanthoides* (41.4 %), and minimum in *R. cynosbati* (<0.1). Certain types of anthocyanins were present in significant amounts only in certain types of gooseberries. Thus, cyanidin-3-(coumaroylglucoside) was found in the fruits of *R. rusticum* (20.7 %) and *R. oxyacanthoides*, and *R. cynosbati* (11.8 and 11.1 %, respectively). Delphinidin-3-glucoside in *R. nivea* (19.0 %) and *R. succirubra* (13.4 %).

Thus, the present study shows that gooseberry berries are a rich source of anthocyanins, demonstrating their potential use as a dietary supplement.

Keywords: Gooseberry, berries, anthocyanins.

Acknowledgments

This work was carried out in accordance with the MBG RAS Research Project No. 118021490111-5.

MORPHOMETRIC PARAMETERS OF CRAMBE SPP. FLOWERS AND FRUITS

Oksana Shymanska, Olena Vergun, Dzhamal Rakhmetov, Oleksandr Bondarchuk, Svitlana Rakhmetova

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>olenavergun8003@gmail.com</u>

Representatives of the *Crambe* L. genus are interesting objects among other Brassicaceae Burnett due to different biological activities. Fruits of these species are rich in oil, which contains more than 54 % of erucic acid that has many applications in the chemical, cosmetic, and food industries. They are promising as fodder, food, decorative and medicinal plant. Species of this genus exhibited different biological activities such as antioxidant and antimicrobial.

One of the important aspects of the introduction study is morphometric parameters of different organs including fruits. Investigated plants have false two-nested two-membered pods. The period of fruitage can last from July to September depending on the species. The investigation was conducted on perennial plants.

Fruits of the following *Crambe* species were used for this study: *C. cordifolia* Steven (CC), *C. hispanica* subsp. *abissinica* (Hochst. et R.E.Fr.) Prina (CH), *C. koktebelica* (Junge) N.Busch (CK), *C. maritima* L. (CM), *C. steveniana* Rupr. (CS). Raw was collected in 2017–2020 from experimental collections of M.M. Gryshko National Botanical Garden of the NAS of Ukraine for measuring of length of flower (mm), the diameter of flower (mm), length of the petal (mm), a width of the petal (mm); fruit length (mm), fruit width (mm), fruit diameter (mm). Weight of fruits given in grams.

The measuring of flower length and diameter of investigated species was 5.03–16.46 mm and 0.23–0.55 mm, respectively. The petal length and width were 3.63–6.56 mm and 3.61–5.51 mm, respectively. The most variable parameters were the diameter of the flower (CM) and the length of the petal (CM). The less variable sign was the length of a flower of CS. Fruit length was 3.02 mm(CH), 3.20 mm (CC), 4.11 mm (CK), 5.36 mm (CS), and 10.14 mm (CM). The fruit width was measured as 2.33 mm for CC, 3.16 mm for CH, 4.05 mm for CK, 4.73 mm for CS, and 9.96 mm for CM. Fruit diameter was 3.41 mm (CH), 4.08 mm (CC), 4.30 mm (CK), 5.58 mm (CS), and 8.78 mm (CM). Also, the thousand-fruit weight of investigated *Crambe* species was 7.34 g (CC), 8.51 g (CH), 8.77 g (CK), 11.12 g (CS), and 12.54 g (CM). The most variable morphometric parameter was fruit width for CK (11.79 %), CM(18.72 %), CC (21.04 %), CS (22.54 %), and fruit length for CH (15.75 %). The study of all investigated parameters showed a very strong correlation between each other. Between length and diameter of fruits, a correlation was 0.993, length and width of fruits 0.990, width and diameter of fruits 0.968, and connection of rest parameters was in range 0.900–0.905.

The study of morphometric parameters of flowers and fruits of *Crambe* growing in M.M. Gryshko National Botanical Garden can be useful for further selective work with this species as potential food, forage, energetic, etc. plants.

Keywords: *Crambe,* flower and fruits morphometric parameters.

RESPONSE AND ABILITY OF THE VINES OF STORGOZIA CULTIVAR TO RECOVER AFTER HAIL DAMAGE

Iliyan Simeonov, Yordanka Belberova, Tatyana Yoncheva

Institute of Viticulture and Enology, Pleven, Bulgaria; E-mail.: <u>t_ion@abv.bg</u>

The research work was carried out in the period 2017–2019 in an experimental plantation of the intraspecific red wine cultivar Storgozia, in the Experimental base of the Institute of Viticulture and Enology (IVE) – Pleven. The objective of the study was to determine the response and the ability to recover cultivar Storgozia after the extreme meteorological phenomenon mesocyclone registered in May 2018, accompanied by intense hail and hurricane wind.

Most of the main shoots in the experimental plantation of the studied cultivar were broken from the base or at different heights, the leaf mass was torn, most of the inflorescences were destroyed or severely damaged. The hail damage impact on the actual fertility elements, the growing strength and the degree of shoots ripening, the yield quantitative and qualitative indicators, and the grape's chemical composition had been determined for the achieving of the objective. The study found that the damages caused by hail on the green parts of the vine in 2018 did not have a negative influence on the formation of inflorescences in the winter eyes and did not affect the vine productivity of cultivar Storgozia next year. The damages caused by hail at the onset of the vegetation had little effect on the growing strength and the degree of shoots ripening. The leaves of the main shoots of cultivar Storgozia were significantly smaller in size in the year with hail compared to the other two years, which was reflected in the size of the leaves of the lateral shoots that were larger after the registered hail. The total leaf area per vine had remained almost the same in all three years, as the difference was only in the leaf area ratio of the main and lateral shoots in 2018 that did not result in disruption of the vital for the vine plant physiological and biochemical processes in the leaves.

Hail had a considerable negative effect on the structure of the cluster, the berry size, the yield per vine, and a significant adverse impact on the chemical composition of grapes in terms of sugars, titratable acids, anthocyanins, and total phenolic compounds.

Keywords: vine, cultivar, response, ability to recover, hail.



Miriam Solgajová, Zuzana Paulovičová, Ján Mareček

Institute of Food Sciences, Slovak University of Agriculture in Nitra, Slovak Republic, E-mail.: <u>miriam.solgajova@uniag.sk</u>

The focus of this study was to evaluate the technological characteristic of four soft wheat cultivars (Hybos, Fabula, Bohemia, Capo) and one durum wheat cultivar (Levante). Flourmilling and baking parameters were classified. From the processing industry aspects, the quality of wheat is very important. Each class of wheat is in practice used for specific processed products such as bread, pasta, and confectionery items.

A sampling of material was following the procedure according to Slovak technical standards for cereals and cereal products. Samples were homogenized using laboratory mill Perten. Flour-milling and baking characteristics such as dry matter content – ICC Standard No. 110/1 (1976), ash content – ICC Standard No. 104/1 (1990), alpha-amylase activity (Falling Number) – FN device 1800 (Perten) according to ICC Standard No. 107/1 (1995), crude protein – ICC Standard No. 159 (1995), starch content – under ICC Standard 123/1, wet gluten content – Glutomatic 22000 (Perten) – ICC Standard No. 155 (1994) and sedimentation index by Zeleny – ICC Standard No. 116/1 (1994) were examined.

All detected values of dry matter ranged about 90 %, which predetermines the evaluated samples as dry grain suitable for safe storage with minimal losses of dry matter during storage. From the flour-milling parameters, the ash content ranged from 1.32 to 1.57 %. From the bakery parameters, the optimal activity of alpha-amylase (220–300 s.) was measured in cultivars Levant, Bohemia, and Capo. The lowest enzymatic activity showed cultivar Fabula (117 s.) and the highest falling number (314 s.) was detected in a cultivar Bohemia. The highest sedimentation capacity expressed as sedimentation index by Zeleny had cultivars Bohemia and Capo (62–63 cm³), which proves the high quality of the flour. The high content of insoluble protein (gluten) was measured in cultivars Capo and Bohemia (more than 35 %). Nitrogen content was in the range of 9.55–12.83 % of dry matter. The starch content was variable (66.16–73.18 %).

It can be concluded that all evaluated soft wheat cultivars are suitable for processing in the milling and baking industry as well as in the pasta industry (durum wheat variety).

Keywords: wheat, technological quality, wet gluten, crude protein.

Acknowledgments

This research was supported by KEGA 044SPU-4/2019.

ANTIBACTERIAL ACTIVITY OF ETHANOLIC EXTRACTS OBTAINED FROM ROOTS AND STALKS OF CHELIDONIUM MAJUS L. AGAINST ENTEROCOCCUS FAECALIS STRAINS

Nataniel Stefanowski, Halyna Tkachenko, Natalia Kurhaluk

Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland; E-mail.: <u>natanielstefanowski89@gmail.com</u>

The present study is an *in vitro* research aimed to evaluate the antimicrobial activity of the ethanolic extracts derived from roots and stalks of *Chelidonium majus* L. against two *Enterococcus faecalis* strains to assess the possible use of this plant in preventing infections caused by this pathogen. *E. faecalis* is a Gram-positive bacterium that commonly inhabits the gastrointestinal tract of mammals. Enterococcal species are core constituents of the intestinal flora of many animal species ranging from humans to flies. When they enter a wound, bloodstream, or urinary tract, however, *E. faecalis* cells can cause serious infections. In immunocompromised individuals, however, it can cause a variety of complications, including surgical wound and urinary infections, endocarditis, and bacteremia. *C. majus* is a medicinal plant well-known as a valuable source of isoquinoline alkaloids, which have a variety of pharmacological properties including anti-viral and anti-bacterial effects.

Plant materials were harvested from natural habitats on the territory of the Kartuzy district ($54^{\circ}20'N$ 18°12′E) in the Pomeranian province (northern part of Poland). Freshly washed samples were weighed, crushed, and homogenized in 96 % ethanol (in proportion 1:19, w/w) at room temperature. The extracts were then filtered and investigated for their antimicrobial activity. The *Enterococcus faecalis* (Andrewes and Horder) Schleifer and Kilpper-Balz (ATCC®51299TM) and linezolid-resistant *Enterococcus faecalis* strain locally isolated were used in the current study. Strains tested were plated on TSA medium (Tryptone Soy Agar) and incubated for 24 h at 37 °C. The antimicrobial susceptibility testing was done on Muller-Hinton agar by disc diffusion method (Kirby-Bauer disk diffusion susceptibility test protocol). Sterile filter paper discs impregnated by extracts were applied over each of the culture plates, 15 min after bacteria suspension was placed. A negative control disc impregnated by sterile 96 % ethanol was used in each experiment. After culturing bacteria on Mueller-Hinton agar, the disks were placed on the same plates and incubated for 24 h at 37 °C. The activity was evidenced by the presence of a zone of inhibition surrounding the well (CLSI, 2014).

The results of the current study showed that C. majus possess weak antimicrobial properties against the tested *Enterococcus faecalis* strains. The ethanolic extract obtained from the roots of *C. majus* collected from rural areas exhibited the maximum antimicrobial activity against linezolid-resistant *E. faecalis* strain (the mean of inhibition zone diameters was 8.85 ±0.42 mm) compared to the control sample (7.1 ±0.91 mm). Stalk extracts of *C. majus* collected from rural areas showed similar properties against the Enterococcus faecalis (Andrewes and Horder) Schleifer and Kilpper-Balz (ATCC®51299™) strain (8.77 ±1.21 mm) compared to the control sample (7.1 ±0.91 mm). Root extracts from *C. majus* collected from urban and rural areas exhibited weak antibacterial ability against linezolid-resistant E. faecalis strains (6.46 ± 0.32 and 7.78 ± 0.34 mm, respectively) compared to the control sample (7.10 ± 0.99 mm), as well as weak antibacterial ability against *E. faecalis* ATCC[®]51299[™]strains (7.90 ±1.08 and 7.97 ± 0.85 mm, respectively) compared to the control sample (7.10 ± 0.99 mm). The results of this study can induce to provide a new perspective for the use of various *Papaveraceae* families as medicinal plants to improve the antibacterial responses using other strains. Identification of precise molecular mechanisms responsible for inhibition of bacterial growth by these extracts requires further research.

Keywords: *Enterococcus faecalis,* disc diffusion method, antibacterial activity, root extracts, stalk extracts.

ANTIOXIDANT EFFECTS OF EXTRACTS DERIVED FROM ROOT AND STALK OF CHELIDONIUM MAJUS L. COLLECTED FROM URBAN AND RURAL AREAS USING THE MODEL OF EQUINE ERYTHROCYTES

Nataniel Stefanowski, Halyna Tkachenko, Natalia Kurhaluk

Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland; E-mail.: <u>natanielstefanowski89@gmail.com</u>

Greater celandine (*Chelidonium majus* L., Papaveraceae) is a perennial herbaceous plant, with an upright and spreading stem, large leaves, and yellow flowers collected on the tops of the stems in rare umbel inflorescence. The main aim of the study was an assessment of the oxidative stress biomarkers (2-thiobarbituric acid reactive substances (TBARS), carbonyl derivatives content of protein oxidative modification (OMP), total antioxidant capacity (TAC)) and also activity of antioxidant enzymes (catalase, ceruloplasmin) in the equine plasma and erythrocytes after treatment by extracts derived from roots and stalks of *Chelidonium majus* collected from rural and urban agglomerations.

Plant materials were collected from natural habitats on the territory of the Kartuzy district in the Pomeranian province (northern part of Poland). Freshly collected leaves were washed, weighed, crushed, and homogenized in 0.1M phosphate buffer (pH 7.4) (in proportion 1:19, w/w). The equine plasma and erythrocyte aliquots were used in the study. A volume of 0.1 ml of the *C. majus* extract was added to 1.9 ml of clean equine erythrocytes or 1.9 mL of plasma. After incubation of the mixture at 37 °C for 60 min with continuous stirring, samples were used for the biochemical assays.

Our results demonstrated that statistically significant reductions in lipid peroxidation byproducts (TBARS) were noted after incubation with root extracts of *C. majus* collected from both urban (by 35 %, p<0.05) and rural (by 34 %, p<0.05) agglomerations compared to the control samples. Stalk extracts from *C. majus* also reduced TBARS levels, but only extracts of *C. majus* were collected from the rural areas; a statistically significant decrease by 21 % (p<0.05) was observed compared to the control samples. The lowest values in the content of the aldehyde derivatives of oxidatively modified proteins (OMP) were observed after incubation with root extracts of C. majus collected from both rural and urban areas (by 4.9 and 7.5 %, p<0.05). On the other hand, levels of ketonic derivatives of OMP were significantly increased after incubation with stalk extracts of *C. majus* collected from both rural and urban areas (by 17 and 16.4 %, p<0.05) compared to the control samples, in contrast to root extracts of *C. majus* collected from urban areas, where there was a statistically significant reduction in ketonic derivatives of oxidatively modified proteins (by 15 %, p<0.05) compared to the control sample. A significant increase in the total antioxidant capacity (TAC) levels were observed after incubation with root and stalk extracts of *C. majus* collected from both urban and rural areas, but the highest values were observed after incubation with root extracts collected from rural areas (by 66.7 %, p<0.05) compared to the control samples. Stalk extracts of *C. majus* collected from urban agglomerations were found to be most effective in increasing catalase activity (by 115 %, p<0.05). Both root and stalk extracts of *C. majus* collected from rural areas caused a statistically significant reduction in ceruloplasmin levels (by 10 and 9 %, p<0.05, respectively).

These *in vitro* studies indicate that extracts from this plant are a significant source of natural antioxidants that may help prevent the progression of various levels of oxidative stress. However, the proportions of secondary metabolites responsible for the antioxidant activity of *C. majus* extracts are currently unclear. Therefore, further studies are needed to isolate and identify the antioxidant compounds present in the plant extracts.

Keywords: root and stalks extract, equine erythrocytes, plasma, lipid peroxidation, oxidatively modified proteins, total antioxidant capacity.

BIOTECHNOLOGY METHOD OF OBTAINING BIOMASS OF MEDICINAL PLANTS FOR MEDICAL AND COSMETIC PURPOSES IN UKRAINE

Sofia Suberliak, Yustyna Tepla, Olena Fedorova, Viktoriia Havryliak, Volodymyr Skorochoda, Romana Petrina

Lviv Polytechnic National University, Lviv, Ukraine; E-mail.: <u>romanna.o.petrina@lpnu.ua</u>

Medicinal plants biomass and its extracts are used in the creation of pharmaceuticals, cosmetics, and hygiene products. The 15,000 plant species from about 70,000, are rare, according to the *International Union for Conservation of Nature, IUCN.* Much attention is now paid to the protection of biodiversity, as this is one of the goals of *The European green deal*, presented in Brussels in 2019. As plants play an important role in ecosystems, so their unrestricted use leads to the destruction of populations and individual plant species. One of the goals of the *Sustainable Development Goals*, approved by the *UN General Assembly* in 2015, is to stop the loss of biodiversity and to ensure the protection and prevention from extinction the endangered species. Also on the initiative of the *UN General Assembly*, 2020, the International Year of Plant Health was declared. Therefore, obtaining plant biomass by alternative methods is an extremely relevant topic today in Ukraine.

Among the innovative biotechnological approaches for plant biodiversity protection, such as tissue culture method, microclonal propagation, synthetic seed technology, use of molecular markers, etc., it is proposed to use plant biomass obtained *in vitro* on the example of the Asteraceae family plants – *Arnica montana, Carlina acaulis, Carlina alpinus, Calendula officinalis*. Some of these plants are cultivated in botanical gardens, research stations, arboretums. Some plant species are protected internationally and are listed in the European Red List.

Plant seeds were germinated in vitro in Murasige-Skuga (MS) medium without growth regulators. 30% hydrogen peroxide and 70% ethanol were used for sterilization. The obtained explants were placed into the MS environment with growth regulators and cultivated under optimal conditions (temperature, lighting, explant type). As growth regulators β -indolyl acetic acid, α -naphthylacetic acid, and kinetin were used. The methodology of biotechnological research is based on the generally accepted classical methods of the culture of isolated cells, tissues, and organs of plant research.

A study of the influence of nutrient composition, lighting, and explant type on callus biomass growth was performed. Optimal *in vitro* cultivation conditions for all plants were selected and biomass was obtained. The content of some biologically active compounds in callus biomass, namely, flavonoids and phenolic compounds, were also studied. The qualitative and quantitative reactions results indicate the presence of these substances, in some cases even in greater quantities than in the original plant.

Thus, the proposed method of *in vitro* tissue culture can be used as an alternative to the traditional plant growth in nature to preserve the biodiversity of rare and endangered medicinal plants of the Ukrainian Carpathian region, as well as to obtain valuable plant biomass with biologically active substances.

Keywords: callus biomass, biotechnology method, *Arnica montana, Carlina acaulis, Aster alpinus, Calendula officinalis.*



Svetlana Sukhaveyeva, Alena Kabachevskaya

Institute of Biophysics and Cell Engineering National Academy of Sciences of Belarus, Minsk, Belarus; E-mail.: <u>suhoveevalmbc@mail.ru</u>

Agricultural practices on Earth have evolved for a lot of years and the challenges may be expected when they are adapted for space-based agriculture. One of the key variables in space is gravity; therefore, it is important to understand the fundamental mechanisms, including molecular biological ones, which underlie the plant's perception of gravity and adaptation to its changes. Gravitropism is a universal property of all plants to perceive changes in gravity and adapt to them through the directed growth of their organs. Different parts of a plant respond differently to gravity: roots grow downwards (positive gravitropism); aerial parts of a plant grow upwards (negative gravitropism). An important step involved in the gravitropic bending is the redistribution of phytohormone auxin between different parts of gravistimulated organs. However, the role of other growth phytohormones, including ethylene and brassinosteroids, in the negative gravitropic response of plants has not been studied in detail, especially at the transcriptional level.

This research aimed to evaluate the influence of gravistimulus on the expression of genes associated with biosynthesis and signaling of brassinosteroids and ethylene such as ACS, EBF, Curl, BRU, and some genes of SAUR-family in leaf cells as well as on sedimentation of amyloplasts in petiole cells and curvature of stems. Gene sensitivity to gravistimulus was determined in the apical leaves of tomato plants. For gravistimulus, the pots with experimental plants were turned 90°C and exposed at different time intervals. The parts of experimental groups were additionally treated with ethephon (the direct ethylene source) or brassinosteroid (BS) epine. RT-PCR was used to quantify the level of relative expression of target genes. Visualization of starch grains was carried out using light microscopy.

It was found that expression of SAURs, Curl, BRU1, and ACS was increased under gravistimulation, while expression of EBF1 was moderately decreased at early stages of response. Pretreatment of plants with a solution of BS increased the level of expression of most of the studied genes, while ethephone reduced the increase in expression of some genes caused by gravistimulation. It was also found, that gravistimulation caused the formation of the angle of stem bending and sedimentation of amyloplasts during the exposure period of 15 min – 3 h, BS accelerated and intensified the effects of gravistimulus, while the ethephone significantly suppressed them.

Thus, the sensitivity of plant leaves to gravistimulation and the participation in the control of the gravitropic response of such important regulators of plant growth and development as BS and ethylene, in the perception of the gravistimulus were shown. It can be assumed that only a part of genes was covered, and probably, gravistimulation will affect other genes expression involved in plant metabolism.

Keywords: Lycopersicum esculentum, gravitropism, gene expression, ethylene, brassinosteroids.

Acknowledgments

We are grateful to the Institute of Physiology of the National Academy of Sciences of Belarus for help in carrying out microscopic studies.

STUDY OF BIOLOGICAL AND BIOCHEMICAL PECULIARITIES OF THYMUS STRIATUS VAHL

Liudmyla Svydenko¹, Natalia Hudz², Liudmyla Hlushchenko³

¹Institute of Rice of National Academy of Agrarian Science of Ukraine, Skadovsk, Ukraine; E-mail.: <u>svid65@ukr.net</u>

²Depertment of Drug Technology and Biopharmaceutics, Danylo Halytsky Lviv National Medical University, Lviv, Ukraine

³Research Station of Medicinal Plants of the Institute of Agroecology and Environmental Management of the National Academy of Agricultural Sciences of Ukraine, Berezotocha, Poltava, Ukraine

One of the valuable aromatics and medicinal plants of the *Thymus* L. genus is *Thymus striatus* Vahl. The above-ground part of the plant in the flowering stage and drugs obtained from it exhibited antibacterial properties. The essential oil contains thymol and carvacrol that demonstrated antiseptic and fungicidal properties.

This study was aimed to investigate the content of essential oil and its components from *Thymus striatus* cv. Yubileinyi that introduced from Nikitsky Botanical Garden to the Kherson region of Ukraine. An investigation was carried out during 2019–2020 on the experimental collection of aromatic and medicinal plants of experimental facility "Novokakhovske" of Rice Institute (Kherson Region). Mass fraction of essential oil determined by the method of hydrodistillation with Clevenger apparatus from fresh plant raw material. Essential oil composition investigated on Agilent Technology chromatograph 6890N with mass-spectrometric detector 5973 N.

Th. striatus cv. Yubileinyi evergreen plants that in Steppe zone conditions of South of Ukraine formed large, compact shrub with a height of 30–35 cm and diameter of 70–75 cm. Flower shoots rounded-rhomboid, pubescent. Leaves oblong-rhomboid with a length of 5–6 mm, the weight of 3–3.5 mm, tapering to base, well-defined petioles, cobweb-pubescent. Leaf edges wrapped on the underside. Corolla from lavender to white color. These plants complete the full development cycle in conditions of the Kherson region, bloom and fruit abundantly. Full blooming was observed at the end of May – the start of June. During the investigation period plants didn't damage by pests and were not affected by diseases. The harvest of flower raw of *Th. striatus* cv. Yubileinyi (plants of 3rd year of growing) varied from 170 to 670 g, from one shrub. Mass fraction of essential oil was from 0.25 to 0.45 % FW or from 0.95 to 1.69 % DW. In essential oil, obtained from plants growing in an experimental facility "Novokakhovske", identified 21 components. Basic components are thymol (57.27 %), para-cymene (10.18 %), γ -terpinene 11.87 %, trans-sabinenhydrat 11.87 %.

Thus, *Th. striatus* cv. Yubileinyi can be perspective aromatic and essential oil plants in the Kherson region. Obtained results can be used for further investigation on different biological peculiarities of these plants for wide use.

Keywords: Thymus striatus, cultivar, essential oil.

Acknowledgments

This study was supported by the active participation of researches by the international network AgroBio*Net*, Visegrad Fund, Bilateral Scholarship of the Ministry of Education, Science, Research and Sport, and National Scholarship Programme of Slovak Republic.

CREATION OF NEW PERSPECTIVE CULTIVARS OF *LAVANDULA ANGUSTIFOLIA* MIIL. FOR GROWING OF AREA OF UKRAINIAN SOUTH

Liudmyla Svydenko¹, Olena Markovska², Iryna Stetsenko²

¹Institute of Rice of National Academy of Agrarian Science of Ukraine, Skadovsk, Ukraine; E-mail.: <u>svid65@ukr.net</u> ²Kherson State Agrarian and Economic University, Kherson, Ukraine

Lavender is a polymorphic plant that is represented in nature by wide diversity. This can help to find signs for obtaining economically valuable forms, propagated after selection by the vegetative way. It was selected samples of *Lavandula angustifolia* Mill. cv. Prima from seed generation to create new high-productive cultivars. They differed by the complexity of morphological characteristics such as the number of flowering shoots, number of whorls in inflorescences, flowers in a whorl. Among selected forms, the best economically valuable signs (essential oil content and its component composition) characterized forms 1-13-14 and 915 that propagated by the vegetative way.

Cv. Syneva Nadii. Shrub of middle size, compact form, height of 65 cm, and diameter of 80 cm. The flower shoots straight, green, with middle thickness. Three-year-old plants have approximately 200 flower shoots. The inflorescence is elongated, length of 12–14 cm. Calix of the corolla is violet. Corollas are richly violet, moderately pubescent. Diameter of an inflorescence of 2 cm. A number of whorls of 10–11. The number of flowers in the inflorescence of 90. Leaves grey-green, narrow 5.5 cm in length, 0.4 cm in width.

These plants are characterized by a mass fraction of essential oil 1.3 % of fresh weight (FW) or 3.3 % of dry weight (DW). The content of linalilool in essential oil, which is a valuable component of 78.8 %.

Cv. Lidiia. Shrub of middle size, compact form, the height of 60–70 cm, and diameter of 80 cm. The flower shoots are straight, green, thick, with a diameter of 25 cm, length of 30 cm. Three-year-old plants have approximately 100 flower shoots. Length of inflorescence 7–9 cm. Calix of the corolla is green. Corollas big, dark-violet, moderately pubescent. Diameter of inflorescence 2 cm. A number of whorls of 8–10. A number of flowers in whorl 14–16. Leaves are grey-green, length of 5.2 cm, the width of 0.7 cm.

The mass fraction of essential oil varied from 1.1 to 1.3 % FW or 2.8–3.3 %. Linalyl acetate is a valuable component of essential oil and its content of 48.10 %.

Obtained cultivars are frost-resistant and tolerant to pest damage diseases. Plants had a high content of essential oil and valuable components. They can be successfully used both in the essential oil industry and in landscaping the Steppe zone of Southern Ukraine.

Keywords: *Lavandula angustifolia,* fruits, cultivars, biochemical composition.

Acknowledgments

This study was supported by the active participation of researches by the international network AgroBio*Net*, Visegrad Fund, Bilateral Scholarship of the Ministry of Education, Science, Research and Sport, and National Scholarship Programme of Slovak Republic.



Liudmyla Svydenko¹, Olena Vergun², Katarína Fatrcová-Šramková³, Eva Ivanišová³, Ján Brindza³

¹Experimental Facility "Novokakhovska" of Rice Research Institute of Ukrainian Academy of Agrarian Sciences; E-mail.: <u>svid65@ukr.net</u>

²M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine

³Slovak University of Agriculture in Nitra, Nitra, Slovak Republic

Hyssopus officinalis L. is a well-known plant from Lamiaceae Martinov in traditional and non-traditional medicine. The pharmacological activity of plant raw this species is caused by the presence of numerous biologically active compounds such as phenolic (flavonoids, phenolic acids). Numerous studies of this plant relate to the rich component content of essential oil that is also characterized by antioxidant, antimicrobial activity and possessed a sedative effect. This study was aimed to investigate the antioxidant activity of *H. officinalis* L. ethanol extracts. Plant raw took from an experimental collection of Experimental Facility "Novokakhovska" of Rice Research Institute of Ukrainian Academy of Agrarian Sciences, at the stage of budding, blossoming, and fruitage. It was analyzed dried herbs (all above-ground parts), leaves, buds, inflorescences, and fruits. All biochemical analyses were conducted at the Slovak University of Agriculture in Nitra in 2021. It was determined total content of polyphenol compounds expressed in gallic acid equivalent (GAE), phenolic acids expressed in caffeic acid equivalent (CAE), flavonoids expressed in quercetin (QE). Antioxidant activity was determined by the phosphomolybdenum method expressed in Trolox equivalent (TE) and the DPPH method expressed in TE. All measurements were carried out using the spectrophotometer Jenway (6405 UV/Vis, England).

As a result, the total content of polyphenol compounds was from 20.54 (fruitage, herb) to 67.43 (budding, leaves) mg GAE/g, the total content of phenolic acids was from 8.76 (fruitage, herb) to 39.15 (budding, buds) mg CAE/g, the total flavonoids content was from 8.16 (fruitage, herb) to 27.97 (blossoming, leaves) mg QE/g. Antioxidant activity by phosphomolybdenum method was from 13.44 (fruitage, herb) to 130.81 (budding, buds) mg TE/g and DPPH method from 8.17 (budding, leaves) to 9.02 (budding, buds) mg TE/g. We found a very strong correlation between total phenolic acid content and antioxidant activity by the phoshomolybdenum method (r = 0.953), total phenolic content and phenolic acid content (r = 0.852), total phenolic and flavonoid content (r = 0.808). A strong correlation was found between antioxidant activity by the phoshomolybdenum method and total flavonoid content (r = 0.606). Antioxidant activity by DPPH did not correlate with all investigated parameters.

This study demonstrated the high antioxidant activity of different ethanol extracts of *H. officinalis*, especially at the budding stage. The use of phosphomolybdenum method of determination antioxidant activity demonstrated the strongest relation with phenolic compound content than the DPPH method. This study can be useful for further biochemical and pharmacological investigations. Antioxidant properties are also important considering that this plant is used as condiment and spices.

Keywords: Hyssopus officinalis, antioxidant activity, polyphenol compounds.

Acknowledgments

The authors are grateful for the Bilateral Scholarship of the Ministry of Education, Science, Research and Sport (Slovak Republic), National Scholarship Programme, and Visegrad Fund Scholarship Programme for supporting this research.



STUDY OF THE MAIN PHYSIOLOGICAL INDICATORS OF PRODUCTIVITY FORMATION IN THE STUDIED GENOTYPES OF DURUM AND BREAD WHEAT

Tamraz Tamrazov

Department of Plant Physiology and Biotechnology, Research Institute of Crop Husbandry, Baku, Azerbaijan; E-mail.: <u>tamraz.tamrazov@mail.ru</u>

Drought stress during the grain filling period has recently become more common in Azerbaijan, where grows wheat (*Triticum aestivum* L., *Triticum durum* Desf.). The study of the effects of drought resistance on fertility measurements and the effect of fertility indicators on typical wheat investigated based on different soil and climatic conditions.

In the 2020–2021 research year, 12 different wheat genotypes were measured in the Absheron Experimental Base of the Institute in three groups (early, medium and late maturing). As a result, two genotypes from each group were compared, including durum and bread wheat.

The net photosynthesis rate (Pn), stomatal conductance (Gs), transpiration rate per leaf area (E), leaf temperature (Tl) and intercellular CO_2 concentration (Ci) were measured using a portable photosynthesis system LI-6400 (LI-COR, USA) on the flag leaves on midday (09:00–12:00) at after anthesis. Photosynthetically active radiation (PAR) of 1,200–1,600 µmol (photon) m-2 s-1 was provided at each measurement by the ambient CO_2 concentration of 380–400 ppm and full sunlight. Photosynthetic water uses efficiency (PWUE) was calculated by dividing Pn to gs.

From the early maturity Garagylchyg-2 durum wheat genotype, both in the two versions, separately on the 8th and 7th layer leaves, (Pn) – 13.6, 15.8/8.9–11.4 (mmol CO₂ $^{m-2s-1}$), CO₂g 322; 381/355; 377 (mmol CO₂ moll/2) and finally E-value 5.9; 6.1/4.5; 3.3 (mol H₂O $^{m-2s-1}$), bread wheat genotypes of Nurlu-99 type Pn – 14.4; 11.9/11.1; 10.8 (mmol CO₂ $^{m-2s-1}$), CO₂g – 358; 358/361; 377 mmol of CO₂ moll/2 and finally E – 5.1; 6.4/4.1; 5.2 (mol H₂O $^{m-2s-1}$). At the flowering phase Pn – 20.2; 19.8/19.9; 18.2 (mmol CO₂ $^{m-2s-1}$), E – 8.7; 8.1/7.2; 6.3 (mol H₂O $^{m-2s-1}$), compared to the previous measurements, the difference between the variants was significantly lower compared to those observed in the third measure.

From the mid matures durum wheat Vugar, both in the two versions, separately on the 8th and 7th leaves, Pn – 25 %; 32.7 %, bread wheat genotypes of Azamatly-95, durum wheat genotype Vugar CO_2 g 4.2; 3.8 %, bread wheat Azamatly-95, 10.2; 11.5 % and finally E-value 4.2; 3.8/5.1; 1.3 %.

From the late mature wheat genotypes the difference in the rate of photosynthesis according to the results of measurements in the genotype durum wheat Terter and bread wheat Girmizy gul-1 the bread wheat of the characteristic wheat was 9.8; 7.4/6.1 %, 4.9 %, CO₂ content in cells; 5.6 %; 6.6/4.2 %; 2.1 %, the difference between the speed of transpiration 25.3 and 22.8 and 22.6; 18.4–23.3 and 21.8 %, respectively.

During the study, we analysed changes in gas metabolism and some physiological features of different wheat genotypes responding to drought stress. Such research will provide valuable information that can be used as a genetic basis for wheat production to increase productivity and productivity from stress. This is because the fast-growing genotypes complement their development before the severe drought, which causes little difference between the options.

On the other hand, the differences between the variants in late-grown samples coincide with the prolongation of maturation and the occurrence of acute drought. This also leads to loss of product. It is important to pay attention to the reproduction of such genotypes as parent species in the creation of new breeding varieties in the future.

Keywords: wheat genotypes, drought resistance, drought stress, wheat productivity, fertility indicators.



WALNUT KERNELS PELLICLE (JUGLANS REGIA L.) – A GOOD SOURCE OF GALLIC, ELLAGIC ACIDS, CATECHIN AND THEIR DERIVATIVES FOR FUNCTIONAL FOODS

Pavel Tatarov¹, Raisa Ivanova², Alexei Baerle¹, Iuliana Sandu¹, Jan Brindza³

¹Technical University of Moldova, Chisinau, Republic of Moldova; E-mail.: <u>pavel.tatarov@tpa.utm.md</u> ²Institute of Genetics, Physiology and Plant Protection, Chisinau, Republic of Moldova ³Slovak University of Agriculture in Nitra, Slovak Republic

The pellicles, which cover the walnut kernels, protect the lipids from the kernel's endosperm against the oxidative degradation. In previous studies, we showed that for the formation of the bad brown colour and bitter taste of walnut kernels, the oxidized polyphenols (naphthoquinones) are responsible. It is necessary to mention that the ratio between the average content of total polyphenols in pellicles and in kernels can reach 12.7, and this excellently correlated with mass fraction of pellicle in the kernels (10–11 %). The majority (more than 90 %) of phenolic compounds are concentrated in the pellicle.

The purpose of this research was to found the optimal extraction's conditions of phenolic compounds from kernel pellicles and to evaluate the antioxidant capacity of these. The yield of extractive components was determined in function of the concentration of food-grade ethanol as solvent, temperature of extraction and previous defatting procedure. Defatting was realized by hydraulic pressing at 20MPa. Results showed that the maximum amounts of phenolic compounds were extracted with 50 % aqueous ethanol at 22–24 °C from the pellicles, obtained from native not-defatted kernels. The total polyphenol content in extract from defatted kernels was of 1.2-1.4 times higher than from the native kernels. But we observed, that the contamination of kernel's pellicle with the lipids, extracted from endosperm during pressing, make much more difficult extraction of phenolic compounds from the pellicle with aqueous ethanol solutions. The optimization of extraction conditions gives the opportunity to obtain the extracts with total phenolic content increased by 1.5–2.0 times. Due to a rich phenolic content, in dry residue consisted approximately 55-60 %, these extracts exhibited pronounced biological activity. HPLC analysis of polyphenols was performed at "Shimadzu LC-2030C 3D-Plus" with PDA detector, by gradient elution with water: acetic acid (polar phase A) and acetonitrile: acetic acid (non-polar phase B), using reversed-phased C₁₈ column "Phenomenex" (150mm*4.6mm*5µm*80nm). HPLC show the presence in extracts of a high quantitates of biologically active compounds: gallic acid and its derivatives, ellagic acid, casuarictin, catechin, epicatechin and partially identified derivatives of rutin. Antioxidative activities of the extracts, obtained from kernel's pellicle, were determined in vitro by evaluation of peroxyl radical scavenging capacity. Antioxidant activities were calculated in gallic acid equivalent (GAE) in mM per gram of the dry residue. Antioxidant activities varied from 2.10 to 3.17 mM GAE/g, in function of harvesting year and defatting pre-treatment.

To conclude, the pellicle of walnut kernels is a valuable source of the biologic active phenolic compounds with antioxidative properties, which could be used for development of the food compositions with functional properties. Notable fact: extraction of phenolic compounds from the pellicle prevent a kernel's browning and bittering. Use of so-called dephenolised walnuts seems to be a promisingly way for the development of smart food technologies.

Keywords: antioxidant activity, functional foods, gradient elution, HPLC, kernel's pellicle, polyphenols.

Acknowledgments:

We express our gratitude to the "*Erasmus Plus*" University Staff Mobilities, funded by the European Union, and to the Postdoctoral Project 20.00208.1908.02, founded by the Government of Moldova.



NEW, DIGITAL BIOLOGY OF THE 21ST CENTURY: THROUGH DIGITALIZATION TO VIRTUALIZATION

Kharlampy Tiras

Pushchino State Institute of Natural Sciences, Institute of Theoretical and Experimental Biophysics, Pushchino, Russian Federation; E-mail.: <u>tiras1950@yandex.ru</u>

New, digital biology of the 21st century: through digitalization to virtualization. A living organism has always occupied a central place in biology, which explains the special interest of biology and biologists in this level of organization of living things. At the same time, there is an objective complexity of the study of a living being. In order to study it, it must be found in nature or diluted in a clinic or greenhouse, and then various traumatic or fixing procedures must be used to study its morphology, physiology, or biochemistry. Such procedures most often lead to the death of the investigated object, that is, its transition from a living to a nonliving state. As a result of all these manipulations, the living turns into inanimate, it is necessary to study not the state of a living object, as such, but a fixed artifact, if we are talking about its morphology, or a gradually dying object when a routine physiological study is carried out.

The opposite of reduction in biology is the naturalistic approach when a living object is studied in its native, undamaged state. This approach dominated biology in the 17–18 centuries, but then, in the 19–20 centuries, the experimental (reduction) approach completely dominated in biology, the result of which was a description of a not quite living or not at all living object. It is fair to call such biology martyrology, as the science of inanimate nature. A good metaphor for old biology is the classic biological museum with thousands of stuffed animals, formalin artifacts, and dry herbarium leaves.

The methodological impasse in the study of living matter began to be overcome during the technological revolution at the turn of the 20th and 21st centuries when the digital technology of remote (non-invasive) study of living objects came to biology. The advent of digital video microscopy, two- and three-dimensional scanners, and various tomography systems made it possible to study the surface, as well as the internal structure and functions of undamaged living objects.

Digital technologies must be implemented precisely at the level of the whole organism, when information is obtained through external (non-invasive) observation, which links the practice (ethics) of modern digital technological reality with the times of the founding fathers of modern biology: Linnaeus, Goethe, and the Humboldt brothers. The rational aspect of this approach consisted in adhering to universal scientific ethics: obtaining accurate information about the structure of a living object without external influence on it.

As the digital revolution develops, we are witnessing the revival of the ethics of naturalism in its new format – as a synthesis of (non-invasive) observation and experiment, which creates the preconditions for the development of a new (true) biology, the biology of a living organism. This is a special observation experiment when the study of the structure and function of a living thing is transferred from the living object itself to its electronic image (avatar).

At the same time, the border between the naturalist and the experimental naturalist is erased – a new, virtual reality appears, in which the naturalist conducts his "experiments". With further digitalization, biology will inevitably switch to working with files, objects of virtual reality. Biological research will consist of the application of different algorithms for analyzing the same image to obtain more and more information about the electronic object under study. The digitalization of biology leads it to more and more complete virtualization, which will be the main trend of its development in the 21st century.

Keywords: digital biology, naturalistic ethics, digitalization, virtualization.



Yeuheniia Tkach, Tetiana Pylypchuk, Oksana Lobova, Alyona Bunas, Viktoriya Starodub

Institute of Agroecology and Environmental Management of National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>bio_eco@ukr.net</u>

Today, more than 25 % of Ukraine's agricultural land is contaminated with pesticides, radionuclides, and inorganic toxicants. There is also a loss of soil fertility in more than 50 % of the territory. In most cases, this situation leads to a shortage of yields of major crops to 50-60 %, while deteriorating product quality.

Many Ukrainian scientists have studied and solved the issue of environmental assessment, in particular, N.A. Makarenko, E.G. Degodyuk, A.I. Fateev, V.I. Kisil, etc.

For research, we selected the following areas in the regions of Kyiv (village Makariv), Kirovohrad (village Danylova Balka), Cherkasy (village Sobkivka), Vinnytsia (village Tsybulivka), Odesa (village Bobryk Druhyi).

Ecological assessment of winter wheat growing technologies was carried out in the farms of the studied areas. The sown area of plots was – from 10 to 50 hectares, accounting for 10 m^2 in 5 repetitions.

To conduct an ecological assessment of winter wheat cultivation technologies, the following indicators were studied: soil fertility. Ecological assessment of soil fertility shows, however, that the studied technologies for growing winter wheat in the studied areas using fertilizers and plant protection products are generally satisfactory, and the proposed technological methods of crops growing need improvement; phytosanitary condition: crops of winter wheat in the ecological assessment of technologies on phytosanitary indicators had an unsatisfactory (1 point) and satisfactory (2 points) condition. In all studied wheat agrocenoses, the economical threshold of weed (ETW), pest, and disease harmfulness exceeded the norm. The overall score was satisfactory (1.7 points) in farms of the Cherkasy region, and unsatisfactory in other researched farms (0.7–1.3 points).

The quality and safety of crop products took into account biometric indicators and yield indicators.

Indicators of productivity and quality of winter wheat as a result of research have the second class – satisfactory. At the same time, in almost all studied farms the yield is normal (2-3 points), the yield varies from 30 to 42.1 c/ha. At the same time, quality indicators – protein and gluten content correspond to unsatisfactory and satisfactory conditions.

Thus, the ecological assessment of technologies for growing winter wheat on a set of indicators makes it possible to objectively assess individual technological processes, identify imperfect technological operations and develop measures to improve them. This guarantees the introduction into production of only those cultivation technologies that will ensure the production of a high-quality grain of winter wheat following international requirements and standards.

Keywords: ecological assessment, phytosanitary condition, winter wheat, ETW.



IN VITRO ANTIBACTERIAL ACTIVITY OF THE CRUDE ETHANOLIC EXTRACTS FROM THE LEAVES OF SOME *BEGONIA* SPP. AGAINST *ENTEROCOCCUS FAECALIS* ISOLATE

Halyna Tkachenko¹, Lyudmyla Buyun², Natalia Kurhaluk¹, Yana Belayeva²

¹Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland; E-mail.: <u>halyna.tkachenko@apsl.edu.pl</u>

²M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine

Begonia is now considered to be one of the five largest genera of vascular plants, and the genus is increasingly used as a model for understanding the evolution of species-rich genera. Moreover, phytochemical screening of *Begonia* species has revealed that many compounds, isolated from these plants are highly bioactive. Considering that the therapeutic efficiency of antimicrobials has become more complex due to the emergence of multidrug resistance, in the present study, we aimed to evaluate the antimicrobial effects of ethanolic extracts obtained from leaves of nine *Begonia* species against the *Enterococcus faecalis* (Andrewes and Horder) Schleifer and Kilpper-Balz ATCC[®] 51299[™] strain using Kirby-Bauer agar disc diffusion assay.

The leaves of *Begonia* plants, cultivated under glasshouse conditions, were sampled at M.M. Gryshko National Botanical Garden (NBG), National Academy of Science of Ukraine. The list of Begonia species, selected for this study includes Begonia solimutata L.B. Sm. & Wassh., Begonia goegoensis N.E.Br., Begonia foliosa Kunth, Begonia × bunchii L.H.Bailey (syn. Begonia × erythrophylla Hérincq), Begonia thiemei C.DC. (syn. Begonia macdougallii Ziesenh.), Begonia peltata Otto & Dietr. (syn. Begonia kellermanii C.DC.), Begonia heracleifolia Cham. & Schltdl., Begonia dregei Otto & Dietr., Begonia mexicana G. Karst. ex Fotsch. Fresh leaves were washed, weighed, crushed, and homogenized in 96 % ethanol (in proportion 1:19) at room temperature. The extracts were then filtered and investigated for their antimicrobial activity. Strain tested was plated on TSA medium (Tryptone Soy Agar) and incubated for 24 hr at 37 °C. Then the suspension of microorganisms was suspended in sterile PBS and the turbidity adjusted equivalent to that of a 0.5 McFarland standard. The antimicrobial susceptibility testing was done on Muller-Hinton agar by the disc diffusion method (Kirby-Bauer disk diffusion susceptibility test protocol). Muller-Hinton agar plates were inoculated with 200 µl of standardized inoculum (10⁸ CFU/mL) of the bacterium and spread with sterile swabs. Zone diameters were determined and averaged.

The current study has shown that ethanolic extracts obtained from leaves of *Begonia* plants possessed moderate activity against *E. faecalis*. The diameters of the inhibition zone were (14.87 ±0.87) mm for *B. solimutata*, (14.26 ±0.91) mm for *B. goegoensis*, (13.78 ±1.02) mm for *B. foliosa*, (11.55 ±1.05) mm for *Begonia* × *bunchii*, (11.18 ±0.99) mm for *B. thiemei*, (12.58 ±1.12) mm for *B. peltata*, (13.2 ±1.04) mm for *B. heracleifolia*, (14.61 ±1.17) mm for *B. dregei*, and (14.53 ±1.20) mm for *B. mexicana*. The highest antimicrobial effect was recorded for *B. solimutata*, *B. dregei*, *B. goegoensis*, and *B. mexicana*. The most antimicrobial effective plant against *E. faecalis* was *B. solimutata*, being more active with the ethanolic extract (diameter of inhibition zone was 14.26 ±0.91 mm).

The results of the current study provide informative data for the use of the crude ethanolic extracts obtained from leaves of some *Begonia* species against bacterial microbial infections caused by *E. faecalis*. According to our results, the leaf extract of *B. solimutata*, *B. dregei*, *B. goegoensis*, and *B. mexicana* exhibited significant anti-*E. faecalis* effects. Therefore, these plants could serve as source materials for the development of new antimicrobial agents. However, further phytochemical research focused on these species will be needed to isolate and characterize their antimicrobial effective constituents.

Keywords: *Begonia*, leaves, ethanolic extract, antimicrobial activity, agar disk diffusion assay.



IN VITRO EVALUATION OF ANTIMICROBIAL EFFICACY OF ETHANOLIC EXTRACTS FROM LEAVES OF *FICUS TINCTORIA* G. FORST.

Halyna Tkachenko¹, Lyudmyla Buyun², Natalia Kurhaluk¹, Anna Góralczyk¹, Vitaliy Honcharenko³, Andriy Prokopiv^{3,4}

¹Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland; E-mail.: <u>halyna.tkachenko@apsl.edu.pl</u> ²M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine ³Ivan Franko National University of Lviv, Ukraine

⁴Botanic Garden of Ivan Franko National University of Lviv, Ukraine

The current study is a continuous line of our investigations directed towards the assessment of the antibacterial potentials of *Ficus* species plants. The current study aimed to determine the antibacterial activity of *Ficus tinctoria* G. Forst. against Gram-positive and Gramnegative bacteria. For this study, a panel of organisms including *Staphylococcus aureus* subsp. *aureus* Rosenbach (ATCC®25923TM) (mecA negative), *S. aureus* subsp. *aureus* Rosenbach (ATCC®29213TM) (mecA negative, weak β-lactamase producing strain), *S. aureus* NCTC 12493 (mecA positive, Methicillin-resistant, EUCAST QC strain for cefoxitin), *Escherichia coli* (Migula) Castellani and Chalmers (ATCC®25922TM), *E. coli* (Migula) Castellani and Chalmers (ATCC®35218TM), *Pseudomonas aeruginosa* (Schroeter) Migula (ATCC®27583TM) were used. The antimicrobial susceptibility testing was done on Muller-Hinton agar by the disc diffusion method. Inhibition zone diameters were determined and averaged.

It was observed, that the ethanolic extract obtained from leaves of *F. tinctoria* resulted in considerable growth suppression of S. aureus and E. coli strains. Moreover, the differential efficacy of ethanolic extract derived from leaves of *F. tinctoria* plant on the test organisms was evidenced. Consequently, the extract screened displayed high antibacterial potency against *S*. *aureus*, i.e. the mean of inhibition zone diameters was (13.49 ± 1.08) and (17.74 ± 1.13) mm for S. aureus subsp. aureus (ATCC[®]29213[™]) and S. aureus NCTC 12493, respectively. Also, E. coli exhibited similar susceptibility for the impact of the ethanolic extract obtained from leaves of *F. tinctoria.* In particular, the mean values of inhibition zone diameters were (16.25 ±1.12) and (15.34 ±0.91) mm for *E. coli* (ATCC[®]25922[™]) and *E. coli* (ATCC[®]35218[™]), respectively. *P. aeruginosa* (ATCC[®]27583[™]) strain was the most resistant to the impact of the ethanolic extract obtained from leaves of *F. tinctoria* with the mean of inhibition zone diameter (10.33 ±0.65) mm. Moreover, the ethanolic extract obtained from leaves of *F. tinctoria* revealed significant antibacterial activity against studied strains compared to control samples (96 % ethanol). A statistically significant increase (p<0.05) in inhibition zone diameters of strain growth was 58 % (for *S. aureus* subsp. *aureus* ATCC[®]29213[™]) and 94.5 % (for *S. aureus* NCTC 12493). A significant increase (p<0.05) in inhibition zone diameters for growth of *E.coli* strains was also observed (by 84 % for *E. coli* ATCC[®]25922[™] and by 71 % for *E. coli* ATCC[®] 35218[™], respectively).

Thus, the present study has revealed that ethanolic extract derived from the leaves of *F. tinctoria* exhibited significant antibacterial activity against different both Gram-positive and Gram-negative strains studied (inhibition zone diameter ranged from 8.3 to 19.7 mm). The promising results on medicinal plants screening for antibacterial activity could be considered as primary information for further phytochemical and pharmacological studies. In particular, the next step in our further investigation will be HPLC-profiling of the plant extract to find new bioactive compounds from a natural source.

Keywords: *Ficus tinctoria*, leaves, antibacterial efficacy, disc diffusion technique, ethanolic extracts.

Acknowledgments

We are grateful to The Visegrad Fund for supporting our study.

IN VITRO ANTIOXIDANT RESPONSE OF THE EQUINE BLOOD TREATED BY EXTRACT OBTAINED FROM *FICUS DRUPACEA* THUNB. LEAVES (MORACEAE)

Halyna Tkachenko¹, Lyudmyla Buyun², Natalia Kurhaluk¹, Vitaliy Honcharenko³, Andriy Prokopiv^{3,4}

¹Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland; E-mail.: <u>halyna.tkachenko@apsl.edu.pl</u>

²M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine ³Ivan Franko National University of Lviv, Ukraine

⁴Botanic Garden of Ivan Franko National University of Lviv, Ukraine

The objective of this report is to highlight the antioxidant properties of the leaf extract obtained from *Ficus drupacea* Thunb. The degree of amelioration of oxidative damage was determined using the equine plasma and erythrocytes model through *in vitro* bioassay by comparing the effects of leaf extract on the superoxide dismutase, catalase, and glutathione peroxidase activities.

The leaves of *F. drupacea* were collected in M.M. Gryshko National Botanical Garden (Kyiv, Ukraine). Freshly collected leaves were washed, weighed, crushed, and homogenized in 0.1M phosphate buffer (pH 7.4) (in proportion 1:19, w/w) at room temperature. The extracts were then filtered and used for analysis. The pellet of blood was resuspended in 4 mM phosphate buffer (pH 7.4). A volume of 0.1 ml of the plant extract was added to 1.9 ml of equine erythrocytes or 1.9 ml of plasma. For positive control (4 mM phosphate buffer) was used. After incubating the mixture for 60 min at 37 °C with continuous stirring, it was centrifuged at 3,000 rpm for 5 min. Erythrocytes aliquots were used in the study. Superoxide dismutase (SOD, E.C. 1.15.1.1) activity was assessed by its ability to dismutate superoxide produced during quercetin auto-oxidation in an alkaline medium (pH 10.0) by Kostiuk et al. (1990). Catalase (CAT, E.C. 1.11.1.6) activity was determined by the method of Koroliuk et al. (1988). Glutathione peroxidase (GPx, EC 1.11.1.9) activity was determined according to the method of Moin (1986). The ceruloplasmin (CP, EC 1.16.3.1) level in the plasma was measured spectrophotometrically, as described by Ravin (1961). The TAC level in the samples was estimated by measuring the 2thiobarbituric acid reactive substances (TBARS) level after the Tween 80 oxidation according to Galaktionova et al. (1998). All statistical calculation was performed on separate data with STATISTICA 8.0 software (StatSoft, Krakow, Poland).

In our study, the aqueous leaf extract of *F. drupacea* has proven effective to increase the SOD, catalase, and GPx activity (by 41.6 %, 32.4 %, and 61.5 %, p<0.05). The increase of the SOD, catalase, and GPx activity was induced by TAC enhancement in the erythrocytes and plasma samples (p>0.05). SOD activity was non-significantly increased by 4 % (p>0.05). On the other hand, *F. drupacea* leaf extract caused a statistically significant decrease in ceruloplasmin level by 58.7 % (p<0.05). The results of this research indicated that crude extract obtained from *F. drupacea* leaves has an effective antioxidant effect after treatment of a suspension of equine erythrocytes. The protective effect of *F. drupacea* extract is evident by amelioration in activities of antioxidant enzymes (SOD, catalase, and GPx). The pronounced effect of *F. drupacea* leaf extract, probably, could be attributed to its secondary metabolites content, e.g. polyphenols and flavonoids contents. It is believed, that there is a substantial discrepancy between findings obtained *in vitro* and *in vivo* experiments. Therefore, further *in vivo* investigation is necessary to reveal the exact cellular mechanisms of the effect of *F. drupacea* extract on the erythrocyte membrane function.

Keywords: Ficus drupacea, leaves, extract, antioxidant enzymes, total antioxidant capacity.

Acknowledgments

ANTIBACTERIAL ACTIVITY OF *SANSEVIERIA AETHIOPICA* THUNB. LEAF EXTRACT Halyna Tkachenko¹, Lyudmyla Buyun², Natalia Kurhaluk¹, Myroslava Maryniuk²

¹Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland; E-mail.: <u>halyna.tkachenko@apsl.edu.pl</u>

²M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine

Several African medicinal plants previously investigated for biological potential showed good antibacterial activities. Some of them include species belonging to the *Sansevieria* genus. In our continuous search of phytochemicals to combat bacterial infections, we designed the current study to evaluate the antimicrobial potential of *Sansevieria aethiopica* against Gramnegative and Gram-positive phenotypes, i.e. *Escherichia coli, Staphylococcus aureus*, and *Pseudomonas aeruginosa* strains, clinically important bacteria, which are indicator organisms commonly used in various projects in order to monitor antibiotic resistance.

Freshly collected leaves were washed, weighed, crushed, and homogenized in 96 % ethanol (in proportion 1:19) at room temperature. The extracts were then filtered and investigated for their antimicrobial activity. All extracts were stored at 4°C until use. For this study, a panel of organisms including *Staphylococcus aureus* subsp. *aureus* Rosenbach (ATCC®25923TM) (mecA negative), *S. aureus* subsp. *aureus* Rosenbach (ATCC®29213TM) (mecA negative, weak β -lactamase producing strain), *S. aureus* NCTC 12493 (mecA positive, Methicillin-resistant, EUCAST QC strain for cefoxitin), *Escherichia coli* (Migula) Castellani and Chalmers (ATCC®25922TM), *E. coli* (Migula) Castellani and Chalmers (ATCC®35218TM), *Pseudomonas aeruginosa* (Schroeter) Migula (ATCC®27583TM) was used. Antimicrobial activity was determined using the agar disk diffusion assay. The following inhibition zone diameter criteria were used to assign susceptibility or resistance of bacteria to the phytochemicals tested: Susceptible (S) ≥ 15 mm, Intermediate (I) = 10–15 mm, and Resistant (R) ≤ 10 mm.

In line with the growing interest in the antibacterial potential of different plants, we examined the antibacterial properties of *S. aethiopica* leaves against *E. coli, S. aureus*, and *P. aeruginosa* strains. The results of antibacterial activity screening indicate that the extract has shown antibacterial activity against all tested organisms. The leaf extract has shown better activity against *S. aureus* strains compared to the *E. coli* and *P. aeruginosa* strains. The diameters of inhibition zones were (26.35 ±1.26) mm, (16.15 ±1.47) mm, and (21.6 ±1.23) mm for *S. aureus* ATCC®25923TM, *S. aureus* ATCC®29213TM, and *S. aureus* NCTC 12493, respectively. The extract has shown less antimicrobial activity against *P. aeruginosa*. The mean value of the inhibition zone was (12.49 ±1.09) mm. Finally, the ethanolic extract exhibited mild antibacterial activity against *E. coli* (mean value of inhibition zone ranged within (18.62 ±1.32) mm for *E. coli* ATCC®25922TM and (16.38 ±1.02) mm for *E. coli* ATCC®35218TM).

Clear inhibition zones indicated that the compounds showed the antibacterial activity of the antibiotic disc against bacterial strains. It was observed that strains of both Gram-positive and Gram-negative strains: *E. coli*, *P. aeruginosa*, and *S. aureus* were sensitive to *S. aethiopica* extract. Therefore, it is concluded that plant extract possesses antibacterial activity against tested organisms. The values of the inhibition zone varied suggesting the various degree of efficacy and different substances of the extract towards the target strains. Additionally, the antibacterial activity of the *S. aethiopica* extract may be due to the presence of various active metabolites. Thus, the preliminary antibacterial screening indicated that the leaves of *S. aethiopica* with antibacterial properties may offer alternative therapeutic agents against bacterial infections.

Keywords: *Sansevieria aethiopica,* leaves, ethanolic extract, antimicrobial activity, disk diffusion method.

IN VITRO ESTIMATION OF TOTAL ANTIOXIDANT CAPACITY OF THE MUSCLE TISSUE OF RAINBOW TROUT (*ONCORHYNCHUS MYKISS* WALBAUM) EXPOSED TO LEAF EXTRACTS OF SANSEVIERIA SUFFRUTICOSA N.E.BR.

Halyna Tkachenko¹, Lyudmyla Buyun², Natalia Kurhaluk¹, Maryna Opryshko², Myroslava Maryniuk², Oleksandr Gyrenko²

¹Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland; E-mail.: <u>halyna.tkachenko@apsl.edu.pl</u>

²M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine

It is believed that the total antioxidant capacity (TAC) can be considered as a marker of oxidative stress, which can be used in biomedical and nutritional studies, since it measures the state of antioxidant capacity in biological tissues. The aim of this study was to evaluate an *in vitro* effect of extract obtained from leaves of *Sansevieria suffruticosa* N.E.Br. on the total antioxidant capacity (TAC) in the muscle tissue of the rainbow trout (*Oncorhynchus mykiss* Walbaum).

The leaves of *S. suffruticosa* plants, cultivated under glasshouse conditions, were sampled at M.M. Gryshko National Botanical Garden, NAS of Ukraine. Freshly collected leaves were washed, weighed, crushed, and homogenized in 0.1M phosphate buffer (pH 7.4). The minced muscle tissue of clinically healthy rainbow trout was used to incubate with extract of *S. suffruticosa* (in a ratio 19:1, v/v) at room temperature. The incubation time was 2 hours. TAC was assessed in the incubated homogenate by measuring the 2- thiobarbituric acid reactive substances (TBARS) level after Tween-80 oxidation. according to Galaktionova et al-(1998). Significance of differences between the oxidative stress biomarkers level (significance level, p<0.05) was examined using the Mann-Whitney *U* test (StatSoft, Poland).

The results showed that extract of *S. suffruticosa* leaf efficiently increased the TAC level in muscle tissue by 66.8 % (p<0.05), suggesting that the extract of *S. suffruticosa* has possessed remarkable antioxidant potential. According to the abovementioned antioxidant mechanisms, extract of *S. suffruticosa* may activate antioxidant enzymes and their synthesis *de novo*. According to the results obtained, we addressed the hypothesis that by-products in the extract of various *S. suffruticosa* may be a major contributor to the increase of antioxidant capacity of muscle tissue of rainbow trout after incubation *in vitro*. To prove this hypothesis, separation and characterization of secondary compounds in plant extracts are required for further study. In fact, different antioxidant effects of various species of the *Sansevieria* genus are determined by their by-products (alkaloids, flavonoids, saponins, glycosides, terpenoids, tannins, proteins, carbohydrates, etc.). Indeed, the study on *S. roxburghiana* and *S. trifasciata* has revealed the presence of important compounds which were separated by thin-layer chromatography. Phytochemical screening of the extracts of the *S. trifasciata* plant showed the presence of major *classes* of phytochemicals.

Taking into account existing experimental *evidence*, it is reasonable to assume that secondary plant metabolites, i.e. polyphenolic compounds in extract of *S. suffruticosa* may contribute to the antioxidant activity. In conclusion, the results of this study provide a new perspective for the use of various *Sansevieria* species as a medicinal plant to improve the antioxidant response of rainbow trout. Further studies including the use of other medicinal plants as food additives in aquaculture, the assessment of its antioxidant effects on various tissues are in progress.

Keywords: Sansevieria suffruticosa, leaves, extracts, total antioxidant capacity, rainbow trout.

Acknowledgments

IN VITRO STUDIES OF ANTIOXIDANT POTENTIAL OF EXTRACT DERIVED FROM THE LEAVES OF *BEGONIA FOLIOSA* KUNTH IN HUMAN ERYTHROCYTE SUSPENSION

Halyna Tkachenko¹, Lyudmyla Buyun², Natalia Kurhaluk¹, Maryna Opryshko², Myroslava Maryniuk², Oleksandr Gyrenko²

¹Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland; E-mail.: <u>halyna.tkachenko@apsl.edu.pl</u>

²M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine

The current study describes the effect of aqueous leaf extracts obtained from *Begonia foliosa* Kunth with human erythrocytes suspension. Erythrocytes were chosen because although less specialized than many other cell membranes they carry on enough functions in common with them, i.e. active and passive transport, the production of ionic and electric gradients, etc. Therefore, their structure can be considered representative of the plasma membrane in general. Thus, 2-thiobarbituric acid reactive substances (TBARS) as a biomarker of lipid peroxidation, aldehydic and ketonic derivatives of oxidatively modified proteins (OMP), and total antioxidant capacity (TAC) have been used in order to assess oxidative stress in erythrocytes' suspension after incubation with plant extract in dose 5 mg/mL.

The leaves of *Begonia foliosa* plants, cultivated under glasshouse conditions, were sampled at M.M. Gryshko National Botanical Garden (NBG), National Academy of Science (NAS) of Ukraine. Freshly collected leaves of *B. foliosa* were washed, weighed, crushed, and homogenized in 0.1M phosphate buffer (pH 7.4) (in ratio 1:19, w/w) at room temperature. All extracts were stored at -20 °C until use. Human blood (10-20 ml) was obtained from normal volunteers *via* venipuncture. The Research Ethics Committee of Medical University in Gdańsk (Poland) approved the study (KB-31/18). Human erythrocytes were isolated by centrifugation at 3,000 rpm for 10 min and washed two times with 4 mM phosphate buffer (pH 7.4). An erythrocyte suspension at 1 % hematocrit was incubated with 4 mM phosphate buffer (pH 7.4) (control) and pre-incubated with the extract (5 mg/mL) at 37 °C for 60 min. This reaction mixture was shaken gently while being incubated for a fixed interval at 37 °C. For positive control, phosphate buffer was used.

The results obtained by incubating human erythrocyte suspension in the presence of the aqueous extract derived from the leaves of *B. foliosa* revealed a significant decrease of TBARS level (by 69.5 %, p < 0.05), while the content of aldehydic and ketonic derivatives of oxidatively modified proteins was non-significantly decreased (by 14.2 and 9.5 %, p >0.05) compared to control samples. The maintenance of oxidative stress biomarkers on the persistent level induced the non-statistically significant decrease in the total antioxidant capacity level (by 23.4 %, p >0.05). In conclusion, extract derived from the leaves of *B. foliosa* possessed antioxidant defenses potential decreasing lipid peroxidation level in the human erythrocytes. These in vitro assays indicate that *B. foliosa* extract screened is a significant source of natural antioxidants, which might help prevent the progress of various oxidative stress-induced pathological disorders. In particular, it was revealed that the antioxidant and antimicrobial activity of *B. trichocarpa* Dalzell is associated with the presence of flavonoid quercetin. However, the phytoconstituents responsible for the antioxidative activity of *B. foliosa* extract have not yet been found. Therefore, further investigations need to be carried out to isolate and identify the phytochemical constituents and antioxidant compounds present in the *B. foliosa* plant extract, including high-performance liquid chromatography-mass spectrometry (HPLC-MS)-based profiling.

Keywords: *Begonia foliosa*, leaves, lipid peroxidation, total antioxidant capacity, erythrocytes.

Acknowledgments

ANTI-HEMOLYTIC EFFECTS OF EXTRACTS OBTAINED FROM LEAVES OF VARIOUS BEGONIA L. SPECIES ON THE EQUINE ERYTHROCYTE MEMBRANES

Halyna Tkachenko¹, Lyudmyla Buyun², Natalia Kurhaluk¹, Maryna Opryshko², Myroslava Maryniuk², Oleksandr Gyrenko²

¹Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland; E-mail.: <u>halyna.tkachenko@apsl.edu.pl</u>

²M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine

In the present study, the percentage hemolysis of equine erythrocytes induced by treatment with leaf extracts of various *Begonia* species are determined to exemplify their further potential development and use as alternative plant-derived agents against metabolic diseases in medicine and veterinary.

The leaves of *Begonia* plants, cultivated under glasshouse conditions, were sampled at M.M. Gryshko National Botanical Garden, National Academy of Science of Ukraine. The leaves of thirty plants species, i.e. Begonia foliosa Kunth, B. psilophylla Irmsch., B. convolvulacea (Klotzsch) A.DC., B. ulmifolia Willd., B. rex Putz., B. thiemei C.DC., B. manicata Brongn., B. solimutata L.B.Sm. & Wassh., B. arborescens var. oxyphylla (A.DC.) S.F.Sm., B. mexicana G. Karst. ex Fotsch, Begonia × credneri F.Haage & E.Schmidt, B. sanguinea Raddi, B. olbia Kerch., B. goegoensis N.E.Br., B. imperialis var. smaragdina Lem., B. epipsila Brade, B. pustulata Liebm., B. heracleifolia var. nigricans Hook.f., Begonia × erythrophylla Hérincq, B. aconitifolia A.DC., B. peltata Otto & Dietr., B. nelumbiifolia Cham. & Schltdl., B. subvillosa Klotzsch, B. oxyphylla A.DC., B. masoniana Irmsch. ex Ziesenh, B. cucullata Willd., B. angularis Raddi, B. glabra Aubl., B. boisiana Gagnep., B. venosa Skan ex Hook.f. were sampled for study. Freshly collected leaves were washed, weighed, crushed, and homogenized in 0.1M phosphate buffer (pH 7.4) (in ratio 1:19, w/w) at room temperature. To evaluate the potential of extracts to cause hemolysis in equine erythrocytes, a hemolysis assay based on the spectrophotometric measurement of hemoglobin in the supernatant was performed. The extent of hemolysis was determined by measurement of the absorbance at 540 nm corresponding to hemoglobin liberation.

Our study demonstrated that among 30 species of the *Begonia* genus, the most species of plants investigated possessed anti-hemolytic activity. The results of these biological assays demonstrated that compounds present in *B. glabra, B. aconitifolia, B. sanguinea, B. thiemei, B. masoniana, B. × credneri, B. oxyphylla, B. subvillosa, B. ulmifolia, B. conconvulaceae* can cause the prevention of formation of methemoglobin and reduce of hemolysis, while *B. erythrophylla, B. psilophylla* and *B. arborescens* var. *oxyphylla* extracts can induce the formation of methemoglobin and cause hemolysis in healthy equine blood. Exposure to extracts from leaves of *B. foliosa, B. rex, B. solimutata, B. mexicana, B. goegoensis, B. imperialis* var. *smaragdina, B. pustulata, B. peltata, B. cucullata, B. angularis, B. boisiana, B. venosa* exhibited the decrease of percentage hemolysis of equine erythrocytes, but these alterations were non-significant.

The extensive use of plants from this genus having ethnobotanical value by the local people in treating various types of diseases and disorders might be justified by their antioxidant activities against oxidative stress and hemolysis, which are known to be responsible for causing various metabolic states and diseases. Further studies aimed at the isolation and identification of active substances from the various species of the *Begonia* genus, as well as assessment of oxidative stress biomarkers could also disclose compounds with better therapeutic value and doses.

Keywords: Begonia, leaves, extracts, hemolysis, equine erythrocytes.

Acknowledgments

TOTAL ANTIOXIDANT CAPACITY IN THE MUSCLE TISSUE OF THE RAINBOW TROUT (ONCORHYNCHUS MYKISS WALBAUM) AFTER IN VITRO INCUBATION WITH EXTRACTS DERIVED FROM LEAVES OF VARIOUS CULTIVARS OF CAMELLIA JAPONICA L.

Halyna Tkachenko¹, Natalia Kurhaluk¹, Lyudmyla Buyun², Igor Kharchenko², Maryna Opryshko², Myroslava Maryniuk², Oleksandr Gyrenko²

¹Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland; E-mail.: halyna.tkachenko@apsl.edu.pl

²M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine

In this study, extracts derived from leaves of various cultivars of *Camellia japonica* L. plants were chosen because of their recorded potential medical significance with antimicrobial, antioxidant, antitumor, anti-allergic, antiviral and skin healing properties. The main objective of the present study was to evaluate the effect of extracts derived from the leaves of various *C. japonica* cultivars on the total antioxidant capacity (TAC) level in the muscle tissue of rainbow trout (*Oncorhynchus mykiss* Walbaum).

The extracts obtained from the leaves of various *C. japonica* cultivars (Kramer's Supreme, C.M.Wilson, La Pace, Mrs. Lyman Clarke, Benikarako, Fanny Bolis) from the living plant collections grown under glasshouse conditions at M.M. Gryshko National Botanic Garden of the National Academy of Sciences of Ukraine (Kyiv, Ukraine) were used. Freshly collected leaves were washed, weighed, crushed, and homogenized in phosphate buffer 0.1M (in a ratio 1:19, w/w) at ambient temperature. Muscle tissue was removed from rainbow trout after immediate decapitation. The tissue samples were rinsed and homogenized in ice-cold 100 mM Tris-HCl buffer (pH 7.2). After centrifugation, the supernatant was used for incubation with leaf extracts of various *C. japonica* cultivars (in ratio 19:1). The incubation time was 2 hrs., after that the TAC was evaluated in the incubated homogenate.

Our results revealed quite a high TAC level in samples of muscle tissue incubated with leaf extracts of *C. japonica* cultivars C.M. Wilson and Benikarako. The levels of TAC were increased by 41.7 and 44.8 % (p < 0.05) as compared with the control samples. Leaf extracts of cultivars La Pace and Kramer's Supreme being incubated with muscle tissue have not changed the level of TAC, while the effect of the leaf extracts of cultivars Mrs. Lyman Clarke and Fanny Bolis on the decrease of TAC level was insignificant (p >0.05). *The results* of the *study suggested the high* antioxidant capacity of Camellia cultivars screened give reason to believe that application of these plant extracts signifies a rational curative strategy to prevent and cure various fish diseases involving oxidative stress by increasing the ability of fish organism to adapt. It was observed that the positive effect of *Camellia*'s preparations for the treatment of various pathological conditions of the organism is associated with high content of the substances with high antioxidant activity responsible for its ability to reduce oxidative stress. The obtained data suggested, that the level of TAC in samples of muscle tissue may be used as one of the indicators in order to assess the functional conditions of antioxidant defenses of the organism and effectiveness of exogenous antioxidant application. Thus, the obtained results, ascertained the potency of the extracts from leaves of various *C. japonica* cultivars as a potential source of natural antioxidant agents to be used in intensive aquaculture. Some discrepancy in scavenging potential of the *C. japonica* leaf extracts screened in this study and bibliographic data reporting profound biological activities of extracts derived from various part of this plant species may be due to variation in the percentage of phytocompounds extracted in various solvents or to different cultivation technology as well. To conclude, *C. japonica* may be used as an antioxidant agent in aquaculture as it can be easily obtained and is not expensive. Furthermore, the use of such plants products in aquaculture systems may also have environmental value because of their biodegradability.

Keywords: Camellia, leaves, extracts, total antioxidant capacity, rainbow trout.

CHANGES IN OXIDATIVE STRESS BIOMARKERS IN THE EQUINE BLOOD TREATED *IN VIT*RO BY EXTRACT DERIVED FROM *SANSEVIERIA PARVA* N.E.BR.

Halyna Tkachenko¹, Natalia Kurhaluk¹, Lyudmyla Buyun², Maryna Opryshko², Myroslava Maryniuk², Oleksandr Gyrenko²

¹Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland; E-mail.: <u>halyna.tkachenko@apsl.edu.pl</u>

²M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine

In this study, we have focused on the antioxidant effect of leaf extract obtained from *Sansevieria parva* N.E.Br. on oxidative stress biomarkers (2-thiobarbituric acid reactive substances (TBARS), carbonyl derivatives content of protein oxidative modification) and antioxidant defenses (total antioxidant capacity) using the equine erythrocytes as an experimental model. Thus, equine erythrocytes were proved to be a good tool for analyzing the oxidative stress biomarkers as predictors of antioxidant action of *S. parva* leaf extract.

The leaves of *S. parva* plant, cultivated under glasshouse conditions, were sampled at M.M. Gryshko National Botanical Garden (NBG), National Academy of Science of Ukraine. Freshly collected leaves were washed, weighed, crushed, and homogenized in 0.1M phosphate buffer (pH 7.4) (in ratio 1:19, w/w) at room temperature. The pellet of blood was resuspended in 4 mM phosphate buffer (pH 7.4). A volume of 0.1 ml of the plant extract was added to 1.9 ml of clean equine erythrocytes. For positive control, phosphate buffer was used. The level of lipid peroxidation was determined by quantifying the concentration of 2-thiobarbituric acid reacting substances (TBARS) with the Kamyshnikov (2004) method. The rate of protein oxidative destruction was estimated from the reaction of the resultant carbonyl derivatives of amino acid reaction with 2,4-dinitrophenylhydrazine as described by Levine et al. (1990) with modification of Dubinina et al. (1995). Total antioxidant capacity (TAC) in the samples was estimated by measuring the TBARS level after the Tween 80 oxidation (Galaktionova et al., 1998). All statistical calculation was performed on separate data with STATISTICA 8.0 software (StatSoft, Krakow, Poland).

The addition of the *S. parva* leaf extract for incubation with erythrocyte suspension caused a non-considerable increase in TBARS formation (by 17 %, p >0.05), while the content of aldehydic and ketonic derivatives of oxidatively modified proteins was decreased (by 0.7 %, p >0.05 and 2.8 %, p <0.05, respectively) compared to control samples. The TAC level increased by 11.6 % (p >0.05).

It is well evidenced that *Sansevieria* species have a wide range of secondary metabolites and are traditionally used in the treatment of various diseases and disorders. Recently, the investigations of Thu et al. (2020) have been *succeeded* by the isolation and identification of hundreds of phytochemical constituents isolated from *Dracaena* and *Sansevieria*. The most characteristic metabolites are steroids, flavonoids, stilbenes, and saponins; many of them exhibit potent analgesic, anti-inflammatory, antimicrobial, antioxidant, antiproliferative, and cytotoxic activities. Thus, the results of the present study reinforce the importance of the analyzed plants as a source of bioactive compounds with antioxidant properties. Further chemical analysis of the aforementioned plant extract should be performed to determine their chemical composition and identify the exact phytocompounds responsible for antioxidant activity. In addition, they should be subjected to pharmacological evaluations to assess theirs *in vivo* efficacy, toxicity, potential adverse effects, interactions, and contraindications.

Keywords: Sansevieria parva, leaves, extracts, oxidative stress, equine erythrocytes.

Acknowledgments

COMPARATIVE ASSESSMENT OF ANTIMICROBIAL EFFICACY OF ETHANOLIC EXTRACTS FROM LEAVES OF CAMELLIA JAPONICA L. CULTIVARS AGAINST STAPHYLOCOCCUS AUREUS STRAIN

Halyna Tkachenko¹, Natalia Kurhaluk¹, Igor Kharchenko², Lyudmyla Buyun², Maryna Opryshko², Myroslava Maryniuk², Oleksandr Gyrenko²

¹Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland; E-mail.: <u>halyna.tkachenko@apsl.edu.pl</u>

²M.M. Gryshko National Botanic Garden, National Academy of Science of Ukraine, Kyiv, Ukraine

According to the estimation of Erasmus+ project Good Herbs (http://good-herbs.eu/), about 90 % of species are harvested from wild flora and only 10 % are cultivated commercially. This work is a continuation of a series of publications directed towards *in vitro* assessment of the antibacterial potentials of *Camellia* L. plants from living plant collections maintained at M.M. Gryshko National Botanical Garden (NBG). Therefore, in this study, we aimed to determine the antibacterial activity of six plant cultivars of *Camellia japonica* L., i.e. Kramer's Supreme, C.M. Wilson, La Pace, Mrs. Lyman Clarke, Benikarako, Fanny Bolis against *Staphylococcus aureus* subsp. *aureus* Rosenbach (ATCC®29213[™]) strain.

The leaves of *C. japonica* and its cultivars Kramer's Supreme, C.M. Wilson, La Pace, Mrs. Lyman Clarke, Benikarako, Fanny Bolis plants cultivated at NBG's glasshouses under natural light, were sampled. The *C. japonica* cultivars included in this study represent four various double flowers types, i.e. "paeony" ('Kramer's Supreme' and 'Benikarako'), "rose" ('C.M. Wilson' and 'La Pace'), "semi-double" ('Mrs. Lyman Clarke'), and "formal double" ('Fanny Bolis'). Freshly collected leaves were washed, crushed, weighed, and homogenized in 96 % ethanol (in proportion 1:19) at room temperature. The *S. aureus* subsp. *aureus* Rosenbach (ATCC®29213[™]) strain was used in the current study. The antimicrobial susceptibility testing was done by the disc diffusion method (Kirby-Bauer disk diffusion susceptibility test protocol). After incubation in an appropriate culture medium (Muller-Hinton agar), the diameter of the inhibition zone was measured and averaged to assess the antibacterial efficacy.

The crude extracts were analyzed for their antibacterial effect by assessing their inhibitory zones against *S. aureus* subsp. *aureus* strain. Among the six plant extracts screened, *C. japonica* 'Mrs. Lyman Clarke' and 'Benikarako' exhibited the highest inhibitory zones against the tested strain (the mean of the zone of inhibitions was 14.87 ± 1.0 mm and 14.56 ± 1.12 mm, respectively). The intermediate activity was presented by variety *C. japonica* (13.78 ± 1.12 mm), 'Fanny Bolis' (13.74 ± 0.85 mm), 'Kramer's Supreme' (13.1 ± 0.98 mm), 'La Pace' (12.56 ± 1.08 mm), and 'C.M. Wilson' (10.25 ± 0.4 mm). The antibacterial effect of positive control was also recorded (the mean value of the inhibition zone was 8.56 ± 0.75 mm). The results obtained in the current study are in line with early reports. The potential presence of naturally occurring antimicrobials in petals of *C. japonica* active against foodborne pathogens in microbiological media and food was studied by Kim et al. (2001).

In conclusion, the alcoholic leaf extracts of *C. japonica* and its cultivars revealed mild antibacterial activity against *S. aureus* subsp. *aureus* Rosenbach (ATCC®29213TM) strain. The antimicrobial ability of various samples of these plants might be due to a wide variety of compounds. The findings reported herein give scientific credence to the traditional use of these plants and suggest that extracts derived from the leaves of *C. japonica* and its cultivars merit further chemical study as natural antibiotics to identify the secondary metabolites.

Keywords: Camellia japonica, leaves, ethanolic extract, antimicrobial activity, disk diffusion assay.

Acknowledgments

TEST-INDICATORS OF *LEPIDIUM SATIVUM* L. SEEDLINGS UNDER THE INFLUENCE OF MICELLAR WATER

Nataliia Tkachuk, Iryna Okulovich

T.H. Shevchenko National University "Chernihiv Colehium", Chernihiv, Ukraine; E-mail.: <u>nataliia.smykun@gmail.com</u>

The use of plants to determine the toxicity of the environment (phytotesting) is widely used in ecological research. In particular, the test-plant sensitive to toxicants is garden cress (*Lepidium sativum* L.). Test-indicators of sensitive plants are the level of seed germination, the value of mass, and the size of seedlings. Today is known, that surfactants are dangerous pollutants. Thus, the synthetic surfactant is poloxamer 124, which together with other organic compounds is part of cosmetics, in particular micellar water. Therefore, this work aimed to study the biometric parameters of garden cress under the influence of cosmetic solutions of micellar water.

The seeds of the test plant (*L. sativum*) 10 pieces were placed on filter paper moistened with distilled water (control) or a suitable aqueous solution of micellar water (experiment). The experiment was repeated three times. Investigated available in the retail network of Ukraine means for removing makeup and cleansing the skin micellar water, which contained (according to the manufacturer): aqua, PEG-40 hydrogenated castor oil, glycerin, *Prunus (Amygdalus) dulcis* oil, panthenol, sorbitol, decyl glucoside, glyceryl glucoside, poloxamer 124, propylene glycol, disodium cocoyl glutamate, sodium chloride, trisodium EDTA, polyquaternium-10, 1,2-hexanediol, citric acid, sodium acetate, phenoxyethanol. The investigated concentrations of the micellar water were 6.25 %, 12.5 %, 25.0 %, 50.0 % and 100 %. Seed germination energy (3rd day), seed germination, and biometric-morphometric parameters (length of roots and aboveground part of seedlings) (5th day) were determined. The phytotoxic effect and the toxicity index of the solutions were calculated. The results were processed statistically using Excel 2010, determining: arithmetic mean and arithmetic mean error; the significance of differences according to Student's t-test.

It was found that the germination rates of garden cress seeds and biometric indicators of seedlings significantly decrease with the increasing concentration of the studied micellar water. Thus, germination energy and seed germination decreased by 14–100 %. At the same time, when watering the seeds of *L. sativum* with a solution with the maximum investigated concentration (100 %), it did not germinate. The length of the aboveground part of garden cress seedlings was determined only for the control and the variant with a concentration of micellar water of 6.25 % (it was 2 times significantly less than in the control) because at other higher concentrations the aboveground part of the seedlings was absent. There was a statistically significant decrease in the length of the roots compared to the control: 1.2 times (6.25 %), 1.6 times (12.5 %), 2.6 times (25.0 %), 3.3 times (50 %). The phytotoxic effect ranged from 49.6 to 100 %. It is established that the value of the total toxicity index of solutions is from 0.55 (6.25 %) to 0 (100 %), indicating an increase in the toxicity of the solution with increasing concentration.

Thus, garden cress *L. sativum* was a sensitive plant to the studied cosmetic. The obtained data confirm the high efficiency of this test plant for use in biotesting. As this cosmetic is used in small quantities and is significantly diluted with water when it enters the sewer system, its toxic effects are likely to be small or non-existent.

Keywords: Lepidium sativum, micellar water, phytotesting.



FORMATION AND PRESERVATION OF COLLECTIONS OF GENETIC RESOURCES OF LEGUMES AND GROATS CROPS

Oleh Tryhub, Serhiy Sylenko, Viktoria Voroncova, Olena Andruschenko, Oleksandr Rohovyi

Ustymivska Experimental Station of Plant Production of Plant Production Institute n.a. V.Y. Yuryev NAAS of Ukraine, Ustymivka, Ukraine; E-mail.: <u>trygub_oleg@ukr.net</u>

Global processes triggered by human activity and natural changes of flora are destroying thousands of species each year. Throughout evolution, some of those species (including legumes and groats crops) have formed the human food resources foundation on the planet. Natural reserves containing wild species of cultivated plants are becoming extinct, the situation with local varieties and forms is equally daunting. The samples of these species have been collected for centuries, and they are the carriers of unique quality indicators of extreme importance for human health and the backbone of a huge polymorphism based on economic and selection value characteristics. Selection institutions are solving the global task of increasing the productivity and quality of new varieties and hybrids. That it can only be solved by involving a new source material with a combination of relevant parameters, including resistance to abiotic environmental factors, disease, and pest damage in the selection process.

Collections are the reserves of such material. In Ukraine, one of the institutions specializing in the formation and preservation of genetic resources is the Ustymivska Experimental Station of Plant Production, a part of the System of Genetic Resources of Plants of Ukraine. During over 60 years of work on mobilization, study, and preservation of plant resources, the institution has accumulated a gene pool of legumes and groat crops totaling more than 13.3 thousand samples (including 5886 millet, 3022 beans, 1643 buckwheat, 1384 grass pea, and 1391 vetches, lupines and vignes). The collections are gathered using annual largescale expeditionary meetings on the territory of Ukraine and other countries, a wide omnidirectional exchange of material with the world's leading gene banks, selection institutions, and research centers, providing mutually beneficial exchange, aimed to enrich the collections. The full-fledged collection of samples is facilitated by the extraordinary natural and climatic diversity of Ukrainian territory that has formed a dramatically diverse flora representation – from steppe and semidesert climate to Polissva, submontane, and mountain with excessive rainfall. Each of the samples of the collection is represented in an electronic database from the moment the seeds are included in the collection until the fact of its transfer to plant breeders for work or other institutions for research.

The experimental station stores the collection material according to the type of mediumterm ex-situ storage in compliance with international standards of seed preparation and storage. Natural and climatic conditions of the research station's location (transition zone from the Forest-Steppe to the Steppe) ensure the completeness of reproduction of newly obtained samples and obtaining quality seeds. Direct storage is carried out in a chamber with controlled conditions – dry air at a temperature of + 2–4 °C. The number of seeds stored is sufficient to meet the needs of selection institutions, and when needed (i.e. in case of a significant order, reduction of grain, or reduced germination in comparison with optimal parameters) scientific units propagate it and put it into storage again.

Aiming to preserve the seeds in case of natural disasters and cataclysms, to be able to restore unique species of cultivated plants that will disappear forever from the earth's biosphere, the Ustymivska Experimental Station of Plant Production transferred 231 samples of the grass pea (*Lathyrus sativus* L.) into in World Seed Vault in the Svalbard archipelago.

Keywords: collections, legumes and groats crops, ex-situ conservation.

ANALYSIS OF DOSAGE FORMS OF FIRST AID MEDICINES FOR INFANTS

Joseph Tseja¹, Maryna Kobets¹, Yuliya Kobets, Natalia Malinina¹, Olena Ibrahimova², Olga Filiptsova¹

¹National University of Pharmacy, Kharkiv, Ukraine; E-mail.: <u>maya4ok777@yahoo.com</u> ²Kharkiv National Medical University, Kharkiv, Ukraine

Today the most acute problem in our society is the state of health of the children's population, since healthy children are the basis for the development of the country, determine it's further economic, scientific, cultural potential and the health of the following generations. Although the proportion of purely medical problems in the formation of a person's health, according to WHO, is not more than 10 %, the medical aspects of preserving health in early childhood have a much greater effect than in subsequent age groups, since two. This study aims to analyze the dosage forms of medicines for the treatment of infants.

According to the pharmacist's protocol, dosage forms were analyzed during the dispensing of over-the-counter drugs for the formation of a first aid kit for infants.

Unfortunately, today, in Ukraine, it's not possible to give birth to a completely healthy child. This is due to the nutrition of a woman, both during pregnancy and before her, the harmful habits of her future mother, the ecological situation in the country, and so on. That is why every mother should use medicines from the first day of her child's life. Most often it is a means for the treatment of gastrointestinal disorders, analgesics, and antipyretics, medicines for the treatment of viral infections, medicines for the treatment of bacterial infections, medicines for nose diseases. We analyzed dosage forms of first-aid drugs for infants in the pharmaceutical market of Ukraine among these five pharmacotherapeutic groups.

The group of medicines for the treatment of gastrointestinal disorders in the Ukrainian pharmaceutical market is represented by six pharmaceutical forms. Syrups occupy a leading position among the drugs of this group. Among the group of analgesics and antipyretics in the first place are suspensions – 49 %, in the second place – suppositories, which have 38 % and the third place are syrups – 13 %. A group of medicines for the treatment of viral infections in infants has no leader in the distribution of drugs in the form of medicine. In the analysis of the range of medicinal products of this pharmacotherapeutic group, it was found that suppositories, drops, and tablets have the same percentages in the distribution of drugs in the form of the drug – 25 %. Also, this group of drugs is presented on the pharmaceutical market of Ukraine in the form of solutions and drops of nasal. Medicines for the treatment of bacterial infections in the Ukrainian pharmaceutical market are presented in four pharmaceutical forms, the leader among which are powders – 62 %. Tablets, lyophilizate for solution for injection, and eye drops are 13 %. A group of drugs in nasal diseases is represented by two forms of medicine - drops, and sprays. The leading position is occupied by nasal drops - 75 %. Most of the first aid drugs for infants are presented in the form of a liquid dosage form. This production of drugs can be explained from the practical point of view: the convenience of using the drug by parents in the treatment of newborn babies. A significant share of the domestic market is taken by foreign manufacturers. Among each analyzed pharmacotherapeutic group, imported drugs have an advantage. The largest percentage of 37.5 % is produced by domestic producers in the manufacture of medicines for the treatment of viral infections. The smallest percentage of 12.5 % – in the manufacture of drugs for the treatment of gastrointestinal disorders, bacterial infections, and nasal diseases.

Keywords: pharmaceutical market, dosage forms, medicines, infants.

Acknowledgments

We would like to express our gratitude to the head of the Department of Pharmaceutical Management and Marketing of the National University of Pharmacy, Professor Volodymyr Malyi, for his help in conducting this study.

ANTAGONISTIC ACTIVITY OF TRICHODERMA VIRIDE 017 TO PATHOGENS OF ROOT ROT

Hanna Tsekhmister, Evgeniy Kopilov, Olena Nadkernychna, Anna Kyslynska

Institute of Agricultural Microbiology and Agro-industrial Manufacture, National Academy of Agrarian Sciences of Ukraine (NAAS), Chernihiv, Ukraine; E-mail.: <u>anna.tceh@gmail.com</u>

In recent decades cases of a new Cucurbitaceae plants disease, which is called "acremonium collapse" and is caused by *Acremonium cucurbitacearum* (syn. *Plectosphaerella melonis*) fungus, have been registered in many countries around the world. We search for the active microorganism-antagonist of this fungus and was established that the strain of *Trichoderma* sp. 017 fungus was characterized by the fastest growing and manifested hyperparasitism on the 5th day of cultivation of the former. Microorganisms with rapid growth and the ability of hyperparasitism colonize the substrate quicker and compete with the pathogenic microflora actively, therefore, *Trichoderma* sp. 017 fungus was selected for further research. A study of morphological and culture features allowed us to refer *Trichoderma* sp. 017 to *T. viride* 017 species.

It is shown that *T. viride* 017 strain has high antagonistic activity in respect of many pathogens of root diseases in plants (*A. cucurbitacearum* 502, *A. strictum, Thielaviopsis basicola, F. moniliforme* var. *lactis* and *Fusarium oxysporum* var. *orthoceras, Rhizoctonia violacea, F. oxysporum* and *F. solani*). Because the antagonism of the microorganism *in vitro* does not always correlate with its antagonism *in vivo*, the antagonistic activity of *T. viride* 017 was also studied in field experiments.

The obtained results showed that mycocenosis observed in the root zone of cucumber seedlings planted in sod-podzolic soils was formed by the micromycetes of the Acremonium Link, Alternaria Nees, Aspergillus Micheli, Cladosporium Corda, Fusarium Link: Fr, Gliocladium Corda, *Mortierella* Coem, *Mucor* Mich, *Penicillium* Link: Fr, *Rhizopus* Ehrenb, *Trichoderma* Hers genera, and the Dematiaceae family. The introduction of *A. cucurbitacearum* 502 plant pathogen into the soil to create an artificial infectious background (AIB) led to a decrease in the 10 total amount of fungi in the rhizosphere and rhizoplane more than 4 and 2.5 times respectively. Also, the proportion of *Penicillium* genus fungi decreased substantially, which can be considered a negative trend. The share of *Acremonium* genus fungi in rhizosphere and rhizoplane was negligible (3.1 and 9.7 % respectively) while in histosphere it made 73.2 %, which is indicative of the fungus migration to the roots of plants. A pre-sowing treatment of seeds with *T. viride* 017 fungus had a positive effect on the process of mycocenisis formation in cucumber plants. The number of fungi in the rhizosphere and rhizoplane increased two times compared with the variant where the chemical fungicide was applied. A pre-sowing treatment of seed with trichoderma led to a decrease in the number of *Acremonium* genera fungi on the root surface down to 2.0 %, they were most likely suppressed by *Trichoderma* fungi. It is shown that *T. viride* 017 strain succeeded in the root zone of cucumber plants successfully, thus the percentage of Trichoderma genus fungi on the root surface was 10.9 %, in histosphere - 17.4 % which indicated during the active development of trichoderma both on the root surface and inside the roots of cucumber plants.

Keywords: *Acremonium cucurbitacearum, Trichoderma viride,* cucumber, antagonism.

Acknowledgments

The authors express their gratitude to PhD Stanislav Nadkernichny for help in identifying fungi and to all employees of the Institute's Laboratory of Plant-Microbial Interactions.

INFLUENCE OF VARIETY ON TOTAL POLYPHENOLS CONTENT AND ANTIOXIDANT ACTIVITY IN APPLE FRUITS (*MALUS DOMESTICA* BORKH.)

Veronika Valková^{1,2}, Hana Ďúranová¹, Eva Ivanišová³, Alexandra Kravárová⁴, Dagmar Hillová⁴, Lucia Gabríny¹

¹AgroBioTech Research Centre, Slovak University of Agriculture in Nitra, Slovakia; E-mail.: <u>veronika.valkova@uniag.sk</u>

²Faculty of Horticulture and Landscape Engineering, Department of Fruit Sciences, Viticulture and Enology, Slovak University of Agriculture in Nitra, Slovakia

³Faculty of Biotechnology and Food Sciences, Department of Technology and Quality of Plant Products, Slovak University of Agriculture in Nitra, Slovakia

⁴Botanic Garden, Slovak University of Agriculture in Nitra, Slovakia

Recently, an increasing interest in fruit and vegetable eating has been noticed in particular through epidemiological and biochemical studies pointing to their health benefits for human health. Specifically, apples (Malus domestica Borkh.) are one of the most frequently consumed fruits. Moreover, their consumption has a positive effect on the protection of several human degenerative diseases, mainly because of their antioxidants that prevent free-radical damage. From them, phenolic compounds are responsible for most of the fruit's antioxidant activity. In addition, phenolics (and particularly flavanols) constitute one of the groups of compounds determining the quality of apples. Therefore, the present study aimed to compare the total polyphenols content (TPC) and antioxidant activity (AA) of apple fruits from columnar apple trees growing in experimental conditions. For this purpose, fruits of a total of 7 apple varieties obtained from the Botanic Garden (Slovak University of Agriculture, Slovakia; vegetative season 2019/2020) were analyzed. Among them, four green-yellow varieties: Mar Golden Spur Delicious, Granny Smith, Goldcats, Rondo; one green variety with red spots: Kordona; one red variety: Redcats, and one pink variety: Pompink were employed. Method using the Folin-Ciocalteu reagent was applied to quantify TPC, and radical scavenging activity of samples was measured with 2,2-diphenyl-1-picrylhydrazyl (DPPH). The extracts of the dried powdered samples were performed using 80 % ethanol. Data from all analyses, carried out in triplicates, were statistically evaluated using Prism 8.0.1 (GraphPad Software, San Diego, California, USA). Our results showed that TPC (mg GAE/ g dry weight) ranged from 2.92 ±0.31 (Pompink) to 9.02 ±0.32 (Granny Smith). Statistically significant differences (P < 0.05) were recorded between all analyzed varieties, except for Rondo (5.07 ±0.44) and Kordona (4.18 ±0.35) as compared to Redcats (4.96 ±1.06). Taking into account the color of individual apple varieties, it can be evident that the highest content of TPC (on average) was shown in yellow-green varieties (7.13) ±1.66), and the lowest values for the parameter were detected in the pink one. Similar to TPC, the lowest values for AA (%) were recorded in the Pompink variety (35.03 ±3.49 %) and, conversely, the highest values in the Granny Smith (88.55 ±4.25 %). On average, the strongest AA was determined in the red variety (84.38 ±1.31 %) and, conversely, the lowest one in the pink variety (35.03 ±3.49 %).

The current study suggests that the values for TPC and AA in apple fruits investigated are significantly influenced in a variety-dependent manner. Upon achievement of this survey, and using more samples, it will be possible to create an overview of the antioxidant properties of diverse apple varieties with the possibility of their application in the food industry in the development of innovative products.

Keywords: Malus domestica, variety, DPPH assay, polyphenols.

Acknowledgments

This publication was supported by the Operational Program Integrated Infrastructure within the project: Demand-driven research for the sustainable and innovative food, Drive4SIFood 313011V336, co-financed by the European Regional Development Fund.



Olena Vergun¹, Eva Ivanišová², Yulia Vinogradova³, Olga Shelepova³, Ján Brindza²

¹M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>olenavergun8003@gmail.com</u> ²Slovak Agricultural University in Nitra, Nitra, Slovakia ³Tsitsin Main Botanical Garden, Russian Academy of Sciences, Moscow, Russian Federation

Plants from the *Symphytum* L. genus (Boraginaceae Juss.) are perennial and well-known as medicinal from ancient times. The therapeutic effect of these plants is based on the content of biologically active compounds, among which are polyphenols. Polyphenol compounds are secondary metabolites that protect plant organisms from UV radiation, pathogens, oxidative stress and are known as strong antioxidants. The search for new sources of polyphenols from plant raw materials has continued last decades. Plants from natural flora are not inferior to cultural species in the content of different groups of polyphenol compounds.

This study aimed to determine the content of groups of polyphenol compounds in *Symphytum* spp. extracts during vegetation. In the experiment used plant raw *Symphytum asperum* Lepech., *S. caucasicum* Bieb., and *S. ×uplandicum* Nyman collected at the spring vegetation (regrowth), stem growing, budding, flowering, and fruitage during 2019–2020. Plants took from the natural flora of M.M. Gryshko National Botanical Garden of the NAS of Ukraine. All investigations were conducted in the Slovak University of Agriculture in Nitra (Slovak Republic). Ethanol extracts of investigated plants were measured for total polyphenol content (expressed as mg of gallic acid equivalent per g of dry weight (mg GAE/g DW)), total flavonoid content (expressed as mg of quercetin equivalent per g (mg CAE/g DW)).

It was found that total polyphenol compound content for *S. asperum* was from 26.84 to 105.14 mg GAE/g DW, for *S. cauasicum* from 65.59 to 113.58 mg GAE/g DW, for *S. ×uplandicum* from 16.17 to 67.59 mg GAE/g depending on the stage of growth. Also, the total content of flavonoids determined in extracts of *S. asperum*, *S. cauasicum*, and *S. ×uplandicum* was 13.23–56.39, 23.05–52.86, and 2.71–19.76 mg QE/g DW, respectively. The total content of phenolic acids was from 11.44 to 46.11 mg CAE/g DW for *S. asperum*, from 34.87 to 66.86 mg CAE/g DW for *S. cauasicum*, and from 2.65 to 39.76 mg CAE/g DW for *S. ×uplandicum* depending on growth period. In total, the content of each group of investigated compounds accumulated unevenly during vegetation for all species. The peak of polyphenol content was determined at the start of vegetation for *S. asperum*, at the stem growth for *S. caucasicum*, and at the budding for *S. ×uplandicum*.

Usually, the most pharmacological and biochemical studies of *Symphytum* genus concerning *S. officinale* L. as world-widely know as a medicinal plant with healing features. However, the results of this study also can be used in future pharmacological researches. Plant raw of investigated species can be a rich source of polyphenol compounds along with other species growing in natural and cultural conditions.

Keywords: Symphytum, polyphenols, flavonoid content, phenolic acid content.

Acknowledgments

This study was supported by the active participation of researches by the international network AgroBio*Net*, Bilateral Scholarship of the Ministry of Education, Science, Research and Sport (Slovak Republic), and Visegrad Fund.



LIGNIN AND SUGARS CONTENT IN THE RAW OF SELECTED POACEAE BARNHART

Olena Vergun, Dzhamal Rakhmetov, Valentyna Fishchenko, Svitlana Rakhmetova

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>olenavergun8003@gmail.com</u>

Last decades the search and study of new plants for energetic purposes has been continued. In Ukraine, many-year investigations have been conducted in the M.M. Gryshko National Botanical Garden (NBG) in the Department of Cultural Flora where collected numerous species, varieties, and cultivars of perspective energetic plants. The complex study focused on the biological, ecological, biochemical, and physiological properties of these plants. The determination of the dry matter, the total content of sugars, ash content, caloricity, and lignin content is an important characteristic in the investigation of the biochemical composition of potent energetic plants.

Lignin is an aromatic heteropolymer predominantly composed of coniferyl and sinapyl alcohol in angiosperms and contains additional p-coumaryl alcohol units in grasses. Lignins from herbaceous plants have been studied not fully relatively with woody plants. Some investigations showed that lignin in the Poaceae plants contains the methoxyl groups than lignin from Fabaceae Lindl. or Caryophyllaceae Juss.

The study was conducted in the NBG. The content of dry matter, the total content of sugars, and lignin were determined in raw of selected Poaceae plants: *Eleusine coracana* (L.) Gaerth. Cv. Tropikanka, *Hordeum bulbosum* L., *Miscanthus sacchariflorum* (Maxim.) Benth., *Panicum virgatum* L., *Setaria italica* (L.) Beauv. spp. maxima (Alef.) Mansf., cv. s. Sviatkova, S. italica Beauv. spp. mocharia (Alef.) Mansf. × *S. italica* (L.) Beauv. ssp. maxima (Alef.) Mansf., f. ETSHCHMIF-3.1, *Sorghum almum* Parodi, *S. bicolor* (L.) Moench., *S. × drummondii* (*Nees ex Steud.*), *S. sudonense, S. saccharatum*, cv. Pamat Shepelia. The investigation was carried out in 2015–2017 at the stage of flowering. The dry matter content was determined by drying plant raw till constant weight at 105 °C... The reducing sugars content was found using Bertrand's method. The lignin content was detected by cellulose stabilization in sulfuric acid.

In the Department of Cultural Flora of the NBG have been studied plants with different useful purposes, among which energetic plants. The collection fund of energetic plants includes species, varieties, and cultivars of representatives of *Miscanthus* Anderss., *Panicum* L., *Sorghum* Moench, *Paulownia* Siebold & Zucc., etc. The complex study of energetic plants found that the content of dry matter for all investigated plants was from 20.40 (*E. coracana*) to 63.32 (*H. bulbosum*) %. The content of reducing sugars was from 1.94 (*S. italica*, cv. s. Sviatkova) to 8.41 (*S. bicolor*) %. The lignin content was found in the range from 2.70 (*S. × drummondii*) to 14.37 (*M. sacchariflorum*) %. We found a very weak correlation between sugars and lignin of investigation plants (r = 0.134). Al other parameters showed a negative correlation between each other.

Results showed that at the flowering stage different Poaceae species accumulated high content of dry matter, reducing sugars, and lignin. This study demonstrated the results of primary biochemical investigations of selected plants from the Poaceae family that can be useful for further biochemical study and selective work.

Keywords: Poaceae, lignin, sugars.

BIOCHEMICAL CHARACTERISTIC OF *CICER ARIETINUM* L. GENOTYPES

Olena Vergun, Dzhamal Rakhmetov, Svitlana Rakhmetova, Oleksandr Bondarchuk, Valentyna Fishchenko

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine Kyiv, Ukraine; E-mail.: <u>olenavergun8003@gmail.com</u>

Cicer arietinum L. (chickpea) is an ancient crop that is cultivated widely in tropical, subtropical regions. This legume is one of the most important food plants in the world with high-quality protein, especially for vegetarian people. In Asia global production of chickpea is approximately 60 %. The biochemical composition of *C. arietinum* is fatty acids, minerals, β -carotenes, and bioactive compounds are flavonoids, phenolic acids, lignin, carotenoids. Selected components of *C. arietinum* have a potential beneficial effect in decrease the risk of some chronic diseases.

This study was aimed to determine selected biochemical parameters in the raw of C. arietinum genotypes: f. CAOCHL, f. CATADJD-2, f. CAUKR, f. CAAZEUR-2, f. CAAFGD-2, f. CAAZEMR-1, f. CABFR-2, f. CABFR-1, f. CAAFGK-1 at the end of flowering-start of fruitage (EFFr) and fruitage-start of ripening (FrSR) during 2020–2021. Plant raw material was collected from the experimental collections of M.M. Gryshko National Botanical Garden of the NAS of Ukraine. The content of dry matter is determined after drying at 105 °C till constant weight. The reducing sugar content was detected by Bertrand's method. Ascorbic acid content determined in acid extracts by Tillman's method. Titrable acidity and tannin content were determined from water extracts by titration with an alkaline solution and indigo carmine solution, respectively. The content of chlorophyll *a*, chlorophyll *b*, and carotenoids was determined after measuring the optic density of acetone solutions on spectrophotometer Unico and results were given as mg/g of fresh weight. Results showed that dry matter in raw of 6 genotypes decreased from EFFr to FrSR. In total, the content of dry matter was 26.62–35.56 % at EFFr and 22.10–33.74 % at FrSR. Reducing sugars content was 7.39–12.81 % at EFFr and 6.47–10.96 % at FrSR. The ascorbic acid content for investigated genotypes was from 35.33 to 217.94 mg% at EFFr and from 52.13 to 169.80 mg% at FrSR. The titrable acidity was from 2.32 to 3.19 % at EFFr and from 1.41 to 3.93 % at FrSR. Content of tannins was from 1.04 to 1.55 % at EFFr and from 0.21 to 6.70 % at FrSR. As a result of the study, the content of chlorophyll q was from 1.11 to 2.61 mg/g at the end of blossoming-fruiting and from 0.82 to 2.04 mg/g at the fruiting-ripening stage. The chlorophyll *a* content was significantly higher than chlorophyll *b*. The content of chlorophyll *b* was from 0.297 to 0.426 mg/g and from 0.09 to 0.24 mg/g at the fruiting-ripening period. Carotenoids accumulated at the end of blossoming-fruiting from 0.56 to 1.28 mg/g and the fruiting-ripening stage from 0.47 to 1.29 mg/g. The relationship of chlorophylls content (a/b) was 3.28–7.48 at the end of blossoming-fruiting and 4.28–15.24 at the fruiting-ripening stage. This ratio shows the light adaptation response. The relationship between chlorophylls and carotenoids was 2.05–2.63 at the end of blossoming-fruiting and 1.67–2.59 at the fruiting-ripening stage. This ratio is an indicator of the greenness of the plant and less values say about the senescence process.

Thus, our study demonstrated that different genotypes of *C. arietinum* are a good source of nutrients. Despite on wide use of this species in the food industry of Asian countries, the study of biochemical composition and physiological parameters in other areas in the world. This study can be useful for further selective work with this species and deep biochemical investigation.

Keywords: *Cicer arietinum*, biochemical composition, chlorophylls, carotenoids.


Olena Vergun¹, Oksana Shymanska¹, Evá Ivanišová², Ján Brindza²

¹M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>olenavergun8003@gmail.com</u> ²University of Life Sciences, Lublin, Poland

Asteraceae Bercht. & J. Presl is a very large family, representatives of which known as medicinal, forage, ornamental, energetic, etc., plants. Numerous studies of different Asteraceae species demonstrated significant pharmaceutical and medicinal potential. The biological activities of extracts of these plants are caused by the presence of various compounds such as polysaccharides, terpenes, fatty acids, phytosterols, lignans, saponins, etc. Plant extracts exhibited antimicrobial, anti-inflammatory, antioxidant, hepatoprotective, cardioprotective activities.

This study aimed to determine the content of groups of polyphenol compounds and antioxidant activity of *Achillea nobilis* L., *Echinops ritro* L., *E. sphaerocephalus* L., *Inula helenium* L., *Tanacetum vulgare* L., *Taraxacum campylodes* G.E. Haglund extracts at the flowering. In the experiment used plant raw collected from the natural flora of M.M. Gryshko National Botanical Garden of the NAS of Ukraine during 2019–2020 at the flowering stage. All investigations were conducted in the Slovak University of Agriculture in Nitra (Slovak Republic). Ethanol extracts of investigated plants were measured for total polyphenol content (expressed as mg of gallic acid equivalent per g of dry weight (mg GAE/g DW)), total flavonoid content (expressed as mg caffeic acid content per g (mg CAE/g DW)). Antioxidant activity measured by DPPH and phosphomolybdenum methods (expressed as mg Trolox equivalent per g (mg TE/g DW)).

These species were selected due to their significant therapeutical properties, especially in folk medicine. It was determined total phenolic content from 34.84 (*A. nobilis*) to 74.39 (*T. vulgare*) mg GAE/g DW, total flavonoid content from 23.70 (*A. nobilis*) to 41.43 (*T. vulgare*) mg QE/g DW, total phenolic acid content from 10.13 (*A. nobilis*) to 28.94 (*T. vulgare*) mg CAE/g DW. Antioxidant activity by DPPH method was from 5.28 (*I. helenium*) to 6.84 (*E. ritro*) mg TE/g DW and phosphomolybdenum method from 64.15 (*A. nobilis*) to 153.28 (*E. sphaerocephalus*) mg TE/g DW.

All investigated plant species are a rich source of polyphenol compounds and characterized by high antioxidant activity. Obtained data can be useful for further biochemical and pharmacological investigations of Asteraceae representatives. Plants from natural flora can be a potential source of antioxidants.

Keywords: Asteraceae, polyphenols, antioxidant activity.

Acknowledgments

This study was supported by the active participation of researches by the international network AgroBio*Net*, Bilateral Scholarship of the Ministry of Education, Science, Research and Sport (Slovak Republic), and Visegrad Fund.



AND *T. RUBENS* L. Olena Vergun¹, Oksana Shymanska¹, Dzhamal Rakhmetov¹, Ján Brindza²,

Eva Ivanišová²

¹M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>en_vergun@ukr.net</u> ²Slovak University of Agriculture in Nitra, Nitra, Slovakia

Trifolium L. genus belongs to Fabaceae Lindl., which is an economically important plant family. *Trolium* representatives are known as forage plants worldwide and a source of isoflavones, protein, and biologically active secondary metabolites, among which phenolic compounds are the main class.

This research provides results of antioxidant activity and polyphenol content of extracts of *Trifolium ambiguum* M. Bieb (Kirovograd region, Alexandria district, Dolynske village) and *T. rubens* L. (Khmelnytsky region, Krasyliv district, Slobidka village) from Ukrainian natural flora during 2019–2020. Inflorescences, leaves, stems, and all above-ground parts of plants were analyzed. The total content of polyphenols (expressed in gallic acid equivalent (GAE) of dry weight (DW)), flavonoids (expressed in quercetin equivalent (QE) DW), phenolic acids (expressed in caffeic acid equivalent (CAE) DW), antioxidant activity by DPPH method (expressed in Trolox equivalent (TE) DW), and reducing power of extracts (expressed in TE DW) were determined in ethanol extracts of investigated plant parts.

The total content of phenolic compounds for *T. ambiguum* and *T. rubens* was from 18.17 (stems) to 91.80 (all plant) and from 17.39 (stems) to 71.24 (leaves) mg GAE/g DW, respectively. The total content of phenolic acids for *T. ambiguum* and *T. rubens* was from 8.16 (inflorescences) to 21.93 (leaves) and from 2.25 (stems) to 12.94 (leaves) mg GAE/g DW, respectively. It was determined from 5.45 to 30.89 and from 9.58 to 53.20 mg QE/g DW of total flavonoid content for *T. ambiguum* and *T. rubens*, respectively. In both cases, minimal values are found in stems and maximum values in leaves. The reducing power of extracts had low values in the stems and high in the leaves for both species. For *T. ambiguum* this parameter was 36.46-58.61 mg TE/g DW and for *T. rubens* 22.93–155.56 mg TE/g DW. The lowest antioxidant activity by the DPPH method is found in stems and the highest in inflorescences for both species. Extracts of *T. ambiguum* demonstrated antioxidant activity from 2.65 to 8.32 mg TE/g DW and *T. rubens* from 2.30to 8.62 mg TE/g DW. A very strong correlation between total flavonoid content and reducing power (r = 0.845) was found in *T. ambiguum* extracts. Between the total content of phenolic acids and flavonoids (r = 0.789), reducing power and antioxidant activity by the DPPH method (r = 0.782) of this extract determined a strong correlation. A very strong correlation of *T. rubens* extracts was found between the total content of phenolic acids and reducing power (r = 0.985), total phenolic content, and total content of flavonoids (r = 0.973). Reducing power strong correlated with flavonoid content (r = 0.971), phenolic acid content (r = 0.915), polyphenol content (r = 0.907). Obtained results showed that *T. ambiguum* and *T. rubens* plants are potent sources of polyphenol compounds with high antioxidant activity that can be used in pharmacological studies. The study of different organs of two *Trifolium* species showed that stems accumulated the least content of polyphenol compounds.

Keywords: *Trifolium ambiguum, Trifolium rubens,* antioxidant activity, polyphenol compounds.

Acknowledgments

Authors are thankful for the Bilateral Scholarship of the Ministry of Education, Science, Research and Sport (Slovak Republic), the National Scholarship Program of the Slovak Republic for supporting this research.



PHYTOCHEMISTRY AND FLOWER'S MORPHOLOGY OF INVASIVE SOLIDAGO L. SPECIES – VALUABLE LATE AUTUMN MELLIFERS

Yulia Vinogradova, Olga Shelepova

N.V. Tsitsin Main Botanical Garden of Russian Academy of Sciences, Moscow, Russian Federation; E-mail.: <u>gbsad@mail.ru</u>

In Europe, two alien North American species of *Solidago* L. have been detected: *S. canadensis* L. and *S. gigantea* Ait. Both species provide a stable late harvest and are valued by beekeepers for their ability to produce pollen and nectar in late fall. This honey is rarely pumped because all of the nectar and pollen goes to support the bee colonies and prepare them for wintering. Goldenrod honey yields up to 150 kg per hectare. Germacren D, which has not been identified in other monofloral kinds of honey, is present in goldenrod honey. Although there is no complete similarity between the chemical components of *Solidago* flowers and goldenrod honey, there is a significant correlation. Honey absorbs the medicinal qualities of the plant from which it is collected, so the study of the phytochemical composition of inflorescences (heads) seems to be very actual. The work aims to determine the total content of saccharides, phenolic compounds, and flavonoids in flowers of *S. canadensis* and *S. gigantea* for comparative evaluation of bee production quality, and also to specify morphometric differences in the structure of flowers and heads of both species.

The heads in the phase of mass flowering were collected in the Moscow Region. The total content of phenolic compounds was determined using the Folin-Ciocalteu method. To evaluate the morphometric characters, plants growing in the same agricultural background were selected, the sample consists of 50 heads for each species; studied parameters (length and diameter of the head, length of the involucre) were measured using a digital electron microscope Keyence VHX 1000. The total content of the saccharides in *S. canadensis* heads was 27.33 ±0.54 %, with monosaccharides ~44-46 %. In S. gigantea's heads total content of the saccharides was 1.5 times lower – 18.07 ± 0.73 %, the content of mono sugars was 7.39 ± 0.15 %. The total content of phenolic compounds in the heads of *S. canadensis* was 105.36 ±1.45 mg GAE/100 g and in *S. gigantea*'s heads was 98.41 ±1.71 mg GAE/100 g. The total flavonoid content as quercetin equivalents was 58.23 ±0.17 mg QE/100 g in the heads of *S. canadensis* and 41.97 ±0.34 mg QE/100 g in S. gigantea's heads. For S. gigantea the head's length was 5.2– 7.7 mm (on average 6.4 \pm 0.1 mm; V=11 %), the head's diameter was 2.0–3.0 mm (2.3 \pm 0.0 mm; V=9 %), the involucre's length was 2.9–4.4 mm (3.7 ±0.1 mm; V=11). For *S. canadensis*, these parameters are significantly lower: the head's length was 3.5–5.2 mm (in average 4.4 ±0.1 mm; V=11 %), the head's diameter 1.5-2.1 mm ($1.8 \pm 0.0 \text{ mm}$; V=6 %), the involucre's length was 2.6–3.9 mm (3.1 ±0.1 mm; V=8 %). However, the relative size of the involucre, on the contrary, is higher in *S. canadensis* – it is 70 % of the head's length, while in *S. gigantea* the involucre is 60 % of the head's length. In Central Europe, *S. canadensis* occurs more frequently than *S.* gigantea and prefers drier and warmer habitats.

It is not advisable to intentionally cultivate *Solidago* species as melliferous plants. In some European countries, there is even a fine for this. Both *S. canadensis* and *S. gigantea* are aggressive invasive species and can displace valuable native honey plants from natural phytocenoses.

Keywords: Solidago, flowers, heads, sugars, phenolic compounds.

Acknowledgments

The authors are grateful SAIA (Bratislava, Slovakia). Experimental activities were realized in laboratories Excellent center for the conservation and use of agrobiodiversity at the Faculty of Agrobiology and Food Resources, Slovak Agricultural University in Nitra.

TRANSIENT EXPRESSION OG UIDA GENE IN PHYSALIS PERUVIANA L. AND PHYSALIS IXOCARPA BROTH.

Olha Yaroshko, Nadiia Matvieieva

Institute of Cell Biology and Genetic Engineering of the National Academy of Science of Ukraine, Kyiv, Ukraine; E-mail.: <u>90tigeryaroshko90@gmail.com</u>

Physalis peruviana L. *and Physalis ixocarpa* Broth. are representatives of the *Solanaceae* Juss. family, native to Central America. Raw material obtained from these species is used in medicine and agriculture.

The research aimed to confirm the possibility of transient expression of reporter *uidA* gene in seedlings of *P. peruviana* and Likhtaryk variety of *P. ixocarpa*.

Physalis peruviana and cultivar Likhtaryk of *Physalis ixocarpa* was used in our research as plant material. Seeds were sown in pots with soil and grown in greenhouse conditions (22–25 ^oC, 14-hour light period, illumination – 3000–4500 lx). Ten day-old seedlings were infiltrated with the *Agrobacterium tumefaciens* strain GV3101 carried pCBV19 genetic vector in the vacuum chamber (for 5–10 min, 22–24 ^oC).

We used two groups of the experimental plants treated with *A. tumefaciens* suspension. The leaves of the first ones were cut with a scalpel before infiltration of bacteria for better penetration of the agrobacterial suspension into the plant tissue. The leaves of the second group of the plants were used without cutting. Leaves treated by the buffer instead of bacteria were studied as a negative control.

Histochemical reaction for detection of β -glucuronidase activity was conducted at 37 °C according to Jefferson on the 10th day after infiltration of seedlings. *B*-glucuronidase activity was detected visually by the appearance of blue staining of the plant tissues. The plants of stable transformed *Nicotiana tabacum* which carry in their tissues *uidA* gene were used as a positive control.

The results of histochemical reaction of *P. ixocarpa* plants treated with *A. tumefaciens* without previous scarification were positive for 30.5 % of the total quantity of infiltrated seedlings. 94.6 % of plants infiltrated with agrobacterial suspension with the previous scarification demonstrated a positive histochemical reaction. The results of histochemical reaction of *P. peruviana* were positive for 14.3 % without previous scarification) and 16.7 % (with the previous scarification). At the same time the groups of plants, which were used as negative controls, did not turn blue after the histochemical reaction. The tobacco leaf surface (positive control) was stained in a completely blue color.

The areas with blue staining were located mainly near midrib and occupied more than 60 % of the surface area of the leaf blade (in a group of plants, which were infiltrated with *Agrobacterium* suspension and scarificated).

The possibility of transient expression of *gus* gene in seedlings of *P. peruviana* and *P. ixocarpa* cv. Likhtaryk was confirmed. Obtained results show that seedlings of *P. peruviana* and *P. ixocarpa* are susceptible to infection with *A. tumefaciens* and can be used for further transformation experiments with selective, reporter and target genes.

Keywords: *Physalis ixocarpa, Physalis peruviana,* transient expression, *uidA* gene, *Agrobacterium tumefaciens.*

Acknowledgments

The author is grateful to doctor Dz. Rakhmetov, who kindly donated the seeds of *Physalis* species. This research didn't obtain financial support or grant from funding agencies in the public, commercial, or not-for-profit sectors.

EFFECT OF CHLORELLA VULGARIS BEIJERINK AS A BIOFERTILIZER ON SOLANUM LYCOPERSICUM L.

Natalia Zaimenko, Nataliya Didyk, Nadiia Rositska, Bogdana Ivanytska

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>rositska.nadiia@gmail.com</u>

The rapid increase in the world population poses a threat to food security, and a large amount of chemical fertilizer were used to increase crop yields to meet the growing food demand, but also have various harmful effects on both living organisms and environment. Biofertilizers are known as eco-friendly, cost effective and renewable source of plant nutrients to supplement and replace the chemical fertilizers for sustainable agriculture. Algal biomass is reported to contain macronutrients as well as micronutrients, growth regulators, polyamines, natural enzymes, carbohydrates, proteins, amino acids, and vitamins implemented for improving vegetative growth. The aim of this work was to study the effect of *Chlorella vulgaris* Beijerink strain on *Solanum lycopersicum* L. and to determine any potential application of *C. vulgaris* microalga as a biofertilizer to improve the yield quality and productivity.

Test plants were cultured in 0.2 l plastic vessels in the phytochamber at temperature of 24–28 °C, soil substrate humidity 60–70 %, and the illumination of 3000 lux. *Chlorella* culture fluid was added in the amount of 1, 3 and 10 ml per vessel once at the beginning of the experiment. Tomatoes were grown for 6 weeks.

S. lycopersicum was sensitive to the stimulating effect of *Chlorella* culture fluid. The introduction of *Chlorella* culture even in the minimum amount (1 ml per vessel) by 36–50 % improved the germination of tomato seeds and intensified 2.4 times the accumulation of mass by aboveground parts and roots of plants. The effect increased with the increasing concentration of culture fluid. Analysis of the content of photosynthetic pigments (chlorophyll a, b and carotenoids) in tomato leaves confirmed the positive effect of the culture fluid in the activity of photosynthesis.

It can be concluded that *Chlorella* culture fluid can enhance the growth of tomatoes.

Keywords: Chlorella vulgaris, Solanum lycopersicum, photosynthetic pigments.



Natalia Zaimenko, Nadiia Rositska, Bogdana Ivanytska

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>rositska.nadiia@gmail.com</u>

Phytopathogens are reported to be present in all the cereal growing regions of the world, and not only affect the growth and seedling survival, but also reduce the quality and production of cereals. Nearly 70–80 % of crop diseases by fungal phytopathogens causing significant reduction in yield and quality of cereal crops, fruits and vegetables. Association of fungal phytopathogens with cereals due to secretion of variety of metabolites and toxins means harmful influence to humans and animals posing threat to agricultural products as become unfit for human consumption. Most studies showed the major effect on seeds include reduced germination, discoloration, visible mould growth, musty or sour odour, dry matter loss and caking and mycotoxins elaboration. Contaminated agricultural products particularly cereals are the main source of mycotoxins in the animal and human food chain. The genera of *Talaromyces* commonly associated with crop plants are known to produce diverse toxic substances causing different diseases in plants and animals including humans. The inhibitory effect of the seed-borne fungi on seed germination, radicle and coleoptile growth has been attributed to the production of certain enzymes and toxins produced by fungi in different crops.

The toxic effect of *Talaromyces ruber* was determined on corn seeds. *T. ruber* was grown in 250 ml of Erlenmayer conical flask containing 100ml CYA broth for 12 days on rotary shaker (LM-450D) at 27 \pm 2 °C. At the end of incubation period, culture filtrates were filtered through Whatman filter paper no. 1 and centrifuged at 12,000 g to get cell-free filtrates. Hundred healthy surface sterilized seeds were suspended in 50 ml of culture filtrates and incubated at 27 \pm 2 °C for 24 hours and transferred to sterile-petri plates containing three layered wet blotter paper and incubated for 5 days under illumination. Seeds soaked in uninoculated broth were served as control. At the end of the incubation period, seed germination and radicle length were measured. Each experiment was run in triplicate (n=3) and the results are statistically analysed and expressed mean and standard deviation.

The present attempts to screen *T. ruber* in its toxic effect on corn seed germination showed significantly retard the seed germination, radicle elongation. Toxic fungal metabolites also induced adverse effects on plants such as inhibition of seed germination, malformation and reducing seedlings. Many fungal toxins are known to be phytotoxic and play role in plant pathogenesis. Very little information is available on the phytotoxic effects of *Talaromyces* species. In the present investigations, we recorded that the culture filtrate of *T. ruber* was highly toxic and caused a significant percentage of inhibition of the seed germination. The mean inhibition of germination was 42.86 %. The mean inhibition of radicle growth was 46.67 %.

From the present investigations, it can be concluded that *T. ruber* was toxic and inhibited the seed germination of *Z. mays*. In present observations, *T. ruber* also showed significant effects on radicle growth of corn seeds.

Keywords: Talaromyces ruber, Zea mays, germination.



PHYTOCHEMICAL COMPOSITION OF BULBOUS OXALIS (*OXALIS* L.) OF SOUTH AMERICAN ORIGIN IN THE M.M. GRYSHKO NATIONAL BOTANICAL GARDEN OF THE NAS OF UKRAINE

Alla Zhila, Olga Tymchenko, Viktor Anishchenko, Olena Boyko, Roman Ivannikov

M.M. Gryshko National Botanic Garden, National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>ivannikov@nbg.kiev.ua</u>

A comprehensive study of species, varieties, cultivars of the genus *Oxalis* L. for their introduction into the culture in Ukraine is done in the M. M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine (Kyiv) to expand the species diversity of medicinal plants and predict the potential of their use.

The genus *Oxalis* is unique among the dicotyledonous plant that has true bulbs. The objects of the study were *Oxalis* from the American section *Ionoxalis* Small with imbricate bulbs – *Oxalis tetraphylla* Cav. (syn. *O. deppei* Lodd.), *O. tetraphylla* cv. Iron Cross, *O. lasiandra* Zucc., *O. latifolia* Kunth. Two varieties of South American rhizomatous *O. triangularis* A. St.-Hil were added to the experiment (var. green and var. red) from the section *Pseudobulbosae*. Plants of these species have antioxidant and anti-inflammatory activity, are used as astringents, antiseptics, hypnotics, have antidiabetic, and antibacterial action.

The choice of research objects was primarily due to the coincidence of vegetation periods in the natural environment of introduced *Oxalis* species with favorable weather and climatic conditions in Kyiv: the rainy season from May to September-October and the dry season from November to April.

Our research has shown that the highest quality composition of phytochemicals is observed in spring bulbs.

Thus, the highest content of anthocyanidins was found in f. green of *O. triangularis* (2000 μ g/g), phenols and carboxylic acid – in var. red of *O. triangularis* (2000 μ g/g), cinnamic acid derivatives – in var. green of *O. triangularis* (500 μ g/g) and *O. lasiandra* (460 μ g/g), flavonoids – in *O. tetraphylla* (3000 μ g/g) and *O. tetraphylla* cv. Iron Cross (2700 μ g/g), flavan-3-ol in *O. tetraphylla* cv. Iron Cross (4300 μ g/g), flavones in *O. tetraphylla* (3800 μ g/g) and *O. tetraphylla* cv. Iron Cross (3500 μ g/g), flavones – in var. red of *O. triangularis* (200 μ g/g), epigallocatechins in *O. tetraphylla* cv. Iron Cross (1500 μ g/g), oxybenzoic acids and aldehydes in f. red of *O. triangularis* (3000 μ g/g) and f. green (2500 μ g/g), proanthocyanidins – in f. green of *O. triangularis* (28000 μ g/g), tannins – in O. tetraphylla (4500 μ g/g), pigment probably of flavonoid origin – in *O. tetraphylla* (3500 μ g/g).

It should be noted that derivatives of hydroxycinnamic acids in the spring selection bulbs were observed only in var. red of *O. triangularis* (550 μ g/g) and var. green (150 μ g/g). Quite high rates of derivatives of hydroxycinnamic acids are observed in the leaves var. green of *O. triangularis* (1540 μ g/g) (in var. red this index is twice less) and *O. latifolia* (1490 μ g/g). In terms of index hydroxycinnamic acid derivatives in stems, they are highest in *O. lasiandra* (300 μ g/g) and contractile roots in *O. tetraphylla* cv. Iron Cross (279 μ g/g). Thus, *O. tetraphylla* and *O. tetraphylla* cv. Iron Cross lead in almost all indicators of phytochemical composition of bulbous *Oxalis* of South American origin, which were analyzed from different vegetative parts of plants in different periods of their vegetation.

Keywords: *ex situ*, phytochemical composition, bulbous oxalis.

POLLEN MORPHOLOGY OF SOME SPECIES OF THE GENUS LYCIUM L.

Mykhailo Zhurba¹, Ivan Gurnenko¹, Svetlana Motyleva²

¹M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>zhurbamikhail@gmail.com</u> ²Federal Horticultural Research Center for Breeding, Agrotechnology and Nursery

²Federal Horticultural Research Center for Breeding, Agrotechnology and Nursery, Moscow, Russian Federation

The visualization of the surface of biological samples using a scanning electron microscope reveals features of the external relief and can resolve very fine and detailed features of the surface. Pollen grain micro sculpture is one of the diagnostic taxonomic and phylogenetic parameters. Study of morphology and morphometry of pollen grains of *Lycium* spp. allows found new additional diagnostic parameters of species. This study aimed to compare the morphological parameters of pollen grains of the five species of *Lycium* spp.

Pollen grains were studied on the species collected in the Forest-Steppe of Ukraine in M.M. Gryshko National Botanical Garden of NAS of Ukraine (NBG). The following species were analyzed: *Lycium barbarum* L., *Lycium chinensis* Mill., *Lycium truncatum* Wang., *Lycium europaeum* L. An investigation was carried out at the laboratory of the Department of Tropical and Subtropical plants of NBG using an electron microscope Carl Zeiss LS 15. The measurement of morphometric parameters was carried out on 50 pollen grains from each species using the AxioVision Rel. 4.8.2.0 program. The measurements were made in a micrometer (μ m). The length of a polar axis (P) and the equatorial diameter (E) of grain, P/E ratio were measured and their variation was compared among studied species. The ratio of polar and equatorial axis (P/E) marks the degree of the pollen grains elongation (roundness).

The average of the polar axis and average length of the equatorial axis of pollen grains in the studied species are as follows: *L. barbarum* from 35.14 to 35.44 and from 17.17 to 17.68 μ m; *L. chinense* from 37.66 to 40.85 and from 18.74 to 21.22 μ m; *L. truncatum* from 36.54 to 38.51 and from 18.79 to 19.13 microns, respectively. The P/E ratio ranges from 1.85 to 2.04, the grains being prolate spheroidal in shape. They are circular, narrowelliptic in equatorial view and semitriangular in polar view, and tricolporate. The colpus is long, narrow, and sunken, and the surface of the colpus membrane is tuberculate. The sculpture of the pollen grain exine is complex, it belongs to the two and three-component sculptural type. The two-component sculptural type – the exine ornamentation is it trickles and fold type of sculpture (LB01, LC05, LT01, Delikat, and Princess Tao). The three-component sculptural type – the exine ornamentation is finely folded, perforated (LC01, LC03, Q1and Tybet).

The studying of the pollen via scanning electron microscope allowed to separate the most important parameters which can be used to identify the representatives of *Lycium* L. They are the form (the pollen grains elongation, the length, and the width ratio). Parameters such as the number of the apertures and the surface picture (micro sculpture) are more specific for different cultivars. Studies have established characteristic differences in the morphometric and micro sculptural features of pollen for each of the studied species of *Lycium* spp., which exhibit certain interesting features, imaged at the nanoscale level. Besides, the relief of pollen grains can affect the strength of the contact between the pollen surface and the pistil, as well as the contact between the pollen surface and water droplets.

Keywords: Lycium spp., pollen, SEM, morphology.



AMINO ACID COMPOSITION OF LEAVES, FLOWERS, PEDICEL, FRUITS, AND SEEDS OF SCHISANDRA CHINENSIS (TURCZ.) BAILL.

Mykhailo Zhurba¹, Natalia Hudz², Eva Ivanišová³, Anna Adriana Bieniek⁴, Agata Antoniewska⁵

 ¹M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine; E-mail.: <u>zhurbamikhail@gmail.com</u>
²Danylo Halytsky Lviv National Medical University, Lviv, Ukraine
³Slovak University of Agriculture in Nitra, Slovak Republic
⁴University of Warmia and Mazury in Olsztyn, Poland
⁵Warsaw University of Life Sciences, Warsaw, Poland

Schisandra chinensis (Turcz.) Baill. (Chinese magnolia vine) a plant species well-known in traditional Chinese Medicine and also in modern Chinese medicine. The fruits were used in the treatment of the diseases of the gastrointestinal tract, respiratory failure, cardiovascular diseases, in the states of body fatigue and weakness, excessive sweating. The *S. chinensis* is also known from traditional Russian medicine as a tonic, reducing hunger, fatigue, delaying the aging process, increasing vitality, and improving mental health. The fruits have hepatoprotective, anti-inflammatory, anticancer, immunostimulant, anti-obesity, antiviral, antibacterial, adaptogenic, ergogenic activity, antioxidative, and detoxification properties. Biologically active compounds are located not only in fruits but in different parts of the plant: bark, shoots, leaves, and seeds. There are practically no data on the biochemical composition and pharmacological effects of *S. chinensis* flowers. This study aimed to investigate the qualitative and quantitive content of amino acids of leaves, flowers, fruits, seeds, and pedicel of *S. chinensis*. Amino acids were determined using post-column derivatisation with ninhydrin and a VIS detector by ion-exchange liquid chromatography (Model AAA-400 amino acid analyzer, Ingos, Czech Republic).

Amino acid analysis has shown that the tested *S. chinensis* fruits, seeds, and pedicel contained 18 amino acids (9 essential and 9 non-essential ones) whereas the leaves and flowers contained 16 amino acids (8 essential and 8 non-essential). The total contents of amino acids, essential amino acids, and non-essential amino acids of the flowers were significantly higher than in the other part of the plant. The total amino acids in the leaves, flowers, fruits, pedicel, and seeds of *S. chinensis* were 156.2, 197.1, 74.6, 37.2, and 122.5 g.kg⁻¹, respectively. The highest glutamic acid content in flowers with the highest mean content among the tested amino acids, accounting for more than 24 % of the entire amino acid profile. Aspartic acid and leucine were the major amino acids found in the seeds. Fruits and pedicel were found to have the lowest amino acid content. The total non-essential amino acids in leaves, flowers, fruits, pedicel, and seeds amounting to 87.4, 124.5, 48.2, 23.7, and 7.2 g.kg⁻¹, respectively, and the percentage of total essential amino acids amounting to 55.95, 63.17, 64.61, 63.71, and 66.94 %, respectively.

Obtained results of this study indicated about high and diversified content of amino acids and allow to suggest the availability of a wide specter of pharmacological activity of leaves, flowers, fruits, pedicel, and seeds *S. chinensis*. The high content of amino acids in the flowers indicates promising to use as a source of essential and non-essential amino acids, and can also be used for in-depth study of other biologically active compounds.

Keywords: Schisandra chinensis, amino acids, leaves, flowers, fruits, pedicel, seeds.

Acknowledgments

The publication was prepared with the active participation of researchers in the International network AgroBioNet and supported by the Visegrad Fund, Bilateral Scholarship of the Ministry of Education, Science, Research and Sport, and SAIA (Slovak Republic).

CHARACTERISTICS OF THE STOMATAL APPARATUS OF THE LEAVES OF VARIETIES AND CULTIVARS OF LYCIUM SPP.

Mykhailo Zhurba, Antonina Ilyinska, Ivan Gurnenko

M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine Kyiv, Ukraine; E-mail.: <u>zhurbamikhail@gmail.com</u>

The stomata are sensitive to changes in ecological factors of the environment, which is especially important with modern climate change. In current introduction studies, stomatal morphometric markers are widely used to determine the adaptiveness of forms and cultivars of different plant species.

We studied the size of stomata, the density of their distribution, as well as the amphistomatic index of the leaves in 13 cultivars and varieties of *Lycium barbarum* L. (LB01, LB02, LB03), *L. chinense* Mill. (Amber Sweet, Delikat, Q1, Tybet, Sweet Lifeberry) and *L. truncatum* Y.C.Wang (LT01, N1 Lifeberry, Korean Big, New Big, Super Sweet), introduced in the M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine.

The leaf surface was analyzed using a PEMMA-102 (SELMI) scanning electron microscope. Fragments of leaf blades were dried, sprayed with copper, and the number of stomata per unit area of the leaf was counted. The morphological types of stomata were determined according to the classification of Baranova (1985), the size of the stomata was determined using the AxioVision 4.8.2 software. The amphistomatic index of the leaves and the stomatal ratio were determined according to Muir, 2018.

All studied cultivars and forms *Lycium* spp. have amphistomatic leaves. The stomata are of the anomocytic type. The upper epidermis has fewer stomata compared to the lower. Biometric analysis showed that there are significant differences in the number and size of stomata in the studied plants. The dimensions of the stomata in the adaxial epidermis are from 23.37 to 33.57 μ m in length and from 11.82 to 21.93 μ m in width. The stomata of the abaxial epidermis are generally somewhat larger, ranging in width from 25.16 to 32.11 μ m and from 12.21 to 21.41 μ m, respectively. The density of stomata on leaves varied significantly between *Lycium* species. Their number per mm² for the adaxial and abaxial surfaces of the leaf blade is 78.72–80.72 and 238.58–241.75 for *L. barbarum*, 12.15–26.07 and 98.09–123.69 for *L. chinense*, 52.95–78.12 and 79.86–105.90 for *L. truncatum*, respectively. The amphistomatic index of *Lycium* leaves is *L. barbarum* 0.24–0.25; *L. chinense* 0.11–0.17; *L. truncatum* 0.34–0.45. The stomatal ratio is: in *L. barbarum* – 0.33; in *L. chinense* – from 0.12 to 0.36; in *L. truncatum* – from 0.53 to 0.84.

According to the results of the study, the most adapted to the climatic conditions of the forest-steppe and deserve further selection research are the cultivars N1 Lifeberry, Korean Big, New Big, Super Sweet of the species *L. truncatum*.

Keywords: *Lycium* spp., cultivars, varieties, leaves, stomata, biometric analysis.



- 1. Agricultural Microbiology and Agro-Industrial Production Institute of Agrarian Sciences National Academy, Chernihiv, Ukraine
- 2. AgroBioTech Research Centre, Slovak University of Agriculture in Nitra, Slovakia
- 3. All Ukrainian Institute of Plant Breeding, Kyiv, Ukraine
- 4. Arctic State Agrotechnological University, Department of Technology and Equipment of the Forest Yakutsk, Russian Federation
- 5. Astrakhan State Technical University, Astrakhan, Russian Federation
- 6. Azerbaijan State Economic University, Baku, Azerbaijan
- 7. Bashkir Research Institute of Agriculture, Subdivision of the Ufa Federal Research Centre of the Russian Academy of Sciences, Ufa, Russian Federation
- 8. Bashkir State University, Ufa, Russian Federation
- 9. Belgorod State National Research University, Belgorod, Russian Federation
- 10. Bogomolets National Medical University, Kyiv, Ukraine
- 11. Botanic Garden of Ivan Franko National University of Lviv, Ukraine
- 12. Botanic Garden, Slovak University of Agriculture in Nitra, Slovakia
- 13. Center for Study of Venoms and Venomous Animals, Botucatu Medical School, São Paulo State University, Botucatu, Brazil
- 14. Central Botanical Garden of the National Academy of Sciences of Belarus, Minsk, Belarus
- 15. Chuiko Institute of Surface Chemistry of NAS of Ukraine, Kyiv, Ukraine
- 16. Community Organization Foundation of Women Beekeepers, Vyshneve, Ukraine
- 17. D.K. Zabolotny Institute of Microbiology and Virology of the National Academy of Science of Ukraine, Kyiv, Ukraine
- 18. Danylo Halytsky Lviv National Medical University, Department of Drug Technology and Biopharmacy, Lviv, Ukraine
- 19. Department of Forestry, Federal State Budget Education Institution of Higher Education "Saint-Petersburg state forest technical University named after S.M. Kirov", Saint-Petersburg, Russian Federation
- 20. Department of Pharmaceutical Technology, Pharmacognosy and Botany, University of Veterinary Medicine and Pharmacy in Košice, Slovak Republic
- 21. Donetsk Botanical Garden, Donetsk, Ukraine
- 22. Educational and Scientific Center "Institute of Biology and Medicine", Taras Shevchenko National University of Kyiv, Ukraine
- 23. Educational and Scientific Centre "P.I. Prokopovych Institute of Beekeeping", Kyiv, Ukraine
- 24. Experimental Facility "Novokakhovska" of Rice Research Institute of Ukrainian Academy of Agrarian Sciences, Plodove, Ukraine
- 25. Faculty of Agrobiology and Food Resources, Institute of Plant and Environmental Sciences, Slovak University of Agriculture in Nitra, Slovakia
- 26. Faculty of Biotechnology and Food Sciences, Department of Technology and Quality of Plant Products, Slovak University of Agriculture in Nitra, Slovakia
- 27. Faculty of Horticulture and Landscape Engineering, Department of Fruit Sciences, Viticulture and Enology, Slovak University of Agriculture in Nitra, Slovakia
- 28. Federal Altai Scientific Centre of Agro-Biotechnologies, Barnaul, Russian Federation
- 29. Federal Horticultural Research Center for Breeding, Agrotechnology and Nursery, Moscow, Russian Federation
- 30. Federal Scientific Center of Grain Legumes and Groats Crops, Orel, Russian Federation
- 31. Federal Scientific Center of Vegetable Growing, Moscow, Russian Federation
- 32. Fergana State University, Fergana, Uzbekistan
- 33. Government Agency "Institute of Hematology and Transfusiology National Academy of Medical Sciences of Ukraine" Kyiv, Ukraine
- 34. Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine, Kyiv, Ukraine



- 35. Institute of Agricultural Microbiology and Agro-industrial Manufacture, National Academy of Agrarian Sciences of Ukraine (NAAS), Chernihiv, Ukraine
- 36. Institute of Agroecology and Environmental Management of National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine
- 37. Institute of Animal Biology National Academy of Agrarian Sciences of Ukraine, Lviv, Ukraine
- 38. Institute of Biochemistry and Genetics Subdivision of the Ufa Federal Research Centre of the Russian Academy of Sciences, Ufa, Russian Federation
- 39. Institute of Biology and Earth Sciences, Pomeranian University in Słupsk, Poland
- 40. Institute of Bioorganic Chemistry of Academy of Sciences of Uzbekistan, Tashkent, Uzbekistan
- 41. Institute of Biophysics and Cell Engineering of the National Academy of Sciences of Belarus, Minsk, Belarus
- 42. Institute of Cell Biology and Genetic Engineering of the National Academy of Sciences of Ukraine, Kyiv, Ukraine
- 43. Institute of Food Biotechnology and Genomics of the National Academy of Sciences of Ukraine, Kyiv, Ukraine
- 44. Institute of Food Sciences, Slovak University of Agriculture in Nitra, Slovak Republic
- 45. Institute of Forest Ecology of the Slovak Academy of Sciences, Department of Plant Pathology and Mycology, Nitra, Slovakia
- 46. Institute of Genetic Resources of the National Scientific Academy of Azerbaijan, Baku, Azerbaijan
- 47. Institute of Genetics, Physiology and Plant Protection, Chişinău, Republic of Moldova
- 48. Institute of Microbiology and Biotechnology, Chisinau, Republic of Moldova
- 49. Institute of Physical Organic Chemistry of the National Academy of Sciences of Belarus, Minsk, Belarus
- 50. Institute of Plant Protection of the National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine
- 51. Institute of Rice of National Academy of Agrarian Science of Ukraine, Skadovsk, Ukraine
- 52. Institute of Viticulture and Enology, Pleven, Bulgaria
- 53. IP Institute of Microbiology and Biotechnology, Chisinau, Republic of Moldova
- 54. Ivan Franko National University of Lviv, Ukraine
- 55. Kharkiv National Medical University, Kharkiv, Ukraine
- 56. Kherson State Agrarian and Economic University, Kherson, Ukraine
- 57. Kryvyi Rih State Pedagogical University, Kryvyi Rih, Ukraine
- 58. L.M. Litvinenko Institute of Physical-Organic and Coal Chemistry of NAS of Ukraine, Kyiv, Ukraine
- 59. Laboratory of Cell and Genomic Technologies, Russian Potato Research Center, Lyubertsy, Russian Federation
- 60. Lviv Polytechnic National University, Lviv, Ukraine
- 61. Lvivskyy National University of Veterinary Medicine and Biotechnology named S.Z. Hzhytskoho, Lviv, Ukraine
- 62. M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine, Kyiv, Ukraine
- 63. N.V. Tsitsin Main Botanical Garden of Russian Academy of Sciences, Moscow, Russian Federation
- 64. National Aviation University, Kyiv, Ukraine
- 65. National Dendrological Park "Sofiyivka" of the National Academy of Sciences of Ukraine, Uman, Ukraine
- 66. National Museum of Natural History of the National Academy of Sciences of Ukraine, Kyiv, Ukraine
- 67. National University of Bioresources and Natural Resources of Ukraine, Kyiv, Ukraine
- 68. National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine
- 69. National University of Pharmacy, Kharkiv, Ukraine
- 70. Orel State University named after I.S. Turgenev, Orel, Russian Federation
- 71. PHEI Kyiv Medical University, Kyiv, Ukraine
- 72. Polissya National University, Faculty of Technology, Zhytomyr, Ukraine
- 73. Private Higher Educational Establishment "Kyiv Medical University", Department of Pharmaceutical and Biological Chemistry, Pharmacognosy; Kyiv, Ukraine
- 74. Pushchino State Institute of Natural Sciences, Institute of Theoretical and Experimental Biophysics, Pushchino, Russian Federation

5th International Scientific Conference Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and Spiritual Human Development



- 75. Razumovsky Moscow State University of Technology and Management, Moscow, Russian Federation
- 76. Research Institute of Crop Husbandry, Department of Plant Physiology and Biotechnology, Baku, Azerbaijan
- 77. Research Station of Medicinal Plants of the Institute of Agroecology and Environmental Management of the National Academy of Agricultural Sciences of Ukraine, Berezotocha, Poltava, Ukraine
- 78. Rice Institute of the NAAS, Sector of Mobilization and Conservation of Plant Resources, Plodove, Ukraine
- 79. Scientific Centre for Medicines, "Nicolae Testemitanu" State University of Medicine and Pharmacy, Chisinau, Republic of Moldova
- 80. SI "Kundiiev Institute of Occupational Health of NAMS of Ukraine", Kyiv, Ukraine
- 81. Slovak University of Agriculture in Nitra, Faculty of Biotechnology, Nitra, Slovakia
- 82. State Ecology Academy of Postgraduate Education and Management, Kyiv, Ukraine
- 83. T. H. Shevchenko National University "Chernihiv Collegium", Chernihiv, Ukraine
- 84. Tashkent State Technical University Named After Islam Karimov, Tashkent, Uzbekistan
- 85. Technical University of Moldova, Chisinau, Republic of Moldova
- 86. Udmurt State University, Izhevsk, Russian Federation
- 87. Ukrainian Research Institute of Forestry and Forest Melioration named after G.M. Vysotsky, Kharkiv, Ukraine
- 88. University of Opole, Department of Analytical Chemistry, Poland
- 89. University of Warmia and Mazury in Olsztyn, Poland
- 90. Ustymivska Experimental Station of Plant Production of Plant Production Institute n.a. V.Y. Yuryev NAAS of Ukraine, Ustymivka, Ukraine
- 91. Uzhhorod National University, Uzgorod, Ukraine
- 92. Vasyl Stefanyk Precarpathian National University, Ivano-Frankivsk, Ukraine
- 93. Warsaw University of Life Sciences, Warsaw, Poland
- 94. Voronezh State University of Forestry and Technologies named after G.F. Morozov, Voronezh, Russian Federation
- 95. Zabolotny Institute of Microbiology and Virology of the National Academy of Sciences of Ukraine, Kyiv, Ukraine



Aboimova O.	Deineka V.
Adamchuk L.	Demianova N.
Alhusseini H.	Demkovich E.
Androshulik R.	Demyanyuk O.
Andruschenko O.	Deineko L.
Andrusyshyna I.	Didyk N.
Anishchenko V.	Dikhtiar O.
Antoniewska A.	Duplij V.
Baerle A.	Ďúranová H.
Belayeva Ya.	Dvykaliuk R.
Belberova Y.	Dvykaliuk R.
Beshliu A.	Dzhurenko N.
Bidnyk H.	Efremova N.
Bielska N.	Eftimová J.
Bieniek A.	Elisovetcaia D.
Bieniek A.A.	Ershova I.
Bilko A.,	Fatrcová-Šramková K.
Blume Ya.	Fedorova O.
Bohdanovych T.	Fedoruk R.
Bondarchuk O.	Feketa I.
Boortseva S.	Ferreira R.S.Jr.
Borovskaia A.	Fesenko I.
Borzova N.	Filiptsova O.
Botsula O.	Fishchenko V.
Boyko O.	Furman S.
Brindza J.	Gabríny L.
Brovarska O.	Garipova S.
Brovarskiy V.	Garkava K.
Bukharina I.	Garshina D.
Bulyhina T.	Gins E.
Bunas A.	Gins M.
Butko A.	Gins V.
Buyun L.	Gniezdilova V.
Bychkova T.	Golub I.
Byrsa M.	Golubkova I.
Călugăru-Spătaru T.	Goncharovska I.
Casian I.	Góralczyk A.
Cherpak M.	Granátová L.
Cherpak O.	Grigoreva O.
Chiselitsa N.	Grushko M.
Chiselitsa O.	Grygorev I.
Chisnicean L.	Grygorieva O.
Chyniaieva Yu.	Gudzenko O.
Corcimaru S.	Gumeniuk I.
Dascaliuc A.	Gurnenko I.

157 5th International Scientific Conference Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and Spiritual Human Development November 3rd 2021

Gyrenko O. Hasanov J.H. Havryliak V. Hillová D. Hlushchenko L. Honcharenko V. Horčinová Sedláčková V. Hrabovetska O. Hrabovyi V. Hryhorenko A. Hudz N. Hudzenko N. Hurtovenko I. Ibragimov A. Ibrahimova O. Ilvinska A. Islamova N. Ivanchina N. Ivanišová E. Ivannikov R. Ivanova R. Ivanytska B. Kabachevskaya A. Kabusheva I. Kalista M. Kanieva N. Khairullin R. Kharchenko I. Kharkhota L. Kikish I. Klimova E. Klymenko S. Kniazieva K. Kobets M. Kobets Yu. Kobza M. Konovalova O. Kopilov E. Kosenko I. Kosogolova L. Koval I. Kovalchuk I. Kovalenko O. Kovalska L. Kozub N., Kravárová A. Kroh A.

Kryvyi M. Kurhaluk N. Kuzema P. Kuznetsov V. Kuznetsova E. Kuznietsova O. Kvitko M. Kyrylenko O. Kyshnirenko O. Kyslynska A. Laguta I. Lampeka O. Lastochkina O. Levishko A. Levon V. Linnik O. Lisohurska D. Lisohurska O. Lobova O. Los S. Lozan A. Lubenets V. Lukash O. Lysenko T. Malinina N. Maltsov I. Mammadova A. Mareček J. Markova O. Markovska O. Maryniuk M. Marynyuk M. Matvieieva N. Mereniuc L. Michailova I. Mirzakhmedova G. V Mirzaxmedov Sh.D. Mňahončáková E. Motyleva S. Mysholov A. Nachychko V. Nadkernychna O. Nasrullaeva G. Niescier G. Okulovich I. Opalko A. Opalko O.

5th International Scientific Conference Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and Spiritual Human Development November 3rd 2021



Sozinov I. Sozinova O. Starodub V. Stavynska O. Stefanowski N. Stetsenko I. Suberliak S. Sukhaveyeva S. Svydenko L. Sylenko S. Tamrazov T. Tatarov P. Tepla Yu. Tiras Kh. Tkach Ye. Tkachenko H. Tofan E. Tryhub O. Tsap M. Tseja J. Tsekhmister H. Tsvigun V. Turdaliev A. Tychinskaya L. Tymchenko O. Tymoshenko U. Valková V. Velichko A. Vergun O. Vinogradova Yu. Vodhanel V. Volkova O. Voroncova V. Wieczorek P.P. Yaroshko O. Yoncheva T. Zahorodnia D. Zaimenko N. Zhila A. Zhurba M.



Title: Book of Abstracts of the 5th International Scientific Conference Agrobiodiversity for Improving the Nutrition, Health, Quality of Life and Spiritual Human Development

Editors: Ján Brindza, Olga Grygorieva Publisher: Slovak University of Agriculture in Nitra Edition: First Year of Publication: 2021 Form of Publication: online Number of Pages: 159

Not edited at the Publishing Centre of the Slovak University of Agriculture in Nitra.

ISBN 978-80-552-2401-5

DOI: https://doi.org/10.15414/2021.9788055224015

