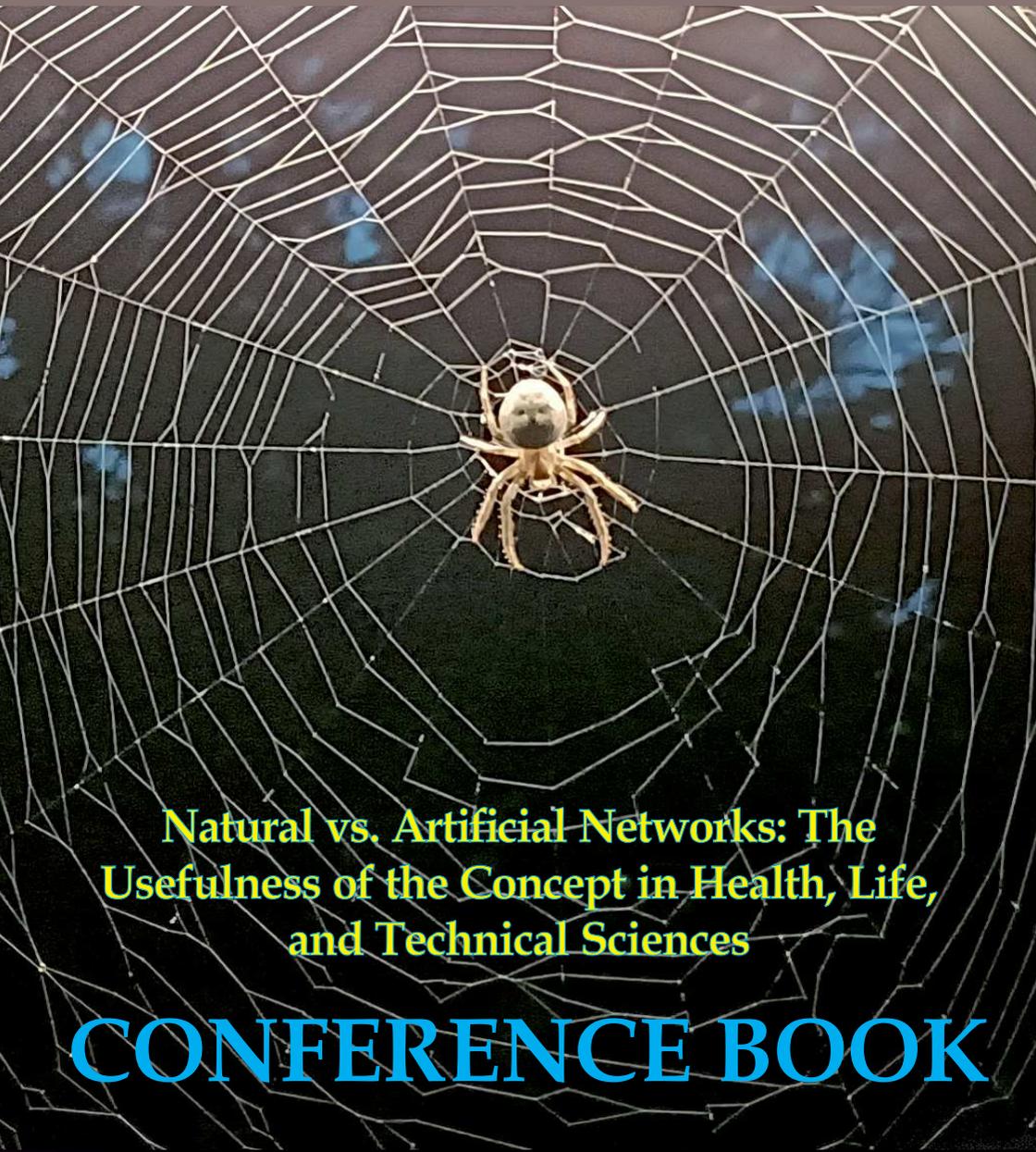


KRAKÓW - MARTIN - SZEGED

16-18 of September 2022



**Natural vs. Artificial Networks: The
Usefulness of the Concept in Health, Life,
and Technical Sciences**

CONFERENCE BOOK



CONFERENCE BOOK

Martin, Kraków, Szeged
16-18th September 2022

Copyright© 2022 by Faculty of Pharmacy Jagiellonian University Medical
College & ZOZ Ośrodek UMEA SHINODA-KURACEJO

The initiators of organization of the first ICPMS CONFERENCE were:
Prof. dr hab. Bożena MUSZYŃSKA, Prof. dr hab. Włodzimierz OPOKA,
Prof. dr hab. Jacek SAPA

Chief Editor
Bożena MUSZYŃSKA

Cover design
Bożena MUSZYŃSKA
Jacek LELEK

Typeset
Joanna PIOTROWSKA

Published by ZOZ Ośrodek UMEA SHINODA-KURACEJO
31-851 Kraków, os. Alertyńskie 1-2, Poland
umea@interia.pl
www.umeaopoka.com

ISBN 978-83-959554-5-7

PART I
ORGANIZERS & SUPPORT
COMMITTEES
SPONSORS
LETTERS
PROGRAMME

MAIN ORGANIZERS

Jagiellonian University Medical College Faculty of Pharmacy

Comenius University in Bratislava, Jessenius Faculty of Medicine
in Martin

University of Szeged Faculty of Pharmacy, Faculty of Engineering

Polish Pharmaceutical Society (the Kraków Branch)

Regional Pharmaceutical Chamber in Kraków

TOP Illegal Pharmaceuticals Association For Health Protection And The
Rule Of Law

Polish Chamber of Physicians

Regional Medical Chamber in Kraków

HONORARY SUPPORT

Vice-Rector of the Jagiellonian University for the Medical College

Prof. dr hab. Tomasz GRODZICKI



SCIENTIFIC COMMITTEE

Prof. dr hab. Dariusz ADAMEK – President; Prof. dr hab. Bożena MUSZYŃSKA, Prof. dr Zsolt SZAKONYI, Dr hab. Katarzyna SUŁKOWSKA-ZIAJA – Secretary

Members of scientific committee

Prof. dr hab. Marek SANAK, Prof. dr hab. Jolanta PYTKO-POŁOŃCZYK, Prof. dr hab. Anna WESOŁOWSKA, Prof. dr hab. Tomasz BRZOZOWSKI, Prof. dr hab. Gabriel NOWAK, Prof. dr hab. Andrzej PILC, Prof. dr hab. Zbigniew FIJAŁEK, Prof. Ján ŠVIHRA, MD, PhD, Prof. dr hab. Zenon J. KOKOT, Prof. dr hab. Roman NOWOBILSKI, Prof. dr hab. Marcin KOŁACZKOWSKI, Prof. dr hab. Jan MATYSIAK, Prof. dr hab. Elżbieta WYSKA, Dr hab. Joanna GDULA-ARGASIŃSKA

ORGANIZING COMMITTEE

Prof. dr hab. Włodzimierz OPOKA, Prof. Erika HALAŠOVÁ – Presidents; Prof. Dušan DOBROTA, Dr. József GÁL, PhD, associate professor, Dr. Sándor BESZÉDES, PhD, associate professor – Vice-Presidents; Dr Joanna PIOTROWSKA – Secretary; Dr Agnieszka SZEWCZYK – Treasurer; Jan LAZUR – IT support; Dr Katarzyna KAŁA – Coordinator of organizing committee

Members of organizing committee

Dr Robert STĘPIEŃ, Dr Jerzy SKUCIŃSKI, Mgr Elżbieta RZAŚA-DURAN, Dr Inga KWIECIEŃ, Dr Bartłomiej ROSPOND

JURY FOR THE BEST PRESENTATION OF YOUNG SCIENTISTS

Prof. Erika HALAŠOVÁ, Prof. Jolanta PYTKO-POŁOŃCZYK, Prof. Andrzej PILC, Prof. Bernadeta SZEWCZYK, Prof. Marek LANKOSZ, MSc Elżbieta RZAŚA-DURAN

SPONSORS





Krakow – due to its demographic, economic, social and scientific-cultural strength – ranks second in Poland among cities. It has unique values that are the basis of its economic development and an increase in the quality of life. It has high-quality human capital at its disposal.

It is a city people consciously choose as a place to live, work, study, spend free time in a variety of ways. Sustainable development and the ability to meet specific challenges with the skillful use of own resources are the main priorities.

The academic center, with its 650 year old University, is permanently connected with the city and builds an unrepeated resource of knowledge in a unique way. It is the key to competitiveness and innovation not only of Krakow, but also of the entire region. The intensively developing economy based on knowledge is a completely new process in the economic life of the City, which makes it part of the modern economies of the world.



photo: Piotr Krochmal

The overriding goal for Krakow is not only to be a modern city but also to be proud of its historical heritage. It aspires to be an open, rich, friendly and safe metropolis, vibrant with culture. Smart management and strengthening the sphere of modern services and the research and development sector are the foundations for the development of Krakow - a city where innovation and effective cooperation between science and business are the focus.

We invite you to visit our website and learn about the possibilities offered by magical Krakow - rooted in tradition, sensitive to everyday life and open to development:

<https://business.krakow.pl/>



photo: Piotr Krochmal



REGIONAL PHARMACEUTICAL CHAMBER IN KRAKOW

The first General Assembly of the Regional Pharmaceutical Chamber in Krakow was held in Krakow on November 9, 1991 and this day should be considered as the official date of the creation of the Regional Pharmaceutical Chamber in Krakow. Currently is a functioning entity of the Polish pharmaceutical self-government. Actually it has more than 3,000 members. The Regional Pharmaceutical Chamber in Krakow consists of the Presidium originated from the Regional Pharmaceutical Council, the Regional Pharmaceutical Court, Regional Professional Liability Commissioner and six committees.

The Regional Pharmaceutical Chamber in Krakow carries out the tasks imposed by the state authorities and participates in the activities primed by the Polish Pharmaceutical Chamber. Collaborates closely with territorial authorities, i.e. the pharmaceutical inspection, a division of the National Health Fund, Regional Medical Chamber, Polish Pharmaceutical Society and the Faculty of Pharmacy Jagiellonian University Medical College. The Pharmaceutical Chamber in Krakow intervenes in everyday problems of pharmaceutical life, like the cases of breaches of ethics, or crossing rules and legislations for the pharmacy professions in Poland. Together with the Faculty of Pharmacy Jagiellonian University Medical College runs Internet portals "e-dukacja" (e-ducation) and "e-pharmacy". It makes possible a regular professional training scheme conducted by e-learning which was particularly useful during a pandemic. The Chamber also conducts webinars on the ClickMeeting platform and organizes stationary training and improvement courses. Furthermore, the Pharmaceutical Board in Krakow acts as an interface between the Faculty of Pharmacy Jagiellonian University Medical College, and pharmacies, student internships are organized in. The Pharmaceutical Chamber has published the journal "Farmacja Krakowska" ("Krakow Pharmacy") and organizes cultural and sport events and meetings for pharmacists.





**LETTER FROM VICE-RECTOR'S PROXY FOR
RESEARCH AND INTERNATIONAL COOPERATION
OF THE JAGIELLONIAN UNIVERSITY MEDICAL
COLLEGE IN KRAKÓW, POLAND**

On behalf of the rector for Medical College, Jagiellonian University this is my honour to welcome participants of the fourth international conference on pharmaceutical and medical sciences. My name is Marek Sanak, I am the rector's proxy for research and development. This year the Jessenius faculty of medicine of Comenius University will host ICPMS in Martin, among organizers is also Chamber of Physicians and Pharmaceutical Chamber of Poland. Participants are coming from Jagiellonian University in Krakow and University of Szeged, Hungary. I had a chance in the past, four years ago to participate in ICPMS in Poprad. This was an exciting time for me to learn about phenomenon of drug forgery and to listen to scientific discussion between students presenting their work and their educators.

This year the conference is dedicated to the networks in science, apparently contrasting natural biological systems with artificial networks. In my opinion this is very timely selection of the topic. Machine learning and artificial intelligence sneaked into our daily life. Actually, we voluntarily allowed to record our daily routines into vast databases of social and telecom network providers. A real power of these big data, when used with adequate algorithms, is still underestimated. However, it already biased British votes on Brexit and beat the world champion in chess. In medicine, machine learning can already outperform human in some specialized tasks but our hope is that it can provide better understanding to a complexity of biological systems.

I would like to thank you for attending this Conference and bringing with you your research results and expertise. As medical researchers, you have the power to create vivid science networking based on your personal knowledge and experience. I ask you to stay involved in excellent

presentations and vivid discussion throughout this conference. My personal respect and thanks goes out to all of you.

Prof. dr hab. Marek Sanak



**LETTER FROM DEAN OF THE FACULTY OF
PHARMACY JAGIELLONIAN UNIVERSITY
MEDICAL COLLEGE**

Ladies and Gentlemen, Dear Colleagues,

The Faculty of Pharmacy at the Jagiellonian University is one of the oldest faculties in Poland and also in Europe. The first Polish Chair of Pharmacy and Medical Matter was established in 1783. So, we have a long history. Today in our Faculty of Pharmacy there are over 1000 students studying pharmacy, medical analytics, cosmetology and industrial pharmacy, clinical studies of pharmaceutical products and enology at postgraduate studies.

Unfortunately, I cannot participate in this conference but I would like to say a few words at the beginning of this event. I believe that this conference is a very good platform for discussions about scientific problems in pharmacy and medicine. Especially, after the pandemic time, we need such face-to-face meetings to exchange ideas to develop medical and pharmaceutical sciences.

I would like to also thank all the organizers of this conference, especially the professor Włodzimierz Opoka from Jagiellonian University, professor Judit Forrai from Budapest University, professor Andrea Čalkovská from Comenius University in Bratislava and professor István Zupkó from University of Szeged.

I wish you the fruitful discussions and successful meeting.

Prof. dr hab. Jacek Sapa



**LETTER FROM DEAN OF THE FACULTY OF
PHARMACY UNIVERSITY OF SZEGED**

Dear Colleagues,

It is my pleasure to welcome all attendees to our 4th International Conference on Pharmaceutical and Medical Sciences conference. I checked the scientific content of the event and think it is versatile, valuable, and colorful. The presentations will give us a cross-section of the research direction currently determining the pharmaceutical and medical sciences. Based on this I am convinced we will have a beneficial and enjoyable two-day conference. This kind of scientific event is always a perfect occasion to disseminate our experimental results and refresh our scientific network.

So dear colleagues, I wish you to enjoy and utilize the scientific content of the meeting; I wish you to refresh your professional connections and establish new cooperation.

I wish all of us thought-provoking discussions, new ideas, new professional connections. Altogether I wish you a successful and memorable congress.

Prof. István Zupkó, Ph.D., D.Sc.



**LETTER FROM VICE-DEAN OF THE FACULTY OF
MEDICINE, JAGIELLONIAN UNIVERSITY
MEDICAL COLLEGE**

Dear participants of the 4th ICPMS,

On behalf of the authorities of the Faculty of Medicine at the Jagiellonian University Medical College, I would like to convey the wishes of fruitful debates during this 4th International Conference on Pharmaceutical and Medical Sciences.

The idea of international conferences is to exchange ideas and thoughts at a joint meeting of scientists from different disciplines and countries. And that is also the purpose of this conference. Our common goal is to improve the quality of life and health of our patients.

We would like to sincerely thank everyone who contributed to the organization of this conference, especially the Dean of the Faculty of Medicine in Martin, prof. Andrea ČALKOVSKÁ and the vice-dean of this faculty, prof. Erika HALAŠOVÁ.

I wish that this conference will be a good opportunity to establish international cooperation for all its participants.

Prof. dr hab. n. med.
Jolanta PYTKO-POLONCZYK



LETTER FROM PRESIDENT OF THE REGIONAL MEDICAL COUNCIL IN KRAKOW

Ladies and gentlemen, participants in the ICPMS conference,

We've made it – we survived the Covid-19 pandemic, which while not yet extinguished is no longer taking as many lives as only a year or two ago. To be sure, most of us probably feared that humanity might fail, at least in the darkest hours of the pandemic, and that we ourselves might lose the fight with the virus. After all, everyone lost someone. If not directly to Covid infection then due to indirect consequences of the pandemic, like severely reduced access to healthcare, delays in diagnosis and treatment of diseases other than Covid-19, lack of proper constant diagnostic control of chronic diseases. We doctors see these problems clearer than others and we cannot consent to covering reality with false hopes and promises, because we fought on the first line of the pandemic front, and today we have to deal with its long-term consequences.

Europe came together to provide personal protective equipment for medical staff, the whole world united in search of an effective drug against Covid-19 and finally, thanks to international effort it was possible to develop the most effective weapon against the virus so far – vaccines. Thanks to international cooperation patients from states which experienced acute shortages of hospital beds, that had no available ventilators, were being transferred to neighboring states, where situation was less dire. We all shared resources for the benefit of all.

In this context the cooperation between professional self-government organizations should be mentioned as well. Efforts made throughout recent decades to bring together and integrate representatives of all medical professions have gained new dimensions. This cooperation continues to develop.

The ICPMS conference is yet another example of this developing cooperation across borders, of collaboration for the common good. In the

face of global pandemics and the war on European soil the continuation of international exchange of knowledge, experience, observations and ideas is even more important than ever. Knowledge and experience should be the basis of all action. It is then of utmost importance that we share it among different professions. In this context two health-related professions stand out. After all, there is no medicine without pharmacy and no pharmacy without medicine.

Robert Stępień
President of the Regional Medical Council in Krakow



**LETTER FROM CO-CHAIRPERSONS OF THE SCIENTIFIC
AND ORGANIZING COMMITTEES
OF THE 4TH ICPMS MARTIN, KRAKÓW, SZEGED 2022**

With every consecutive year or even faster we are getting more and more aware of the impact of different sorts of networks on social, economic and biological aspects of our life. Most of these networks we actively create forming bonds sometimes very tight, which couple us together via information routes, exchange of goods and services, imparting formal law regulations and informal diverse principles of behavior. Thanks to these network systems we can work much more effectively, travel with ease to most remote corners of the world, enjoy in real time the events that happen virtually in any place in any country etc etc. On the other hand not infrequently we feel restrained by these pervasive mutual dependence. In such moments we do not have feeling of being a “knot” of the “net”, even if tiny, still significant, but rather of being entangled in something more resembling a cobweb, constraining us against our will... But let’s face it. It is always question of a balance between good and bad. Especially intriguing are countless natural (as opposition to “artificial”) networks inside of living biological systems. There are networks of metabolism, of extra and intracellular signaling systems, most complicated multicellular networks like the immune, nervous, blood circulation systems and others. The “network approach” in investigations of these systems seems to be more promising in the search for new treatment of illnesses or in more effective prevention.

Trying to make as much good as possible of all imaginable networks of social and individual life and trying to understand all networks inside our bodies and their cellular constituents, obviously we have to study them

frequently using... just another and this time - artificial “networks” (say, neuronal networks) as tools... So, the phrase: “studying networks using networks” though sounds paradoxical but seems to reflect some essential truth.

This brings us to conclusion that the concept of “network” is not only valuable word but also a useful notion, worth to become, let it be, a “catchword” but as well as an important idea of the 4th ICPMS justifying its title, i.e. " Natural vs. Artificial Networks: The Usefulness of the Concept in Health, Life, and Technical Sciences".

At the same time this forms a formula which is extensively broad and inclusive, making a rationale for invitation of representatives of diverse sciences, not only strictly medical, pharmaceutical or biological, but also technical and the most basic i.e. mathematical or “computational” sciences and, why not, even humanistic disciplines... to take part in the upcoming 4th ICPMS and to share ideas and achievements in the study of the “network of life” in the most broad sense and understanding of such concept.

Of all conceivable consequences, concept of the network inevitably assumes at least that even minor discovery or a solution of a problem, or even new rational scientific hypothesis brings about not only its “local” but also very remote changes, which may be difficult to elucidate and to predict and which maybe tiny but sometimes having quite profound impact within the whole scientific “field” or “are” that is covered by the particular network. For instance, finding new chemical compound that influences the activity of an enzyme or cellular-membrane receptor may lead to the discovery of a new drug, even a family of drugs. This in turn would change indications for other drugs, to different approach in whole treatment of particular ailment, and at the same time this new finding may shed new light on mechanisms of cellular or intracellular signalization or else on some metabolic phenomena etc, etc. However the true understanding of “network” in this example means in particular to be aware of possible consequences of modification of activity of even a single enzyme for the whole metabolic “network” in cells, since the

“knots” of this network respond to the change that may nullify the results of the change in a singular “knot”. Here probably there lies the cause of failure of many attempts in finding new effective medicine.

In conclusion, something that can be called the “network thinking” maybe a useful “paradigm” in science. Therefore we would like to suggest one (but not very strict) condition for any reported presentations in 4th ICPMS, namely to try to state as remote as possible consequence of the reported work or proposed hypothesis in concluding sentence of the abstract.

We do welcome most cordially especially young adepts of science and technology and students obviously not excluding the older scholars... inviting to take part in the 4th ICPMS in Martin.

Last but not least, we would like to mention with pride and joy that for the second time ICPMS will be organized together by three academic centers in Martin (Slovakia), Kraków (Poland) and Szeged (Hungary) which seems to be a new and fruitful tradition.

Prof. dr hab. med. Dariusz Adamek

Prof. dr hab. Bożena Muszyńska

Prof. dr hab. Włodzimierz Opoka

JAGIELLONIAN UNIVERSITY MEDICAL COLLEGE



Jagiellonian University Medical College (JU MC) is a part of the Jagiellonian University – the oldest higher education institution in Poland and one of the oldest in Europe founded on May 12, 1364 by the Polish king Casimir the Great.

Since its very beginning has been an international institution. Poles, Ruthenians, Lithuanians, Hungarians, Germans, Czechs, the Swiss, the English, the Dutch, the French, the Spanish, Italians, and even Tatars studied here in the old days.

Some of the Jagiellonian University students and academics have been major historical figures, e.g. Nicolaus Copernicus, Karol Olszewski, Karol Wojtyła, the future Pope John Paul II, Wisława Szymborska.

JU MC – as the oldest medical school – strives for the highest teaching standards by constantly extending and updating the didactic and research base.

Today JU MC comprises three faculties: Medicine – instituted in 1364, Poland's oldest unit schooling physicians, Pharmacy and Health Sciences, where nearly 1600 academic staff conduct research and provide education to almost 6 thousand students, within the framework of 14 different fields of study.

All faculties cooperate with numerous European and American universities, currently putting into effect many bilateral agreements with institutions from a number of countries. We are accredited by the U.S. Department of Education and Medical Board of California.

Part of JU MC is the School of Medicine in English. Its rapid development resulted in currently educating nearly 700 students coming from five continents. SME cooperates with institutions playing an important role in the American and European educational systems, like the National Board of Examiners, the Association of American Medical Colleges, and the European Board of Medical Assessors. SME graduates are completing their residencies and postgraduate training in university hospitals in various countries such as the USA, Canada, Australia, England, Ireland, Norway, Sweden, as well as Poland.

The University also offers doctoral and postgraduate studies for physicians from various regions of the country in all fields of medicine.

The university's prestige in both Poland and abroad is illustrated by its widely recognised research achievements. The scientists and physicians from the JU Medical College carry out pioneer studies, e.g. in cardiac surgery, urology and neurology, often leading to the development of novel treatment methods. Their findings have been published in some of the most prestigious international journals, for instance European Journal of Cardio-Thoracic Medicine, New England Journal of Medicine, and Lancet.

Since 2019 JU MC partakes in the Excellence Initiative – Research University program. As part of the qLife Priority Research Area “Quality of research for the quality of life,” our scientists are realising research projects in social diseases and diseases of affluence, reproductive health, regenerative medicine.

Our research and didactic base includes the University Hospital – one of the most innovative in Europe, University Children’s Hospital – the largest pediatric hospital in the region, University Hospital of Orthopedics and Rehabilitation in Zakopane, University Clinic of Dentistry, and select clinical departments located in Krakow. University Hospitals are leading medical facilities that blend years of experience with state-of-the-art medicine.



On the JU MC Medical Campus is also located: Innovative Medical Education Center, a didactic base for students of medicine, dentistry, nursing and midwifery, Medical Library, Faculty of Pharmacy and dormitories with a sports complex.

We constantly improve and expand our infrastructure to create an ever better environment for scholarly research, teaching and learning.

The next stage of the extension of Campus will be launched soon. The investment will allow us to fully utilize the research-scientific potential of our three faculties. It will also enable us to ensure that the highest teaching standards are maintained, provide the best possible environment for the development of our students, and also realize medical research in various areas – from basic research, optimisation of treatment, to solving public health problems.

As per our motto: "INSPIRED BY THE PAST, WE SHAPE THE FUTURE", we continue the work of our renowned graduates and professors in order to meet the new challenges of modern times.



PROGRAMME

16th September 2022

9.00 – 9.30 **Opening ceremony**

Doc. Štefan Sivák

Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Slovakia

Prof. Marek Sanak

Jagiellonian, University Medical College, Poland

Prof. Jacek Sapa

Jagiellonian University Medical College, Poland

Prof. István Zupkó

University of Szeged, Hungary

Prof. Jolanta Pytko-Polończyk

Jagiellonian University Medical College, Poland

9.30 – 11.00 **Honorary Lectures**

Chairman: Prof. Erika Halašová, Prof. Dariusz Adamek

9.30 – 9.55 Prof. Lukáš Plank

Comenius University Bratislava, Slovakia

FROM TRADITIONAL TO NEXT GENERATION PATHOLOGY:
ACHIEVEMENTS IN CANCER BIOPSY DIAGNOSIS

10.00 – 10.25 Prof. Attila Hunyadi

University of Szeged, Hungary

THE COMPLEX ROLE OF ECDYSTEROIDS IN NATURE AND
THEIR DRUG DISCOVERY PERSPECTIVES

10.30 – 10.55 Prof. Paweł Idziak

Jagiellonian University, Poland

NETWORKS – A PERSONAL PERSPECTIVE

11.00 – 11.15 **Technical break**

11.15 – 13.00 The first main session: Next-generation Sequencing and OMICs in the Era of Advanced Medical Diagnostics

Chairman: Doc. Štefan Sivák, Prof. Zsolt Szakonyi

11.15 – 11.30 PhD Peter Amersdorfer

Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Slovakia

BIOBANKS AS INNOVATION INFRASTRUCTURE FOR TRANSLATIONAL MEDICINE

11.30 – 11.45 PhD Michal Cibulka

Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Slovakia

SINGLE NUCLEOTIDE VARIANT rs708727 OF SLC41A1 GENE IS ASSOCIATED WITH PARKINSON'S DISEASE

11.45 – 12.00 PhD Michal Pokusa

Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Slovakia

ADVANCED ANALYSIS OF FLUORESCENCE MICROSCOPY OUTPUTS FROM BIOLOGICAL SAMPLES

12.00 – 12.15 PhD Oliver Strbak

Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Slovakia

USABILITY OF MAGNETIC RESONANCE TECHNIQUES IN METABOLOMICS

12.15 – 12.30 PhD BEng Jan Strnadel

Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Slovakia

DEVELOPMENT OF NOVEL IN VITRO MODELS FOR HUMAN CANCERS AND NEURODEGENERATIVE DISESES

12.30 – 12.45 PhD Ilona Notar

*John Wesley Theological College – Doctoral School,
Hungary*

OPPORTUNITIES FOR THE HEALTH EDUCATION OF ROMA
WOMEN WITHIN THE FAMILY

12.45 – 13.00 PhD, DSc Alina Plenis

Medical University of Gdansk, Poland

EFFECTS OF IONIC LIQUIDS ON THE SEPARATION PROPERTIES
OF ALKYL AND PHENYL-BASED STATIONARY PHASES IN
REVERSED-PHASE LIQUID CHROMATOGRAPHY

13.00 – 14.30 Lunch time

14.30 – 16.30 The second main session

Chairman: PhD, DSc Bernadeta Szewczyk, Prof. Marek
Lankosz

14.30 – 14.45 Prof. Jolanta Pytko-Polończyk

Jagiellonian University Medical College, Poland

NETWORK IN DENTISTRY – COOPERATION BETWEEN
DENTISTS AND OTHER MEDICAL DOCTORS

14.50 – 15.05 PhD Igor Łoniewski

Pomeranian Medical University in Szczecin, Poland

PROBIOTICS IN POST-COVID SYNDROME

15.10 – 15.25 PhD Eszter Ducza

University of Szeged, Hungary

REGULATORY ROLE OF AQUAPORIN 5 IN THE FUNCTION OF
LATE PREGNANT RAT UTERUS

15.30 – 15.45 Prof. Dariusz Adamek

Jagiellonian University Medical College, Poland

PRELIMINARY OBSERVATIONS IN APPLICATION OF THE
TRANSCRIPTION FACTORS IN HISTOPATHOLOGICAL
DIAGNOSIS ACCORDING TO THE GUIDELINES OF THE NEW
WHO CLASSIFICATION

15.50 – 16.05 PhD Zsuzsanna Schelz

University of Szeged, Hungary

IN VITRO ANTICANCER EFFECTS OF ISTAROXIME

16.10 – 16.25 Prof. Tomasz Brzozowski

Jagiellonian University Medical College, Poland

NON-PHARMACOLOGICAL TREATMENT OF INFLAMMATORY BOWEL DISEASE (IBD). ROLE OF EXERCISE, ADIPOSE TISSUE AND MYOKINES

16.30 – 16.45 Prof. Keyhan Sayadpour Zanjani

Tehran University of Medical Sciences, Iran

PULMONARY ANTIHYPERTENSIVE DRUGS AND REVERSAL OF PULMONARY VASCULAR OBSTRUCTIVE

16.45 – 17.15 Technical break

17.15 – 17.35 Young Scientists' Session part I

Chairman: PhD Katarzyna Kała

17.15 – 17.25 PhD Student Eszter Pázmándi

University of Szeged, Hungary

WHY DO CHILDREN HAVE DIFFICULTIES IN ELEMENTARY SCHOOL? METHODS TO HELP STRUGGLING STUDENTS DEVELOP THEIR EXECUTIVE FUNCTIONS IN A SCHOOL ENVIRONMENT

17.25 – 17.35 MSc Jan Lazur

Jagiellonian University Medical College, Poland

HYPsizYGUS MARMOREUS AND THEIR MYCELIUM FROM *IN VITRO* CULTURES AS A DIETARY AND MEDICINAL AGENT FOR HUMAN ORGANISM

17th September 2022

10.00 – 12.00 The third main session

Chairman: Prof. Jolanta Pytko-Polończyk, Prof. Erika Halašová

10.00 – 10.15 Prof. Andrzej Pilc

Polish Academy of Sciences, Poland

ENHANCEMENT OF THE ANTIDEPRESSANT EFFECT OF HALLUCINOGENS BY MGLU 2/3 RECEPTOR ANTAGONISTS OR SELECTIVE MGLU2 RECEPTOR NEGATIVE ALLOSTERIC MODULATORS (NAMS)

10.20 – 10.35 PhD Tímea Körmöczy

University of Szeged, Hungary

ANALYSIS OF DESIGNER DRUGS AND THEIR METABOLITES IN THE FORENSIC PRACTICE

10.40 – 10.55 Prof. Marek Lankosz

AGH University of Science and Technology, Poland

AN APPLICATION OF ARTIFICIAL NEURAL NETWORKS TO DIFFERENTIATE SELECTED OVARIAN TUMORS

11.00 – 11.15 PhD Anita Sztojkov-Ivanov

University of Szeged, Hungary

EFFECTS OF GESTATION ON THE PHARMACOKINETICS OF DESLORATADINE

11.20 – 11.35 PhD DSc Bernardeta Szewczyk

Polish Academy of Sciences, Poland

ZINC DEFICIENCY BLUNTS THE EFFECTIVENESS OF ANTIDEPRESSANTS IN RODENT MODELS OF DEPRESSION

11.40 – 12.00 Technical break

12.00 – 14.20 Young Scientists' Session part II

Chairman: Prof. Andrzej Pilc, Prof. Paweł Idziak

12.00 – 12.10 MD Monika Kujdowicz

Jagiellonian University Medical College, Poland

THE SPECTROSCOPIC MARKERS OF BLADDER CANCER AND
THEIR POTENTIAL USEFULNESS IN PATIENT TREATMENT

12.10 – 12.20 MD Krzysztof Szymoński

Jagiellonian University Medical College, Poland

DEEP LEARNING EMPOWERS DETAILED MOLECULAR
IMAGING OF PANCREATIC TUMORS

12.20 – 12.30 PhD Student Paweł Gumułka

Jagiellonian University Medical College, Poland

POSSIBILITIES OF USING AN ELASTOMERIC INFUSION PUMP
FOR THE SUPPLY OF MIXTURES OF PARENTERAL DRUGS

12.30 – 12.40 MSc Karol Jędrejko

Jagiellonian University Medical College, Poland

SAFETY AND SIGNAL DETECTION OF UNAPPROVED
PHARMACEUTICALS AVAILABLE FOR OVERALL SALE IN
ELITE AND NON-ELITE ATHLETES

12.40 – 12.50 PhD Student Bibiána Baďurová

*Jessenius Faculty of Medicine in Martin, Comenius
University in Bratislava, Slovakia*

DENTAL PULP STEM CELLS AS AN ATTRACTIVE TOOL FOR
BONE TISSUE REGENERATION

12.50 – 13.00 PhD Student Hiba Faroug Muddather

University of Szeged, Hungary

IN VITRO ANTI-PROLIFERATIVE AND ANTI-METASTATIC
PROPRIETIES OF PEGANUM HARMALA

13.00 – 13.10 PhD Student Ali Hazhmat

University of Szeged, Hungary

IN VITRO EVALUATION OF ANTIPROLIFERATIVE AND
ANTIMETASTATIC ACTIVITY OF THE NEWLY SYNTHESIZED 2-
(4-CHLOROPHENYL)-13 α -ESTRONE SULFAMATE

THE EFFECT OF THE PARACELSIAN MEDICAL CONCEPT ON
THE 20TH CENTURY'S MEDICAL VISION

14.20 – 15.45 Lunch time

15.45 – 17.15 Poster Presentations

Chairman: Prof. Bożena Muszyńska, PhD DSc Katarzyna
Sułkowska-Ziaja

PhD, DSc Alina Plenis *Medical University of Gdańsk, Poland*

PhD, DSc Anna Sobańska *Medical University of Łódź, Poland*

PhD Zuzana Hatoková *Jessenius Faculty of Medicine in Martin,
Comenius University in Bratislava, Slovakia*

PhD Veronika Holubekova *Jessenius Faculty of Medicine in Martin,
Comenius University in Bratislava, Slovakia*

MD Monika Fekete *Semmelweis University, Hungary*

PhD Student Michał Rychlik *Jagiellonian University Medical College,
Poland*

PhD Student Agata Fijałkowska *Jagiellonian University Medical College,
Poland*

PhD Student Paweł Gumułka *Jagiellonian University Medical College,
Poland*

PhD Student Żaneta Binert-Kusztal *Jagiellonian University Medical
College, Poland*

PhD Student Martin Cseh *University of Szeged, Hungary*

Student Alicja Radzimska *Jagiellonian University Medical College,
Poland*

Student Piotr Dziura *Jagiellonian University Medical College, Poland*

Student Bartosz Babik *Jagiellonian University Medical College, Poland*

Student Dominika Zych *Jagiellonian University Medical College, Poland*

Student Kamil Hnatyk *Jagiellonian University Medical College, Poland*

PhD Kacper Packi *Calisia University, Poland*

PhD Jakub Misek *Jessenius Faculty of Medicine in Martin, Comenius
University in Bratislava, Slovakia*

18th September 2022

10.00 – 11.30 Conclusion Remarks and Closing Ceremony

PART II
HONORARY LECTURES

FROM TRADITIONAL TO NEXT GENERATION PATHOLOGY: ACHIEVEMENTS IN CANCER BIOPSY DIAGNOSIS

Prof. Lukáš Plank

Department of Pathology, Comenius University Jessenius Medical Faculty and
University Hospital in Martin, Slovakia

In the flow of time, the pathology has changed substantially from a discipline originally focused on morbid anatomy to a clinical pathology playing a substantial role in the multidisciplinary care of cancer patients. According to the world-wide accepted criteria of WHO, primary histological confirmation of the cancer diagnosis (incl. typing, grading and staging) represents *conditio sine qua non* for every cancer patient's treatment. The biopsy examination of a cancer tissue and/or cancer cells allows the identification of various histological types of given cancer categories. Later on, based on the understanding that in spite of the tissue fixation the detection of various cancer antigens directly in the tissue specimen is possible, the pathologist's histological classification was supplemented by phenotypic features of the cancer cells using immunohistochemistry (IHC). Phenotypic characterisation contributed to more precise differential diagnostic approaches as well as to the prognostic stratification of the patients. At the same moment IHC started to be used also for the identification of predictive biomarkers allowing to predict the treatment response of the patients by targeted therapy and immunotherapy approaches. Nowadays the same is true for the implementation of the molecular and genomic profiling of the cancer tissue alterations either by single and multiplex gene detection or by more complex NGS analyses. Recent development of modern medicine demonstrate, that identical cancer molecular genetic analyses might be done from the plasma sample either on nucleic acids or tumor cells isolated from the patient's blood and this started to be called „liquid biopsy“ analysis. Liquid biopsies show also great importance for the follow-up of the patients and recognition of the therapy resistance identification.

In summary, the implementations of all these methods into the real clinical practice means that complex cancer biopsy diagnostics contributes essentially to better outcome of many cancer patients.

THE COMPLEX ROLE OF ECDYSTEROIDS IN NATURE AND THEIR DRUG DISCOVERY PERSPECTIVES

Prof. Attila Hunyadi

¹Institute of Pharmacognosy, University of Szeged, Eötvös str. 6, H-6720
Szeged, Hungary

Ecdysteroids are insect molting hormones also widespread in the Plant Kingdom. These compounds serve as a chemical defense of plants against non-adapted herbivores. It was recently reported that there is a significant transfer of such compounds through the food chain from plants through insects towards insectivorous animals (songbirds and bats), and this may affect blood-sucking parasites.^{1,2} Ecdysteroids are also bioactive in mammals including humans, and their high chemical diversity manifests in a versatile pharmacology.³ The presentation gives a summary on the current knowledge on these aspects, and covers the possible roles of ecdysteroids in terms of ecology and drug discovery.

References

1. Hornok S, Berkecz R, Sós E, Sándor AD, Körmöczi T, Kontschán J, Hunyadi A. *Mammal Rev* doi: 10.1111/mam.12283 (2022).
2. Hornok S, Csorba A, Kováts D, Csörgő T, Hunyadi A. *Sci Rep*, 9: 17002 (2019)
3. Issaadi M, Csábi J, Hsieh TJ, Gáti T, Tóth G, Hunyadi A. *Bioorg Chem*, 82, 405-413 (2019)

Acknowledgment

NKFIH, K-134704.

NETWORKS – A PERSONAL PERSPECTIVE

Prof. Paweł Idziak

Jagiellonian University, Poland

Computer networks, that initially emerged for military purposes are now used widely in almost all areas of human activities. That includes (tele)communication, sharing data and software, sharing hardware resources (processors, storage space etc), decentralizing data processing and many, many more.

Here we concentrate on presenting networks as dynamical systems that efficiently model neural networks - both natural and artificial ones. Starting with many simplifications in attempt to model brain processes we focus on (in some sense one-dimensional, or one-level) neural network that can be used to analyse many medical problems. Our starting point is a short study of PageRank algorithm used for positioning web pages by Google Inc. Then a brief description of how this idea of Markov processes can be used in improving bibliometrical coefficients (like IF, i.e., impact factor) to differentiate the importance of citations (that has actually been done by the so called AIS, i.e., Article Influence Score).

Finally two other application of Markov processes in medical realm are described. One is in epidemiology, where Markov processes are used for identifying nodes that are important in disease spreading. This is one of the central topics in network epidemiology - it helps in identifying areas that have both high potential transmission risk and high vulnerability to infectious diseases.

The second natural example of applying PageRank ideas in medicine is in fighting cancer, by determining the probabilities of cancer spreading (metastasis) to or from certain organs to more accurately determine which organs are rather spreaders or rather sponges.

PART III
ORAL PRESENTATIONS
SESSION OF YOUNG SCIENTISTS
POSTER PRESENTATIONS
OTHER ABSTRACTS

ORAL PRESENTATIONS

**BIOBANKS AS INNOVATION INFRASTRUCTURE
FOR TRANSLATIONAL MEDICINE**

Peter Amersdorfer

BioMed Center, Jessenius Medical Faculty in Martin, Comenius University

The aim of the presentation is to review the emerging field of biobanking supporting translational medicine applications. As the concept has evolved over time, biobanks have grown from simple biological sample repositories to complex and dynamic units belonging to large infrastructure networks, university hospitals and private enterprises.

SINGLE NUCLEOTIDE VARIANT rs708727 OF SLC41A1 GENE IS ASSOCIATED WITH PARKINSON'S DISEASE

Michal Cibulka¹, Mária Brodňanová¹, Marian Grendár¹, Ján Necpal²,
Matej Škorvánek³, Vladimír Haň³, Branislav Veselý⁴, Ján Benetín⁵,
Egon Kurča⁶, Milan Grofik⁶, Martin Kolísek¹

¹Biomedical Centre Martin, Jessenius Faculty of Medicine in Martin,
CU in Bratislava

²Clinic on Neurology, Agel Hospital, Zvolen

³Clinic of Neurology, L. Pasteur University Hospital, Košice

⁴Clinic of Neurology, Faculty Hospital Nitra, Nitra

⁵Clinic of Neurology, University Hospital Bratislava, Bratislava

⁶Clinic of Neurology, University Hospital Martin, Martin

Parkinson's disease (PD) is a highly prevalent neurodegenerative disease of elderly patients. The main risk factors for the development of this treatable but incurable disease are advanced age and male sex. The pathogenesis of the idiopathic form of PD is multifactorial. Genetic predisposition as well as environmental factors play a key role in the development of the disease. Recently, the attention of the scientific world has been focused on the possible association of deviations in Mg²⁺ homeostasis with the pathogenesis of PD. The *SLC41A1* gene, encoding the eponymous sodium-magnesium exchanger, has been identified as one of the genes located within the *PARK16* locus. This locus has been associated with the risk of PD development in several populations. The aim of our multicentric study was to analyze the association of the presence of single nucleotide variants of the ORF region (rs11240569, rs708727, and rs823156) of *SLC41A1* with the risk of PD development. DNA samples of 508 patients diagnosed with PD from the Centers for Extrapyrimalid Diseases in Martin, Zvolen, Košice, Nitra and Bratislava were analyzed in the study. DNA samples from 472 individuals who were included in the study based on defined inclusion and exclusion criteria were used as controls. Variants in the ORF region were identified using TaqMan® probes by qPCR. The obtained data were analyzed by frequentist statistics as well as by machine learning approaches in the

Random Forest algorithm. By analyzing the data in the dominant (GG vs. GA+AA) and completely over-dominant (GG+AA vs. GA) models, we found that the rs708727 variant was significantly ($p < 0.05$) associated with an increased risk of developing PD. The remaining variants and haplotypes did not show significant correlation with the risk of PD development. The presence of any of the variants did not influence the age of onset of the disease. The results of our study support the theory linking Mg^{2+} homeostasis to the etiopathogenesis of PD. The rs708727 variant and its effect on *PM20D1* expression may partly explain the pathogenesis of dementia that often develops in patients with PD.

ADVANCED ANALYSIS OF FLUORESCENCE MICROSCOPY OUTPUTS FROM BIOLOGICAL SAMPLES

Michal Pokusa

Laboratory of Microscopy, Biomedical Center Martin, Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Malá Hora 4C Martin

The majority of methodological approaches based on fluorescence microscopy usually aim at the morphological and structural mapping of investigated samples. However, the additional analysis of all data provided by imaging systems could significantly enrich obtained results. Investigation of vital cells and tissues could provide insight into intracellular physiology. To provide a brief introduction to advanced analysis of fluorescence microscopy outputs is the aim of the current work. Firstly described is the analysis of emitted fluorescence decay by a method called fluorescence lifetime imaging (FLIM). Using the FLIM method provides a unique tool for the analysis of changes in the energy metabolism along with interactions of investigated molecules beyond the recognition limit of fluorescence microscopy. Further description would be devoted to proper quantification of emitted fluorescence intensity. This very common outcome of fluorescence microscopy provides a data for the assessment of the physiology status of subcellular structures in the case of the use of relevant fluorescent probes. The third part would be devoted to the advanced processing of morphology features obtained by imaging the cell environment. The appearance of the compact e.g. mitochondrial network reflects the mitochondrial fitness in observed sample. Described handling procedures with fluorescence microscopy data could be found very beneficial in the evaluation of progression as well as therapy response in such serious diseases like a neurodegenerative disorders or cancer.

USABILITY OF MAGNETIC RESONANCE TECHNIQUES IN METABOLOMICS

Eva Baranovicova¹, Katarina Dirnbachova¹, Jan Gombos¹, Petra Hnilicova¹, Alica Lokajova¹, Oliver Strbak¹

¹Laboratory of Metabolomics, Biomedical Centre Martin, Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Mala Hora 4, 036 01 Martin, Slovakia

Cell metabolism is an essential feature of life and results in the formation of metabolites in living systems. Alterations in metabolism are often associated with various pathological processes [1]. Analysis of their concentration changes is one of the essential diagnostic tools of modern medicine. Laboratory of Metabolomics specializes in targeted and non-targeted metabolomics analysis using magnetic resonance [2,3] and mass spectroscopy [4] techniques combined with non-invasive imaging (MRI) [5]. Besides, we focus also on theranostic applications using functionalized magnetic nanoparticles [6]. Here we present our laboratory's latest results and possibilities, including cooperation potentiality.

References

1. Varma V.R., et al., PloS Med. 2018, 15(1): e1002482.
2. Baranovicova E. et al., Biomolecules 2022, 12(4), 554.
3. Hnilicova P. et al., Neurochem. Int. 2022, 154, 105293.
4. Gondas E. et al., Gen. Phys. Biophys. 2021, 40(2), 127-135.
5. Strbak O., et al.; Int. J. Mol. Sci. 2021, 22(16), 8487.
6. Strbak O., et al., Nanomaterials 2020, 10(12), 2468.

Acknowledgment

This research was funded by the following projects: APVV SK-AT-20-0010, VEGA 1/0092/22, and Ministry of Health SR 2018/11-UKMT-7.

DEVELOPMENT OF NOVEL IN VITRO MODELS FOR HUMAN CANCERS AND NEURODEGENERATIVE DISESES

Jan Strnadel, Romana Zahumenska, Sandra Mersakova, Dusan Brany

Laboratory of Flow Cytometry, Cell Phenotyping and Engineering, Biomedical Centre Martin, Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Slovakia, Mala Hora 4, 036 01 Martin, Slovakia

In vitro modelling of human diseases is an essential part of biomedical research. Without appropriate cell models that fully reassemble the pathology of human diseases (at least on *in vitro* level, in the dish), there is no chance to make progress in human therapy. Generation of fully characterized cell lines is therefore important part of biomedical research. Moreover, cell lines generated by 3D technology are capable to replace a significant part of *in vivo* experiments. The recent progress in the field of *in vitro* modelling is greatly supported with sophisticated 3D cell culture protocols, new 3D matrix development and 3D printing. A total revolution in this field was made by recent discovery of induced pluripotency; the technique awarded by Nobel Prize in 2012. Technology of induced pluripotency allows the generation of any type of healthy or mutation-bearing cells from skin or blood cells. Hard-to-get cells (like motor neurons or cardiomyocytes) are simply prepared by this technique, in virtually any amount thus allowing researches to get access and perform research. Here, we present the development of very first Slovak induced pluripotent stem cell lines for modelling ALS and progress in derivation of induced pluripotent stem cell line modelling Duchenne muscular dystrophy. Our team also present the successful story of 3D cell line development for modelling colorectal and pancreatic cancer.

Acknowledgement

This project was supported by Slovak research and development agency, grant No. APVV-21-0372. Research was also performed with the support of the Integrated Infrastructure Operational Program for the project: Systemic public research infrastructure - Biobank for cancer and rare diseases, ITMS: 313011AFG5, co-financed by the European Regional Development Fund.

OPPORTUNITIES FOR THE HEALTH EDUCATION OF ROMA WOMEN WITHIN THE FAMILY

Ilona Notar

Supervisor: Prof. Dr. Forrai Judit

John Wesley Theological College – Doctoral School

I wish to write about the process of change in the identity of Roma communities where women are at the center of community life, though they might not be aware of this

In traditional Roma communities in Hungary, women are the most important actors of passing on culture and identity, due to their traditional roles.

I will present some foundational research studies on the health situation of Roma women (Gyukits 2000, Neményi 1988, Puporka-Zádori 1999, Doncsev 2000). I will point out the ways Roma women become central figures in health education.

What happens to intellectual Roma women who transcend their traditional roles as wives and homemakers, and/or complement these with their own career goals? How can their new body awareness enter the education of their children – as opposed to the traditional ideas related to female virginity, “honor” and “uncleanliness” – and how can health screenings for men and women be emphasized (beyond the virtue of virginity, considering suspicion towards male doctors or along “masculine” behavior)? By becoming aware of and shaping male and female role models, young people can themselves have agency in preserving and shaping their health (prevention, screenings, expanding sexual awareness).

I did a survey among women who are at the center of this complex process. I would like to explore how the internal structures of the family and the community are changing, how the individual changes of women affect her children’s conscious choices of roles, the development of their health, prevention attempts and the shaping of their self-image.

EFFECTS OF IONIC LIQUIDS ON THE SEPARATION PROPERTIES OF ALKYL AND PHENYL-BASED STATIONARY PHASES IN REVERSED-PHASE LIQUID CHROMATOGRAPHY

Alina Plenis¹, Natalia Treder¹, Ilona Olędzka², Anna Roszkowska²,
Piotr Kowalski², Tomasz Bączek²

¹Department of Analytical Chemistry, Faculty of Pharmacy, Medical University of Gdańsk, Str. Hallera 107, 80-416 Gdańsk, Poland

²Department of Pharmaceutical Chemistry, Faculty of Pharmacy, Medical University of Gdańsk, Str. Hallera 107, 80-416 Gdańsk, Poland

Ionic liquids (ILs) belong to a wide group of compounds commonly called “green solvents” due to their low vapor pressure, thermal stability or non-flammability. Structurally, ILs are formed by a combination of different organic cations with organic or inorganic anions, so they have different physicochemical properties. They are also considered as “designer” compounds which may control the conditions and, consequently, the results of many experiments [1]. For example, the application of ILs as additives to the mobile phase in reversed-phase liquid chromatography (RP-LC) can influence the dynamic coating of the stationary phases and lead to a change in their chromatographic properties [2,3].

The aim of the study was to evaluate the interaction occurring between different ILs added to an aquatic mobile phase and the functional groups on alkyl and phenyl based stationary phases during RP-LC analysis of four tetracycline antibiotics belonging to group of cytostatic drugs. Changes in behaviors of the studied analytes during RP-LC separation were evaluated on the basis of the calculated chromatographic parameters such as retention factor (k), peak area (A), number of theoretical plates (N_A) and tailing factor (T). It allowed to assess how different IL anions and cations influence separation results, and whether these results depend on their concentration. Moreover, the modifications of mobile phase composition (0.1% formic acid vs phosphate buffer) and pH changes on the IL effect were also evaluated. In the study, a wide group of ILs was tested on various stationary phases, including alkyl, phenyl and pentafluorophenyl stationary phases.

The results showed the significant differences in the outcomes for the tested stationary phases which clearly indicated that the choice of ILs has to be adjusted to the type of chromatographic column. For example, π - π type interactions occurring on the phenyl based columns gave more distinct effects from the ILs compared to those observed on the alkyl column [3]. Therefore, the more significant shortening of analysis time without increasing the percentage of organic solvent in the mobile phase in respect to alkyl based silica columns was achieved. However, independently of the type of used stationary phase, it was possible to reduce the analysis time, improve the peak shape as well as the column efficiency as a result of adding appropriate IL to the mobile phase.

References

1. Treder N., Baczek T., Wychodnik K., Rogowska J., Wolska L., Plenis A., *Molecules*, 2020, 25, 286.
2. Treder N., Olędzka I., Roszkowska A., Bączek T., Plenis A., *J. Chromatogr., A* 2021, 462257, 462257.
3. Treder N., Olędzka I., Roszkowska A., Kowalski P., Bączek T., Plenis A., *Microchem. J.*, 2022, 178, 107396.

NETWORK IN DENTISTRY – COOPERATION BETWEEN DENTISTS AND OTHER MEDICAL DOCTORS

Jolanta Pytko-Polończyk

Chair and Department of Integrated Dentistry, Jagiellonian University Medical College, Institute of Dentistry, 12 Montelupich 4 str., 31-155 Cracow, Poland

Oral cavity – the initial part of the gastrointestinal tract can trigger pathological processes (i.g. dental caries with complications like pulpitis and periapical diseases or diseases of periodontium) that cause focal infections. Through the continuity of the tissues or vessels, bacteria from these areas can reach even distant organs such as heart, lungs, kidneys, liver, brain, joints and cause serious complications. These are: pericarditis and inflammation of heart valves, rheumatic disease, nephritis, ophtalmitis, meningitis, inflammation of face's veins, brain abscess, sepsis and others diseases. Cooperation between dentists and other medical professionals is particularly important before begining with treatment of these patients, surgical procedures or organ transplants, as the sites of infection discovered in the mouth must be removed prior these procedures.

Another type of cooperation or a specific network in dentistry is collaboration with pediatricians, dermatologists, gastroenterologists, oncologists or psychiatrists. Due to the different ages of patients (infants, adults and elderly patients) treated by dentists, joint consultations with medical doctors are necessary, as patients suffer from different systematic diseases that also manifest themselves in the mouth.

**PRELIMINARY OBSERVATIONS IN APPLICATION
OF THE TRANSCRIPTION FACTORS
IN HISTOPATHOLOGICAL DIAGNOSIS ACCORDING
TO THE GUIDELINES OF THE NEW WHO CLASSIFICATION**

Dariusz Adamek^{1,2}, Edyta Radwańska^{1,3}, Aneta Szymańska³,
Anna Hulacka^{2,3}, Ryszard A. Czepko⁴, Marek Betlej⁵, Borys Kwinta⁵,
Ryszard Czepko⁴, Aleksandra Gilis-Januszevska⁶,
Alicja Hubalewska-Dydejczyk⁶

¹Department of Neuropathology, Jagiellonian University Medical College,
Faculty of Medicine, Grzegórzecka Str. 16, 31-531 Kraków

²Chair and Department of Pathomorphology, Jagiellonian University Medical
College, Faculty of Medicine, Grzegórzecka Str. 16, 31-531 Kraków

³Department of Pathomorphology University Hospital, Jagiellonian University
Medical College, Jakubowskiego Str. 2, 30-688 Kraków ⁴Clinical Department
of Neurosurgery, Scanmed SA, Andrzej Frycz-Modrzewski Krakow University,
Herling-Grudziński Str. 1, Kraków ⁵Department of Neurosurgery and
Neurotraumatology, Jagiellonian University Medical College, Jakubowskiego
Str. 2, 30-688 Kraków ⁶Chair and Department of Endocrinology, Jagiellonian
University Medical College Jagiellonian University Medical College,
Jakubowskiego Str. 2, 30-688 Kraków

Pituitary adenomas – most typical tumors of anterior part of hypophysis (“adenohypophysis”) since some time are counted among broad family of neuroendocrine neoplasms that can be encountered in many other parts or locations of the body and duly termed as PitNET/adenomas. Newest WHO classification (Internet beta version issued in 2022) divides them according to separate cell lineages of cellular and functional differentiation they seem to represent, namely: PIT-1 lineage tumors, TPIT lineage tumors, SF-1 lineage tumors, (and tumors without distinct cell lineage). The attribution is based upon immunoexpression (or the lack of it) of particular developmental markers (PIT-1, TPIT, SF-1) which, playing a role of transcription factors during development of the gland, decide about the “trophic-hormonal” destiny of the cells in the gland and what can be replicated in adenomas. Though conceptually “lines” of developmental “lineages” (of cells and tumors) are

straight the practical implementation is not (that) straight and, what is more important, we are still far away from the point where their “targets” prove their practical-clinical validity, especially in helping to infallibly discern and predict aggressive behavior of the particular tumor. Our preliminary data with application of the new WHO classification of anterior pituitary will be shown. Special attention will be paid to the necessity of high quality standards of laboratory procedures and to cautious interpretation of their results. One of the simplest and in fact most expected results of the introduction of transcription factors into process of diagnosis is the recognition of many subtypes of pituitary adenomas where all trophic hormones detected by immunohistochemistry are negative. It has been becoming evident (or it seems so) that even if “lines” (of developmental lineages determined by transcription factors) are “straight”, they crisscross or entangle with other “lines” or “strings” formed by other factors including many other particular pathological properties of adenomas (for instance the type of immunoexpression – scarcely or densely granulated), as well as pathophysiological and clinical features, what inevitably results in something of a semblance of ... a “network”?

References

1. WHO Classification of Tumours. Endocrine and Neuroendocrine tumours [Internet]. Lyon (France): International Agency for Research on Cancer; 2022. (WHO classification of tumours series, 5th ed. Available from: <https://tumourclassification.iarc.who.int>. Website beta version

Acknowledgment

This report received financial support from Jagiellonian University grant No. N41/DBS/000792

REGULATORY ROLE OF AQUAPORIN 5 IN THE FUNCTION OF LATE PREGNANT RAT UTERUS

Kata Kira Kemény¹, Adrienn Seres-Bokor¹, Tamara Barna², Róbert Gáspár², Eszter Ducza¹

¹ Department of Pharmacodynamics and Biopharmacy, Faculty of Pharmacy, University of Szeged, Eötvös u. 6, 6720, Szeged, Hungary

² Department of Pharmacology and Pharmacotherapy, Albert Szent-Györgyi Medical School, University of Szeged, Dóm tér 12., 6720, Szeged, Hungary

The aquaporin (AQP) water channels are small hydrophobic integral membrane proteins. Most of them are expressed in the female reproductive tissues and they play an important role during pregnancy. AQP5 expression was found predominant during pregnancy in the uterus of rats, although it was significantly down-regulated at the last gestational day. Moreover, our results lead us to suppose that the AQP5 expression is regulated by oxytocin and female hormones. We hypothesized an “osmotic pathway” - through AQP5 - might have an influence on the changes in transient receptor potential vanilloid 4 (TRPV4) function and uterus contraction. We aimed to determine the possible role of AQP5 in this osmotic regulation of TRPV4, thus in pregnant uterine contraction. Moreover, we investigated the “receptor pathway” in the AQP5 expression through the tocolytic agents in the late pregnant rat uterus.

The pharmacological influence on AQP5 expression was investigated by terbutaline, doxazosin, and citral treatment, *in vivo*; and mercuric chloride, *in vitro*. The effect of AQP5 on the lengths of the gestational period was investigated by AQP5-siRNA-treated rats. The changes in AQP5 and TRPV4 mRNA and protein expressions were measured using RT-PCR and western blot, respectively.

The TRPV4 antagonist citral increased the AQP5 level in the uterus which was prevented by the TRPV4 agonist RN1747. In addition, citral treatment significantly prolonged the normal gestation period and delayed preterm delivery. The gestational period was significantly shorter after AQP5 siRNA treatment compared to the control. Terbutaline treatment significantly increased the AQP5 mRNA and protein expression, *in vivo*.

We created an AQP5 down-regulated animal model with AQP5 siRNA which proved the crucial role of AQP5 in the process of birth. We proved that the AQP5 expression can regulate by pharmacology (e.g. citral and terbutaline), therefore we hope this will open a new possibility for the therapy and prevention of preterm birth.

Acknowledgment

This work was supported by the National Research, Development, and Innovation Office, Hungary (grant NKFI-FK19-132499). Project no. TKP2021-EGA-32 has been implemented with the support provided by the Ministry of Innovation and Technology of Hungary from the National Research, Development and Innovation Fund, financed under the TKP2021-EGA funding scheme.

IN VITRO ANTICANCER EFFECTS OF ISTAROXIME

Zsuzsanna Schelz, Etelka Kovács, István Zupkó

Institute of Pharmacodynamics and Biopharmacy, Faculty of Pharmacy,
University of Szeged, H-6720 Szeged, Eötvös Str. 6., Hungary

Istaroxime, a luso-inotropic agent has drawn scientific attention by exerting possible antitumor effects. Based on the literature of digoxin, our attempt was to do a comparative *in vitro* study on human cervical cancer cells and oral squamous cell carcinomas related to human papilloma virus infection. Our aim was to investigate the antiproliferative, antimetastatic and proapoptotic properties of istaroxime compared to digoxin. Antiproliferative effects were tested by MTT assay on a selection of cervical cancer cells and oral squamous cell carcinoma cells. IC₅₀ values were measured and tumor selectivity was determined by testing the compounds on NIH/3T3 murine fibroblast cells. The IC₅₀ values of istaroxime varied from 2.60 to 8.89 µM, meanwhile digoxin exerted a more pronounced effect with IC₅₀ values between 0.08 and 0.48 µM. Antimetastatic effects were assessed by the wound healing assay. Inhibition of wound closure was concentration dependent and detectable at each cell line, which points to a mechanism that all tested cell lines share. Na⁺/K⁺-ATPase as part of a so called signalosome, has fundamental role in the cellular regulatory mechanisms of cancers. Inhibition of the signalosome might be a possible target mechanism in the development of new anticancer agents.

Acknowledgment

Project no. TKP2021-EGA-32 has been implemented with the support provided by the Ministry of Innovation and Technology of Hungary from the National Research, Development and Innovation Fund, financed under the TKP2021-EGA funding scheme.

NON-PHARMACOLOGICAL TREATMENT OF INFLAMMATORY BOWEL DISEASE (IBD). ROLE OF EXERCISE, ADIPOSE TISSUE AND MYOKINES

Tomasz Brzozowski¹, Dagmara Wojcik¹, Jan Bilski²,
Agnieszka Mazur-Bialy²

¹Department of Physiology, Faculty of Medicine, Jagiellonian University
Medical College, Cracow, Poland

²Department of Ergonomics and Exercise Physiology, Faculty of Health
Sciences, Jagiellonian University Medical College, Cracow, Poland

The pathogenesis of inflammatory bowel disease (IBD), which mainly includes Crohn's disease (CD) and ulcerative colitis (UC), remains largely unknown. Earlier studies have documented that both diseases are cyclical, alternating between active and quiescent resting states. The development of IBD significantly deteriorates the physical performance and quality of life of patients despite pharmacotherapy including antibiotics, steroids, thiopurines, 5-ASA derivatives such as mesalazine, biological response modifiers, immunomodulators and Janus kinase inhibitors. However, given the immune-based mechanism and host response, the safety profile of some of these drugs and formulations remains a matter of concern because of possible adverse side-effects. There is a need for alternative and non-drug therapy. Obesity is a risk factor in IBD, but exercise of varying intensity is recommended as an alternative therapy to prevent and treat these intestinal disorders. An important brush border apical enzyme, intestinal alkaline phosphatase (IAP) released from cell walls during stressful events, maintains a tight junctions and intestinal barrier integrity, but whether treatment with IAP could influence the course of experimental colitis in obese mice with voluntary or forced the treadmill has been little studied. Our studies in obese mice fed a high-fat diet with experimental colitis showed that the severity of colitis as defined by the Disease Activity Index (DAI) was significantly reduced in obese mice voluntarily spinning wheels compared to sedentary mice. This protective effect of voluntary exercise in obese mice was accompanied by a significant increase in colon blood flow

(CBF), plasma myokine levels of irisin released from skeletal muscle and the skeletal muscle strength assessed by grip test compared to respective values obtained in sedentary obese mice. In contrast, treadmill exercise exacerbated DAI activity in obese mice and reduced CBF below that obtained in mice fed the standard diet. Moreover, treatment of IAP in conjunction with treadmill exercise decreased DAI, improved relative muscle strength, and significantly decreased the expression of mRNA for proinflammatory biomarkers IL-1 β , TNF- α , MCP-1, IL-12 and phospho-NF κ B, and the MMP-9 protein. The IAP treatment significantly increased occludin and ZO-1 protein expression, and these effects were much more pronounced in obese mice. We conclude that moderate exercise that increases colonic microcirculation possibly due to myokines released from exercising muscles should be recommended in patients with IBD as an alternative or complementary drug therapy. Forced treadmill exercise can exaggerate colon damage in obese mice and perhaps obese patients, by a mechanism involving a decrease in colonic microcirculation due to increase in oxidative stress parameters in the colonic mucosa and the upregulation of local and systemic pro-inflammatory biomarkers without changing the plasma myokine irisin levels. IAP treatment ameliorates the escalating effects of forced exercise on the course of experimental colitis by alleviating oxidative stress and preserving the intestinal barrier protein in the colon mucosa. IAP-induced alleviation of experimental colitis may have translational potential as a new alternative to clinical treatment of IBD.

Acknowledgment

Supported from the National Science Center under a project grant (UMO-2015/19/B/NZ4/03130).

ENHANCEMENT OF THE ANTIDEPRESSANT EFFECT OF HALLUCINOGENS BY mGLU 2/3 RECEPTOR ANTAGONISTS OR SELECTIVE mGLU2 RECEPTOR NEGATIVE ALLOSTERIC MODULATORS (NAMs)

Agnieszka Pałucha-Poniewiera, Agata Machaczka, Yana Babii,
Bernadeta Szewczyk, and Andrzej Pilc

Maj Institute of Pharmacol., Polish Acad. Sci. and UJ CM, Fac. Health Sci,
Kraków, Poland

Hallucinogens from various groups (ketamine - dissociative, scopolamine - deliriant or psilocybin - psychedelic) have antidepressant effects in both preclinical and clinical studies. Group II glutamate (mGlu) metabotropic receptor antagonists also show antidepressant efficacy in animal studies and have been tested in humans.

In our studies, we show that the combined administration of subliminal doses of ketamine and the mGlu2/3 receptor antagonist of LY341495 resulted in a pronounced and long-lasting antidepressant effect. Also, the ineffective dose of scopolamine HBr (0.03 mg/kg) together with LY341495 caused a pronounced antidepressant in the forced swim test (FST), and the side effects of scopolamine were additionally weakened. Moreover a selective M1 muscarinic receptor antagonist VU0255035 produced a dose dependent antidepressant effects which were potentiated by a low dose of mGlu2 receptor NAM VU60001966.

Psilocybin (0.5 mg/kg) + LY341495 (0.3 mg/kg), doses that are not active on their own, induced long-term antidepressant effects in mice in the tail suspension test (TST) 24, 72 h. or 7 hours days after single dose administration. The unions were also active after 24 hours. in the novelty suppressed eating test (NSFT).

The results show that hallucinogens of different classes exert an antidepressant effect which is potentiated by mGlu2/3 receptor antagonists or mGlu2 receptor NAMs. The mechanism of this enhancement appears to be through increased glutamate release and activation of a cascade of neurogenesis-related elements.

ANALYSIS OF DESIGNER DRUGS AND THEIR METABOLITES IN THE FORENSIC PRACTICE

Tímea Körmöczi¹, Éva Sija², István Ilisz¹, Róbert Berkecz¹

¹ Institute of Pharmaceutical Analysis, Faculty of Pharmacy, University of Szeged, Somogyi utca 4., Szeged, Hungary

² Department of Forensic Medicine, Faculty of Medicine, University of Szeged, Kossuth Lajos sgt. 40., Szeged, Hungary

Synthetic cannabinoids (SCs) are the most rapidly growing group of new psychoactive substances (NPS) that mimic the effect of the main psychoactive ingredient in marijuana. The consumption of SCs serves as a high health risk problem because of their significantly higher binding affinities to the cannabinoid receptors than the well-known Δ^9 -tetrahydrocannabinol (THC). In forensic and clinical practice the most commonly used techniques for quantitation of SCs in urine and blood samples are liquid chromatography coupled to tandem mass spectrometry (LC-MS/MS). Only analyzing the parent compounds cannot confirm the consumption of SCs due to their low concentration and rapid metabolism.

Developing and applying targeted analytical LC-MS/MS methods to properly analyze the new SCs and their main metabolites in human urine and blood samples.

Optimized liquid-liquid extraction method is used for sample preparation procedures of urine and blood samples. The developed targeted LC-MS/MS method is based on the reversed-phase separation of SCs and their metabolites. Quantifier ion and qualifier ion were selected for qualitative and quantitative analysis of targeted compounds using an external calibration procedure with internal standard normalization.

In general, the metabolite concentrations were significantly higher than the parent compounds of SCs in biological samples. In several cases, the parent compounds were under the detection limit while their main metabolites were present in high urinary and blood levels.

Our developed targeted LC-MS/MS method is suitable to confirm the consumption of SCs in human urine and blood samples. In doing so, we have great support for the work of forensic toxicology.

Keywords: synthetic cannabinoids; metabolites; targeted LC-MS/MS

AN APPLICATION OF ARTIFICIAL NEURAL NETWORKS TO DIFFERENTIATE SELECTED OVARIAN TUMORS

Patrycja Śliż-Szpytma¹, Zdzisław Stęgowski¹, Dariusz Adamek², Łukasz Chmura², Edyta Radwańska², Milko Jakšić³, Iva Božičević Mihalić³, Georgios Provas³, Zdravko Siketić³, Marko Barac³, Marek Lankosz¹

¹Department of Medical Physics and Biophysics AGH-University of Science and Technology, al. Mickiewicza 30, 30-059 Krakow, Poland

²Department of Clinical and Experimental Pathology, Jagiellonian University, ul. Grzegórzecka 16, 31-531 Krakow, Poland

³Laboratory for Ion Beam Interactions, Division of Experimental Physics, Ruđer Bošković Institute, Bijenička cesta 54, 10000 Zagreb, Croatia

Trace and minor elements have crucial roles in the pathophysiology of cancer. Certain metals are known to play a role in oncogenetic processes, either directly or indirectly [1-2]. In order to understand how trace elements contribute to the development of neoplastic diseases, it is essential to have knowledge about the chemical elements within tissue samples. There is a direct correlation between the presence or absence of certain elements in different areas of tissue and the metabolic process, which impacts an individual's "health status".

The measurements were conducted at Ruđer Boskovic Institute in Laboratory for Ion Beam Interaction, Zagreb, Croatia. In measurements 1MV Tanderon was used. The samples were measured at the cellular level with the use of fine focused ion microbeam. with protons energy up to 2 MeV. For elemental analysis Particle Induced X-ray Emission (PIXE) was applied. Tissue materials used for the research purposes were shock-frozen and cut into sections of ca. 5 micrometers thick using cryo-microtome. The scraps were mounted onto the gold-covered LowStress Silicon Nitride Si₃N₄ Window (nitride thick: 200 nm, window size: 2x2 mm², frame size: 5x5 mm², frame thick: 200 nm) and freeze-dried at temperature -80°C. Positioning and selecting areas for research was done with Scanning Transmission Electron Microscopy (STIM).

The research determined the presence of Na, Mg, Al, P, S, Cl, K, Ca, Ti, Fe, Cu and Zn in ovarian tumors. Neural networks were used to

analyze seven tissue samples, including one with no tumor lesions as a reference.

Keywords: PIXE; trace elements; tumor

References

1. Quaid-i-Azam University. Qaisara Pashaa Salman, Quaid-i-Azam University. A.Malika, Quaid-i-Azam University. Munir H.Shahb, *Journal of Hazardous Materials* 153 (2008) 1215-1221.
2. Universitat Rovira i Virgili. Elisabet Rodríguez-Tomàsa, Universitat Rovira Virgili. Gerard Baiges-Gaya, Universitat Rovira i Virgili. Helena Castañé, Universitat Rovira i Virgili. Meritxell Arenas, Universitat Rovira i Virgili. Jordi Camps, Universitat Rovira i Virgili. Jorge Joven, *Journal of Trace Elements in Medicine and Biology* 68 (2021) 126858.

Acknowledgment

The presented study was carried out under the CERIC grant number 20197010 at the Ruder Boskovic Institute at the Ion Beam Interaction Laboratory in Zagreb (Croatia)

EFFECTS OF GESTATION ON THE PHARMACOKINETICS OF DESLORATADINE

A. Sztojkov-Ivanov¹, B. Majercsik¹, R. Gáspár²

¹ Institute of Pharmacodynamics and Biopharmacy, Faculty of Pharmacy,
University of Szeged, Hungary

² Department of Pharmacology and Pharmacotherapy, Albert Szent-Györgyi
Medical School, University of Szeged, Hungary

Pregnancy is associated with physiological changes that alter the pharmacokinetics and pharmacodynamics of medications during gestation. In this study, the effects of pregnancy on the maternal pharmacokinetics and fetal disposition of a second generation antihistamine drug desloratadine were examined in a rat model.

Maternal and fetal desloratadine plasma concentration-time curves and pharmacokinetic parameters were determined following administration of a single per os dose of desloratadine to 21-day pregnant and non-pregnant Sprague-Dawley rats.

Our results demonstrated that gestation affects the pharmacokinetic profile of desloratadine in rats and the fetal exposure is relatively high.

The study highlights the importance of modified dosing strategies in pregnancy to improve efficacy and limit maternal and fetal risks.

Acknowledgment

Permission number of animal experiments: IV/198/2013. The study was supported by RECOOP HST Association.

ZINC DEFICIENCY BLUNTS THE EFFECTIVENESS OF ANTIDEPRESSANTS IN RODENT MODELS OF DEPRESSION

Bernadeta Szewczyk, Justyna Turek, Agata Machaczka, Łukasz Gąsior, Bartłomiej Pochwat

Department of Neurobiology, Maj Institute of Pharmacology Polish Academy of Sciences

Currently used antidepressants do not always provide the desired results, and many patients suffer from treatment-resistant depression [1]. Clinical studies suggest that zinc deficiency (ZnD) may be an important risk factor for depression. Similarly, preclinical studies have shown that a zinc-deficient diet induces depressive symptoms in rodents [2]. Moreover, rats subjected to an olfactory bulbectomy (OB) model of depression and chronically fed a zinc-deficient diet simultaneously developed depressive-like symptoms that were resistant to some standard antidepressants [3]. Our recent studies showed that mice subjected to chronic stress and fed a zinc-deficient diet (ZnDD) develop depression-like behavior with increased anxiety symptoms. As shown further, only selected drugs reversed the deficits in behavior induced by chronic stress and ZnDD [4]. These findings suggest that zinc deficiency may be an important factor in the development of drug-resistant depression. Furthermore, we believe that a rodent model incorporating a zinc-deficient diet and chronic stress at the same time could be a valuable tool in the search for new and more effective pharmacotherapies for drug-resistant depression.

References

1. Kautzky, A.; Baldinger-Melich, P.; Kranz, G.S.; Vanicek, T.; Souery, D.; Montgomery, S.; Mendlewicz, J.; Zohar, J.; Serretti, A.; Lanzenberger, R., et al. A New Prediction Model for Evaluating Treatment-Resistant Depression. *J Clin Psychiatry* 2017, 78, 215-222, doi:10.4088/JCP.15m10381.
2. Rafalo, A.; Sowa-Kucma, M.; Pochwat, B.; Nowak, G.; Szewczyk, B. Zinc Deficiency and Depression. *Nutritional Deficiency* 2016, 10.5772/63210, 3-22, doi:10.5772/63210.
3. Rafalo-Ulinska, A.; Pochwat, B.; Misztak, P.; Bugno, R.; Kryczyk-Poprawa, A.; Opoka, W.; Muszynska, B.; Poleszak, E.; Nowak, G.; Szewczyk, B. Zinc

Deficiency Blunts the Effectiveness of Antidepressants in the Olfactory Bulbectomy Model of Depression in Rats. *Nutrients* 2022, 14, doi:10.3390/nu14132746.

4. Pochwat, B.; Misztak, P.; Masternak, J.; Bączyńska, E.; Bijata, K.; Roszkowska, M.; Bijata, M.; Włodarczyk, J.; Szafarz, M.; Wyska, E.; Muszyńska, B.; Krakowska, A.; Opoka, W.; Nowak, G.; Szewczyk, B. Combined hyperforin and lanicemine treatment instead of ketamine or imipramine restores behavioral deficits induced by chronic restraint stress and dietary zinc restriction in mice. *Front. Pharmacol* 2022, doi.org/10.3389/fphar.2022.933364.

Acknowledgment

This research was partially funded by a grant from the National Science Center UMO 2020/37/B/NZ5/03891 (BS)

SESSION OF YOUNG SCIENTISTS

WHY DO CHILDREN HAVE DIFFICULTIES IN ELEMENTARY SCHOOL? METHODS TO HELP STRUGGLING STUDENTS DEVELOP THEIR EXECUTIVE FUNCTIONS IN A SCHOOL ENVIRONMENT

Eszter Pázmándi¹

¹Semmelweis University, András Pető Faculty

The drastic increase in modern-day expectations is making everyday life difficult not only for adults, but also for children in pre-school. The primary pillar of pre-school teacher training is play-based education, i.e. the transmission of literacy in a playful way. The nature of playful activities has changed to a lesser extent over the last 10 years in institutional settings, although it has increased significantly in the home environment. Vibrant, pulsating screens, easy access to virtual reality and interactive devices can be found in countless Hungarian households, thus conditioning children's nervous system to simultaneously absorb millions of visual stimuli, while pre-school educational tools develop children's skills using traditional, mostly paper-and-pencil-based tasks. The contrasting stimuli can also be reflected in children's cognitive and sensorimotor abilities in both domains, and in extreme cases they may be labelled lazy, inattentive, and badly behaved by their teachers and family members. If those involved in the care of children could understand the underlying causes of their different behaviour, future students would be able to perform better and be more prepared to take complex cognitive challenges.

***HYPsizYGUS MARMOREUS* AND THEIR MYCELIUM FROM IN VITRO CULTURES AS A DIETARY AND MEDICINAL AGENT FOR HUMAN ORGANISM**

Jan Lazur¹, Katarzyna Kała¹, Wojciech Pająk¹, Katarzyna Sułkowska-Ziaja¹, Krystian Marzec², Maciej Fidurski², Piotr Zięba², Agata Krakowska³, Agnieszka Szewczyk¹, Bożena Muszyńska¹

¹Jagiellonian University Medical College, Faculty of Pharmacy, Department of Pharmaceutical Botany, Medyczna 9 Str., 30-688 Kraków, Poland

²University of Agriculture in Kraków, Faculty of Biotechnology and Horticulture, Department of Horticulture, 29 Listopada 54, 31-425 Kraków, Poland

³Jagiellonian University Medical College, Faculty of Pharmacy, Department of Inorganic and Analytical Chemistry, Medyczna 9 Str., 30-688 Kraków, Poland

Number of studies have shown that the mushroom is a source of many biologically active components such as polysaccharides, bioelements, amino acids and proteins. It has been attributed to anti-inflammatory, anticancer, antioxidant and anti-allergic effects.

Hypsizygus marmoreus is an edible mushroom species, with high aroma and dietary valuable for human organism. The objects of the study were the fruiting bodies obtained from commercial crops and the fruiting bodies from own cultivation and mycelium from *in vitro* cultures of *H. marmoreus*. Both cultivars of this species, white and brown, were analyzed.

The aim of this study was to analyze the fruiting bodies and mycelium from *in vitro* cultures of *H. marmoreus* for the presence of biologically active substances and to determine the effect of the addition of zinc and magnesium ions to the culture medium on the content of the tested compounds in mycelial cultures.

Mycelial cultures were cultured in 10-L bioreactors on Oddoux medium and on the same medium with the addition of magnesium sulfate and zinc sulfate with the air-lift system in order to obtain a sufficient amount of biomass for mycochemical analysis.

The contents of lovastatin, ergothioneine, phenolic compounds, phenylalanine, sterols and indole compounds were determined by HPLC,

the contents of bioelements by F–AAS method, the levels of glucans were determined spectrophotometrically and antioxidant activity was estimated by DPPH, FRAP and ABTS method.

H. marmoreus mycelium from *in vitro* cultures was found to be a good source of bioelements, glucans, and lovastatin. The content of active compounds differed depending on the cultivar and the tested material. It was also shown that the addition of zinc and magnesium ions had a variable effect on the content of active substances. This species turned out to be a mushroom with potential anti-atherosclerotic and antioxidant activity. It has been shown that the mycelial cultures and fruiting bodies obtained on appropriate media can be a source of important substances for the human body.

References

1. Podkowa A., Kryczyk-Poprawa A., Opoka W., Muszyńska B. (2021). Culinary–medicinal mushrooms: a review of organic compounds and bioelements with antioxidant activity. *European Food Research and Technology*.
2. Muszyńska B., Grzywacz-Kisielewska A., Kała K., Gdula-Argasińska J. Anti-inflammatory properties of edible mushrooms: a review. *Food Chemistry* 2018; 243(3): 373-381.

THE SPECTROSCOPIC MARKERS OF BLADDER CANCER AND THEIR POTENTIAL USEFULNESS IN PATIENT TREATMENT

Monika Kujdowicz^{1,2}, Kamilla Małek², Krzysztof Okoń¹

¹Jagiellonian University Medical College, Faculty of Medicine,
ul. Grzegorzewska 16, 31-531 Krakow

²Jagiellonian University, Faculty of Chemistry, ul. Gronostajowa 2,
30-387 Krakow

The bladder urothelial carcinoma (BC) is one of the most common malignant neoplasms and it recurs very often. Vibrational spectroscopies, Infrared (IR) and Raman (RS), are potential diagnostic tools of BC. These simple and label-free methods show changes in many biochemical components. We observed based on the vibrational signature that BC has a higher protein level than healthy control. The BC malignancy also affects the content of carbohydrates, fatty acids, cholesterol, nucleic acids, and their structure. The most often treatment of this cancer in the early stage is surgery and BCG therapy and it becomes more difficult in the advanced stages when cis-platin, vinca alkaloids, anti-PLL-1, and anti-nectin therapies are used. Herein, we consider well-known cancer mechanisms of chemoresistance and potential markers that might stand by this phenomenon. The most important biochemical change in BC is a Warburg effect and, furthermore, the epigenetic changes and higher levels of free radical scavengers.

Acknowledgement

MK thanks the National Science Centre in Poland (Preludium 16, no. UMO-2018/31/N/NZ4/00911) and the National Centre for Research and Development in Poland (InterDokMed project, no. POWR.03.02.00-00-I013/16)

DEEP LEARNING EMPOWERS DETAILED MOLECULAR IMAGING OF PANCREATIC TUMORS

Krzysztof Szymoński^{1,2}, Ewelina Lipiec³, Kamila Sofińska³, Katarzyna Skirlińska-Nosek³, Natalia Wilkosz³, Łukasz Chmura^{1,2},
Dariusz Adamek¹

¹Department of Pathomorphology, Jagiellonian University Medical College, Cracow, Poland

²Department of Pathomorphology, University Hospital, Cracow, Poland

³M. Smoluchowski Institute of Physics, Jagiellonian University, Cracow, Poland

The prognosis of pancreatic cancer (PC) patients has not improved in decades, despite the rising understanding of the tumor nature. Currently, there are no efficient early diagnostic options, which leads to late-stage disease at the time of PC diagnosis. Raman hyperspectral mapping (RHM) was confirmed to be efficient in detailed molecular imaging of PC tissue samples, but the spectral data interpretation is time-consuming and human-dependent. To overcome this drawback, here we evaluated the use of convolutional neural networks (CNN) in RHM data classification. The study did not evaluate the CNN-based image recognition, but raw spectral data classification. We used custom 1D and 2D CNN architectures and classified 20,759 PC raw Raman spectra into regions of the nucleus and cytoplasm of cancer cells, as much as the tumor stroma, with validation accuracy of approximately 97% and 98%, respectively. This proof-of-concept study showed the advantages of using CNNs in RHM map classification over standard hierarchical cluster analysis plotting. Additionally, the study revealed a new potential for PC tumors' subtyping.

POSSIBILITIES OF USING AN ELASTOMERIC INFUSION PUMP FOR THE SUPPLY OF MIXTURES OF PARENTERAL DRUGS

Paweł Gumułka^{1,2}, Monika Dąbrowska², Małgorzata Starek²

¹Doctoral School of Medical and Health Sciences, Jagiellonian University
Medical College, 16 Łazarza St, 31-530, Krakow, Poland

²Department of Inorganic and Analytical Chemistry, Faculty of Pharmacy,
Jagiellonian University Medical College, Medyczna 9 St,
30-688 Krakow, Poland

Portable elastomeric infusion pumps are non-electronic pumps that deliver intravenous medication through an elastomeric reservoir typically made of latex, polyisoprene or silicone. Operation is based on the elastomeric property of the balloon filled with the drug solution, i.e. uniform shrinkage, which determines a constant flow along the infusion line. For many years, such devices have been successfully used to administer cytotoxic drugs, analgesics and antibiotics. The great advantage is their small size, which allows for daily operation, non-electronic operation and easy management by the patient. In addition, elastomeric pumps enable safe, continuous drug delivery at a constant flow rate, absolute silence, and a better cost-effectiveness profile than electronic models. Many diseases require the administration of several drugs at the same time. Only through the synergistic effects of the preparations can a beneficial therapeutic effect be obtained, avoiding strong side effects. In addition, in many cases, taking into account the fluid balance, it is required to administer drugs in the smallest infusion volume. Taking this into account, as well as the patient's comfort and mobility, the ideal solution seems to be the administration of several parenteral drugs in one elastomeric infusion pump. The biggest problem with this solution is potential drug-drug or drug-excipient interactions. As a result of such interaction, it is possible to intensify the degradation of the drug substance, modify the chemical structure or even produce harmful derivatives. A review of the work analyzing the stability of mixtures of at least two drugs in one elastomeric infusion pump is presented. The most frequently tested mixtures are combinations of opioids, eg. morphine and other

analgesics in postoperative analgesia. In addition, combinations of haloperidol, metoclopramide and ondansetron have been frequently investigated. A bibliographic review identified drug combinations with sufficient evidence of physical and chemical stability. These are, for example, mixtures of morphine with midazolam or mixtures of midazolam with haloperidol or metoclopramide. The main factors determining the stability are the concentration of the individual components, the storage temperature and the infusion time. However, most of the results obtained do not allow for unequivocal confirmation of the stability of the analyzed mixtures, which determines the need for further research.

References

1. María Espinosa Bosch, Fuensanta Sánchez Rojas, and Catalina Bosch Ojeda, "Compatibility and stability of drug mixtures: An overview," *GSC Biol. Pharm. Sci.*, vol. 18, no. 2, pp. 295–325, 2022.
2. A. A. Theodorides, "The role of elastomeric pumps in postoperative analgesia in orthopaedics and factors affecting their flow rate," *J. Perioper. Pract.*, vol. 27, no. 12, pp. 276–282, 2017.
3. B. Fernández-Rubio *et al.*, "Stability of Antimicrobials in Elastomeric Pumps: A Systematic Review," *Antibiotics*, vol. 11, no. 1, pp. 1–15, 2022.
4. A. Singh, "Efficacy of Epidural Infusion of 0 . 0625 % Bupivacaine with 1µg_m / Cc Fentanyl for Postoperative Analgesia After Major Abdominal Surgeries Using Elastomeric Infusion Pump (Infusor Baxter Health Care Usa) or Electronic (Emco) Infusion Pump : Quality of Sensory & Motor Block," vol. 14, no. 4, 2022.

SAFETY AND SIGNAL DETECTION OF UNAPPROVED PHARMACEUTICALS AVAILABLE FOR OVERALL SALE IN ELITE AND NON-ELITE ATHLETES

Karol Jędrejko¹, Ashley Anderson², Bożena Muszyńska¹

¹Jagiellonian University Medical College, Faculty of Pharmacy, Department of Pharmaceutical Botany, Medyczna 9 Str., 30-688 Kraków, Poland

²International Sports Pharmacists Network, Fort Collins, Colorado, United States

In the community of elite athletes, the safety of pharmacotherapy required extending the scope of the analyzed products and focused attention not only on medicines but also on products for general sales available online such as dietary supplements or products that do not have a precise classification. Unauthorized or unapproved pharmaceutical substances not always listed on the label of product. They may contain substances recognized by WADA as doping in sport. This creates a risk of unintentional doping for elite athletes and the related sanctions or disqualification. However, it is necessary to look more broadly at the whole issue and the fact that it is a public health problem. These substances pose a risk of interactions or adverse events. Potential interactions between active substances in relationship dietary supplement-drug, dietary supplement-dietary supplement, dietary supplement-conventional foods (e.g. coffee, tea).

Methylxanthines such as theophylline registered as a prescription broncholytic drug indicated for the treatment of asthma, have been confirmed in dietary supplements. Theophylline exhibits a narrow therapeutic index and may interfere with caffeine or sympathomimetic drugs, antihypertensive drugs and β_2 -adrenergic agonists. The amount of determined theophylline in dietary supplements excludes that it comes from natural ingredients, because the concentration of theophylline in natural raw materials is negligible.

In dietary supplements confirmed substance with strong activity stimulating the β -adrenergic receptors, including higenamine and isopropyltotoxamine (also known as isopropyltotoxamine, betaphrine

or deterenol). Higenamine has been on the WADA Prohibited List in the category S3 Beta-2-Agonists since 2017.

Cardiovascular adverse events reports have been associated with the use of dietary supplements containing combinations of ingredients such as theophylline, isopropylotopamine, and huperzine A.

Selected nootropic and cognitive enhancement substance were identified in dietary supplements. The analyzed products showed substances with cholinergic activity e.g. dimethylaminoethanol (DMAE), huperzine A or substances improving cerebral circulation such as vinpocetine. Centrophenoxine also known as meclofenoxate was present in analyses products in dosages ranging from 79 to 251 mg per single serving. Another example is phenibut, a synthetic psychotropic drug that was developed in the Soviet Union in the early 1960s. Phenibut is still used in pharmacotherapy in Ukraine, Russia, Latvia, among others in premedication, treatment of sleep disorders and anxiety disorders, alleviation of withdrawal symptoms. Within in the EU, phenibut is classified as a novel psychoactive substance (NPS).

Huperzia serrata (also known as Toothed Clubmoss or *Lycopodium serratum*) contain quinolizidine alkaloid huperzine A. This compound exhibits cholinergic activity. Reported an adverse events manifested as cholinergic syndrome associated with the use of dietary supplements contains huperzine A in combination with other ingredients. Some signals of potential adverse events related to supplementation of *Huperzia serrata* or huperzine A were covered in database CFSAN Adverse Event Reporting System (CAERS).

Further discrepancies are related to products which, the label and description of which indicate that they contain peptides or their analogues. Examples of peptide substances is Body Protection Compound-157 (BPC-157). BPC-157 is a peptide in ongoing trials, not approved for pharmacotherapy. So far, BPC-157 has been shown to stimulate the regeneration of damaged tissues. BPC-157 is recognized as doping in sports and is on the prohibited list in the category S0 Non-Approved Substances.

So far only the few online auctions/sellers dealt with distribution of products with according to the label/description containing myo-inositol trispyrophosphate (ITPP). This substance is recognized as a doping agent and it is prohibited in sport as a method for the manipulation of Blood and Blood Components. ITPP as a reoxygenation substance, is undergoing clinical trials in oncology.

Selective androgen receptor modulators (SARMs) agonists are undergoing clinical trials. It has been shown that SARMs agonist have the ability to stimulate muscle growth (anabolism), bone reconstruction and improve lean body mass. So far, no molecule classified as a SARMs agonist has not been approved by the FDA or EMA for pharmacotherapy. In products sold online, it has been confirmed that SARM content such as Andarine (S-4), Ligandrol (LGD-4033), Ostarine (Enobosarm or MK-2866), Testolone (RAD-140). Also identified, other active ingredients not recognized as SARMs, such as ibutamoren (known as Nutrobal or MK-677) growth hormone (GH) secretagogue, and Cardarine (known as Endurobol) peroxisome proliferator-activated receptor delta agonist (PPAR- δ). SARMs have been recognized as doping agents by WADA Prohibited List since 2008 in the group S1 Anabolic Agents. Many signals of potential adverse events included in database CAERS. Some case reports of adverse events required hospitalization such as liver injury or rhabdomyolysis have been associated with the use of SARMs.

So far, little is known about agmatine which is biogenic amine, chemical derivatives of guanidine, formed in the human body via the decarboxylation reaction of L-arginine. Agmatine has a broad biological activity profile, including antagonist of NMDA and nicotinic cholinergic receptors, agonist of α_2 -adrenergic, serotonergic and imidazoline receptors, regulates the activity of calcium channels and inhibition of synthase nitric oxide (NOS).

According to notifications in RASFF panel on 2022, still a major problem in the EU is dietary supplements mainly from category “fat burner” or “pre-workout” that contain unauthorized substances as stimulant aliphatic amines, dimethylamylamine (DMAA),

dimethylbutylamine (DMBA), dimethylhexylamine (DMHA or octodrine), all include in WADA Prohibited List.

Marginal cases are related to β -aminoisobutyric acid (BAIBA) in “fat burner” dietary supplements.

Some of described discrepancies related to unauthorized ingredients in dietary supplements was covered and still expand by speciality educational program IOC Certificate in Drugs in Sport.

References

1. Duiven, Erik, et al. "Undeclared doping substances are highly prevalent in commercial sports nutrition supplements." *Journal of Sports Science & Medicine* 20.2 (2021): 328.
2. Cohen, Pieter A., et al. "Nine prohibited stimulants found in sports and weight loss supplements: deterenol, phenpromethamine (Vonedrine), oxilofrine, octodrine, beta-methylphenylethylamine (BMPEA), 1,3-dimethylamylamine (1,3-DMAA), 1,4-dimethylamylamine (1,4-DMAA), 1,3-dimethylbutylamine (1,3-DMBA) and higenamine." *Clinical Toxicology* 59.11 (2021): 975-981.
3. Cohen, Pieter A., Bharathi Avula, and Ikhlas Khan. "The unapproved drug centrophenoxine (meclofenoxate) in cognitive enhancement dietary supplements." *Clinical Toxicology* (2022): 1-3.
4. Cohen, Pieter A., et al. "Quantity of phenibut in dietary supplements before and after FDA warnings." *Clinical Toxicology* 60.4 (2022): 486-488.
5. Knapik, Joseph J., et al. "Adverse effects associated with use of specific dietary supplements: The US Military Dietary Supplement Use Study." *Food and Chemical Toxicology* 161 (2022): 112840.
6. U.S. Anti-Doping Agency (USADA) [Internet]. Available from: <https://www.usada.org/spirit-of-sport/key-changes-2022-prohibited-list/> Accessed: 20 August 2022.
7. World Anti-Doping Agency (WADA). The Prohibited List 2022 [Internet]. Available from: <https://www.wada-ama.org/> Accessed: 20 August 2022.
8. The Global Drug Reference Online (Global DRO) [Internet]. Available from: <https://www.globaldro.com/Home> Accessed: 20 August 2022.
9. Schneider, Marcel A., et al. "Phase Ib dose-escalation study of the hypoxia-modifier Myo-inositol trispyrophosphate in patients with hepatopancreatobiliary tumors." *Nature communications* 12.1 (2021): 1-1

10. Lee, Byung K., Brian B. Park, and Richard J. Bower. "Selective Androgen Receptor Modulator–Induced Liver Injury in Active Duty Male." *Military Medicine* (2022).
11. Jędrejko, Karol, Jan Lazur, and Bożena Muszyńska. "Risk associated with the use of selected ingredients in food supplements." *Chemistry & Biodiversity* 18.2 (2021): e2000686.
12. European Commission (EC). RASFF. [Internet]. Available from: <https://webgate.ec.europa.eu/rasff-window/screen/search> Accessed: 20 August 2022.
13. International Olympic Committee (IOC). IOC Certificate in Drugs in Sport [Internet]. Available from: <https://www.sportsoracle.com/course/ioc-certificate-in-drugs-in-sport/> Accessed: 20 August 2022.
14. Neil Chester, Mark Stuart, and David Mottram. "Drugs in Sport - 8th Edition". Routledge. (2022).

DENTAL PULP STEM CELLS AS AN ATTRACTIVE TOOL FOR BONE TISSUE REGENERATION

Bibiána Baďurová^{1,2}, Romana Záhumenská², Tereza Pavlišová²,
Ján Strnádel², Mária Janičková³, Slavomíra Nováková², Erika Halašová²,
Henrieta Škovierová²

¹ Department of Medical Biochemistry, Jessenius Faculty of Medicine in Martin,
Comenius University in Bratislava, Malá Hora 4D, Martin, Slovakia

² Biomedical Centre Martin, Jessenius Faculty of Medicine in Martin, Comenius
University in Bratislava, Malá Hora 4D, Martin, Slovakia

³ Department of Stomatology and Maxillofacial Surgery, Jessenius Faculty of
Medicine and University Hospital Martin, Comenius University in Bratislava,
Kollárova 4248/2, Martin, Slovakia

Lack of bone regeneration may result in a poor prognosis, even in common bone fractures. Regenerative medicine is the innovative branch of medicine that develops methods to regrow, repair or replace damaged or diseased cells, tissues and the production of artificial organs. It refers to a group of biomedical approaches to clinical therapies that may involve the use of stem cells. Mesenchymal stem cells (MSCs) have great potential in therapy due to their self-renewal capacity and capability of differentiation to various cell types. Their properties may vary slightly depending on the source, from which they were isolated. The dental stem cells (DSCs) are multipotent MSCs, and their roles are to repair dental tissue after damage. They also represent a promising tool for bone tissue repair in the future.

The aim of the presented work is to characterize and compare different sources of dental stem cell based on their osteodifferentiation potential. We isolated stem cells from the patient's dental pulp from various type of deciduous (SHEDs) and from adult teeth (DPSCs). We phenotypized the cell lines and proved their mesenchymal properties. Then we differentiated the cells using a commercially available osteodifferentiation medium. We compared the cell morphology, expression level of specific genes and proteins to prove the stemness or differentiation level, respectively. In addition, we monitored the production of bone extracellular matrix. At the same time, we compared

the ability of cells to differentiate into osteoblasts/osteocytes or odontoblasts/odontocytes in 2D and 3D culture conditions. We proved that both types of DSCs have a great potential in osteodifferentiation and can be used in autologous transplantation during bone regeneration.

Acknowledgment

This work was supported by Slovak Research and Development Agency under the contract GUK 65/2022 and VEGA 1/0310/21

IN VITRO ANTIPROLIFERATIVE AND ANTI-METASTATIC PROPRIETIES OF *PEGANUM HARMALA*

Hiba F. Muddather¹, Schelz Zsuzsanna¹, Tohfa Nasibova²,
Judit Hohmann², István Zupkó¹

¹ Institute of Pharmacodynamics and Biopharmacy, University of Szeged,
Eötvös u. 6, H-6720 Szeged, Hungary

² Institute of Pharmacognosy, University of Szeged, Eötvös u. 6, H-6720
Szeged, Hungary

Most of the available anticancer agents are expensive and might cause serious adverse effects. One of the alternative approaches is the use of antitumor compounds of plant origin. Since, they are readily available, have a lower potential for serious side effects, and are relatively less expensive. Our aim was to investigate the cytotoxic and antimetastatic effects of total alkaloid extracts obtained from different parts of *P. harmala* as well as the isolated bioactive constituents on a selection of gynecological cancer cells and oral squamous cell carcinoma cells using MTT assay and wound healing assay. The IC₅₀ values were determined and compared to NIH/3T3 murine fibroblast cells to define tumor selectivity. The root extract exhibited the highest cytotoxicity with IC₅₀ values between 8.49 and 26.74 µg/mL. Concerning the isolated bioactive constituents, harmine exerted a pronounced effect with IC₅₀ between 6.05 and 27.85 µM. Our data revealed that inhibition of wound closure was concentration dependent in 24h and 48h of exposure. Our results give insight into the anticancer and antimetastatic effects of *P. harmala*'s root extract and harmine, suggesting that further research is worth for the development of phytotherapeutics for cancer treatment.

**IN VITRO EVALUATION OF ANTIPROLIFERATIVE
AND ANTIMETASTATIC ACTIVITY OF THE NEWLY
SYNTHESIZED 2-(4-CHLOROPHENYL)-13 α -ESTRONE
SULFAMATE**

Hazhmat Ali¹, Erzsébet Mernyák², Péter Traj², Gábor J. Szebeni³,
Renáta Minorics¹, István Zupkó¹

¹Department of Pharmacodynamics and Biopharmacy, University of Szeged,
Szeged, Hungary

²Department of Organic Chemistry, University of Szeged, Szeged, Hungary

³Laboratory of Functional Genomics, Biological Research Centre, Szeged,
Hungary

Despite the availability of various pharmacological interventions to treat cancer, it remains the second cause of mortality among the population globally. Exploitation of steroids particularly with estrane origin as anticancer agents is of great value owing to their outstanding antiproliferative activity. Previous research in our lab examined various derivatives of 13 α -estrone which proven to display outstanding antiproliferative, antimetastatic as well as proapoptotic effects.

The aim of the present study is to examine the antiproliferative and antimetastatic effects of the newly synthesized 2-(4-chlorophenyl)-13 α -estrone sulfamate (13AOS).

All cell based experiments were conducted on HPV-16 positive uterine cervical cancer cell line (SiHa). Cell cycle distribution was determined by flow cytometry. Antimetastatic property of 13AOS was evidenced by wound healing assay and Boyden chamber.

13AOS displayed outstanding growth inhibition against SiHa (IC₅₀= 2.71). The test compound displayed a cell cycle disturbance characterized by increased subG1 and G2/M populations on the expense of G1. It also displayed remarkable anti-migratory and anti-invasive effects in a dose dependent manner.

The test compound exhibited substantial antiproliferative and antimetastatic effects against the invasive cervical cancer cell line (SiHa) which can be considered as a promising anticancer agent. Therefore, it

might be of great importance in the design of anticancer agents targeting cervical carcinomas.

Acknowledgment

Sources of financial support: Project no. TKP2021-EGA-32 has been implemented with the support provided by the Ministry of Innovation and Technology of Hungary from the National Research, Development and Innovation Fund, financed under the TKP2021-EGA funding scheme.

EFFECTS OF CALONYSTERONE AND 20-HYDROXYECDYSONE IN THE OBESE RAT MODEL

Alaa A.M. Osman¹, Dávid Laczkó², Máté Vágvölgyi², Attila Hunyadi²,
Eszter Ducza¹

¹ Department of Pharmacodynamics and Biopharmacy, Faculty of Pharmacy,
University of Szeged, Eötvös u. 6, 6720, Szeged, Hungary

² Institute of Pharmacognosy, Faculty of Pharmacy, University of Szeged,
Eötvös u. 6, 6720, Szeged, Hungary

Obesity is a global pandemic and a serious health problem. Phytoecdysteroids, the polyhydroxylated steroids of the C-27 cholesterol skeleton, has a wide variety of beneficial effects including anabolic, anti-diabetic, and anti-obesity. Our studies aimed to investigate the effects of two phytoecdysteroids derivatives (calonysterone and 20-hydroxyecdysone) on body weight, blood glucose, antioxidant capacity, and the level of adipokines, the expression of cytokines of low-grade inflammation, and the epigenetic modification in the obese rat model.

48 male Sprague Dawley rats, aged 5-6 weeks were divided into 8 groups (6 rats/group) and fed high fat and high sugar diet (HFHSD) or a normal diet. Rats received daily oral treatments for 12 weeks of calonysterone, 20-hydroxyecdysone, vehicle, or no treatment. Body weight, caloric intake, and plasma glucose during the glucose tolerance test were measured at baseline and during the experiment. We measured the liver levels of catalase (CAT) and superoxide dismutase (SOD), total antioxidant capacity (T-AOC), and global DNA methylation using colorimetric assay kits. The hepatic expression of leptin, adiponectin, TNF α , IL-6, IL2, and IL10 mRNA and protein were measured using RT-PCR and western blot, respectively.

CAT levels were increased by both treatments, while T-AOC increased by 20-hydroxyecdysone. Obese rats showed increased expression of leptin mRNA and protein levels that were reduced by calonysterone. 20-hydroxyecdysone further increased leptin mRNA but reduced protein levels. The levels of global DNA methylation were

increased by both treatments.

Calonysterone may have anti-obesity effects and both treatments may have antidiabetic and antioxidant effects. Our preliminary screening of the effects of treatments on markers of inflammation showed significant differences in the levels of IL-6 and IL10 between normal and obese rats. We suppose these phytoecdysteroids may affect epigenetic modification at specific gene levels too.

Acknowledgment

This work was supported by the National Research, Development and Innovation Office, Hungary (grant NKFI-FK19-132499). Project no. TKP2021-EGA-32 has been implemented with the support provided by the Ministry of Innovation and Technology of Hungary from the National Research, Development and Innovation Fund, financed under the TKP2021-EGA funding scheme.

**PHARMACOLOGICAL INVESTIGATION OF A NEWLY
SYNTHESIZED MONOTERPENE-BASED
2,4-DIAMINOPYRIMIDINE TYPE DERIVATIVES
ON HUMAN CANCER CELL LINES *IN VITRO***

Viktória Nagy¹, Raji Mounir², Zsolt Szakonyi², Gábor J. Szebeni³,
Zupkó István¹

¹Department of Pharmacodynamics and Biopharmacy, University of Szeged,
Szeged, Hungary

²Institute of Pharmaceutical Chemistry, University of Szeged, Szeged, Hungary.

³Laboratory of Functional Genomics, Biological Research Centre, Szeged,
Hungary

According to estimates from the World Health Organization (WHO), cancer ranks as one of the major health burdens and a leading cause of mortality globally. Gynecologic cancers (breast, uterus, cervix, and ovaries) are found among the 10 most frequently diagnosed cancer types. Natural products including terpenes are one of the most investigated group of compounds in lead-finding studies. Several studies have revealed that monoterpenes may prevent the carcinogenesis process and exert growth-inhibiting action against cancer cells.

To determine the antiproliferative activity of a newly synthesized set of monoterpene-based 2,4-diaminopyrimidine type derivatives against gynecological cancer cell lines. The mechanism of the most effective analogues was additionally tested to describe their mechanism of action.

The growth-inhibitory effects of the tested compounds were determined by MTT assay on a cell line panel (Hela, Siha, MDA-MB-231, and MCF-7, A2780, and NIH/3T3 fibroblast to characterize the cancer selectivity). To identify the changes in the cell cycle phase distribution of the treated cells, cell cycle analysis was performed. To distinguish apoptotic and necrotic cells by their nuclear morphology and membrane integrity, fluorescent staining was applied.

Two out of 20 monoterpene derivatives exhibited promising antiproliferative action with IC₅₀ values below 10 µM. These analogues elicited substantial changes in the cell cycle distribution of A2780 ovarian

cancer cells with increased number of cells in SubG1 and G2/M phases on the expense of G1 population. The proapoptotic potential of these agents were confirmed by propidium-Hoechst 33258 staining.

Our results suggest that the new monoterpene compounds may be regarded as promising candidates in the development of new anticancer agents, against ovarian cancer cell lines.

ANTIBIOTIC EXPOSURE OF A VULNERABLE POPULATION: CONSUMPTION OF THE ELDERLY

Ikhwan Y. Kusuma^{1,2}, Maria Matuz^{1,3}, Réka Bordás¹,
Maria Juhasz Haverinen⁴, Muh. Akbar Bahar^{1,5}, Edit Hajdú⁶,
Ádám Visnyovszki⁶, Roxána Ruzsa¹, Péter Doró¹, Zsófi Engi¹,
Dezső Csupor^{1,7}, Ria Benko^{1,3,8}

¹Institute of Clinical Pharmacy, University of Szeged, Szeged, Hungary

²Pharmacy Study Program, Universitas Harapan Bangsa, Purwokerto, Indonesia

³Albert Szent-Györgyi Health Centre, Central Pharmacy, University of Szeged,
Szeged, Hungary

⁴Public Healthcare Services Committee, Stockholm, Sweden

⁵Department of Pharmacy, Faculty of Pharmacy, Universitas Hasanuddin,
Makassar, Indonesia

⁶Albert Szent-Györgyi Health Centre, Department of Internal Medicine
Infectiology Unit, University of Szeged, Szeged

⁷Institute for Translational Medicine, Medical School, University of Pécs, Pécs

⁸Albert Szent-Györgyi Health Centre, Emergency Department, University of
Szeged, Szeged, Hungary

Elderly people are vulnerable to infectious diseases which might result in antibiotic prescribing. The elderly population is growing worldwide¹, hence they can contribute substantially to the antibiotic use. This drug utilization study use retrospective, descriptive, cross-national design to compare elderly antibiotic exposure of two elderly population of two European countries: Hungary and Sweden. We focused our analysis on systemic antibacterials (ATC code: J01). Our findings showed that the scale and pattern of antibiotic use in the elderly differed considerably between the two countries. Antibiotic use was higher by almost 20% in the Hungarian elderly population compared to Swedish. Broad spectra agents such as co-amoxiclav were used ten-, fluoroquinolones were used almost four-fold more frequently in Hungary compared to Sweden. These findings indicate that interventions are required to optimize antibiotic use in the Hungarian elderly.

References

1. Eurostat. Ageing Europe - statistics on population developments. Eurostat. Published 2020. Accessed May 12, 2022.
https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Ageing_Europe_-_statistics_on_population_developments#:~:text=The population of older people,reach 129.8 million by 2050.

URINARY CATHETER-ASSOCIATED COMPLICATIONS AND ITS PREVENTION USING ADVANCED MATERIAL MODIFICATIONS IN CLINICAL USE & IN RESEARCH

S P Yamini Kanti¹, Livia Adalbert¹, Orsolya Jójárt-Laczkovich¹,
Ildikó Csóka¹

¹Institute of Pharmaceutical Technology and Regulatory Affairs, University of Szeged, Szeged, Hungary

Urinary Tract Infection is an infection which can occur in any part of the urinary system that includes Urethra, Bladder, Kidney & Ureters.(1) Urinary Tract infections are most common in healthcare settings mainly in patients using catheter. Hospital Acquired Urinary Tract Infection comprises up to 75% of the infections associated with Urinary Catheters. Major cause of catheter associated infections is linked to non-ideal materials used for fabrication of Urinary Catheters. Materials with antimicrobial, biocompatible, antifouling properties and patient friendly in nature are ideal for urinary catheters.(2) Even though, a lot of research and studies have been conducted to develop ideal materials or coating of the catheters but yet no study demonstrated satisfactory clinical benefits. In this presentation, we would like to focus on the complications associated with the use of urinary catheters and the preventive measures taken related to use of antimicrobial coatings and biocompatible materials applied for catheters in clinical use and in research.

References

1. Centre for Disease Control and Prevention. Catheter Associated Urinary Tract Infection. U.S. Department of Health & Human Services. 2015.
2. Singha P, Locklin J, Handa H. A review of the recent advances in antimicrobial coatings for urinary catheters. *Acta Biomater* [Internet]. 2017 Mar; 50:20–40. Available from: <https://linkinghub.elsevier.com/retrieve/pii/S1742706116306663>

PATIENT SAFETY ISSUES IN TELEMEDICINE APPLICATION DEVELOPMENT IN CASE OF PERIPHERAL ARTERIAL DISEASE

Adam Pannonhalmi¹, Andrea Vass², Balazs Bende¹, Ildikó Csóka³,
Lajos Kemeny¹

¹University of Szeged, Center of Excellence for Interdisciplinary Research, Development and Innovation, H-6720, Szeged, Dugonics sq. 13

²University of Szeged, Department of Internal Medicine and Cardiology Center, Szeged, H-67258 Semmelweis u.

³University of Szeged, Institute of Pharmaceutical Technology and Regulatory Affairs, H-6720 Szeged, Eötvös str. 6

E-health and telemedicine applications are of great importance in this pandemic era (limitations in personal care delivery), and opens the space for wide range of services through mobile health applications.

Peripheral arterial disease (PAD) is a major public health concern worldwide, use of telemedicine interventions in PAD is a challenging task and investigations are still limited in case of this disease.

Our study summarizes some of our preliminary studies in the development of telemedicinal applications in case of patients with peripheral arterial disease; focusing on patient safety issues.

References

1. Susel Góngora Alonso et al., Telemedicine and e-Health research solutions in literature for combatting COVID-19: a systematic review, *Health and Technology* (2021) 11:257–266
2. Kastriot Alushi et al., Distribution of Mobile Health Applications amongst Patients with Symptomatic Peripheral Arterial Disease in Germany: A Cross-Sectional Survey Study, *J. of Clinical Medicine*, 2022, 11, 498.
3. Aboyans V, Ricco J-B, Bartelink M-LEL, Björck M, Brodmann M, Cohnert T, et al. 2017 ESC Guidelines on the Diagnosis and Treatment of Peripheral Arterial Diseases, in collaboration with the European Society for Vascular Surgery (ESVS). *Eur Heart J*. 2017 Aug 26
4. McDermott MM, Spring B, Berger JS, Treat-Jacobson D, Conte MS, Creager MA, et al. Effect of a Home-Based Exercise Intervention of Wearable Technology and Telephone Coaching on Walking Performance in Peripheral

Artery Disease: The HONOR Randomized Clinical Trial. JAMA 2018;
319(16):1665–76.

THE IMPACT OF MEDICATION REVIEW ON FALL RISK PREVENTION IN THE ELDERLY

Érszegi András^{1,2}, Bodó Gabriella², Engi Zsófia¹, Matuz Mária^{1,2},
Benkő Ria^{1,2}, Pető Zoltán³, Csupor Dezső¹, Viola Réka^{1,2}

¹University of Szeged, Faculty of Pharmacy, Department of Clinical Pharmacy

²University of Szeged, Albert Szent-Györgyi Medical Centre; Central Pharmacy

³University of Szeged, Albert Szent-Györgyi Medical Centre, Emergency Care Unit

Falling of the elderly means an enormous risk. Severe injuries, such as hip fractures, place a significant burden on the elderly as well as the healthcare system.^{1; 2} The EU(7)PIM list summarizes the medications, which are not recommended for the elderly³. With this list, medications which increase the fall of risk can be excluded or modified, and safety can be assured.

Our aim was to review the medications of elderly patients admitted to the Emergency Care Unit (ECU), because of their falling, with special focus on medicines on the potentially inappropriate medication (PIM) list.

Case-control study was performed for one-month period (03-04 2022) by examining the medications of the elderly (≥ 65 years) who were admitted to the ECU with fall (ICD 10 codes: W00-W19 and/or S). Apart from their medications, other parameters like the circumstance of the fall and comorbidities were recorded as well. The control group (≥ 65 years of patients without medical history of fall) were randomly selected from a GP practice. Quantitative (polypharmacy: >5 drugs) and qualitative analysis (PIM according to the EU(7)PIM list) of medical treatment was carried out. Logistic regression was used to estimate relationship between medication and fall.

In the studied period 293 elderly patient were admitted to the ECU with the diagnosis of falling. 24.2% of the admitted patients needed further treatment at the department of traumatology. Fracture of the hip area (S32, S72) happened with the 14,67% of the falls. The mean age of the examined population was 79.33% (± 8.03), in the control group that value was 75.06 (± 7.35). In the examined group, the women : men ratio was 66.79:33.21.

The risk of falling was significantly higher, if the patient is older than 81 years. Significant difference was observed between two group regarding the mean number of PIM drugs (fall group: 1.72 ± 1.5 vs control group: 1.0 ± 1.5) The five most commonly used PIMs were pantoprazole, alprazolam, piracetam, rilmenidine and trimetazidine. Pantoprazole, alprazolam and trimetazidine was more common in the examined group, however, this difference was not significant. The OR of piracetam was found 4.095.

The risk of falling is exalted for the elderly people, who are older than 81 years. Piracetam is widely used for cognitive disorders, despite of the fact, that its efficacy is not proven. Regular assessment of the medication of elderly patients is a prior objective to identify substances, that increase the risk of falling.

References

1. Konstantinos I Alexiou, Andreas Roushias, Sokratis E Varitimidis, Konstantinos N Malizos. Quality of life and psychological consequences in elderly patients after a hip fracture: a review. *Clin Interv Aging*. 2018 Jan 24;13:143-150. doi: 10.2147/CIA.S150067. eCollection 2018
2. A. Marques, Ó. Lourenço, J. A. P. da Silva. The burden of osteoporotic hip fractures in Portugal: costs, health related quality of life and mortality . *Osteoporos Int*. 2015 Nov;26(11):2623-30. doi: 10.1007/s00198-015-3171-5. Epub 2015 May 19.
3. Renom-Guiteras, Anna; Meyer, Gabriele; Thürmann, Petra A. (2015). The EU(7)-PIM list: a list of potentially inappropriate medications for older people consented by experts from seven European countries. *European Journal of Clinical Pharmacology*, 71(7), 861–875. doi:10.1007/s00228-015-1860-9

THE EFFECT OF THE PARACELSIAN MEDICAL CONCEPT ON THE 20TH CENTURY'S MEDICAL VISION

Bálint Madarász¹, Mónika Fekete¹, Judit Forrai¹

¹Semmelweis University, Medical Faculty. Doctoral School

The rebellious and divisive Theophrastus Bombastus von Hohenheim, or better known as Paracelsus, was known as a unique doctor, scientist and polymath in the 16th century. His unusual theories and attitudes have earned him many followers and haters over the centuries. Theophrastus' teachings, which included modern holistic views, then faded over the centuries until his work was rediscovered in the 20th century, thanks among others to the work of Austrian physician Bernard Aschner (1883-1960).

Aschner's reintroduction of Paracelsian medicine to the world influenced not only his own medical views, but it also effected many other Colleague's approach, for example his coworker, András Pető (1893-1967). This holistic approach was the key to the creation of the Pető Method, or The Aschner Method, which has since become world famous. In our Presentation, we will look for the 20th century re-emergence of this holistic approach.

POSTER PRESENTATIONS

THE DEVELOPMENT OF DLLME COMBINED WITH LC-MS/MS FOR THE DETERMINATION OF SIROLIMUS IN THE WHOLE BLOOD SAMPLES AND ITS APPLICATION IN CLINICAL PRACTICE

Alina Plenis¹, Natalia Treder¹, Anna Roszkowska², Olga Maliszewska^{1,2},
Natalia Kaczmarczyk², Ilona Olędzka², Piotr Kowalski²,
Tomasz Bączek², Ewa Bień³, Małgorzata Anna Krawczyk³

¹Department of Analytical Chemistry, Faculty of Pharmacy, Medical University
of Gdańsk, Str. Hallera 107, 80-416 Gdańsk, Poland

²Department of Pharmaceutical Chemistry, Faculty of Pharmacy, Medical
University of Gdańsk, Str. Hallera 107, 80-416 Gdańsk, Poland

³Department of Pediatrics, Hematology and Oncology, Faculty of Medicine,
Medical University Gdańsk, Str. Dębinki 7, 80-211, Gdańsk, Poland

Sirolimus (SIR) (also known as rapamycin) is one of the most widely used immunosuppressive drugs. This drug can also be used in *off-label* applications like the treatment of various types of cancers and vascular anomalies [1,2]. However, the regular monitoring of SIR in individual patients is required to achieve therapeutic blood levels of SIR during treatment [3].

The aim of the study was to develop a simple, fast, and sensitive analytical method based on dispersive liquid-liquid microextraction (DLLME) followed by liquid chromatography-mass spectrometry (LC-MS/MS) for the quantification of SIR in whole-blood samples. Thus, many experiments were performed for the optimization of DLLME protocol and to select the most effective chromatographic separation of SIR in biological fluid. Next, the developed method was validated, and the obtained results confirmed that a limit of detection (LOD) and a limit of quantification (LOQ) were of 0.2 ng/mL and 0.6 ng/mL, respectively, when the linearity was found in the range of 1-50 ng/mL ($R^2 > 0.999$). The extraction recovery was established at the level of 65.57% and 67.27% for SIR and everolimus (EVE) which was used as the internal standard, respectively. At the end, the usefulness of the developed DLLME-LC-MS/MS method in clinical practice was confirmed by using it for

quantification of SIR profiles in real whole-blood samples obtained from two pediatric patients with lymphatic anomalies undergoing treatment with this drug.

To sum up, a fast, simple, precise and accurate method DLLME-LC-MS/MS method for SIR determination was developed and successfully applied in routine clinical practice for the assessment of SIR levels in real samples. It can be considered as an interesting alternative to previous reported methods allowing SIR dosages to be adjusted in real time during pharmacotherapy.

References

1. Nandi U., Onyesom I., Douroumis D. J. *Drug Deliv. Sci. Technol.*, 2021, 66, 102900.
2. Ricci K.W., Hammill A.M., Mobberley-Schuman P., Nelson S.C., Blatt J., Glade Bender J.L., McCuaig C.C., Synakiewicz A., Frieden I.J., Adams D.M., *Pediatr. Blood Cancer*, 2019, 66, e27614.
3. Roszkowska A., Treder N., Plenis A., Miękus N., Ołędzka I., Kowalski P., Bączek T., *Sustain. Chem. Pharm.*, 2021, 21, 100433.

ARTIFICIAL NEURAL NETWORK MODELS OF DRUGS' SOIL AND WATER PARTITION BASED ON IAM CHROMATOGRAPHIC AND COMPUTATIONAL DESCRIPTORS

Anna W. Sobańska¹

¹Department of Analytical Chemistry,
Medical University of Lodz, Poland
90-151 Łódź, ul. Muszyńskiego 1

Chromatographic retention factor $\log k_{IAM}$ obtained from IAM HPLC chromatography with buffered, aqueous mobile phases and calculated molecular descriptors (molecular weight - $\log M_W$; molar volume - V_M ; polar surface area - PSA ; total count of nitrogen and oxygen atoms - $(N+O)$; count of freely rotatable bonds - FRB ; H-bond donor count - HD ; H-bond acceptor count - HA ; energy of the highest occupied molecular orbital - E_{HOMO} ; energy of the lowest unoccupied orbital - E_{LUMO} ; dipole moment - DM ; polarizability - α) obtained for a group of 175 structurally unrelated compounds were tested in order to generate useful models of solutes' soil-water partition coefficient normalized to organic carbon $\log K_{oc}$. It was established that $\log k_{IAM}$ obtained in the conditions described in this study is not sufficient as a sole predictor of the soil-water partition coefficient. Simple, potentially useful models based on $\log k_{IAM}$ and a selection of readily available, calculated descriptors and accounting for over 88% of total variability were generated using Artificial Neural Networks (ANN) [1]. The models proposed in the study were tested on a group of 50 compounds with known experimental $\log K_{oc}$ values by plotting the calculated vs. experimental values. There is a close similarity between the calculated and experimental data for ANN models for compounds from different chemical families ($R^2 > 0.80$, $n = 50$) which proves the models' reliability.

References

1. Sobańska, A.W. Environ Sci Pollut Res 2022, doi:10.1007/s11356-022-22514-x.

Acknowledgment

This research was supported by an internal grant of the Medical University of Łódź no. 503/3-016-03/503-31-001.

PROCEDURE FOR EFFICIENT PROTEIN EXTRACTION FROM PARAFORMALDEHYDE FIXED ADIPO-DIFFERENTIATED CELLS

Zuzana Hatoková¹, Slavomíra Nováková¹, Romana Záhumenská¹,
Bibiána Baďurová², Erika Halašová^{1,3}, Henrieta Škovierová¹

¹Biomedical Centre Martin, Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Malá Hora 4C, 03601 Martin, Slovakia

²Department of Medical Biochemistry, Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Malá Hora 4D, Martin, Slovakia

³Department of Medical Biology, Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Malá Hora 4, 03601 Martin, Slovakia

Adipocyte cell culture is an important tool for studies of energy metabolism and obesity. To study adipogenesis *in vitro*, it is possible to use various types of stem cells that are able to differentiate into adipocytes [1]. Understanding of this mechanism might facilitate the cognition of adipogenesis. One from techniques, which could be use to monitor adipodifferentiation is Oil Red O staining of lipid droplets accumulation. In last few years, the biomedical research focused on the improvement to obtain accurate quantitative data. Normalization to total protein amount is one from widely used types. In our study we present a modified method for protein extraction from paraformaldehyde-fixed cells.

We used human dermal fibroblasts (HDFa), routinely used in cell laboratories for various types of experiments. HDFa were divided into two groups: controls and adipo-differentiated cells. When cells reached 60% confluence, the growth medium was replaced with specific cultivation medium for adipogenic differentiation. In parallel, undifferentiated HDFa (control) were cultured in the growth medium. Differentiation kinetics was monitored by light microscopy for 14 days. During this process, lipid accumulation was detected as presence of oil droplets. On 14th day, after fixation, cells were stained using Oil Red O. After destain, total proteins were isolated from fixed cells using various types of lysis buffers [2,3,4]. We compared ability of three different types of lysis buffers in three

independent experiments. Our preliminary data showed the best extraction efficiency SDT (SDS-DTT-Tris) lysis buffer. This procedure was combined with high temperature. Then, we have obtained enough intact proteins able to use to possible further analysis.

References

Bunell B. A., Flaas M., Gagliardi Ch., Patel B., Ripoll C., Adipose-derived stem cells: Isolation, expansion and differentiation, *Methods* 2008, 2, 115-120.

1. Kraus N. A., Ehebauer F., Zapp B., Rudolphi B., Kraus B. J., Kraus D., Adipocyte 2016, 5, 351-358.
2. Rodriguez-Rigueiro T. et al, *Proteomics* 2011, 11(12), 2555-2559.
3. Sadick J.S., Darling E.M., *Biotechniques* 2018, 63(6), 275-280

Acknowledgment

This work was supported by the project VEGA 1/0313/21 and VEGA 1/0310/21.

DIVERSITY OF VAGINAL MICROBIAL STRAINS IN CERVICAL CYTOLOGICAL SMEARS IN RELATION TO HPV INFECTION

Veronika Holubekova¹, Tomas Rokos², Zuzana Kolkova¹, Andrea Hornakova¹, Terezia Pribulova², Erik Kozubik², Kamil Biringer², Erik Kudela²

¹Department Of Molecular Oncology and Diagnostics, Biomedical Center Martin, Jessenius Faculty of Medicine, Comenius University in Bratislava, Mala Hora 4C, 03601 Martin, Slovakia

²Department of Gynecology and Obstetrics, Jessenius Faculty of Medicine, Comenius University in Bratislava, Kollarova 2, 036 01 Martin, Slovakia

Background: According to GLOBOCAN, cervical cancer (CC) is the second most frequently diagnosed malignancy in women aged 15-44 and the fourth most common female malignancy worldwide(1). More than 95% of CC cases are caused by Human Papillomavirus (HPV) infection and HPV 16 and HPV18 genotypes are present in 70% of CCs(2). A composition of the vaginal microbiome is the one of the important cofactors, contributing to the reactivation of latent HPV infection, formation of precancerous cervical lesions, and/or progression to cancer(3). The aim of our study was to investigate the diversity of bacterial strains associated with bacterial vaginosis and to identify the HPV genotypes in cervical cytological smears.

Methods: Overall, cervical cytological smears were taken from women with different degrees of cervical abnormality (n=17), as well as from women negative for intraepithelial lesion or malignancy (NILM, controls, n=4) at the range 21-47 years. DNA was extracted from all samples and tested for the presence of HPV infection by PCR and Sanger sequencing, as well as bacterial strains associated with bacterial vaginosis using real-time PCR method.

Results: HPV 16 was identified as the most frequent genotype in 53% (9/17) of precancerous lesions (ASCUS, LSIL, HSIL). The most frequent bacterial strains identified in case/control cervical smears were: *Gardnerella vaginalis* (15/21), *Ureaplasma parvum* (11/21), *Prevotella*

bivia (9/21), *Atopobium vaginae* (8/21), *Prevotella disiens* (7/21), *Leptotrichia amnionii* (6/21), *Sneathia sanguinegens* (5/21), *Streptococcus mitis* (5/21), *Bacteroides ureolyticus* (5/21), *Parvimonas micra* (4/21), and *Fusobacterium nucleatum* (4/21). On average, the most bacterial strains were found in HSIL lesions, followed by LSIL lesion, ASCUS and the fewest strains were detected in NILM. The largest amount of bacterial DNA in case/control smears was detected from *Candida albicans*, *Gardnerella vaginalis*, *Leptotrichia amnionii*, *Atopobium vaginae*, *Sneathia sanguinegens*, *Parvimonas micra* and *Prevotella bivia* ($2^{-dCt} > 0,01$).

Conclusion: In addition to HPV detection, a simple vaginal swab can be also used for detection of bacterial strains that can help in identification of women with bacterial vaginosis and at higher risk of CC development.

References

1. Cancer today [Internet]. [cited 2022 Sep 9]. Available from: <http://gco.iarc.fr/today/home>
2. Li N, et al. Int J Cancer. 2011;128(4):927–35.
3. Curty G, et al. Int J Mol Sci. 2019;21(1):222.

Acknowledgment

This work was supported by the Grant Agency of the Ministry of Education of the Slovak Republic under contract no. 1/0398/21.

COVID-19 INFECTION IN PATIENTS WITH COPD

Monika Fekete¹, Bálint Madarász¹, Judit Forrai¹, Zsafia Szarvas¹,
Vince Fazekas-Pongor¹, Agnes Feher¹, Janos Tamas Varga²

¹Department of Public Health, Semmelweis University, Faculty of Medicine,
Budapest, Hungary

²Department of Pulmonology, Semmelweis University, Budapest, Hungary

Coronavirus infection is a particular risk in COPD patients, who are much more likely to become severely ill due to oxygen supply problems, and therefore primary prevention, the COVID-19 vaccination, is of paramount importance in this disease group.

We would like to review the health outcomes of chronic obstructive pulmonary disease (COPD) and COVID-19 infection in the presence of both diseases.

Review of national and international medical databases using the keywords COVID-19, COPD, disease risk, prevention, complications, prognosis.

Research shows that COPD is one of the most common underlying conditions in patients hospitalised for COVID-19. These patients are five times more likely to develop a serious complication and are therefore more likely to be admitted to intensive care units, where they may require mechanical ventilation. In underlying COPD, it is essential to follow the usual care plan for COVID-19 infection and all public health recommendations to minimise the risk of developing and transmitting COVID-19 disease.

Our summary highlights the reasons for the increased risk of COVID-19 in COPD patients, highlights the importance of smoking cessation and the particular importance of increased surveillance, prevention, early detection, treatment and rehabilitation of this disease group.

Keywords: COPD; SARS; coronavirus; COVID-19; complications; prevention

References

1. Jacobs M, Van Eeckhoutte HP, Wijnant SRA, Janssens W, Joos GF, Brusselle GG, et al. Increased expression of ACE2, the SARS-CoV-2 entry receptor, in alveolar and bronchial epithelium of smokers and COPD subjects. *European Respiratory Journal*. 2020; 56(2): 2002378. <https://doi.org/10.1183/13993003.02378-2020>
2. Leung JM, Yang CX, Tam A, Shaipanich T, Hackett T-L, Singhera GK, et al. ACE-2 expression in the small airway epithelia of smokers and COPD patients: implications for COVID-19. *European Respiratory Journal*. 2020; 55(5): 2000688. <https://doi.org/10.1183/13993003.00688-2020>
3. Ni W, Yang X, Yang D, Bao J, Li R, Xiao Y, et al. Role of angiotensin-converting enzyme 2 (ACE2) in COVID-19. *Critical Care*. 2020; 24(1): 422. <https://doi.org/10.1186/s13054-020-03120-0>
4. Escher R, Breakey N, Lämmle B. Severe COVID-19 infection associated with endothelial activation. *Thrombosis Research*. 2020; 190: 62. <https://doi.org/10.1016/j.thromres.2020.04.014>
5. Tang N, Bai H, Chen X, Gong J, Li D, Sun Z. Anticoagulant treatment is associated with decreased mortality in severe coronavirus disease 2019 patients with coagulopathy. *Journal of Thrombosis and Haemostasis*. 2020; 18(5): 1094-9. <https://doi.org/10.1111/jth.14817>
6. Lippi G, Henry BM. Chronic obstructive pulmonary disease is associated with severe coronavirus disease 2019 (COVID-19). *Respiratory Medicine*. 2020; 167: 105941. <https://doi.org/10.1016/j.rmed.2020.105941>
7. Zhao Q, Meng M, Kumar R, Wu Y, Huang J, Lian N, et al. The impact of COPD and smoking history on the severity of COVID-19: A systemic review and meta-analysis. *Journal of Medical Virology*. 2020; 92(10): 1915-21. <https://doi.org/10.1002/jmv.25889>
8. Wang B, Li R, Lu Z, Huang Y. Does comorbidity increase the risk of patients with COVID-19: evidence from meta-analysis. *Aging*. 2020; 12(7): 6049-57. <https://doi.org/10.18632/aging.103000>
9. Varga J. Practical and theoretical principles of pulmonary rehabilitation. Levels of treatment. *Korányi Bulletin* 2016; 1: 44-7.
10. Fekete M, Kerti M, Fazekas-Pongor V, Balazs P, Csizmadia Z, Nemeth AN, et al. Effect of interval training with non-invasive ventilation in severe chronic obstructive pulmonary disease—a prospective cohort study with matched control group. *Annals of Palliative Medicine*. 2021; 10(5): 5289-98. <https://doi.org/10.21037/apm-21-378>

11. Fazekas-Pongor V, Fekete M, Balazs P, Árva D, Péntes M, Tarantini S, et al. Health-related quality of life of COPD patients aged over 40 years. *Physiology International*. 2021; 108(2): 261-73.
<https://doi.org/10.1556/2060.2021.00017>
12. Varga JT, Szilasi M: A pulmonológiai rehabilitáció kézikönyve: SpringMed Kiadó Kft. 2018.
13. Varga J, Madurka I, Boros E, et al: COVID-19 betegek komplex rehabilitációja. Available at:
<https://tudogyogyasz.hu/Media/Download/29632> [accessed: 08. 06. 2022]
14. Fekete M, Szarvas Z, Fazekas-Pongor V, et al. COVID-19 infection in patients with chronic obstructive pulmonary disease: From pathophysiology to therapy. Mini-review [published online ahead of print, 2022 Feb 28]. *Physiol Int*. 2022;10.1556/2060.2022.00172.
15. Varga JT. Smoking and pulmonary complications: respiratory prehabilitation. *J Thorac Dis*. 2019;11(Suppl 5):S639-S644.
16. Singh D, Mathioudakis AG, Higham A. Chronic obstructive pulmonary disease and COVID-19: interrelationships. *Curr Opin Pulm Med* 2022;28:76–83.
17. Sanchez-Ramirez DC, Mackey D. Underlying respiratory diseases, specifically COPD, and smoking are associated with severe COVID-19 outcomes: A systematic review and meta-analysis. *Respir Med*. 2020;171:106096.

EFFECTS OF CHRONIC TREATMENT WITH A GPR39 AGONIST (TC-G 1008) ON HIPPOCAMPUS-DEPENDENT MEMORY OF BDNF +/- AND WT MALE MICE

Michał Rychlik¹, Katarzyna Młyniec¹

¹Department of Pharmacobiology, Faculty of Pharmacy, Jagiellonian University Medical College, Medyczna 9, PL 30-688 Krakow, Poland

In the hippocampus, the brain-derived neurotrophic factor (BDNF) is responsible for survival of neurons, synaptogenesis and memory formation. BDNF expression is modulated by zinc and the zinc-sensing GPR39 receptor. Since zinc dyshomeostasis is observed in neurodegenerative disorders and has been linked to symptoms of dementia, direct targeting of GPR39 could be a strategy for pharmacotherapy.

The aim of this study was to test this hypothesis and elucidate its BDNF-related mechanism. Adult WT mice and their littermates with a heterozygous knock-out (HET) of BDNF were chronically administered a GPR39 agonist (TC-G 1008, 10 mg/kg), memantine (NMDA antagonist, 10 mg/kg) or vehicle. Subsequently, animals were tested in the episodic-like memory (ELM) and Morris water maze tests. Gene expression and protein levels of biological markers of inhibitory and excitatory neurotransmission, as well as neuronal survival, were measured in hippocampi *ex vivo*.

Neither ELM nor spatial memory were modulated by the drugs. When compared to WT mice, BDNF HET animals displayed a spatial memory deficit, lower hippocampal BDNF and GABAA1 protein levels; and, higher *Mapk3* gene expression. Additionally, memantine caused a downregulation of *Bdnf* mRNA and the CREB protein, irrespective of the animals' genetic background.

These results confirmed the importance of BDNF for hippocampus-dependent memory, and suggest that chronic pharmacological activation of GPR39 is insufficient to modulate this function in mice.

Acknowledgement

This study was supported by a grant from the National Science Centre (2015/19/B/NZ7/00255), and by the statutory funds of the Faculty of Pharmacy, Jagiellonian University Medical College, Poland.

COMPARISON OF THE EFFECTS OF DIETARY SUPPLEMENTATION WITH THREE ARBOREAL MEDICINAL MUSHROOMS ON LONG-TERM MEMORY, ANXIETY-LIKE BEHAVIOR AND HIPPOCAMPAL GENE EXPRESSION IN MALE MICE

Agata Fijałkowska¹, Michał Rychlik², Agata Krakowska³, Bożena Muszyńska¹

¹Department of Pharmaceutical Botany, Faculty of Pharmacy, Jagiellonian University Medical College, Medyczna 9, PL 30-688 Krakow, Poland

²Department of Toxicological Biochemistry, Faculty of Pharmacy, Jagiellonian University Medical College, Medyczna 9, 30-688 Kraków, Poland

³Department of Inorganic and Analytical Chemistry, Faculty of Pharmacy Jagiellonian University Medical College 30-688 Kraków, Poland

Lion's mane (*Hericium erinaceus*, HE) is an arboreal medicinal mushroom with antioxidative, neuroprotective, and stress-modulating effects corroborated by *in vitro* and *in vivo* studies. HE has also been shown to improve short-term memory of healthy male mice, pointing to potential use outside the clinic. The pink oyster mushroom (*Pleurotus djamor*, PDJ) and agarikon (*Fomitopsis officinalis*, PDJ) are two arboreal medicinal mushrooms that share bioactive compounds (such as polysaccharides and 5-hydroxy-L-tryptophane) with HE, but their functional effects are yet to be investigated.

Therefore, in this study we compared the effects of 40 days of dietary supplementation with either HE, FO or PDJ on anxiety-like behavior, long-term memory, and hippocampal gene expression, in healthy CD-1 male mice. The animals were fed with control diet (AIN-93G) or mushroom-supplemented chow (2 mg per 1 g of dry chow), and – subsequently – were subjected to object novelty recognition and elevated plus maze tests. The hippocampi were collected for qRT-PCR experiments 24h after the last day of behavioral testing.

We observed that HE-supplemented mice were the only group to show long-term memory, which extends previous results. Anxiety-like behavior was not affected by supplementation, but additional analyses showed that it was modulated by the amount of ingested food only in the

mushroom-supplemented animals. This suggests that anxiolytic effects of mushroom supplementation may be dose-dependent. Lastly, hippocampal expression of *Gsk3β* and *Mtor* genes was lower in mice with higher weight gain regardless of experimental treatment.

PRELIMINARY STUDIES OF THE RELEASE RATE OF CELECOXIB AND ITS INCLUSION COMPLEX FROM THE NANOSTRUCTURED LAYER OF TITANIUM DIOXIDE

Paweł Gumułka^{1,2}, Magdalena Jarosz³, Jakub Latosiński³, Monika Dąbrowska², Małgorzata Starek²

¹Doctoral School of Medical and Health Sciences, Jagiellonian University Medical College, Łazarza 16 St, 31-530, Krakow, Poland

²Department of Inorganic and Analytical Chemistry, Faculty of Pharmacy, Jagiellonian University Medical College, Medyczna 9 St, 30-688 Krakow, Poland

³Department of Physical Chemistry and Electrochemistry, Faculty of Chemistry, Jagiellonian University, Gronostajowa 2 St, D1-16, 30-387, Kraków, Poland

Selective COX-2 inhibitors, eg. celecoxib, are used to relieve post-operative pain in orthopedic surgery. When dosed and delivered to the site of inflammation in an appropriate manner, these drugs can be a good alternative to high-risk opioids. However, they also has many side effects, such as damage to the heart system. Reduction of side effects can be achieved by topical administration, but also by modifying the rate of release - prolonging the duration of action of the minimum effective dose of drugs. Local drug delivery not only prevents systemic side effects, but also ensures optimal exposure around the joint, and lowers the levels of inflammatory mediators produced during the procedure. One suggestion for topical drug delivery may be the use of celecoxib-saturated nano-structured titanium dioxide layer attached to a titanium bone implant. Additional modification of physical properties, by forming inclusion complexes with cyclodextrin molecules, may modify the release rate. Cyclodextrins are cyclic oligosaccharides linked by α -1,4-glycosidic bonds. Due to the hydrophilic outer surface, They are well soluble in water, while the inner space is hydrophobic and may contain another hydrophobic substance forming an inclusion complex. Complexes increase the stability and solubility of poorly water-soluble substances.

The influence of the generated inclusion complexes on the release rate of celecoxib from the nanostructured layer of titanium dioxide was

determined. The complexes were prepared by mechanical kneading in a mortar, and matrices on titanium plates were produced by electrochemical oxidation. Then, by applying and evaporating the solutions of celecoxib and its complex several times, the nanopores were saturated with the drug in a strictly defined amount. The next step was to carry out the release of the drug from the matrix into a PBS solution simulating the release process into the intercellular space. For this purpose, the titanium plate was immersed in the buffer solution and the entire volume of the solution was withdrawn at specified intervals, supplemented with a new portion of PBS. The collected samples were subjected to quantitative chromatographic analysis of the celecoxib content. The obtained results show different release profiles of the drug and its complex from the matrix. Due to the complexation of the drug with cyclodextrin, it is possible to obtain a prolonged release of the drug from the tested matrix.

References

1. M. Jarosz, A. Pawlik, M. Szuwarzyński, M. Jaskuła, and G. D. Sulka, “Nanoporous anodic titanium dioxide layers as potential drug delivery systems: Drug release kinetics and mechanism” *Colloids Surfaces B Biointerfaces*, vol. 143, pp. 447–454, 2016.
2. C. A. Kahlenberg, R. M. Patel, M. Knesek, V. K. Tjong, K. Sonn, and M. A. Terry, “Efficacy of Celecoxib for Early Postoperative Pain Management in Hip Arthroscopy: A Prospective Randomized Placebo-Controlled Study” *Arthrosc. - J. Arthrosc. Relat. Surg.*, vol. 33, no. 6, pp. 1180–1185, Jun. 2017.
3. N. Sharma and A. Baldi, “Exploring versatile applications of cyclodextrins: An overview” *Drug Deliv.*, vol. 23, no. 3, pp. 739–757, 2016.

CEPHALOSPORINS - STRATEGIES IN THE SEARCH FOR NEW MEDICINAL SUBSTANCES

Żaneta Binert-Kusztal¹, Małgorzata Starek¹, Monika Dąbrowska¹

¹Department of Inorganic and Analytical Chemistry, Faculty of Pharmacy,
Medical College, Jagiellonian University, 9 Medyczna St., 30-688 Kraków,
Poland

Every year, the pharmaceutical industry brings a large number of innovative drugs to the market. Faced with the global problem of antimicrobial resistance, there is a continuing need for new effective drugs that can break this barrier. The history of searching for new drugs goes back to ancient times, when plant materials were used in medicine as a valuable source of compounds with various properties (morphine, quinine, cocaine). Antibiotics play an important role here. The history of the discovery of cephalosporins dates back to 1945, when the Italian microbiologist G. Brotzu isolated a strain of the fungus *Cephalosporium acremonium*, and then, thanks to cooperation with Florey (in 1948), he produced a number of antibiotics, including several types of cephalosporins. Their structure has become the basis of the group of cephalosporin antibiotics present in medicine until today. Cephaloridin was introduced as the first cephalosporin antibiotic (in 1962). Cephalosporins constitute a very diverse group of β -lactam antibiotics due to the presence of a β -lactam ring in the structure, the hydrolysis of which (by means of β -lactamases) inactivates the antibiotic. They exert a bactericidal effect by inhibiting bacterial cell wall peptidoglycan synthesis, which causes cell death. The scope of activity allows for grouping these compounds according to the next generations. It can be assumed that the lower the generation, the greater the activity against G-positive bacteria, and similarly, the higher the generation, the greater the activity against Gram-negative bacteria.

The constant fight against bacteria and the problem of antibiotic resistance results in a strategy of searching for new and new forms of cephalosporins. The newest available is cefiderokol, a new parenteral drug that is highly active against gram-negative pathogens. Cefiderokol

(Fetroja) is an antibiotic manufactured by Shinogi & Co Ltd. Japan is an injectable siderophore cephalosporin that uses active bacterial iron transport channels to pass through the outer membrane and enter the periplasm, thus avoiding enzyme breakdown. Due to this action, cefiderocol appears to be one of the most innovative antibiotics recently approved for use.

References

1. Brzeziński K. Opracowanie nowych substancji leczniczych – projektowanie leków. Rynek Kosmetyków i Farmaceutyków. 2007. 2, 16-17.
2. Wrzeszcz E., Wybrane zagadnienia z historii chemioterapii: Archiwum Historii i Filozofii Medycyny. 2015, 78, 16-24.
3. Abdul-Mutakabbira J.C, Alosaimya S, Morrisettea T, Kebriaeia R, Rybaka J.M. Cefiderocol: a novel siderophore cephalosporin against multidrug-resistant Gram-negative pathogens. *Pharmacotherapy*. 2020, 40(12), 1228-1247.
4. Korbut R.. *Pharmacology*. PZWL. Warsaw (2019) 233-234, 241-243.

SYSADOA - SYMPTOMATIC SLOW ACTING DRUGS FOR THE PREVENTION AND OSTEOARTHRITIS

Żaneta Binert-Kusztal¹, Małgorzata Starek¹, Monika Dąbrowska¹

¹Department of Inorganic and Analytical Chemistry, Faculty of Pharmacy,
Medical College, Jagiellonian University, 9 Medyczna St., 30-688 Kraków,
Poland

Skeletal diseases are one of the most common causes of disability and therefore constitute a global threat. Joints are the synovial connections that make up the most mobile connections of bones. Proper joint function also supports the tendons of the muscles that protect the joint capsule. Additional protection of the joint is the goo, which influences the proper friction in the joint and nourishes the joint cartilage. Due to the formation of synovial fluid, it is possible to make movements without unnecessary friction in the joint, which can over time damage the bone structure and lead to injury. Pain, stiffness in the joints and difficulty in movement are characteristic symptoms of this disease, especially as joint structures degrade over the years. People actively practicing sports may be exposed to less severe joint ailments, where damage may occur due to overload, heavy effort and incorrect exercise technique. Among the diseases of the joints we can distinguish: rheumatoid arthritis, psoriatic arthritis, reactive arthritis, gout, osteoarthritis. Joint structures should be supported by providing them with components that are part of the fluid and elements building the joint through the selection of appropriate preparations in the form of dietary supplements used orally, containing numerous ingredients of plant and synthetic origin.

SYSADOA - slow-acting drugs used in the prevention of degenerative diseases, which include: glucosamine, chondroitin sulfate, curcumin, ginger, collagen, Indian frankincense extract. Glucosamine occurs as an endogenous amino acid in the cartilage of our body (necessary for the synthesis of glycoproteins) and as an exogenous glucosamine in selected tissues of animals such as crustaceans (obtained synthetically from molluscs). Various forms of glucosamine are available, such as hydrochloride or sulfate. Glucosamine sulphate helps to protect

articular cartilage and at the same time reduces its breakdown and, as studies show, it can alleviate the pain symptoms associated with osteoarthritis (the recommended daily dose of glucosamine is 1500 mg). Another equally effective form of glucosamine is hydrochloride, which is more easily absorbed by the body, so you can take it in smaller amounts. Some of the available studies show that using glucosamine hydrochloride alone or in combination with chondroitin does not reduce the symptoms of osteoarthritis of the knee; however, other analyzes show that this combination has a pain reduction effect in patients with severe symptoms. Chondroitin is a building block of the joint matrix. It is most often in the form of chondroitin sulfate and is combined with other ingredients from the SYSADOA flu in the preparations available on the market. Collagen is a protein that is a building block of connective tissue. There are about 30 types of collagen, however type II collagen is found in articular cartilage, tendons and skin, has a positive effect on the condition of the joints and protects against the development of inflammation within the musculoskeletal system. Turmeric is actually the rhizome of turmeric (*Curcuma longa L.*) also sometimes called Indian saffron. The pharmacologically active ingredient is curcumin, a yellow color pigment that has an anti-inflammatory effect by inhibiting COX-2, prostaglandins and leukotrienes. Some preliminary clinical studies suggest that it may improve symptoms of rheumatoid arthritis. Whereas, ginger may have anti-inflammatory effects by inhibiting COX and lipoxygenase. Simultaneously with the use of mentioned ingredients in dietary supplements, people should remember about physical activity, maintaining a proper body weight, and a properly balanced and varied diet.

References

1. Gregory P.J., Sperry M., Friedman Wilson A., Dietary supplements for osteoarthritis. *Am Fam Physician*. 2008, 15;77(2):177-84.
2. Liu X., Machado C.G., Eyles J.P., Ravi V., Hunter D.J., Dietary supplements for treating osteoarthritis: a systematic review and meta-analysis. *Br J Sports Med*. 2018, 52(3):167-175.

3. Nieman D.C., Shanely A.R., Luo B., Dew D., Meaney M.P., Sha W., A commercialized dietary supplement alleviates joint pain in community adults: a double-blind, placebo-controlled community trial. *Nutr J.* 2013, 12:154.
4. <https://www.spine-health.com/conditions/arthritis/effectiveness-glucosamine-and-chondroitin-sulfate-osteoarthritis>

NEUROPROTECTIVE AND NEUROREGENERATIVE ACTIVITY OF ACTIVE COMPOUNDS CONTAINED IN MUSHROOMS AND PLANTS

Alicja Radzimska¹, Bartosz Babik¹, Piotr Dziura¹, Dominika Zych^{1,2},
Bożena Muszyńska^{1,2}

¹Polish Society of Pharmacy, Branch of Young Pharmacy, Faculty of Pharmacy,
9 Medyczna Str., 30–688 Kraków, Poland

²Jagiellonian University Medical College, Faculty of Pharmacy, Department of
Pharmaceutical Botany, 9 Medyczna Str., 30–688 Kraków, Poland

The use of natural products or their parts: fruiting bodies, natural strains, biomass from *in vitro* cultures, leaves, roots, rhizomes, flowers, seeds, as well as extracts or isolated metabolites is becoming more and more popular. Natural remedies not only act prophylactically, but also help to alleviate symptoms of many diseases and enhance the overall functioning of the internal organs. Many raw materials of natural origin play a role as neuroprotective and neurodegenerative agents.

The aim of work was to choose the most important natural products, plants: *Bacopa monnieri*, *Centella asiatica*, *Ginkgo biloba* and mushrooms: *Cordyceps militaris*, *Ganoderma lucidum*, *Hericium erinaceus* which can be useful in this activity.

Bacopa monnieri is one of the most prominent herbs in Indian traditional medicine Ayurveda and is used as a memory enhancing agent and substance against various neurological diseases. The most important active compounds from this plant are saponins called bacosides. Studies have proven that both bacoside A and bacoside B improve memory brain function and logical learning in both adolescent and elderly people. What is more, they can reverse scopolamine and diazepam-induced amnesia in mice. It is suggested that use of *Bacopa monnieri* extracts can have positive effect in neurodegenerative diseases such as Parkinson's disease or Alzheimer's disease – in which many *in-vitro* and *in-vivo* studies imply slowing the disease progression. The anti-neurodegenerative effect of *Bacopa monnieri* extracts may result, inter alia, from the anti-apoptotic effect, as well as the ability to modulate the cholinergic system.

Centella asiatica is a plant from the *Apiaceae* family found in countries such as Malaysia, India, Sri Lanka and China. It is reported to have neuroprotective properties in various diseases of the central nervous system, including Alzheimer's disease. The main active compounds in *Centella asiatica* extracts are the pentacyclic triterpenes: madecassoside, asiaticoside, madecassic acid and asiatic acid. They show high permeability across the blood-brain barrier, where they reduce inflammatory responses and mitochondrial dysregulation caused by Alzheimer's beta-amyloid. The anti-neuroinflammatory, antioxidant and mitoprotective effect is achieved due to the action of several metabolic pathways, for instance by activating the Nrf2 pathway.

Ginkgo biloba is one of the most effective plants used in neuroprevention and neuroprotection. *Ginkgo biloba* standardized extract from *in vitro* cultures (Egb 761), reduces neurons' mortality rate caused by numerous factors, including hypoxia, nitric oxide (NO) or amyloid-beta. *In vivo*, studies show a reduction in neuronal damage after exposing individuals to stress factors such as focal cerebral ischaemia or hypoxia. Active ingredients responsible for these neuroprotective effects are mainly ginkgolides A and B and bilobalide. In patients, especially those with Alzheimer's disease and dementia, Egb 761 plays a huge role in improving their memory (mainly working memory) as well as reducing neuronal apoptosis.

Cordyceps militaris an Ascomycota mushroom, has been used for years in traditional Asian medicine. In recent years, its potential use in therapy of neurodegenerative diseases and neuroregeneration has been indicated. This effect is attributed to the presence of cordycepin (3-deoxyadenosine), which has anti-inflammatory and antioxidant properties. It has shown neuroprotective effects in *in vivo* studies on mouse microglia cells in an LPS-induced stress model by reducing the release of NO, PGE₂ and pro-inflammatory cytokines. In addition, there are indications of possible applications of *C. militaris* in neurodegenerative diseases such as Alzheimer's disease. It counteracts memory deficits induced by scopolamine administration and during

ischemic brain injury. It also reduces amyloid precursor protein activity, beta-secretase activity and increases NGF production.

Ganoderma lucidum is a *Basidiomycota* mushroom valued in Asia for its biological activity. Polysaccharides derived from this species showed a neuroprotective effect on rat nerve cells subjected to prolonged oxygen and glucose deficiency, the purpose of which was to study pathological changes in neurons and their network of connections during stroke. This activity consisted in normalizing abnormal biochemical reactions, limiting pathological changes within the cell membrane of nerve cells, their volume and density of interneuronal connections. The number of neurons undergoing apoptosis as a result of oxygen and glucose deprivation decreased under the effect of *Ganoderma lucidum* polysaccharides solutions which was caused by their influence on the bax and bcl-2 proteins. Additionally, these solutions decreased concentration of caspase-3 the increase of which was correlated with apoptotic changes.

Hericium erinaceus is a *Basidiomycota* mushroom widely spread across East Asia, commonly used in cuisine, and appreciated for its medicinal properties. Hericenones and erinacines present in fruiting bodies and mycelium are proven to enhance synthesis of nerve growth factor (NGF) in *in vitro* research. An exobiopolymer isolated from the liquid culture broth of *H. erinaceus* mycelium enhanced the growth and extension of neurites of rat PC12 (they are derived from the pheochromocytoma of the adrenal medulla and used in the study of brain diseases). In Alzheimer's disease NGF pathway in the brain is impaired. It has been shown that an aqueous extract of *H. erinaceus* used in combination with NGF increases its secretion, resulting in increased outgrowth and differentiation of nerve cells. It may be an indication for usage of this mushroom extract supplementation in NGF therapies.

In conclusion prophylaxis consisting of constant supplementation of vital for health substances can be a base to keep the organism in good condition and prevent diseases occurrence.

References

1. Muszyńska B., Łojewski M., Sułkowska-Ziaja K., Szewczyk A., Gdula-Argasińska J., Hałaszuk P. *In vitro* cultures of *Bacopa monnieri* and an analysis of selected groups of biologically active metabolites in their biomass. *Pharmaceutical Biology* 2016, 54(11), 2443-2453.
2. Banerjee S., Anand U., Ghosh S., Ray D., Ray P., Nandy S., Deshmukh G.D., Tripathi V., Dey A. *Bacosides* from *Bacopa monnieri* extract: An overview of the effects on neurological disorders. *Phytotherapy Research* 2021, 35(10), 5668-5679.
3. Lai P.L., Naidu M., Sabaratnam V., Wong K.H., David R.P., Kuppusamy U.R., Abdullah N., Malek S.N. Neurotrophic properties of the Lion's mane medicinal mushroom, *Hericium erinaceus* (Higher *Basidiomycetes*) from Malaysia. *International Journal of Medicinal Mushrooms* 2013, 15(6), 539-554.
4. Jeong J.W., Jin C.Y., Kim G.Y., Lee J.D., Park C., Kim G.D., Kim W.J., Jung W.K., Seo S.K., Choi I.W., Choi Y.H. Anti-inflammatory effects of cordycepin via suppression of inflammatory mediators in BV2 microglial cells. *International Immunopharmacology* 2010, 10(12), 1580-1586.
5. Kim Y.O., Kim H.J., Abu-Taweel G.M., Oh J., Sung G.H. Neuroprotective and therapeutic effect of *Cordyceps militaris* on ischemia-induced neuronal death and cognitive impairments. *Saudi Journal of Biological Sciences* 2019, 26(7), 1352-1357.
6. Zhou Z.Y., Tang Y.P., Xiang J., Wua P., Jin H.M., Wang Z., Mori M., Cai D.F. Neuroprotective effects of water-soluble *Ganoderma lucidum* polysaccharides on cerebral ischemic injury in rats. *Journal of Ethnopharmacology* 2010, 131(1), 154-164.
7. He M.T., Park C.H., Cho E.J. Caterpillar Medicinal Mushroom, *Cordyceps militaris* (Ascomycota), Attenuates A β 1-42-Induced Amyloidogenesis and Inflammatory Response by Suppressing Amyloid Precursor Protein Progression and p38 MAPK/JNK Activation. *International Journal of Medicinal Mushrooms* 2021, 23(11), 71-83.
8. Hambali A., Kumar J., Hashim N.F.M., Maniam S., Mehat M.Z., Cheema M.S., Mustapha M., Adenan M.I., Stanslas J., Hamid H.A. Hypoxia-Induced Neuroinflammation in Alzheimer's Disease: Potential Neuroprotective Effects of *Centella asiatica*. *Frontiers in Physiology* 2021, 14, 12,712317.

9. Wong J.H., Barron A.M., Abdullah J.M. Mitoprotective Effects of *Centella asiatica* (L.) Urb.: Anti-Inflammatory and Neuroprotective Opportunities in Neurodegenerative Disease. *Frontiers in Pharmacology* 2021, 12, 687935.
10. Ahlemeyer B., Krieglstein J. Neuroprotective effects of Ginkgo biloba extract. *Cellular and molecular life sciences* 2003, 60(9), 1779–1792.

POLYSACCHARIDES WITH IMMUNOMODULATORY PROPERTIES

Piotr Dziura¹, Bartosz Babik¹, Dominika Zych^{1,2}, Alicja Radzimska¹,
Bożena Muszyńska^{1,2}

¹Polish Society of Pharmacy, Branch of Young Pharmacy, Faculty of Pharmacy,
9 Medyczna Str., 30–688 Kraków, Poland

²Jagiellonian University Medical College, Faculty of Pharmacy, Department of
Pharmaceutical Botany, 9 Medyczna Str., 30–688 Kraków, Poland

A very important group among fungal polysaccharides are those with anticancer activity. They have various mechanisms of action, one of them is immunomodulatory activity, which consists in strengthening and accelerating the body's defensive response. Thanks to this, they act not only on developed neoplastic changes, but also prevent their formation. The most important polysaccharides for their biological activity are β -glucans. Their mechanism of action is based on action on macrophages, stimulating the release of reactive oxygen species (ROS) and nitric oxide (NO), stimulating T lymphocytes, B lymphocytes, activating NK cells. Numerous studies on various fungi have demonstrated that they potentiate the secretion of interleukin (IL)-1 and IL-6, tumor necrosis factor (TNF) - α , and other pro-inflammatory cytokines, showing an antagonistic effect on the expression of anti-inflammatory agents.

Lentinan, a substance isolated from the fruiting bodies of *Lentinula edodes* (Berk.), is the most active of the known β -glucans. It is most often used in the treatment of tumours of the stomach, colon, lungs, breast and malignant leukaemia. Clinical trials in China have shown that lentinan, when used with chemotherapy, is more effective in treating lung cancer than chemotherapy alone, and it improves quality of life of patients by reducing the side effects of chemotherapy and radiation therapy. This polysaccharide exhibits no cytotoxicity or side effects, except for allergic reactions and episodes of fever and vomiting.

Another important β -glucan fungal polysaccharide is pleuran, isolated from *Pleurotus ostreatus*. In studies, it has shown effectiveness in reducing the risk of upper respiratory tract infections among athletes by

increasing the number of NK cells, as well as protecting against the loss of their number and activity caused by intense physical activity. Other studies have shown its activity in inhibiting the proliferation of tumor cells in the rat colon and the induction of their apoptosis.

Algae are a source of polysaccharides with immunomodulatory properties, the use of which has become increasingly popular in recent years. Fucoidan obtained from many species of brown algae has an immunostimulating effect, the strength of which depends on the organism from which it was isolated. The test with RAW264.7 cells showed inhibition of their growth under the influence of fucoidan extracts. The mechanism of action of fucoidans differs within this group, but the essence is the effect on TNF- α and IL-6. Extracts from *Porphyra tenera*, a species whose major part of its mass is porphyran, also influenced the production of cytokines by RAW264.7 cells, increasing the production of IL-1 β , IL-2, IL-4, interferon- γ and nitric oxide (NO), which is responsible for their immunomodulatory action.

Extracts obtained from *Echinacea* spp (*Echinacea purpurea*, *Echinacea pallida*, *Echinacea angustifolia*) containing various polysaccharides, including arabinogalactans, heteroxylans and fructofuranosides, induced macrophage and NK cell activation and enhanced the release of IL-1 β , IL-6, IL-8, IL-10, IL-12, TNF- α , interferon and antibodies. Increase in macrophage activity during the carbon clearance test varied between species and was greatest after administration of the *Echinacea purpurea* extract. The activation of macrophages led to an anti-cancer activity. Additionally, it has been speculated that inulin-type fructans may play an important role in the immunomodulatory effects of polysaccharides present in various *Echinacea* species. By stimulating the development of some parts of the microbiome and proliferator-activated receptor gamma modulation, they can affect AMP-activated protein kinase, which suggests the possibility of using *Echinacea* preparations in the treatment of obesity, diabetes and inflammatory bowel disease.

References

1. Muszyńska B., Jękot B., Topolska-Pasek M. & Rzewińska A. Właściwości prozdrowotne węglowodanów występujących w algach. *Farm. Pol.* 2016, 72, 2-13.
2. Kang H. B., Song J., You Y., Park J., Kwak S., Lee Y. H. & Jun W. Porphyrin extracts have immune stimulation activity via increasing cytokines in mouse primary splenocytes and RAW264.7 macrophages. *J. Food Nutr. Res.* 2016, 4, 558-565.
3. Dobrange E., Peshev D., Loedolff B., & Van den Ende W. Fructans as immunomodulatory and antiviral agents: The case of Echinacea. *Biomolecules.* 2019, 9(10), 615.
4. Barrett B. Medicinal properties of Echinacea: a critical review. *Phytomedicine.* 2003, 10(1), 66-86.
5. Melchart D., Linde K., Worku F., Bauer R. & Wagner H. Immunomodulation with Echinacea—a systematic review of controlled clinical trials. *Phytomedicine.* 1994, 1(3), 245-254.
6. Motta F., Gershwin M. E. & Selmi C. Mushrooms and immunity. *Journal of autoimmunity.* 2021, 117, 102576.

ACTIVITY OF SELECTED POLYSACCHARIDES OBTAINED FROM ALGAE

Bartosz Babik¹, Piotr Dziura¹, Dominika Zych^{1,2}, Alicja Radzimska¹,
Bożena Muszyńska^{1,2}

¹Polish Society of Pharmacy, Branch of Young Pharmacy, Faculty of Pharmacy,
9 Medyczna Str., 30–688 Kraków, Poland

²Jagiellonian University Medical College, Faculty of Pharmacy, Department of
Pharmaceutical Botany, 9 Medyczna Str., 30–688 Kraków, Poland

Seaweed is classified into three major groups: *Chlorophyta*—green algae, *Phaeophyceae* — brown algae, and *Rhodophyta* — red algae. Polysaccharides found in macroalgae have specific and distinguished characteristics, and such substances are absent in terrestrial plants. Algal polysaccharides are fascinating tools for both therapeutic and industrial applications.

Laminarin is a storage polysaccharide found in brown algae. It is a low molecular weight β -glucan, which general features are species-dependent. One of the main activities is anti-cancer effect. Numerous studies have reported its capacity to inhibit colony formation and induce apoptosis in human colon and prostate cancers via death receptor or mitochondrial pathways. Evidence from several studies suggests that sulfate-modified laminarin is more bioactive and inhibits cell proliferation at a higher rate than unmodified polysaccharide. During research, this compound also showed an anti-cancer activity by promoting NK cell cytotoxicity in immunosuppressive mice. Furthermore, laminarin presents noteworthy antioxidative and anti-inflammatory activities due to increasing the levels of catalase, superoxide dismutase and glutathione peroxidase. Further investigation into the performance of laminarin as a support for cell culture and tissue engineering applications is warranted, as laminarin-based materials show properties of stimulating the wound healing process.

The cell wall matrix of green seaweed contains highly sulfated polysaccharides named ulvans which could be an alternative for heparins, as it has anticoagulant activity. Studies have proved that sulfation is

indispensable for this effect to occur. Sulfated derivatives show strong anticoagulant activity comparable to commonly used drugs like Lovenox® regardless of the coagulation pathway tested. Numerous studies have shown other uses for ulvans. High sulfate derivatives with low molecular weights exhibited a significant antioxidant effect in hyperlipidemic rats, due to increasing the level of HDL and decreasing the level of LDL. They also participated in the regulation of the antioxidant enzyme system by activating its transcription enzymes. It has also been established that ulvans induce a pro-inflammatory response in animal and human macrophages by increasing mRNA expression and upregulating the production of pro-inflammatory cytokines, enzymes, and their products (e.g., NO and PGE2). Furthermore, there is a growing body of research showing that ulvan acts as an anti-proliferation agent and promotes apoptosis in malignant cells. However, despite the variability in cytotoxic activity among sources, ulvans activity is still significantly lower than that of traditional chemotherapy drugs.

Furcellaran is a polysaccharide found in red algae, *Furcellaria lumbricalis* and it is a promising natural biopolymer. Recent years have seen it gain notoriety due to its prominent film-forming abilities, appearing thanks to its ability to interact with proteins and polysaccharides to create two-component and ternary films. The petroleum-based plastics are difficult to recycle and are creating a growing amount of waste. That is why there is now an abundance of research on the use of this substance in the development of films and coatings for food packaging. Not only is it safe and non-toxic, but it is also biodegradable and easily available. Furthermore, furcellaran can be mixed with other substances, such as antimicrobial peptides, organic acids, essential oils, enzymes, and nanoparticles, to gain antimicrobial and antioxidant abilities. Another interesting application of this substance is the creation of biopolymer micro- and nanocapsules that could be used in targeted therapy. Although promising, further research is needed before the material can be fully utilized.

Fucoidan is a polysaccharide rich in sulfuric acid groups and is mainly found in extracellular matrix of brown algae. Fucoidan has

received increasing attention due to its extensive biological activities. Numerous investigations have revealed that fucoidan has a cytotoxic effect on cancer cells, but not on normal cells. The action of fucoidan involves cell cycle arrest, induction of apoptosis via various mechanisms and inhibition of angiogenesis by reducing the expression of VEGF (vascular endothelial growth factor). The safety of this substance has been fully confirmed in clinical research and toxicology reports. Furthermore, studies have shown the anti-inflammatory effects of fucoidan, which occur through various mechanisms, including the downregulation of pro-inflammatory cytokines. The characteristics and effectiveness of these biological activities, however, depend on the composition, the sulfate groups position, and other factors that vary depending on the source of fucoidan and preparation method. The molecular structure of this polysaccharide is very complex and the relationship between its composition and activity is unclear. Therefore, more research is needed.

References

1. Zargarzadeh M., Amaral A.J.R., Custódio C.A., Mano J.F. Biomedical applications of laminarin. *Carbohydr Polym.* 2020 15, 232, 115774.
2. Chen J., Yang J., Du H., Aslam M., Wang W., Chen W., Li T., Liu Z., Liu X. Laminarin, a Major Polysaccharide in Stramenopiles. *Mar Drugs.* 2021, 19(10), 576.
3. Zhu X., Zhu R., Jian Z., Yu H. Laminarin enhances the activity of natural killer cells in immunosuppressed mice. *Cent Eur J Immunol.* 2019, 44(4), 357-363.
4. Sulastri E., Lesmana R., Zubair M.S., Elamin K.M., Wathoni N., A Comprehensive Review on Ulvan Based Hydrogel and Its Biomedical Applications *Chem Pharm Bull (Tokyo).* 2021, 69(5), 432-443.
5. Adrien A., Bonnet A., Dufour D., Baudouin S., Maugard T., Bridiau N. Anticoagulant Activity of Sulfated Ulvan Isolated from the Green Macroalga *Ulva rigida*. *Mar Drugs.* 2019, 17(5), 291.
6. Li W., Jiang N., Li B., Wan M., Chang X., Liu H., Zhang L., Yin S., Qi H., Liu S. Antioxidant activity of purified ulvan in hyperlipidemic mice. *Int J Biol Macromol.* 2018, 113, 971-975.

7. Marangoni Júnior L., Vieira R.P., Jamróz E., Anjos C.A.R. Furcellaran: An innovative biopolymer in the production of films and coatings. *Carbohydr Polym.* 2021, 252, 117221.
8. Štěpánková K., Ozaltın K., Pelková J., Pištěková H., Karakurt I., Káčerová S., Lehocky M., Humpolicek P., Vesel A., Mozetic M. Furcellaran Surface Deposition and Its Potential in Biomedical Applications. *Int J Mol Sci.* 2022, 423(13), 7439.
9. Pluta-Kubica A., Jamróz E., Khachatryan G., Florkiewicz A., Kopel P. Application of Furcellaran Nanocomposite Film as Packaging of Cheese. *Polymers (Basel).* 2021, 13(9), 1428.
10. Kidgell J.T., Magnusson M., de Nys R., Glasson C.R.K, Ulvan: A systematic review of extraction, composition and function, *Algal Research*, 2019, 39, 101422.
11. Wu L., Sun J., Su X., Yu Q, Yu Q., Zhang P., A review about the development of fucoidan in antitumor activity: Progress and challenges, *Carbohydrate Polymers*, 2016, 154, 96-111,
12. Ahmad T., Eapen M.S., Ishaq M., Park A.Y., Karpiniec S.S., Stringer D.N., Sohal S.S., Fitton J.H., Guven N., Caruso V., Eri R. Anti-Inflammatory Activity of Fucoidan Extracts In Vitro. *Mar Drugs.* 2021, 19(12), 702.
13. Li J., Guo C., Wu J. Fucoidan: Biological activity in liver diseases. *The American journal of Chinese medicine*, 2020, 48(07), 1617-1632.

PLEUROTUS DJAMOR AND ITS PROHEALTH ACTIVITY

Dominika Zych^{1,2}, Bartosz Babik¹, Piotr Dziura¹, Alicja Radzimska¹,
Bożena Muszyńska^{1,2}

¹Polish Society of Pharmacy, Branch of Young Pharmacy, Faculty of Pharmacy,
9 Medyczna Str., 30–688 Kraków, Poland

²Jagiellonian University Medical College, Faculty of Pharmacy, Department of
Pharmaceutical Botany, 9 Medyczna Str., 30–688 Kraków, Poland

Pleurotus djamor, also known as the pink oyster mushroom due to the colour of its fruiting bodies, is a *Basidiomycota* mushroom. It is spread in tropical and subtropical regions where it is widely used in cuisine.

The pink oyster mushroom's popularity is growing, and the use of its parts, extracts, or isolated metabolites is becoming more and more prominent. The preparations with powdered fruiting bodies or extract from this species are being used prophylactically, but also as a way of easing symptoms of many diseases and improving the overall organism functioning.

The pink oyster mushroom has a very potent antioxidative activity as well as anti-aging properties. These effects have been proved in both *in vivo* and *in vitro* studies using acetylated mycelia polysaccharides (AMPS) from *P. djamor*. Moreover, its antimicrobial activity is being postulated, with higher efficacy towards Gram (+) bacteria (such as *Staphylococcus aureus*).

According to the data protein content of *P. djamor* ranged from 31,48 to 35,50 g per 100 grams of dry mass which makes it a good source of these nutrients. It can be used in food for special medical purposes. Aromatic amino acids present in fruiting bodies, such as phenylalanine, L-tryptophan, and 5-hydroxy-L-tryptophan are essential to produce neurotransmitters: serotonin, catecholamines, and also vitamin B₃.

Study shows that cultivating *P. djamor* in a medium enriched with magnesium salts increases the magnesium content in fruiting bodies and alters other elements' content (showing antagonism with zinc content), which makes it possible to classify it as a functional food. It also increased

L-tryptophan production, which had a significant impact on its antioxidant activity.

References

1. Zięba P., Sękara A., Bernaś E., Krakowska A., Sułkowska-Ziaja K., Kunicki E., Suchanek M., Muszyńska B. Supplementation with Magnesium Salts—A Strategy to Increase Nutraceutical Value of *Pleurotus djamor* Fruiting Bodies. *Molecules*. 2021, 26, 3273.
2. Jegadeesh R., Hariprasath L., Jang K., Oh M., Oh Y., Im J. Nutritional composition and antioxidant activity of pink oyster mushrooms (*Pleurotus djamor var. roseus*) grown on a paddy straw substrate. *Journal of Mushrooms*. 2020, 18, 189-200.
3. Li H., Zhao H., Gao Z., Song X., Wang W., Yuan F., Feng Y., Zhang Y., Zhang J., Zhang S., Jia L. The Antioxidant and Anti-Aging Effects of Acetylated Mycelia Polysaccharides from *Pleurotus djamor*. *Molecules*. 2019, 24, 2698.
4. Jegadeesh R., Hariprasath L., Kumaresan K., Raaman N. In vitro Antioxidant and Antibacterial Activities of Fractionized Extracts of Edible Mushroom *Pleurotus djamor var. roseus*. *Journal of Academia and Industrial Research*. 2014, 3, 202-208

HERICUM SP. AS DIETARY AND MEDICINAL MUSHROOMS

Kamil Hnatyk¹, Katarzyna Kała¹, Kristian Marzec², Piotr Zięba²,
Katarzyna Sułkowska-Ziaja¹, Agnieszka Szewczyk¹, Agata Krakowska³,
Bożena Muszyńska¹

¹Department of Pharmaceutical Botany, Faculty of Pharmacy, Jagiellonian
University Medical College, Medyczna 9 Str., 30-688 Kraków, Poland

²Department of Horticulture, Faculty of Biotechnology and Horticulture,
University of Agriculture in Kraków, 29 Listopada 54 Str., 31-425 Kraków,
Poland

³Department of Inorganic and Analytical Chemistry, Faculty of Pharmacy,
Jagiellonian University Medical College, Medyczna 9 Str., 30-688 Kraków,
Poland

One species of medicinal mushroom of increasing interest is *Hericum erinaceus*. This species has a long history of use in traditional Chinese medicine. It contains many bioactive compounds that have health-promoting properties. Among the most important are terpenoids such as herinacins and erinacins. They have the effect of stimulating the synthesis of nerve growth factor (NGF), a protein of great importance for the health and functioning of the nervous system.^{1,2} Together with *Hericum coralloides* and *Hericum americanum*, it belongs to the *Hericiaceae* family. This two species are still poorly studied for their bioactive and dietary compounds.²

The study was conducted to analyze the biochemical composition of three *Hericum* species (both fruiting bodies and mycelial cultures): *H. erinaceus*, *H. coralloides* and *H. americanum*. The analyses carried out were comprehensive and included the study of antioxidant properties, content of indole compounds, lovastatin, p-hydroxybenzoic acid, total content of phenolic compounds, and β -glucans. Their aim was not only to study the medicinal properties of the studied species, but also to select which of them has the best health-promoting potential.

It turns out that the species studied to a small extent - *Hericum coralloides* - has interesting medicinal properties and stands out through the content of bioactive compounds among the studied species. The biotechnological potential for this species was shown to be particularly

important, as mycelium from *in vitro* cultures had the best content of health-promoting substances. In the mycelium of *Hericium coralloides* L-phenylalanine (997 mg/100 g d.w.), p-hydroxybenzoic acid (11.0 mg/100 g d.w.) and lovastatin (21.6 mg/100 g d.w.) were determined in the highest amounts. The total content of phenolic compounds was also the highest in this material. On the other hand, when analyzing the content of one of the neurotransmitters, L-tryptophan, it can be seen that for all analyzed species, the fruiting bodies are a better source of it than mycelial cultures.

In conclusion, it is worthwhile to study mushroom species that are less popular among consumers, as they may prove to be a valuable new source of many substances of medicinal importance. In addition, when analyzing mushroom species, it is important to conduct comparative studies between fruiting bodies and mycelial cultures, since each of these materials is proving to be an important source of other groups of substances.

References

1. Chong P.S., Fung M.-L., Wong K.H., Lim L.W. 2019. Therapeutic potential of *Hericium erinaceus* for depressive disorder. *Int J Mol Sci*, 21(1): 163.
2. Gonkhom D., Luangharn T., Raghoonundon B., Hyde K., Stadler M., Thongklang N. 2021. *Hericium*: A review of the cultivation, health-enhancing applications, economic importance, industrial, and pharmaceutical applications. *Fungal Biotech*, 1(2): 115–127.

EFFECTS OF THE ELECTROMAGNETIC FIELD ON THE CARDIOVASCULAR AND NERVOUS “NETWORK” SYSTEMS

Jakub Misek¹, Katarina Hamza Sladicekova¹, Marcel Veternik¹, Martin Kopani², Ingrid Tonhajzerova³, Nadezda Visnovcova¹, Daniel Parizek¹, Jakusova Janka⁴, Jan Jakus¹

¹Dept. of Medical Biophysics, JFMED in Martin, Comenius University Bratislava, Mala Hora 4, 036 01 Martin, SR.

²Institute of medical physics, biophysics, informatics and telemedicine, FMED in Bratislava, Comenius University Bratislava, Sasinkova 2, 813 72 Bratislava, SR.

³Dept. of Physiology, JFMED in Martin, Comenius University Bratislava, Biomedical Center, Mala Hora 4, 036 01 Martin, SR.

⁴Dept. of Pathological Physiology, JFMED in Martin, Comenius University Bratislava, Mala Hora 4, 036 01 Martin, SR.

Wireless technologies have undergone great development and have become an integral part of the human population. The expansion of the radio frequency (RF) sources of the electromagnetic fields (EMF) has led to the investigation of their effect especially on the head and neck region with a focus on the autonomic nervous system (ANS).

Our experiments in the humans focused on determining the responses of the ANS after the exposure to a generated radiofrequency signal. Our findings using heart rate variability (HRV) analysis in adolescent students (1) showed that RF EMF (1788 MHz, with the 17 min. exposure and electric field intensity $E = 54$ V/m) predominantly lead to the activation of the parasympathetic part of the ANS (with a significant decrease in heart rate in supine position compared to control). The numeric simulation revealed increased absorption in some parts of the CNS. Two groups of the experimental animals (rabbits) were exposed to occupation levels of real GSM and generated EMF (1788 MHz, with the 150 min. exposure and electric field intensity $E = 160$ V/m). The aim was to evaluate HRV after exposure to public-above-limits EMFs (2). We observed a slight increase in vagal tone what correspond to the results in humans. Temperature changes revealed an increase in central temperature with maximum in 60 min of the exposure. This was attributed to the direct

effect of EMF on biological tissue. Histopathological analysis of the exposed animals (cerebellum) showed the formation of iron deposits in the area of the cerebellum (3). Spectral analysis also revealed the presence of other elements such as aluminum and accompanying degenerative changes in the brain tissue. These findings, especially with long-term exposure, can negatively affect the functions of the nervous system and lead to the development, or deterioration, symptoms of neurodegenerative diseases (e.g. Alzheimer's disease, etc.)

The researchers all over the world agree that the non-thermal effects of long-term EMF exposure play an important role in assessing the effects of these fields on the human health. The kind of warning could be decision of the WHO, which in 2011 classified RF EMF as a possible carcinogen (group 2B). The currently valid limit values are obsolete for the needs of modern world. These standards are adapted from short-term exposures and thermal effects. However, they do not consider cumulative, long-term low-level EMF, which can also cause the so-called non - thermal bioelectromagnetic effects. Currently, the subject of interest is to propose an objective marker of the RF EMP radiation effects.

References

1. Misek J., Belyaev I., Jakusova V., Tonhajzerova I., Barabas J., Jakus J. Heart rate variability affected by radiofrequency electromagnetic field in adolescent students. *Bioelectromagnetics*, 2018, 39(4): 277-288.
2. Misek J., Veternik M., Tonhajzerova I., Jakusova V., Janousek L., Jakus J. Radiofrequency electromagnetic field affects heart rate variability in rabbits. *Physiological Research*, 2020, 69(4): 633-643.
3. Kopani M., Filova B., Sevcik P., Kosnac D., Misek J., Polak S., Kohan M., Major, J., Zdimalova, M., Jakus J. Iron deposition in rabbit cerebellum after exposure to generated and mobile GSM electromagnetic fields. *Bratislavské lekárske listy*, 2017, 118(10): 575-579.

Acknowledgment

This work was supported by Slovak Research and Development Agency under the contract no. APVV-19-0214 and projects VEGA 1/0173/20 and KEGA 057UK-4/2021

OTHER ABSTRACTS

DETERMINATION OF THE SELECTED BIOELEMENTS (Mg, Zn, Fe, K) IN THE SPRING WATER WITH THE USE OF THE MINI-GRADUATION TOWER

Bartłomiej Rospond¹, Joanna Piotrowska¹, Agata Krakowska¹, Elżbieta
Rząsa-Duran², Włodzimierz Opoka¹

¹Jagiellonian University Medical College, Faculty of Pharmacy, Department of
Inorganic and Analytical Chemistry, 9 Medyczna Street, 30-688 Kraków,
Poland

²Regional Pharmaceutical Chamber in Kraków, Kobierzyńska 98 Str.,
30-382 Kraków, Poland

According to Polish law, spring water should come from a documented source, and should be of appropriate quality and verified by microbiologists. More and more attention is paid to the use of spring water for inhalation. It has many positives, it can be used especially in the cough therapy and other respiratory diseases [1]. The aim of the study was to determine the concentration of metal ions such as potassium, magnesium, sodium, zinc which were delivered by inhalation with the use of the prototype device "Mini-graduation tower". With the usage of the aforementioned device, aerosols were produced from the selected spring water types (Stefan Helena Henryk, Franciszek) and the concentration of the metals was measured using Atomic Absorption Spectrometry. The highest concentration was obtained for potassium (1.1 ppm - Helena water), and the lowest for zinc (0.006750 ppm - Słotwinka water). The smallest differences in the content in the investigated waters were obtained for magnesium (0.2837-0.3240 ppm).

References

1. Opoka W, Szłósarczyk M, Maślanka A, Rojowski J, Stopa K, Borkowska I, et al. Some micro- and trace elements in selected bottled natural waters from the Polish market evaluated by electrochemical methods. *Journal of Elementology* 2017;22:463–74. doi:10.5601/jelem.2016.21.4.1164.

**DETERMINATION OF ZINC AND COPPER
IN DERMATOLOGICAL PREPARATIONS WITH
THE ADDITION OF NATURAL RAW MATERIALS**

Agata Kryczyk-Poprawa¹, Justyna Mikołajczyk¹, Elżbieta Rząsa-Duran²,
Joanna Piotrowska¹, Bartłomiej Rospond¹, Bożena Muszyńska³,
Włodzimierz Opoka¹

¹Jagiellonian University Medical College, Faculty of Pharmacy, Department of Inorganic and Analytical Chemistry, Medyczna 9 Str., 30-688 Kraków, Poland

²Branch in Kraków—Hospital Pharmacy, Maria Skłodowska-Curie National Research Institute of Oncology, Garncarska 11 Str., 31-115 Krakow, Poland

³Jagiellonian University Medical College, Faculty of Pharmacy, Department of Pharmaceutical Botany, Medyczna 9 Str., 30-688 Kraków, Poland

Dermatological preparations containing natural raw materials and extracts derived from them are successfully used in many dermatological diseases. Their most important effects are: moisturizing, protective, healing, anti-inflammatory, astringent and antimicrobial. Due to the content of natural ingredients, a high content of bioelements in these preparations is expected.

The aim of this study was to determine two bioelements of zinc and copper in selected dermatological preparations containing natural raw materials that were available in pharmacies and drugstores in Poland using the flame atomic absorption spectrometry method. Ten dermatological preparations in the form of creams, gels or ointments were tested (PD1 - PD-10). Zinc was determined in all tested preparations. The highest content of this element was determined in the PD-4 preparation, which, apart from natural raw materials, also includes zinc oxide itself. The lowest zinc content was found in the PD-8 preparation. The highest copper content was determined in the preparation PD-8 ($2.196 \pm 0.153 \mu\text{g/g}$), and the lowest content in the formulation PD-10 ($0.415 \pm 0.028 \mu\text{g/g}$). The determined concentrations of zinc and copper in the tested preparations may have a positive effect on the functioning of the skin. The presence of zinc in dermatological preparations can reduce skin inflammation, accelerate wound healing and soothe irritation. On the other hand, the

copper content in these preparations may facilitate the regeneration of the epidermis and accelerate the wound healing process.

References

1. Chermahini S.H., Majid F.A.A., Sarmid, M.R.: Cosmeceutical value of herbal extracts as natural ingredients
2. Dattner A.M.: From medical herbalism to phytotherapy in dermatology: back to the future. *Dermatol Ther.* 2003;16(2):106-13.
3. Reuter J., Merfort I., Schempp C.M.: Botanicals in dermatology: an evidence-based review. *Am J Clin Dermatol.* 2010;11(4):247-67.

DRUGS USED IN THE PHARMACOTHERAPY OF THE ORGAN OF LOCOMOTION IN A HUMAN

I. PHARMACOTHERAPY OF THE SPINE

Agnieszka Smok-Wilisowska

Agafarmax Pharmacy

14V/2 Poniatowskiego St., 40-055 Katowice

As the human body ages, changes occur in the functioning of its musculoskeletal system. Among other things, changes appear in the spine resulting not only from advanced age, but also dependent on lifestyle. It often happens that already in young people there are complaints of pain in the spine, mainly in the lumbar and cervical segments, caused by its load resulting from, among other things, many hours of work in a sitting position at a computer, hence they are included in the wide group of so-called civilization diseases. On the other hand, degenerative changes are common in the elderly due to an imbalance between the formation and breakdown of proteoglycans and collagen in intervertebral discs (disks). These changes result from gradual wear and tear of the intervertebral discs. There is then a reduced hydration of the intervertebral discs, which, because of this, lose their elasticity, and the fibrous ring becomes convex. In this case, the biomechanics of the spine is disturbed. Bone outgrowths known as osteophytes may also be produced at the borders of adjacent vertebral bodies. There may also be hypertrophy of the yellow ligament, calcification of the posterior longitudinal ligament, which will exacerbate the symptoms of stenosis. The rate of development of spinal changes is influenced by genetic factors, trauma, metabolic co-morbidities, as well as a very important influence of lifestyle and occupational work. As a result of pathological changes in the spine of an acute or chronic nature, there is usually very intense pain. When a doctor decides to undertake conservative treatment of the spine using, for example, physical therapy or manual therapy (1) at the same time he usually recommends pharmacotherapy to reduce the inflammation or pain that occurs.

In modern medicine and pharmacy, many different drugs are used to affect nociceptors, signal conduction by nerve fibers, or stimulated nerve

cells in the brain centers responsible for the sensation of pain. Drugs with analgesic, anti-inflammatory and antipyretic effects are recommended to combat the sensation of pain present in spinal conditions (2,3). The name of the frequently used non-steroidal anti-inflammatory drugs, abbreviated as NSAIDs or NSAIDs, is derived from the name in English (Non-Steroidal Anti-Inflammatory Drugs, NSAIDs) such as aspirin, indomethacin, ibuprofen, diclofenac, naproxen. The mentioned drugs can be used in osteoarthritis, rheumatoid arthritis, ankylosing spondylitis, tendonitis and synovial bursitis, seronegative spondyloarthropathies, gout attacks, as well as in spinal diseases such as, disc disease or degenerative changes. Most often, an analgesic, anti-inflammatory or antipyretic effect is intended, and the effectiveness of NSAIDs is in the range of 50% to 70%. Nevertheless, it is important to keep in mind the adverse side effects of NSAID drugs, which can be purchased over-the-counter in various forms and dosages. These drugs cause, among other things, damage to the gastric mucosa, disruption of blood flow through the kidneys, there may be epigastric pain, heartburn, nausea and belching, the occurrence of erosions, ulceration of the stomach, and even bleeding and perforation of this organ, so they should be taken under medical supervision.

References

1. Kasperczyk T, Dariusz Mucha D.: Basics of manual therapy. Jet Publishing House, Krakow 2012
2. Filipek B, Nowak G, Sapa J, Opoka W, Bednarski M, Zygmunt M: Elements of general pharmacology and selected issues in pain pharmacotherapy, Krakow 2009.
3. Gadomski A: Nonsteroidal anti-inflammatory drugs in the home medicine cabinet. *Borgis - Med. Family* 2006;2:37-40.

**A CASE REPORT OF THE TREATMENT OF A SUSPECTED
STOMATOGNATHIC DISORDER IN THE MULTISPECIALTY
COOPERATION OF A PHARMACIST AND
A PHYSIOTHERAPIST WITH COEXISTING COMPLAINTS
OF THE TRAPEZIUS MUSCLE**

Dariusz Wilisowski¹, Agnieszka Smok-Wilisowska²

¹Luxdentica Dental Center, Lubostroń 22G LU7 street, 30-383 Kraków

²Pharmacy Agafarmax Poniatowskiego 14 street, 40-959 Katowice

The stomatognathic system (US) is a complex of interacting tissues and organs of the oral cavity and the facial part of the skull, which form a functional whole controlled by the central nervous system(1). Coexisting elements of the system that interact with each other in an abnormal way can lead to dysfunction of any coexisting dependent system in our body. This case report concerns the treatment of a patient aged 32 years complaining of headaches in the temporalis muscle area and pressure soreness at the base of the quadriceps. The patient presented to Luxdentica dental clinic. On physical examination and subject examination, there was increased activity of stress generators and episodes of nocturnal teeth clenching. Pressure soreness was found to be absent in the temporalis and masseter and medial pterygoid muscles. Therapies were centered around decluttering the teeth with the use of a staggered splint and searching for the cause of the complaints in disorders of the US central relationship. In the course of the treatment process, there was no apparent improvement and reduction of pain. At the same time, the patient was referred to a physiotherapist for treatment of complaints from the quadriceps muscle as an adjunct to the therapeutic process. At the same time, pharmacotherapy was prepared to modify the tension of the skeletal muscles if the headaches persisted. At the next follow-up visit to the dentist's office, the patient reported complete resolution of her headaches.

This clinical case shows us how easy it is to divert the doctor's attention from the source of the problem. The patient redirects the doctor's attention to her intractable headache concerns by suspecting nighttime teeth clenching while diverting attention from the source of the cause of

the pain which was the quadriceps. The clinician must always remember that for treatment to be effective it must be directed toward the source the pain, not the site. Therefore, a clinician must always search for the true source of pain (2)

References

- 1 Stanisław Majewski Gnatofizjologia Stomatologiczna Normy Okluzji i Funkcje Układu Stomatognatycznego , PZWL, wyd. 1, 2007 ,23-25
2. Jeffrey P. Okeson Leczenie dysfunkcji Skroniowo-Żuchwowych i Zaburzeń Zwarcia , Czelej , 2018 , 34-35

USING RESTORATIVE APPROACHES IN THE RECOVERY PROCESS OF DEPENDENT FAMILIES

Melinda Imréné Csákányos¹

¹John Wesley Theological Collage, Doctoral School
szabkermelinda@gmail.com

The main topic of this presentation will be a systems approach to families with addiction and an outline of the recovery process for these families in the light of a restorative approach.

The aim of my topic is to demonstrate that involving the whole family in the recovery process of an addicted person is a much greater gain than treating only the addicted member alone. Conflict between the family and the addicted person becomes a positive resource for all family members when each member is involved in restoring balance. To illustrate the family's healing process, I will draw on the techniques of the restorative approach as a method that I am personally familiar with and use in my work. From the outset, I have tried to draw on literature that is prominent in national and international practice on this subject. Finally, I would like to present a study that is relevant to my presentation. I will present research and the best practice carried out in the UK by family support workers using restorative techniques with local care leavers.

MODELS OF ANTIBIOTICS' BIOREMEDIATION

Monika Dąbrowska¹, Joanna Żandarek^{1,2}, Małgorzata Starek¹

¹Department of Inorganic and Analytical Chemistry, Faculty of Pharmacy, Medical College, Jagiellonian University, 9 Medyczna St., 30-688 Kraków, Poland

²Doctoral School of Medical and Health Sciences, Jagiellonian University Medical College, 16 Łazarza St, 31-530, Kraków, Poland
Correspondence: monika.1.dabrowska@uj.edu.pl

Antibiotics are natural, synthetic and semi-synthetic compounds that exhibit antimicrobial activity. Since Alexander Fleming discovered penicillin in 1928, many different antibiotics have been synthesized. Antibiotics have a short existence period, however their hydrophobicity and lipophilic nature result to their persistence in the environment. The residues of antibiotic in surface water can violate the key bacterial cycles, mechanisms, processes, which are essential to aquatic balance and soil fertility agricultural equilibrium.

Bioremediation techniques are the best proper and non-exchangeable methods for cleaning of water ecosystem. Bioremediation, used in the removal of pollutants from environment, is a section of biotechnology which uses living organisms (microbes and bacteria) to disinfect contaminated areas. One way of remediating contaminated ground water or soil is control the subsurface habitat, in order to native microorganisms can biodegrade various contaminants. Biodegradation of antibiotics takes place by biotic and abiotic processes. Biotic pathway is connected with the use of microorganisms, while abiotic requires sorption, hydrolysis, photolysis, oxidation and reduction reactions. Oxidation is the most common and important route of the degradation of antibiotics. The alternative process of photolysis (the degradation of substances by obtaining solar energy) is an equally important way of their degradation.

UV-VIS irradiation can transform antibiotic to another miscellaneous structures, both known and unknown, therefore it is necessary to explore the photolysis residues of parent structures of antibiotics and their impact on the microbial fauna.

Microbial remediation uses variety metabolic strategies responsible for enzyme production, which primarily participated in the degradation of antibiotics. Customary techniques for bioremediation, *in situ* and *ex situ*, are mainly based on the area of bioremediation. *In situ* technique is applied to the site to minimize soil disturbance. The main *in situ* methods are: bioaugmentation, bioventing, biosparging, and engineered *in situ* bioremediation, while *ex situ* are solid phase system (composting, landfarming, and biopiling) and slurry phase system (bioreactors).

Persistent contamination of the environment with antibiotics states as a major pollution threat, and bioremediation is one of solution to removing stubborn pollutants from the environment.

However, traditional bioremediation methods have some limitations, so in order to obtain better results, it is necessary to search for new methods of bioremediation.

References

1. Jaiswal S., Shukla P., *Frontiers in Microbiology*. 2020. 11, 1-14.
2. Umesh B.J., *Antibiotics and Antimicrobial Resistance Genes*. 2020. 319–337.
3. Al-Gheethi A.A.S., Norli I., Lalung J., Megat Azlan A., Nur Farehah Z.A., Omar Ab. Kadir M., *Clean Technologies and Environmental Policy*. 2014. 16,137–148.

COMPARISON OF THE ACTION OF DOCOSAHEXAENOIC ACID AND METFORMIN IN INFLAMED PRE-ADIPOCYTES AND ADIPOCYTES

Joanna Gdula-Argasińska¹, Aitana Colomer Querol², Anna Lipkowska¹,
Tadeusz Librowski¹

¹ Department of Radioligands, Faculty of Pharmacy, Jagiellonian University Medical College, Medyczna 9, 30-688 Kraków, Poland

² Facultat de Farmàcia i Ciències de l'Alimentació, Campus Diagonal, Av. de Joan XXIII, 27-31, 08028 Barcelona, Spain

The research aimed to assess the impact of docosahexaenoic acid (DHA) and/or metformin (MET) on the pro-inflammatory genes and proteins in 3T3-L1 cells activated with lipopolysaccharide (LPS), a pro-inflammatory factor.

Our results suggest that both DHA and MET significantly mitigate adverse effects caused by inflammatory factors in the pre-and adipocytes. The data indicated synergistic anti-inflammatory properties of docosahexaenoic acid and metformin in inflamed adipocytes. Interestingly, the activation of FABP4 and GLUT4 receptor by DHA and MET suggests a unique role of these compounds in regulating adipocyte metabolism and preventing insulin resistance. Moreover, they suggest that a diet rich in n-3 fatty acids can be helpful in the reduction of harmful effects of inflammatory factors in white adipose tissue in obese patients.

Acknowledgment

This work was supported by Jagiellonian University Medical College's statutory activity N42/DBS/000220.

ENVIRONMENTAL IMPACT OF SUNSCREENS

Adrián Sánchez Hidalgo¹, Agata Kryczyk-Poprawa¹, Elżbieta Rząsa-Duran², Bożena Muszyńska³, Włodzimierz Opoka¹

¹Jagiellonian University Medical College, Faculty of Pharmacy, Department of Inorganic and Analytical Chemistry, Medyczna 9 Str., 30-688 Kraków, Poland

²Branch in Kraków—Hospital Pharmacy, Maria Skłodowska-Curie National Research Institute of Oncology, Garncarska 11 Str., 31-115 Krakow, Poland

³Jagiellonian University Medical College, Faculty of Pharmacy, Department of Pharmaceutical Botany, Medyczna 9 Str., 30-688 Kraków, Poland

The risks associated with skin exposure to UV radiation have led to an increasing use of cosmetic products. The prevalence of skin cancer is growing every year and the population has accepted the importance of sun protection, including the use of creams with UV filters. UV filters are widely used in sunscreens and other personal care products. Although its residues have been widely identified in the aquatic environment, little is known about the influence of UV filters on aquatic environments around the world. Sunscreens fall into two categories according to the types of their active ingredients: organic and inorganic ultraviolet (UV) filters and both are detected in natural environment. Due to the progressive pollution of the aquatic environment with sunscreens, there is a threat to the life of living organisms. For this reason Hawaii, due to its harmful effect on coral reefs, recently restricted the use of the two most common organic filters: oxybenzone and octinoxate. Researcher Craig Downs, a cellular and molecular biologist, and his colleagues found in their study that oxybenzone can begin to damage coral at a concentration as low as 0.062 g/L. Oxybenzone bioaccumulates in fish, which has possible consequences for the food chain. This compound can also react with chlorine, producing a dangerous by-product, the concentration of which can increase in swimming pools or in sewage treatment plants. A substance often found in mussels, fish and crustaceans was octyl-methoxycinnamate. High concentrations of octocrylen, homosalt and 2-ethylhexyl salicylate were also observed in marine organisms. On the other hand, camphor derivatives were present in relatively low

concentrations. Despite the above, it is important to continue to emphasize the public health impact of overexposure to the sun and to advise appropriate photoprotection practice by looking for shade, wearing photoprotective clothing (including hats and sunglasses) and the use of appropriate sunscreen.

References

1. Schneider SL, Lim HW. Review of environmental effects of oxybenzone and other sunscreen active ingredients. *J Am Acad Dermatol*. 2019 Jan;80(1):266-271.
2. Siller A, Blaszkak SC, Lazar M, Olasz Harken E. Update About the Effects of the Sunscreen Ingredients Oxybenzone and Octinoxate on Humans and the Environment. *Plast Surg Nurs*. 2019 Oct/Dec;39(4):157-160.
3. Cheryl Hogue. (2016). Hawaii targets sunscreens with oxybenzone. *C&EN Global Enterprise*, 94(36), 16–16.

PRODUCTION OF POLYPHENOLIC COMPOUNDS IN *SCHISANDRA HENRYI* IN VITRO CULTURES MAINTAINED IN PLANTFORM BIOREACTORS

Karolina Jafernik¹, Paweł Kubica¹, Halina Ekiert¹,
Agnieszka Szopa¹

¹Chair and Department of Pharmaceutical Botany, Jagiellonian University,
Medical College, Medyczna 9, 30-688 Kraków, Poland
e-mail: karolina.jafernik@doctoral.uj.edu.pl

Increasingly, a special bioreactors to multiply *in vitro* cultures in plant biotechnology are used. Such cultivation increases the biomass yield and secondary metabolites production scale. The Sweden Plantform bioreactors working as temporary immersion systems (TIS) are used the most frequent for organ cultures [1].

Under this study, the microshoot cultures of a new potential medicinal plant species - *Schisandra henryi* C.B. Clarke, were maintained in Plantform TIS [2].

In the biomass extracts the polyphenolic compounds (phenolic acids and flavonoids) production was estimated. This group of metabolites shows e.g. antioxidant, cardioprotective and anti-inflammatory effects [3].

S. henryi in vitro cultures were cultivated in Murashige and Skoog [4] medium with 2 mg/l indolyl-3-butyric acid and 0.5 mg/l 6-benzyladenine in the 30-day growth cycles (3 series).

The biomass increases were about 5,2-folds.

In the lyophilized microshoot methanol extracts using the DAD-HPLC method, 8 phenolic acids (gallic, caftaric, neochlorogenic, chlorogenic, vanillic, caffeic, syringic and 3,4-dihydroxyphenylacetic acids) and 6 flavonoids (hyperoside, kaempferol, quercitrin, rutinoid, trifolin, quercetin), were quantified [5].

The total content of phenolic acids was equal 288.82 mg/100 g DM. The amounts of individual compounds ranged from 3.46 to 93.62 mg/100 g DM. The dominant were chlorogenic acid (93.62 mg/100g DM) and 3,4-dihydroxyphenylacetic acid (91.41 mg/100g DM).

The total content of flavonoids was equal 78.51 mg/100g DM. The contents of individual compounds ranged from 4.73 to 36.42 mg/100 g DW. The dominant were kaempferol (36.42 mg/100 DW) and trifolin (15.82 mg/100g DW).

The high content of polyphenolic compounds prompts to continue research on the bioactivity of extracts from *S. henryi* microshoots maintained in Plantform bioreactors.

References

1. Szopa A et al. Plant Cell, Tissue Organ Culture, 2019,139, 199-206
2. Szopa A, Barnaś M., Ekiert H, Phytochemistry Reviews, 2019, 18,109-128
3. Handique, J. G., & Baruah, J. B. Reactive and Functional Polymers, 2002, 52, 163–188.t
4. Murashige, T., & Skoog, F. Physiologia Plantarum, 1962, 15, 473–497.
5. Ellnain-Wojtaszek, M., & Zgorka, G. Journal of Liquid Chromatography and Related Technologies, 1999, 22, 1457–1471.

Acknowledgment

Funded by: National Science Center, 2020/37/N/NZ7/02436

SPORTS PHARMACY IN PERSPECTIVE ON OTC DRUG SAFETY IN ELITE AND NON-ELITE ATHLETES

Karol Jędrejko¹, Ashley Anderson², Bożena Muszyńska¹

¹Jagiellonian University Medical College, Faculty of Pharmacy, Department of Pharmaceutical Botany, Medyczna 9 Str., 30-688 Kraków, Poland

²International Sports Pharmacists Network, Fort Collins, Colorado, United States

The use of over-the-counter (OTC) drugs is common in the sports environment and in the general population. Also, the use of dietary supplements or other agents to support psychomotor skills (ergogenic effect) is a popular phenomenon among elite and non-elite athletes. Non-elite athletes who use OTC medications and dietary supplements are a large and heterogeneous group, with specific subgroups covered e.g. military personnel/soldiers and college students. Pharmacists are highly educated on drugs and already well-positioned to guide consumers selection of self-treatment and supplementation. Sports pharmacists safeguard athletes health by advising against inappropriate selection or misuse of drugs. Sports pharmacy clinical specialists also investigate drug safety and effectiveness for athletes, intervene on clinically significant drug interactions, and review drug impact on exercise capacity (improvement or deterioration on exercise performance) in elite and non-elite athletes. Sports pharmacists watch for trends in use, aware that some athletes may misuse OTC medications with the belief that these will improve exercise capacity. Pharmacists should evaluate patient perception, as this belief may be formed by modeling elite athletes, from false marketing, or from anecdotal reports lacking scientific evidence. N-acetylcysteine (also called NAC) found in cough remedies, is a potential candidate for off-label use to support exercise performance. Athletes frequently self-treat musculoskeletal pain with high dose non-steroidal anti-inflammatory drugs (NSAIDs) though risks may outweigh the benefit of use for some sporting individuals. Excessive or long-term application of NSAIDs, like ibuprofen or naproxen may cause acute abdominal pain or cramps. Gastrointestinal pain may disrupt training or competing in tournaments but could potentially indicate a more serious adverse drug event that requires medical evaluation. The World Anti-

Doping Agency (WADA) and associated drug databases provide examples of active pharmaceutical ingredients in OTC medications or supplements prohibited in sport. Dehydroepiandrosterone (DHEA), classified by WADA in S1 category (Anabolic Agents), recommended as an adjuvant in the treatment of andropause in men, may not be recognized by some athletes as prohibited substances. Multi-ingredient cough, flu and cold products present a higher-risk category for elite and non-elite athletes when these contain pseudoephedrine, a popular active compound in decongestants and listed in WADA S6 category (Stimulants). Likewise, nikethamide an OTC analeptic, cardiac and respiratory stimulant found in oral liquid or lozenges has potential for misuse. Nicotine and phenylephrine were covered by WADA Monitoring Program. Selected OTC medications can have negative effects on human psychomotor performance (sometimes called ergolytic), making physical activity difficult or impossible. Dextromethorphan in cough suppressant medication may impair psychomotor skills. First-generation antihistamines drugs indicated for treatment of allergies (chlorpheniramine) or motion sickness (dimenhydrinate) are examples, due to the sedative effect. OTC medications containing codeine, an antitussive or analgesic, is also sedating, but takes the keen knowledge of a sports pharmacist to recognize its status in sports, as some prohibited lists may ban the use entirely, but WADA does not. Codeine is found on the WADA Monitoring Program but is not prohibited by WADA despite its active metabolite – morphine, being listed. Pharmacists trained to work with athletes can help improve safe drug use for this consumer group.

References

1. Locquet, Médéa, et al. "Self-administration of medicines and dietary supplements among female amateur runners: a cross-sectional analysis." *Advances in Therapy* 33.12 (2016): 2257-2268.
2. International Olympic Committee (IOC). IOC Certificate in Drugs in Sport [Internet]. Available from: <https://www.sportsoracle.com/course/ioc-certificate-in-drugs-in-sport/> Accessed: 21 August 2022.
3. Bomfim, José Henrique Gialongo Gonçalves. "Pharmaceutical Care in Sports." *Pharmacy* 8.4 (2020): 218.

4. Rhodes, Kate, and Andrea Braakhuis. "Performance and side effects of supplementation with N-acetylcysteine: a systematic review and meta-analysis." *Sports Medicine* 47.8 (2017): 1619-1636.
5. Hainline, Brian, et al. "International Olympic Committee consensus statement on pain management in elite athletes." *British Journal of Sports Medicine* 51.17 (2017): 1245-1258.
6. World Anti-Doping Agency (WADA). *The Prohibited List 2022* [Internet]. Available from: <https://www.wada-ama.org/> Accessed: 21 August 2022.
7. The Global Drug Reference Online (Global DRO) [Internet]. Available from: <https://www.globaldro.com/Home> Accessed: 21 August 2022.
8. Collomp, K., et al. "DHEA, physical exercise and doping." *The Journal of steroid biochemistry and molecular biology* 145 (2015): 206-212.
9. Adami, Paolo Emilio, et al. "Cardiovascular effects of doping substances, commonly prescribed medications and ergogenic aids in relation to sports: a position statement of the sport cardiology and exercise nucleus of the European Association of Preventive Cardiology." *European Journal of Preventive Cardiology* 29.3 (2022): 559-575.
10. Peppin, John F., et al. "History of Respiratory Stimulants." *Journal of pain research* 14 (2021): 1043.
11. Caslavská, Jitka, and Wolfgang Thormann. "Bioanalysis of drugs and their metabolites by chiral electromigration techniques (2010–2020)." *Electrophoresis* 42.17-18 (2021): 1744-1760.
12. Schifano, Fabrizio, et al. "Focus on over-the-counter drugs' misuse: a systematic review on antihistamines, cough medicines, and decongestants." *Frontiers in psychiatry* 12 (2021): 458.
13. Zandonai, Thomas, Mónica Escorial, and Ana M. Peiró. "Codeine and tramadol use in athletes: a potential for abuse." *Frontiers in pharmacology* (2021): 1383.

CORDYCEPS AND CORDYCEPIN IMPACT ON BONE FUNCTIONS

Karol Jędrejko¹, Katarzyna Kała¹, Jolanta Pytko-Polończyk², Bożena Muszyńska¹

¹Jagiellonian University Medical College, Faculty of Pharmacy, Department of Pharmaceutical Botany, Medyczna 9 Str., 30-688 Kraków, Poland.

²Jagiellonian University Medical College, Faculty of Medicine, Chair and Department of Integrated Dentis-15 try, 4 Montelupich Street, 31-155 Kraków, Poland.

On animal experiment, showed that *Cordyceps* spp. and cordycepin, interacts via adenosine receptors (AR), AMPK, ATP signaling pathway. Demonstrated immunostimulatory, anti-inflammatory, anti-tumor, ergogenic activities [1, 2]. Among the many various biological activities attributed to *Cordyceps* spp. and cordycepin, the effects on bone functions still require future research [3]. Impact on purinergic signaling such as adenosine receptors (AR) may contribute to regulate proliferation, differentiation of dental pulp stem cells or bone marrow, modulate osteogenesis and repair of bone. In vitro test showed that selective stimulation of A₁R contribute to greater differentiation of dental pulp stem cells into osteoblasts. Selected agonist of A₁R was related to the activation of the phosphatidylinositol 3-kinase (PI3K)/Akt and the mitogen-activated kinase (MAPK) pathways [4]. In rats demonstrated that 8 weeks oral administration of doses 300 or 500 mg/kg/day *Cordyceps sinensis* extract (content cordycepin 5.27 µg/g) contribute to increase of bone mineral density and prevent disuse-induced bone loss [5].

An *in vitro* test demonstrated that cordycepin (isolated from *Cordyceps militaris*) in concentration at 50 µg/mL decreases activity of alkaline phosphatase (ALP) and tartrate resistant acid phosphatase (TRAP). On *in vitro* test cordycepin (at concentration 10 µg/mL) promotes osteogenesis of bone marrow mesenchymal stem cells. An *in vivo* experiment demonstrated that cordycepin (in dose 10 mg/kg/day) promotes and accelerates fracture healing via hypoxia in the rat model of closed femoral fracture [6].

In recent years, also focused on the effects of cordycepin on bone tissue or dental pulp stem cells. In relations to osteogenesis, was shown that cordycepin increase expression of runt-related transcription factor 2 (RUNX2), collagen, type I, alpha 1 (COL1A1), transcription factor Sp7/Osterix (OSX) and bone gamma-carboxyglutamic acid-containing protein/osteocalcin (OCN) genes [7]. Cordycepin can influence on the migratory ability of dental pulp stem cells. Cordycepin in dose at 1 μ M, 2.5 μ M and 5 μ M can increase the number of stem cells, and did not impact on the viability of dental pulp stem cells [8].

References

1. Boontiam, Waewaree, Chalong Wachirapakorn, and Suchat Wattanachai. Growth performance and hematological changes in growing pigs treated with *Cordyceps militaris* spent mushroom substrate. *Veterinary World* 13.4 (2020): 768.
2. Boontiam, Waewaree, et al. Effect of Spent Mushroom (*Cordyceps militaris*) on Growth Performance, Immunity, and Intestinal Microflora in Weaning Pigs. *Animals* 10.12 (2020): 2360.
3. Lindequist, Ulrike, and Beate Haertel. Medicinal Mushrooms for Prevention and Therapy of Osteoporosis." *International Journal of Medicinal Mushrooms* (2021)23.4
4. D'Alimonte, Iolanda, et al. Adenosine A1 receptor stimulation enhances osteogenic differentiation of human dental pulp-derived mesenchymal stem cells via WNT signaling. *Stem cell research* 11.1 (2013). 611-624.
5. Qi, W., et al. Prevention of disuse osteoporosis in rats by *Cordyceps sinensis* extract *Osteoporosis International* 23.9 (2012). 2347-2357.
6. Li, Zhengzhao, et al. Cordycepin promotes osteogenesis of bone marrow-derived mesenchymal stem cells and accelerates fracture healing via hypoxia in a rat model of closed femur fracture. *Biomedicine & Pharmacotherapy* 125 (2020). 109991.
7. Patil, Shankargouda, et al. Adipogenic stimulation and pyrrolidine dithiocarbamate induced osteogenic inhibition of dental pulp stem cells is countered by cordycepin. *Journal of Personalized Medicine* 11.9 (2021). 915.
8. Boreak, Nezar, et al. Dose-Dependent Effect of Cordycepin on Viability, Proliferation, Cell Cycle, and Migration in Dental Pulp Stem Cells. *Journal of Personalized Medicine* 11.8 (2021). 718.

ANTIOXIDANT SUBSTANCES IN DIETARY SUPPLEMENTS CONTAINING *CORDYCEPS MILITARIS*

Katarzyna Kała¹, Katarzyna Sułkowska-Ziaja¹, Jan Lazur¹, Agnieszka Szewczyk¹, Joanna Piotrowska², Bartłomiej Rospond², Bożena Muszyńska¹

¹Department of Pharmaceutical Botany, Faculty of Pharmacy, Jagiellonian University Medical College, Medyczna 9 Str., 30-688 Kraków, Poland

²Department of Inorganic and Analytical Chemistry, Faculty of Pharmacy, Jagiellonian University Medical College, Medyczna 9 Str., 30-688 Kraków, Poland

Cordyceps militaris belongs to the Cordycipitaceae family. It comes from Asia and owes its popularity to its healing, antioxidant and physical endurance properties. In addition, it has anti-inflammatory, anti-cancer and immunomodulatory properties. Due to its similarity to *C. sinensis*, it has been used as an alternative raw material that is cheaper and easier to grow.

The aim of work was extraction *C. militaris* preparations for qualitative and quantitative analysis by the RP-HPLC. Using these methods, the amount of antioxidant substances in dietary supplements such as cordycepine, ergothioneine, lovastatin, sterols, indole compounds, kojic acid, and phenolic compounds was determined. Additionally, the content of bioelements by F–AAS methods was estimated.

In all the tested samples, the presence of two main substances with antioxidant activity were found – cordycepin and ergothioneine. Quantitative analysis has shown that the amounts of determined substances in dietary supplements can have an anti-free radical effect and prevent the aging of the body. It has also been shown that the addition of cordycepine may increase the amount of individual bioelements.

The form of used dietary supplements may be important when it comes to the content of individual compounds, because enriched extracts turned out to be the most valuable in terms of biologically active substances present in them. Based on the qualitative and quantitative analysis of dietary supplements in the form of capsules, it has been shown

that they do not contain only powdered *C. militaris* fruiting bodies and may contain additional substances, e.g. fillers, which reduce their antioxidant effect. After analyzing the content of biologically active compounds, as well as their antioxidant potential, it can be concluded that the best choice in the fight against aging of the skin and the human body are preparations containing extracts of *C. militaris* fruiting bodies enriched with cordycepin.

References

1. Fijałkowska, A., Jędrejko, K., Sułkowska-Ziaja, K., Ziaja, M., Kała, K., Muszyńska, B. 2022. Edible mushrooms as a potential component of dietary interventions for major depressive disorder. *Foods*, 11, 1489.

BIOREMEDIATION OF IBUPROFEN AND KETOPROFEN BY IMMOBILIZED *IN VITRO* CULTURES OF *CHLORELLA VULGARIS*

Jan Lazur¹, Katarzyna Sułkowska–Ziaja¹, Paweł Żmudzki², Bożena Muszyńska¹

¹ Jagiellonian University Medical College, Faculty of Pharmacy, Department of Pharmaceutical Botany, Medyczna 9 Str., 30-688 Kraków, Poland

² Jagiellonian University Medical College, Faculty of Pharmacy, Department of Medicinal Chemistry, Medyczna 9 Str., 30-688 Kraków, Poland

The presence of drugs and their metabolites in the natural environment is a threat to organisms for which it is their habitat and indirectly to humans. Some drugs are characterized by high resistance to conventional methods of disposal, e.g. photodegradation or ozonation, therefore the search for more effective methods of neutralizing pharmaceutical contaminants is a challenge for scientists in the 21st century. [1]

The aim of this study was to compare the effectiveness of bioremediation of selected non-steroidal drugs – ibuprofen and ketoprofen by immobilized and control *in vitro* cultures of freshwater microalgae *Chlorella vulgaris*. The effectiveness of bioremediation was determined based on the analysis of the remaining amount of these compounds in the culture medium using the RP-HPLC method.

Additionally, the analysis of the decomposition products in the culture medium after the completed bioremediation process using the UPLC-MS/MS method was performed.

The comparison of the effectiveness of ibuprofen and ketoprofen bioremediation between control and immobilized *in vitro* cultures was performed for the first time.

The *in vitro* cultures of *C. vulgaris* were found to be effective in removing ibuprofen from the culture medium, whether they were control or immobilized *in vitro* cultures. The likely bioremediation mechanism in this case is bioaccumulation with ibuprofen utilization as part of

cometabolism. Ketoprofen was not effectively removed from the culture medium by *in vitro* cultures of *C. vulgaris* regardless of the method of cultivation. The likely bioremediation mechanism of this compound is adsorption on the surface of the microalgae cell wall.

References

1. Bai X, Acharya K Sci Total Environ 2017, 581–582:734–740

ASSESSMENT OF ZINC CONTENT IN PREPARATIONS WITH THE ADDITION OF NATURAL RAW MATERIALS SUPPORTING THE THERAPY OF DIABETES

Anna Maj¹, Agata Kryczyk-Poprawa¹, Elżbieta Rząsa-Duran², Joanna Piotrowska¹, Bożena Muszyńska³, Włodzimierz Opoka¹

¹Jagiellonian University Medical College, Faculty of Pharmacy, Department of Inorganic and Analytical Chemistry, Medyczna 9 Str., 30-688 Kraków, Poland

²Branch in Kraków—Hospital Pharmacy, Maria Skłodowska-Curie National Research Institute of Oncology, Garncarska 11 Str., 31-115 Krakow, Poland

³Jagiellonian University Medical College, Faculty of Pharmacy, Department of Pharmaceutical Botany, Medyczna 9 Str., 30-688 Kraków, Poland

Diabetes mellitus is a group of civilization diseases and it is closely related to the development of human lifestyle and diet. Nowadays, the number of people with type 2 diabetes is increasing rapidly due to the aging population, unhealthy eating habits, lack of physical activity and obesity associated with it. Diabetes is a major cause of blindness, kidney failure, heart attacks, stroke and lower limb amputation.

Bioelement which plays an important role in maintaining normal blood glucose levels is zinc. Numerous studies have shown a beneficial effect of zinc supplementation in patients with type 2 diabetes because it is involved in the synthesis, storage and secretion of insulin, reduces insulin resistance, and reduces glycated hemoglobin (HbA1c) and insulin levels. For zinc, the recommended daily intake is 8 mg/day for women and 11 mg/day for men, regardless of the age of adults. In addition to diet and exercise, diabetes prevention also includes the use of dietary supplements, which contain, among others, plant-derived substances such as: barberry extracts (*Berberis spp.*), banaba leaf extract (*Lagerstroemia speciosa*), gurmar leaf extract (*Gymnema sylvestre*), white mulberry leaf extract (*Morus alba*), Chinese cinnamon bark extract (*Cinnamomum cassia*), and edible mushrooms. Raw material compositions of dietary supplements can be very diverse, but plant extracts and selected micro- and macro-elements are usually used. Seven preparations (symbols: S1-S7) of various companies purchased in a pharmacy in Poland were tested, available in

the form of tablets, capsules or herbal teas. Zinc was determined in all tested preparations. The highest amount of zinc was determined in the dietary supplement S1 amounts to 1.5496 ± 0.08 mg for tablet, while the smallest amount was determined in the preparation S2 in which the zinc content was 0.0528 ± 0.003 mg for tablet. Taking the tested dietary supplements as recommended will not exceed the recommended daily intake. During the measurement of the weight of tablets, capsules or sachets, differences in their weights were found: the largest differences in weights were found in the S6 preparation (15.16%), and the smallest was found for the S3 preparation (2.44%).

References

1. Roohani N., Hurrell R., Kelishadi R., Schulin R.: Zinc and its importance for human health: An integrative review. *J Res Med Sci.* 2013 Feb;18(2):144-57
2. Gapys B., Raszeja-Specht A., Bielarczyk H.: Rola cynku w procesach fizjologicznych i patologicznych organizmu. *J Lab Diagnostics* 2014; 50 (1), s. 45–52. PZWL Wydawnictwo Lekarskie 2018
3. Noormagi A., Gavrilova J., Smirnova J., Tougu V., Palumaa P.: Zn (II) ions co-secreted with insulin suppress inherent amyloidogenic properties of monomeric insulin. *Biochem J.* 2010, 430: 511-518

AMANITA SP. AS INEDIBLE SPECIES OF POTENTIAL MEDICINAL IMPORTANCE

Marcin Mól¹, Katarzyna Sułkowska-Ziaja², Katarzyna Kała²,
Piotr Zięba³, Agnieszka Szewczyk², Bożena Muszyńska²

¹Molpharma Cosmetics&Drugs, Sportowa 7 Str., 43-450 Ustroń, Poland

²Department of Pharmaceutical Botany, Faculty of Pharmacy, Jagiellonian
University Medical College, Medyczna 9 Str., 30-688 Kraków, Poland

³Department of Horticulture, Faculty of Biotechnology and Horticulture,
University of Agriculture in Kraków, 29 Listopada 54 Str., 31-425 Kraków,
Poland

More than 2.000 species of mushrooms are now considered edible and about 700 mushroom species have documented medicinal or health-promoting properties (according to the described list of medicinal mushrooms). Dietary properties and their effectiveness in the prevention and treatment of diseases including civilization and chronic diseases have been proven. They have immunostimulatory, antioxidant, antidepressant, antiatherosclerotic, antidiabetic, and antimicrobial effects, thus positively affecting human health. Among medicinal species, there are also mushrooms that are inedible, but contain unique substances that, when isolated, exhibit medicinal effects. One such compound is muscimol found in *Amanita* sp.

The aim of this study was to analyze the composition of bioactive substances in two species: *Amanita muscaria* and *Amanita panterina*. To perform the analyses, an HPLC method with both UV and DAD detection was used. Compounds such as muscimol, ibotenic acid, ergosterol, ergosterol peroxide, lovastatin, ergothioneine, as well as indole compounds such as: 5-hydroxy-L-tryptophan, L-tryptophan, tryptamine, 5-methyltryptamine and melatonin were tested. The material for the research was obtained in the form of fruiting bodies and mycelium from *in vitro* cultures of both analyzed species.

Comparing the content of bioactive compounds in the analyzed material, it turned out that in the case of most of the analyzed bioactive compounds, *Amanita muscaria* fruiting bodies were the best source of

them. However, for two of the indole compounds analysed – tryptamine and melatonin – the highest amounts of them (0.06 and 10.5 mg/100 g d.w., respectively) were determined in mycelial cultures of *Amanita muscaria*. Mycelial cultures of *Amanita pantherina*, on the other hand, proved to be the best source of 5-methyltryptamine. Muscymol, which is one of the characteristic substances of *Amanita* sp. was determined in amounts ranging from 0.05 to 0.69 mg/100 g d.w.

In conclusion, it has been successfully demonstrated that substances with medicinal potential can also be isolated from fruiting bodies and mycelial cultures of inedible mushrooms. In addition, material obtained under laboratory conditions can provide a competitive source of determined substances.

References

1. Voynova, M., Shkondrov, A., Kondeva-Burdina, M., Krasteva I. 2020. Toxicological and pharmacological profile of *Amanita muscaria* (L.)

NANOCARRIERS AS A METHOD OF ENHANCING THE THERAPEUTIC EFFECT OF A DRUG

Małgorzata Starek¹, Paweł Gumułka^{1,2}, Monika Dąbrowska¹

¹Department of Inorganic and Analytical Chemistry, Faculty of Pharmacy,
Jagiellonian University Medical College, 9 Medyczna St, 30-688, Kraków,
Poland

²Doctoral School of Medical and Health Sciences, Jagiellonian University
Medical College, 16 Łazarza St, 31-530, Kraków, Poland

Nanotechnology is an interdisciplinary field of science that deals with the design and manufacture of materials and structures with nanometric dimensions, i.e. up to 100 nm. It is one of the most dynamically developing fields of science and technology. The beginnings of the development of nanotechnology date back to the 1950s, when R. Feynman presented the concept of miniaturization and the possibilities of using technology that can operate at the nanometer level. The following years marked the dynamic development of nanotechnology: the first tunnel microscope enabling the study of nanoparticles was constructed, fullerenes, carbon nanotubes and quantum dots were discovered [1]. Later studies concerned the use of nanoparticles in the diagnosis and therapy of many diseases, including cancer or targeted therapy. Nanoparticles include all nano-scale structures, including also particulate inorganic materials, e.g. silver, gold, copper, titanium dioxide, zinc oxide. Research on the nanoparticles structure has shown that their properties change with miniaturization. For example, silver nanoparticles have strong antibacterial properties, and they can be used in eg. dressing materials [2]. The therapeutic effect of each drug is possible due to the proper interaction of the molecule on the therapeutic target. Often, however, the target is protected by certain biological barriers or the drug molecule does not have the appropriate physicochemical properties. The solution to this problem can be achieved, for example, by binding the drug on specially designed nanocarriers [3]. The immobilization of drugs on nanocarriers is carried out through the use of physical processes: adsorption, absorption and encapsulation, and chemical processes: covalent, ionic, van der Waals bonds. Biologically active compounds are transported by liposomes, micelles, dendrimers or carbon nanotubes. The benefits of using such modifications are, for example, better solubility, increased permeability

through biological barriers, increased resistance to degradation, possibility of prolonged action, reduction of toxicity. For example, gold nanoparticles are used in the diagnosis of HIV, silver nanoparticles in ACTICOAT bandages, quantum dots in flow cytometry, carbon nanotubes in the diagnosis of the respiratory system, dendrimers in the treatment of cancer [4]. The biologically active substances closed in liposomes include, among others proteins (eg. elastin, collagen), plant extracts (eg. aloe, ginseng), synthetic compounds (eg. vitamins, caffeine), and other (eg. heparin, glutathione) [5]. They also include antifungal agents, wound healing accelerators, anti-inflammatory and analgesic agents, which, when given in the form of a liposome, have a longer duration of action [6].

References

1. Priestly BG., *Med. J. Aust.* 2007, 186, 187-188.
2. Lansdown AB., *Curr. Probl. Dermatol.* 2006, 33, 17-34.
3. Arruebo M., et al. *Nanotaday* 2007, 2(3), 22-32.
4. Rzeszutek J., et al., *Hygeia Pub. Health*, 2014, 49, 449-457.
5. Kolhe P., et al. *Int. J. Pharm.* 2003, 259, 143-160.
6. Żwawiak J., Sowa-Kasprzak K., *Farmacja współcz.* 2014, 7, 1-8.

ANALYSIS OF THE POSSIBILITY OF REMOVING NSAID RESIDUES FROM THE ENVIRONMENT

Małgorzata Starek¹, Monika Dąbrowska

¹Department of Inorganic and Analytical Chemistry, Faculty of Pharmacy,
Jagiellonian University Medical College, 9 Medyczna St, 30-688, Kraków,
Poland

Nowadays, compounds which exhibit toxic properties despite very low concentrations are a serious threat to aquatic ecosystems. These include substances found in, inter alia, in hygienic preparations, cosmetics, industrial chemistry, pharmaceutical preparations. It is estimated that around 4,000 pharmaceutical products are currently used worldwide, and the production of active pharmaceutical ingredients (API) exceeds 100,000 tons per year [1]. Active ingredients of drugs, after getting into the natural environment, undergo transformation into simpler forms. The rate of decomposition depends on the environment, structure and properties of the drugs. Environmental pollution with such substances results from the failure to adapt conventional wastewater treatment plants to their disposal. Therefore, the treated sewage (with the use of activated sludge) contains drug residues both in the initial form of active substances and their metabolites [2]. The most common wastewater receivers are surface water, most of which is a source of drinking water. Over 3,500 pharmaceutical substances have been identified in surface waters and wastewater treatment plants. Among them, the largest group was non-steroidal anti-inflammatory drugs (NSAIDs), a group of drugs that are mostly available over the counter [3].

Pharmaceuticals contained in the mixture may undergo biotic (eg. biotransformation, biodegradation) and abiotic (eg. photodegradation, phototransformation) processes. The most frequently observed processes enabling the degradation of API in the aquatic environment include: biodegradation (aerobic, anaerobic), metabolic degradation, transformation under the influence of aquatic organisms, adsorption on particles suspended in water, sedimentation at the bottom of a water reservoir, photodegradation and phototransformation [4].

The effectiveness of many of these methods depends on the interaction of drugs with solid particles, and the physicochemical properties of the drug. Most NSAIDs are acidic drugs that are poorly adsorbed and circulate in the water phase. When the natural API biodegradation is very slow or not at all, biostimulation is used. It consists in stimulating the development of indigenous microflora by introducing nutrients and electron acceptors into the environment. Basically, the methods of removing NSAIDs from the aquatic environment can be divided into the following groups: biological - based on the phenomenon of biodegradation; physical - consisting in adsorption and filtration processes, and chemical - based on eg. on oxidation processes [5].

References

1. Boxall AB. et al., Environ. Health Perspect. 2012, 120, 1221-1229.
2. Pereira AM. et al., Environ. Res. 2015, 136, 108-119.
3. Aissaoui S. et al., Iran. J. Biotechnol. 2017, 15, 135-142.
4. Rosenberg E., Analytical techniques for the determination of organic and metal-organic analytes, CRC Press, 2009.
5. Taheran M. et al., Sci. Total Environ., 2016, 547, 60-77.

BIOACTIVE SECONDARY METABOLITES IN MYCELIAL CULTURES OF MEDICINAL MUSHROOM – *INONOTUS OBLIQUUS*

Katarzyna Sułkowska-Ziaja¹, Justyna Robak¹, Andrzej Szczepkowski², Katarzyna Kała¹, Joanna Piotrowska³, Bartłomiej Rospond³, Agnieszka Szewczyk¹, Bożena Muszyńska¹

¹Department of Pharmaceutical Botany, Faculty of Pharmacy, Jagiellonian University Medical College, Medyczna 9, 30-688 Kraków, Poland

²Department of Forest Protection, Institute of Forest Sciences, Warsaw University of Life Sciences – SGGW, Nowoursynowska 159, 02-787 Warsaw, Poland

³Department of Inorganic Chemistry, Faculty of Pharmacy, Jagiellonian University Medical College, Medyczna 9 Str., 30-688, Kraków, Poland

Arboreal mushrooms, can biosynthesize bioactive compounds with a wide spectrum of activity¹. *Inonotus obliquus*/Chaga is a rich source of secondary metabolites – phenolic acids, triterpenes, sterols and indole compounds in biomass obtained *in vitro*². The aim of the study was the qualitative and quantitative analysis of secondary metabolites and bioelements present in mycelial cultures obtained from different host species on which the mushroom organism grows. The objects of the study were mycelial cultures of Chaga, derived from steril conks collected from three species of deciduous trees: *Betula pendula*, *Alnus glutinosa*, and *Carpinus betulus*. Initial cultures were conducted on two types of media (agar-maltose medium without and/or with the addition of birch wood). Experimental cultures were conducted in 2 L bioreactors on the 10-day growth cycle on a modified, liquid, universal medium according to Oddoux. Bioelements were determined by FAAS and FAES methods. The qualitative and quantitative analysis of phenolic acids, indole compounds, sterols, and triterpenes was determined by HPLC-DAD. In the extracts was confirmed the presence of triterpenes – betulin, betulinic acid; sterols – ergosterol, lanosterol, ergosterol peroxide; phenolic acids – 3,4-dihydroxyphenylacetic acid, gallic acid, p-hydroxybenzoic acid, protocatechuic acid; indole compounds – 5-hydroxy-L-tryptophan, 5-methyltryptamine, L-tryptophan, and bioelements – sodium, potassium, magnesium, calcium, zinc, manganese, iron and copper. It was shown that the host species from which *Inonotus obliquus* was obtained and the type

of culture medium influence the content of bioactive substances in the obtained biomass. Mycelial cultures can be proposed as a potential source of compounds with applications in the prevention of various diseases and for the supplementation of specific components.

References

1. Szczepkowski A. Biology and medicinal properties of the chaga mushroom *Inonotus obliquus* (Fr) Pilát. *Sylvan* 2013; 157 (3), 223–33.
2. Glamočlija J., Ćirić A., Nikolić M., Fernandes Â., Barros L., Calhelha R.C. Chemical characterization and biological activity of Chaga (*Inonotus obliquus*), a medicinal mushroom. *Journal of Ethnopharmacology* 2015; 162, 323–32.

NATURAL COMPOUNDS USED IN SKIN DISCOLORATION

Katarzyna Sułkowska-Ziaja¹, Gabriela Legutko¹, Agnieszka Gunia-Krzyżak², Katarzyna Kała¹, Bożena Muszyńska¹

¹Department of Pharmaceutical Botany, Faculty of Pharmacy, Jagiellonian University Medical College, Medyczna 9 Str., 30-688 Kraków, Poland

²Department of Bioorganic Chemistry, Chair of Organic Chemistry, Faculty of Pharmacy, Jagiellonian University Medical College, Medyczna 9 Str., 30-688 Kraków, Poland

Due to the increasing phenomenon of abnormal skin pigmentation, the cosmetic industry is constantly looking for effective means to eliminate this type of dysfunction. The beneficial effects of compounds of natural origin on the skin have been known for centuries, and the intensive progress of scientific research on the effects of extracts and the active compounds they contain on the skin provides irrefutable evidence of the effectiveness of these substances in improving skin tone.

Nowadays, the most widely used natural ingredients in cosmetic preparations are extracts and single compounds of plant origin. Plant extracts have gained great popularity due to their effectiveness. *In vitro* and *in vivo* studies conducted on bioactive plant compounds are increasingly proving their effectiveness in treating hyperpigmentation¹. Natural whitening substances have been proven to affect different levels of melanin production in the skin.

Modern cosmetology, based on both traditional medicine experience and research on the chemical composition of fruiting bodies, has seen great potential among mushrooms representatives. It has been proven that the ability to inhibit the activity of the enzyme tyrosinase, by extracts or isolated single compounds obtained from mushrooms is not often higher than the bleaching substances commonly used in medicine and cosmetics. In light of this, it seems important to conduct research on the effectiveness and safety of extracts and compounds of natural origin, including those from mushrooms, whose potential is currently not fully exploited. Numerous data confirmed by scientific studies confirm that these extracts

are potential candidates for the development of pharmaceutical and cosmetic products for skin whitening².

References

1. Parvez S., Kang M., Chung H.S., Bae H. 2007. Naturally Occurring Tyrosinase Inhibitors: Mechanism and Applications in Skin Health, Cosmetics and Agriculture Industries. *Phytotherapy Research*, 21(9): 805–816.
2. Wu Y., Choi M.H., Li J., Yang J., Yang H., Shin H.J. 2016. Mushroom Cosmetics: The Present and Future. *Cosmetics*, 3(3): 22.

**MELITTIS MELISSOPHYLLUM L. SHOOT CULTURES
AS A SOURCE OF SECONDARY METABOLITES
WITH BIOLOGICAL ACTIVITIES**

Ewa Skrzypczak-Pietraszek¹, Hanna Przyczyna¹, Kamila Suchanek¹,
Agnieszka Szewczyk¹

¹Department of Pharmaceutical Botany, Jagiellonian University, Medical
College, Medyczna 9, 30-688 Kraków, Poland

M. melissophyllum L. (Lamiaceae) contains secondary metabolites with diverse biological activities. Plant *in vitro* cultures can be used as an alternative source of active compounds. The aim of the study was to run the shoot cultures in agitated flasks and in Plantform™ bioreactors to investigate the effect of plant growth regulators, sucrose and phosphate content and L-phenylalanine supplementation on the accumulation of secondary metabolites in the shoot biomass. Qualitative and quantitative analysis of phenolic acids and flavonoids was performed by DAD-HPLC. Eight phenolic acids (protocatechuic, chlorogenic, vanillic, *p*-coumaric, ferulic, *m*-coumaric, *o*-coumaric, rosmarinic acid) and four flavonoids (cinaroside, rutoside, quercitrin, apigenin) were found in extracts from the biomass. The obtained amounts of secondary metabolites were many times higher than their contents in the ground plant. The shoot cultures of *M. melissophyllum* could potentially be a rich source of secondary metabolites with therapeutic activity.

RESEARCH ON *IN VITRO* CULTURES OF *RUTA MONTANA* IN PLANTFORM® BIOREACTORS

Agnieszka Szewczyk¹, Monika Trepa², Dominika Zych²

¹Chair and Department of Pharmaceutical Botany, Jagiellonian University
Medical College, Medyczna 9 str, 30-688, Cracow

²SSG of Medicinal Plants and Mushroom Biotechnology Department of
Pharmaceutical Botany, Jagiellonian University Medical College, Medyczna 9
str, 30-688, Cracow

In the present study, *in vitro* cultures of *Ruta montana* were conducted in Plantform® bioreactors. The aim of the study was to evaluate the effect of growth cycle (5 and 6 weeks) and plant growth regulators (auxine: NAA, cytokinin: BAP) at concentrations: 0.1/0.1, 0.1/0.5, 0.5/0.5, 0.5/1.0 and 1.0/1.0 mg/L on biomass growth and secondary metabolites accumulation. HPLC analysis of the prepared methanolic extracts revealed the presence of compounds from the coumarin, alkaloid and catechin groups. The qualitative and quantitative analyses were conducted for following metabolites: catechin, psoralen, xanthotoxin, bergapten, osthole, isopimpinellin, isoimperatorin, γ -fagarine, skimmianine and isopentyloxy- γ -fagarine. Coumarins were the main secondary metabolites (maximum total content 2046.8 mg/100 g d.m.), and among them xanthotoxin, psoralen and bergapten were the dominant compounds. The best parameters for the accumulation of metabolites in *R. montana* cultures were: growth cycle - 5 weeks and LS NAA/BAP 0.1/0.1 mg/l medium.

PRACTICAL METHODS USED IN THE ASSESMENT OF PHARMACEUTICAL POLLUTION IN THE AQUATIC ENVIRONMENT

Joanna Żandarek^{1,2}, Małgorzata Starek¹, Monika Dąbrowska¹

¹Department of Inorganic and Analytical Chemistry, Faculty of Pharmacy,
Medical College, Jagiellonian University, 9 Medyczna St, 30-688 Kraków,
Poland

²Jagiellonian University, Medical College, Doctoral School of Medical and
Health Sciences, 16 św. Łazarza St, 31-530 Kraków, Poland

Keywords: method development, pharmaceuticals, water pollution

Analysis of pharmaceutical contamination in the aquatic environment involves several steps. The first is sample collection and storage. Next, is the appropriate preparation of samples, separation by chromatographic methods and detection. The final stage involves the analysis of the resulting data. Analytes differ in their physicochemical properties, so detection methods must be adapted to their properties. It is also important to properly validate the newly developed method to confirm its reliability. Thanks to chromatographic methods, it is possible to isolate the substances under study from the matrix. The most commonly used techniques are liquid chromatography (LC) and gas chromatography (GC). Compounds analyzed by GC must have sufficient volatility and chemical stability. When samples are not sufficiently volatile an essential step in this type of chromatography is derivatization. This involves preparing analytes by converting the sample under study into more volatile and thermally stable derivatives. The use of LC is more popular due to the low volatility of many polar pharmaceutical substances. Some of the most commonly used chromatography techniques in which the mobile phase is a liquid are high-performance liquid chromatography (HPLC) and ultra-high-performance liquid chromatography (UHPLC). These methods are characterized by fast separation times of small particles. Identification of labeled substances is possible by combining chromatographic techniques with mass spectrometry (MS). Using this technique, it is possible to read the molecular mass, and even the structure of the

compound under study. The MS technique provides the ability to measure small concentrations of contaminants in sewage sludge, and analysis of the degradation processes of drug substances into individual metabolites. Using the method of GC coupled to mass spectrometry (GC/MS), drugs such as metoprolol, propranolol, estrogen hormones have already been determined. Liquid chromatography was used eg. to determine antibiotics such as azithromycin, clindamycin, ciprofloxacin, as well as analgesics: ibuprofen, diclofenac and the antiepileptic drug carbamazepine.

References

1. Patel M., Kumar R., Kishor K., Mlsna T., Pittman Jr. C.U., Mohan D., *Chemical Reviews*, 2019, 119(6)3510-3673
2. Kuczyńska A., *Geologos*, 2019, 25, 3, 231–240
3. Giebułtowiec J., Nałęcz-Jawecki G., Harnisz M., Korzeniewska E., Płaza G., *Molecules*, 2020, 25, 1470
4. Giebułtowiec J., Tyski S., Wolinowska R., Grzybowska W., Zareba T., Drobniewska A., Wroczyński P., Nałęcz-Jawecki G, *Environmental Science and Pollution Research*, 2018, 25, 5788–5807
5. Wagil M., Kumirska J., Stolte S., Puckowski P., Maszkowska J., Stepnowski P., Białk-Bielińska A., *Science of the Total Environment*, 2014, 493, 1006–1013

QUALITY ANALYSIS OF SURFACE WATERS IN POLAND IN TERMS OF PHARMACEUTICAL CONTAMINATION

Joanna Żandarek^{1,2}, Małgorzata Starek¹, Monika Dąbrowska¹

¹ Department of Inorganic and Analytical Chemistry, Faculty of Pharmacy,
Medical College, Jagiellonian University, 9 Medyczna St, 30-688 Kraków,
Poland

² Jagiellonian University, Medical College, Doctoral School of Medical and
Health Sciences, 16 św. Łazarza St, 31-530 Kraków, Poland

Keywords: ecotoxicity, water pollution

Consumption of medicines in Poland remains high and this is linked to pollution of the water environment. Along with cleaning products and cosmetics, medicines are one of the problems of pollution of the water environment. Among the main sources of water pollution by drugs are sewage treatment plants. Excreted pharmaceutical substances from both hospitals and households enter sewage systems. Drug substances are often dumped into garbage and even sewer systems. Improper disposal results in medicinal substances entering the environment.

In addition, during the wastewater treatment process, complete removal of pharmaceuticals is a problem, and their residues cause pollution of the aquatic environment. Misuse of medicines in the agricultural sector is also a source of pollution. Veterinary medicines enter the environment, for example, by fertilizing agricultural fields with animal feces. In the conducted studies, most of the analyzed substances are detectable in the environment. The highest concentrations of pharmaceutical substances are recorded in rivers close to sewage discharge points. Drugs such as hormones, non-steroidal anti-inflammatory drugs (naproxen, diclofenac), antimicrobials are most often detected in the aquatic environment. Among antibiotics, fluoroquinolones, macrolides and tetracyclines are the most frequently detected. The following concentrations were recorded for azithromycin 631 ng/L, erythromycin 456 ng/L and clarithromycin 442 ng/L in samples collected from the Vistula River. Drugs used in the treatment of cardiovascular diseases such as β -blockers, sartans and diuretics are also found in surface

waters. Samples taken in 2017 from the downstream Vistula River from near Krakow contained an average of 345 ± 27 ng/L of valsartan. The highest concentration of furosemide (2670 ng/L) was recorded at a discharge point on the Vistula near Warsaw. Analyses conducted on the presence of immunosuppressive drugs have also proven the presence of mycophenolic acid in the surface waters of the Warsaw area. In downstream of wastewater treatment plants outfalls, concentrations of up to 180 ng/L were recorded.

Studies conducted in various regions of Poland show a correlation between the degree of industrialization of a region and the level of pollution. Wastewater from the Silesian province is more polluted compared to the less industrialized Małopolska province. In the water environment, medicinal substances undergo various degradation processes, including photodegradation and phototransformation. These processes result in products with different biological properties. Both reduced and increased toxicity products can be formed. The presence of drugs in aquatic ecosystems can primarily have negative effects on aquatic organisms.

References

1. Giebułtowiec J., Tyski S., Wolinowska R., Grzybowska W., Zaręba T., Drobniewska A., Wroczyński P., Nałęcz-Jawecki G, *Environmental Science and Pollution Research*, 2018, 25, 5788–5807
2. Styszko K., Proctor K., Castrignanò E., Kasprzyk-Hordern B., *Science of the Total Environment*, 2021, 768, 144360
3. Giebułtowiec J., Nałęcz-Jawecki G., Harnisz M., Kucharski D., Korzeniowska E., Płaza G, *Molecules*, 2020, 25(6), 1470
4. Giebułtowiec J., Nałęcz-Jawecki G., *Chemosphere*, 2016, 148, 137-147
5. Hubeny J., Harnisz M., Korzeniowska E., Buta M., Zieliński W., Rolbiecki D., Rolbiecki D., Giebułtowiec J., Nałęcz-Jawecki G., Płaza G., *PLoS ONE*, 2021, 16(6)



STOWARZYSZENIE „LEKARZE NADZIEI”

Médecins de l'Espoir • Doctors of Hope

Organizacja Pożytku Publicznego KRS 0000047746

ZARZĄD GŁÓWNY

Al. Pokoju 7, 31-548 Kraków, tel. (48 12) 414-30-05,

fax. (48 12) 413-25-29

e-mail: medaid@sln.org.pl • www.sln.org.pl

Przewodniczący: Dr n. med. Marian Kopciuch

The Doctors of Hope Association is an organization of public utility, active since 1989, initially as a branch of French charity organizations Médecins du Monde, located in Cracow. Within this structure, the Polish Doctors of the World had their branches in Warsaw, Gdańsk, Wrocław, Cracow and Nowy Sącz. In Cracow they operated already then the free Pharmacy of Donated Medicines, existing since the times of the 1981 communist martial law in Poland. They also organized numerous humanitarian aid convoys, among others to Romania (1989), Lithuania (1991), Kurdistan (1991), Kazakhstan (1992-1997), the countries of former Yugoslavia (1992-1994), Chechnya (1994-1996), Rwanda (1994), the hospital in Ngaoundaye in the Central African Republic (2019) and recently the hospital in Tarnopol, Ukraine (2022).

The necessity of concentration on still more extensive programs of assistance to the poorest and most needy members of society in Poland and also to our compatriots in the former south-eastern Borderlands was, among others, the reason of transforming in 1995 the Doctors of the World Association into the Polish non-profit extra-governmental organization Doctors of Hope Association. On 11th September 2004 the said Association on the Extraordinary General Assembly of Members passed the formal Statute, in force to this day. The reasons of transformation were more complex and ensued from ideological differences.

The world economic, political and philosophical outlook changes, observed in the recent years also in Poland, have exerted profound influence on dwindling the community spirit and social responsibility for the fate of „those others” in need due to poverty or alienation, as in the case of our compatriots in the East.

In the course of its 33-year long operation, the Doctors of Hope Association, in cooperation with the Polish medical organizations in the Borderlands, has been undertaking actions serving not only the maintaining of national ties, but also aimed at rendering the concrete emergency medical aid to those in need, living in ultra-difficult conditions and facing numerous hardships, particularly the Polish population in foreign lands. This is particularly true regarding the part of society with hampered access to medical services, particularly the elderly, unemployed and disabled persons.

Creating the foundations of our Association 33 years ago, we were basing on the principles contained in the so-called Charter of Humanitarian Actions, passed by the European Congress of Humanitarian Medicine and Human Rights, co-organized by us (then Médecins du Monde) in Cracow. In the said Charter, signed by 400 delegates from the West and East in 1990, we included our motto: *convinced that humanitarian actions should aim at the benefit of both our compatriots and foreigners, both in our country and abroad, we object to any discrimination originating from poverty, pathology and uncertain social status, we pledge to render assistance to all victims of natural, ecological and political catastrophes both in this country and abroad; we voice conviction that the principle of non-interference ends where the threat of non-assistance begins.*

Many stipulations of this Charter, known in the West as the Cracow Charter, were included into the Association’s Statute, as a medical humanitarian and charity organization.

The scope of the Association’s humanitarian activities are the areas of our so-called missions, i.e. the expeditions of medical teams with medical equipment and materials to the countries where civilians were victims of

wars or domestic rebellions. In such cases it happened sometimes that we went without the invitation from local authorities or even against their will, bearing the burden of consequences ensuing from the lack of international regulations concerning humanitarian and medical aid.

Further examples of emergency medical assistance for civilians, always disregarding their ethnic or political background, were our medical missions to Chechnya, Sarajevo, Albania, Belgrade or Kosovo. I think that these activities also encompass our dispatching of medical transports to Georgia after the 2008 Moscow invasion within the framework of cooperation proposed by the late senator Maciej Płażyński, chairman of the Polish Community.

Our humanitarian, medical and charity activities for the Polish borderland population wouldn't be effective but for the cooperation with Polish medical associations in Lithuania, Belarus, Ukraine, Romania, Moldova and lately Georgia. We experienced great assistance from the local Polish ecclesiastical organizations, notifying their congregations about the arrival of *the doctors from Poland*.

In the course of the above mentioned operations, we were always assisted by the Polish organizations, such as the Polish Community, Association of the Polish Knights of the Order of Malta, Polish Medical Mission, and later for many years, the Polish Mission of Médecins du Monde, based in Bordeaux, with the late lamented Delegate dr René Chassaingne, a Honorary Member of our Doctors of Hope Association.

Regrettably, it has to be stated that the growing expansion of regulations, orders and administrative prohibitions, employed by bureaucratic directives of the European Union resulted in considerable limitation of those our activities which were aimed at charity assistance to population both in Poland and in the Borderlands. This anti-social procedure follows in Poland as well. Consequently, soon the so-called Pharmacies of Donated Medicines will shortly disappear in this country, which is incredible in the light of the fact that for over half a century they have been functioning superbly and beneficially to many in such rich countries as England, France and Germany.

We deem it as our duty to further participate in actions and programmes aimed at continuing advancement of medical communities in the Borderlands, which profoundly influence the biological status of local populations, particularly the younger generation.

I would also like to emphasize that we are greatly satisfied with the successes of our Colleagues from the Borderlands which we witnessed to during the VII World Congress of the Medical Polonia in Toruń or the III Congress of Polish Doctors and X Congress of the Medical Polonia in Gdańsk. Any suchlike achievements will bear fruits to the still better view of the role of Polish doctors in their native locations.

The coronavirus pandemic has changed the world and considerably restricted the contacts with the Polish diaspora. We have recently received doctor of Medical Sciences Borys Duda-Chairman of the Polonia Medical Organizations in the Republic of Moldova and doctor Krystyna Rotkiewicz from Vilnius, the latter particularly committed to cherish the memory of Professor Kazimierz Pelczar, an eminent Polish oncologist, murdered in Ponary near Vilnius in 1943. It is worth mentioning that in 2019 she was honoured by the President of Poland with the Gold Cross of Merit.

Fortunately, coronavirus failed to disorganize the operations of the Doctors of Hope Association in Poland; they were performed incessantly in spite of the initial lack of basic protective equipment and disinfectants.

Are we aware of the following facts concerning hundreds or even thousands members of our population, facing difficulties:

- in obtaining the benefits of the public healthcare system?
- in purchasing medicines in comercial pharmacies?
- in getting aid for lonely people, those in Old People's Homes or lodging houses?

For 33 years, the Doctors of Hope Association has been striving to help these people living in poverty, unemployed, homeless, disabled, pensioners and Polish families living in the former eastern Borderlands. To meet its ends, the Association runs the following:

– Ambulatory for the Homeless and Poor in Cracow, 4 Smoleńsk Street, located in the Centre of Father Pio’s Work, the Capuchin Fathers

This healthcare institution admitted in 2021 more than 5 thousand patients, with many in dramatic state of health among them, on average 2-3 persons weekly. Following a basic medical treatment, they were directed to Hospital Emergency Wards and usually hospitalized. Many specialists work benevolently here from different fields of medicine: internal diseases, cardiology, geriatrics, neurosurgery, general surgery, vascular surgery, thorax surgery, orthopaedics, laryngology, ophthalmology, psychiatry, gynaecology, dentistry and psychology. The team of experienced nurses performs electrocardiography, intravenous and intramuscular injections, hygienic treatment, dressings, they also conduct health education. The patients receive free emergency pharmacological treatment, hygienic underclothes and personal hygiene articles.

– Charity Station of Medicines and Medical Materials Distribution (formerly Pharmacy of Donated Medicines), Os. Dywizjonu 303, Pavilion 1, Cracow

The Station distributes free medicines to people unable to receive them otherwise, prepares the batches of medical materials for the Ambulatories for the Homeless, Old People’s Homes and also for the charity and humanitarian missions both in this country and abroad. The Station seeks the donors of non-expired medical materials which can be brought to the Centre of the Doctors of Hope in Cracow, Al. Pokoju 7, Ambulatory at 4 Smoleńsk Street or to the above-mentioned Charity Station.

In this way the achievements can be supported of hundreds of doctors, nurses, pharmacists and medical personnel all over the world, who reached those particularly in need of health and life protection, but also requiring respect for human rights, conscience and objection to the evil. THE DOCTORS OF HOPE appeared in Romania, Lithuania, Ukraine, Latvia, Moldova, Chechnya, Albania, Georgia, Rwanda, Zambia and many other regions of the world, offering what is the most valuable - human health and life protection and so needed HOPE.

Unfortunately, the lack of funding hampers considerably the scope of help offered by us. Our activities are namely based upon the financial and material support from the wide public.

For this reason, we appeal wholeheartedly to all to who are not indifferent to the fate of „those others” to participate in the actions of the Doctors of Hope Association by:

– transferring 1% from the personal income tax to our account, using KRS Nr 0000047746

– voluntary money transfers to our account:

PKO BP S.A. I/O Kraków 58 1020 2892 0000 5902 0171 3833

– undertaking voluntary work in our organization

Let us all the same not deprive those in need of assistance, of hope they will not be left to themselves in the situation they face. The terms of praise to our actions include numerous prizes and diplomas of appreciation, granted by the bodies of public administration and also non-public entities, testifying to the validity of mission to the benefit of our neighbour in need.

Med. Dr Marian Kopciuch
Chairman of the Main Board of the Doctors of Hope Association

TABLE OF CONTENT

| | |
|--|----|
| PART I ORGANIZERS & SUPPORT COMMITTEES SPONSORS LETTERS PROGRAMME | 3 |
| MAIN ORGANIZERS | 4 |
| HONORARY SUPPORT | 4 |
| SUPPORT | 5 |
| SCIENTIFIC COMMITTEE..... | 6 |
| ORGANIZING COMMITTEE | 6 |
| JURY FOR THE BEST PRESENTATION OF YOUNG SCIENTISTS... | 6 |
| SPONSORS | 7 |
| KRAKOW | 8 |
| REGIONAL PHARMACEUTICAL CHAMBER IN KRAKOW | 10 |
| LETTER FROM VICE-RECTOR'S PROXY FOR RESEARCH AND INTERNATIONAL COOPERATION OF THE JAGIELLONIAN UNIVERSITY MEDICAL COLLEGE IN KRAKÓW, POLAND..... | 11 |
| LETTER FROM DEAN OF THE FACULTY OF PHARMACY JAGIELLONIAN UNIVERSITY MEDICAL COLLEGE..... | 14 |
| LETTER FROM DEAN OF THE FACULTY OF PHARMACY UNIVERSITY OF SZEGED..... | 15 |
| LETTER FROM VICE-DEAN OF THE FACULTY OF MEDICINE, JAGIELLONIAN UNIVERSITY MEDICAL COLLEGE | 16 |
| LETTER FROM PRESIDENT OF THE REGIONAL MEDICAL COUNCIL IN KRAKOW | 17 |
| LETTER FROM CO-CHAIRPERSONS OF THE SCIENTIFIC AND ORGANIZING COMMITTEES OF THE 4 TH ICPMS MARTIN, KRAKÓW, SZEGED 2022..... | 19 |
| JAGIELLONIAN UNIVERSITY MEDICAL COLLEGE..... | 22 |
| PROGRAMME..... | 25 |

| | |
|---|-----------|
| PART II HONORARY LECTURES | 34 |
| FROM TRADITIONAL TO NEXT GENERATION PATHOLOGY: ACHIEVEMENTS IN CANCER BIOPSY DIAGNOSIS..... | 35 |
| THE COMPLEX ROLE OF ECDYSTEROIDS IN NATURE AND THEIR DRUG DISCOVERY PERSPECTIVES | 36 |
| NETWORKS – A PERSONAL PERSPECTIVE | 37 |
| PART III ORAL PRESENTATIONS SESSION OF YOUNG SCIENTISTS | 38 |
| POSTER PRESENTATIONS OTHER ABSTRACTS..... | 38 |
| ORAL PRESENTATIONS | 39 |
| BIOBANKS AS INNOVATION INFRASTRUCTURE FOR TRANSLATIONAL MEDICINE..... | 40 |
| SINGLE NUCLEOTIDE VARIANT rs708727 OF SLC41A1 GENE IS ASSOCIATED WITH PARKINSON’S DISEASE | 40 |
| ADVANCED ANALYSIS OF FLUORESCENCE MICROSCOPY OUTPUTS FROM BIOLOGICAL SAMPLES..... | 43 |
| USABILITY OF MAGNETIC RESONANCE TECHNIQUES IN METABOLOMICS | 44 |
| DEVELOPMENT OF NOVEL IN VITRO MODELS FOR HUMAN CANCERS AND NEURODEGENERATIVE DISESES..... | 45 |
| OPPORTUNITIES FOR THE HEALTH EDUCATION OF ROMA WOMEN WITHIN THE FAMILY | 46 |
| EFFECTS OF IONIC LIQUIDS ON THE SEPARATION PROPERTIES OF ALKYL AND PHENYL-BASED STATIONARY PHASES IN REVERSED-PHASE LIQUID CHROMATOGRAPHY | 47 |
| NETWORK IN DENTISTRY – COOPERATION BETWEEN DENTISTS AND OTHER MEDICAL DOCTORS..... | 49 |
| PRELIMINARY OBSERVATIONS IN APPLICATION OF THE TRANSCRIPTION FACTORS IN HISTOPATHOLOGICAL | |

| | |
|---|----|
| DIAGNOSIS ACCORDING TO THE GUIDELINES OF THE NEW WHO CLASSIFICATION | 50 |
| REGULATORY ROLE OF AQUAPORIN 5 IN THE FUNCTION OF LATE PREGNANT RAT UTERUS..... | 52 |
| <i>IN VITRO</i> ANTICANCER EFFECTS OF ISTAROXIME | 54 |
| NON-PHARMACOLOGICAL TREATMENT OF INFLAMMATORY BOWEL DISEASE (IBD). ROLE OF EXERCISE, ADIPOSE TISSUE AND MYOKINES..... | 55 |
| ENHANCEMENT OF THE ANTIDEPRESSANT EFFECT OF HALLUCINOGENS BY mGLU 2/3 RECEPTOR ANTAGONISTS OR SELECTIVE mGLU2 RECEPTOR NEGATIVE ALLOSTERIC MODULATORS (NAMs)..... | 57 |
| ANALYSIS OF DESIGNER DRUGS AND THEIR METABOLITES IN THE FORENSIC PRACTICE..... | 58 |
| AN APPLICATION OF ARTIFICIAL NEURAL NETWORKS TO DIFFERENTIATE SELECTED OVARIAN TUMORS | 60 |
| EFFECTS OF GESTATION ON THE PHARMACOKINETICS OF DESLORATADINE | 62 |
| ZINC DEFICIENCY BLUNTS THE EFFECTIVENESS OF ANTIDEPRESSANTS IN RODENT MODELS OF DEPRESSION | 63 |
| SESSION OF YOUNG SCIENTISTS..... | 65 |
| WHY DO CHILDREN HAVE DIFFICULTIES IN ELEMENTARY SCHOOL? METHODS TO HELP STRUGGLING STUDENTS DEVELOP THEIR EXECUTIVE FUNCTIONS IN A SCHOOL ENVIRONMENT | 66 |
| <i>HYPsizYGUS MARMOREUS</i> AND THEIR MYCELIUM FROM <i>IN VITRO</i> CULTURES AS A DIETARY AND MEDICINAL AGENT FOR HUMAN ORGANISM..... | 67 |
| THE SPECTROSCOPIC MARKERS OF BLADDER CANCER AND THEIR POTENTIAL USEFULNESS IN PATIENT TREATMENT | 69 |

| | |
|--|----|
| DEEP LEARNING EMPOWERS DETAILED MOLECULAR IMAGING OF PANCREATIC TUMORS | 70 |
| POSSIBILITIES OF USING AN ELASTOMERIC INFUSION PUMP FOR THE SUPPLY OF MIXTURES OF PARENTERAL DRUGS | 71 |
| SAFETY AND SIGNAL DETECTION OF UNAPPROVED PHARMACEUTICALS AVAILABLE FOR OVERALL SALE IN ELITE AND NON-ELITE ATHLETES | 73 |
| DENTAL PULP STEM CELLS AS AN ATTRACTIVE TOOL FOR BONE TISSUE REGENERATION | 78 |
| <i>IN VITRO</i> ANTIPROLIFERATIVE AND ANTI-METASTATIC PROPRIETIES OF <i>PEGANUM HARMALA</i> | 80 |
| <i>IN VITRO</i> EVALUATION OF ANTIPROLIFERATIVE AND ANTIMETASTATIC ACTIVITY OF THE NEWLY SYNTHESIZED 2-(4-CHLOROPHENYL)-13 α -ESTRONE SULFAMATE..... | 81 |
| EFFECTS OF CALONYSTERONE AND 20-HYDROXYECDYSONE IN THE OBESE RAT MODEL | 83 |
| PHARMACOLOGICAL INVESTIGATION OF A NEWLY SYNTHESIZED MONOTERPENE-BASED 2,4-DIAMINOPYRIMIDINE TYPE DERIVATIVES ON HUMAN CANCER CELL LINES <i>IN VITRO</i> | 85 |
| ANTIBIOTIC EXPOSURE OF A VULNERABLE POPULATION: CONSUMPTION OF THE ELDERLY..... | 87 |
| URINARY CATHETER-ASSOCIATED COMPLICATIONS AND ITS PREVENTION USING ADVANCED MATERIAL MODIFICATIONS IN CLINICAL USE & IN RESEARCH | 89 |
| PATIENT SAFETY ISSUES IN TELEMEDICINE APPLICATION DEVELOPMENT IN CASE OF PERIPHERAL ARTERIAL DISEASE | 90 |
| THE IMPACT OF MEDICATION REVIEW ON FALL RISK PREVENTION IN THE ELDERLY | 92 |

| | |
|---|-----|
| THE EFFECT OF THE PARACELSIAN MEDICAL CONCEPT ON THE 20 TH CENTURY'S MEDICAL VISION | 94 |
| POSTER PRESENTATIONS | 95 |
| THE DEVELOPMENT OF DLLME COMBINED WITH LC-MS/MS FOR THE DETERMINATION OF SIROLIMUS IN THE WHOLE BLOOD SAMPLES AND ITS APPLICATION IN CLINICAL PRACTICE | 96 |
| ARTIFICIAL NEURAL NETWORK MODELS OF DRUGS' SOIL AND WATER PARTITION BASED ON IAM CHROMATOGRAPHIC AND COMPUTATIONAL DESCRIPTORS..... | 98 |
| PROCEDURE FOR EFFICIENT PROTEIN EXTRACTION FROM PARAFORMALDEHYDE FIXED ADIPO-DIFFERENTIATED CELLS | 100 |
| DIVERSITY OF VAGINAL MICROBIAL STRAINS IN CERVICAL CYTOLOGICAL SMEARS IN RELATION TO HPV INFECTION .. | 102 |
| COVID-19 INFECTION IN PATIENTS WITH COPD..... | 104 |
| EFFECTS OF CHRONIC TREATMENT WITH A GPR39 AGONIST (TC-G 1008) ON HIPPOCAMPUS-DEPENDENT MEMORY OF BDNF +/- AND WT MALE MICE | 107 |
| COMPARISON OF THE EFFECTS OF DIETARY SUPPLEMENTATION WITH THREE ARBOREAL MEDICINAL MUSHROOMS ON LONG-TERM MEMORY, ANXIETY-LIKE BEHAVIOR AND HIPPOCAMPAL GENE EXPRESSION IN MALE MICE..... | 109 |
| PRELIMINARY STUDIES OF THE RELEASE RATE OF CELECOXIB AND ITS INCLUSION COMPLEX FROM THE NANOSTRUCTURED LAYER OF TITANIUM DIOXIDE..... | 111 |
| CEPHALOSPORINS - STRATEGIES IN THE SEARCH FOR NEW MEDICINAL SUBSTANCES | 113 |

| | |
|--|-----|
| SYSADOA - SYMPTOMATIC SLOW ACTING DRUGS FOR THE PREVENTION AND OSTEOARTHRITIS..... | 115 |
| NEUROPROTECTIVE AND NEUROREGENERATIVE ACTIVITY OF ACTIVE COMPOUNDS CONTAINED IN MUSHROOMS AND PLANTS..... | 118 |
| POLYSACCHARIDES WITH IMMUNOMODULATORY PROPERTIES | 123 |
| ACTIVITY OF SELECTED POLYSACCHARIDES OBTAINED FROM ALGAE | 126 |
| <i>PLEUROTUS DJAMOR</i> AND ITS PROHEALTH ACTIVITY | 130 |
| <i>HERICUM</i> SP. AS DIETARY AND MEDICINAL MUSHROOMS ... | 132 |
| EFFECTS OF THE ELECTROMAGNETIC FIELD ON THE CARDIOVASCULAR AND NERVOUS “NETWORK” SYSTEMS ... | 134 |
| OTHER ABSTRACTS..... | 136 |
| DETERMINATION OF THE SELECTED BIOELEMENTS (Mg, Zn, Fe, K) IN THE SPRING WATER WITH THE USE OF THE MINI-GRADUATION TOWER | 137 |
| DETERMINATION OF ZINC AND COPPER IN DERMATOLOGICAL PREPARATIONS WITH THE ADDITION OF NATURAL RAW MATERIALS..... | 138 |
| DRUGS USED IN THE PHARMACOTHERAPY OF THE ORGAN OF LOCOMOTION IN A HUMAN I. PHARMACOTHERAPY OF THE SPINE..... | 140 |
| A CASE REPORT OF THE TREATMENT OF A SUSPECTED STOMATOGNATHIC DISORDER IN THE MULTISPECIALTY COOPERATION OF A PHARMACIST AND A PHYSIOTHERAPIST WITH COEXISTING COMPLAINTS OF THE TRAPEZIUS MUSCLE | 142 |
| USING RESTORATIVE APPROACHES IN THE RECOVERY PROCESS OF DEPENDENT FAMILIES | 144 |

| | |
|--|-----|
| MODELS OF ANTIBIOTICS' BIOREMEDIATION | 145 |
| COMPARISON OF THE ACTION OF DOCOSAHEXAENOIC ACID AND METFORMIN IN INFLAMED PRE-ADIPOCYTES AND ADIPOCYTES..... | 147 |
| ENVIRONMENTAL IMPACT OF SUNSCREENS..... | 148 |
| PRODUCTION OF POLYPHENOLIC COMPOUNDS IN <i>SCHISANDRA HENRYI IN VITRO</i> CULTURES MAINTAINED IN PLANTFORM BIOREACTORS..... | 150 |
| SPORTS PHARMACY IN PERSPECTIVE ON OTC DRUG SAFETY IN ELITE AND NON-ELITE ATHLETES..... | 152 |
| CORDYCEPS AND CORDYCEPIN IMPACT ON BONE FUNCTIONS | 155 |
| ANTIOXIDANT SUBSTANCES IN DIETARY SUPPLEMENTS CONTAINING <i>CORDYCEPS MILITARIS</i> | 157 |
| BIOREMEDIATION OF IBUPROFEN AND KETOPROFEN BY IMMOBILIZED <i>IN VITRO</i> CULTURES OF <i>CHLORELLA VULGARIS</i> | 159 |
| ASSESSMENT OF ZINC CONTENT IN PREPARATIONS WITH THE ADDITION OF NATURAL RAW MATERIALS SUPPORTING THE THERAPY OF DIABETES | 161 |
| <i>AMANITA</i> SP. AS INEDIBLE SPECIES OF POTENTIAL MEDICINAL IMPORTANCE..... | 163 |
| NANOCARRIERS AS A METHOD OF ENHANCING THE THERAPEUTIC EFFECT OF A DRUG | 165 |
| ANALYSIS OF THE POSSIBILITY OF REMOVING NSAID RESIDUES FROM THE ENVIRONMENT..... | 167 |
| BIOACTIVE SECONDARY METABOLITES IN MYCELIAL CULTURES OF MEDICINAL MUSHROOM – <i>INONOTUS OBLIQUUS</i> | 169 |
| NATURAL COMPOUNDS USED IN SKIN DISCOLORATION..... | 171 |

| | |
|--|-----|
| <i>MELITTIS MELISSOPHYLLUM</i> L. SHOOT CULTURES AS A SOURCE OF SECONDARY METABOLITES WITH BIOLOGICAL ACTIVITIES | 173 |
| RESEARCH ON <i>IN VITRO</i> CULTURES OF <i>RUTA MONTANA</i> IN PLANTFORM® BIOREACTORS..... | 174 |
| PRACTICAL METHODS USED IN THE ASSESMENT OF PHARMACEUTICAL POLLUTION IN THE AQUATIC ENVIRONMENT | 175 |
| QUALITY ANALYSIS OF SURFACE WATERS IN POLAND IN TERMS OF PHARMACEUTICAL CONTAMINATION | 177 |
| STOWARZYSZENIE „LEKARZE NADZIEI” | 179 |
| ANNEX | 193 |

ANNEX

Opening ceremony: prof. dr. hab. Štefan Sivák delivers a welcome speech to the participants of the 4th ICPMS on behalf of the Dean of the Faculty of Medicine in Martin, prof. dr hab. med. Andrea Čalkovská



Behind the presidential table from the left: prof. dr hab. Božena Muszyńska, prof. dr hab. Dariusz Adamek, prof. dr hab. Jolanta Pytko-Polończyk, prof. dr hab. Erika Halašová, prof. dr hab. Włodzimierz Opoka



Welcome speech – prof. dr hab. Jolanta Pytko-Polończyk Vice-Dean for student affairs and study program in the field of medicine and dentistry at the Faculty of Medicine



Prof. dr hab. Marek Sanak – Rector’s proxy for science of the Jagiellonian University for the Medical College (Kraków, Poland) delivers a welcome speech to the participants of the 4th ICPMS on behalf of the Vice-Rector of the Jagiellonian University for the Medical College prof. dr hab. Tomasz Grodzicki (on-line)



Prof. dr hab. Jacek Sapa – Dean of the Faculty of Pharmacy in Kraków (Poland) gives a speech at the Opening Ceremony to the participants of the 4th ICPMS (on-line)

Honorary lectures – chairman: prof. Erika Halašová, prof. Dariusz Adamek



Prof. Lukáš Plank
(Comenius University
Bratislava, Slovakia)



Prof. Attila Hunyadi
(University of Szeged,
Hungary) online



Prof. Paweł Idziak
(Jagiellonian
University, Poland)

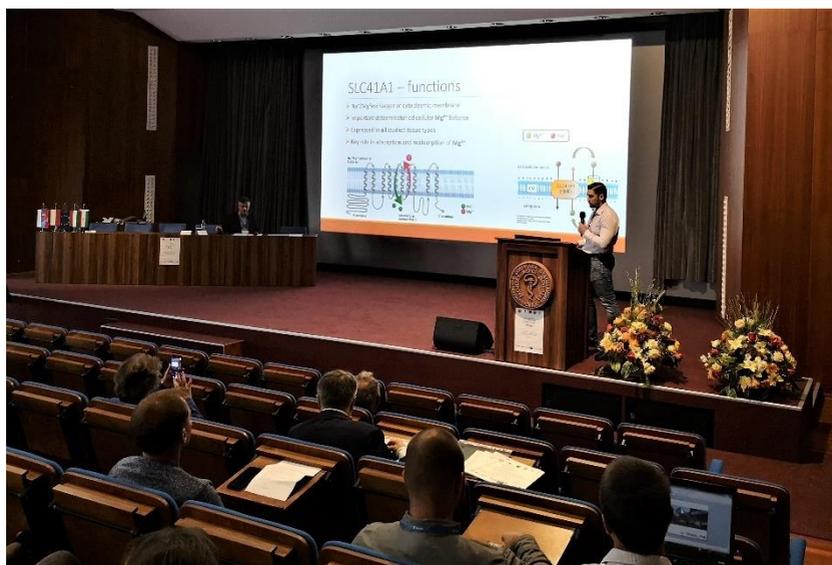


MSc Elżbieta Rząsa-Duran (President of the Regional Chamber of Pharmacists in Kraków, Poland) during the work of the organizing committee

The first main session: Next-generation Sequencing and OMICs in the Era of Advanced Medical Diagnostics; chairman: doc. Štefan Sivák and prof. Zsolt Szakonyi (online)



PhD Oliver Strbak from Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Slovakia



PhD Michal Cibulka from Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Slovakia



PhD BEng Jan Strnadel Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Slovakia



PhD Ilona Notar John Wesley Theological College – Doctoral School, Hungary (online)

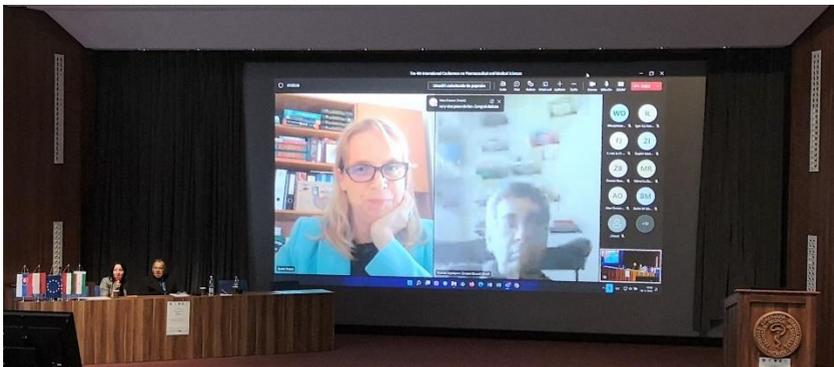


PhD, DSc Alina Plenis from Medical University of Gdansk, Poland

The second main session chaired by PhD, DSc Bernardeta Szewczyk (Polish Academy of Sciences, Poland) and prof. Marek Lankosz (AGH University of Science and Technology, Poland).



Prof. dr hab. Jolanta Pytko-Polończyk (Institute of Dentistry Jagiellonian University Medical College)



PhD Eszter Ducza from University of Szeged, Hungary and prof. Keyhan Sayadpour Zanjani from Tehran University of Medical Sciences, Iran (online)



Prof. Dariusz Adamek from Jagiellonian University Medical College, Poland

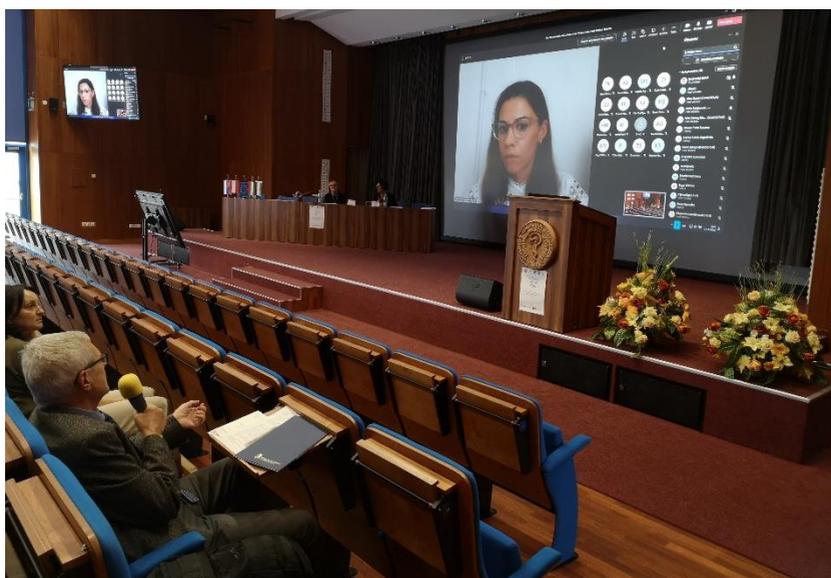


Prof. Tomasz Brzozowski (Jagiellonian University Medical College, Poland) and PhD Igor Łoniewski (Pomeranian Medical University in Szczecin, Poland) online

The third main session. Chairman: prof. dr hab. Jolanta Pytko-Polończyk, prof. Erika Halašová. Discussions after speaking in session.



Speaker: prof. dr hab. Andrzej Pilc (Polish Academy of Sciences, Poland)



Speaker: PhD Anita Sztojkov-Ivanov (University of Szeged, Hungary)

Young scientists' session. Chairman: prof. dr hab. Andrzej Pilc, prof. dr hab. Paweł Idziak



Discussion after speaking in session of young scientists. Speaker: PhD Student Hiba Faroug Muddather (University of Szeged, Hungary)

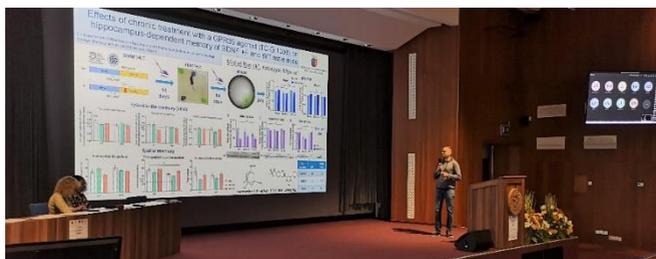


Discussion after speaking in session of young scientists. PhD Student Ikhwan Yuda Kusuma (University of Szeged, Hungary, Universitas Harapan Bangsa, Indonesia) and PhD Student Viktória Nagy (University of Szeged, Hungary)

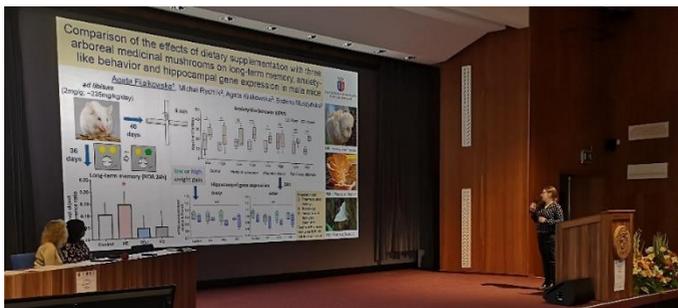


PhD Student Bálint Madársz from Semmelweis University, Hungary

Poster presentations. Chairman: prof. dr hab. Bożena Muszyńska, dr hab. Katarzyna Sułkowska-Ziaja (Jagiellonian University Medical College)



PhD Student Michał Rychlik Jagiellonian University Medical College, Poland



PhD Student Agata Fijałkowska Jagiellonian University Medical College, Poland



During the technical break...



Dr Katarzyna Kała –
coordinator of organizing
committee (Jagiellonian
University, Poland)

Photos: dr Katarzyna Kała, prof. dr. hab. Włodzimierz Opoka

Martin

Szeged

Kraków



**4TH INTERNATIONAL CONFERENCE ON PHARMACEUTICAL
AND MEDICAL SCIENCES**



**JAGIELLONIAN UNIVERSITY
MEDICAL COLLEGE
IN KRAKOW**

ISBN 978-83-959554-5-7