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ENVIRONMENTAL SUSTAINABILITY

EUROPEAN SUSTAINABILITY: AMBITIONS AND CHALLENGES

Igor Yakymenko[1]*, Oksana Salavor[1], Yevhenii Shapovalov[1],
Diane Henshel[2], Anatoli Giritch[3]
[1]National University of Food Technologies, Kyiv, Ukraine
[2]Indiana University Bloomington, USA
[3]Nomad Bioscience GmbH, Germany
**Speaker: iyakymen@gmail.com*

The European Union has been a global leader in sustainable development strategy and climate change mitigation for decades. Key strategic documents, which indicate dedicated environmentally-friendly policies of the block, include, e.g. Europe 2020 Strategy (EC, 2010), the Strategy for the Circular Economy (EC, 2015), the European Green Deal / EGD (EC, 2019) , and Fit for 55 package (EC, 2021). In terms of Europe 2020 strategy on smart, sustainable and inclusive growth, the EU reached 20% reduction of greenhouse gas (GHG) emission (from 2010 to 2020) and over 20% of renewables in total energy consumption at the end of 2020. However, the ambitions of EGD are much bigger and imply to make Europe the first climate-neutral continent with zero net GHG emission by 2050. And middle-term goals till 2030, indicated in Fit for 55 package, include reduction of GHG emission on 55% compared to 1990 and 40% of total energy production of the block from renewables. Obviously, significant parts of these plans imply fast transition from fossil fuels to renewables. Russian aggression against Ukraine forced Europe to be ready for new challenges, including fighting dependence on Russian energy resources and readiness for looming military threats from the terroristic Russian regime. Answering these challenges, the EU adopted RePowerEU strategy (EC, 2022) to totally eliminate its dependence on Russian fossil fuels till 2030. The block imposes economic sanctions on the Russian regime and provides powerful economic support to Ukraine, including recent 50 billion euros package for the next few years. In April 2024, it was topped by the next, long waiting package of military support from the USA in over 60 billion dollars. Keeping in mind a huge military machine of Russia and terroristic way of thinking of its leader, it seems we still need much more international efforts to turn Europe back to sustainable track of development. This paper explores the EU's sustainability ambitions, the challenges posed by the current geopolitical landscape, and the need for international collaboration to ensure a sustainable future for Europe.

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CHALLENGES AND APPLICATIONS OF CELLULOSE NANOFIBRILS IN DIFFERENT CONTEXTS FOR SUSTAINABLE DEVELOPMENT

Gustavo Henrique Denzin Tonoli*, Ianca Oliveira Borges, Lays Camila Matos, Jenaina Ribeiro Soares, Fabiana Felix da Silva, Julio Cesar Ugucioni

Universidade Federal de Lavras, Brazil

**Speaker: gustavotonoli@ufla.br*

Engineering materials are mainly based on petroleum-based materials, which are not biodegradable and compromise their disposal or recycling. The use of cellulose-based materials is promising for different applications as alternative to find more sustainable developments. This presentation brings the background of our group in the Universidade Federal de Lavras (UFLA) on obtention of cellulose nanofibrils from different vegetable species (De Oliveira et al., 2023), fiber treatments and their use for different applications such as films, fruit coatings (Lago et al. 2023), polymer reinforcement (Mascarenhas et al., 2022), reinforcement in inorganic-based composites (Souza et al., 2022), paper coatings (Santos et al., 2023), etc. There is still the need for environmentally safe ways to decrease cellulose hydrophilicity and it is important to understand the several characteristics of the cellulose nanofibrils for further optimizations of their applications.

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BIOSURFACTANT PRODUCTION AND PETROLEUM DEGRADATION USING SPENT MUSHROOM SUBSTRATE

Marília Santiago Carvalho[1], Carlos Godinho de Abreu[1], Leonardo de Figueiredo Vilela[2], Tatiana Cardoso e Bufalo[1], Eustáquio Souza Dias[1]*

[1]Federal University of Lavras, Brazil

[2]Faculdade de Ciências Médicas de Três Rios, Suprema - Três Rios/RJ, Brazil

**Speaker: esdias@ufla.br*

Mushroom cultivation generates enormous amounts of post-cultivation substrate at the end of each production cycle, which is known as spent mushroom substrate (SMS). Once known as a waste product of mushroom production, SMS is actually a valuable co-product of mushroom production. There are countless possibilities for using this material and, considering the large volumes produced, it is interesting to continue looking for new alternatives for its use in different human activities. In this work, we evaluated the potential for biosurfactant production in SMS from different species of oyster mushrooms, in addition to evaluating the potential for oil degradation in the presence of SMS from *Pleurotus ostreatus* and *Lentinula edodes*. Even with the use of dry SMS, a decrease in several hydrocarbons was observed after 3 months of oil treatment. Furthermore, *Pleurotus* species showed high emulsification rates. Future studies will be necessary to characterize the molecules responsible for the bioemulsification activity, since both biosurfactants and bioemulsifiers can act in a similar way.

ADVANCING BIOPROCESS DEVELOPMENT BY FULLY AUTOMATED MODEL-BASED CHARACTERIZATION OF MICROBIAL PRODUCTION PROCESSES

Peter Neubauer
KIWI-biolab and Chair of Bioprocess Engineering, Technical University of Berlin, Germany
Speaker: peter.neubauer@tu-berlin.de

Identifying and characterizing potential production strains is essential in bioprocess development and often done in mini-bioreactor systems. It is important that the experiments in this screening stage reflect the key aspects of the final industrial-scale bioprocess. Necessary variations can be tested with reasonable effort by model based DoEs (mbDOEs), that utilize mathematical models to describe the dynamic behaviour of the cell factory. Then, the aim of the experiments is to identify cell-specific parameters in context of the dynamically changing bioprocess environment. A well-parametrized model is an important tool for computation-based process development.

Efficient parameterization of parallel cell factories within process conditions is on of the main goals in the KIWI-biolab. Here, well-controlled fed-batch cultivations are performed in parallel 48x10mL or 8x100ml bioreactor systems. Fully automated and integrated process analytics enable quick access to the data for extensive parallel simulations and real-time process control. This allows to target multiple objectives, such as the maximization of cell or product yields. Relevant examples of previous projects include the characterisation of *Escherichia coli* mutant libraries and the scalable optimization of processes for recombinant products.

TRANSFORMATIONS OF ENERGY LANDSCAPES. LOCATION CONSIDERATIONS RELATED TO THE CUMULATIVE ENVIRONMENTAL IMPACT OF PHOTOVOLTAIC FARM COMPLEXES

Michał Kupiec
Institute of Spatial Management and Socio-Economic Geography, University of Szczecin, Poland
Speaker: michal.kupiec@usz.edu.pl

The local example of a typical Pomeranian municipality shows the dynamics and scale of the problems associated with the formation of energy landscapes in open countryside. Results presents the characteristics of landscape changes related to the implementation of the renewable energy development strategy. In the analysed municipality, agricultural production is partly dedicated to energy purposes. Wind investments on large areas of agricultural land were made possible through local spatial planning acts. The biggest impact on the landscape has been photovoltaic investments, which at the present time are the easiest form of RES investment in terms of legal, administrative and locational aspects. As a result of these conditions, a process of intensive landscape transformation has begun in agricultural areas. The research presents problems related to the inadequacy of environmental impact assessment procedures, especially related to the assessment of cumulative impact.

POSITIVE IMPACT OF SUSTAINABLE PRACTICES ON SETTING THE COMPANY'S GOALS FOR IMPLEMENTING CHANGES

Mykhailo Buriak[1], Oksana Makovoz[1,2]*

[1]National Technical University «Kharkiv Polytechnic Institute», Kharkiv, Ukraine

[2]IHI Zittau, Dresden Technical University, Dresden, Germany

**Speaker: oksana.makovoz@tu-dresden.de*

Companies now redefine success beyond revenue and employee growth, considering social and environmental impact alongside financial performance for sustainable scaling. A proposed framework highlights fostering internal innovation, strategic regional expansion, leveraging geographical proximity, and establishing collaborative partnerships. Aligned with UN Sustainable Development Goals (SDGs) 8, 9, and 17, this approach emphasizes responsible growth. Traditional scaling, focusing solely on revenue and headcount, often falls short, with only 12% achieving sustained growth. Such approaches can lead to negative externalities like environmental damage and social inequality. Integrating SDGs addresses these concerns while promoting responsible growth. For example, internal innovation aligns with SDG 9, addressing environmental concerns and gaining a competitive edge. Strategic regional expansion optimizes resource allocation and minimizes environmental impact, while local partnerships reduce transportation needs and carbon emissions. Collaborative partnerships leverage expertise for successful innovation, empowering businesses to achieve sustainable growth and become responsible global citizens. This approach aligns with the broader perspective of success emerging alongside SDGs, emphasizing job creation, innovation, and collaboration. Case studies of companies like Patagonia and Chobani demonstrate how sustainable practices positively impact key performance indicators (KPIs), fostering employee engagement and contributing to economic expansion and social impact. Integrating SDGs into business strategies showcases how traditional scaling metrics can coincide with social and environmental responsibility. This holistic approach underlines a future where business success and sustainability intertwine, emphasizing responsible growth in today's global landscape.

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MICROBIAL METAL RESISTANCE FOR THE SUSTAINABLE ENVIRONMENT

Vira Hovorukha[1,2]*, Iryna Bida[2], Olesia Havryliuk[2,3], Ewa Moliszewska[1], Oleksandr Tashyrev[1,2]

[1]University of Opole, Opole, Poland

[2]D. K. Zabolotny Institute of Microbiology and Virology of the National Academy of Sciences of Ukraine, Kyiv, Ukraine

[3]Universitat Politècnica de Catalunya-BarcelonaTech, Terrassa, Spain

**Speaker: vira.hovorukha@uni.opole.pl*

Pollution of ecosystems with toxic metals is currently one of the most relevant environmental problems. It is caused worldwide, but in Ukraine, soil contamination is now aggravated by military actions. Environmental pollution will lead to catastrophic consequences for the environment and health. Therefore, it is necessary to develop effective methods for metal detoxification. Although many of them have been developed, the problem remains unsolved (Vardhan et al., 2019). Biological methods are now particularly promising. Since microorganisms have a wide range of pathways to interact with metals, their metabolic potential may be key to metal detoxification.

Therefore, the goal of our work was to study the level of soil contamination in the Kyiv region (Ukraine) with toxic metals, as well as to assess the resistance of microorganisms to metals and the possibility of their application for metal detoxification.

The concentration of metals such as chromium, lead, cobalt, and nickel in soil was shown to be in the range of 5 to 410 ppm, while iron – 9800 ppm. The number of aerobic chemoorganotrophic microorganisms was up to 3.6×10^5 CFU/g. Moreover, the number of chromium-resistant bacteria at 200 ppm of Cr(VI) was $n\times10^4$ - $n\times10^5$ CFU/g. Bacteria detoxify Cr(VI) reducing it to insoluble $Cr(OH)_3$. This indicates the potential of microorganisms to maintain the stability of their functioning in the presence of toxic metals. The pattern was confirmed for 4 strains (*Brevundimonas vesicularis* USM1, *Pseudoarthrobacter oxidans* USM2, *Pseudomonas lini* USM3, *Pseudomonas putida* USM4) that showed high resistance to metals. The maximum permissible concentration they grew was up to 600 ppm Cu^{2+}, 200 ppm Co^{2+}, 250 ppm Cr(VI) 400 ppm Ni^{2+}, and 2500 ppm Fe(III). The analysis of their genomes showed the presence of genes providing resistance to metals and interaction with them. It is possible to use bacteria to detoxify metals via precipitation, accumulation in cells, etc.

Thus, microorganisms exhibit high resistance to toxic metals and have a great metabolic potential to detoxify them. The prospects of further research are the development of approaches to regulate the metabolism of microorganisms to purify the environment and provide its sustainability.

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METHODS AND FUTURE PROSPECTS OF ANIMAL FAT CONVERSION INTO BIOFUEL

Vladyslav Sukhenko[1]*, Lesya Avdieieva[2], Yevgeny Sukhenko[3]
[1]Cherkasy State Technological University, Cherkasy, Ukraine
[2]Institute of Engineering Thermophysics of the National Academy of Sciences of Ukraine
[3]National University of Life and Environmental Sciences of Ukraine, Kiyv, Ukraine
**Speaker:* vladsuhenko@gmail.com

Raw materials for the production of methyl and ethyl esters of fatty acids can be vegetable oils, animal and bird fat, lard, yellow fat and by-products of fish farming (Heletukha et al., 2023). The main component of oils and fats are triglycerides, which make up about 90-98% of the total mass of raw materials.

In real production conditions, periodic emissions of fatty waste are not excluded, which leads to the loss of fat-retaining raw materials, which worsens the environmental situation. Therefore, the task of the poultry processing industry is to obtain food products from high-quality raw materials, as well as third-party products in order to reduce production waste (Marulanda et al., 2010).

The research used technical chicken fat, which was heated to 75-80°C and kept at this temperature for one hour with constant stirring to remove moisture, and then filtered to separate insoluble impurities (Jagadale et al., 2012).

The level of free fatty acids (FFA) in the raw material must be reduced to 1% before using an alkaline catalyst for fat transesterification. Therefore, the first step in the research was preliminary preparation of the KTZ. The fat used had an acid value (AC) of 5-45 mg KOH/g. Since the KC fat was more than 2 mg KOH/g, it was necessary to carry out esterification of this raw material.

So, according to the conclusions of the research analysis, we can say that sulfuric acid is one of the most effective catalysts for reducing the level of high cholesterol during the esterification of chicken fat. The decrease in the level of UVC during the esterification of chicken fat depends significantly on the molar ratio of methanol/fat, the amount and type of acid catalyst, as well as the duration of the reaction. The initial level of VHD in chicken fat (15-27 %) can be reduced to 1% using 20% H_2SO_4 by weight of fat and methanol at a molar ratio of 40:1 to fat in a reaction at 60 °C for 80 min.

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IMPLEMENTATION OF SUSTAINABLE DEVELOPMENT GOAL 6 IN UKRAINE: CHALLENGES AND OBSTACLES (AS EXAMPLE OF RIVER ROS')

Vlas Berezovyi*, Viacheslav Kharchenko
National University of Food Technologies, Kyiv, Ukraine
**Speaker: elvlas@ukr.net*

Introduction. Goal 6 of the sustainable development is "Clean water and sanitation" ("Ensure availability and sustainable management of water and sanitation for all"). The paper considers challenges and obstacles on the way to achieving sustainable use of water resources of the Ros' River.

Materials and methods. Open data on enterprises that cause the greatest damage to the ecological state of the water resources of the Ros' River (the hydropower plants and the sewage treatment plants), their forms of ownership, as well as precedents regarding their violation of Ukrainian environmental legislation and the response of state authorities to this were analyzed.

Results. The enterprises that cause the greatest damage to the water resources of the Ros' River are privately owned. The Stebliv HPP (Fig. 1), is the most harmful HPP for this river. It shuts the river's flow to almost zero, causing maximal eutrophication. The "Bilotserkivvoda" LLC is a private company that holds the sewage treatment facilities of Bila Tserkva city in a concession, and is the biggest polluter of the Ros' River (sewage discharge into the Ros' River is shown on Fig. 2).

Fig.1. The dam of Stebliv HPP

Fig. 2. Sewage discharge of "Bilotserkivvoda" LLC

In Ukrainian legislation there are no effective mechanisms of influence on private business by the state regarding environmental protection. On the contrary, there are a number of legislative incentives for the maximum use (depletion) of these resources. The interests of private business are better protected by law than the natural environment is.

It should be noted that the predominance of business sectors based on the use of natural resources over technological and intellectual sectors based on is characteristic of relatively poor countries ("third world countries", developing countries).

Conclusions. Sustainable development ensures careful use of natural resources, particularly the balance of use and conservation. In turn, business, especially a private one, means the maximum use of resources, up to their depletion. One of the ways to preserve Ukraine's water resources is the reorientation of business from raw material industries to those that consume less use of natural resources (technological industries, *IT*).

THE EUROPEAN GREEN DEAL AS A ROAD MAP FOR THE RESTORATION OF ZAPORIZHZHIA

Olena Boika*, Iryna Poliakova
Zaporizhzhia National University, Zaporizhzhia, Ukraine
**Speaker: olena.boika.ua@gmail.com*

The European Green Deal outlines measures to reshape the EU into a more efficient, sustainable, and competitive economy. Its goal is to pave the way for Europe to become the world's pioneer in achieving climate neutrality by 2050. This initiative is designed to drive economic growth, enhance public health and well-being, and convert climate and environmental challenges into opportunities across all sectors and policies of the EU, ensuring an equitable and inclusive transition towards a greener future.

Key focal points of the Green Deal include preserving biodiversity, implementing a sustainable agricultural policy (through the Farm to Fork Strategy), promoting clean energy, fostering sustainable industry practices, advancing construction and renovation methods, encouraging sustainable transportation solutions, reducing pollution, and taking decisive action on climate change.

The main goals of the current Development Strategy of Zaporizhzhia city are the restoration of the city's environment to make it safe for living, enhancing the competitiveness of the economy, and improving the quality of life for the residents of Zaporizhzhia by attracting investments and rallying the community around the idea of sustainable urban development, which becomes particularly relevant during the post-war recovery of the city. Particular attention should be paid to restoration issues, particularly in light of the goals of sustainable development, as well as the modernisation and improvement of urban areas to better meet the needs of a sustainable society. Climate change adaptation is one of the most critical issues, accelerating over time. According to recent surveys, the residents of Zaporizhzhia city consider the following areas of restoration as priorities: construction and agriculture (42 %), healthcare (31 %), education and science (26 %), military industry (25 %), tourism (14 %), and heavy industry and metallurgy drew the most attention from respondents (51 %).

The European Green Deal can and should serve as the basis for developing post-war reconstruction programs for Zaporizhzhia city, with a mandatory modernisation of approaches to problem-solving and ensuring the city's sustainable development.

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CIRCULAR BIOECONOMY FOR SUSTAINABLE DEVELOPMENT IN UKRAINE

Maryna Yaremova*, Liudmyla Tarasovych
Polissia National University, Zhytomyr, Ukraine
**Speaker: yaremovam@ukr.net*

Today's global problems are a long-term confrontation between man and nature on the way to socio-economic growth. They are planetary and affect the interests of all peoples of the world, therefore there is a need to consolidate the efforts of the entire world community in overcoming destructive manifestations in the ecosystem that arise from thoughtless human economic activity. In the outlined conditions, there is a need for society to transition from a traditional classical economic model to a circular bio-economic one, which is considered one of the key directions on the way to achieving sustainable growth to overcome global challenges related to climate change, ecosystem degradation, social inequality, and economic well-being society. In addition, bioeconomic activity is carried out considering the factors of post-industrial society development, the focus of which is knowledge and high intellectual potential, implementation of new technologies, the increased role of information resources and communication processes, the inevitable growth of the service sector, etc. The activation of the mentioned processes makes it possible to provide a number of advantages for the country, namely the reduction of dependence on non-renewable energy sources, the rational use of available natural resources, the production of safe industrial and food products, ensuring food security, creating additional jobs in the conditions of the innovative production implementation and improving the state of the environment in general.

The development of a circular bioeconomy in Ukraine is vital in connection with the strengthening of environmental problems as a consequence of military operations in the country, the aggravation of social issues that require immediate resolution, as well as the increase of business risks. Therefore, rethinking the basic principles of conducting economic activity, taking into account the principles of long-term sustainable development is decisive for Ukraine, since, in addition to the possibility of solving local problems, it will make it possible to strengthen the investment attractiveness in the period of post-war reconstruction. The development of the circular bioeconomy will contribute to the positioning of Ukraine as a country with an innovative economy, socially responsible and ecologically conscious, which is important in the conditions of the need to overcome destructive manifestations as a result of the war now and the formation of a conscious society for the further European future.

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ENVIRONMENTAL LEGISLATION OF UKRAINE: TOWARDS THE EUROPEAN UNION APPROACHES

Igor Yakymenko*, Olena Dotsenko, Victoria Negretova, Oleksandra Pobuta, Maryna Grychenko, Svitlana Madzhd

National University of Food Technologies, Kyiv, Ukraine

**Speaker: iyakymen@gmail.com*

Environmental legislation of Ukraine is an important part of national legislation and based on fundamental principles of sustainable development. These include some particular articles of the Constitution (the main law) of Ukraine (VRU, 1996), the Law of Ukraine on Environmental Protection (VRU, 1995), relevant articles of Code of Ukraine on Administrative Offenses (1984) and Criminal Code of Ukraine (VRU, 2001) and many others. Starting from 2014, Ukraine began the implementation of key elements of EU legislation in terms of the EU – Ukraine Association Agreement (AA, 2014). And according to the Cabinet of Ministry of Ukraine, currently Ukraine implemented about 80% of European Union legal norms into national legislation as for the environmental protection (CMU, 2024). Good example of effective implementation of the EU laws into the legislation of Ukraine is an adapting a new Law of Ukraine on Waste Management (2022), which introduces European principles and European hierarchy in waste management into Ukrainian legislation.

Meanwhile, one of the crucial parts of the legislation of Ukraine, which needs urgent development is laws on legal responsibility for violators of environmental laws. For example, due to old-fashion Code of Ukraine on Administrative Offenses, Ukraine imposes just symbolic fines for environmental pollution, mostly no more than a few euros both for citizens and officials. Knowing these norms will rather provoke wrongdoers to break the laws than follow good social practices according to the law.

No doubt, all parties of the society – citizens, business, authorities and social services are interested in clean environment for present and future generations. That is why we believe, the work should be done urgently, even despite the other huge challenges for the country at the moment.

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SOME PECULIARITIES BIOFILM FORMING AT WASTEWATER TREATMENT IN BIOREACTORS

Serhii Telyma[1]*, Oleksandr Diatel[2]

[1]*Institute of Hydromechanics of National Academy of Science of Ukraine, Kyiv, Ukraine*

[2]*State Ecological Academy of Postgraduate Education and Management, Kyiv, Ukraine*

**Speaker: sertelyma@gmail.com*

In last years in Ukraine sharply worse the ecological situation of the water media. Therefore there is the necessity in construction and implementation of the modern technologies for wastewater treatment on the objects of the different profile. One of the method for improving of the quality of wastewaters which are polluted water media are treatment ones. Now most effective among them are methods of biological cleaning with using the bioreactors of the different construction.

In paper the analysis of the influence of some hydrodynamical processes and biochemical transformation on the characteristic and the structural peculiarities of the biofilm at the wastewater treatment in bioreactors of different constructions is carried out. The different types of biofilm and main its parameters which characterized its structure and exploitation possibility are considered.

In the theoretical investigations it is accepted that the biofilm consists of two parts namely the liquid phase in which dissolved substances are transferred by molecular diffusion and the solid part (base) which consists of from various bacteria, undissolved substances and inert material (Beynal et al., 2005; Henze et al., 2008; Oliynyk et al., 2023; Wanner et al. 2006).

In the whole carried out studies allows to do the next conclusions: for practical calculations of wastewater treatment the one-dimensional model of homogeneous biofilm is proposed taking into account on the obtained valuations and limitation of its using. Comparisons the calculation results with experimental data were shown that such homogeneous model in many cases has a good agreement with experimental ones. It can to say that the effectiveness of biological methods of removing pollutants of various origins in various bioreactors may be improved by means of the arrangement on the surface of the additional loading a fixed biocenosis with a high concentration of microorganisms (biofilm). To our mind the accepted homogenous model of a biofilm with uniform thickness requires further improvement relative forming its structure taking into account on the heterogeneity of its thickness, the forms of its surface, the influence of various hydrodynamic factors on the functioning of the one, the presence of other inactive substances in particular inert biomass and polymeric substances, etc.

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METHODOLOGY OF DIGITAL IT PROJECTS MANAGEMENT IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT STRATEGY

Olena Chukurna, Tetiana Tardaskina*, Violeta Alkhimova, Leonid Pankovets
State University of Intelligent Technologies and Telecommunications, Odessa, Ukraine
**Speaker: tardaskina@ukr.net*

The paper presents the theoretical justification of the digital IT project management methodology in the context of the sustainable development strategy. It was determined that modern trends in the development of design methodology should meet the goals of sustainable development and the standards of this area, as evidenced by the international regulatory framework in terms of achieving the goals of sustainable development. The limitation of scientific research in the part of the formation of the methodology of management of digital IT projects in the context of the implementation of the sustainable development strategy is indicated.

It was studied the main aspects of the formation of the methodology of managing digital IT projects, such as: Waterfall, Agile, Scrum, KanBan, Lean, DevOps. The advantages and disadvantages of each methodology and their compliance with the goals of the sustainable development strategy are determined. It has been proven that the functionality of the Agile methodology provides opportunities for the formation of the principles of sustainable development in terms of social responsibility of the project team and economic sustainability. Agile methodology involves the availability of technologies, tools and business models that allow achieving the goals of the sustainable development strategy. Kanban and Lean were included in such business approaches within the Agile methodology. It has been proven that almost all methodologies are focused on creating foundations for social interaction between project team members, thanks to which all approaches are aimed at realizing the goals of the sustainable development strategy.

A comparative analysis of functionality, scope of application (domain), advantages and disadvantages of the digital IT project management methodology was made. The advantages of digital IT project management methodologies, such as Waterfall, Agile, include increased labor productivity, reduced IT product time-to-market, improved IT product quality and functionality, and increased customer satisfaction. A conclusion was drawn regarding the high level of compliance with the strategy of sustainable development of Agile, Lean, DevOps methodology.

NON-DESTRUCTIVE ANALYSIS OF THE CONTENT OF MINERAL COMPONENTS OF CHICORY TO INCREASE ITS ENVIRONMENTAL SAFETY

Inna Popova[2]*, Igor Palamarchuk[1], Marija Zheplinska[1], Mikhailo Mushtruk[1], Volodymyr Vasyliv[1]

[1]National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine

[2]National University of Food Technology, Kyiv, Ukraine

**Speaker: ivpopova@bigmir.net*

Introduction. The content of heavy metals both in plants and in soils for growing agricultural crops steadily changes the state of ecological safety of the corresponding biocenosis. An increased amount of trace elements and compounds of heavy metals causes metabolic disorders in plant tissues. As a result, there is an accumulation of toxic elements in the crops, which disrupts the biocenosis in the system for both farm animals and humans. Therefore, the contamination of plant raw materials, in particular chicory, for the food industry with ions of heavy and toxic metals is a significant environmental problem (Marangu, 2021; Zavadska et al., 2023).

Materials and methods. The study was carried out on an Elvatex X-ray fluorescence spectrometer-analyzer (Elva X software) in automatic mode to search for the 60 elements that were considered the most likely. Chicory samples were previously dried and ground. Qualitative detection was performed in two modes of X-ray tube operation - with an X-ray tube current of 15 μA and 35 μA. To assess the effect of heat treatment on the content of mineral components, the elemental composition of dried samples was compared with the composition of similar ashed samples. Analysis of the elemental composition of hydrocarbon-containing raw materials was carried out by the X-ray fluorescence method. To study the influence of the matrix (carbohydrate) on the analysis results, some chemically pure carbohydrates, the most common in chicory plant material, were taken: monosaccharides - glucose, fructose, disaccharides - sucrose, polysaccharides - dextrin, as well as inulin in the amount of 1.0 or 1.5 g of variable amounts of cadmium, zinc, mercury and lead salts, namely from 0.1·10-5 to 4.0·10-5 mol of the corresponding salt.

Results and conclusions. The results of studies of the content of trace elements and their interaction with carbohydrates of vegetable inulin-containing raw materials are presented. X-ray fluorescence analysis was used to determine the content of 20 macro- and microelements in chicory roots. According to the results of the experiments, a group of samples was recommended for the determination of such elements as Cd, Zn, Pb and Hg, and the corresponding calibration curves were constructed.

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PESTICIDE CONTAMINATION OF HONEY

Oksana Tsekhmistrenko
Bila Tserkva National Agrarian University, Bila Tserkva, Ukraine
Speaker: tsekhmistrenko-oksana@ukr.net

Honey is a natural product, the composition, aroma, taste and color of which depend on the type of plant, geographical regions, climate and species of honey bees. The product contains carbohydrates, minerals, amino acids, vitamins, volatile chemicals, phenolic acids, flavonoids, and carotenoid-like substances (Size, 2022), thanks to which honey is used as a sweetener, anti-inflammatory, antioxidant and antimicrobial agent. Pesticides are a significant threat to the quality and safety of honey (Fikadu, 2020). The direct interaction of bees and the nectar of pollinated plants is a source of pesticides entering honey (Belsky, & Joshi, 2020) Pesticides are considered persistent organic pollutants and can persist in the environment through bioaccumulation and biomagnification in ecosystems, have chronic toxicity properties (Gupta, & Gupta, 2020) due to their carcinogenicity, neurotoxicity, adverse growth, endocrine disruption, or respiratory effects (Mejías, & Garrido, 2022). To determine the concentration of pesticides in honey, solid-phase and dispersion extraction, spectrometric and chromatographic analysis are used.

Data on bactericides, rodenticides and larvicides are rarely reported in the literature, as most studies on this topic have focused on the effect on the honey bee as a key insect (Gupta, & Gupta, 2020), however, the ability of organochlorine compounds to bioaccumulate can lead to lethal and sublethal effects for consumers. About 92 types of pesticides are recorded in commercial honey. Their presence is associated with the possibility of deterioration of sperm quality (organophosphorus pesticides) and a high risk of infertility in women (organochlorine type). Consumption of honey containing lindane may be associated with miscarriages, delayed implantation, shortened menstrual cycles, and even prostate cancer.

Currently, acaricides and fungicides have in common the fact that they are insecticides, the mechanism of action of which is to inhibit the enzyme acetylcholinesterase or one of its types of receptors (nAChRs), causing an adverse effect on the nervous system of certain organisms under study. Another group includes associations of chemical compounds classified as insecticides and neonicotinoids. When using this or that pesticide in your activities, you should understand their impact on the environment and possible toxicity and bioaccumulation in the human body and bees

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WET WIPES AS A CAUSE OF ENVIRONMENTAL PROBLEMS: A MINI REVIEW

Nataliia Tkachuk[1]*, Liubov Zelena[2], Yaroslav Novikov[1]
[1]T. H. Shevchenko National University "Chernihiv Colehium", Chernihiv, Ukraine
[2]Danylo Zabolotny Institute Microbiology and Virology, NAS of Ukraine, Kyiv, Ukraine
**Speaker: nataliia.smykun@gmail.com*

Our everyday life cannot be imagined without using various hygiene and cleansing products, wet wipes in particular, that protect us from undesirable pollution and contamination, and even could be used as a medical treatment. Besides all these positive aspects wet wipes can be very harmful for the different natural environments. The aim of this study was to analyze and summarize data from literary sources regarding wet wipes as a cause of environmental problems. Methods of theoretical research of available information, analysis of scientific and methodical sources on this problem, empirical method of accumulating facts, method of argumentation for proving own judgments were used. It has been established that the society produces and uses wet wipes in large quantities, and there is a trend towards an increase in the volume of their production and an increase in their volume on the market is expected in the future (IMARC, n.d.; Kyrychenko et al., 2020; Ramya & Amutha, 2021). Wet wipes pose a threat to the environment because they contain toxic compounds (surfactants, plastic) (Siegert, 2011) and have low biodegradability (Sülar & Keçeci, 2021). As a result, a number of environmental problems arise: 1) accumulation of wet wipes in the environment; 2) increase in greenhouse gas emissions; 3) pollution of water, soil, groundwater; 4) an increase in microplastics in the environment. To eliminate the environmental problems associated with wet wipes while maintaining the functionality of the products, it is suggested, first of all, to use eco-safe, biodegradable base fabric materials and non-toxic solutions for wetting. In addition, an important place is occupied by the formation of a conscious attitude of consumers of wet wipes to their disposal.

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THE ROLE OF FUNGI IN THE GREEN SYNTHESIS OF CdS QUANTUM DOTS: NANOBIOTECHNOLOGY APPLIED TO SOLAR ENERGY

Tatiana Cardoso e Bufalo[1]*, Helena Rabelo Freitas[2], Mylene Silva Ladislao[1], Carlos Godinho de Abreu[1], Hector José Valério Ardon[1], Joaquim Paulo da Silva[1], Eustáquio Souza Dias[1*]

[1]Institute of Natural Sciences - Federal University of Lavras, Lavras, Brazil

[2]Catalan Institute of Nanoscience and Nanotechnology, Barcelona, Spain

**Speaker: tatiana.cardoso@ufla.br, esdias@ufla.br*

Solar energy, the direct conversion of sunlight into electricity by a photovoltaic cell, is the most significant renewable technology and green energy source towards energy sustainability. Photovoltaic technology helps the mitigation of the effects of global warming, generating no greenhouse gas emissions on the process of generating electric power and, consequently, no pollution. The application of nanomaterials and nanocomposites in solar cells enhance solar light absorption, and can be easily designed by biological methods, resulting in more efficient and cleaner energy sources. The present work explores the ability of fungi to perform the green synthesis of CdS semiconductor quantum dots (CdS QDs) in order to assemble a quantum dot sensitized solar cell prototype. CdS QDs were synthesized by Pleurotus, Coprinus, Agaricus and Fusarium fungi. UVVis spectra of CdS QDs highlighted a broad band of absorption, while the luminescence spectrum revealed excitonic bands of nanoparticles with different sizes and TEM images showed that the CdS QDs were quasi-spherical in shape and had diameters ranging from 3-7nm. The innovative application of nanoparticles synthesized by fungi in solar cells relies on the assumption that the metabolites secreted by fungi can act as molecular linkers capable of adsorbing the QDs onto solid substrates so as to build an eco-friendly and efficient photovoltaic energy prototype.

WASTE FROM BAKING SODA PRODUCTION TO BE USED FOR BIOCEMENTATION

Iryna Kovshar*, Viktor Stabnikov
National University of Food Technologies, Kyiv, Ukraine
**Speaker: irynakovshar@ukr.net*

The current cost of the biocementation process prevents its widespread use in civil and geotechnical engineering. The use of industrial waste as raw materials for biocementation not only diminishes the cost of biocement, but also reduces the load on the environment, thereby contributing to its conservation. In baking soda production, for instance, calcium chloride ($CaCl_2$) is generated as a byproduct. Meanwhile, this compound is one of the necessary components for the production of biocement.

The production of baking soda involves several steps, including the utilization of carbon dioxide, CO_2 and ammonia, NH_3. CO_2 is chemically synthesized through the combustion of limestone, $CaCO_3$, in a lime calcining furnace operating at 900–1100 °C. This process yields CO_2 and calcium oxide, CaO. The lime is mixed with water to produce milk of lime, $Ca(OH)_2$, which participates in the ammonia regeneration reaction: $2NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2NH_3\uparrow + 2H_2O$ (Rakhmatzhanovna & Ibrokhimovich, 2023).

Calcium chloride finds application in the biocementation process as a source of soluble calcium ions, which in the presence of the enzyme urease and carbamide under alkaline pH conditions form insoluble crystals of calcium carbonate, which leads to clogging of pores and channels in building materials, increasing their strength and reducing hydraulic conductivity.

Contemporary research has identified two primary methods for biocementation utilizing urease: microbial precipitation and enzyme precipitation (Ivanov & Stabnikov, 2020). Microbial precipitation of calcium carbonate relies on urease-producing microorganisms, for example, such as bacteria as *Bacillus subtilis*, *Sporosarcina pasteurii,* and *Yersinia* sp. This method faces challenges due to the high cost associated with cultivating these microbes. Additionally, there's a concern about potential microbial contamination of the environment. Enzyme precipitation involves utilizing urease derived from various sources, primarily plants of such families as *Fabaceae* and *Cucurbitaceae*. Modern research is drawing attention to the potential use of urease extracted from the leaves (*Morus alba*), roots (*Glycine max*), and shoots (*Zea maize* L.) of certain plants, which are considered agro-industrial waste. This method is more environmentally friendly compared to microbial precipitation.

Indeed, integrating multiple approaches, such as utilizing $CaCl_2$ from soda production and plant-derived urease, can yield significant benefits. This combination has the potential to reduce costs while simultaneously enhancing the environmental friendliness of the biocementation process.

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SUSTAINABLE DEVELOPMENT OF CIVIL AVIATION: ENVIRONMENTAL ISSUES FOR UKRAINIAN AIRPORT RESTORATION

Kateryna Kazhan*, Iryna Yakymets
National Aviation University, Kyiv, Ukraine
**Speaker: kazhank@gmail.com*

The ongoing conflict in Ukraine has precipitated catastrophic damage to the nation's civil aviation infrastructure. Extensive damage dealt by Russian missile strikes has left many airports in a state of disrepair, halting most civil aviation activities. As Ukraine begins to contemplate the revival of its aviation sector, it is imperative to address the potential environmental ramifications that may accompany airport reconstruction and development. This study seeks to scrutinize the environmental concerns related to the sustainable progression of civil aviation in Ukraine, emphasizing the rehabilitation of airports post-conflict. It underscores the urgency of restoring air transportation, a critical lever for bolstering the local economy and general welfare, proposing immediate action to refine legislative frameworks, align with European Union regulations, and adhere to sustainable development principles recognized within the EU, such as the European Green Deal (EC, 2019). By prioritizing sustainability – including the adoption of environmentally conscious strategies, emissions mitigation, and the diminution of ecological footprints – Ukraine can meaningfully contribute to collective global initiatives aimed at combatting climate change, while simultaneously propelling ethical advancements within its aviation industry. This undertaking envelops an array of intricate concerns, from policy formulation and technological evolution to the convergence of stakeholder interests, rendering it both formidable and worthwhile.

Key recommendations include: developing a robust policy framework aligned with EU Green Deal objectives, including aviation-specific targets for greenhouse gas emission reduction and minimizing noise and air pollution; investing in sustainable infrastructure for airport reconstruction and modernization, incorporating energy-efficient, renewable, and eco-friendly design principles (Meindl, 2024); promoting sustainable aviation fuel infrastructures and fostering partnerships for clean aviation technologies; encouraging stakeholder engagement and capacity building within the aviation workforce for adherence to environmental regulations; implementing monitoring and reporting protocols to assess sustainability milestones.

This research presents a cohesive framework for sustainable aviation in Ukraine, highlighting the importance of environmental stewardship in shaping the industry's future.

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ENVIRONMENTAL SUSTAINABILITY: BIOTIC POTENTIAL OF HYDROECOSYSTEMS

Svitlana Madzhd*, Oksana Nychyk
National University of Food Technologies, Kyiv, Ukraine
**Speaker: madzhd@ukr.net*

The intensive inflow of pollutants into ecosystems necessitates the development of a methodology for assessing the state of ecosystem reliability in order to implement measures aimed at ensuring their environmental sustainability. The paper studies the distribution and redistribution of anthropogenic pollutants in hydroecosystems. The reaction of living organisms to the impact of pollutants is determined using the method of mathematical modelling. Changes in the self-regulation mechanism are described on the example of interconnected components of the Dnipro basin system: «small river - medium river - large river». It has been established that the constant trophic connections between the rivers of the Dnipro basin provide a homeostatic mechanism for the development of a single integrated basin system at different levels of hierarchical development. The obtained results allow us to consider the complex system of the basin as a set of hierarchical structures united by hydrographic interconnections and functionally (Ekins, 2021; Isayenko, 2019). The modeling results indicate a slight disturbance of the ecological balance and indicate the ability of hydroecosystems to restore ecological sustainability through the restoration of their biotic potential. The dynamics of changes in the biotic potential of hydroecosystems and the reliability of hydroecosystems based on the reliability theory are described using statistical and mathematical models. The results of determining reliability indicate that under conditions of intensive pollutant input, even highly reliable hydroecosystems are capable of probable failures of the functions of their specific elements. Based on the results of determining the reliability of hydroecosystems, the risks of their environmental sustainability were assessed and an algorithm for managing the reliability of the ecosystem to restore their natural environmental sustainability was proposed (Morelli, 2022).

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ECOLOGICAL ASPECTS AND POTENTIAL OF *EUGLENA GRACILIS* APPLICATION IN VARIOUS FIELDS OF SCIENCE AND TECHNOLOGY

Evgeniya Fedoryshyna*, Olena Semenova
National University of Food Technologies, Kyiv, Ukraine
**Speaker: zhenyaomelchenko0312@ukr.net*

Euglena gracilis is a unicellular organism that belongs to the *Euglenophyceae* class and has unique characteristics that make it the subject of intensive scientific research and application in various fields. In the presence of organic substrates in the environment, excess carbon and energy in cells is stored in the form of the polysaccharide paramylone. Its medicinal properties include its ability to stimulate the body's immune system, protect against infections, and have anti – tumour and radioprotective effects (Rodríguez-Zavala, Ortiz-Cruz, Mendoza-Hernández, & Moreno-Sánchez, 2010).

Microalgae is also recognised as a promising producer of vitamins A, E, C, complete protein, contains 59 types of nutrients, paramylon, waxes and polyunsaturated fatty acids, and is therefore used in the food industry and for livestock feed. It accumulates up to 97 % of α – tocopherol and β – carotene in its cells and can absorb large amounts of carbon dioxide (Rodríguez-Zavala et al., 2017). There are also opportunities for its use in the production of biopolymers and bioactive substances, for the creation of biodegradable packaging and tableware.

Euglena also accumulates biomass in domestic wastewater with a high content of nutrients, namely N_2 and P, reducing their concentration by 98 % and 85 %, making them successful bioagents for wastewater treatment (Nezbrytska, Shamanskyi, Pavliukh, &Gorbunova, 2022).

In Japan, buses running on biofuel made from this algae have already started running. The fats produced in the body by euglena during metabolism have a composition that makes them suitable for use as jet fuel.

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BIOMATERIALS BASED ON FUNGI MYCELIUM IN THE CONCEPT OF SUSTAINABLE DEVELOPMENT

Polina Prykhodko*, Olha Kaliuzhnaia, Natalya Khokhlenkova
National University of Pharmacy, Kharkiv, Ukraine
**Speaker: polinaprihodko30@gmail.com*

Materials based on fungi mycelium are being actively implemented today as an alternative to resource- and energy-consuming and quite often environmentally harmful production of textile, construction and other types of materials. Today, on the basis of fungi mycelium, the production of furniture and interior items, tableware, mycoleather and fabrics, accessories, building composite and polymer materials, and packaging materials is implemented. Artists and designers are adapting this new material to create a variety of eco-friendly products, such as the MarsBoot shoes designed by Liz Ciocajlo and Maurizio Montalti, the MycoComposite pot and transport boxes designed by Ecovative, the ecological lamp and the Sinewave panel by Krown led by Eric Klarenbeek. Temporary architectural installations are also realized by designers using mycelium, one such example being the Hy-Fi Tower by David Benjamin of The Living, New York Architects, which opened at the MoMA PS1 exhibition space in New York (Andrew, & Dhakal, 2022). Ukraine also has innovators in this field, for example, the Ukrainian startup S.Lab, which produces ecological materials based on technical hemp and fungi.

Biomaterials based on fungi mycelium are being developed at the Department of Biotechnology of the National University of Pharmacy, in particular as packaging materials, interior items, tableware, and building materials. Cultures of higher basidial fungi of the genera *Pleurotus ostreatus, Pleurotus citrinopileatus*, and *Lentinula edode* are used as research objects. The process of creating a biomaterial is based on solid-phase surface cultivation on the substrate, forming a mixed substrate with mycelium in the forms of the future product, growing under optimal conditions and baking the substrate in order to stop the growth of the mycelium and give the product strength (Zubkov, 2023). Cellulose-containing raw materials were used as the main substrate - oak sawdust, coffee husks, wheat seeds, which, firstly, acts as a model of the nutrient environments of mushrooms in nature, and secondly, is waste from other industries, which allows us to attribute the production of products to secondary processing industries, - also, they are cheap and available in our region. As mineral additives, gypsum and calcium carbonate were added to the substrate, which also give strength to the finished product, and wheat flour was used as an organic additive. Nowadays, this technology has been used to produce products based on fungi mycelium, and studies are being conducted to study the properties of the products.

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USE OF PROTEASES OF MICROORGANISMS TO SOLVE ENVIRONMENTAL PROBLEMS

Olena Gudzenko*, Liudmyla Varbanets
Zabolotny Institute of Microbiology and Virology, NAS of Ukraine, Kyiv, Ukraine
**Speaker:* alena.gudzenko81@gmail.com

The study of biochemical characteristics of proteolytic enzymes, conditions of their expression and influence on ecological processes are of great importance for understanding the dynamics of aquatic environments. Thus, exoproteases, in particular with collagenase and fibrin(ogen)olytic activity, produced by marine bacteria, play a key role in aquatic ecosystems. These enzymes break down proteins such as fibrin, fibrinogen, and collagen, which are then used by other microorganisms as a food source. Exoproteases also affect the availability of nutrients for phytoplankton and zooplankton, which are the basis of food chains in aquatic environments. It should be noted that all currently known producers of the above-mentioned proteolytic enzymes are mainly isolated from the waters of the Pacific Ocean and nearby seas, in particular, such as South China and East China (Bhagwat, P., Dandge, B., 2018). At the same time, sources of enzymes from other marine environments have been studied much less. Yes, only single producers are isolated from the Antarctic and the Indian Ocean. Microbial collagenolytic proteases play an important role in the global processing of collagen wastes, particularly fish yak, and can be used as a cost-effective alternative to mammalian collagen sources. About 75% of fish is thrown away as waste, which contains a high concentration of collagen. Fish collagen has many advantages over mammalian collagen and may therefore be a promising alternative to it.

As a result of the screening, active strains were selected among bacteria isolated from bottom sediments at depths of 1499, 888 and 2080 m in the Black Sea. The ability of exoproteases of supernatants of culture liquids of bacteria *Bacillus subtilis* 1, *Bacillus atrophaeus* 08, *Priestia megaterium* 035, *Priestia megaterium* 116, *Bacillus subtilis* 231, *Bacillus* sp. Myco, *Bacillus licheniformis* 249, *Bacillus subtilis* 248, to hydrolyze collagen, fibrin and fibrinogen was shown. It was established that two of the eight investigated bacterial strains, namely *Bacillus subtilis* 248 and *Bacillus subtilis* 231, are promising for their further research as producers of collagenases, fibrin(ogen)ogenases, and elastase. The study of the physicochemical properties of partially purified enzyme preparations of these strains showed that that *Bacillus subtilis* 248 and *Bacillus subtilis* 231 preparations differ in physicochemical properties, in particular, pH and thermooptimum. It was shown that the optima of the collagenase activity of the enzymes were: pH 7.0-8.0 and temperature 50°C for *B. subtilis* 248 and pH 9.0 and 11.0 (two optima) and temperature 15 and 50°C (two optima) for *B. subtilis* 231. The study of substrate specificity indicates that *Bacillus subtilis* 248 and *Bacillus subtilis* 231 may be promising for further scientific research as producers of proteases with collagenase, fibrin(ogen)ase and elastase activities. Thus, the investigated collagenases have the potential to become a powerful tool for achieving the goals of sustainable environmental development.

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SUSTAINABLE RECOVERY OF UKRAINE – EXPERIENCE AND OFFERS OF DTEK GRIDS

Olena Potapenko
LLC DTEK Grids, Dnipro, Ukraine
Speaker: PotapenkoEV@dtek.com

Ukraine acquired the status of a candidate for joining the EU on June 23, 2022. Environmental protection and combating climate change are one of the most important priorities for the implementation of the European Green Course. Energy facilities are purposefully destroyed by the aggressor, which brings not only challenges to the system, but also damage to the environment.

DTEK Grids develops the business of electricity distribution and operation of power lines in Kyiv, Kyiv, Dnipropetrovsk, Donetsk, and Odesa regions. Distribution system operators (DSOs) serve 5.4 million households and 150,000 legal entities. DSOs have restored more than 6,000 objects of electrical infrastructure and power supply in the homes of more than 11 million customers since February 24. Despite the war, the Company remains committed to the agenda of sustainable development and continues to develop the infrastructure of power grids.

A modern waste management system has been implemented in all DSOs. Waste is sorted by 40 types and sent for recycling as much as possible. In total, more than 2,000 containers for separate collection of waste have been installed. Employees are regularly trained. In addition, DTEK Grids supports the "Precious Plastic" project. A program on ornithological safety of electrical grids has been implemented, developed on a scientific basis in accordance with the recommendations of UNEP and BirdLife International since 2013. A complex approach to solving this issue makes it possible not only to protect birds, but also to increase the reliability of electricity supply. 5,561 bird protection devices have been installed on 48 km of power lines, including on the territories of the nature reserve fund and ecological Grids since 2013. 137 artificial nests for birds of prey were installed in 4 regions of Ukraine in 2021.

#EnergyWings is DTEK Grids project launched in 2021. 669 nests of the white stork, coiled on the poles of power lines, have been transferred to special platforms since 2013. DTEK Grids, in cooperation with the Western Ukrainian Ornithological Society, joined the international project of the Polish Society of Ornithologists Małopolskiego Towarzystwa Ornitologicznego on the study and protection of the white storks in 2023. Energy workers helped ornithologists ring 42 chicks.

At the same time, there are several problematic issues, the solution of which will help to obtain a synergetic effect. There is a tripling of waste reporting - business entities are required to issue up to 4 reports of similar content in various information systems. A cross-sectoral approach to the expansion and creation of nature reserve fund objects on lands where infrastructure objects are already located is needed. It is advisable to include research on the interaction between biodiversity and industrial facilities in the research plans of universities and research institutions to protect both biodiversity and industrial facilities.

We believe that our good deeds will continue and gain momentum outside the company. Ukraine's recovery must be green, according ESG principles. And we have already started the green restoration of Ukraine and the systematic implementation of European environmental protection standards. DTEK Grids plans to continue developing environmental protection projects. We invite you to cooperate.

RISKS AND PROBLEMS OF DRINKING WATER SUPPLY IN UKRAINE IN MODERN CONDITIONS

Tetiana Chorna[1]*, Nataliia Husiatynska[2]
[1]State Tax University, Irpin, Ukraine
[2]National University of Food Technologies, Kyiv, Ukraine
**Speaker: t.m.chorna@dpu.edu.ua*

Military operations and their consequences lead to a deterioration of the water situation. The analysis of information sources made it possible to identify the main risks and problems of drinking water supply in the current environment.

1. Damage to water resources as a result of the destruction of treatment facilities, dams, and the disruption of service organizations that provided water supply and wastewater treatment. As a result, untreated water enters water bodies, especially in areas of active hostilities (Life will be shorter after the war, 2022). In addition, the constant shelling of water pumping stations, water pipelines, sewage and treatment facilities makes it difficult for people to access drinking water.

2. Pollution of surface and groundwater due to the destruction of chemical warehouses and leakage of oil products. There is a significant threat of unauthorized dumping of human waste in cities with damaged municipal infrastructure, broken equipment in regions of active hostilities near water bodies, and as a result of unauthorized burials.

3. The threat of infectious disease epidemics and the destruction of aquatic ecosystems as a result of shallowing, water pollution, and damage to dams and dams.

4. Damage to hydraulic structures that regulated the flow of water; deterioration of water quality due to the flushing of pollutants and an increase in the concentration of biogenic and organic compounds in water due to the flooding of large areas (Environmental Forum: the impact of military operations on the environment, 2022).

5. Illegal withdrawal of Dnipro water from the Kakhovka reservoir and its supply to Crimea in violation of technological requirements (War and climate change threaten Ukraine's water security, 2022).

6. The seizure of water supply facilities by Russian troops and the temporary resumption of water supply to Crimea could lead to an increase in water shortages both on the mainland and on the peninsula (War and climate change threaten Ukraine's water security, 2022).

7. Complication of surface water monitoring, rapid response and adjustment under martial law, as a significant number of monitoring points are located in areas where access is absent or difficult (Environmental Forum: the impact of military operations on the environment, 2022).

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THE ROLE OF FAMILY HOMESTAD SETTLEMENTS IN THE ECOLOGICAL TOURIST ACTIVITIES AS GROWTH FOR SUSTAINABLE DEVELOPMENT

Mariia Plotnikova*, Oksana Prysiazhniuk, Oleksiy Buluy
Polissia National University, Zhytomyr, Ukraine
**Speaker: mfplotnikova@gmail.com*

Family Homestead Settlements are a modern phenomenon. They play a unique role in the development of the tourism industry. These settlements are based on the principles of community, self-sufficiency and harmony with nature. They become attractive to tourists who are looking for an alternative to traditional recreation (Goncharenko, 2021). Family Homestead Settlements are based on common values and traditions that create a unique cultural atmosphere. Tourists who visit such places have the opportunity to immerse themselves in the life of the community, learn about local customs and exchange cultural experiences. This enriches the experience of visitors, contributes to the preservation and popularization of cultural heritage. Family Homestead Settlements and ethnographic villages are becoming popular tourist attractions. This is explained by people's interest in the authentic culture, traditions and way of life of different peoples (Kilnitska, 2022). Ethnographic villages offer tourists a unique experience of learning about traditions. Visitors can get acquainted with the traditional life, crafts, folklore and cuisine of a particular nation. Tourists have the opportunity to communicate with cultural representatives, study about their customs and traditions, and enjoy recreation in nature. Ethnographic villages are located in picturesque places where you can enjoy fresh air, peace and quiet (Prysiazhniuk, 2020). This process is accompanied creation of new jobs. The formation of ecotourism stimulates the development of the local economy on the basis of sustainability, a traditional way of life. It allows you to avoid negative consequences for the environment. Preservation of cultural heritage and the preservation and popularization of traditional culture and crafts provides significant advantages of ecotourism in the conditions of Family Homestead Settlements. This enables local residents to sell their products to tourists and provide a variety of services. Therefore, ecological ecotourism becomes an important source of income for households of the population of the territorial community (Shvets, 2023).

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THE USE OF NANOPARTICLES FOR REMEDIATION OF THE ECOLOGICAL ENVIRONMENT OF UKRAINE CAUSED BY WAR

Svitlana Tsekhmistrenko*, Volodymyr Bityutskyy, Oksana Tsekhmistrenko
Bila Tserkva National Agrarian University, Bila Tserkva, Ukraine
**Speaker: svetlana.tsehmistrenko@gmail.com*

One of the most discussed topics in Ukraine today is the war and the environment. Millions of tone's of emissions are released into the atmosphere - fine dust, heavy metals, oil spills, non-metal oxides, aldehydes, anhydrides, etc. Removal of pollutants is usually problematic due to the complexity of the mixture of compounds, high volatility and low reactivity. New technologies and nanomaterial's are being developed for environmental remediation, and they are gaining considerable attention due to the unique physical properties of their materials, including increased reactivity and efficiency due to their higher surface-to-volume ratio compared to bulk counterparts. The surface of nanomaterial's can be supplemented with functional groups to act on specific molecules for effective recovery (Tsekhmistrenko et al., 2022).

The cleaning materials themselves should not be pollutants after use, given that the use of biodegradable materials does not create waste materials, does not require additional removal after treatment and offers a greener and safer alternative to environmental remediation. Capture of specific pollutants, cost-effectiveness, easy synthesis, use of environmentally friendly green chemistry methods, non-toxicity, biodegradability, recyclability and regeneration are the main issues in the development of new nanomaterial's for environmental remediation. Capture of specific pollutants, cost-effectiveness, easy synthesis, use of environmentally friendly green chemistry methods, non-toxicity, biodegradability, recyclability and regeneration are the main issues in the development of new nanomaterial's for environmental remediation. However, despite their advantages, some nanomaterial's are unstable under normal conditions, requiring special methods of preparation, additional manipulations to prevent agglomeration, increase monodispersion and stability, and can be toxic and produce by-products (Kamilov, 2023; Tsekhmistrenko, 2022).

There are several engineered nanomaterial's (carbon nanotubes, nanocomposites, quantum dots, fullerenes, quantum wires and nanofibres), a wide range of commercial products (metals, ceramics, polymers, smart textiles, cosmetics, sunscreens, electronics, paints, varnishes) for which nanomaterial's are purposefully manufactured to achieve specified characteristics, and natural nanoparticles (dust, wood and diesel combustion products) (Kamilov, & Valikhonov, 2023).

Nanomaterial's (inorganic, carbon and polymeric) that can be used for environmental remediation can improve the environmental situation in Ukraine.

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THE PRINCIPLE OF ENSURING ECOLOGICAL CONTINUITY IN THE ZONES OF INFLUENCE OF PUBLIC ROADS

Tetiana Morozova
National Transport University, Kyiv, Ukraine
Speaker: tetiana.morozova@ukr.net

The ecological footprint of the road network exceeds its length, which is due to environmental impacts such as animal mortality on roads, landscape fragmentation, and other factors. These impacts include loss of biodiversity, decrease in populations, and reduced levels of connectivity in the ecosystem. In addition, roads contribute to soil erosion, the spread of invasive species, and other forms of pollution. To reduce this negative impact, various technical means can be used, such as eco-transitions and screens. Particular attention should be paid to identifying the most vulnerable species and the risks to their populations, as well as the possibility of mitigating these risks. Roads passing through natural areas can cause negative impacts on ecosystems and species, so it is necessary to take measures to reduce this environmental footprint, in particular through the correct laying and planning of roads. The problem of the impact of transport infrastructure on biodiversity lies in the fragmentation of the landscape, that is, the loss of the territorial and structural integrity of ecosystems. This leads to a variety of consequences, such as barrier effects, isolation and loss of species ranges, which threatens their survival and distribution. A decrease in the number of victim populations can cause changes in energy flows and genetic diversity, which worsen the state of the ecosystem. The barrier effect, or the formation of obstacles to the movement of animals, is one of the most negative consequences that can affect the survival of species. The application of biotransitions and engineering solutions, as well as careful infrastructure planning, can help reduce these negative impacts and ensure ecological continuity in the landscape.

For most large mammals, transport infrastructure becomes a barrier only when there is a high traffic intensity or the presence of fences. Fences enhance this effect, but they can be used for animals to cross roads safely. For invertebrates, the road surface also performs a barrier function, since they avoid crossing roads due to fear and poor condition of the pavement. Large species often avoid areas near roads due to noise, and small mammals and birds avoid large open spaces. An effective measure may be to align two or more types of transport infrastructure along the same corridor or to place parallel routes as close to each other as possible. It is difficult to assess the impact of transport facilities on wildlife, but it is important to take into account the possible damage to rare species and the environment.

Roads cause the formation of communication and tape landscapes by compaction and anthropogenization of roadside ecotopes, which leads to the destruction of biotopes for every 2.5 km of the route. Roadside habitats are dominated by ruderal vegetation. Transport infrastructure has a negative impact on the animal world, causing the mortality of animals when trying to overcome isolated sections of roads, as well as the formation of anthropogenic zoocenoses and the loss of synecological ties. Roadsides attract a diverse species composition of organisms, such as insects and birds, that find optimal living and feeding conditions that can affect the ecosystem. Habitat fragmentation caused by roads leads to the extinction of populations of many species and creates barriers to animal migration, which can lead to death and declining populations.

EFFECTIVENESS OF USING MEDIA COMMUNICATION IN ENVIRONMENTAL GOVERNANCE

Olena Mykhailovska
Chernihiv Polytechnic National University, Chernihiv, Ukraine
Speaker: m-olena@ukr.net

The paper examines the effectiveness of media communications in enhancing environmental governance and influencing public behaviour toward sustainability. The research synthesises findings from various investigations to assess how different forms of media shape public perceptions, engage communities, and support environmental policy initiatives. By integrating empirical data and theoretical insights, the paper explores the dynamic role of media in promoting environmental awareness and pro-environmental behaviours. It highlights the pivotal function of digital platforms in disseminating information rapidly and engaging a broad audience. The paper discusses the impact of media credibility and the strategic framing of messages on enhancing public compliance with environmental policies. Key findings indicate that effective media communication can significantly boost public involvement in sustainability initiatives and influence individual behaviours. The research underscores the necessity for continuous monitoring and adapting media strategies to keep pace with public sentiments, ensuring that environmental messaging remains effective and relevant. The paper offers evidence-based recommendations for policymakers, environmental activists, and corporations, aiming to optimise the use of media communications to foster a more informed and engaged public in support of sustainable development goals. This comprehensive approach sheds light on the current state of media influence on environmental governance and provides a roadmap for future research and practical applications in the field.

PROCESSING OF ORGANIC WASTE IN UKRAINE AND THE EU

Oksana Salavor[1]*, Nataliya Bublienko[1], Oksana Nychyk[1],
Yevhen Lukashevich[2], Yuliya Voytenko Palgan[3]
[1]National University of Food Technologies, Kyiv, Ukraine
[2]Ukrainian Technological Company, Kyiv, Ukraine
[3]Lund University, Lund, Sweden
**Speaker: oksanasalavor7@gmail.com*

In 2022 Ukraine received official status as a candidate for EU membership which brings Ukraine closer to high European environmental standards. Implementation of European strategy within the framework of the European Green Deal will bring Ukraine closer to the model of circular economy and the sustainable development. Effective waste management is one of pillars of the strategy.

The waste framework Directive 2008/98/EC introduces a five-step waste hierarchy where prevention is the best option, followed by re-use, recycling and other forms of recovery, with disposal such as landfill as the last resort.

Organic waste, represents a valuable resource that deserves greater attention. Organic wastes are those prone to biodegradation under aerobic or anaerobic conditions. The placement of organic wastes in landfills leads to bacteriological pollution of water sources, soils, and forming harmful gases that have the greenhouse effect.

Two main directions of organic waste management were analyzed: composting and anaerobic fermentation with biogas production. These ways of using waste correspond to the principles of the circular economy and help to use the existing potential of waste.

Anaerobic digestion of waste is preferred over composting, as both energy resources (biogas) and biofertilizers (digestate) are obtained as a result. Biogas can be purified to biomethane, as well as converted into electrical and thermal energy.

The use of organic waste of various origins (households, agricultural raw materials, food enterprises, municipal wastewater, etc.) for the production of biogas or biomethane is actively developing in European countries. There is a growing trend in the production of biomethane - purified biogas, which has a wider application than biogas. European countries are intensifying the production of energy carriers from organic waste to reduce dependence on natural gas imports.

Ukraine has a great potential for the development of biogas and biomethane technologies, considering the large amount of generated organic waste and residues of agricultural raw materials. The European long-term experience in managing organic wastes is successful and different, given its diversity depending on the member countries. Analysis of successful practices of organic waste processing in the EU is important for more effective development of this direction in Ukraine.

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БІОХІМІЧНІ ПОКАЗНИКИ КРОВІ ВРХ ЗА ТРИВАЛОГО УТРИМАННЯ НА ЗАБРУДНЕНІЙ РАДІОНУКЛІДАМИ ТЕРИТОРІЇ

Микола Лазарєв, Алла Клепко, Лілія Калачнюк*
Національний університет біоресурсів і природокористування України
**Доповідач: lilkalachnyuk@gmail.com*

Представлені нижче результати обстеження тварин вказують на порушення обмінних процесів у організмі корів різних груп, але відокремити вплив радіаційного фактору наразі неможливо через подібність процесів у всіх дослідних групах, що свідчить про вагомий вплив як екологічних, так і зоогігієнічних умов господарського утримання (перш за все годівлі) худоби.

Система крові в цілому (і периферійна кров зокрема) є однією з радіочутливих систем організму. Середи змін картини крові, що виникають у периферійної крові, найбільш ранніми і достатньо зручними для виявлення біологічних ефектів дії іонізуючих випромінювань є зміни її морфологічного складу (Лазарєв, 2023).

Порівнюючи показники гормонального статусу тварин з найбільшим впливом радіаційного фактору – 40-80 Гр на щитоподібну залозу (ЩЗ) та біля 1Гр на весь організм з такими ж із меншими параметрами радіаційного впливу, виявляють тенденцію до зниження концентрації тиреоїдних гормонів за більших доз опромінення ЩЗ, хоча в обох групах рівень даних гормонів був нижчим за норму.

Аналіз біохімічних показників демонструє різнобічні відхилення за впливу двох чинників: 1) рівня забруднення території та 2) впливу пори року (березень, липень), звідси, умов годівлі та складу раціону тварин.

Основна увага приділялася змінам у перебігу метаболічних процесів і функціонуванню всього організму в цілому й окремим органам, зокрема печінки, та іншим гепато-асоційованим відхиленням.

З аналізу таких біохімічних показників, як: активність амілази, аспартат- і аланінамінотрансфераз, глутатіонпероксидази, концентрація церулоплазміну, загального білку, холестеролу, сіалових кислот та гідроперекисів ліпідів, можна констатувати, що спостережувані їх відхилення свідчать про порушення функціонування як організму в цілому, так і його органів, особливо печінки, яка задіяна в детоксикаційних процесах.

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ECONOMIC GROWTH FOR SUSTAINABLE DEVELOPMENT

ENVIRONMENTAL START-UPS IN THE SOLAR ENERGY SECTOR: SOCIAL INITIATIVES OR PROFITABLE PROJECTS?

Tetiana Stroiko[1], Carlos de las Heras Jambrino[2]*, Patricia P. Iglesias Sánchez[2]
[1]V. O. Sukhomlynskyi National University of Mykolaiv, Mykolaiv, Ukraine
[2]Universidad de Málaga, Málaga, Spain
**Speaker: carlosdelasheras@uborasolar.com*

A special category of startups is social startups, which primarily seek to solve a certain social, environmental or cultural problem, and not to make money on it. This approach makes it difficult to monetize and attract funds, which endangers their survival. A typical startup measures success by revenue and profit. The goal of a social business is to recoup its costs (optimistic scenario) and solve a social problem. Its success is measured by impact (positive impact, return). We have to prove that green start-ups (alternative solar energy) can be effective business projects that can ensure project profitability and realize social and environmental benefits.

In recent decades, the world has seen a tendency to move away from traditional sources of energy to alternative ones. A responsible business, realizing the importance of preserving the environment, tries to minimize the negative impact of its activities on the environment. On the basis of global reports, the development of the global market for green technologies and sustainable development is studied. According to experts, it has been proven that the growth of green technologies is ahead of the predicted indicators (Sachs et al., 2023).

As of January 15, 2023, there are 80 Climate Tech Unicorns around the world who are now collectively valued at $180B+ (GCTU,2024). The global GreenTech and sustainability market was estimated to hold around $417 billion by 2030 (Statista, 2023).

At the end of 2021, solar energy in Ukraine accounted for more than 5% of total electricity production. As of the end of 2021, the total capacity of solar power plants was 6320 MW (excluding those located in the temporarily occupied territories). In recent years, Ukraine has had one of the highest rates of solar energy development in Europe (UEE, 2024).

The peculiarity of eco-startups is that they are created not only to make a profit, but primarily to solve the problem of environmental protection. Therefore, the implementation of such projects will also contribute to the formation of an environmentally conscious generation.

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THE INTERCONNECTED NATURE OF SUSTAINABLE DEVELOPMENT GOALS: A HOLISTIC APPROACH TO GLOBAL DEVELOPMENT

Oksana Liashenko[1]*, Olga Demianiuk[2]
[1]*Universidad de Sevilla, Seville, Spain*
[2]*West Ukrainian National University, Ternopil, Ukraine*
**Speaker* oliashenko@us.es

The Sustainable Development Goals (SDGs) represent a holistic framework designed to address the most critical challenges faced by humanity, ranging from eradicating poverty to preserving the environment. Central to the SDGs is recognising the profound interconnections among different aspects of sustainable development where economic, social and environmental targets are intertwined in the unified framework of 17 SDGs (Griggs et al., 2013; Nilsson et al., 2016).

Understanding the interdependencies among the SDGs is crucial for crafting effective policies that can anticipate and address associated risks. Ensuring coherence and harmony in policymaking is essential to avoid conflicts between different objectives and to promote a well-rounded and inclusive approach to development. Ultimately, the interconnected nature of the SDGs highlights the significance of sustainable development strategies that harmonise economic advancement, social inclusivity, and environmental conservation, thereby nurturing resilient and fair societies for generations.

Rather than focusing on specific interactions among SDGs, we take a holistic approach to unveil the underlying factor complex governing these relationships. By examining the intricate interplay of various SDGs as interconnected factors, our study provides a comprehensive understanding of how these factors collectively shape sustainable development pathways. That will help to facilitate informed decision-making and policy formulation by offering insights into SDG synergies and trade-offs.

Empirical analysis has shown that the essential SDGs that have a synergetic effect on SDG Index Score are: Goal 1 “No Poverty” (targets eradicating extreme poverty by ensuring access to resources and social protection); Goal 4 “Quality Education” (strives for inclusive and equitable education opportunities); Goal 7 “Affordable and Clean Energy” (focuses on sustainable energy access); Goal 10 “Reduced Inequalities” (aims to promote social inclusion); Goal 14 “Life Below Water” (emphasises marine conservation); Goal 15 “Life on Land,” (prioritises terrestrial ecosystem preservation); Goal 17 “Partnership for the Goals” (stresses global cooperation for sustainable development). These goals collectively address fundamental challenges toward a more equitable and sustainable future.

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ACCELERATING SUSTAINABLE BUSINESS TRANSFORMATION

Tetiana Sobolieva*, Anna Dobropas
Kyiv National Economic University named after Vadym Hetman, Kyiv, Ukraine
**Speaker: sobolieva_tetiana@kneu.edu.ua*

Indicators of economic development, focused on the intensification of production and consumption, which is the basis of modern models of national economies, neglect the importance of the current problems of our time, such as global warming, environmental pollution, inequality and low social standards. An important prerequisite for the transition of development on the basis of sustainability is the transformation to sustainable consumption and production.

Sustainable Development Report (Sachs et al., 2023) estimates national SDG Index for different countries. In 2023, Ukraine took 38th place with scores of 76.5 among 166 countries according to the index of sustainable development goals. An important accelerator of sustainable development is the transition of companies to the principles of sustainability and green management practices, implementing sustainable development strategies and circular business models. Research (Babiak&Trendafilova, 2011) indicates that organizations are aware of the economic potential of environmental CSR and are motivated not only by concern for the environment, but also perceive such initiatives as a source of innovation and competitive advantage.

The analysis of 32 quantitative studies carried out by Molina-Azorín *et al*. (2009) demonstrated that regardless of the country, industry and company type, the positive influence of environmental management on financial indicators prevails. Based on econometric analysis, Iraldo *et al.* (2009) confirm that a well-developed environmental management system has a positive effect on the environmental performance of companies, and also stimulates the introduction of relevant technical and organizational innovations. Greening of the organizational culture involves the constant support of environmental initiatives by the management of the organization and changing the guidelines in the behavior of employees.

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UKRAINIAN NATIONAL POLICY IN AGRARIAN SECTOR COMPETITIVENESS PROMOTION CONSIDERING THE SUSTAINABLE DEVELOPMENT CONCEPT

Tetyana Sokolska*, **Olha Shaitor**
Bila Tserkva National Agrarian University, Bila Tserkva, Ukraine
**Speaker: tetyana.sokolska@gmail.com*

In the conditions of world economy globalization accompanied by a dramatic change in the environment, the priority task of the state is to ensure national security and a high level of the economy key sectors competitiveness, with the agri-food sector among the important ones in our country (BNAU, 2019). Ukraine's agriculture with its leading place in the commodity structure of exports and thus contributing to the development of other industries, has remained export-raw material and import-dependent sector so far (Borodina, 2018). Along with general positive evaluation of the Government actions in terms of the agrisector support, we believe that the future state agrarian policy should be aimed at forming a new post-war model of its development with a balance of economic, ecological and social components meeting the goals of sustainable development. At the same time, the key direction of the industry modernization of in the conditions of a full-scale war is increased the level of agricultural raw materials processing, the reconstruction of damaged infrastructure and the construction of modern facilities. In the conditions of post-war recovery, the diversification of the agricultural production development should be ensured through increase in the capitalization and the investment attractiveness of agricultural enterprises. To this end, it is necessary to promote the equal development of all organizational and legal forms of business through institutional and financial support of medium and small producers of agricultural products. Farms and individual peasant farmsteads can be considered as points of economic growth, which ensure the livelihood of a significant part of rural areas and integrate small private households around them. Having a competitive advantage over many other countries in the process of digitalization, Ukraine is able to quickly introduce modern technologies into Ukrainian agricultural research and business and give a powerful impetus to the development of the industry through creating a unified information support system for agricultural producers and using modern technical means of design and programming based on IT technologies through the Internet, as well as involving higher education institutions in this activity. In order to implement an innovative model of the agricultural sector development and to activate economic growth, it is advisable to establish long-term relationships between the entrepreneurial activity subjects through public-private partnerships, agrarian clusters and technology parks, interaction of state and local authorities with self-regulatory organizations, partnership at the local levels regarding the support of rural communities initiatives in the development of the their social infrastructure. The formation and development of human capital through the support of agricultural education and science, training and retraining of personnel is another factor in increasing the industry competitiveness.

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THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF THE INNOVATION PROCESS IN THE SYSTEM OF SUSTAINABLE DEVELOPMENT

Larysa Strashynska*, Volodymyr Strashynskyi
National University of Food Technologies, Kyiv, Ukraine
**Speaker: vip1967@ukr.net*

In the conditions of world globalization, sustainable development becomes more important, which is possible only under the condition of socio-economic upliftment, preservation of the natural environment, elimination of all types of conflicts and poverty, etc., which is carried out at the national, regional and local levels.

One of the components of Ukraine's transition to sustainable development was the economic system, the structural reorganization of which was to be carried out by transitioning from an extensive-type industrial-agrarian model to a competitive innovative market economy with an intensive type of development. One of its components is the national innovation system. Such a system operates in the USA and leading European countries. It was formed on the basis of private business and a small share of the state. In Ukraine, the innovation system should consist of several sectors connected by a set of legal mechanisms and financial and economic instruments to support these processes, such as scientific research, development of new technologies, manufacturing of innovative products and their final consumption. The absence of any component negatively affects the innovation process as a whole.

The innovation process is the transformation of scientific knowledge into an innovation or a sequential chain of actions during which the innovation goes from an idea to a concrete product, technology (intellectual good) or service, spreading during practical use.

Several generations (stages) of the innovation process are distinguished. The first generation is associated with a linear-sequential process, in which scientific and technical works play an important role. Its existence dates back to the 1950s - mid-60s of the 20th century. The second generation of the innovation process dates back to the late 1960s and early 1970s and is characterized by the presence of a linear-sequential model, in which the market and the needs of scientific and technical works play an important role. The third generation was observed in the period from the early 1970s to the mid-1980s and was characterized by the presence of a combined model of interdependence between technologies and consideration of market needs. The fourth generation of the innovation process model emerged in the mid-1980s. The model is identical to the Japanese model of best practice, which is characterized by the phenomenon of parallel activities. The last is the model of the fifth generation of the innovation process (the model of the present and the future), which is associated with the model of strategic networks and integration, establishing connections. Its difference from the previous ones is due to the fact that new functions are added to the parallel process, among which the process of conducting scientific and technical works using the information technology system is distinguished.

Having analyzed the existing models of the innovation process, it should be noted that this process does not end with implementation, because due to the diffusion of the innovation, the product that is brought to the market is improved. It is characterized by the phenomenon of efficiency and the acquisition of previously unknown consumer properties.

NAVIGATING CHALLENGES: NGO DEVELOPMENT IN POLAND AND UKRAINE

Tetiana Popova
Poltava State Agrarian University, Poltava, Ukraine
Speaker: popovatatiana89@gmail.com

The development of non-governmental organizations (NGOs) in Poland and Ukraine has been influenced by various factors, including legal frameworks, historical contexts, and ongoing challenges. Poland has had a faster progression, because it established its legal framework for NGOs earlier, allowing for a longer period of development and professionalization. Establishing legal frameworks for NGOs not only aids their advancement but also clarifies their definition. Employing a structural-operational approach based on characteristics observed in various countries helps define NGOs accurately (Popova, 2013). Understanding their non-profit nature is crucial for society to recognize them as distinct self-help and self-governance organizations. Common challenges in the third sector of both Poland and Ukraine include struggles with funding and resource availability for NGOs. Polish NGOs secure financing from diverse sources, including donations, subsidies, business activities, and grants, while also benefiting from a tax deduction. Similarly, Ukrainian NGOs rely on funding from charity, membership fees, and governmental budgets, with additional support coming from donor organizations like the United Nations Development Program and the European Union (Prostir Center for International Studies, 2019). When considering the overall diversity of funding sources, Poland appears to have a more diverse funding landscape. The inclusion of commercial services, business revenue, and the 1% tax contribution showcases a broader range of financial resources available to NGOs (Dąbkowska-Dworniak, 2020). The experiences of Polish NGOs offer valuable insights for Ukraine's NGO sector. Diversifying funding sources, improving the legal framework, enhancing capacity-building efforts, and promoting collaboration are key strategies that Ukraine can adopt to overcome challenges and foster a more robust NGO environment, drawing from Poland's experiences.

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THE POSSIBILITY FOR SUSTAINABLE DEVELOPMENT UNDER MILITARY-ECONOMIC CYCLICITY

Vasylyna Podliesna
Institute for Economics and Forecasting of NAS of Ukraine, Kyiv, Ukraine
Speaker: podlesnw2019@gmail.com

Large-scale wars are an integral component of cyclical social development. In the course of large-scale wars in historical retrospect there was a resolution of contradictions of social development, but the very periods of intensified military operations are a time of turbulence and slowdown of those constructive social processes that bring sustainable socio-economic development closer. The achievement of the goals of implementing the concept of sustainable development, first of all the elimination of poverty, hunger, ensuring good health and well-being, quality education, decent work and economic growth, reduction of inequality, is now hampered by the aggravation of geopolitical contradictions, and in countries that have become a space of localisation of the resolution of these contradictions by military means, is becoming impossible in the foreseeable future. The implementation of the concept of sustainable development contributes to the resolution of deep inter-class, inter-country and inter-civilisational contradictions, the periodic aggravation of which leads to deep systemic crises of the capitalist world-system, the exit from which occurs in the process of deployment of crisis-militaristic phases of global military-economic cycles.

Military-economic cycles are a special form of socio-economic cyclicality generated by the struggle of social units (in historical retrospect) or complex social organisms - the actors of geopolitics (under capitalism) for resources that guarantee the winners in this struggle for economic and military-political leadership, the opportunity to dominate in the long term and successfully develop. Each historical form of the political-economic system of domination, which was established as a consequence of war, contained the preconditions for the next war - deep socio-economic, political, civilisational contradictions. The cyclical dynamics of global military-economic processes is formed by the unity of a variety of different forms of military-economic cycles, among which the leading role is played by the long cycles of world politics by J. Modelski and W. Thompson and the cycles of hegemony by I. Wallerstein, the deployment of which is coordinated with the Kondratiev cycles.

Today it is necessary to consolidate all the actors of geopolitics to achieve the goals of sustainable development, which will stabilise the global political-economic system, resolve its most antagonistic contradictions, smooth out cyclical fluctuations, and reduce the dynamism of crisis-militaristic phases of military-economic cycles. In modern conditions, in order to avoid large-scale human casualties, economic and environmental damage from warfare, which are threateningly increasing with scientific and technological progress, one of the guidelines for sustainable development should be the transformation of crisis-militaristic phases of global military-economic cycles into non-militaristic phases of cyclical geopolitical processes. Successful achievement of sustainable development goals is possible only if the capitalist economy and public consciousness are demilitarised.

CHANGING DIRECTIONS IN THE DEVELOPMENT OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES

Ganna Kolomiyets, Olga Melentsova*
V. N. Karazin Kharkiv National University, Kharkiv, Ukraine
**Speaker: omelentsova@karazin.ua*

We encounter artificial intelligence (AI) every day. This includes voice search - Siri and Alexa, which are available on iOS, Android and Windows, video games - characters that can behave unpredictably for the player, autonomous cars that can analyze the situation on the road and act on their own, online customer support on websites, recommendations of products that may be of interest to the consumer, which is created as a result of the analysis of visited Internet pages.

Analysts of the international consulting agency PwC believe that AI will become the main market trend and the best business tool in the next decade. According to the latest report, the contribution of intelligent technologies to the global GDP is estimated at USD 15.7 trillion. Experts predict that AI will help to increase this figure by another 14% by 2030. China will be the leader in the successful exploitation and adaptation of AI technologies. It is expected that by 2030, its GDP could be 26% higher than the global average. According to analysts, the financial services, retail, and healthcare sectors will benefit the most from AI technologies.

A WIPO study (1) documents that the number of AI-based inventions has increased dramatically in recent years. The leaders in the number of such inventions are the American companies IBM and Microsoft. This growth is explained by the fact that in recent years, AI has turned from a theoretical concept into a real product that is gaining ground in the global market.

Deep Knowledge Analytics has compiled the Artificial Intelligence Industry in Eastern Europe rating by the number of companies operating in the AI field (2). Ukraine is one of the three leaders among Eastern European countries (57 AI companies operate in Ukraine).

With the technological development of AI, the issues of legal regulation have become more acute. The most practical measures in this area are taken in the European Union. The European Parliament adopted Resolution 2015/2103(INL) on the civil law regulation of robotics with recommendations for the European Commission (2). An analysis of the document's content allows us to identify several main blocks of issues. It is worth noting that this Resolution is one of the first real steps towards legislative consolidation of standards for the development and use of AI. The next important step is to consolidate these aspects at the legislative level, as is currently being done in the West, where there has long been an understanding of the direct impact of innovation on the overall development of the state.

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THE USE OF ADVANCED IT TECHNOLOGIES IN HR OPERATIONS

Anastasiia Dukhnenko
Kyiv National Economic University, Kyiv, Ukraine
Speaker: anaduh1805@gmail.com

In the current context, there is an urgent need to closely align human resource management with the business strategy of the organization. To achieve this, companies worldwide are implementing modern HCM (Human Capital Management) systems, significantly enhancing the efficiency and speed of decision-making in HR through automation and data analysis.

The emergence of artificial intelligence and machine learning technologies has greatly expanded the capabilities of HCM systems. These technologies leverage large volumes of data to provide predictive insights, personalized recommendations, and decision support. Access to AI tools increases productivity by an average of 14% (Brynjolfsson, 2023). Although AI and ML offer transformative potential, ethical concerns regarding data confidentiality, job displacement, and algorithmic bias are increasingly arising.

Among Ukrainian companies, Russian software such as BAS is still widely used, forming the majority of Ukraine's business infrastructure. Disregarding the ethical component of this issue, it can be argued that domestic organizations deprive themselves of advanced technologies and practices that have emerged as a result of the introduction of high-tech HCM solutions on the global market.

Therefore, the integration of high-tech solutions fundamentally changes human resource management methods. By leveraging machine learning algorithms and advanced statistical tools, organizations can make more informed decisions, optimize HR processes, and enhance the employee experience. However, it is crucial to consider ethical issues and ensure appropriate technology use, fostering transparency and trust in the workplace environment. The impact of artificial intelligence on HR processes is expected to continue growing, creating impressive opportunities for development and encouraging Ukrainian businesses to abandon outdated solutions.

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MARKETING ASPECTS OF FRUIT AND BERRY PRODUCT EXPORT

Volodymyr Khlivetskyi
Dmytro Motornyi Tavria State Agrotechnological University, Melitopol, Ukraine
Speaker: khlivetskiy.v@gmail.com

The fruit and berry market is a traditional branch of Ukraine's agricultural sector. Currently, a portion of the industry's economic potential can be realized through exporting products to the European market. To achieve this goal, market research has been conducted and an export plan has been developed.

The analysis utilized the Harmonized System code for the description and coding of goods of the World Customs Organization 2012 edition.: 081110 Frozen strawberries, uncooked or cooked by steaming or boiling in water, whether or not sweetened. The economic activity of enterprises was examined according to the code 10.3 (Processing and preserving of fruit and vegetables) according to the classification of types of economic activity of the European Community (NACE Rev.2). Using the Trade Map resource (Trade Map, 2024), the trade balance of EU countries was investigated to identify markets that are potentially attractive for domestic export of frozen strawberries. An analysis of data over recent years revealed priority markets (Access2Markets, 2024), wherein Germany, France, the United Kingdom, Austria, and Italy have a negative trade balance (imports exceed exports).

Germany: the country has a negative trade balance of $120.4 million. The value of imports is $146.7 million, with a share of 10.1% in global imports. The share of enterprises producing frozen strawberries is 6.5% of the total in the EU-28. It's worth noting that the market has seen a yearly decrease in imports over the last 5 years (5%). France: the country has a negative trade balance of $85.5 million. The value of imports is $100.6 million, with a share of 6.9% in global imports. The share of enterprises producing frozen strawberries is 13% of the total in the EU-28. The market has seen a yearly decrease in imports over the last 5 years (1%). United Kingdom: the country has a negative trade balance of $34.9 million. The value of imports is $36.2 million, with a share of 2.5% in global imports. The share of enterprises producing frozen strawberries is 4.2% of the total in the EU-28. The market has seen a yearly increase in imports over the last 5 years (1%). Austria: the country has a negative trade balance of $20.7 million. The value of imports is $23.3 million, with a share of 1.6% in global imports. The share of enterprises producing frozen strawberries is 1.3% of the total in the EU-28. Italy: the country has a negative trade balance of $17.6 million. The value of imports is $21.6 million, with a share of 1.5% in global imports. The share of enterprises producing frozen strawberries is 13,4% of the total in the EU-28. Also, attention should be paid to factors such as Concentration of supplying countries and Unit value.

Based on the conducted research, markets with the highest economic opportunities have been identified (Legeza et al., 2023), to which domestic producers should pay attention.

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IMPROVING THE CLASSIFICATION OF FOOD SECURITY INDICATORS IN THE CONTEXT OF THE WAR IN UKRAINE

Olha Kovalenko, **Olena Bokiy**, **Hanna Lysenko***, **Natalia Riabinina**
Institute of Food Recourses of NAAS, Kyiv, Ukraine
**Speaker: lysenko_h@ukr.net*

The military aggression of the russian federation in Ukraine together with other macroeconomic factors, caused an increase in food prices, complicated the availability of food to the population, deprived regular food supplies to displaced persons and population in the front-line regions. The institutional foundations of food security in Ukraine are outlined in the National Economic Strategy of Ukraine until 2030 and the Draft Food Security Strategy of Ukraine for the period until 2030. These documents provide for the improvement of current normative legal acts and programs, ensuring their effective implementation, regular research, taking into account certain indicators and criteria for food security.

By summarizing national and international approaches, indicators of food security in the study are classified into groups according to five criteria: level and quality of nutrition; physical and economic availability of food products; food independence, market stability. This approach makes it possible to comprehensively assess the state of food security in the country and determine directions for improving the situation.

The level and quality of nutrition are ensured by the daily caloric content of the diet, the sufficiency of consumption in accordance with the recommended norms, the ratio of plant and animal foods, the capacity of the markets of individual products, the prevalence of healthy eating, harmonization with EU sandartes. It is necessary to improve the current norms and standards, the current legislation, the system of quality control and traceability of food products in each section of the food chain.

Physical accessibility to available food depends on the condition and density of product delivery routes, the level of urbanization of the area, accessibility to quality water, the availability of outlets in hard-to-reach areas. The supply of food is formed at the expense of domestic production and import of products. Food supply systems should be based on short food chains in local communities, which at the same time will provide increased employment.

Economic availability of food is based on the ratio of income and expenditure of the population with the level of food prices. In this direction, it is important to achieve parity in food prices, increase the standard of living and purchasing power of the population, strengthen support of low-income sections of the population, and contribute to overcoming poverty and economic growth.

Food independence implies independence from the external supply of raw materials and products, a sufficient level of food stocks in retail chains, a small share of imports in consumption, moderate costs of energy and labor resources per unit of production. This direction requires increasing the level of import substitution, expanding domestic production, improving logistics.

Market stability assumes the existence and functioning of uninterrupted food supply chains that can not be influenced by negative factors, risks and challenges. Stability is largely ensured by a stable institutional environment, balanced state agrarian policy, low volatility of consumer prices, sustainable production and consumption of food products, the absence of wars and conflicts, sustainable development of agriculture.

READINESS OF THE COMMUNITY OF KHARKIV TO SPREAD THE CONCEPT OF CIRCULAR ECONOMY AND SOCIAL ENTREPRENEURSHIP

Nataliia Gavkalova*, Yuliia Lola
Simon Kuznets Kharkiv National University of Economics, Kharkiv, Ukraine
**Speaker: ngavl@ukr.net*

The paper presents the results of a social study of the Kharkiv community's readiness to transition to a circular economy and the concept of social entrepreneurship. 183 persons participated in the survey. The method of online survey of representatives of the educational community was used in the study. The results showed:

1) the presence of the community's need for educational and informational measures, which should be aimed at increasing the awareness of the residents of Kharkiv about the ideas, concepts and principles of the circular economy;

2) during the war, the value of preserving the ecology of the region and the understanding of the importance of environmental protection in Ukrainian society decreases. The highest value among those proposed for 91.7% of respondents in 2021. and 100% of respondents in 2024 have family well-being. The lowest value of Kharkiv residents in 2021 protected the region's ecology (36.1%), but during the war, this figure halved. In 2024, the number of people who believe that it is important to help a part of the population that needs it increase significantly;

3) in 2024, Kharkiv residents are even more worried about political instability and high corruption, the importance of protecting the region's ecology is decreasing. Ways to support new forms of ecological and social entrepreneurship in Ukraine after the war were identified.

The conducted sociological research has certain limitations: the project provided for a limited number of respondents, however, this sample is sufficient to generalize the results of the survey for the selected target group; respondents with higher education were interviewed, so the results reflect the values and the possibility of behavioral changes of this population category. The development of social entrepreneurship and circular economy in the Kharkiv urban community should become an important factor in the post-war recovery of Ukraine, contributing not only to economic growth, but also to the strengthening of social capital and stability in the country. The results of the study will be useful for the adaptation of educational and environmental strategies of regional development.

The social study was conducted within the framework of the project "Cities in the expanded European space: joint development of the potential of state institutions with the help of Slovak-Ukrainian cross-border cooperation and improvement of integrity in public affairs (CEEA)".

THE SOCIAL ENTREPRENEURSHIP AS A MECHANISM FOR REALIZING THE GOALS OF SUSTAINABLE DEVELOPMENT

Nataliia Suprun
Institute of Economics and Forecasting of the National Academy of Sciences of Ukraine, Kyiv, Ukraine
Speaker: suprun.nataliia@gmail.com

Social entrepreneurship (SE) has become an alternative way of using economic tools to achieve important social goals, such as the fight against poverty and unemployment, the social activation of people in a difficult life situation, and the integration of local communities. This is an activity whose main goal is not profit, but the realization of a mission based on solidarity, participation and self-governance.

The mission of most social enterprises is to provide conditions for employment and resocialization, and therefore, to overcome the level of social isolation of the most vulnerable population groups (people with disabilities, refugees, former prisoners, the elderly) and to solve environmental problems. The main types of SE are defined: inclusive entrepreneurship, eco-entrepreneurship (green business), veteran business, creative entrepreneurship, academic entrepreneurship, school entrepreneurship, sports entrepreneurship, advocacy business.

The most popular sphere of SE activity in EU countries is alternative forms of social assistance, development of renewable energy and eco-saving, advocacy, financial consulting, educational projects. According to the data of the European Commission, social enterprises in Europe today make up 10% of all European businesses, social enterprises employ more than 6% of workers

The development of social entrepreneurship in Ukraine intensified with the beginning of the Russian-Ukrainian war in 2014. Today, most social enterprises are engaged in solving problems caused by the war: resocialization, advocacy and overcoming the stigma of vulnerable categories of the population - forced migrants, disabled people and war veterans. Therefore, the most common forms are veteran businesses and inclusive companies.

The economic potential of social entrepreneurship lies in the fact that it increases the overall economic efficiency (national wealth) due to the involvement in the economic cycle of such previously unused resources as: labor of socially limited groups; positive behavioral norms (initiative, solidarity, trust); non-traditional sources of energy supply, production waste, etc. Therefore, the social significance of social entrepreneurship lies in the fact that it solves important problems at the expense of minimal resources, which contributes to the realization of the goals of sustainable development.

One of the effective mechanisms for supporting the development of social enterprises is impact investing, which is aimed at creating a sustainable commercial business model and achieving measurable positive social and environmental impacts. Impact investing can be effective if the following principles are followed: a) the contribution can be made through goods, services or through projects financed in various sectors or areas provided for by the UN Sustainable Development Goals; b) the impact of the investment must take into account all externalities during the life cycle of this investment; c) priority is given to investing in self-charging projects.

ORGANIZATION OF TAX PLANNING EFFICIENCY ANALYSIS

Ruslana Shurpenkova*, Oksana Sarakhman
Ivan Franko National University of Lviv, Lviv, Ukraine
**Speaker: ruslana.shurpenkova@gmail.com*

The main provisions for improving the existing theoretical foundations and practical measures of the tax planning system at an enterprise are outlined, taking into account the analysis of its effectiveness. The problems of taxation and the direction of its impact on the efficiency of financial and economic activities of enterprises are among the most pressing issues of modern Ukrainian financial management. From the point of view of taxation, the entire process of activity of economic entities is characterized by the emergence and change of tax relations. It is necessary to predict the emergence of such tax relations in order to influence them even before the relevant business transactions are carried out. The analysis of the effectiveness of tax planning reduces the uncertainty of future tax expenses of economic entities and the degree of their adaptation to an aggressive external environment.

Organizational forms of analysing the effectiveness of tax planning at an enterprise may vary and are determined by its size, organizational and legal form, and industry specifics. Successful conduct of this analysis depends on carefully planned work. In addition, the information base of the analysis plays an important role, so before starting the analysis, it is necessary to check its completeness, quality and reliability. The paper identifies the stages of assessing the effectiveness of tax planning of enterprises and proposes a system of performance indicators which can be used to carry out such an assessment.

A well-founded tax planning system can sufficiently minimize the risks arising from the taxation of business activities. And when making management decisions, tax planning is a mandatory tool for the company's management. However, individual measures to optimize taxation will not become a full-fledged tax planning system unless they are implemented as part of a unified strategic plan for the development and operation of the company. Without fundamental provisions, methods and ways of developing (applying) certain tax optimization measures and schemes, tax planning cannot be implemented as intended, and will only act as a tool for minimizing tax payments in the short term - without planning the company's activities and business development in the long term.

SOCIAL INCLUSION AND PUBLIC HEALTH

CHALLENGES AND OPPORTUNITIES OF INTEGRATION ONE HEALTH COMPETENCIES FOR SUSTAINABLE VETERINARY EDUCATION IN UKRAINE

Mariia Galaburda[1]*, Valeria Yustyniuk[2], Olena Kuzminska[1], Oleksandr Martyniuk[1]
[1]National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine
[2]University of Minnesota, USA
**Speaker: galaburda_ma@nubip.edu.ua*

Sustainable Development is one of the key issues for both industrialised and developing countries. Sustainability of human and environmental resources are of great importance for ensuring the global safety and the common future of humanity. Whereas without a One Health (OH) approach, experts in environmental, animal, and human health will continue to address different challenges independently and in an uncoordinated manner, missing the opportunity to maximize the benefits of shared knowledge, professional expertise, and available resources. That is why compliance with the OH concept is crucial, as this approach combines the activities of veterinarians, physicians and the public health community to ensure the health and well-being of the global community. Therefore, to ensure sustainable future development, current veterinary professionals are required to possess OH competencies. However, while there are numerous studies on the integration of OH competencies into medical training standards, there is a current gap of similar studies in the veterinary field.

As the Erasmus+ Jean Monnet Module "Integration EU One Health framework and policies in Ukraine" (101048229 – EU4OH – ERASMUS-JMO-2021-HEI-TCH-RSCH) (Yustyniuk, Kuzminska, Galat, Pikka, & Galaburda, 2023), aims to enhance veterinary education through the promotion the development and delivery of training with a specific focus on One Health, providing a sustainable framework for educational integration; to transfer the expertise in the field of One Health and implement it on different levels, to raise awareness on emerging issues our study was targeted to fulfil this gap. With the Dimension SDG Mapping Initiative, we analysed publications over the past 5 years to identify research clusters linking OH competencies and the Sustainable Development Goals (SDGs), and through a SWOT analysis involving 123 veterinary experts, we identified the strengths, weaknesses, opportunities and threats of integrating OH competencies for veterinary education in Ukraine with the SDGs. The study also included a comparative assessment of the OH competencies of veterinary professionals with the WOAH, ESEVT, RCVS Day One Competences (EAEVE, 2023; OIE, 2012; RCVS, 2022).

Proper veterinary training will ensure the quality of National Veterinary Services and prepare professionals supporting OH, while also advancing international and European standards.

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ANALYSIS OF GAPS IN DEMAND AND PROVISION OF PSYCHOLOGICAL ASSISTANCE OF THE MILITARY

Olena Ivanova
State University of Trade and Economics; Kyiv Medical University, Kyiv, Ukraine
Speaker: ivanova.olena.2015@gmail.com

The war conflict in Ukraine has drawn considerable attention to the mental health problem, including the probability of the occurrence and consequences of mental health issues. The circumstances of service and the conditions of military personnel in the areas of active hostilities have a significant impact on the deterioration of their mental health. Significant gaps in the provision of psychological assistance and between potential and actual demand for psychological assistance have been identified. The specifics of the military as a target category for various providers of psychological assistance and the characteristics of the military's demand for psychological assistance are identified. The priority and importance of forming the actual demand of the military are determined. Based on the analysis of psychological assistance providers, the paper identifies a gap in addressing the mental health problems of military personnel during the most vulnerable and peak periods of their service. The formation of factual demand of the military for psychological assistance on the spot is important and can be met due to digital advancements. It is offered to develop and use the digital tool that would help reduce the gap between the potential and actual demand of the military for psychological assistance and its targeted provision by the most relevant specialists.

EUROPEAN POLICIES AGAINST ADULTERATION OF PRODUCTS ON THE WAY TO SUSTAINABLE DEVELOPMENT

Zhanna Klishchova[1,2]*, Victoriia Petrashenko[2], Yurii Ataman[2], Jarmila Pekarcikova[3], Tetiana Dereka[4], Sergiy Kyrylenko[2]

[1]*Universidade Federal de Lavras, Minas Gerais, Brazil*

[2]*Biomedical Research Center, Medical Institute of Sumy State University, Sumy, Ukraine*

[3]*Faculty of Health Care and Social Work, Trnava University, Trnava, Slovak Republic*

[4]*Faculty of Healthcare, Alexander Dubcek University of Trencin, Trencin, Slovak Republic*

**Speaker: zhanna@ufla.br*

Adulteration of products refers to the practice of adding or removing ingredients to make a product appear different or of higher quality than it actually is. This can occur in a variety of industries, including food, beauty and pharmaceuticals. Adulteration can take various forms, such as addition of unauthorized substances, mislabeling or false claims about ingredients, dilution with inferior or cheaper substances, substitution of authentic ingredients with lower-quality alternatives etc. It may lead to serious health issues. Moreover, concealment of detailed information about product composition by manufacturers exacerbates these risks. Counterfeit medicines may result in ineffective treatment and potential harm to patients. Altogether, this represents a significant risk to consumers and therefore is regarded as an obstacle for sustainable development. The European Union (EU) employs an elaborated legal framework and a robust public culture that collectively aim to combat the falsification of products. The legislation includes regulations on product labeling, quality control measures and stringent penalties for those involved in the falsification of food and medicines. For this, governments have set up regulatory bodies such as the European Food Safety Authority (EFSA) in the EU and the Food and Drug Administration (FDA) in the USA to monitor and regulate food safety standards. These organizations set strict guidelines to prevent food adulteration. By implementing these regulations, Europe strives to uphold high standards of product integrity and safety, safeguarding public health and promoting sustainable development. Another fundamental component of European legislation is HACCP (The Hazard Analysis and Critical Control Points), which is set out in Regulation (EC) No 852/2004 of the European Parliament and of the Council on food hygiene. The HACCP system is an integral part of ensuring food safety and controlling hazards throughout the food production process, reflecting the EU's commitment to maintaining high standards of food safety and quality. This control system is applicable also to manufacturing of medicines. Pharmaceutical companies are obliged to comply with the regulatory standards set out in legislation, as the detection of counterfeit products is punishable by revocation of the license.

Despite these measures, there have been notable cases of food adulteration in the EU and elsewhere, including the adulteration of olive oil with cheaper oils, substitution of premium seafood with lower-quality alternatives and fraudulent labeling of organic products. The EU emphasizes that consumer education and awareness to identify and report suspected cases of food adulteration is paramount for prevention of adulteration of products. On the other hand, maintaining the integrity of the products is crucial for safeguarding public health and ensuring sustainable development.

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SUSTAINABLE DEVELOPMENT OF THE SYSTEM OF PUBLIC ADMINISTRATION IN UKRAINE THROUGH RESILIENCE OF ITS MANAGERIAL STAFF

Volodymyr Bondar
Kyiv International University, Kyiv, Ukraine
Speaker: ptc.charit@gmail.com

The paper reflects the issue of resilience, the phenomenon which draws attention by world leading democracies once full-scale invasion of Ukraine had begun, alongside with increased destructive informational and psychological impact on public sphere. Protracted war, with its hybrid component, continues to strain national and domestic public arena and weaken its resilience posture. All these underlines the major challenge, to ensure sustainable development by joined efforts in every aspects of public life, make them resilient and competitive. Some distinctive actions by the European institutions in enhancing conceptual approaches, adoption new strategies are highlighted in the manuscript. For example, of Germany − the country updating its national strategic programmes to ensure sustainable development and resilience in secure, industrial and public sectors as equal targeted components. In the paper, to reach the purpose, the phenomenon resilience is interpreted due to interdisciplinary approach. The importance to develop resilience in the system of public administration in a context of personality traits the managerial staff, is underlined. The major hypothesis, that resilience of public managerial staff is sufficient, and inevitable preposition in sustainable development of the whole system. The scientific novelty of the paper, that on the example of applying the systematic approach, and the methodology of public administration, and the systematic methodology, as well as other scientific tools, the phenomenon resilience is treated as the system-forming factor of the system of public administration. This means, through resilience of its managerial personnel, resilience of the system of public administration is ensured alongside. The paper's results indicate, that State policy, on practice, must contribute to strategies on defeating the threats of informational and psychological impact on public area, introduce special training programs targeted on the managerial staff.

IMPROVING THE MEDICAL FIELD AND MEDICAL EDUCATION IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

Olga Kyrylenko*, Olga Kovalenko
PHEE Kyiv Medical University, Kyiv, Ukraine
Speaker: o.kyrylenko@kmu.edu.ua

The entire history of human existence and development into a global human society that jointly maintains own existence and economic development shows that economic development has always followed the success of medicine in overcoming certain socially significant diseases along with the health and well-being improvement and increase of life expectancy. Moreover, the industrial growth of 19th and 20th centuries was made possible by the development of global measures to control infectious diseases, such as disinfection, including water chlorination, vaccination, mandatory and effective hand washing, antibiotics, which stopped many epidemics, greatly improved the health of all mankind and led to the increase in life expectancy from 40-50 years in the 19th century to 70 years in the 20th century. People simply got the opportunity to do this because, thanks to a longer life, they had more time to accumulate more knowledge, and thanks to better health, they could implement this knowledge.

Therefore, it is logical that in the Sustainable Development Goals (SDGs) by 2030, proposed in 2015, one of the first goals (Goal 3) is "Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages" along with its subsection Goal 3.8 „Achieving Universal Health Coverage (UHC)".

In our literature review, based on current scientific publications, we analyzed the current global state of human health and quality of life, as well as the actions and approaches of the medical field to improve it. Our goal was to understand whether the medical sector is working efficiently enough to meet the goals set for 2030, and what needs to be improved to increase its efficiency. Based on the analyzed scientific publications, we concluded that unfortunately we are still far to the announced, healthy lives and well-being for all at all ages", and that the medical sector should immediately and more effectively implement into medical practice the approaches and compounds already developed by medical science, many of which are relatively simple to implement, relatively inexpensive and such that can be implemented globally. It is wrong way to develop new and new approaches or compounds from scratch, because it is very expensive, while the funding of medicine is already disproportionately large. Moreover, current scientific data show that these scientifically known while not yet implemented in clinical practice approaches and/or compounds can significantly improve situation with very common and fatal systemic diseases - cardiovascular and cerebrovascular diseases, chronic diseases of the respiratory organs and lung, diabetes, cancer, neurodegenerative diseases, as well as to prevent severe course of new diseases that appear more and more often. Furthermore, they can prevent and/or treat the pathophysiology of all these diseases simultaneously, because they target causes that are common causes to all systemic diseases.

Thus, in order to achieve the declared goals by 2030, it is necessary to introduce into clinical practice approaches and/or compounds that are able to prevent many diseases at the same time and that can be implemented worldwide, while already scientifically known and developed, which will save financial resources for others sectors of the economy.

MODELING ECONOMIC RECOVERY IN THE WAKE OF COVID-19: THE ROLE OF HR AND SOFT SKILLS

Oleh Sokil[1]*, Yana Sokil[2]
[1]Lviv Polytechnic National University, Lviv, Ukraine
[2]Dmytro Motornyi Tavria State Agrotechnological University, Zaporizhzhia, Ukraine
**Speaker: oleh.h.sokil@lpnu.ua*

The COVID-19 pandemic has caused significant global economic and social disruptions, requiring urgent and innovative responses to support economic recovery and sustainable development. This paper examines the essential role of human resource management (HR) and soft skills enhancement in facilitating the post-pandemic recovery process. It highlights how effective HR strategies and robust communication skills are foundational for rebuilding businesses and future-proofing them against uncertainties. The paper explores the transformation of HR from primarily an administrative role to a strategic cornerstone that actively shapes recovery and sustainable growth strategies. This involves fostering a culture of adaptability, continuous learning, and proactive employee engagement. The importance of flexible work arrangements, such as remote work and adaptable scheduling, is also emphasized as critical for maintaining productivity and retaining employees during volatile periods.

Additionally, the paper underscores the critical role of effective communication skills in reducing uncertainties and facilitating clearer pathways for organizational change. Improved communication is shown to enhance change management processes and employee engagement, contributing to more resilient organizational structures. The creation and implementation of targeted training programs aimed at enhancing key soft skills are discussed. These programs are designed to address specific industry needs and have practical applications that benefit various organizational levels. Furthermore, we propose several economic models to assess the impacts of the pandemic and to forecast recovery trajectories. These models incorporate indicators like GDP changes, employment levels, and sector-specific growth, providing a comprehensive framework for analyzing and planning economic resurgence. Overall, this study contributes valuable insights and practical strategies to the discourse on post-COVID economic recovery, emphasizing the pivotal roles of strategic HR management and soft skills development. These elements are crucial for navigating the complexities of recovery and fostering enduring organizational and economic resilience.

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SELF-ASSESSMENT AS A WAY TO DETERMINE THE LEVEL OF COMPETENCIES DEVELOPMENT OF FUTURE SPECIALISTS IN SPECIAL AND INCLUSIVE EDUCATION

Halyna Ponomarova, Alla Kharkivska, Olena Kapustina*
Municipal Establishment «Kharkiv Humanitarian Pedagogical Academy»
of the Kharkiv Regional Council, Kharkiv, Ukraine
**Speaker: lenaik1996@ukr.net*

At the current stage of societal development, particular attention is paid to educating children with special educational needs. Therefore, there is a need to study the self-assessment of the level of competencies development by specialists in the field of special and inclusive education.

Graduates were presented with questionnaires aimed at self-assessing the level of development of their general and special competencies according to the higher education standard for specialty 016 Special Education at the second (master's) level of higher education.

Since "the assessment system is the main means of measuring achievements and diagnosing learning problems, allowing you to determine the quality of the educational process, make fundamental decisions on the strategy and tactics of training, improve both the content of education and the forms of evaluation of expected results", self-assessment enables individuals to adjust their own trajectory of personal and professional development in the right direction (Kharkivska et al., 2023, p. 406).

Therefore, graduates were suggested to assess the level of their competencies development according to the higher education standard for specialty 016 Special Education at the second (master's) level of higher education (Approval of the Higher Education Standard for Specialty 016 Special Education for the Second (Master's) Level of Higher Education).

Students their ability to communicate in a foreign language high (81%), indicating not only the effectiveness of the educational techniques used but also the greater confidence in their own abilities. The increase in the ability to conduct research at an appropriate level (85%) and make informed decisions (85%) reflected in the subsequent self-assessment is attributed to the effectiveness of the interactive methods. The high self-assessment of the ability to develop and implement innovative methodologies and technologies for correctional and developmental work with individuals with special educational needs (84%) is the result of meaningful webinars that the participants attended.

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FORMS AND METHODS OF PRESERVING AND STRENGTHENING CHILDREN'S HEALTH IN THE CONDITIONS OF TODAY'S MILITARY CHALLENGES

Alla Kharkivska, Alona Prokopenko, Nelli Tarasenko*
Municipal Establishment «Kharkiv Humanitarian-Pedagogical Academy» of Kharkiv Regional Council, Kharkiv, Ukraine
**Speaker*: nelliashka@gmail.com

In the annual report on the health state of the population of Ukraine and the epidemic situation for 2022, it is noted that «the large-scale armed aggression of the Russian Federation has led to a serious increase in the risks of severe epidemic complications and the burden on the public health system (especially in the occupied and front-line zones)» (Annual report on the health state of the population of Ukraine and the epidemic situation for 2022, 2023). At the same time, it is stated that on behalf of creating conditions for the preservation of children's health, it is necessary to form a unified state policy in the field of children's health care in accordance with internationally.

In the course of scientific research, it was confirmed that to achieve a reliable result in the process of implementing professional activities to preserve and strengthen all components of children's health in the conditions of today's military challenges is possible during implementation appropriate forms and methods in working with children, in an offline or remote format. So, in those regions of Ukraine where it is possible to organize offline learning and visiting extracurricular groups and sections by children appropriate forms for implementation are: forum theaters, game libraries, discos, graffiti contests, dance contests, flash mobs, contests of theatrical productions, art exhibitions, quizzes, station quests, dance competitions, sports competitions, etc. In regions where hostilities are active, forms and methods that have proven their effectiveness include those based on the use of ICT technologies: web quests, webinars, video conferences on the free Zoom platforms, Microsoft Teams, and others. In the course of an experimental study of the effectiveness of the proposed forms and methods according to the determined criteria (motivational, cognitive, behavioral and activity) and levels (high, medium, low), their positive influence on the process of children's readiness to preserve and strengthen health in all its components, at the levels of: physical, mental, spiritual (mental) and social health was proven. The statistical significance of the results of the research and experimental work was confirmed by the Spearman rank correlation method - a positive correlation was found between the level of children's readiness to preserve and strengthen health in general and motivational, cognitive, behavioral and activity criteria in particular ($R = 0.72$). So, the results of the experiment indicate positive changes, which is confirmed by the qualitative dynamics in the levels of children's readiness to preserve and strengthen their health, and the analysis of these results provides grounds for asserting the effectiveness of well-founded forms and methods. The conducted research does not pretend to be a comprehensive solution to the problem of preserving and strengthening children's health in the conditions of military challenges of today and requires a further search for appropriate means and tools for protecting children's health in the conditions of military events in Ukraine.

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SOCIAL RESILIENCE OF UKRAINE IN WAR AND POST-WAR PERIODS: THE NEED FOR INSTITUTIONALIZATION

Tetiana Burlay
Institute for Economics and Forecasting of NAS of Ukraine, Kyiv, Ukraine
Speaker: btv2008@ukr.net

The full-scale war of the Russian Federation against Ukraine has greatly exacerbated the issue of social resilience of our state. Under the ongoing geopolitical confrontation and other global hybrid threats (Sidenko, 2024), it's really important to evaluate the institutional dimension of the social resilience phenomenon as a strategic element of public welfare, countering war shocks and post-war recovery of Ukraine. At the same time, it is worth taking into account the best global governance policies and practices regarding the strengthening of this institution. The EU, relying on the approaches of strategic foresight, has good experience in the policy-making of multidimensional resilience. As early as 2021, EU Member States are implementing National Recovery and Resilience Plans until December 2026, aimed at overcoming the shock consequences of the COVID-19 pandemic and the war in Ukraine and promoting "Green Deal" reforms. The total EU financial support for the implementation of the specified Plans reached EUR 648 billion at the end of 2023 (EU, 2024).

Ukraine needs not only the adaptation of relevant European experience, but also the development of its own public governance concept to ensure social stability during the war and post-war recovery, adequate consideration domestic realities in demography, employment, the social insurance system and public finances. In the interests of socio-economic stabilization and maintain of high solidarity in Ukrainian society, the institutionalization of social resilience to the country's public governance is objectively necessary. The first step towards this goal should be the upgrading of a number of program and strategic documents, in which this category is still missing. Primarily, it is advisable to incorporate the social resilience component into the existing Concept of Introducing the National Resilience System of Ukraine (enacted by the Decree of the President of Ukraine No. 479 of 09/27/2021). It is also necessary to introduce corrective elements to the Ukraine's Strategy of National Security and the Strategy of Human Development, respectively approved by the Decrees of the President of Ukraine No. 392/2020 of 09/14/2020 and No. 225/2021 of 06/02/2021. Alongside, the mentioned documents will require an understanding of the social resilience context, agreed with the Strategy of Demographic Development of Ukraine for the period until 2040, the draft of which was submitted for discussion by the Ministry of Social Policy of Ukraine in March 2024. In the proposed steps of institutionalization, it is expedient to substantiate the key pillars of Ukraine's social resilience, mindful the effects of war shocks, the deepening of the demographic crisis, digitalization, and the realization of its opportunities for capacity-building as the EU candidate country.

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FEATURES OF SOCIAL INTEGRATION AND SOCIAL INCLUSION OF PRESCHOOL CHILDREN WITH SPECIAL EDUCATIONAL NEEDS IN THE EDUCATIONAL PROCESS OF THE PRESCHOOL EDUCATION INSTITUTION

Nataliia Lisnevska
Oleksandr Dovzhenko Hlukhiv National Pedagogical University, Hlukhiv, Ukraine
Speaker: lisnevsky.nv@gmail.com

It is substantiated that childhood is the most crucial period in the formation of physical, mental, social and spiritual health, physical and mental development, and socialization. It is proved that the process of formation and development of the child's body, the child's socialization depends primarily on parents and is closely related to preschool education institutions. It is determined that the number of children with special educational needs is increasing in preschool education institutions. The research of scientists on the importance of social integration and inclusion of children with special educational needs is analyzed. It is established that only a few studies are devoted to the social integration of preschool children with special educational needs. It is noted that preschoolers with special educational needs require an individual approach. It has been studied that today preschool education institutions are attended by children with the following disorders: autism, delayed speech development. It is determined that for children with special educational needs, the creation of an inclusive group and the functioning of a resource room are provided. The educational process of such children is carried out on the basis of an individual development program in accordance with the conclusion of a comprehensive psychological and pedagogical assessment of their development. It was clarified that the development of an individual program for the development of children with special educational needs is carried out by members of the psychological and pedagogical support team. It has been established that inclusive groups can be attended by one to three children, depending on the levels of support, which are from the first to the fifth. Advice to parents on the necessity of applying to an inclusive resource center is outlined. It is substantiated that children with special needs should receive from two to eight psychological, pedagogical and correctional and developmental sessions per week, depending on the level of support, their age, the degree of complexity of their disorders and taking into account their individual characteristics. It has been established that the duration of classes depends on the age of the child and the type of activity in the educational areas.

SCIENTIFIC CONCEPTS OF SUSTAINABLE DEVELOPMENT SOCIETIES IN THE DEVELOPED COUNTRIES OF THE WORLD AT THE END OF THE XX – AT THE BEGINNING OF THE XXI CENTURY

Oleksandr Pylypenko
National University of Food Technologies, Kyiv, Ukraine
Speaker: pylypenko08@ukr.net

The problem of ensuring sustainable development has remained relevant for many years. In many scientific works, the definition of sustainable development was based on different provisions. The sustainability of the subject in them provided for the preservation of the environment, the rational use of natural resources, economic growth and the satisfaction of the basic needs of society. Since the term "Sustainable development" refers to eco-social and socio-economic systems, the stability of the system should be understood as its ability to function without changing its own structure, and to be in balance in the presence of external influences. It is worth recalling here that in macroeconomics, sustainability means a long-term. There are now many definitions of "Sustainable Development", formulated both by individual researchers and entire groups. Among the most common are: according to the global nature conservation strategy, "Sustainable development" is development that ensures a real improvement in the quality of people's lives, and at the same time maintains the natural balance on earth; as defined by the UN, "Sustainable development" is development that meets the needs of today, but does not endanger the lives of future generations; application of a model of production and consumption that preserves the regenerative capabilities of the land, human rights and the well-being of communities; "Sustainable development" is the managed development of society, which ensures the continuous development of civilization (Lazorenko T. V., 2020).

This problem was first formulated in the report "Limited growth" by D. Meadows based on the analysis of a mathematical model of the world, built specifically to study five global processes identified by his scientific group: rapid industrialization, population growth, increasing food shortages, depletion of non-renewable sources, degradation of the natural environment. The general conclusion was the need and opportunity to change growth trends and move to long-term economic and environmental stability in all countries of the World (Meadows D., 2018).

The sustainable development of the planet's civilization implies the existence of a single and defined system of values and views that states could focus on when forming their national strategies. It should be noted that sustainable development at the international or national level is impossible without a targeted system of actions at the local level, therefore, regions are the main players of sustainable development, as they enter into the interaction of the state and citizens, and thereby translate large international agreements into concrete activities at the local level (Duyunov V., 2017).

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SOCIAL INTELLIGENCE AND MENTAL HEALTH OF UKRAINIAN UNIVERSITY STUDENTS WITH SPECIAL EDUCATIONAL NEEDS IN WARTIME

Olena Starynska, Liubov Spivak*
Berdyansk State Pedagogical University, Zaporizhzhia, Ukraine
**Speaker: l.spivak.work@gmail.com*

Creating the necessary conditions for every person's mental health is an important task of modern society in war, pandemic and natural disasters. Mental health is a successful personality adaptation in society that depends on its social intelligence. According to the Law of Ukraine "On Higher Education", university students who have special educational needs deserve special attention, which increases the importance of such studies. The aim of the paper is to research the social intelligence and mental health of students with special educational needs in wartime.

135 university students with special educational needs took part in the online empirical research of 2023. Social intelligence is an integrated complex of human abilities that relate to knowledge and solving problems that allow it to succeed in interactions with other people in society. Social intelligence was researched with the "Test of Social Intelligence" (O'Sullivan, & Guilford, 1978). The presence below average (31.1%), average (51.1%) and above average (17.8%) levels and lack of low and high levels of social intelligence in respondents were empirically revealed. The ability to know and understand other people's behavior in respondents with a below average level of social intelligence concerns the successful solution of almost one fourth part, respondents with an average – almost half, respondents with the above average – almost three fourth parts of social interactions. Mental health of a person without psychopathological sign is his psychological, social and subjective well-being. Mental health was investigated with a "The Mental Health Continuum - Short Form" (Keyes, 2002). Most respondents found an average (73.4%), the minority – high (13.3%) and low (13.3%) mental health levels. Respondents with an average level feel happiness, pleasure, or interest in life about two or three times a week; with high – almost daily; with low – once or twice over the past two weeks. The results obtained indicate that the higher the level of social intelligence, the higher the level of mental health. This conclusion is statistically confirmed by the Pearsons' correlation coefficient ($r=0.17$; $p\leq0.05$). It should be noted that the connection between social intelligence and mental health of students with special educational needs was empirically discovered during the Covid-19 pandemic (Starynska et al., 2021). Therefore, connected of social intelligence with mental health is statistically significant. This stimulates the search for social intelligence development measures in these students.

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СОЦІАЛЬНА БЕЗПЕКА І НАПРЯМИ ЇЇ РЕАЛІЗАЦІЇ В СУЧАСНИХ УМОВАХ

Оксана Гончаренко
Пенітенціарна академія України, Чернігів, Україна
Доповідач: oksana1915-1@ukr.net

В умовах війни особливої актуальності набуває соціальна безпека, як можливість розв'язання суперечностей між об'єктивною реальністю, такою як небезпека, і потребою індивіда, соціальних груп і спільнот запобігти їй, локалізувати чи усунути її наслідки. Наукова думка по різному трактує соціальну безпеку, яка включає і психологічний стан населення країни. Подольська розглядає безпеку як «комплекс заходів спрямованих на збереження і розвиток у державі соціальної системи» (Подольська, 2015). Сучасна наука визначає наступні підходи до її дослідження: *вертикальний* – розглядає соціальну безпеку і елементи її ієрархічної структури, та формування і розвиток їх на регіональному рівні; *горизонтальний* – досліджує функціональну структуру соціальної безпеки, а саме трудовий потенціал, регіональні ринки праці і зайнятість, міграцію, та соціальний захист населення; *моністичний* – досліджує напрями врегулювання проблем тіньової економіки, корупції, інші порушення чинного законодавства; *зовнішньоекономічний* – досліджує ступінь захисту життєво важливих інтересів соціальних одиниць на макро- і мікрорівні, що сприяє розвитку людського потенціалу, соціалізації, життєзабезпечення та збереження життя (Антонюк, П., 2013). В умовах війни актуальними є питання соціальної політики держави, що характеризуються результативністю і ефективністю соціального захисту населення. В цьому контексті важливими є безпека людини, бо мірилом соціальної безпеки є індивід і можливість його гідного існування, вільного розвитку і забезпечення його потреб. Соціальний захист населення в умовах війни для держави є складним завданням, і зміни соціальної політики адаптовані до реалій часу, а саме, розширено список осіб, яким надається соціальна допомога (внутрішньо переміщені особи, біженці, військові тощо). Кількість тільки внутрішньо переміщених осіб в державі понад 5 млн, більше 6 млн біженців. Крім того, соціальна безпека – це стан соціальної сфери, за якого забезпечується якість життя, захищеність життєво важливих аспектів людини, зокрема: її фізичне здоров'я та психологічне здоров'я, економічне благополуччя, соціальне благополуччя, можливості для самореалізації, безпека, екологія тощо. Сьогодні рівень бідності населення України перевищує 25%, а завдяки системі соціального захисту, людина має можливість повноцінно жити. І в сучасних умовах, державі необхідно мати ефективні методи соціальної підтримки, що базуються на реальних даних і потребах людей, і потребують усвідомленого підходу з боку держави, бізнесу і суспільства. Крім того, реальність така, що кожен з нас повинен постійно працювати, щоб створювати собі власний безпековий простір.

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ЗАБЕЗПЕЧЕННЯ СТАЛОГО ФУНКЦІОНУВАННЯ СИСТЕМИ ВОДОПОСТАЧАННЯ ІРПІНСЬКОЇ ТЕРИТОРІАЛЬНОЇ ГРОМАДИ

Ірина Сагайдак*, Тетяна Чорна, Артур Зубрицький, Ірина Качур, Тетяна Микитенко
Державний податковий університет, Ірпінь, Україна
**Доповідач: i.s.sahaidak@dpu.edu.ua*

Серед 17 Цілей сталого розвитку, Ціль 6 охоплює забезпечення наявності та сталого управління водними ресурсами та санітарією. Для реалізації вказаної Цілі передбачено ряд завдань (National Baseline Report «Sustainable Development Goals: Ukraine», 2017) забезпечення доступності якісних послуг з постачання безпечної питної води; будівництво та реконструкція систем централізованого питного водопостачання; забезпечення доступності сучасних систем водовідведення; будівництво та реконструкція водозабірних та каналізаційних очисних споруд; зменшення обсягів скидання неочищених стічних вод із застосуванням новітніх технологій та обладнання; підвищення ефективності водокористування; забезпечення впровадження інтегрованого управління водними ресурсами. Особливо важливим це є для регіонів, які постраждали через бойові дії.

Представлена робота присвячена аналізу функціонування системи питного водопостачання Ірпінського регіону до повномасштабного вторгнення та після деокупації території.

Показано, що відбувалась поступова модернізація системи водопостачання: реконструкція та будівництво свердловин; будівництво станцій водопідготовки та знезалізнення води; придбання нової техніки і обладнання; ремонт водопровідної мережі та каналізаційних колекторів. Продемонстровано, що до 2022 року проблеми з питним водопостачанням в регіоні були пов’язані, в першу чергу, зі швидкими темпами забудови та зростанням чисельності населення. Акцентовано увагу на тому, що питне водопостачання в регіоні до початку вторгнення забезпечувалося повністю артезіанською водою. Представлено результати порівняння даних лабораторних досліджень артезіанської води на станції знезалізнення та води з різних точок водогону. Показано, що внаслідок військових дій інфраструктура водозабезпечення регіону зазнала суттєвих ушкоджень і ситуація з питним водопостачанням стала критичною. Висвітлено особливості відновлення системи водопостачання, яке полягало у прокладанні водогону Київ-Ірпінь. Представлено результати лабораторних досліджень на відповідність нормативам показників якості питної води з нового водогону, тобто дніпровської води. Зазначено, що в умовах децентралізації об’єднані територіальні громади мають можливість планувати і реалізовувати програми з модернізації, оптимізації та розвитку систем життєзабезпечення, що особливо актуально в умовах війни. На прикладі Ірпінської територіальної громади показано, що такий підхід забезпечує ефективність управлінських рішень щодо відновлення зруйнованої інфраструктури. Продемонстровано, що не зважаючи на труднощі системи життєзабезпечення відновлюються, в тому числі, за рахунок донорської допомоги та грантів.

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ЕФЕКТИВНЕ ВИКОРИСТАННЯ ПОТЕНЦІАЛУ ВЕТЕРАНІВ ВІЙНИ ДЛЯ ЇХ СОЦІАЛЬНО-ПСИХОЛОГІЧНОГО ВІДНОВЛЕННЯ

Юрій Жидецький*, Наталія Пряхіна
Львівський державний університет внутрішніх справ, Львів, Україна
**Доповідач: cezh03@gmail.com*

У період війни важливим питання постає ефективне використання ресурсів, що в свою чергу потребує комплексних рішень на рівні громадськості. Ресурс кожної особистості набуває вагомого значення, особливо у питанні соціально-психологічного відновлення ветеранів російсько-української війни.

Соціологічне опитування «Портрет ветерана» виявило що громада яка оточує ветеранів не сприймається ними (49,6 %) як безпечне середовище. Важливе місце у допомозі ветеранам займають громадські організації. Міжнародна організація з міграції (далі МОМ) втілює проєкт під назвою «Шлях стійкості»: підвищення стійкості українців через посилення можливостей психосоціальної підтримки ветеранів» у форматі груп «Рівний – рівному». Співпраця у групі підвищує рівень окситоцину, який в свою чергу збільшує рівень довіри та групових зв'язків, що в сукупності з іншими факторами викликатиме відчуття благополуччя (Юнгер, 2023). Ветеран зможе прискорити процес лікування, терапії, задовільнити базові потреби, так як багато хто з них можуть мати недостатній дохід, опинитись в необлаштованому житлі або ж воно може бути пошкоджене чи зруйноване внаслідок збройної агресії ворога.

За результатами загальнонаціонального опитування проведеного МОМ в Україні спільно з організацією «SREO Consulting» ветеранам комфортніше говорити про свій досвід з іншими ветеранами, які пережили подібні ситуації. Підчас цього вони можуть не боятись непорозумінь то осуду. Серед респондентів переважає думка що цивільні особи можуть не до кінця розуміти досвід ветеранів та емоційні проблеми з якими вони зустрічаються. На даний момент, в час війни, ми усі знаходимось у світі невизначеності, і коли вона набуває глобального характеру (травми, втрати тощо) або ж невизначеностей стає надто багато, а вони мають накопичувальний ефект, підвищується тривожність, виникають негативні психоемоційні стани – особистість «застрягає», втрачає здатність до адаптації. Потрібно сприяти розширенню кола спілкування, не від'єднувати себе від спільноти якої потребуєш і яка потребує одночасно тебе, щоб мати змогу здійснити цей непростий перехід. І цей перехід має бути його усвідомленим рішенням інакше він не відбудеться.

Війна ще триває, але така програма як «рівний – рівному» потрібна вже, бо той хто зараз перебуває на фронті чи лише призивається на службу має бути впевнений що їх чекають такі групи, вони зможуть отримати необхідну допомогу і вони також будуть корисними соціуму.

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ОЗНАЙОМЛЕННЯ ДІТЕЙ СТАРШОГО ДОШКІЛЬНОГО ВІКУ З РІЗНИМИ ВИДАМИ ТРАНСПОРТУ ЯК ЗАСІБ ЗАЛУЧЕННЯ ДО ЄВРОПЕЙСЬКИХ ЦІННОСТЕЙ

Тамара Андреєва*, Олена Дзюбенко, Вадим Яловець
Університет Григорія Сковороди в Переяславі, Переяслав, Україна
**Доповідач: andreeva.tamara.t@gmail.com*

Базовий компонент дошкільної освіти вказує на необхідність виховання ціннісного ставлення дітей до предметного довкілля, ознайомлювати з винаходами людства, зокрема транспортними засобами, їх функціонуванням, значенням для суспільства взагалі і кожної людини зокрема, а також пояснювати необхідність дотримання правил вуличного руху. Без розвитку транспорту неможливий сталий розвиток України, як і всього світу. Відомо, що на європейському просторі та в США відбулися революційні відкриття, які послугували стабільному та масовому виробництву транспортних засобів, автомобілів зокрема.

Ознайомлення дітей з історією винаходів автомобілів та їх удосконаленням може стати цікавим і ефективним видом роботи. Для цього проводять спостереження, досліди, читають науково-довідкову літературу та використовують сучасні інформаційні технології.

Важливою умовою цілісного, системного підходу до ознайомлення дітей 6-го року життя з різними видами транспортних засобів має стати інтеграція всіх видів діяльності протягом часу перебування дитини в закладі дошкільної освіти, а також відповідна робота з батьками

З моменту винайдення механічних транспортних засобів потреба у використанні тварин поступово зменшувалась, натомість перед педагогами практиками постала задача ознайомлювати дітей з різними видами транспорту. Це завдання мало вирішуватися одночасно у двох напрямках:

- ознайомлення з будовою, призначенням та використанням різних транспортних засобів як умова всебічного, в найбільшій мірі розумового виховання;
- ознайомлення з правилами безпеки при використанні транспортних засобів, в тому числі з правилами вуличного руху.

Діти старшого дошкільного віку мають знати про різні види транспортних засобів більш ґрунтовно. адже в майбутньому стануть самостійними і повноправними учасниками дорожнього руху. Тому в діючих програмах чітко визначено об'єм знань, яким повинні оволодіти вихованці на кінець дошкільного дитинства. Зокрема вони повинні знати назви таких транспортних засобів: «легковий автомобіль», «вантажівка». автомобілі спецтехніки «пожежний», «швидка допомога», «поліція». «евакуатор», «снігоприбиральна», «поливальна машина», «трамвай», «тролейбус», «таксі» «трактор» тощо. Деякі діти вже досить усвідомлено називають декілька марок легкових автомобілів. Дітей також слід знайомити з такими дорожніми знаками як «пішохідний перехід», «рух транспорту заборонено», з дорожньою розміткою, правами і обов'язками пішоходів, пасажирів, водіїв, правилами перебування в громадському транспорті. Обов'язково слід наголошувати на ключовій ролі у винайденні транспортних засобів винахідників з Європи, в доступній формі показувати послідовність і важливість їх винаходів в сучасному житті для сталого розвитку.

ADVANCED TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

FROM THEORY TO PRACTICE: INSIDE THE NATIONAL CENTER FOR THERAPEUTICS MANUFACTURING

Andrew Syvyk
National Center for Therapeutics Manufacturing, Texas A&M University, USA
Speaker: andrew_e_syvyk@tamu.edu

The National Center for Therapeutics Manufacturing (NCTM) stands as a pioneering hub at the forefront of interdisciplinary workforce education and cutting-edge research, catering to the dynamic needs of the global biopharmaceutical and vaccine manufacturing sectors. Nestled within the esteemed Texas A&M Engineering Experiment Station, NCTM is dedicated to crafting a transformative learning experience that integrates customizable instructor-led sessions, immersive computer-based modules, and hands-on practical training.

Our comprehensive curriculum is meticulously designed to immerse students in a diverse array of critical disciplines, ranging from the intricate realms of cell culture and fundamental molecular biology to the meticulous nuances of aseptic processes and microbiology. Participants are methodically guided through the details of upstream and downstream processing, navigating the complexities of handling biological materials such as viruses, mRNA, monoclonal antibodies, and other recombinant proteins with precision and expertise.

Beyond education, NCTM serves as a catalyst for innovation, offering a rich tapestry of enabling technologies to academic institutions, medical researchers, and biotech startups. Our unique blend of academic rigidity, scientific expertise, and industrial competency forms the bedrock of a versatile infrastructure, facilitating smooth transitions from bench-scale experimentation to pilot-scale production and beyond.

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Media Screening: Leveraging advanced techniques, we meticulously screen and optimize cell culture media to enhance productivity and efficiency.

Expression Systems: Whether it's bacteria, mammalian cells, or insect lines, our diverse expression systems provide researchers with a versatile toolkit for protein expression and manipulation.

Process Development: Our experts offer invaluable support in process development and optimization, ensuring scalability and efficiency.

Analytical Methods: Through meticulous method development and characterization, we equip researchers with the tools needed to dissect and understand the intricacies of their bioprocesses with clarity and precision.

At NCTM, we are not just shaping the future of therapeutics manufacturing; we are empowering a new generation of pioneers to drive innovation and transformation in the biopharmaceutical landscape.

DIAGNOSTIC AND THERAPEUTIC POTENTIAL OF EXTRACELLULAR VESICLES

Igor Kurochkin
Central Research Laboratory, Sysmex Co., Kobe, Japan
Speaker: kurochkin1108@gmail.com

Extracellular vesicles (EVs) are a highly heterogeneous group of membrane-enclosed nano-sized particles secreted by almost all cell types. These include EVs derived from animal, plant, yeast, and bacteria cells. Discovered more than 50 years ago, EVs were initially considered simply as "garbage bags", particles involved in the removal of waste material from cells. Research in the EV field exploded after discovery in 2007 that these nanoparticles carry a large number of mRNA and miRNA molecules. EVs produced by one cell type were shown to deliver mRNA to another cell type where they were translated to proteins. Thus, EVs provided a new way of exchanging genetic information between cells. Furthermore, EVs were found to be involved in the pathogenesis of cancer, cell maturation and development, cellular stress response, cardiovascular functions and neurodegenerative diseases.

Diverse names for EVs have been proposed reflecting different cell sources, biogenesis pathways, size, and function. These include exosomes, microparticles, microvesicles, apoptotic bodies, archaeosomes, argosomes, dexosomes, epididymosomes, prostasomes, oncosomes, mitovesicles, and migrasomes.

In addition to various RNA species, EVs were found to contain DNA, proteins, lipids, and metabolites. The content of EV components was found to reflect their abundance in host cells. Because EVs secreted by various tissues reach the blood, urine, saliva, and other biological fluids, they represent a valuable new source of liquid biopsy of diseases. The high information capacity of EVs is currently being intensively exploited by companies for the development of novel non-invasive diagnostic assays.

Recent studies have unveiled the therapeutic potential of EVs in tissue repair, regeneration, and anti-tumor activity. Researchers are actively developing engineered EVs that could be targeted to specific tissues and carry therapeutic molecules. In this regard, milk and plants might provide excellent source of EVs for oral delivery-based therapies because of their high biocompatibility, non-immunogenicity, and capacity for large-scale production.

I will also review here the current state-of-the-art and challenges regarding EV production, purification, and analysis.

MADE IN PLANTS RECOMBINANT PROTEINS FOR MEDICINE AND FOOD

Anatoli Giritch
Nomad Bioscience GmbH, Halle (Saale), Germany
Speaker: giritch@nomadbioscience.com

For millennia, people have used plants as a source of food, construction materials, fibers for clothing, fuel, medicines. Progress in modern biotechnology have made it possible to use plants also for production of recombinant proteins. The new scientific and technological area which is called Plant Molecular Farming (PMP) emerged about 30 years ago and is still in the process of formation. During this time, PMP experienced periods of intensive development, stagnation, hopes, disappointments, and achievements. Today, plant-based systems for production of recombinant proteins belong to biotechnological arsenal alongside with alternative systems using prokaryotic and eukaryotic organisms: *Escherichia coli,* yeast, mammalian cells, whole animals, insects, etc.

Using proprietary plant-based expression platform, NOMAD Bioscience GmbH focuses on development of several products including 1) antimicrobial proteins (bacteriocins) for the food safety and medicinal use, and 2) sweet-tasting proteins (thaumatin and brazzein) for the food industry.

NOMAD's bacteriocin colicin is efficient against *E. coli* bloodstream infections in animal model.

NOMAD's recombinant bacteriocins to control *E. coli* and *Salmonella* during food processing were designated as GRAS (Generally Recognized as Safe) products by U.S. FDA (U. S. Food and Drug Administration). Similarly, NOMAD's recombinant protein thaumatin received GRAS status from U.S. FDA and FEMA (Flavor and Extract Manufacturers Association of the United States). GRAS approval opens the regulatory way for industrial production and commercialization of these products.

REGENERATION OF PERIPHERAL NERVE INJURIES WITH MXene BASED ELECTROCONDUCTIVE POLYMER NERVE GUIDANCE CONDUITS

Sergiy Kyrylenko[1]*, Kateryna Diekova[2], Inna Chorna[1], Zhanna Klishchova[1,3], Serhii Duchnovskiy[4], Ivan Baginskiy[4], Veronika Zahorodna[4], Iryna Roslyk[4], Oleksiy Gogotsi[4], Paola Caro[5], Alexandre Oliveira[5], Maksym Pogorielov[1,2]

[1]Biomedical Research Center, Medical Institute of Sumy State University, Sumy, Ukraine
[2]Institute of Atomic Physics and Spectroscopy, University of Latvia, Riga, Latvia
[3]Federal University of Lavras UFLA, Lavras, MG, Brazil
[4]Carbon Ukraine Ltd, Kyiv, Ukraine; [5]University of Campinas UNICAMP, Campinas, SP, Brazil
**Speaker: kyrylenk@gmail.com*

Injuries to peripheral nerves remain a significant public health concern. The increasing frequency of travel and regrettable proliferation of armed conflicts contribute to the prevalence of such injuries. While diagnosing peripheral nerve injuries is relatively straightforward, their management is still a challenge. The current gold standard surgical technique involves utilizing autografts, where a nerve graft from a donor side of the patient's own body is used to bridge the injury gap. However, this results in additional injury at the donor site, highlighting the complexity of managing such injuries. It is evident that the treatment approach for peripheral nerve injuries has remained largely unchanged for a century. Therefore, there is a critical need for innovative alternative approaches that can effectively address these injuries without causing additional harm to the patient. Nerve guidance conduits are structures designed to guide the reparation of damaged nerves, facilitating recovery post-injury. Constructed from a variety of biomaterials, these conduits create a supportive environment for nerve regeneration. While tubulisation using materials like silicon tubing offers a basic solution, it falls short of being optimal. The demand for new biomaterials that are biocompatible, biodegradable and supportive is evident, with a focus on polymers to meet these criteria. Given the electrical nature of neuronal signals, the need for electro-conductive conduits was suggested to enhance efficacy of nerve regeneration. This requirement has steered the development of conductive polymer neuronal conduits, marking a cutting-edge approach to neural recovery. Such conduits hold promise in overcoming the challenges associated with rehabilitation of neuronal injuries. However, a key obstacle emerges: the majority of polymers lack conductivity, functioning instead as dielectrics. We suggest that the solution for the problem lies in MXenes, a novel family of graphene-like two-dimensional nanomaterials with exceptional properties. MXenes have attracted considerable interest in various areas of science and technology, notably for their remarkable electro-conductivity surpassing that of the graphene. The non-toxic and biocompatible nature of MXenes positions them as ideal candidates for design of the next generation neuronal conduits. Our project is aimed at developing polymer nanofibrous membranes coated with titanium carbide MXene. We employ such membranes to construct neural guidance conduits in the model of sciatic nerve injury in rats. The project is in progress, while we have already observed enhanced functional recovery in the injured paw treated with the MXene based nerve guidance conduits.

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USING OF UNDERWATER VERTICAL AXIS TURBINES ARRAYS FOR CLEAN ENERGY HARVESTING

Olena Haisha[1], Eugen Rusu[1], Oleksandr Haisha[2]*
[1]*Dunarea de Jos University of Galati, Galati, Romania*
[2]*Institute of Marine Sciences, Barcelona, Spain*
**Speaker: oleksandrgaysha1982@gmail.com*

The paper presents the concept of an array of modular vertically oriented turbines (ARPA-E, 2020) that are installed under the water surface to harvest energy from water flows. Such modular technical decisions may be of more interest (World Economic Forum, 2022) and total economic efficiency in some specific conditions rather than giant wind turbines with hundred-meter blades. Particularly module structure is more appropriate under war threats, natural catastrophic events caused by a climate changes, relocation of production due to economic and political reasons, etc. Also underwater functioning may reduce typical disadvantages of the vertical-axis turbine systems, such as small efficiency coefficient (LUVSIDE). The geometric parameters of one device are justified, and, on their basis, an estimated calculation of the possible generated power (about 0.5 kW per module) is made. The calculations of number of the modules, which are expedient to be combined within one system, are made, thus approaching modern horizontal axis wind turbines in terms of the amount of generated power. There are pointed out the paths for the development of the technology for production of the proposed modules, in particular, with using modern integrated printing systems (industrial 3D printers) (Haisha & Haisha, 2024), instead of environmentally unfavorable composites (which are used to make turbine blades of modern wind energy stations). The issues of ensuring the static stability of one module, as well as the features of the electrical part of the entire system, are also considered. Overall, in this paper, based on the preliminary calculations, the expediency of carrying out more precise in-depth research of the proposed construction is substantiated, which is planned in future work.

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APPLICATION OF SYSTEM ANALYSIS IN THE DEVELOPMENT OF GREEN ENERGY IN UKRAINE

Veronika Ostapenko*, Yuliya Gladka
Kyiv National Economic University, Kyiv, Ukraine
**Speaker: veronikaalexandrovna1243@gmail.com*

This research is devoted to an overview of the use of system analysis in the context of green energy development in Ukraine. The paper focuses on systems analysis methods as an important tool for solving complex problems related to planning, choosing between several alternatives, types of renewable energy, optimisation and implementation of projects in this field. An illustrative project example demonstrates the practical application of these methods. The paper describes the process of completing the stages of systematic analysis, such as collecting and analysing information on the state of the country's energy sector, building a production model for presenting knowledge based on the collected facts, necessary actions and proposals; forecasting and making the most rational decisions based on expert assessment and objective analysis methods. The paper also explores the use of mathematical tools based on a systematic approach and methods of mathematical modelling.

ECOLOGICAL USE OF ADVANCE TECHNOLOGIES IN EDUCATION

Inna Cheremnykh*, Liudmyla Fedorchuk
Taras Shevchenko National University of Kyiv, Ukraine
**Speaker: innache99@gmail.com*

It is important to consider the concept of sustainable development as an integrated system of industries and problems that must be solved comprehensively. The plan for the development of the planet until 2030 is recorded in the resolution adopted by the UN General Assembly on September 25, 2015 (Resolution, 2015). Essential problems that should be solved urgently, in particular in Ukraine, include not only the issues of achieving peace, ecology and preservation of natural resources, but also the social sphere, economic development, and education.

Given the seriousness of the implementation of rights and responsibilities, which "include an understanding of the importance of universal rights and the recognition that our actions may have consequences for present and future generations" (United Nations, 1992), in the field of education, despite the war, advanced technologies with the use of AI are rapidly developing and being introduced into the educational process. During the creation of media products by students of the Institute of Journalism, only Telegram channel LEVEL covered topics related to eco-awareness in war conditions, the impact of man on nature, the impact of war on the field of transplantology, and the impact of AI on television (Telegram, 2024). The master's thesis includes a series of video blogs "AI VS TV presenter. Whose future is it?" - TV presenter of the Dnipro channel "D1" Margarita Sopilniak draws a parallel between herself as a real and virtual author, created with the help of Creative Reality Studio and Heygen programs. The work raises a number of important issues, in particular Is it ecological to spread information, being a virtual copy? Is AI capable of displacing a person, his emotions, professionalism? Is the Ukrainian audience ready to consume news from robotic authors?

Therefore, in order to achieve the goals of sustainable development regarding the ecological use of information in the field of modern Advanced technologies for sustainable development, the efforts of the world community should develop, implement and adhere to ethical norms of behavior in the use of AI technologies. And also answer how advanced technologies can contribute to the sustainable development of various fields, in particular education, without causing harm and "without jeopardizing the ability of future generations to meet their own needs" (United Nations, 1992).

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AI IN EDUCATION: CORRESPONDENCE WITH SUSTAINABLE PEDAGOGY APPROACH AND PRACTICAL IMPLEMENTATION CASE AT NUFT

Yevhenii Shapovalov[1,2]*, Maryna Shapovalova [2], Viktor Shapovalov[2], Oksana Salavor[1], Fabian Andruszkiewicz[3]

[1]National University of Food Technologies, Kyiv, Ukraine

[2]National Center of Junior Academy of Sciences, Kyiv, Ukraine

[3]University of Opole, Poland

**Speaker: sjb@man.gov.ua*

Recent advancements in education, including the implementation of artificial intelligence (AI) and innovative methodologies such as ontologies (Stryzhak et al., 2023), smart tools (Shapovalov, Bilyk, et al., 2023). This study introduces a pilot course implemented at the National University of Food Technologies for Bachelor's students, focusing on "Modeling and Forecasting Environmental Conditions" during 2023/2024. The course leveraged modern technologies such as AI to enrich the learning process, aiming to improve quality and provide tailored learning experiences. Additionally, AI has the potential to simplify the introduction of coding concepts, such as Python, to non-computer science students. Strategies like integrating Python interpreters alongside Large Language Models (LLMs) including fine-tuning math-specific LLMs, coupled with Python code interpreters have shown promise in addressing these field (Gao et al., 2023; Liao et al., 2024). The proposed approach focuses on the development and implementation of a prompt-based approach in teaching mathematical modeling. The curriculum, emphasized practical orientation and encouraged students to use various tools, including Mathcad, MS Excel, Python, GeoGebra, and LLMs. Students had the freedom to implement models in environments that fit, improving their analytical skills and platform selection. They also learned to provide prompts for mathematical models and to present their ideas. As a result, motivation, and interest were improved, aligning with sustainable pedagogy principles. (Shapovalov, Slipukhina, et al., 2023).

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STRATEGIE OF PRETREATMENT OF LIGNOCELLULOSIC BIOMASS FOR BIOETHANOL PRODUCTION AS BIOFUEL

Kateryna Danilova*, Sergii Oliynichuk
Institute of Food Resources of NAAS, Kyiv, Ukraine
**Speaker: dankoek77@gmail.com*

Bioethanol is recognized as a valuable substitute for renewable energy sources to meet the fuel and energy demand, considered an environmentally friendly resource obtained from agricultural residues such as sugarcane bagasse, wheat straw, corn and rice straw. Lignocellulosic biomass (LCB) is the point of attention in replacing the dependence on fossil fuels. In an attempt to find an alternative approaches to bioethanol production, lignocellulosic biomass raises an intensive attention as cellulose is similar to starch and sugar because it is also a polymer of glucose (Shukla et al., 2023). Lignocellulosic biomass (LCB) is a complex structure consisting of fermentable and non-fermentable sugar. Cellulose is the most abundant lignocellulosic biomass with compositional analysis of 33-47 % that is utilized for further process of hydrolysis (Gao et al., 2021). Another copious compound in the LCB is hemicellulose (19-27 %) in composition. Non-fermentable part of biomass are lignin (5-24 %) and silica (18.3 %) component which forms lignin–carbohydrates complex and hinders the further process of hydrolysis by binding with cellulose, reducing the exposed surface area for enzymatic action (Singh et al., 2016) as well as forms a hindrance against external encroachment and prevents degradation. The recalcitrant structure of the lignocellulosic biomass is disrupted using effective pretreatment techniques that separate complex interlinked structures among cellulose, hemicellulose, and lignin. Recently, the thermophysical method or high-temperature steam explosion treatment of lignocellulosic biomass under pressure has become more popular. The method of decompression or steam explosion changes the biostructure of the product, destroys lignin bonds and affects the composition of the obtained products. The optimal conditions for explosive defibrillation are preliminary moistening of the product with water, a heating temperature of up to 200 ºC and a processing time of 10 minutes, which contributes to the transition of cellulose into a more accessible amorphous form, which later becomes available for enzymatic hydrolysis under the action of cellulases with the formation of sugars, which are fermented by yeast in ethyl alcohol – glucose, fructose. The obtained results show that with an increase in the processing temperature from 150 to 200 ºC, the delignification of cellulose-containing raw materials increases, which is evidenced by a decrease in the content of residual lignin by 2.2 times, a decrease in the residual content of hemicelluloses in the product from 16.76 to 2.6 %.

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MUSHROOMS OF THE GENUS *HERICIUM* AS A TOOL FOR SUSTAINABLE BIORESOURCE MANAGEMENT: ANALYSIS OF GROWTH CONDITIONS

Olena Dotsenko[1]*, Viktoriia Krasinko[1], Margarita Lomberg[2], Oksana Mykchaylova[2,3]
[1]National University of Food Technologies, Kyiv, Ukraine
[2]M. G. Kholodny Institute of Botany of the National Academy of Sciences of Ukraine, Kyiv, Ukraine
[3]Igor Sikorsky Kyiv Polytechnic Institute, Kyiv, Ukraine
**Speaker: lenadotsenko5@gmail.com*

Mushrooms of the genus *Hericium*, known for their unique bioactive compounds, have generated significant interest in the scientific community because their utilization can make a substantial contribution to achieving the UN's Sustainable Development Goals. These mushrooms hold potential not only in medicine, where they can be used to develop new pharmaceuticals, but also in creating environmentally friendly biotechnologies that help conserve natural resources and maintain ecological balance. Studying *Hericium* mushrooms could play a crucial role in improving public health quality, promoting sustainable use of natural resources, and expanding global partnerships.

This paper reviews the potential of *Hericium* mushrooms in the context of sustainable development. It examines both theoretical and practical aspects of the application of these basidiomycetes. Special attention is given to their potential uses in healthcare, with a particular focus on their neurogenerative, antioxidant, antimicrobial, anti-inflammatory, and other therapeutic properties. Strategies for cultivation, selection of nutrient media, and optimal growth conditions that can ensure maximum yield of bioactive substances with minimal environmental impact are also discussed. The paper presents research findings on the growth performance of *Hericium* strains on various nutrient media, including those containing cellulose components. It was found that media such as malt agar and malt agar supplemented with cellulose additives like oak bark and pine needles were most conducive for achieving the maximum growth characteristics of the studied mushroom strains. The use of *Hericium* mushrooms can serve as a vivid example of how integrated scientific research and innovation can promote sustainable development on a global scale.

WAYS FOR BIOSYNTHESIS OF SILVER NANOPARTICLES USING MICROORGANISMS, ALGAE, AND PLANTS

Valeriia Marchenko, Oksana Skrotska, Rostyslav Koval*
National University of Food Technologies, Kyiv, Ukraine
**Speaker: kovalrost119@gmail.com*

For the biosynthesis of silver nanoparticles, various biological objects are used, including bacteria, cyanobacteria, fungi, yeast, algae, plants. When microorganisms are employed for the biosynthesis of silver nanoparticles, both intracellular and extracellular synthesis pathways are possible. Additionally, the synthesis of nanoparticles using exo- and endogenous cellular metabolites is feasible (Vadakkan, Rumjit, Ngangbam, Vijayanand, & Nedumpillil, 2024). Extracts from algae and plants containing polysaccharides, phenolic compounds, proteins, vitamins, carotenoids, astaxanthins, polyols, terpenoids, and sterols are used for the biosynthesis of silver nanoparticles. The mechanisms of nanoparticles biosynthesis using plants are not fully elucidated at present. However, it is known that hydroxyl, methylene, and carboxyl groups of various biological substances participate in the processes of silver ion reduction, nanoparticles formation, and stabilization (Mustapha, Misni, Ithnin, Daskum, & Unyah, 2022). Depending on the biological object and the biosynthesis method, nanoparticles of various shapes (spherical, cubic, icosahedral, triangular, pentagonal, hexagonal) and sizes are formed, affecting their biological properties. Biogenic nanoparticles exhibit antibacterial activity against both gram-negative and gram-positive bacteria. The mechanism of their antimicrobial action involves denaturation of bacterial surface proteins and inhibition of cell metabolism and respiration by damaging the electron transport system. Additionally, nanoparticles inhibit bacterial protein translation. Antitumor activity of biogenic nanoparticles using various cancer cell lines has been demonstrated, with evidence of their non-toxicity towards normal cell lines. The antitumor effect of biosynthesized nanoparticles is associated with inducing cellular and subcellular morphological changes, enhancing oxidative stress and metabolic toxicity, and inducing apoptosis in cancer cells by reducing the expression of anti-apoptotic proteins and increasing the expression of apoptotic proteins (Koul, 2021; Saravanan, 2021).

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PRODUCTION OF IRON ENRICHED *SACCHAROMYCES CEREVISIAE*

Hanna Bondar*, Viktoriia Krasinko
National University of Food Technologies, Kyiv, Ukraine
**Speaker: abn2292@gmail.com*

Iron is crucial for various biological processes, yet its bioavailability is often hindered by low solubility under physiological conditions. Iron deficiency remains a global health concern, particularly in vulnerable populations.

Among the most common ways to overcome this deficiency are oral intake of iron medications/dietary supplements and consumption of iron-fortified foods. Among the advantages of fortified-foods are its safety and cost-effectiveness, but the limitation is the potential reactivity of iron with other components, which triggers undesirable changes in color and flavor (Man et al. 2022).

Traditional approaches to addressing iron deficiency include oral iron supplements such as ferrous sulfate, ferrous succinate, ferrous fumarate, ferrous gluconate, ferrous glycine (Chen, 2024), but it may have limited effectiveness and can cause side effects such as vomit, diarrhea and nausea (Mimura et al. 2008).

This study explores the potential of *Saccharomyces cerevisiae* yeast to accumulate iron, offering a safer alternative for preventing anemia. Cultivation experiments with different iron sources revealed that iron salts such as iron (III) chloride and iron (II) sulfate significantly enhanced yeast growth and intracellular iron levels. Cultivations supplemented with iron (III) chloride and iron (II) sulfate exhibited elevated levels of intracellular iron, approximately 50 ppm Fe/g dry matter, which is six times the amount of iron observed under control conditions. Notably, yeast supplemented with iron citrate showed the highest iron accumulation despite its higher iron concentration, suggesting potential toxicity or nutrient dilution effects at high concentrations.

Iron-enriched yeast biomass represents a promising approach for iron supplementation due to its enhanced bioavailability and decreased toxicity compared to conventional supplements. Further research is needed to optimize cultivation conditions and explore the practical applications of iron-enriched yeast in food and dietary supplements.

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A DEVELOPMENT OF FAST CHROMATOGRAPHIC METHOD FOR INDOLEACETIC ACID DETERMINATION IN CELL CULTURES

Mykhailo Tymofiienko*, Liudmila Butsenko
National University of Food Technologies, Kyiv, Ukraine
**Speaker: mt8457@gmail.com*

A novel high-performance liquid chromatography (HPLC) method using fluorescence detection (HPLC-FLD) for the rapid determination of indoleacetic acid (IAA) in bacterial cell cultures was developed and validated. Indoleacetic acid, a critical plant growth hormone, plays an essential role in enhancing root and xylem growth, promoting lateral root formation, and improving plant stress tolerance to adverse environmental conditions such as high soil salinity and drought (Khoso et al, 2024). The conventional methods for IAA determination are often hampered by the complexities of the matrix, the presence of interfering substances, and the need for extensive sample preparation, making the development of a rapid and robust method necessary (Hou et al, 2008, Chen et al, 2018, Liu et al, 2022.

Our study primarily focused on streamlining the sample preparation and expediting the overall analysis process. The newly developed method employed simple sample preparation techniques, which significantly reduced the analysis time and solvent use, aligning with environmental sustainability goals. This method was validated in accordance with the International Conference on Harmonisation (ICH) guidelines, which included assessments of specificity, linearity, accuracy, and repeatability. The method demonstrated excellent linearity across a wide concentration range and provided high repeatability and accuracy in IAA quantification. Furthermore, the method was capable of resolving IAA peaks clearly from other components in complex biological matrices, thereby confirming its suitability for routine use in microbial IAA analysis. The analytical robustness of the method was tested using two bacterial strains known for their contrasting IAA production capabilities: *Bacillus subtilis* 26D and *Bacillus amyloliquefaciens* IMV A4. These strains were selected to study the method performance in its intended use conditions.

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SACCHAROMYCES GENUS YEAST: BIOSYNTHESIS OF NANOPARTICLES

Oksana Skrotska, Pavlo Holubiev*
National University of Food Technologies, Kyiv, Ukraine
**Speaker:* p.holubiev@gmail.com

Biological methods of nanoparticle synthesis are environmentally friendly, as well as simple, fast and cost-effective. Among the various biological entities that can be used for the biosynthesis of nanoparticles, yeast of the genus *Saccharomyces* have several advantages, since these microorganisms and their metabolites are completely safe for humans, animals and the environment. In addition, yeast synthesize a large number of biologically active compounds (proteins, enzymes, amino acids, organic acids, vitamins), which can participate in the biosynthesis and stabilization of nanoparticles (Skalickova, Baron, & Sochor, 2017).

Up to date, the biosynthesis of various nanoparticles using yeast of the genus *Saccharomyces* has been investigated. These are nanoparticles of precious metals (gold, silver, platinum, palladium), which are characterized by antibacterial, antifungal, antiviral and antitumor properties. The possibility of nanoparticles' usage in the food industry, medicine, agriculture and energy was shown (Koul, Poonia, Yadav, & Jin, 2021). The biosynthesis of nanoparticles of metal oxides using saccharomycetes is also being investigated – nanoparticles of oxides of silver, zinc, antimony, manganese, iron, selenium, silicon dioxide and titanium (Mohamed & Kadium, 2022). The biosynthesis of nanoparticles of binary chalcogenides (sulfide of selenium, zinc, cadmium) using Saccharomyces cerevisiae is studied (Asghari-Paskiabi, Imani, Rafii-Tabar, & Razzaghi-Abyaneh, 2019). Such nanoparticles have better biological and electrochemical properties compared to their monocomponent counterparts due to faster electrochemical kinetics and higher electronic conductivity. There are different approaches when using yeast for the biosynthesis of nanoparticles. In particular, biomass, culture liquid, supernatant, cell-free aqueous extract can be used. At the same time, the parameters of biosynthesis differ: temperature, pH, mixing, duration. Depending on the choice of technique, nanoparticles of different shapes and sizes can be obtained, and they will also differ in their physicochemical and biological properties.

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KILLER YEAST AS AN IMPORTANT ECOLOGICAL FACTOR FOR BIOCONTROL MICROFUNGII IN THE AGRICULTURE

Maksym Klymenko*, Viktoriia Krasinko
National University of Food Technologies, Kyiv, Ukraine
**Speaker: maksym1klymenko@gmail.com*

Every year worldwide, fungal decay often results in significant economic losses in agriculture. Synthetic fungicides, which have traditionally been used to effectively combat putrefactive agents, have caused environmental and human health problems. Killer yeasts can be considered an alternative to fighting microbes. Killer yeasts secrete so-called killer toxins, which inhibit sensitive microbial cultures. The practical use of such yeasts for the purpose of bioregulation of micromycetes is becoming increasingly common. Fungal diseases of fruits and vegetables cause significant crop losses – from 25% in industrialized countries to 50% in developing countries. Control measures include chemical, physical and biological approaches. Fungicides are most commonly used to combat fungal infections of field crops, as these chemically synthesized compounds are quite cheap, can be stored for a long time, and are quite effective. However, their routine use raises concerns because, in addition to threatening human health and the environment, resistant pathogenic fungal biotypes are emerging in parallel. A number of countries, such as the United States and the European Union, are supporting a project called Integrated Pest Management (IPM), which aims to reduce or, if possible, completely replace chemical pesticides (Díaz et al., 2020).

A number of microorganisms have been found that can protect fruits from fungal infections, including bacteria, filamentous fungi, and yeast. However, the latter have a clear advantage over the others because their nutrient requirements are quite simple, they can be easily grown in high quantities using inexpensive substrates, they are not harmful to humans, the environment or host fruit, and last but not least, the target organisms are unlikely to develop resistance (Díaz et al., 2020).

Killer yeasts are practically used for fruit protection in pre- and post-harvest processing of fruits, citrus and vegetables such as grapes, lemon, papaya, tomatoes and others (Lima 2013; Liu, 2018). For example, they help to prevent the severe disease anthracnose caused by *Colletotrichum gloeosporioides*, inhibit the formation of phytopathogens on the surface of fruits, which reduces the amount of harm to the human body.

The use of killer yeast as an important environmental factor for the biocontrol of micromycetes in agriculture is a priority for further research.

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FORMATION OF THE DOMESTIC MARKET OF GLUTEN-FREE PRODUCTS IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

Anastasiia Riznyk*, Tetiana Sylchuk, Vita Tsyrulnikova, Olha Dulka, Olena Tyshchenko
National University of Food Technologies, Kyiv, Ukraine
**Speaker: riznyk_nastya2707@ukr.net*

This paper discusses the use of promising domestic raw materials in the technology of innovative agglutinin products that create a new generation of food products. According to experts from the World Health Organization (WHO), human health is interconnected with lifestyle, especially with the quality of food. Given the current conditions in our country, there is a lack of a wide and diverse range of food products for people suffering from genetic diseases. One of these diseases is celiac disease (gluten enteropathy), a multifactorial, progressive disease caused by damage to the villi of the small intestine by certain food components (wheat, rye, barley) containing the protein gluten. If left untreated, the intestinal mucosa can completely atrophy.

The popularity of eating gluten-free products is driven not only by the diagnosis of celiac disease, but also by the general idea of maintaining health and preventing nutritional diseases. In addition, increased marketing efforts and improved distribution channels are driving the need for gluten-free products.

One of the ways to reproduce the state policy in the field of healthy nutrition of the Ukrainian population is to create highly efficient technologies in the agricultural industry, search for new domestic raw materials and develop an innovative generation of food products rich in essential micronutrients. Sales of such products will expand the range of domestic bread products and help replace expensive imported gluten-free products.

In addition, the introduction of innovative technologies using domestic raw materials in domestic enterprises and hospitality facilities remains an equally pressing issue. Taking into account the opinion of experts and the results of international experience, it is obvious that the introduction of advanced technologies in Ukrainian production will create a new generation of safe food products for gluten-dependent consumers and solve an important problem of our time.

BACTERIA *MESORHIZOBIUM CICERI* IS AN ECONOMICALLY AND ECOLOGICALLY BENEFICIAL BIOLOGICAL AGENT FOR GROWING CHICKPEAS

Oleh Vysotskyi*, Viktoriia Krasinko
National University of Food Technologies, Kyiv, Ukraine
**Speaker: konradwhittaker2@gmail.com*

In the context of global efforts to achieve the Sustainable Development Goals, efficient and cost-effective cultivation practises of pulses using biofertilisers based on symbiotic nitrogen-fixing bacteria can help solve the global problem of malnutrition and protein deficiency in the diet, as well as significantly reduce CO_2 emissions from meat processing enterprises through a gradual transition to alternative sources of complete protein (Logosha et al., 2020). In chickpea cultivation technology, as a more environmentally friendly alternative to mineral fertilisers, it is advisable to use a bacterial inoculant containing bacteria of the *Mesorhizobium ciceri* species, which enter into symbiosis with chickpea plants (*Cicer arientum*) and they are able to fix up to 176 kg of nitrogen per hectare per year from the atmosphere (Zhang et al., 2023). Literature data shows that a successful selection of *M. ciceri* strain increases yields on nitrogen-enriched soils (more than 50 kg of nitrogen per hectare) by 5…20%, and on poor soils (less than 20 kg of nitrogen per hectare) (Logosha et al., 2020) by 20…50%, depending on the concentration of other micro- and macroelements in the soil (Oparah et al., 2022), which can potentially not only increase yields, but also reduce the use of mineral nitrogen fertilisers for the next crop by 40…60% (Rochester et al., 2001).

However, in order to maximise the potential of *Mesorhizobium ciceri*, it is important to further investigate the optimal conditions for cultivation this bacteries. It is also essential to understand how variable environmental conditions affect the efficiency of these bacteria in interaction with chickpea, which will help to develop more effective strategies for their use. Such research should not only increase the yield and quality of chickpea, but also ensure a more sustainable adaptation of plants to climate change and other environmental challenges.

Thus, the inoculating chickpeas with *Mesorhizobium ciceri* bacteria opens up new horizons for sustainable and environmentally friendly agricultural practices that address global environmental and food challenges.

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INNOVATIVE AUTOCATALYTIC PYROLYSIS: TRANSFORMING CHICKEN MANURE INTO VALUABLE RESOURCES

Roman Tarasenko[1], **Yevhenii Shapovalov**[2,3]*, **Lydmila Starzhinska**[1], **Ievgen Polunkin**[1]
[1]*P. Kukhar Institute of Bioorganic Chemistry and Petrochemistry of the National Academy of Sciences of Ukraine, Kyiv, Ukraine*
[2]*National University of Food Technologies, Kyiv, Ukraine*
[3]*National Center of Junior Academy of Sciences, Kyiv, Ukraine*
**Speaker: sjb@man.gov.ua*

The poultry industry's growth has made managing livestock manure a significant environmental issue (Salyuk, 2015; Shapovalov, 2019; Zhadan, 2021; Salyuk, 2012). One promising solution is the autocatalytic pyrolysis of waste (Padoan et al., 2024). It produces valuable co-products like syngas, Bio-Oil, and humate-containing fertilizer. Traditional high-temperature pyrolysis is not economically feasible due to its high energy costs and extended process times. This research explores a more cost-effective low-temperature autocatalytic pyrolysis process. An experimental reactor was designed for this purpose, processing 1 kg of dried chicken manure with water and a catalyst. The mixture was heated to 200 °C for four hours. This process yielded 204.48 g of syngas, 649.12 g of Bio-Oil, and 649.12 g of humate-containing fertilizer, corresponding to 12.78 %, 40.57 %, and 46.65 % of the total weight, respectively.

The study demonstrated that the humate-containing fertilizer, which has numerous applications, was produced in significant quantities, making the process economically viable. The syngas showed increased flammability over time, with methane and hydrogen contents reaching 21.6 % and 33.6 %, respectively. The Bio-Oil contained various chemicals, including alkylbenzenes and alkylbenzoles. Therefore, the autocatalytic pyrolysis of chicken manure at lower temperatures is a promising technology for waste management and the production of valuable by-products.

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MODERN BIOTECHNOLOGIES IN THE FIELD OF FOOD WASTE PROCESSING WITH REGARD TO THE PRINCIPLES OF CIRCULAR ECONOMY

Iryna Korniienko*, Olena Kuznietsova, Victoria Kermash,
Larysa Yastremska, Mykhailo Baranovskyi
National Aviation University, Kyiv, Ukraine
**Speaker: irina.kornienko.1979@gmail.com*

The technology of food waste processing using a specific consortium of microorganisms (EM technology) in accordance with the principles of the circular economy is gaining great relevance in the context of modern challenges. Aimed at reducing the use of resources, the proposed technology implements technical and organizational solutions to improve the efficiency of digestate and biogas production. This approach is becoming an important element of sustainable development for the EU and Ukraine (The Circularity Gap Reform 2020). In EU countries, expired bread is recommended to be added as an additional substrate (on Janis Winter's farm, bread is added to the digester) in vegetable waste bioconversion processes, as it stimulates fermentation processes and helps to increase amount of biomass to produce organic biofertiliser for own use (Korniienko et al, 2022). In view of the above, waste bread should not be a source of microbial contamination, especially with fungi, as this is unacceptable for agricultural purposes. Therefore, in waste recycling technologies, attention should be paid to the suitability of bread for such purposes. From a microbiological point of view, unfortunately, bread that is not sold in time shows signs of diseases caused by the pathogens of potato bread disease - the spore-forming bacteria *Bac. mesentericus-subtilis*, or signs of mould, often caused by fungi of the genera *Aspergillus*, *Rhizopus* or *Mucor*, which appear in the form of spots or bubbles on the surface of the bread, which can lead to a decrease in its commercial value. Taking into account the importance of this issue, we have developed an improved bread recipe based on sourdough that has a high titer of lactic acid bacteria, which, in turn, act as powerful antagonists against bread pathogens, which makes it possible to increase the shelf life of bread (without detecting signs of disease) for 12 days with the possibility of further processing. Also, a modern biotechnology of processing vegetable waste was developed with the addition of expired bread in the amount of 2, 3 and 5% with the determination of the optimal value for the implementation of the process of bioconversion of vegetable waste within 10 days into biofertilizer and biohydrogen and compliance with the relevant conditions. The obtained digestate was successfully tested during the cultivation of grain crops. Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Education and Culture Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

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ADVANCED ENERGY-EFFICIENT LOW-TEMPERATURE SEED DRYING TECHNOLOGIES

Vadym Paziuk, Kateryna Samoilenko*, Serhii Biriukov
Institute of Engineering Thermophysics of NAS of Ukraine, Kyiv, Ukraine
**Speaker: katerynasamoilenkoittf@gmail.com*

The development of drying technologies for grain drying occupies a significant place in the world. Improvements are constantly being made to plant designs and technologies, which are interconnected and aimed at reducing drying time, increasing the energy efficiency of dryers and preserving the quality of grain material (especially seed material). The drying process is regulated by the maximum heating temperature of the seed material. Our preliminary research showed that it is possible to carry out drying up to a grain temperature of 48°C, at which seed germination is 97%. When drying seed material, it is not possible to intensify the process by increasing the temperature of the coolant. Therefore, there is a need to apply another method of intensification, which is achieved by reducing the moisture content of the heat carrier, which in turn increases the drying speed and reduces the duration of the process. Advanced energy-efficient low-temperature technologies for drying seed materials are implemented through the use of a heat pump in the drying unit. This drying technology has the following advantages:

- efficiency: use of thermal energy of the environment (air) and conversion of energy from low-potential sources into usable energy;
- environmental friendliness: during operation, the heat pump does not emit harmful emissions;
- manufacturability: can be used for both heating and cooling, or a compatible simultaneous operation of the heating and cooling system;
- operational feasibility: low service costs and a long service life.

The application of advanced energy-efficient low-temperature technologies in the study of drying seed materials yielded the following results:

1. The effective moisture content of the heat carrier in the dryer with a heat pump was established, which should be less than 10 but more than 4 g/kg of dry air. It was determined that at a coolant temperature of 50°C and a moisture content of 6 g/kg of dry air, the heat pump conversion factor is 3.2.

2. Increasing the intensity of seed drying is achieved by reducing the moisture content of the coolant. The task is solved by developing a drying unit with a heat pump at a low temperature drying of 50°C and a moisture content of the coolant of 6 g/kg of dry air with an increase in the intensity of the process by 13%.

3. The energy efficiency of the installation is determined by the specific consumption, which is 4480 kJ/kg of evaporated moisture (when the moisture content of rapeseed is reduced from 19.2 to 8%), which is 7-12% lower than analogues. The efficiency of a drying installation with a heat pump is 58.4%.

4. Germination of grain after drying in a heat pump installation is 99-100%, which makes it possible to recommend this technology for drying seed material.

ENRICHMENT OF WHOLE GRAIN BREAD WITH HERBAL ADDITIVES

Svitlana Bazhay-Zhezherun, Ludmyla Bereza-Kindzerska,
Alla Bashta, Tetiana Fedorenko*
National University of Food Technologies, Kyiv, Ukraine
**Speaker: tetmykoliv@ukr.net*

Bread and bakery products are in high consumer demand in all social segments of the population and are prominent in the food diet. It is known that in the process of production, varietal types of flour lose a significant share of valuable micronutrients, which are contained in the peripheral parts of the grain and removed when grinding. Therefore, it is advisable to increase the use of whole grain flour in the technology of bread-bakery products, as well as the use of promising natural enrichers, in particular herbal raw materials, which are the source of the necessary nutrients (Bazhay-Zhezherun et al. 2022).

The purpose of the work is to substantiate the feasibility of inclusion in the recipe of whole wheat bread of high-protein raw materials - hemp flour and sweet potato puree, as a source of antioxidant compounds and natural sorbents to increase the nutritional value of the finished product.

A comparative assessment of the chemical composition of whole grain and hemp flour was carried out. The content of the main energogenic substances: proteins, fats, carbohydrates, as well as the content of important micronutrients – vitamins C, E, β -carotene, B_1, B_2, PP was investigated in flour samples. The moisture content and acidity of raw materials are determined.

It is found that hemp flour contains in three times more protein, in seven times more fats and five times more fiber, compared to wheat whole grain flour; the amount of vitamins, in particular tocopherols, carotenoids, B_1, is also much higher in hemp flour.

We investigated the organoleptic parameters of sweet potato fruits and puree from it, as well as the chemical composition of the specified raw materials. Sweet potato puree is a source of natural antioxidants – ascorbic acid, rutin, carotenoids, phenolic compounds.

We researched the influence of hemp flour and sweet potato puree on physico-chemical quality indicators of dough and whole grain bread.

Enrichment of whole wheat bread with hemp flour and sweet potato puree does not impair the porosity structure of products. If hemp flour is added in an amount of 4-8%, and sweet potato puree in an amount of 2-6%, the taste and aroma remain not only acceptable, but also acquire a pleasant light shade of enrichers.

Whole grain bread enriched with hemp flour and sweet potato puree is a functional food product. It was found that the degree of provision of daily demand for macro- and micronutrients, adult population of the first group of intensity, due to the consumption of 100 g of whole grain bread enriched with hemp flour is: proteins – 15 %, fats – 3.1 %, carbohydrates – 15.6%, dietary fiber – 11 %; vitamins: E – 18 %, β -carotene – 11.5 %, B_1 – 17 %, B_2 – 5.8 %.

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INNOVATIVE PROBIOTICS, ENRICHED WITH SELENIUM NANOPARTICLES: A STEP TOWARDS SUSTAINABLE DEVELOPMENT IN NUTRITION AND HEALTHCARE

Daria Syniavska*, Natalia Gregirchak
National University of Food Technologies, Kyiv, Ukraine
**Speaker: sinyavska.daria.2001@gmail.com*

Selenium nanoparticles represent an innovative and new alternative as green synthesis objects due to their lower toxicity and higher bioavailability compared to traditional chemical forms of dietary Se (Au, Mojadadi, Shao, Ahmad, & Witting, 2023).

Traditional methods for the synthesis of SeNPs are physical and chemical syntheses, which have complex operational processes, high production costs, and difficult large-scale production. However, the production of SeNPs using lactic acid bacteria is a more promising method that efficiently utilizes inorganic Se to synthesize elemental Se^0 through biological enrichment (Liao & Wang, 2022). This technology will better meet the demand for Se supplements for people, especially those who have a deficiency of this element in their bodies.

For example, scientists from Argentina achieved 98% enrichment of selenium from the culture medium. At the same time, the bacteria *Lactobacillus plantarum* CRL 2030 intracellularly accumulated 1.96 mg/ml of the added precursor – 5 mg/L Na_2SeO_3 and formed spherical SeNPs with a size of 50-90 nm. The number of viable cells was 8.8×10^{10} CFU/ml. To achieve this result, the cells were cultured at 30 °C for 24 h in MRS nutrient medium and 2% inoculum was used (Martínez, Moreno-Martin, Pescuma, Madrid-Albarrán & Mozzi, 2020).

The results of a research by Chinese scientists show that Se enrichment at a Se concentration of 10 μg/ml enhances the probiotic properties of *L. plantarum* 6076, with Se accumulating in amorphous or non-crystalline form (Zan, et al., 2024).

In summary, metal nanoparticles and probiotics can create a synergistic effect to improve human health, but the development of such drugs requires more in-depth study of their safety, toxicity, biosolubility, and environmental impact, as this will allow for the future high-quality and safe use of thoroughly researched technologies as the most environmentally friendly and effective.

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RESEARCH OF THE PROCESS OF ENZYMATIC HYDROLYSIS OF MILK WHEY PROTEINS AND SOY PROTEINS

Hanna Dekusha*, Lesia Avdieieva, Mykola Kozak
Institute of Engineering Thermophysics of Ukraine National Academy of Sciences, Kyiv, Ukraine
**Speaker: hansik25@ukr.net*

The paper deals with studies of enzymatic proteolysis of whey protein concentrate (WPC) and isolated soy protein (ISP) with food enzymes for the further creation of products for special dietary purposes.

It has been shown that the use of the discrete pulse energy input method, developed at the Institute of Engineering Thermophysics of the Ukraine National Academy of Sciences, is an effective way to restore and dissolve high-protein products in an aqueous environment. The method makes it possible to reduce the duration of their recovery several times and improve the unsolubility index for ISP by 25 % and for WPC by 33 %.

The dependence of the degree of hydrolysis of ISP and WPC on the mass fraction of the enzymes Protamex, Protease C and ORBAproteo P–1200 was studied.

It was determined that hydrolysis of proteins at a mass fraction of enzyme of 5 % (of the protein mass), a mass fraction of protein in an aqueous solution of 7.3-8.1 %, a temperature of 55-57 °C and pH of 6.1-6.2 for 60 min allows to obtain a degree of hydrolysis for ISP 65-75 % with Protamex, 65-68 % with Protease C and 55-60 % with ORBAproteo P–1200.

Under the same conditions, the degree of hydrolysis of WPC was 60–65% with Protease C, 50-52 % with Protamex and 45-48 % with ORBAproteo P–1200.

NANOTECHNOLOGY AS A COMPONENT OF ADVANCED TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT

Vitaly Polishchuk*, Elena Yakhnovska, Svitlana Polishchuk, Svitlana Tsekhmistrenko
Bila Tserkva National Agrarian University, Bila Tserkva, Ukraine
**Speaker: vitnik2007@ukr.net*

Nanotechnology plays a key role in solving global problems of sustainable economic development, preserving human health, protecting the environment, and providing the world's population with clean water, food, and effective medicines. Understanding this will facilitate the creation and implementation of new environmentally friendly, resource- and energy-saving technologies, ensure the modernization of the country's economy and the transfer to a modern high-tech path of development of many environmental and environmental problems.

Green technologies and green chemistry hold great promise in addressing these global planetary challenges. This is especially true for the creation of nanomaterials, which have a wide range of applications in various fields of technology, ecology, biology, medicine, agriculture, food industry, etc. (Bityutskyy, 2022; Malik, 2023). In addition to penalties and a ban on the use of a number of particularly hazardous chemicals, attention has increased to the search for less toxic substitute chemicals and alternative energy and resource saving technologies. Moreover, toxicological control of chemicals and materials produced and used was introduced by law. The definition of green chemistry (green technologies) adopted by the scientific community is as follows: "Green chemistry and green technologies are the discovery, development and use of chemical products and processes that reduce or eliminate the use and formation of harmful substances". The definition directly indicates the need to take into account possible negative effects at the stage of creating new compounds, which researchers often did not think about before.

The principles of green chemistry are a philosophy that applies to all areas of chemistry, not just one chemical discipline, and is aimed at preventing pollution at the molecular level. These principles envisage the use of innovative scientific solutions that lead to a reduction in the formation of hazardous substances, as they prevent the formation of pollution, reduce the negative impact of chemical products and processes on human health and the environment, and reduce and even, in some cases, eliminate hazards from existing products and processes.

The application of nanotechnology in various sectors of the economy, ecology, biology, medicine and agriculture is among the most pressing issues in science and technology.

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EVALUATION OF THE INFLUENCE OF THE AMINO ACID COMPOSITION OF WHEAT GERM AS ADDITIVE TO MEAT PRODUCTS

Marija Zheplinska*, Volodymyr Vasyliv, Larisa Bal-Prylypko, Mikhailo Mushtruk, Nataliia Slobodianiuk, Konstantyn Gorenkov

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

**Speaker: jeplinska@ukr.net*

Introduction. The possibility of extracting fiber in the composition of meat products is becoming particularly relevant, thanks to its nutritional value and functional and technological properties. These fibers significantly contribute to increasing the vulnerability of the human organism to the harmful effects of the environment. An increase in the production of products enriched with pectin substances and fiber is necessary not only for use in medical and preventive nutrition for those workers who work in conditions of increased radioactive background or in contact with heavy metals, but also for mass consumption (Bozhko, 2018; Feifei, 2022).

Thus, the analysis of work performance confirms the expediency of adding vegetable raw materials to minced meat. And therefore, the study of amino acid composition in a herbal supplement is an expedient and relevant issue.

Materials and methods. The amino acid composition of the additive was determined by the method of ion chromatography. Other indicators were determined according to generally accepted physicochemical research methods.

Results and conclusions. It has been established that the protein in the amount of 16% of wheat germ fiber with apple pectin contains all essential amino acids. A comparative analysis of the amino acid composition of the protein of the vegetable supplement with the ideal protein of FAO/WHO established that the content of all essential amino acids, except for tryptophan, is 5.32% less than in the ideal protein. However, this protein contains a significant amount of such substitute amino acids as glutamine, arginine, histidine and proline. These acids provide a high hydration capacity of wheat germ fiber with apple pectin, and the use of this plant additive in sausage production technology will lead to improvement of the functional properties of minced meat and finished sausage products. The ratio of replaceable and non-replaceable amino acids in the protein supplement does not significantly differ from the adequate and maximum permissible values and approaches the ideal protein. Research allows to harmonize the amino acid composition of the protein component in finished sausage products.

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COMPARATIVE CHARACTERISTICS OF SUSTAINABLE DEVELOPMENT STRATEGIES IN FOOD INDUSTRY ENTERPRISES

Oksana Hrebelnyk*, Liudmyla Zahorui
Bila Tserkva Agrarian University, Bila Tserkva, Ukraine
**Speaker: hrebelnyko@gmail.com*

Implementation of the principles of sustainable development in the food industry is currently important, their activity is a potential source of environmental pollution.

The purpose of the work was to compare the sustainable development strategies of domestic and foreign enterprises in various branches of the food industry (Yakymenko et al., 2022).

The research used data from the companies' official websites. Economic, environmental and social aspects of implementation were highlighted. The research was carried out in the following branches of the food industry: meat, dairy, food, bakery, confectionery.

Common trends for foreign food industry enterprises have been identified. From an economic point of view, this means expanding the global production network, maintaining local brands, introducing the latest technologies and equipment, investing in scientific developments, focusing on family company technology, customer orientation (including age, health, religion, eating style)

The social direction is the implementation of teamwork, educational support, psychological support, health care, work safety, flexible work schedule, implementation of the principles of gender equality, code of ethics, youth support, charity, support for Ukrainians affected by hostilities.

The ecological aspect is the introduction of renewable energy, biodegradable materials, waste-free and resource-saving technologies, the NAASR system, waste processing, promotion of "rational food consumption", etc.

Smaller scales of the declared goals were found for domestic enterprises. For economic indicators, this is the formation of a new Ukrainian market, strengthening of positions on the world market. Customer orientation may not apply to all consumption features. Scientific investments are usually absent. The development of the social aspect is more aimed at supporting youth and education. The development of environmental activities is more aimed at improving technological lines as objects of environmental danger (Hrebelnyk, 2023).

At the same time, for Ukrainian enterprises, there is a wider implementation of sustainable development goals in new areas of the food industry (for example, frozen semi-finished products). For such areas, there is a more complete coincidence of trends with global strategies of sustainable development in the food industry.

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CONCEPTUAL PRINCIPLES OF THE CREATION OF THE NATIONAL ELECTRONIC SCIENTIFIC INFORMATION PLATFORM OF ACADEMIC EVENTS

Oleksandr Platonov, Yevhenii Shapovalov, Tetiana Rudakova*, Viktor Shapovalov
The State Scientific and Technical Library of Ukraine, Kyiv, Ukraine
**Speaker: Rudakovatati@gmail.com*

In the global world of modern technology and the development of open knowledge, digitization is a driving force for innovative developments, free knowledge transfer, and idea exchange for progress not only worldwide but also in Ukraine.

ConfIDent, Conference Index, EasyChair, WikiCFP conference platforms exists. These platforms provide structured metadata for organizers, presenters, participants, etc. However, none of the existing conference platforms provide free access to information about conferences with free access, as well as full utilization of permanent identifiers such as ORCID, DOI, etc. Additionally, challenges include ensuring the effectiveness of conducting scientific events in the conditions of digital societal transformation, improving the quality of material preparation, integration with international platforms, and providing open access to materials.

Addressing the above-mentioned issues is possible through the creation and phased development of a national electronic scientific information platform for academic events within the National Scientific Information System URIS. According to the developed concept, all registered higher education institutions and research institutions in URIS will be provided with functionality for forming a list of planned institution events, recording data for each stage of the academic event life cycle. Placing open data information about academic events on platform will be useful for widespread and ensuring permanent access to this data via the Internet. This concept includes integration of the national platform with existing international platforms such as Crossref, ISSN, ConfIDent, etc.

The centralized infrastructure of the platform will: • Significantly improve conditions for researchers regarding planning and implementing their own conference activities with multiple reuses of materials from conducted academic events; • Conduct comprehensive automated monitoring of conference activities of subjects of scientific and scientific-technical activities at all levels of organizational hierarchy; • Improve the representation of research results by Ukrainian researchers; • Simplify and reduce the cost of conducting quantitative surveys and comparisons of scientific productivity; • Create a positive image of Ukrainian science globally and foster new successful collaborations between Ukrainian scientists and foreign partners.

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ENVIRONMENTAL FRIENDLINESS OF THE PRODUCTION OF GLYCOSAMINOGLYCANS BY BIOTECHNOLOGICAL MEANS

Maryna Hryshchenko*, Svitlana Starovoitova
National University of Food Technologies, Kyiv, Ukraine
**Speaker: mari.gryshchenko54@gmail.com*

Hyaluronic acid (HA) is an important biomolecule with wide applications in pharmaceuticals, cosmetics, and medicine. Traditionally obtained through extraction from animal tissues, this method poses contamination risks and quality control issues. Microbial engineering, or chemical synthesis, emerges as a promising eco-friendly, controlled, and cost-effective alternative for producing HA.

Literature sources of foreign and domestic scientists in leading periodicals and specialized world publications devoted to various methods of obtaining hyaluronic acid and selecting the most optimal method from an environmental point of view were analyzed.

Animal tissue extraction has significant environmental drawbacks due to high energy and water consumption, as well as toxic waste emissions during raw material processing (Cristiano & Guagni, 2022). It also risks transmitting zoonotic diseases from close animal contact and tissue processing. The microbiological method ensures high product purity and quality. Unlike animal sources, biotechnological production eliminates contamination risks and allows obtaining a pure product under controlled conditions. It is less costly and more environmentally friendly than traditional extraction methods (Balbinot-Alfaro et al., 2021). Moreover, it aligns with the growing cruelty-free and vegan cosmetics trend, as mandated by EU Regulation No. 1223/2009 on cosmetic products. However, natural HA producers are zoonotic pathogens grown on media with sheep's blood and brain heart infusion. Their synthesis product contains endotoxins, requiring costly additional cleaning and isolation steps. This issue is addressed by developing new non-pathogenic producer strains capable of growing on eco-friendly media. Now, the genetically modified strain *Bacilius subtilis* 3NA is recognized as the most efficient and non-pathogenic producer of hyaluronic acid, which allows obtaining 7 g/l of HA and it significantly reduces the risk of obtaining contaminated hyaluronate and reduces the cost of additional purification of the target product. (Hryshchenko, Starovoitova, 2024).

So, summing up everything said above, the microbiological method of obtaining glycosaminoglycans is not only effective, but also sustainable and environmentally friendly approach to obtaining valuable anti-aging ingredients for cosmetology, which meet the requirements of modern consumers and support the concept of eco-friendly and ethical production.

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TOXICITY OF SODIUM SELENITE AND INTRACELLULAR BIOSYNTHESIS OF SELENIUM NANOPARTICLES USING *SACCHAROMYCES CEREVISIAE* M437 FOR THEIR FURTHER USE IN DETOXIFICATION OF THE BODY

Oleksandr Zholobko*, Maria Protsenko, Oksana Skrotska
National University of Food Technologies, Kyiv, Ukraine
Speaker: Zholobkoov@gmail.com

Introduction. Today, selenium nanoparticles (SeNPs) are gaining importance because of their special properties that can be useful in conditions of war. Due to the full-scale Russian invasion of Ukraine on February 24, 2022, a large area of Ukrainian territory has been contaminated by explosive ordnance. Thus, according to the SES, as of January 2023, more than 30% of Ukraine's territory is contaminated with explosive items containing heavy metals, namely in the form of mercury fulminate (rattlesnake mercury), which releases stable mercury salts upon detonation, as well as mercury itself, which settles on the ground and can subsequently be absorbed into the human body (through water or dust by inhalation). To date, there are studies confirming the potential of selenium to reduce the toxicity caused by mercury by forming inert complexes that are excreted in the urine, and, given that selenium has a small maximum permissible range of consumption, it is the best option to use selenium nanoparticles due to their inherent lower toxicity compared to its macro analog.

The aim of the study: the study on the ability of sodium selenite biotransformation into selenium nanoparticles by the *Saccharomyces cerevisiae* M437 yeast, determination of the toxic effect of selenite on yeast cells and establishment of the location of the formed nanoparticles.

Materials and methods. The cultivation of *S. cerevisiae* M437 cells was carried out in Rider liquid medium. For the synthesis of SeNPs, sodium selenite was used as a precursor, which was added at the beginning of the cultivation process at concentrations ranging from 0.5 to 3.0 mM. At the end of the cultivation process (7 days), the unreacted amount of selenite-ion (SeO_3^{2-}) was determined.

Results. During the cultivation process, a gradual change in the color of the culture fluid from milky to pale orange/pink was observed, depending on the concentration of sodium selenite added. The change in the color of the culture fluid to orange/pink indicates the formation of selenium nanoparticles, since one of the allotropic forms of elemental selenium is red in color. After the inoculation of culture fluid samples on Petri dishes, it was found that sodium selenite has a toxic effect on *S. cerevisiae* M437 cells at all studied concentrations, as in 24 hours after the introduction of sodium selenite, cell growth on Petri dishes was absent. Nonetheless, despite the viability loss, the process of selenium nanoparticles formation continued. As a result of centrifugation of the culture fluid at the end of the cultivation process, it was found that selenium nanoparticles were formed intracellularly, since the resulting cell precipitate was orange-pink in color, and the supernatant was transparent. After 7 days, the residual concentration of selenite ion in the culture fluid was determined; the amount of unreacted selenite ion was observed in the range of 40-70%. It is interesting that with an increase in the initial concentration of sodium selenite in the culture fluid, the percentage of unreacted selenite decreased.

Conclusion. The possibility of synthesizing selenium nanoparticles by *S. cerevisiae* M437 yeast was established, it was determined that the accumulation of selenium nanoparticles occurs intracellularly and the amount of unreacted selenite ion decreases with the increase in initial sodium selenite concentration.

INTENSIFICATION OF WASTEWATER TREATMENT BIOTECHNOLOGY USING YELLOW SAPONITE

Tetiana Suleiko*, Olena Semenova
National University of Food Technologies, Kyiv, Ukraine
**Speaker: tata_t2008@ukr.net*

Water is the basis of life on Earth. The properties of water are very diverse, so it was able to find the widest application on our planet. Despite this, people in the course of their activities mercilessly pollute it with chemical and radioactive substances, pesticides, synthetic fertilizers, domestic and industrial wastewater. This is the cause of the global environmental problem of today (Khvesyk, & Levkovska, 2019).

Modern methods of wastewater treatment are called upon to solve this problem, the most traditional of which is called the biotechnological method through anaerobic and aerobic fermentation of wastewater.

Depending on the concentration of pollutants in the wastewater, anaerobic stage (methane fermentation), aerobic fermentation, or a complex combination of these two stages are recommended as the main treatment step. If the chemical oxygen consumption (COC) doesn`t exceed 2000 mg O_2/dm^3, it is necessary to use aerobic fermentation (Tkachenko, Semenova, Bublienko, & Levandovsky, 2011), but if it exceeds, then it is advisable to use methane fermentation as the main stage, and the aerobic method for post-treatment.

The aerobic stage of wastewater treatment is an integral part of the technological scheme of neutralization of polluting substances of the specified effluents. That is why one of the primary tasks of improving the cleaning process is the intensification of the aeration tank, which, for example, can be carried out by the following methods: increasing the concentration of activated sludge; improvement of methods of aeration of the mixture of sludge and water; increasing the enzymatic activity of activated sludge organisms; by influencing the activity of microbial cells by physical factors, for example, electrostatic or electrodynamic fields; by sorption of pollutants on, mainly, solid carriers, etc.

Studies were conducted on the use of crushed yellow saponite. It was established that the quality and speed of the cleaning process can be regulated by the ratio of the amount of filler to the amount of activated sludge. The optimal ratio is 1:2. These conditions of aerobic fermentation make it possible to carry out the process of cleaning effluents of medium concentration (approximately 2000 mg O_2/dm^3 by COC) to the standards of discharge into natural water bodies in 36 hours, which is almost 2 times faster than under standard conditions.

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RECYCLING AND DISPOSAL OF LITHIUM-ION BATTERIES

Petro Zinkevych*, Serhii Baliuta, Iuliia Kuievda
National University of Food Technologies, Kyiv, Ukraine
**Speaker: petrozinkevich@gmail.com*

The development of green energy, electric vehicles, and comprehensive recycling of resources are critical aspects on the way to sustainable development, considering that the energy crisis and environmental security are two problems that need immediate solutions (Liang et al., 2021). The transition to renewable energy sources can ensure the end of the fossil fuel era. Electrochemical storage systems, particularly lithium-ion batteries (LIBs), are key technologies to successfully implement this transition (Brückner, Frank, & Elwert, 2020).

First introduced to the commercial market in the 1990s, LIBs have gained rapid adoption and have become one of the fastest growing technologies in energy storage. The main advantages of these batteries are high energy and power density, high reliability and long service life. A total of approximately 10.5 trillion watt-hours of EVs are projected to be generated by 2030, of which electric vehicles (EVs) will account for 77%. The duration of service of LIBs depends on their application in various areas. Typically, in consumer electronics, the life of a LIB is 1-3 years, while for more powerful applications, such as energy storage, this life is usually 8-10 years.

Used LIBs contain significant amounts of valuable metals such as lithium (Li), cobalt (Co), nickel (Ni), manganese (Mn), iron (Fe), copper (Cu) and aluminum (Al). Due to the rapid increase in the production of LIB, the prices of these metals are increasing sharply, in particular for strategic cobalt, the price of which has increased four times in the last two years - from 22 dollars per kilogram to 81 dollars. Therefore, the used LIB should be considered as waste containing valuable strategic materials, taking into account the principles of sustainable development.

To date, developed countries are actively demonstrating successful experience in solving the problem of processing spent sources of electricity by implementing a state policy on environmental protection. However, there are currently no regulatory acts in Ukraine that would regulate the process of dealing with used LIBs. Ukraine should develop a regulatory and legal framework that provides for the responsible attitude of both producers and consumers to used LIBs. It is necessary to organize the collection and logistics of the used LIB to the places of their further processing and to raise the environmental awareness of citizens, emphasizing that the separate collection of waste is the only way to achieve a clean environment. It is also important to inform citizens about the harmful effects on health of throwing batteries into landfills together with household waste.

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PROSPECTS AND IMPACTS OF INNOVATIVE TECHNOLOGY FOR PROCESSING NATURAL FRUIT RAW MATERIALS INTO POWDER FORM

Andrii Makarenko*, Tetiana Turchyna, Lesia Avdieieva
Institute of Engineering Thermophysics, National Academy of Sciences of Ukraine, Kyiv, Ukraine
**Speaker: tbds_ittf@ukr.net*

The wide range of Ukrainian fruit raw materials as a source of valuable bioactive substances should be processed into powdered products for health, therapeutic, and dietary nutrition.

Processing whole fruits enriches powdered products with their own bioactive substances, including vitamins, minerals, pectins, dietary fibers, organic acids, phytoestrogens, and many others. Such products not only serve as food but also have health-promoting functions, such as boosting immunity and cleansing the body of dangerous heavy metals or chemical elements absorbed from air, water, or food. Therefore, powdered products from fresh fruit raw materials are strategically important for the health improvement of our nation.

The innovative technology of such production consists of two main stages:

– Preparation of the raw material for drying, where within a few minutes of hydrodynamic treatment with the introduction of a biopolymer additive, a structured heterogeneous system - suspension is obtained;

– Drying of the suspended material using a disc atomizer in a stream of heated heat carrier to obtain a fine-dispersed powder.

– The introduction of biopolymer additives during the preliminary homogenization of fruit masses contributes to the improvement of their rheological properties, simultaneously achieving several positive effects:

– Conservation and stabilization of newly formed, just opened during fruit structure disintegration, bonds by nanoparticle layers of the dispersion medium;

– Ordering and uniform distribution of all micro- and nanoparticles of insoluble fractions of the specified dispersion composition in the volume of the liquid system, resistant to delamination, i.e., its structuring;

– Stabilization of pH values at ≥4-5, preventing the development of adhesive phenomena in the dryer;

– Improvement of structural-forming, strength, and moisture-conducting properties when obtaining dry powder, which contributes to its high yield and high quality;

– Microencapsulation of thermolabile bioactive substances of the initial raw material within the volume of microparticles and their thermal stability, which ensures a high level of preservation of bioactive substances, minimal powder moisture, and long storage period - over 1 year.

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ONLINE-GAMES FOR THE DEVELOPMENT OF EMOTIONAL INTELLIGENCE

Svitlana Derevyanko
T. H. Shevchenko National University «Chernihiv Colehium», Chernihiv, Ukraine
Speaker: svetl7788svetl@gmail.com

Emotional intelligence is the ability to understand and manage emotions. This is an important personal quality of a modern person who strives to achieve success in life (Mayer, Caruso, & Salovey, 2016). Modern scientists believe that in the conditions of the spread of information and communication technologies, online games are the most optimal means of developing emotional intelligence (Santos et al., 2021).

We will briefly describe modern online games that can be used to develop emotional intelligence: 1. «Emotionary». This online game aims to develop the ability to recognize emotions. The player must identify the emotion shown by the face of the character in the online game. 2. «Empathy Toy». This game greatly helps players develop their empathy and general social skills. The game is an interactive toy set that is used to understand the emotions and feelings of other players. 3. «Mindful Powers». This game contains a series of interactive challenges that help players develop emotional self-regulation skills. 4. «Gratitude Garden». This game is a virtual garden and can contribute to the development of players' self-motivation and their positive thinking. 5. «The Sims» (2000; 2003). This is a video game in the genre of life simulator. Its content is to develop the skills of managing the emotions of others - the player controls the life of sims and their mood (if a sim is happy - a green crystal lights up next to him). 6. «S.T.A.L.K.E.R.» (2007; 2008; 2009). It is a series of video games that contain elements of role-playing games. Completing tasks during the game will help you reflect on your own emotional experiences. 7. «Cosmic Kids Yoga». This game contains a series of practical yoga exercises that can be used not only for children. Persons of a more mature age can also use the exercises of this game to develop concentration on emotional states, their awareness.

You can also use an online game based on artificial intelligence: «Never Mind» (2015) to develop components of emotional intelligence. This game gives you the opportunity to manage your own anxieties and fears. The essence of the game is to identify with the central character, who has traumatic memories. Successfully overcoming fears leads to a positive change in the scenario and resolution of the characters' problems. This game uses markers and sensors to monitor the emotional state of the players.

All these games can be found on websites on the Internet. These games promote the development of emotional intelligence and its components, as well as develop the social skills of the players and improve the mood.

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INTELLECTUAL PROPERTY LAW IN THE CONTEXT OF OPEN ACCESS: CHALLENGES AND OPPORTUNITIES FOR UKRAINIAN UNIVERSITIES

Iryna Druzhkova
Odessa State University of Internal Affairs, Odesa, Ukraine
Speaker: irise2002@gmail.com

The advancement of open access initiatives, exemplified by the Budapest and Berlin Declarations, underscores the global commitment to freely disseminating scientific research. Ukrainian universities actively embrace these principles, showcasing their research through conferences and establishing technoparks to foster innovation. Collaboration with industry clusters, like the Kyiv and Kharkiv IT Clusters, enhances the innovation ecosystem.

Leading Ukrainian universities, such as Taras Shevchenko National University and Lviv Polytechnic National University, contribute significantly to scientific progress. However, challenges persist, notably in patent maintenance due to issues like non-payment of fees.

Despite hurdles, these initiatives bolster the confidence of Ukrainian researchers and improve access to scientific information. By leveraging open access platforms and fostering innovation ecosystems, Ukrainian universities propel the nation's scientific and technical prowess, enhancing global competitiveness. In conclusion, the initiatives undertaken by Ukrainian universities to embrace open access principles and foster innovation demonstrate their commitment to advancing scientific research and contributing to global knowledge exchange. Despite challenges, such as patent maintenance issues, these universities play a pivotal role in enhancing Ukraine's scientific and technical capabilities.

ІННОВАЦІЙНІ ТЕХНОЛОГІЇ В ГОТЕЛЬНО-РЕСТОРАННОМУ ПІДПРИЄМСТВІ ДЛЯ СТАЛОГО РОЗВИТКУ

Інга Дочинець
Національний університет харчових технологій, м. Київ, Україна
Доповідач: inha123vn@ukr.net

У процесі виходу зі світової фінансової кризи й економічної нестабільності перед підприємствами сфери послуг постає чимало завдань, найважливіші з яких є перебудова системи управління й орієнтація на сталий розвиток. Недостатнє врахування попиту на споживчому ринку, застарілі технології, невірні управлінські рішення з розвитку призвели багато вітчизняних підприємств до низьких результатів господарювання.

Підприємства готельно-ресторанного господарства й інформаційні системи впливають один на одного, використовуючи їх підприємства отримують конкурентні переваги у використанні сучасних інформаційних технологій і підвищують свою конкурентоспроможність на ринку. Інформаційна система включає організаційні й комунікаційні засоби, які доводять до керівників різних ієрархічних рівнів і структурних підрозділів управління інформацію про динаміку та результативність реалізації напрямків розвитку ресторанного бізнесу. Заклади готельно-ресторанного господарства, які прагнуть підвищити свою якість послуг, повинні приділяти значну увагу розробленню такої стратегії, яка ґрунтується на засадах розвитку, що відповідає міжнародним стандартам і здатна подолати усі бар'єри на шляху до результату. Як ефективний інструмент для підвищення якості послуг ресторанні підприємства можуть впровадити новітню на даний час CRM-стратегію.

CRM-система (Customer Relationship Management, з англ. "управління відносинами з гостями") – це система управління взаємовідносинами з гостями, яка є автоматизованим програмним продуктом. З її допомогою відбувається збереження необхідної внутрішньої та зовнішньої потокової інформації з метою подальшого аналізу та пошуку способів якнайкращого задоволення потреб споживачів закладів ресторанного господарства. Концепція CRM передбачає регулярний збір й аналіз інформації про гостей: як відреагували на ділову пропозицію, чи задоволені якістю отриманих послуг, наскільки ретельно виконують зобов'язання і, зрештою, скільки доходу приносять підприємству. У залежності від заданого рівня оброблення інформації застосовується: операційна CRM-система (реєстрація та оперативний доступ до первинної інформації, call-центр); аналітична CRM-система (звітність й аналіз інформації у різних розрізах, аналіз результатів маркетингових заходів, аналіз ефективності продажів у розрізі сегментів гостей, програм лояльності); корпоративна CRM-система – рівень організації тісної взаємодії з кінцевими споживачами (опитування, для зміни якостей послуги або порядку обслуговування, веб-сторінки для відстеження відвідувачами стану замовлення, повідомлення по SMS про події, пов'язані із замовленням або особовим рахунком, можливість самостійно конфігурувати та замовити у режимі реального часу продукти та послуги, інші інтерактивні можливості).

Впровадження на підприємствах ресторанного господарства новітніх інноваційних технологій підвищить рентабельність, продуктивність, якість надання послуг, ефективність використання матеріальних та фінансових ресурсів. Але цей процес потребує значних капіталовкладень і багато часу для того щоб окупити вкладені кошти.

ЕКОЛОГІЧНА СКЛАДОВА СТРАТЕГІЇ СТАЛОГО РОЗВИТКУ У ТЕХНОЛОГІЯХ КОМБУЧІ

Ольга Дулька*, Віталій Прибильський
Національний університет харчових технологій, Київ, Україна
**Доповідач: olga.ds210791@gmail.com*

Одним з головних напрямів розвитку людства у XXI сторіччі є збереження довкілля та розроблення технологій, які передбачають не тільки його охорону, але й здоров'я майбутніх поколінь. Із початку індустріального розвитку світу приділялось недостатньо уваги ендоекології. Стрімкий розвиток промислових технологій призвів до поширення хвороб, які і насьогодні є актуальними. Викиди діоксиду вуглецю у біосферу планети значно перевищують його усвоєння фотосинтезом. Як наслідок, у минулому і нинішньому сторіччі спостерігається стійке зростання захворювань людини. Крім цього, унаслідок воєнних дій (Україна, Близький Схід та ін.) додатково утворюються продукти окислення вуглецю та азоту, токсична органіка грунтів та деревини тощо.

Тому Організацією Об'єднаних Націй у вересні 2015 року (70-та сесія Генеральної Асамблеї) прийнята постанова «Перетворення нашого світу: порядок денний у сфері сталого розвитку до 2030 року». Затверджено 17 цілей та 169 завдань. Україна, як і інші країни-члени ООН, приєдналася до цієї постанови. Вона стала основою сучасної глобальної політики, передбачає задоволення потреб нинішнього покоління, створює перспективи для життєдіяльності наступних поколінь і запобігає завданню шкоди довкіллю.

Для харчової промисловості концепція сталого розвитку пердбачає, насамперед, забезпечення споживачів якісною продукцією із збільшенням частки оздоровчих та лікувально-профілактичних продуктів. Водночас виробництво харчових продуктів повинне забезпечити мало- або безвідходність технологій.

Комбуча є перспективним ферментованим напоєм на ринку безалкогольної прдукції і до 2027 року може перевершити 10 млрд. $.

Технологія Комбучі передбачає використання культури *Medusomyces gisevii*, яка є природньою зооглеєю різних родів і видів дріжджів та бактерій. Унаслідок розвитку культур мікроорганізмів утворюється не тільки біомаса мікроорганізмів, але й своєрідна мікробна целюлоза (Dulka та ін., 2023). Протягом тривалої ферментації їх кількість зростає і потребує утилізації. Мікробна целюлоза може використовуватись в харчовій та легкій промисловостях, медецині (папір для юридичних документів, заміна рослинної целюлози, одяг)

Таким чином, для забезпечення стратегії сталого розвитку країн світу, зокрема України, технології ферментованого напою Комбуча можуть не тільки забезпечити ендоекологію готової продукції, але й завдяки унікальності культури *Medusomyces gisevii* визначити нові перспективні напрями її використання у різних галузях промисловості.

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EUROPEAN STUDIES FOR SUSTAINABLE DEVELOPMENT

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INTERDISCIPLINARY EUROPEAN STUDIES IN THE FIELD OF GREEN INITIATIVES

Olena Mitryasova[1]*, Ruslan Mariychuk[2], Viktor Smyrnov[1], Vadym Chvyr[1], Andrii Mats[1]
[1]Petro Mohyla Black Sea National University, Mykolaiv, Ukraine
[2]University of Presov, Presov, Slovakia
**Speaker: eco-terra@ukr.net*

In recent years, cooperation between Ukraine and the EU in the field of higher education has become increasingly important. One of the most effective tools for cooperation is project activities using international platforms. At the initiative of the European Union, the international Erasmus+ programme is being implemented, which involves higher education institutions of Ukraine and the world in the study of European integration processes, promotes the perfection of European integration studies, activates the European integration discourse; disseminates the ideas of a united Europe.

The Ecology Department of the Petro Mohyla Black Sea National University implements interdisciplinary European studies in the field of European green initiatives. Interdisciplinary European studies are implemented in the format of separate Modules, the content of which took into account the provisions of the new Law of Ukraine "On Higher Education", the tools of the Bologna Process for Quality Assurance: ECTS (European Credit Transfer and Accumulation System) with special attention to the competence-based approach & measurable learning outcomes, as well as other quality assurance mechanisms, including the involvement of potential employers to provide a practical component, determine the specific competencies of a future ecologist, etc.

Interdisciplinarity is realized through the coverage of key aspects of the sustainable development strategy, covering the following issues: quality of life; Climate; environmental safety; relationships in the environment; forecasting the future development of man and nature; the idea of co-evolution and sustainable development of nature and human; sustainable development; depletion of natural resources; the human health problem. The content will also include the international dimension, the role of the EU in international environmental movements and the impact of European policies on other regions of the world (European Green Dimensions, 2022; Mitryasova & Mats, 2021).

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INTERNATIONALIZATION AS A LEADING FACTOR OF UKRAINIAN UNIVERSITY INTEGRATION INTO THE EUROPEAN EDUCATIONAL SPACE

Alina Maslova*, Olga Goncharova
Bogdan Khmelnitsky Melitopol State Pedagogical University, Zaporizhzhia, Ukraine
**Speaker: mav2429@gmail.com*

The European Union has recognized internationalization in higher education as essential for enhancing quality, competitiveness, and innovation. This study explores the impact of internationalization on Ukrainian universities, focusing on Bogdan Khmelnitsky Melitopol State Pedagogical University's (BKMSPU) participation in the EU-funded Erasmus+ programmes. The research aims to highlight BKMSPU's experience in grant projects as part of its internationalization strategy (Bogdan Khmelnitsky Melitopol State Pedagogical University, 2023).

The methodology of the study involves online research and analysis of recent publications and documents on higher education internationalization in Ukraine and at BKMSPU in particular. The results show that internationalization is crucial for transforming and modernizing Ukraine's education system, integrating it into the global educational landscape. The authors stress that internationalization enhances academic quality and mobility, fosters global competencies, develops international partnership, and promotes knowledge exchange. Despite its benefits, challenges like ensuring the quality of qualifications obtained abroad, lack of clear policies and guidelines, non-alignment of international and domestic programmes, financial problems, cultural differences, unequal and non-reciprocal relationships, the brain drain and overcoming language barriers should be taken into account (Moshtari & Safarpour, 2023).

The authors conclude that BKMSPU's participation in Erasmus+ projects demonstrates positive outcomes, enhancing the staff and students' competencies and promoting international collaboration. This experience will contribute to BKMSPU's further integration into the European Higher Education Area and enrich its internationalization strategy.

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INTEGRATING SUSTAINABLE DEVELOPMENT GOALS INTO TEACHING EFL

Halyna Cherednichenko, Olha Nykytenko*
National University of Food Technologies, Kyiv, Ukraine
**Speaker: nikitolya@i.ua*

Education for sustainable development (ESD) is UNESCO's education sector response to the urgent and dramatic challenges the planet faces. To contain global warming before it reaches catastrophic levels means addressing environmental, social and economic issues in a holistic way. UNESCO's ESD for 2030 education programme aims to bring about the personal and societal transformation that is necessary to change course. According to Tang (2009), the purpose of incorporating environmental education in teaching English as a foreign/second language is to raise student awareness of global environmental crises. In the present study, the researchers aim to shed light to different ways to spread sustainable development into the curriculum, by specifically focusing on the ways to integrate environmental issues to EFL (English as a Foreign Language) lessons for university students. Here are some activities of the EFL teachers, designed to raise students' awareness of sustainable development issues.

Global Issues Reading and Discussion. Students read articles and discussed them in small groups. Also, some of the articles had writing exercises or worksheets associated with them. Most of the materials that we used in this activity came from textbooks.

Global Issues and Poetry. Students began by reading poems with environmental or global issues themes. In addition to having relevant themes, these poems have elements that enable them to serve as models for student poetry. After reading the poems aloud, students chose one and discussed them in a small group. Next, they wrote their own poem using the poem they had chosen as a model. During both the discussion and the writing, the teacher assisted students by answered questions. Finally, volunteers read their poems aloud to the class.

Environmental Movie. Students watched and discussed the film on the topic. Students are given a worksheet tracking their opinions of different characters. They filled it out while watching the movie, and questions were discussed in groups after key scenes in the film.

Environmental Projects. Choosing a specific sustainable development problem is another important step in designing a project focused on sustainability. It can be a local or global issue such as climate change, waste reduction or sustainable agriculture. When choosing a topic, it is important to consider the level of students.

THE JEAN MONNET CHAIR: ENVIRONMENTAL MANAGEMENT AND COMMUNICATION IN THE EUROPEAN UNION

Igor Yakymenko[1]*, Natalia Hrehirchak[1], Anatoli Giritch[2], Yevhenii Shapovalov[1,3], Oksana Skrotska[1]

[1]National University of Food Technologies, Kyiv, Ukraine

[2]Nomad Bioscience GmbH, Halle (Saale), Germany

[3]Ministry of Digital Transformation of Ukraine, Kyiv

**Speaker: iyakymen@gmail.com*

The European Union is a global leader in environmentally friendly strategies, policies and practices, including climate change challenges. Reaching EU ambitious goals toward climate-neutral Europe relies on active involvement of governments, industry and citizens. The EU demonstrates that effective communication between all these parties is crucial for success.

The Jean Monnet Chair proposed aims to implement European Union studies on environmental management and communication into the curricula of Ukrainian students to increase their awareness in the subject and promote these approaches in Ukrainian society. The main activities of the project imply implementation of three interconnected teaching courses for bachelor's students in environmental science and in biotechnology: 1) European Union environmental policies and legislation; 2) European Union environmental project management; and 3) European Union environmental communication. Additional activities of the project include annual Jean Monnet Summer School for policy makers, civil servants and civil society representatives for broader promotion of European Union values in Ukrainian society. English speaking club on effective communication for all interested participants aims to forge environmental communication in English.

The project covers 732 academic hours and involve about 540 learners. Indirect involvement through the project's website and sharing experience of learners will be up to one thousand people annually. The main results of the project will be an increased awareness and practical skills of learners on effective environmental management and communication in the EU. The outputs of the project will include three European Union studies / university teaching courses, three manuals for university students, three peer-reviewed research papers, six reports at international conferences, and a website of the project.

The project received the grant support of Erasmus+ programme (#101127449-EcoEurope-ERASMUS-JMO-2023-HEI-TCH-RSCH) in 2023 Jean Monnet Activities Call, and currently we are at the stage of successful implementation of the project's first year activities.

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MARKET PECULIARITIES OF THE POLISH CONFECTIONERY MARKET

Vitalii Venger[1], Nataliia Romanovska[1]*, Andrii Ramskyi[2], Oleksandr Sheiko[3], Olena Burunova[4]

[1]State Institution "Institute for Economics and Forecasting of National Academy of Sciences of Ukraine", Kyiv, Ukraine

[2]Borys Grinchenko Kyiv Metropolitan University, Kyiv, Ukraine

[3]The Ukrainian Chamber of Commerce and Industry, Kyiv, Ukraine

[4]Jan Dlugosz Uniwersity in Czestochowa, Poland

**Speaker: romnatalina@gmail.com*

The Polish confectionery market is considered to be one of the most developed and dynamic markets in the world. Poland is the fourth largest supplier of confectionery products to the EU market, as well as the largest European exporter of sweets to the markets of third countries. The market is dominated by domestic manufacturers of almost all categories of confectionery, which are able to fully meet the needs of the market. But in recent years, the Polish food industry has faced a sharp increase in production and marketing costs, disruptions in the supply chains of raw materials, consumables and packaging, as well as the loss of traditional sales markets due to the war in Ukraine. The study of the peculiarities of the Polish confectionery market made it possible to assess the main indicators of the Polish market of confectionery goods of all categories, as well as its volume and trends.

The situation on the Polish confectionery market, including production, exports, imports, consumption, geographical location of the market, level of competition and development of production and transportation infrastructure of the market, was analyzed. It was concluded that during 2022 there was a 12% increase in the volume of production of confectionery goods of all categories. At the same time the manufacture of Polish flour confectionery products increased by 19.3%. The growth rates of production of cocoa–rich and sugar sweets were 3.8% and 6.8%, respectively. About 50–70% of manufactured products are exported by Polish manufacturers. It is necessary to mention that during 2022 a record number of products were exported from Poland, exceeding the similar figures of the previous year by 13.8%.

Meanwhile, despite the presence of developed domestic production of confectionery goods in Poland, the volume of imported supplies traditionally remains high and increased by 7.8% in 2022. At the same time, the level of competition in the Polish domestic market for flour, cocoa–rich/chocolate and sugar confectionery products is estimated as high. The level of the market's production and transport infrastructure is rated as developed.

SUSTAINABLE FUTURE FOR UKRAINE: CLARIFYING THE SENSES AND STUDYING THE CASES OF DOUGHNUT MODEL

Viktoriia Kiptenko, Snizhana Ulanova*
Taras Shevchenko National University of Kyiv, Kyiv, Ukraine
**Speaker: ulanova544@gmail.com*

Sustainability discourse after 2015 got several interpretations, among which Doughnut idea still is rather unknown in Ukraine. Challenges of war and vectors of post-war recovery raise the issue of better acknowledgment with it and its implications inspiring the search for testing the cases and benchmarking recovery framework for Ukraine. The integrative capabilities of geographical knowledge and the analytical capacity of modern tools of applied geospatial and contextual analysis can serve to substantiate the Doughnut glocalisation model for urban planning in particular. At the same time additional research of critique and feasibility of applying Doughnut model can serve more reasonable discourse in academic and applied aspects focused on selection of indicators and parameters for the analysis.

ВИМІР СТАЛОГО РОЗВИТКУ АГРОПРОДОВОЛЬЧОЇ СИСТЕМИ У РАМКАХ СПІЛЬНОЇ АГРАРНОЇ ПОЛІТИКИ ЄС

Ольга Попова
ДУ «Інститут економіки та прогнозування НАН України», Київ, Україна
Доповідач: olgpomail@gmail.com

Спільна аграрна політика (САП) ЄС на програмний період 2023-2027 рр. концентрується на десяти ключових соціальних, екологічних і економічних цілях: 1) забезпечення справедливого доходу для фермерів, 2) підвищення конкурентоспроможності, 3) покращення позицій фермерів у продовольчому ланцюзі, 4) боротьба зі зміною клімату, 5) турбота про довкілля, 6) збереження ландшафтів та біорізноманіття, 7) підтримка оновлення поколінь фермерів, 8) процвітаюча сільська місцевість, 9) захист якості харчових продуктів і здоров'я, 10) сприяння знанням та інноваціям. Система моніторингу та оцінки ефективності (Performance Monitoring and Evaluation Framework, PMEF) встановлює перелік індикаторів для оцінки ефективності реалізації Національних стратегічних планів САП. Країни-члени ЄС у своїх планах визначили фактичні і прогнозовані рівні індикаторів для відображення дій у впровадженні цілей САП і надаватимуть щорічні звіти про результати діяльності. ЄК проведе аналіз ефективності кожного плану з рекомендацією подальших заходів у 2025 р., а 2027 р. – повторний перегляд. Панель індикаторів результатів упровадження цілей САП ЄС у розрізі країн-членів включає загалом 44 один., зокрема, такі: R.1 Підвищення продуктивності завдяки знанням та інноваціям; R.3 Цифровізація сільського господарства; R.9 Модернізація ферм; R.12 Адаптація до зміни клімату; R.14 Зберігання вуглецю у ґрунті та біомасі; R.19 Поліпшення та охорона ґрунтів; R.36 Оновлення поколінь фермерів; R.44 Поліпшення благополуччя тварин. Україна наразі розробляє свою національну аграрну стратегію. У Плані для Ukraine Facility (програма підтримки від ЄС Ukraine Facility 50 млрд євро на 2024-2027 рр.) для забезпечення сталого розвитку агропродовольчого сектору та адаптації його до європейських стандартів задекларовано реалізацію 6-ти реформ, серед них – узгодження інституційних рамок аграрного і сільського розвитку із політикою ЄС, з прийняттям Стратегії розвитку сільського господарства та сільських територій України на період до 2030 р. У представленому в березні 2024 р. проєкті Стратегії зазначено, що вона окреслює бачення секторального розвитку в Україні відповідно до формату Національних стратегічних планів країн-членів ЄС у рамках нової САП. Однак передбачені у Стратегії 29 індикаторів для оцінки результатів реалізації аграрної політики істотно відрізняються від переліку індикаторів у рамках PMEF ЄС. Має місце й розходження між ключовими цілями САП ЄС і задекларованими реформами у сфері розвитку сільського господарства та сільських територій в Україні, що актуалізує подальшу належну імплементацію засад САП ЄС у національну аграрну політику і практику.

Література:

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RUSSIAN INVASION OF UKRAINE AS A THREAT TO EUROPEAN SUSTAINABILITY

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THE ENVIRONMENTAL DEVASTATION OF UKRAINE: A RESULT OF RUSSIA'S WAR CRIMES

Viacheslav Kharchenko*, Andriy Kotynsky, Igor Yakymenko
National University of Food Technologies, Kyiv, Ukraine
**Speaker: graf_geo_ua@yahoo.co.uk*

In 2014, the Russian-Ukrainian war began. The Russian army occupied the Crimea, and then invaded Donbas. For 8 years, thousands of Ukrainian soldiers and civilians were killed by the attacks of enemy troops, the enemy destroyed settlements and caused an environmental crisis. On February 24, 2022, Russia started a full-scale invasion, and its war crimes spread to the entire territory of our country. Russia is waging a war against Ukraine in the manner of war crimes. The whole complex of such crimes can be divided into 8 classes (Stakhiv & Demydenko, 2023). One of the classes of such crimes is environmental degradation. During the full-scale war, 4 744 facts of causing damage and losses to the environment because of Russian armed aggression were documented. Almost 105 million tons of pollutants and 82 tons of poisonous substances were released into the air due to fires at industrial facilities and forests. Millions of square meters of land were contaminated and clogged. Tens of thousands of tons of foreign objects, materials, waste and/or other substances were dumped into water bodies. And even more pollutants have entered seawater. Environmental damages in Ukraine due to Russian war's crimes calculated by the State Environmental Inspection of Ukraine in accordance with approved methods are more than 57 billion euros (EcoZagroza, 2024).

Russia's war crime with the greatest one-time damage to the environment was the destruction of the dam of the Kakhovka Reservoir. 61 settlements (4 341 houses and 856 gardens) were flooded. As a result of the explosion, at least 150 tons of oil have leaked into the Dnipro River. 333 species of animals and plants, which have various conservation statuses, as well as 25 types of habitats, are at risk of destruction. The estimated damage caused by the catastrophe only to water resources is approximately EUR 50 mln (EcoZagroza, 2024).

In conclusion, the damage to the environment of Ukraine due to Russian war's crimes currently exceeds 57 billion euros. And these war's crimes continue. The revenues of the state budget of Ukraine in 2021 (before the destruction of our economy by the war) amounted about 42 billion euros (MinFin, 2024). Thus, the scale of environmental crimes of Russian invaders in Ukraine is huge and need to be stopped and fully compensated by Russian regime. International support of Ukraine is crucial for both these needs.

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THE MARINE POLLUTION UNDER CONDITIONS OF RUSSIAN AGGRESSION AND PROPORTIONAL MEASURES TO RESPOND TO SUCH ACTIONS

Liliia Timofieieva
National University «Odesa Law Academy», Odesa, Ukraine
Speaker: L.ju.t@ukr.net

The problem of environmental pollution, in particular the sea, became more acute in connection with the war of the Russian Federation against Ukraine, which began in 2014 and became full-scale on February 24, 2022. This is due to the dumping of corpses into the sea, the fall of fragments of rockets, shells, martyrs and other dangerous things for flora and fauna. In particular, as a result of such actions, dolphins and other fish are dying en masse in the Black Sea. On June 6, 2023, the dam of the Kakhovka hydroelectric plant, which has been occupied by Russian troops for a year and a half, was blown up. Thus, the Russian Federation committed a large-scale ecological and man-made disaster.

The above causes new challenges in the issue of regulatory measures to protect the sea from pollution and proportionate response to the damage caused.

The purpose of this paper is to approximate the national criminal legislation in the context of combating sea pollution to European and international standards.

Methods. The methodological basis of the research is general scientific and special methods of scientific knowledge. In particular, the dogmatic, dialectical method, methods of induction and deduction, analysis and generalization, systematics, methods of formal logic, comparison, hypothesis, synthesis, as well as structural-functional, system analysis, method of system-structural analysis, case study method were applied.

Results. It has been established that the concept of personal culpable responsibility in the context of sea pollution needs revision. Measures to optimize the national legislation with the legislation of the European Union in terms of measures regarding sea pollution are proposed. It is proposed to spread the “polluter pays” concept in Ukraine. It is necessary to integrate with international and European organizations that focus their activities on environmental protection and protection of the sea from pollution, in particular.

UKRAINE'S SOCIAL SECURITY IN THE CONTEXT OF OVERCOMING MILITARY SHOCKS

Tetiana Burlay*, Viktoriia Blyzniuk
Institute for Economics and Forecasting of NAS of Ukraine, Kyiv, Ukraine
**Speaker*: btv2008@ukr.net

The authors summarized the social consequences of war upheavals in the Ukraine's economy. This made it possible to determine the elements and principles of ensuring social stability in the Ukrainian post-war society. The theoretical and methodological approach of social security was deepened with the elements of the policy of social quality and inclusiveness, which should ensure the effectiveness of public governance in post-war development. It is proved that in the pre-war period in Ukraine, no system was created that would correspond to the consensus model of the societies development, social goals of the Association Agreement between Ukraine and the EU; and should ensure a balance between the state's economic capabilities and the population expectations regarding well-being and quality of life. The reason for this phenomenon was insufficiently effective public governance and low institutional capacity of the state and social development of Ukraine. The paper summarizes ways of minimizing the consequences of war upheavals, overcoming military shocks and strengthening Ukrainian social security through policies in three key areas: employment; social protection and macro-financial stability. Special attention will be needed to develop the potential of the national social protection system in accordance with the ILO experts' recommendations on increasing the share of social expenditures in Ukraine as a country with lower average incomes.

STUDYING HIGH SCHOOL STUDENTS ABROAD IN THE DIMENSIONS OF CIVIC AND CULTURAL IDENTITY

Natalia Hlebova*, Natalia Falko, Lyudmila Afanasieva, Ernest Murtaziiev, Mykhailo Semikin
Bohdan Khmelnitsky Melitopol State Pedagogical University, Zaporizhzhia, Ukraine
**Speaker: nat.glebova2005@gmail.com*

The civic and cultural identity of a person is an integral part of the existence of any human community and a marker of its national, political and cultural subjectivity. In view of the ongoing russian-Ukrainian war, the issue of civic and national-cultural identity of high school students studying abroad is becoming extremely important for our society. In fact, the martial law in the country, the socio-cultural and educational space of the countries of forced residence simultaneously have a noticeable direct impact on the attraction to or distance from the national and cultural identity of young Ukrainians living abroad.

The purpose of the paper is to assess the current state of civic and cultural identity of Ukrainian high school students abroad in the context of the public demand for the formation of civic and national consciousness in times of war.

The paper uses general scientific methods: classification, abstraction, comparison, formalisation, analogy, deduction, induction, synthesis, analysis. general scientific and special methods, in particular, In the analytical part of the study, we used the methodology of an interdisciplinary approach to form a holistic picture of the research. In order to determine the optimal methodology for empirical sociological research, a comparative analysis of the data available on studies of students' and parents' subjective perception of the peculiarities of the educational process in the host country and other important factors was conducted. The sociological study of the attitude of Ukrainian schoolchildren to the impact of the foreign educational environment and factors of personal choice in the near future was conducted by an online survey using a questionnaire in Google Form online; the graphical and analytical method was used to illustrate the main results of the sociological study.

As a result of the sociological study, it was found that the socio-cultural orientations of an individual in the process of studying abroad are not unreasonably associated with the significant influence of the educational and social environment of the countries of temporary residence. The actual factors of influence and modifications of the dimensions of the socio-cultural identity of Ukrainian high school students abroad are identified. The conclusions substantiate the importance of state and society's attention to the identified problems and the actual directions of measures to adjust these processes in view of their importance for the post-war Ukrainian society.

RADIOECOLOGICAL MONITORING OF ATMOSPHERIC AIR DURING MILITARY OPERATIONS

Kostiantyn Grygoriev, Anna Aleksieieva, Liudmyla Grygorieva*
Petro Mohyla Black Sea National University, Mykolaiv, Ukraine
**Speaker: ludmila.grygorieva@chmnu.edu.ua*

The relevance of the presented research is related with drawing attention to the organization of radiation and radioecological monitoring in Ukraine. This is due to the increased risks of radioecological accidents, the threat of changes in the radiation situation, and the release of radionuclides into the air as a result of constant shelling of the territories near Nuclear Power Plants (NNPs) by Russian missiles and drones.

The aim is to conduct radioecological studies to assess the radiation state of the atmospheric air, atmospheric deposition in the territory of Mykolaiv and Mykolaiv region and to develop proposals for optimizing radioecological monitoring of the atmospheric air during military operations. The research methods were an analysis of the current system of radiation monitoring of atmospheric air in Ukraine, analysis of cases of recording changes in the radionuclide composition of atmospheric air due to the movement of the radioactive cloud, results of own observations of the effective dose rate and radiometry of atmospheric deposition samples.

The paper presents research materials on the radioactive state of the atmospheric air, the content of radionuclides in atmospheric deposition in the city of Mykolaiv in 2023, and a comparative analysis with the indicators of previous years and in the settlements of the Mykolaiv region. To fully assess the effectiveness and efficiency of the current system of radioecological monitoring of atmospheric air, the results of radiometry of atmospheric air samples in the Mykolaiv region during the movement of the radioactive cloud with ruthenium-106 in autumn 2017 are presented. The scientific novelty is to expand the understanding of the tasks of radioecological monitoring of atmospheric air during military operations. The practical significance of the presented results is to obtain field research data for dosimetry of the population of Mykolaiv and Mykolaiv region during military operations of the Russian Federation, for cartographic modelling of the current formation of individual and collective external dose of the population in certain areas.

RUSSIAN AGGRESSION AND EXISTENTIAL CHALLENGES OF THE MODERN WORLD: UKRAINIAN CONTEXT

Andrii Minosian*, Oleksiy Varypaev
State Biotechnological University, Kharkiv, Ukraine
**Speaker: minosian02@gmail.com*

The events of the early twenty-first century, accompanied by Russia's seizure of sovereign territories of certain countries, challenged the maintenance of political stability which led to the collapse of international legal order. The claims of some political leaders of the leading countries to have played a decisive role in the fateful events have not been confirmed either.

The Russian aggression against Ukraine in 2022 finally removed from the agenda the question of having effective security guarantees provided by international organizations such as the UN, OSCE, etc. At the same time, the outbreak of war demonstrated the maniacal determination of the Russian authorities to destroy Ukrainian statehood and the Ukrainian nation which was in line with the doctrines and narratives of the "russkiy mir" that had been put forward in advance (Minosian et al., 2023). Existential threats against Ukrainians were actually confirmed by large-scale killings of civilians, acts of genocide in the form of abductions of Ukrainian children, etc. The internal problems of the Russian regime with its attempts to restore the country's imaginary greatness have become even more apparent in the context of the ongoing aggression.

Meanwhile, existential threats have become quite real for Europe itself. This has led to an increase in NATO's political activity as a bloc designed to play a stabilizing role on the European continent and in the world as a whole. Even during the war itself, the world has had the opportunity to see how individual local conflicts of varying magnitude are fueled and influence the situation as a whole. It is easy to trace Russia's connection to most of the crises, terrorist attacks, revolutions and wars that periodically occur in the world (Brzezinski, 2022). The activities of various political organizations, the revival of radicalism, leftism and sharp criticism of Western democratic values and liberalism with the active participation and mediation of Russian authoritarianism have become no less threatening in the twenty-first century (Fukuyama, 2023).

Existential confrontations have spread to much larger geographical areas than the Ukrainian territories. They have renewed the humanitarian crisis, updated previously unsolved problems and created the illusion of the permissibility of solving certain problems from the "force" position. Russia`s aggression has demonstrated the depth and scale of the humanitarian catastrophe caused by this conventional war and has become a real threat to the sustainable development of Europe and the entire world.

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ENVIRONMENTAL CONSEQUENCES OF SOIL POLLUTION IN WAR ZONES IN UKRAINE

Olha Tertychna*, Valeriy Pinchuk, Yuriy Podoba
Institute of Agroecology and Nature Management of the National Academy of Sciences, Kyiv, Ukraine
**Speaker: olyater@ukr.net*

Ecocide, which has been taking place in Ukraine since February 24, 2022 due to the aggression of the Russian Federation, leads to a catastrophic state of all components of the natural environment, including soils. A large number of projectiles from artillery, mortars, grenade launchers and other firearms, as well as combustion products of military equipment, oil products, etc. fall into the soil. Dangerous substances contained in ammunition are explosives. Military equipment and ammunition contain a wide range of heavy metals (lead, mercury, arsenic, cadmium, copper, nickel, zinc, etc.). The priority pollutant is lead, which is part of many ammunition (mines, rockets, aerial bombs and other types of modern projectiles). Ukrainian scientists found an excess of the background level in terms of lead content in all soil samples, the average content of the element in the contaminated territories in the combat zone in the Sumy region was 5.4 times higher than the background value (Zaitsev Yu., 2022). Decomposition of Pb compounds that have already entered the environment is very slow, because the surface of lead ammunition residues in the anaerobic sediment zone is covered with Pb sulfides, which have low solubility and prevent further decomposition. Vertical and horizontal migration of heavy metals is predicted in the explosion zones of artillery shells and aerial bombs. Dangerous geomorphological processes can occur in sinkholes and on their slopes, which lead to the engineering complication of the territory, unfavorable physical and chemical processes in the soil and, accordingly, the expansion of the area of contaminated soil (Bonchkovskyi O.,2023). The ecological state of domestic soils as a result of russian aggression is an important problem of ecological security, which requires a comprehensive approach to its solution. Multicomponent soil contamination with a wide range of dangerous pollutants and xenobiotics of various chemical compositions occurs in the areas of hostilities. A feature of danger in war zones is the circulation of persistent toxicants in all objects of the natural environment. Such a powerful negative impact leads to large-scale pollution of atmospheric air, groundwater, irreversible changes in microbiocenosis, herpetofauna, phytocenosis, as a result of global degradation of ecosystems, disruption of biogeochemical cycles and cycles of biogenic elements.

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USE OF POLYMER-BASED NANOMATERIALS FOR ENVIRONMENTAL RESTORATION

Nadiia Hayuk*, Oleksii Mykhailenko, Oleksandra Selezniova, Svitlana Tsekhmistrenko
Bila Tserkva National Agrarian University, Bila Tserkva, Ukraine
**Speaker: svetlana.tsehmistrenko@gmail.com*

As a result of military activity, cities, villages, plants and factories are destroyed, and the environment is affected. A number of toxic substances accumulate in water and soil, and their removal and disposal require significant material costs. Nanocomposites are one of the most promising materials for solving today's environmental problems. Today, nanocomposites are being introduced into commercial products at a faster pace. However, the occurrence of aggregation, nonspecificity and low stability limits the use of nanotechnology products due to insufficient functionality.

Polymers are generally used to detect and remove chemical pollutants (manganese, nitrate, iron, arsenic, heavy metals), gases (CO, SO_2, NO_x), organic pollutants (aliphatic and aromatic hydrocarbons, pharmaceuticals, volatile organic compounds, biological agents (bacteria, parasites, viruses). Polymeric bases (surfactants, emulsifiers, stabilising agents and functionalised surface ligands) are used to improve stability, overcome the limitations of pure nanoparticles and provide desired properties, increased mechanical strength, thermal stability and recyclability, among other things.

Amphiphilic polyurethane nanoparticles recover multinuclear aromatic hydrocarbons from soils. Polyamidoamine is capable of encapsulating cations dissolved in water (Cu^{2+}, Ag^{+}, Au^{+}, Fe^{2+}, Fe^{3+}, Ni^{2+}, Zn^{2+}, U^{6+}) and is used as an antibacterial/antiviral agent. Polymers containing metal and metal oxide nanoparticles are used for environmental remediation. The use of polymeric nanomaterials for the specific capture of gas mixture compounds of non-target pollution is described. Carbon nanofibres based on chitosan have been developed that effectively adsorb Cr^{6+} from water. The impregnation of SiO_2 nanoparticles in an acrylamide hydrogel improves the adsorption capacity for the removal of cationic dyes.

Biocompatibility and biodegradability are key elements in the use of polymer nanocomposites. In particular, a green hybrid adsorbent removes dyes as a magnetic hydrogel. Another composition of Fe_3O_4 with magnetic nanoparticles was used to remove Cu^{2+}, Cd^{2+}, Pb^{2+}, and Zn^{2+} from water. It is obvious that polymeric nanoparticles effectively remove several pollutants by different mechanisms, performing a critical function in environmental remediation.

It is worth noting other models of nanoparticles that effectively remove environmental pollution. Ag-doped TiO_2 successfully removes 2,4,6-trichlorophenol, Ag-doped TiO_2 nanofibres – methylene blue dye. Cu/Fe/Ag-doped TiO_2 binds nitrate (NO_3^-). Silica nanoparticles contribute to the removal of polycyclic aromatic hydrocarbons and Pb^{2+}, Hg^{2+}, Cd^{2+}, $Cr_2O_7^{2-}$ from contaminated water. Cr6+ is removed by the Fe^0 polymer matrix. Gold coated with chitosan polymer and a multi-walled carbon nanotube adsorb Zn^{2+} and Cu^{2+}. Th^{4+} from wastewater and industrial water is purified by chitosan/bentonite material with polymethacrylic acid.

Thus, the use of polymer-based nanomaterials will contribute to the effective restoration of the environment, which will significantly improve the environmental situation in Ukraine, especially in overcoming the consequences of the ongoing war in the country.

PROBLEMATIC ASPECTS OF IMPLEMENTATION OF UKRAINE FACILITY REFORMS

Yuriy Ivanov*, Vlada Karpova, Olena Revenko
Simon Kuznets Kharkiv National University of Economics, Kharkiv, Ukraine
**Speaker: yuriy.ivanov.ua@gmail.com*

As a result of the military aggression of the Russian Federation in Ukraine, the state budget deficit increased significantly, and tax revenues decreased. In these conditions, to ensure the economy and defense capability, Ukraine needs to receive external financing. In 2024, EU Regulation 2024/792 was adopted, which regulates the implementation of the Ukraine Facility program and provides for the provision of funding to Ukraine for the period from 2024 to 2027. The measures established in EU Regulation 2024/792 are related to the implementation of the Ukraine Facility Plan, developed by the Government of Ukraine. Funding under EU Regulation 2024/792 depends on legislative reforms implemented in Ukraine.

Based on the results of the analysis of the Plan of Ukraine, it can be concluded that this document is drawn up in accordance with EU Regulation 2024/792 and contains all the main conditions stipulated in the Regulation. However, according to certain reforms, it is necessary to make clarifying changes in the National Revenue Strategy until 2030. It should also be taken into account that the National Revenue Strategy until 2030 does not fully meet the conditions specified in the National Economic Strategy until 2030. Therefore, it is necessary to make appropriate adjustments to the National Economic Strategy 2030 in order to align it, first of all, with the National Revenue Strategy until 2030.

In the Plan of Ukraine, only directions for carrying out relevant reforms are given and there is no specific toolkit for their implementation. And the results of the reform directly depend on this. Therefore, a final assessment of the compliance of the measures and reforms specified in the Plan of Ukraine with the requirements of EU Regulation 2024/792 can be provided only after the instruments for their implementation, including tax, have been clearly defined in National Revenue Strategy.

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STATISTICS OF WAR-INDUCED MIGRATION FROM UKRAINE TO EUROPE: SUSTAINABILITY ASPECTS

Ruslana Zadorozhna[1]*, Tetiana Stepanova[2]
[1]Bila Tserkva National Agrarian University, Bila Tserkva, Ukraine
[2]Sumy National Agrarian University, Sumy, Ukraine
**Speaker: ruslana.zadorozhna@gmail.com*

The Russian-Ukrainian war has severely affected Ukrainian economy (Satyr et al., 2023) and has caused a large-scale population displacement from Ukraine to European countries. The main reasons for migration were immediate threat to life, destruction of housing and infrastructure. The forced migration of Ukrainians to the EU was sudden and massive: as of March 1, 2022, more than 650,000 Ukrainian refugees had arrived in the EU (Malynovska, 2023). This prompted the European Council to activate Directive 2001/55/EC. Number of beneficiaries of temporary protection in the EU-27 increased from 3613130 persons at the end of August 2022 to 4160895 persons at the end of February 2024 (Eurostat, 2024). TOP-3 countries with the largest number of Ukrainians are Germany (12456475), Poland (952650) and Czech Republic (384180). From the onset of the invasion, Poland has had the first place in receiving Ukrainian migrants (max 1367555 by the end of September 2022). However, as of February 2023, Germany has taken the lead, with 1000530 people compared to Poland's 989080. The highest level of Ukrainian beneficiaries of temporary protection per thousand people of the host country is observed in the Czech Republic (35.6 %). There are also high rates in Lithuania (26.5 %), Estonia (25.8 %), Poland (26.0 %), Latvia (23.6 %), Slovakia (21.6 %), Cyprus (21.5 %). France (0.94 %) and Greece (2.62 %) have the lowest levels for this indicator, with an EU average of 9.4 ‰. Migration processes will continue throughout the duration of the war. The longer it lasts, the less likely refugees are to return to Ukraine. Mass migration flows have a significant impact on sustainability in Ukraine and Europe. Migration processes resulting from war pose numerous threats and challenges to sustainable development, namely: social stability, economic development, environmental sustainability, sociocultural integration etc. Successfully addressing these challenges demands a comprehensive approach that considers all aspects of sustainable development.

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CONTACTS OF THE ORGANIZING COMMITTEE:
National University of Food Technologies, Volodymyrska Str. 68, 01033 Kyiv, Ukraine;
Mobile: +38 098 958 2007; Email: edsd@nuft.edu.ua
Secretary of the organizing committee: Oksana Skrotska, PhD