

2023 RISK FACTORS OF FOOD CHAIN

XXIII. INTERNATIONAL CONFERENCE

BOOK OF ABSTRACTS



University of Rzeszów

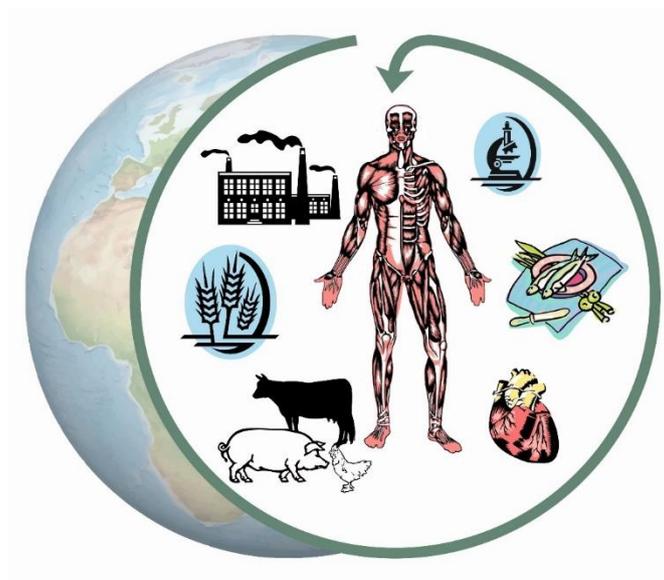
RISK FACTORS OF FOOD CHAIN 2023

XXIII. INTERNATIONAL CONFERENCE

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BOOK OF ABSTRACTS



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The history of the conference "Risk Factors in the Food Chain" began in 2000 and fortunately continues to this day. So it has been

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- 2001 (II.):** Nitra (SK) – 27/09/2001
- 2002 (III.):** Nitra (SK) – 26/09/2002
- 2003 (IV.):** Nitra (SK) – 03/12/2003
- 2004 (V.):** Nitra (SK) – 07/10/2004
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- 2007 (VIII.):** Nitra (SK) – 11/10/2007
- 2008 (IX.):** Kraków (PL) – 17/09/2008
- 2009 (X.):** Račková dolina (SK) – 18–19/09/2009
- 2010 (XI.):** Nitra (SK) – 13–14/09/2010
- 2011 (XII.):** Iwonicz (PL) – 05–06/09/2011
- 2012 (XIII.):** Topoľčianky (SK) – 19–20/09/2012
- 2013 (XIV.):** Gödöllő (H) – 24–26/10/2013
- 2014 (XV.):** Jaworze (PL) – 09–10/10/2014
- 2015 (XVI.):** Dudince (SK) – 19–21/10/2015
- 2016 (XVII.):** Rzeszów (PL) – 19–21/09/2016
- 2017 (XVIII.):** Żmiąca (PL) – 20–22/09/2017
- 2018 (XIX.):** Mátrafüred (H) – 26-28/09/2018
- 2019 (XX.):** Osrbile (SK) – 09–11/09/2019
- 2021 (XXI.):** Iwonicz (PL) – 06–08/09/2021
- 2022 (XXII.):** Węgierska Górka (PL) – 10–12/10/2022
- 2023 (XXIII.):** Gyöngyös (H) – 20-22/09/2023
- 2024 (XXIV.):**2024

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TABLE OF CONTENTS

RISK FACTORS OF INDUSTRIAL FEED MANUFACTURING AND THEIR MANAGEMENT	
Koppány Gy.	13
THE ROLE OF REGIONAL COOPERATION IN ADDRESSING FOOD CHAIN RISKS	
Korzenszky E.	14
ENVIRONMENTAL SAFETY AS A KEY TO FOOD SAFETY	
Székács A.	15
THE EFFECT OF DIETARY FIBER ADDITIVE ON GLYCAEMIC BALANCE OF PROTEIN SUPPLEMENTATION	
Bóday Á. J.	16
EFFECT OF ENDOCRINE DISRUPTORS ON VARIOUS CELLS LINE	
Lukáč N., Bistáková J., Jambor T., Greifová H., Tokárová K., Štefunková N., Bažány D., Massányi P.	17
STUDY MODEL AND ROUTE OF ADMINISTRATION DOES REALLY MATTER. THE CASE OF MONOSODIUM GLUTAMATE.	
Formicki G., Greń A., Goc Z., Muchacka R., Kapusta E.	18
SAFEGUARDING FOOD CHAINS AND ECOSYSTEM HEALTH: A REVIEW OF RISK FACTORS IN SOIL-RELATED DYNAMICS AND INNOVATIVE APPROACHES TO LONG-TERM ECOSYSTEM MONITORING	
Ocansey C.M., Géczi G., Simon B., Keleti J.R., Csorba Á., Michéli E.	19
FISH FARMING IN WASTEWATER – WHY IS IT A BAD IDEA AND HOW IS IT DONE DESPITE KNOWING THIS	
Tutor L., Barczy A., Géczi G.	20
CONCENTRATION OF BIOGENIC AND TOXIC ELEMENTS IN MILK AND THEIR CORRELATIONS	
Massányi P., Gajdošová D., Capcarová M., Bulla J., Kováčik J.	21
NITROPHENOLS AS POTENT ENDOCRINE DISRUPTORS IN THE HEN OVARY	
Sechman A., Grzegorzewska A.K., Kozubek A., Katarzyńska-Banasik D., Kowalik K., Hrabia A.	22
TEMPORAL ANALYSIS AND ARIMA MODELLING OF AIR POLLUTANTS IN BUDAPEST: A COMPREHENSIVE MULTI-STATION STUDY	
Bouzghiba H., Géczi G.	23
ENERGY EFFICIENCY IN AGRICULTURAL PRODUCTION IN TIMES OF ECONOMIC CRISIS	
Lisowska-Lis A.	24



THE HIDDEN FATE OF SPENT GUNSHOT IN WETLANDS Binkowski Ł.J., Potysz A., Albrycht M., Karpl A., Kurek M., Wiśniowska I.	25
SOLAR-ASSISTED HEAT PUMPS FOR HEATING AND COOLING APPLICATIONS IN THE FOOD INDUSTRY Hasna S., Korzenszky P., Hermanucz P.	26
A NEW APPROACH IN VOCATIONAL TRAINING IN ECOLOGICAL FARMING Takács E., Bažok R., Kramarič M., Stolz M., Richter G., Klátyik Sz., Mörtl M., Gémes B., Székács A.	27
THE PROFIKOMP MODEL FOR CIRCULAR ECONOMY Aleksza L.	28
EFFECT OF BISPHENOL A TREATMENT ON VIABILITY AND IL-6 PRODUCTION OF HUVEC CELL LINE Lukáč N., Bažány D., Greifová H., Tokárová K., Štefunková N., Jambor T.	29
THE USE OF THERMAL ANALYSIS FOR ADULTERATED HONEY DETECTION Džugan M., Tomczyk M., Czerniecka-Kubicka A., Miłek M., Sidor E.	30
INFLUENCE OF THE ANTIESTROGEN TAMOXIFEN ON CONNECTIN 43 EXPRESSION AND LOCALIZATION IN THE HEN OVIDUCT Wolak D., Kowalik K., Sechman A., Hrabia A.	31
EFFECT OF ZnO NANOPARTICLES ON METABOLIC ACTIVITY AND STEROIDOGENESIS Štefunková N., Greifová H., Jambor T., Zuščíková L., Bažány D., Lukáč N., Urban I., Massányi P.	32
CORNELIAN CHERRY EXTRACT-INDUCED CELL DEATH BY ELEVATING THE ENDOPLASMIC RETICULUM STRESS RESPONSE IN HUMAN COLORECTAL ADENOCARCINOMA CELLS Fialková V., Klongová L., Urbanová L., Farkasová S., Grabacka M., Capcarová M., Speváková I.	33
THE USE OF HPTLC METHOD TO QUANTIFY THE COUMARIN LEVEL IN CINNAMON AND SPICE MIXES Miłek M., Džugan M.	34
EFFECT OF POLYCYCLIC AROMATIC HYDROCARBON ADMINISTRATION ON IODOTHYRONINE CONCENTRATIONS IN BLOOD PLASMA OF THE DOMESTIC HEN Kowalik K., Katarzyńska-Banasik D., Kozubek A., Sechman A.	35
CYTOTOXIC EFFECT OF ATRAZINE ON CELLS OF THE MALE REPRODUCTIVE SYSTEM Greifová H., Štefunková N., Jambor T., Tokárová K., Bažány D., Capcarová M., Lukáč N.	36



SCREENING OF PROFILIN ALLERGEN HOMOLOGS IN CEREALS AND PSEUDOCEREALS Farkasová S., Žiarovská J.	37
EFFECT OF <i>CORNUS MAS</i> L. FRUIT ETHANOL EXTRACT ON THE YEAST <i>SCHIZOSACCHAROMYCES POMBE</i> Klongová L., Kovár M., Navrátilová A., Požgajová M., Fialková V., Spevákova I.	38
APPLICATION OF THE BBAP TECHNIQUE TO DISTINGUISH BLUEBERRY SPECIES AND THEIR VARIETIES Urbanová L., Žiarovská J.	39
<i>IN VITRO</i> PROPERTIES OF ESSENTIAL OILS FROM AROMATIC PLANTS Pinto B., Rodriguez Fernandez V., Piaggi S.	40
ASSESSMENT OF TILLAGE STRATEGIES AND THEIR IMPACT ON SOIL HEALTH AND SUSTAINABILITY ON ARABLE LAND Modiba MM., Dekemati I., Tharwat MIH., Ocansey CM., Keleti JR., Birkás M., Simon B.	41
ENVIRONMENTAL AND FOOD SAFETY ASPECTS OF HOME-MADE BOTANICAL INSECTICIDES Klátyik Sz., Takács E., Mörtl M., Székács A.	42
SMALL-SCALE EXPERIMENTS OF PM ₁₀ DISPERSION AROUND OBSTACLES Qor-el-aïne A., Benécs J., Béres A., Géczí G.	43
BALANCING FOOD SECURITY AND CARBON SEQUESTRATION - THE COMPLEXITIES OF CULTIVATING SPHAGNUM MOSS-DOMINATED PEATLANDS Keleti J.R., Döbröntey R., Fuchs M., Szegi T., Simon B., Ocansey C.M., Michéli E.	44
HARNESSING SOLAR THERMAL ENERGY FOR SUSTAINABLE INDUSTRIAL AND AGRICULTURAL DEVELOPMENT IN THE V4 REGION Ghabour R., Korzenszky P.	45
MITIGATING ENVIRONMENTAL RISK FACTORS AND PROMOTING SUSTAINABLE AGRICULTURE THROUGH PÁLINKA SPENT WASH COMPOSTING Silva L.R.B., Sipos E., Kardos L.	46
EFFECT OF RESORCINOL ADMINISTRATION ON MOTILITY PARAMETERS AND MORPHOLOGY OF RABBIT SPERM <i>IN VIVO</i> Zemanová J., Massányi P., Ondruška Ľ.	47
ENERGY ANALYSIS OF REFRIGERATION CYCLES IN THE FOOD INDUSTRY Hermanucz P., Herzallah L., Korzenszky P.	48
EFFECT OF IRRIGATION METHODS ON ARSENIC CONCENTRATION OF RICE CROP Szalóki T., Székely Á., Tarnawa Á., Jancsó M.	49



AGRICULTURAL WASTE AND BY-PRODUCT COMPOSTING AT PROFIKOMP INC. Fekete Gy., Varga Zs., Aleksza L.	50
THE ROLE OF INSECTS IN WASTE MANAGEMENT AND THEIR IMPACT ON THE FOOD CHAIN Pintér R., Fekete Gy., Aleksza L.	51
EFFECT OF BEE BREAD ON REDUCED GLUTATHIONE CONCENTRATION IN THE LIVER OF ZUCKER DIABETIC FATTY (ZDF) RATS. Goc Z., Kapusta E., Greń A., Muchacka R., Formicki G., Kalafova A., Capcarová M., Schneidgenová M., Massányi P.	52
ONLINE MARKETPLACE AS A TOOL FOR EFFECTIVE FARMER COOPERATION IN SUPPLY CHAIN MANAGEMENT Magó L.	53
NUTRACEUTICAL DIETARY BENEFITS ON GROWING-RABBIT MEAT COMPOSITION Vizzarri F., Tirpak F., Bucko O., Ondruska L.	54
INVESTIGATION OF INDOOR AIR QUALITY IN A FOOD STORAGE AREA OF A MILITARY CAMP Patonai Z., Barczy A., Géczi G.	55
IMPACT OF POST-HARVEST COLD STORAGE ON ETHYLENE AND CO ₂ EMISSIONS FROM GOLDEN DELICIOUS APPLES Kassebi S., Korzenszky P.	56
SOLAR ENERGY AND BIOGAS UTILIZATION FOR THE DEVELOPMENT OF SCALABLE CO-GENERATION POWER PLANTS Korzenszky P., Bártfai Z., Seres I., Víg P., Bércesi G., Szalay K., Gárdonyi P., Kurják Z., Magó L.	57
EFFECTS OF ENVIRONMENTALLY FRIENDLY PLANT CONDITIONERS ON YIELD AND GRAIN QUALITY OF WINTER WHEAT Tury R., Tóth Sz.Zs., Lehoczky É., Láposi R.	58
DETERMINATION OF THE THERMAL ENERGY DEMAND OF PIG FATTENING Páger Sz., Földi L., Géczi G.	59
INDEX	61
CONFERENCE SPONSORS	



RISK FACTORS OF INDUSTRIAL FEED MANUFACTURING AND THEIR MANAGEMENT

Koppány György

VITAFORT Co.

The comprehensive risk assessment in the food chain - from field to the fork – provides us with the most important information regarding the food chain dangers. Although this information is strongly correlated to each other, the different parts of the food chain might be studied individually too.

The industrial feed production is a very important part of the food chain, since it is the “anteroom“ of animal-originated food consumption. Those undesirable materials, which may occur in the feeds, by their residual substances can cause serious risks in the foods to the human health.

Industrial feed production is well-regulated in the European Union. In this paper the most important aspects of EU practice will be presented.

Some of the most important regulations:

(183 / 2006/ EU) -The development and use of HACCP system have been compulsory in the industrial feed production plants, since 2006.

68/2013 / EU -The list of raw materials which may be used for feed production.

Register of feed additives - Serious system, which is continually developed by the permissions and recommendation of EFSA. Those feed additives may be used only, which are in the register.

Directive 2002/ 32/ EC on undesirable substances in animal feeds. -The directive is developing continuously by the new regulations - according to the new knowledge and information (e.g. melamine, dioxins, PCB-s, etc).

The most important risks in the feed production practice:

Mycotoxins - Unfortunately, it is not the best-treated area of feed safety. There is only one compulsory regulation for the limit of Aflatoxin B1 concentration in the feedstuffs, and for other also very important mycotoxins (like DON, F2, T2, HT2, Fumonisin, Ochratoxin, etc.) there are only “proposed guiding values“ which aren’t obligatory for the practice. The significance of mycotoxins unfortunately increasing – mainly because of climate change - so the development and regulation of this problem would be important.

GMO – It is also a well-regulated area, (1829 /2003 / EC, 1830/2003/ EC) but the significance of GMO problem is decreasing, mainly because of the genetic engineering (CRISPR) development.

The use of medicines and antibiotics in the feeds - It is one of the most important risk factors in feed production. Although, the regulation is strict and correct (2019/4/EU) the practice is problematic. The irresponsible use of antibiotics in the feeds caused the evolution of resistant superbacteria. The use of antibiotics should be reduced in the feeds, and high-level manufacturing technology is needed, which can avoid “cross-contamination” and by this way the development of resistant bacteria.

Otherwise, there are more risks besides the above-mentioned, which also need to be treated (e.g. herbicide residues). At the same time, there are well-developed quality management systems, that can help the feed safety of feed production companies to avoid the dangers (e.g. HACCP, QS, FamiQS, GMP+, etc.) together and by utilizing well-equipped laboratories.

However, the mentioned well-regulated system of the EU and the feed safety systems can help to manage the risks, but the responsible, good manufacturing practice of feed producer companies remains fundamental.

Keywords: Mycotoxins, GMO, Antibiotics, Feed safety



THE ROLE OF REGIONAL COOPERATION IN ADDRESSING FOOD CHAIN RISKS

Korzenszky Emőke

Embassy of Hungary in Warsaw

The COVID-19 pandemic, as well as the Ukrainian conflict and thereby the global energy crisis called attention to the strategic nature of food supply. Climate change and political conflict combined with the undulating pandemic left millions in insecurity without access to safe and nutritious food. The recuperating supply chains got swept away by armed conflict in an instance, resulting in a historic crisis of global food supply. At the same time, demand for safe and healthy food has never been this high than it is today. We are experiencing a turning point: our lifestyles and our consumer demands are changing, whereas agricultural production is facing growing droughts, floods, plant and animal diseases.

Food chain risks resulting from human-induced factors, such as political conflicts, but also climate change, demand resilience building strategies from the side of policy makers, who need to quickly respond to issues never experienced before. The key to resilience is preparedness and quick response in policy making, elaborated through global and regional cooperation instead of competition.

The historic alliance of the Czech Republic, Hungary, Poland and Slovakia, known as the Visegrád Group (V4) aims to advance cooperation, inter alia, in agricultural issues, such as addressing food chain risks. Since all four Visegrád Countries joined the European Union in 2004, and are linked by similar geopolitical setting, the Group can represent their common interest in policy making on a European level. V4 does not aim to be an alternative to European integration, on the contrary, it strengthens partnership and coordination, exchange of information, thereby, cooperation mechanisms addressing crises in the food chain arising from emergencies.

Keywords: cooperation mechanisms, food supply, Visegrád Group



ENVIRONMENTAL SAFETY AS A KEY TO FOOD SAFETY

Székács András

Agro-Environmental Research Centre, Institute of Environmental Sciences, Hungarian University of Agriculture and Life Sciences, Páter Károly u. 1., 2100 Gödöllő, Hungary
szekacs.andras@uni-mate.hu

In "food safety," the two terms "food" and "safety" are inseparable, as evidenced by the slogan "if it's not safe, it's not food." A fundamental principle in agricultural production is that agriculture is a technology open to the environment. Consequently, ensuring the environmental safety of agricultural production is a prerequisite for food safety because agricultural activities can be a source of various environmental and food contaminants, including agrochemicals. In this regard the European Green Deal has set ambitious goals for the European Union (EU) related to agricultural production to be achieved by 2030. These goals include "green growth" in agricultural production, specifically targeting a 50% reduction in pesticide usage by phasing out the more hazardous ones and promoting a 25% increase in ecological (organic) agriculture based on arable land use.

The presentation will highlight our recent major EU projects related to biosafety and the use of pesticides. These projects include the Horizon 2020 project NetPoulSafe (Grant Agreement No. 101000728) titled "Improving biosecurity compliance in poultry farms," running from 2020 to 2023; and three Erasmus+ projects ProtectLife (2017-1-TR01-KA202-045641) titled "Best Management Practices for Handling Plant Protection Products in Turkey to Prevent Water Resources Contamination of Point Sources," running from 2018 to 2022; TopPlant (2020-1-AT01-KA202-078107) titled "Trainers for Plant Protection in Organic Farming," running from 2020 to 2022; and Hort4EUGreen (2020-1-AT01-KA202-078107) titled "Enhance Practical Skills of Horticulture Specialists to Better Address the Demands of the European Green Deal," running from 2020 to 2023.

Pesticide-related issues, both in general and as they relate to the European Green Deal and the Precautionary Principle concerning technologies with uncertain risks, will be discussed. The presentation will also cover our research findings in three specific areas currently subject to intense and controversial societal debates: (a) the use of neonicotinoid-type neurotoxic insecticides in the EU; (b) the re-registration of the market-leading herbicide active ingredient glyphosate in the EU; and (c) the regulation of genetically modified (GM) plants in the EU, including insect-resistant and herbicide-tolerant GM crops, with a special emphasis on current legislation regarding genome editing techniques. The discussion will focus on the "objectivity" of risk analysis, including environmental risk assessment, and the differentiation between science-based and policy-based decision-making.

Keywords: The European Green Deal, plant protection products, the Precautionary Principle, neonicotinoids, glyphosate, genetically modified crops

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THE EFFECT OF DIETARY FIBER ADDITIVE ON GLYCAEMIC BALANCE OF PROTEIN SUPPLEMENTATION

Bóday Ádám János

Cordi R&D Inc.

Objective: This study aims to investigate the impact of incorporating dietary fiber (at levels of 10-15%) into protein supplements on the glycaemic index, blood glucose levels, insulin responses, and subsequent effects on fat metabolism and muscle mass gain.

Hypothesis: The inclusion of dietary fiber in protein supplements is expected to decrease the glycaemic index of these supplements, resulting in attenuated blood glucose and insulin spikes. Consequently, this intervention is anticipated to prevent the conversion of proteins into fat while facilitating the development of lean muscle mass.

Scope: The investigation primarily concentrates on the influence of dietary fiber additives on the glycaemic response elicited by protein supplementation. The underlying mechanism is rooted in the delayed gastric emptying of protein supplements due to the presence of dietary fibers. This delay leads to a more gradual absorption of amino acids and proteins, which subsequently contributes to a balanced glycaemic load. Consequently, insulin secretion is regulated, mitigating undue stress on the liver to convert excess amino acids into lipids. As a result, serum lipid levels are stabilized, and adipose tissue's fat storage is controlled. Beyond its impact on glycaemic balance, the dietary fiber additives also yield secondary advantages. Enhanced secretion of digestive juices and increased motility in the upper digestive tract are notable among them. These improvements foster optimal nutrient digestion and absorption. Furthermore, the probiotic properties exhibited by dietary fibers yield benefits for the gut microbiome. This fosters an environment conducive to colonic fermentation of vital micronutrients while concurrently diminishing xenobiotics and metabolic toxins.

Conclusion: The study underscores the potential of dietary fiber inclusion (10-15%) in protein supplements to modulate glycaemic responses, insulin secretion, and fat metabolism. The observed outcomes not only contribute to balanced lipid profiles and adipose tissue health but also foster improved digestion, absorption, and a healthier gut microbiome. Consequently, the findings suggest that the incorporation of dietary fiber into protein supplements holds promise as a multifaceted strategy to optimize both metabolic and nutritional outcomes.

Keywords: Glycaemic balance, insulin spikes, protein supplement, microbiome composition, athletes, skeletal muscle mass, insulin regulation



EFFECT OF ENDOCRINE DISRUPTORS ON VARIOUS CELLS LINE

Lukáč N.^{*1}, Bistáková J.¹, Jambor T.¹, Greifová H.¹, Tokárová K.¹,
Štefunková N.¹, Bažány D.¹, Massányi P.¹

¹*Institute of Applied Biology, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic*

* norbert.lukac@uniag.sk

Endocrine disrupting chemicals (EDCs) are ubiquitous chemical compounds that may disrupt endocrine system functions and have adverse developmental, reproductive, neurological, and immunological impacts in both humans and wildlife. In our research, we used a diverse range of *in vitro* laboratory models to assess the impact of EDCs. For the alterations of the reproductive system, we used bovine spermatozoa, which were cultivated with distinct concentrations of nonylphenol (NP), octylphenol (OP), bisphenol A (BPA), for 0, 2, 4, 6, and 24h. The results of movement activity revealed a significant decrease in motility following exposure to concentrations of 100 µg/mL of ED, with bisphenol A having the most influence. Low doses (10 µg/mL) of NP, BPA, and DEHP increased spermatozoa motility considerably ($P < 0.001$). Spermatozoa survival was considerably reduced following exposure to 100 µg/mL of NP, OP, and BPA and at a concentration of 200 µg/mL of DEHP. The aim of our steroidogenesis research was to look into the impact of NP and OP on the activity of isolated mouse Leydig cells and the TM3 cell line. The TM3 cell line was cultivated in the presence of 0.2, 1, 2.5, 5, 10, and 25 µg/mL 4-n-NP or 4-OP for 30 min, 6 h, and 24 h. Our findings show a considerable ($P < 0.001$) increase in androstenedione and testosterone synthesis following 2.5 to 5 g/mL 4-n-NP treatment. In addition to 2.5 and 5 g/mL 4-OP, a similar tendency was seen in dehydroepiandrosterone and androstenedione secretion ($P < 0.05$; $P < 0.001$). Significant changes ($P < 0.001$) in testosterone production were also observed at dosages of 2.5 and 5 µg/mL. The simultaneous action of 1 mM cAMP and 4-n-NP caused a significant ($P < 0.05$; $P < 0.001$) decrease in dehydroepiandrosterone (1; 2.5; 5 µg/mL) and androstenedione (5 µg/mL) production. The highest concentrations of 4-OP (2.5 and 5 µg/mL) decreased cAMP-stimulated dehydroepiandrosterone synthesis considerably ($P < 0.05$; $P < 0.001$). Another part of our study aimed to determine the potential effect of bisphenol A, AF, B, F, and S on the biosynthesis of steroid hormones in human adrenocortical carcinoma cells. Human adrenocortical carcinoma cells (H295R) were cultivated in the presence of bisphenol A, AF, B, F, or S (0.05, 0.1, 0.5, 1; 10; 25; 50; 75; 100 M) for 24 or 48 hours. The most significant biphasic effect was observed with BPF and BPAF; low concentrations of these endocrine disruptors stimulated mitochondrial activity, despite the fact that the viability of the cells was mainly affected by BPB. Our findings show that EDCs can alter physiological processes on many levels in terms of reproductive and immunological mechanisms, and thus their ubiquitous nature may increase their harmful effects on living systems.

Keywords: Endocrine disruptors, bisphenols, cell line, steroid hormones

Acknowledgments: This study was supported by the OPII within the project: creation of nuclear herds of dairy cattle with a requirement for high health status through the use of genomic selection, innovative biotechnological methods, and optimal management of breeding, NUKLEUS 313011V387, cofinanced by the projects: APVV-20-0218 VEGA 1/0207/23 and KEGA 023SPU-4/2022.

**STUDY MODEL AND ROUTE OF ADMINISTRATION DOES REALLY MATTER.
THE CASE OF MONOSODIUM GLUTAMATE.**

Formicki G.^{*1}, Greń A.¹, Goc Z.¹, Muchacka R.¹, Kapusta E.¹

¹ *Institute of Biology and Earth Sciences, Pedagogical University of Krakow*

^{*} grzegorz.formicki@up.krakow.pl

Our contribution presents results of scientific literature review over toxicity of monosodium glutamate (MSG) studied in different models and human health risk related to MSG consumption. According to some data exposure to MSG leads to enlarged glutamate signaling in brain by activation of NMDA, MPA and KA receptors. As a result massive influx of calcium cations into the neural cells occurs which disturbs intracellular signaling and causes oxidative stress. Such a condition is referred to as excitotoxicity. Oxidative imbalance after exposure to MSG was also reported in other organs. MSG is efficiently metabolized by transamination and its consumption has negligible influence on the glutamate concentration in blood. Toxicity of MSG is strongly related to exposure route and the study model. Generally in vitro models show higher toxicity than animal models. In animal model intraperitoneal administration of MSG causes higher toxicity than oral exposure. Toxic effects were found in animals orally exposed to MSG doses which extremely exceeded mean MSG consumption in human. Mean MSG consumption in human goes from 0.5 to 3 g per day which does not have any health affect.

Keywords: monosodium glutamate, food, toxicity, study models, human health



**SAFEGUARDING FOOD CHAINS AND ECOSYSTEM HEALTH: A REVIEW OF
RISK FACTORS IN SOIL-RELATED DYNAMICS AND INNOVATIVE
APPROACHES TO LONG-TERM ECOSYSTEM MONITORING**

Ocansey C.M.¹, Géczi G.², Simon B.¹, Keleti J.R.¹, Csorba Á.¹, Michéli E.¹

¹*Department of Soil Science*

²*Department of Environmental Analysis and Technologies,*

^{1,2}*Institute of Environmental Sciences, Hungarian University of Agriculture and Life Sciences,
Gödöllő Hungary*

* melenya.ocansey.caleb@uni-mate.hu

Soil, an indispensable component of terrestrial ecosystems, is intricately linked to food chains and the long-term sustainability of our planet's ecological balance. However, this delicate balance faces an increasing array of risk factors driven by human activities and environmental changes. To mitigate these risks, innovative approaches to long-term soil and ecosystem monitoring are essential. This comprehensive review explores the diverse risk factors affecting soil within food chains and their profound implications for ecosystem health. We study innovative methods to monitor and manage risks to soil health, including immediate threats, soil microbe-climate interactions, and the potential of AI and advanced monitoring for long-term ecosystem and food chain sustainability. Our analysis draws on multidisciplinary insights, highlighting the urgent need for proactive management of soil-related challenges. We observed soil health and long-term ecosystem sustainability are jeopardized by a multitude of risk factors, including pollution, climate change, land use changes, and invasive species. Soil microbes played a pivotal role in ecosystem dynamics and resilience with their diversity and functions directly affected by changing environmental conditions. This emphasized the need for preserving microbial diversity to safeguard food chains. We posit that promoting sustainable agriculture practices, such as enhancing soil organic matter stabilization, no-till farming and crop rotation, can significantly contribute to soil health and food chain sustainability. Public awareness and education campaigns are crucial in fostering a sense of responsibility toward soil and ecosystem preservation. Empowered communities can actively participate in the protection of food chains and long-term ecosystem health. Given the dynamic nature of soil-related risk factors, adaptive management strategies are essential. Flexibility and the ability to adjust approaches based on ongoing monitoring are key to success. As we navigate this complex terrain of risk factors and innovative monitoring, our review underscores the importance of understanding and preserving the intricate web of life that depends on these systems. The future of food chains and ecosystems hinges on our ability to address soil-related risks effectively. Innovative approaches and a commitment to long-term monitoring are paramount for safeguarding the delicate balance of our planet's ecological systems.

Keywords: artificial intelligence, climate change, ecosystem monitoring, food chains, risk factors, soil health, sustainability



FISH FARMING IN WASTEWATER – WHY IS IT A BAD IDEA AND HOW IS IT DONE DESPITE KNOWING THIS

Tutor L.^{*1}, Barczy A.², Géczi G.²

¹ *Doctoral School of Environmental Sciences*

² *Department of Environmental Analysis and Environmental Technology, Institute of Environmental Sciences, Hungarian University of Agriculture and Life Sciences, 2100, Páter Károly utca 1, Gödöllő, Hungary*

* ifjtutor@gmail.com

Most municipal wastewater systems are not feasible for farming, since the water quality in these are not appropriate for the growing fish, and it holds a great risk as microbial infestations and heavy metal accumulation in fish flesh have a high probability.

Using animal manure in fish farming has a rich history and is still used today as the cheapest means for producing fish mass. The procedure partially aims to enrich microbial and thus planktonic life by providing necessary nutrients for bacteria and algae, feeding zooplankton which will serve as a considerable nutrient source for fish. Several aquaculture fish species, such as Nile tilapia (*Oreochromis niloticus*) are feeding directly on the manure itself.

The practice has historical backgrounds in ancient China, where mixed fish stock was utilized by feeding grass carps (*Ctenopharyngodon idella*) with hay and freshly cut grass. The grass carp manure serves as a fertilizer for the ponds feeding other species, mainly common carps and silver carp (*Hypophthalmichthys molitrix*). The aquaculture of Nile tilapia goes back to Ancient Egypt, where it was represented by the hieroglyph K1, of the Gardiner list: . Tilapia is traditionally fed by chicken and pig manure. Hungary has rich background in using manure for fish farming, widespread by the works of Elek Woynarovich, who received an order from the Communist Party for using pig manure from penstocks bred for war indemnity to the Soviet Union. He worked out a technology to utilize this resource which was considered a waste. His scientific approach enhanced fish production but raised the risk of infections.

Fish are experienced to swim up to wastewater treatment effluents in recipients, and mainly mullet is caught around the effluent channel in South-Pest.

During extensive commission processes in China, we experienced operators farming fish in clarifiers and even aerobic reactors, which cannot be reached from external water body, so accidental migration is impossible. The species identified as channel catfish (*Ictalurus punctatus*). The fish were cleaned and consumed, the operators reported they were not affected by any disease or parasite infection.

Fish and humans have several common parasites such as roundworms and tapeworms. Contaminations of Coliform and Salmonella bacteria are a threat and may occur during farming or processing.

A water body that contains these sources of infections in ample numbers, such as untreated wastewater or MLSS should be considered risky for fish farming and should be avoided, although traditional pond fertilization with manure is proven safe if did with an appropriate technology.

Keywords: wastewater, fish farming, manure, pond fertilization



CONCENTRATION OF BIOGENIC AND TOXIC ELEMENTS IN MILK AND THEIR CORRELATIONS

Massányi P.*¹, Gajdošová D.¹, Capcarová M.¹, Bulla J.¹, Kováčik J.¹

¹*Institute of Applied Biology, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic*

*peter.massanyi@uniag.sk

Humans are constantly in contact with toxic substances. Every day is the organism exposed to various amount of chemicals – neutral, toxic, or harmful. Information on their impact on human health is sometimes absent or incomplete. These substances are also found in foods, so it is important to monitor them constantly and to decrease concentrations. The aim of our study was to analyze the concentration of various chemical elements – lead, copper, cadmium, zinc, potassium, nickel, iron, calcium, sodium, and magnesium in bovine milk. The average, maximum and minimum concentrations in thirty samplings of milk were analyzed by AAS and later correlations between elements were detected. We have detected the average concentrations of these elements and the levels were – Cd 0.34 µg/ml, Pb 3.04 µg/ml, Zn 12.13 µg/ml, Cu 2.13 µg/ml, Fe 1.81 µg/ml, Ni 0.90 µg/ml, Mg 235.61 µg/ml, Ca 3416 µg/ml, K 3138 µg/ml, Na 879.16 µg/ml. Interesting are also correlations between the elements with middle positive correlation between Pb and Cu (0.49), Pb and K (0.47), Mg and Na (0.49). High positive correlation was detected between Ca and Na (0.68). The levels of toxic metals are an important part of milk safety and quality. Environmental conditions and processes play a key role in the distribution of toxic metals in raw and heat-treated milk.

Keywords: lead, copper, zinc, cadmium, sodium, potassium, nickel, iron, calcium, magnesium, milk

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**NITROPHENOLS AS POTENT ENDOCRINE DISRUPTORS IN THE HEN OVARY**

Sechman A.^{*1}, Grzegorzewska A.K.¹, Kozubek A.¹, Katarzyńska-Banasik D.¹, Kowalik K.¹, Hrabia A.¹

Department of Animal Physiology and Endocrinology, University of Agriculture in Krakow, Poland

** andrzej.sechman@urk.edu.pl*

Nitrophenols (NPs) are organic compounds which consist of a phenol molecule with one or more nitro-groups attached to the aromatic ring. The main sources of NPs, such as 4-nitrophenol (PNP; *p*-nitrophenol) and 3-methyl-4-nitrophenol (4-nitro-*m*-cresol; PNMC) in the environment are fumes from diesel engines (Diesel exhaust particles; DEPs) and hydrolysis of organophosphorus pesticides, like methyl-parathion or fenitrothion which are commonly used in agriculture and forestry. NPs are environmental pollutants and endocrine-disrupting chemicals that seriously affect animal and human reproduction. In our study, to verify the hypothesis that PNP and PNMC affect steroidogenesis in the chicken ovary. *In vitro* and *in vivo* experiments were carried out. In these experiments, white (1-4 mm) and yellowish (4-8 mm) prehierarchal follicles, as well as theca and granulosa layers of preovulatory follicles (F3-F1; 20-36 mm), were isolated 2 h after ovulation from the hen ovary. Following *in vitro* (6 or 24 h incubation) or *in vivo* (6-day i.m. administration) exposure to PNP or PNMC, ovarian steroids (progesterone, testosterone and estradiol) in incubating medium or blood plasma were determined by RIA, and mRNA expression of three the steroidogenic genes, i.e. steroidogenic acute regulatory protein (*STAR*), 3 β -hydroxysteroid dehydrogenase (*HSD3B*) and P450 aromatase (*CYP19A1*), as well as luteinizing hormone receptor (*LHR*), estrogen α (*ESR1*) and β (*ESR2*) receptors in chicken ovarian follicles were evaluated by real-time qPCR.

Results of the *in vitro* experiments revealed that PNP and PNMC (10^{-6} M): (1) inhibit the basal and LH (10 ng/ml)-stimulated secretion of testosterone and estradiol from the prehierarchal follicles and the theca layer of the preovulatory follicles, as well as progesterone secretion from the granulosa layer of the preovulatory follicles; (2) are negative modulators of mRNA expression of *STAR*, *HSD3B*, and *CYP19A1* genes involved in ovarian steroidogenesis; (3) inhibit expression of *LHR* and estrogen receptors (*ESR1* and *ESR2*) in white prehierarchal follicles and the theca layer of the preovulatory follicles; in respect to the granulosa layer the negative effects were found only in the F2 and F1 follicles.

Results of the *in vivo* experiment showed that treatment of the laying hen with PNP or PNMC (10 mg/kg b.wt.) for 6 days: (1) decreases concentrations of sex steroids in the blood plasma; (2) inhibits mRNA expression of *STAR* and *CYP19A1* in the theca layer and *HSD3B* in the granulosa layer of F2 and F1 follicles; and (3) affects the expression of *LHR*, *ESR1*, and *ESR2* in the wall of ovarian follicles, however, effects depend on the maturational stage of the follicle and the type of injected nitrophenol.

The results obtained revealed that nitrophenols are potent endocrine disruptors in the chicken ovary, and acting on the steroidogenesis process may impair the development and selection of yellowish pre-recruitment follicles to the preovulatory hierarchy as well as the maturation of yellow hierarchical follicles.

Keywords: domestic hen, ovary, steroidogenesis, nitrophenols

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TEMPORAL ANALYSIS AND ARIMA MODELLING OF AIR POLLUTANTS IN BUDAPEST: A COMPREHENSIVE MULTI-STATION STUDY

Bouzghiba H. ^{*1}, Géczi G. ²

¹ *Doctoral School of Environmental Sciences*

² *Department of Environmental Analysis and Environmental Technology, Institute of Environmental Sciences*

^{1,2} *Hungarian University of Agriculture and Life Sciences, 2100, Páter Károly utca 1, Gödöllő, Hungary*

* Bouzghiba.Houria@phd.uni-mate.hu

This study presents a comprehensive analysis of air pollutant data in Budapest, encompassing pollutants such as PM₁₀, PM_{2.5}, O₃, CO, NO₂, and NO. The dataset spans four years, from 2018 to 2022, and covers six distinct air quality measurement stations across the city. Data preprocessing involved rigorous cleaning, outlier treatment, and missing value imputation using Python. Furthermore, the study computed the number of exceedance days for PM₁₀, CO, and PM_{2.5}, shedding light on air quality violations.

A significant aspect of the analysis pertained to assessing the correlations among the six measurement stations, revealing robust correlations, particularly notable was the strong correlation coefficient of 0.71 observed. Additionally, the study delved into the intricacies of autocorrelation and partial autocorrelation, examining temporal dependencies across three granularity levels: 1-hour, 3-hour, and 12-hour intervals. Notably, a daily seasonality pattern emerged in NO₂ concentrations, attributed to the diurnal behaviour of NO₂, which peaks during the day and decreases at night.

To forecast NO₂ concentrations effectively, the study employed the ARIMA model with a systematic search grid approach. Leveraging criteria such as AIC/BIC and insights from ACF/PACF analyses, this technique demonstrated its proficiency in capturing observed NO₂ measurements. The Mean Absolute Scaled Error (MASE) of 0.92 underscores the model's robust performance in forecasting NO₂ concentrations accurately.

This research contributes to a better understanding of air quality dynamics in Budapest and demonstrates the utility of ARIMA modelling in forecasting pollutant concentrations, offering valuable insights for air quality management and policy formulation.

Keywords: ARIMA, Air Quality, Urban air pollution, NO₂, Time series analysis.



ENERGY EFFICIENCY IN AGRICULTURAL PRODUCTION IN TIMES OF ECONOMIC CRISIS

Lisowska-Lis A.¹

¹*Department of Electrical Eng., Faculty of Politechnics,
University of Applied Sciences in Tarnow (AT), Mickiewicza 8, 33-100 Tarnow, Poland*
**lisowskalis@anstar.edu.pl*

Agriculture is an important sector of the economy which is negatively affected by the energy crisis, the increase in the prices of energy carriers and the shortage of energy resources in the EU and in Poland in 2021-2023. One of the industries that requires large amounts of energy for technological purposes is poultry farming. The aim of the work was to analyse activities in poultry production aimed at improving energy efficiency. In poultry farms, over 40% of heat energy in the heating season is lost for ventilation. The research was carried out on selected poultry production farms. Cheaper coal products are more often used to heat chicken coops than more expensive gas. In hatcheries where it is not possible to replace electric heating, heat recovery systems are used. Heat recovery is possible from water as well as from air, in technological processes, with the use of heat pumps and recuperators. In order to reduce the demand for thermal energy, a good building design and thermal modernization of older buildings as well as process automation are necessary. Automation of the process, replacement of devices with energy-saving devices (engines, lighting) contribute to the reduction of electricity consumption in farm buildings. Farmers are investing in renewable energy sources for self-consumption of electricity. Reactive power compensation systems are also used to reduce energy charges in settlements with the electricity distributor.

Keywords: energy efficiency, poultry production, renewable energy

Acknowledgments: The research was financially supported by University of Applied Sciences in Tarnow

**THE HIDDEN FATE OF SPENT GUNSHOT IN WETLANDS**

Binkowski Ł.J.¹, Potysz A.², Albrycht M.¹, Karpl A.¹, Kurek M.¹, Wiśniowska I.¹

¹ *Institute of Biology and Earth Sciences, Pedagogical University of Krakow,
Podchorążych 2, 30-084 Kraków, Poland*

² *Institute of Geological Sciences, University of Wrocław,
M. Borna 9, 50-204 Wrocław, Poland*

* ljbinkowski@gmail.com

Even though numerous countries, including the USA and European Union, have already introduced a ban on lead-hunting ammunition use on wetlands, the problem of gunshot has not been solved. Introducing the ban only stopped the input of new gunshot into the environment, but still, hundreds of tons of spent gunshot are deposited in some wetland areas. That means that not only birds (through the mistaken ingestion of gravel) but whole ecosystems are exposed to lead gunshot shot. Deposited gunshot undergoes bioweathering, influenced by various abiotic and biotic factors, which leads to elemental leaching of elements included in gunshot (such as lead (Pb), antimony (Sb), and arsenic (As)). We already know the efficiency and influential factors of mentioned leaching. However, still vague is the whole process of bioweathering. In this study, we focused on processes and their consequences on the surface of gunshot immersed in water and sediments. Due to that fact, we run experimental observations of gunshot bioweathering in microcosmic simulations of wetlands.

Contrary to intuitive, superficial thinking, the shot does not lose weight but gains some weight during bioweathering. This is probably because surface alterations in gunshot form a weathering crust and secondary phases. Moreover, the size of a spent gunshot also changes during bioweathering, and it can grow in size. Both parameters (weight and size) can be proxied by various parameters like surface area or shape (both measured with different techniques adopted from geological studies). However, different techniques give entirely different results and are not even correlated. Thus, we concluded that studying gunshot surfaces can be limited and significantly influenced by a technique used. That means technical papers and reports are needed to implement standards, ensuring repeatability and accuracy.

Keywords: BET, optical tomography, weight change, leaching, lead

Acknowledgments: The research was financially supported by project NCN OPUS 2019/35/B/ST10/00129 Drivers of abiotic and biological weathering of spent lead gunshot in the environment.



SOLAR-ASSISTED HEAT PUMPS FOR HEATING AND COOLING APPLICATIONS IN THE FOOD INDUSTRY

Hasna S.^{*1}, Korzenszky P.², Hermanucz P.³

¹ *Doctoral School of Mechanical Engineering*

² *Department of Farm and Food Machinery, Institute of Technology*

³ *Department of Building Engineering and Energetics, Institute of Technology*

^{1,2,3} *Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary*

* hasnasaadi2021@gmail.com

Solar-assisted heat pump systems were investigated to provide efficient and sustainable heating and cooling solutions across various stages of food production, processing, storage, and distribution. As well as reducing energy bills and lowering carbon emissions, making them an attractive option for the food industry. The study aims to construct a double-source solar-assisted heat pump (solar energy and ambient temperature) with a storage tank and investigate the impact of controlling the inlet temperature by comparing the results of the solar collector's outlet temperature under identical solar irradiance conditions and the same mass flow of the heat transfer medium over three days. The hypothesis says the lower the temperature of the heat transfer medium entering the collector, the greater the efficiency of the system, resulting in a greater amount of extracted heat to assist the heat pump over a longer period of time. The obtained results after analyzing the data record demonstrate that in high solar irradiation ranges the extracted heat by the heat transfer medium is more significant when the inlet temperature is much lower than when it is close to the ambient temperature. It was also noticed that solar irradiation has a strong and direct effect on the variation of the outlet temperature of the solar collector. When the absence of solar irradiation the heat pump system can be assisted by the ambient temperature as a heat source making a double-source solar-assisted heat pump. However, in high solar irradiation ranges (in my experiments) the ambient temperature has a neglected effect on increasing the outlet temperature of the solar collector.

Keywords: Solar energy, Heat pump, Food industry



A NEW APPROACH IN VOCATIONAL TRAINING IN ECOLOGICAL FARMING

Takács E.^{*1}, Bažok R.², Kramarič M.³, Stolz M.⁴, Richter G.⁵, Klátyik Sz.¹, Mörtl M.¹, Gémes B.¹, Székács A.¹

¹*Agro-Environmental Research Centre, Institute of Environmental Sciences, Hungarian University of Agriculture and Life Sciences, Páter Károly u. 1, 2100 Gödöllő, Hungary*

²*Faculty of Agriculture, University of Zagreb, Trg Republike Hrvatske 14, 10000 Zagreb, Croatia*

³*Biotekniški Center Naklo, Strahinj 99, 4202 Naklo, Slovenia*

⁴*biohelp GmbH, Kapleigasse 16, 1110 Wien, Austria*

⁵*ipcenter.at GmbH, Schönbrunner Straße 218-220, 1120 Wien, Austria*

* takacs.eszter84@uni-mate.hu

Agricultural production significantly contributes to environmental pollution due to the intensive and, in some cases, improper application of agrochemicals, mainly fertilizers and plant protection products. Pollution of various environmental elements such as surface water, soil, and air occurs through leaching or drifting of agrochemicals from agricultural fields. Pesticide residues found in various crop products lead to issues affecting food and drinking water safety. One approach to avoid pesticide residues is to cultivate crops without using synthetic pesticides is ecological or organic agriculture. However, organic farming goes far beyond simply avoiding the use of chemicals; it involves cultivating food crops while incorporating the latest developments in agricultural science. Organic farming differs from agrochemical-based production methods, as it is practiced on controlled fields while adhering to predefined rules and documenting all production stages. Success in organic farming requires professional knowledge and practical experience, which can be acquired through participation in practical vocational training programs.

The Erasmus+ project "Trainers for Plant Protection in Organic Farming" (TOPPlant) was organized to create a training manual for plant protection in organic farming. This manual includes comprehensive theoretical and practical information on ecological farming, covering tools to manage pests, diseases, and weeds. An innovative methodological curriculum and crop-specific guidelines were also developed. The main innovative aspect lies in the methodological approach, where trained facilitators assist organic farmers in the learning process. The project also offers an e-learning tool providing access to innovative training online and via smartphones, and also useful in higher education training at BSc and MSc levels. Furthermore, the TOPPlant project supports the development of cooperative agricultural production in various regions, particularly through intensive guidance in biological plant protection, production techniques, and quality management.

Keywords: TOPPlant, organic farming, theoretical and practical background, methodological curriculum

Acknowledgments: The project was financially supported by ERASMUS+ program (Project Number: 2020-1-AT01-KA202-078107).



THE PROFIKOMP MODEL FOR CIRCULAR ECONOMY

Aleksza L. ^{*1}

¹ *ProfiKomp® Environmental Technologies Inc; Gödöllő, Hungary, Kühne Ede str. 7.*

^{*} alexa@profikomp.hu

The European waste management system is currently undergoing revolutionary change as a result of the circular economy program, which has been introduced into the legislations of all EU Member States.

The ProfiKomp® Model implements the principles of the biological circular economy in an innovative way. ProfiKomp® Environmental Technologies Inc. strives to develop products and services on an ongoing basis that are harmonious with the principles of the circular economy. In the ProfiKomp® Model, all three cycles are involved, as wastes and by-products can be recycled in three directions. Materials that through tests and analysis prove suitable for feeding insects are entered into the ProfiKomp® Insect Farming System as substrates, following the right preparation. In this way, two marketable products can be made from wastes and by-products: insect protein, and chitosan from chitin. The insect frass and the remaining substrate are further recycled and become part of the material stream that enters anaerobic and aerobic treatment units. Materials that are not suitable for feeding insects but have great potential to produce methane enter ProfiKomp® Dry Fermentation Technology, and are used to produce biogas. Burning the biogas in a gas engine produces electricity and heat. We are also planning to clean the biogas further through the production of biomethane. The fermentation waste that remains after the dry fermentation process is fed into aerobic recycling (composting) equipment. The fermentation waste, insect frass, and substrate that remain, together with wastes that are not suitable for biogas production, are treated with ProfiKomp's® membrane-covered, direct-composting technology, which is equipped with adaptive aeration. This equipment makes it possible to produce good quality organic yield-increasers in a short period of time.

To sum up, using the ProfiKomp® Model, the company produces marketable products and renewable energy such as insect protein, chitosan, biogas, electricity, heat, biomethane and compost from biowaste, agricultural and food-industry waste and by-products. The ProfiKomp® Model also has a positive energy balance as the energy demand of the technological elements that are used is less than the renewable energy produced through dry fermentation.

Keywords: Circular economy, biowaste, anaerobic, aerobic, biomethane

**EFFECT OF BISPHENOL A TREATMENT ON VIABILITY AND IL-6
PRODUCTION OF HUVEC CELL LINE**

Lukáč N.^{*1}, Bažány D.¹, Greifová H.¹, Tokárová K.¹, Štefunková N.¹, Jambor T.¹

¹*Institute of Applied Biology, Faculty of Biotechnology and Food Sciences, Slovak
University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic*

**norbert.lukac@uniag.sk*

Bisphenol A (BPA), also known as 4,4'-isopropylidenedi-phenol and 2,2-bis(4-hydroxyphenyl)propane, is a crystalline structured chemical compound that has been widely used as a key monomer in epoxy resins and polycarbonate plastics for over fifty years. As a result of its widespread manufacture and usage, BPA has been constantly produced and widely distributed in the natural environment. BPA is currently considered a hazard to human health because of its extensive distribution, environmental durability, and reputation as an endocrine disruptor, and its suspected association with cardiovascular difficulties, metabolic disorders, cancer, and infertility raises concerns. One of the most significant effects of BPA on human organisms can also be associated with its immunotoxic properties. In our study, we evaluated the effect of BPA treatment on the viability and interleukin production of human umbilical vein endothelial cells (HUVEC). We treated cells with chosen concentrations of BPA (0.05; 0.1; 1; 10; 25 and 50 μM). Cells were cultivated with various concentrations of bisphenol A for 24 hours. After 24 hours of incubation, we conducted a metabolic activity assay (MTT), determination of lysosome integrity (Neutral Red) and we also measured IL-6 production by using the ELISA method. Our viability results shown that metabolic activity was significantly increased in groups treated with 0.1 μM of BPA, with level of significance ($P \leq 0.001$). In terms of lysosome integrity determination, we recorded statistically significant results in groups treated with 0.05; 0.1; 1; 10 and 25 μM of BPA ($P \leq 0.001$). Production of IL-6 was increased in all experimental groups very slightly and was significantly changed ($P \leq 0.001$) just in group that was cultivated with 0,05 μM of BPA. As a positive control in our study, we used zymosan. The submitted study's conclusion established that BPA did not exhibit cytotoxicity at the evaluated concentrations, but on the other hand, we confirmed the increase of lysosomal integrity and of metabolic activity in some experimental groups. Effect like this is very usual in usage of endocrine disrupting chemicals due to their biphasic effects. Production of the pro-inflammatory interleukin IL-6 and thus the pro-inflammatory effect of BPA on endothelial cells was also shown. Further analyses are needed for better understanding of interactions between BPA and inflammatory processes.

Keywords: Bisphenol A, HUVEC, Viability, Inflammation

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THE USE OF THERMAL ANALYSIS FOR ADULTERATED HONEY DETECTION

Dżugan M.^{*1}, Tomczyk M.¹, Czerniecka-Kubicka A.², Miłek M.¹, Sidor E.¹¹*Department of Food Chemistry and Toxicology, Institute of Food Technology and Nutrition, University of Rzeszów, Ćwiklińskiej 1a, 35-601 Rzeszów, Poland*²*Department of Experimental and Clinical Pharmacology, Medical College of Rzeszow University, University of Rzeszow, 35-310 Rzeszow, Poland** mdzugan@ur.edu.pl

The growing scale of honey adulteration prompts the search for simple methods to detect the adulterated honey. Among many tested analytical methods, the use of thermal analysis is a relatively new approach. Due to, the addition of sugar syrups to the honey sample has an impact on the change of thermal parameters of honey, the use of the differential scanning calorimetry (DSC) seems to be promising solution. The study focused on self-prepared two model systems “honey + adulterant“ with an increasing dosage (0 to 30%) of of two different sugar syrups (S- sugar syrup and I- invert syrup) used as bee feed which were stored in real conditions. After 24 months of storage the changes in thermal characteristics, physicochemical parameters and sugar profile, antioxidant and enzymatic activity of adulterated samples (partially crystallized) were monitored in comparison to the control honey (fully crystallized).

The addition of sugar syrups to honey affected the course of crystallization of artificially adulterated honeys in a syrup type- and dose-dependent manner causing the delamination of products which was not observed for pure honey. It was found that used adulteration changed physicochemical parameters and reduced antioxidant and enzymatic activity of honey ($p < 0.05$) which can be explained by the dilution effect of the sample. Moreover, using the high-performance thin-layer chromatography (HPTLC) the changes in sugar profile of adulterated honeys were demonstrated. The fructose/glucose content ratio gradually increased with an addition of syrups in the adulterated honey (up to 1.0 for 30% addition) compared to control honey (0.62). The most evident changes were found for the viscosity value and heat flow rate course obtained by DSC method. The viscosity of the liquid phase of delaminated honey decreased linearly with the addition of syrup. For the artificially adulterated honeys a specific glass transition (T_g) in the range of 34–38.05 °C was found during DSC analysis which was not observed for control honey. Moreover, the additional T_g s in a wide range from –19.5°C to 4.10°C for honeys adulterated by syrup S only and from 50.4 to 57.6°C for syrup I addition were observed. These specific T_g s seem to be useful to detect honey adulteration and to identify the kind of adulterant used. However, the research was carried out for a single sample of multifloral honey, so confirmation of the effectiveness of the proposed tools for identifying adulterated honey requires further studies including various honey variety.

Keywords: honey, adulteration, sugar syrup, thermal characteristics, DSC analysis

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**INFLUENCE OF THE ANTIESTROGEN TAMOXIFEN ON CONNECTIN 43
EXPRESSION AND LOCALIZATION IN THE HEN OVIDUCT**Wolak D.^{*1}, Kowalik K.¹, Sechman A.¹, Hrabia A.¹¹*Department of Animal Physiology and Endocrinology, University of Agriculture in Krakow,
Poland*^{*}dominika.wolak@urk.edu.pl

Proper intercellular communication within the oviductal tissues is essential for the efficient transport of signaling molecules, ions, and metabolites determining normal egg formation and transportation as well as sperm storage and movement in the avian oviduct. The direct exchange of small molecules between neighboring cells in tissues is realized by gap junction proteins such as connexins (Cx). Information concerning the expression and regulation of Cxs in the chicken oviduct is lacking. The aim of the present study was to examine whether selected Cxs are present in the chicken oviduct and, if so, whether expression of the most abundant Cx changes following tamoxifen (TMX; estrogen receptor modulator) treatment. Hy-Line Brown laying hens were injected (s.c.) daily with a vehicle (n = 6) or with TMX (n = 6) at a dose of 6 mg/kg of body weight for 7 consecutive days until complete cessation of egg laying by TMX-treated hens. All oviductal segments, i.e., infundibulum, magnum, isthmus, shell gland, and vagina were collected from hens on day 8 of the experiment. First, the gene expression of GJA1 (i.e. Cx43 protein), GJA4 (Cx39), GJB1 (Cx32), and GJD2 (Cx36) was investigated by real-time PCR in tissues of control chickens. The results demonstrated gene- and oviductal segment-dependent expression of GJB1, GJD2, GJA4, and GJA1 mRNA. Since the GJA1 transcript was the most abundant in all oviductal parts, subsequently, the Cx43 expression and localization were examined in the oviduct of all hens. The relative expression of GJA1 mRNA in control hens was highest in the infundibulum and vagina and lowest in the magnum. The pattern of Cx43 protein abundance evaluated by Western blot was similar to that of mRNA. Treatment of hens with TMX decreased the GJA1 mRNA levels in the magnum and isthmus, and Cx43 protein abundances were reduced in the isthmus and vagina. Immunofluorescence demonstrated cell- and segment-dependent localization of Cx43 protein in the oviductal wall; the most intense immunoreactivity was observed in the muscle cells of the shell gland and vagina. In TMX-treated hens, the immunoreactivity for Cx43 in all oviductal segments was slightly reduced and had a different signal pattern compared with control chickens. These results suggest that Cx43 likely takes part in the regulation of oviduct functioning, especially in the coordination of muscle contraction required for egg transport and oviposition. In addition, the results strongly suggest a contribution of estrogen in the regulation of Cx43 expression and/or fates in the chicken oviduct. New insights into the expression and regulation of Cxs in the hen oviduct, indicating their potential involvement in the mechanisms of egg formation and transport that may affect poultry production, were obtained in this study.

Keywords: Chicken; Cx43; Gap junction; Oviduct; Tamoxifen.*Acknowledgments:* The research was financially supported by by the Ministry of Education and Science to the University of Agriculture in Krakow, Poland (subvention numbers: SUB-020002-D015, -D016, and -D017).

**EFFECT OF ZNO NANOPARTICLES ON METABOLIC ACTIVITY AND STEROIDOGENESIS**

Štefunková N.^{*1}, Greifová H.¹, Jambor T.¹, Zuščíková L.¹, Bažány D.¹, Lukáč N.¹, Urban I.¹,
Massányi P.¹

¹*Institute of Applied Biology, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic*

^{*}nikola.knizatova@uniag.sk

ZnO NPs have at least one dimension in the 1 to 100 nm range. ZnO nanoparticles are a novel form of high-functional fine inorganic material with increased chemical activity, exceptionally strong oxidation resistance, corrosion resistance, photocatalysis, unique stronger absorption, and UV ray shielding capacity. It has found widespread application in consumer and industrial products, including cosmetics, food additives, photo electricity, and the rubber sector. Small particles can easily accumulate and migrate deeply in the body when particle size decreases. For these reasons, information regarding ZnO NPs' safety and possible risks is important. As a result, the purpose of this study was to determine the effect of ZnO nanoparticles on the production of testosterone and estradiol by the human adrenocortical carcinoma cell line H295R, which is often employed as a cellular model for determining endocrine disruption *in vitro*. Moreover, we evaluated metabolic activity. H295R cells were cultivated for 24 hours with different concentrations of ZnO nanoparticles (0.1 - 10 mg/ml) and compared to untreated control. An enzyme-linked immunosorbent assay (ELISA) was used to measure the level of testosterone and progesterone in cell culture media, and an Alamar blue test was used to assess the metabolic activity. After 24-hour cultivation with 0.1 - 10 mg/ml ZnO NPs, a significant decrease in metabolic activity was observed. A significant decrease in estradiol production was observed after cultivation with 0.1 - 10 mg/ml ZnO NPs. A significant decrease in testosterone production was observed after cultivation with 0.1 - 10 mg/ml ZnO NPs. Further investigations are required to elucidate molecular mechanisms of action of ZnO nanoparticles on steroidogenesis and viability.

Keywords: H295R, nanoparticles, metabolic activity, steroidogenesis, viability

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**CORNELIAN CHERRY EXTRACT-INDUCED CELL DEATH BY ELEVATING THE ENDOPLASMIC RETICULUM STRESS RESPONSE IN HUMAN COLORECTAL ADENOCARCINOMA CELLS**

Fialková V.^{*1}, Klongová L.¹, Urbanová L.¹, Farkasová S.¹, Grabacka M.², Capcarova M.³, Spevaková I.¹

¹*AgroBioTech Research Centre, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic*

²*Department of Biotechnology and General Technology of Foods, Faculty of Food Technology, University of Agriculture, Al. Mickiewicza 21, 31-120 Cracow, Poland*

³*Institute of Applied Biology, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic*

*veronica.fialkova@uniag.sk

Colorectal cancer is the third most common type of cancer and the second leading cause of cancer death worldwide. The major obstacle of effective treatment is the resistance to current chemotherapeutic drugs. The potential anticancer properties of naturally occurring phytochemicals have been extensively investigated for their proven safety and effective chemopreventive impact on colorectal cancer. Cornelian cherry (*Cornus mas L.*) leaves serve as a rich source of polyphenols and flavonoids with many antiproliferative, antioxidant and anti-inflammatory activities. The objective of our study was to evaluate the effects of *Cornus mas L.* ethanol extract, derived from leaves, on cell viability, oxidative stress and the expression of genes associated with the endoplasmic reticulum stress response in the human colorectal adenocarcinoma cell line (HT-29). The cells were treated with different doses of the extract (37,5; 75; 150; 300; 600; 1000 and 1200 µg/mL) for 24-72 hours to evaluate the cell viability using the metabolic activity (MTT) assay and the production of superoxide (O₂⁻) anion via the NBT assay. For determining the mRNA expression levels of selected genes (Activating Transcription Factor 6, *ATF6*; Heat Shock Protein Family A Member 5, *GRP78*) was used the real-time PCR method. Our results showed that the cornelian cherry extract significantly ($p < 0.05$) decreased the cell viability at concentrations ≥ 600 µg/ml and induced the superoxide anion production in dose-dependent manner. In addition, the extract caused the significant ($p < 0.01$) elevation in the mRNA expression levels of *GRP78* and *ATF6* even at lower doses (≥ 75 µg/mL) compared to the control group. These findings strongly indicate that the cornelian cherry leaf extract exerts cytotoxic effects on HT-29 cells by upregulating the expression of genes associated with endoplasmic reticulum stress response.

Keywords: cornelian cherry extract, endoplasmic reticulum stress, gene expression, HT-29 cells

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THE USE OF HPTLC METHOD TO QUANTIFY THE COUMARIN LEVEL IN CINNAMON AND SPICE MIXES

Milek M.^{*1}, Dżugan M.¹

¹*Department of Food Chemistry and Toxicology, Institute of Food Technology and Nutrition, University of Rzeszów, Ćwiklińskiej 1a, 35-601 Rzeszów, Poland*

^{*}mmilek@ur.edu.pl

Coumarin is a secondary metabolite of some plants, found mainly in some grasses and plants of the Lamiaceae, Fabaceae and Orchidaceae families. It is also one of the main bioactive ingredients of cinnamon, a spice obtained from cinnamon tree bark. Due to some toxicity and cirrhosis-causing effect, it is a controversial compound. The European Regulation established limits for coumarin in various kinds of food: in traditional and/or seasonal bakery products containing a reference to cinnamon in the labelling as 50 mg/kg, breakfast cereals including muesli as 20 mg/kg, and fine bakery products as 15 mg/kg, and desserts as 5 mg/kg.

The aim of the study was to evaluate the content of coumarin in 10 samples of cinnamon and 3 spice mixtures (gingerbread spice, hot wine spice) available on the Polish market. To analyze a new approach was applied – a fast, simple and inexpensive high-performance thin layer chromatography (HPTLC) method. Cinnamon and spice samples were extracted with 50% aqueous ethanol assisted by ultrasound. The extracts were analyzed on HPTLC silica gel 60 plates with a fluorescent label using the mobile phase consisted of hexane, ethyl acetate and ammonia (3.8:1.5:0.5, v/v/v). After separation, the results were visualized by observing the plate under UV light (254 nm). Coumarin was identified as a dark band quenching the fluorescence of the plate at $R_f = 0.28$. Quantitative analysis was performed by applying a coumarin standard in the range of 1 to 6 μg in parallel with the analyzed samples. The content of coumarin in the samples was assessed based on the standard curve. Among tested cinnamons, coumarin was detected in 7 samples (70% of total), the content ranged from 0.79 to 6.76 g/kg. In addition, in one of the analyzed spices (gingerbread spice) coumarin was detected in the amount of 0.82 mg/kg. The method used allows for a quick screening of many samples before performing more precise quantitative analysis, and can also be an alternative to more expensive HPLC analysis.

Keywords: cinnamon, coumarin, HPTLC



EFFECT OF POLYCYCLIC AROMATIC HYDROCARBON ADMINISTRATION ON IODOTHYRONINE CONCENTRATIONS IN BLOOD PLASMA OF THE DOMESTIC HEN

Kowalik K.^{*1}, Katarzyńska-Banasik D.¹, Kozubek A.¹, Sechman A.¹

¹Department of Animal Physiology and Endocrinology, Faculty of Animal Sciences,
University of Agriculture in Krakow, Poland

*kinga.kowalik@urk.edu.pl

Polycyclic aromatic hydrocarbons (PAHs) are endocrine-disrupting compounds classified as Persistent Organic Pollutants. PAHs are products of incomplete combustion of organic matter. These processes occur both in the natural environment (e.g. during forest fires) and as a result of human activity (e.g. thermal processing of food, vehicle exhaust fumes, industrial and production processes). PAHs can be manufactured as individual chemicals but in the environment, they occur as complex mixtures. Therefore the studies aimed to determine the effect of the mixture of 16 PAHs (consisting of naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, benzo[g,h,i]perylene, indeno[1,2,3-c,d]pyrene, and dibenz[a,h]anthracene) on the thyroid hormones (THs): thyroxine (T4) and triiodothyronine (T3) concentration in the blood plasma of laying hens. Bovans hens at the age of 70 weeks (n= 24) were divided into 3 groups (n=8 in each group): the control group, which received dichloromethane at a concentration of 0.1% (solvent for PAHs), and two experimental groups, which were treated with a mixture of PAHs at a higher (MIX I) and lower (MIX II) concentration. Tested compounds were administered *per os* to chickens, for 28 consecutive days of the experiment. The doses of PAH mixtures were selected based on determinations of these compounds in egg yolks from free-range hens (MIX I) and cage hens (MIX II). Blood samples were collected on the 0, 7th, 14th, 21st and 28th day of the experiment. The concentrations of THs (T4 and T3) in the blood plasma were determined by the RIA method using commercial kits from the Institute of Isotopes Co. Ltd. IZOTOP (Hungary). The results were statistically analyzed using Two Way Repeated Measures ANOVA, and the significance of differences between the means was checked by Tukey's test at $p < 0.05$. Compared to the control group, MIX I diminished T4 concentration on the 21st and 28th day of the experiment by 15% and 17%, respectively ($p < 0.05$) in chicken blood. The same inhibitory effect was observed on the 28th day of the experiment after administration of MIX II (T4 level was lower by 17%, $p < 0.05$). On the other hand, only MIX I reduced the level of T3 in the blood on the 14th, 21st and 28th day of the experiment by 19%, 24% and 18%, respectively ($p < 0.05$). These results suggest that PAHs affect the concentration of THs in the hen's blood; MIX I (higher PAH concentration) decreased levels of both iodothyronines, while MIX II (lower PAH concentration) reduced only T4 levels in the blood. The observed effects may be related to the inhibitory effect of PAHs on the synthesis and/or secretion of THs as well as on the deiodination process, which in birds is the main source of T3 in the organism. An explanation of the mechanism of PAH influence on thyroid function requires further research.

Keywords: Polycyclic aromatic hydrocarbons, thyroid hormones, chicken

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**CYTOTOXIC EFFECT OF ATRAZINE ON CELLS OF THE MALE
REPRODUCTIVE SYSTEM**

Greifová H.^{*1}, Štefunková N.¹, Jambor T.¹, Tokárová K.¹, Bažány D.¹, Capcarová M.¹,
Lukáč N.¹

¹*Institute of Applied Biology, Faculty of Biotechnology and Food Sciences, Slovak
University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic*

^{*}hgreifova@gmail.com

Atrazine as a widely used selective systemic triazine herbicide, is an environmental endocrine disruptor that represents the most commonly detected pesticide contaminant of ground, surface, and drinking water globally. The aim of this study was to compare the cytotoxicity of this compound on different male testicular tissue-forming cells, namely steroidogenic Leydig cells and Sertoli cells - sustentacular "nurse" cells of the primary spermatogonia. In this study, we used cell lines TM3 (Leydig cells) and TM4 (Sertoli cells) to investigate the effect of atrazine (0.5 – 800 μM) on the different cell viability parameters after 24 h of exposure. Metabolic activity of exposed cells was evaluated using alamarBlue assay, MTT test was performed to observe mitochondrial activity of cells and impairment of lysosomes integrity was analysed by neutral red cytotoxicity assay. Metabolic activity of Leydig cells cultured in the presence of 200 and 300 μM atrazine ($P < 0.01$), and 500 and 800 μM atrazine ($P < 0.001$) showed significant decline of values compared to control group, but experimental group of cells treated with 25 μM atrazine were significantly ($P < 0.05$) affected in the manner of increasing values. On the other hand, metabolic activity of Sertoli cells was not affected in any experimental group. According to MTT test, atrazine treatment of Leydig cells resulted in significantly reduced cell proliferation at concentrations 200 μM ($P < 0.05$); 300, 500 and 800 μM ($P < 0.001$) and as in the previous case, the experimental group exposed to 25 μM atrazine showed a significant increase ($P < 0.01$) of values. Regarding Sertoli cells, we observed significant decrease in mitochondrial activity only at concentrations of 500 μM ($P < 0.01$) and 800 μM ($P < 0.001$). Assessment of Leydig cells lysosomal activity revealed significant decline of values in samples containing 100 μM ($P < 0.05$); 200 μM ($P < 0.01$); and 300, 500 and 800 μM ($P < 0.001$). Integrity of Sertoli cell lysosomes was significantly affected by 200 μM ($P < 0.05$); and 300, 500 and 800 μM ($P < 0.001$) atrazine, which was reflected by a decrease in the values, but also by increased values in samples of experimental group exposed to 0.5 μM ($P < 0.05$) atrazine. Based on these partial results, it can be concluded that steroidogenic Leydig cells are more sensitive to the action of atrazine in terms of cytotoxicity, while in further experiments it is necessary to confront these data with the endocrine-disrupting nature of atrazine in the steroidogenesis process.

Keywords: Atrazine, Leydig cells, Sertoli cells, metabolic activity, mitochondrial activity, integrity of lysosomes

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**SCREENING OF PROFILIN ALLERGEN HOMOLOGS IN CEREALS AND PSEUDOCEREALS**Farkasová S.*¹, Žiarovská J.²¹ *AgroBioTech Research Centre, Slovak**University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic,*² *Institute of Plant and Environmental Sciences, Faculty of Agrobiological and Food Resources, Slovak**University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic** silvia.farkasova@uniag.sk

DNA marker systems that explore the genetic polymorphism between individuals and populations are fundamental part of plant genomics. Several methodologies are widely applied with proven results. However, plant genomics is still looking for new methods to study plant genome. Some allergens, whose genes are conserved in the genome of several plant species, may provide good conditions for the development of DNA marker systems. This work explores a DNA marker system based on profilins. High sequence and structural similarity is observed in profilins from even distantly related plants that accounts for cross-reactivity in allergic patients. Although the observed IgE cross-reactivity does not correlate with clinical symptoms, sensitization to profilin is considered a potential risk for the development of several pollen-related food allergies. Varieties of cereals and pseudocereals were analysed for the presence of profilin homologs in their genomes. The biological material was represented by grains of cereals and pseudocereals. Cereals used in the work were *Triticum aestivum* L., *Triticum durum* Desf., *Avena sativa* L., *Hordeum vulgare* L., the pseudocereals were represented by *Amaranthus cruentus* L. and *Fagopyrum esculentum* Moench. PCR analysis was performed with primers designed for profilin gene with accession number AY792608.1 in the NCBI database. PCR amplification products were separated on 1.5% agarose gels. The acquired images of electrophoretograms were processed using GelAnalyzer software. The results obtained from the agarose gels were transcribed into a binary matrix and a UPGMA dendrogram was created according to the Jaccard coefficient. The correlation coefficient was 0.877. The results are pointing to sequence polymorphism in profilin homologs of the studied crops. The clusters created by the dendrogram corresponded to the species distribution of the crops, except for the amaranth sample Plansman, which was grouped with buckwheat varieties, but buckwheat and amaranths formed a supergroup together. PIC value was 0,195, P % value was 96 % and the amplicons ranged in size from 75 to 2019 bp.

Keywords: profilin, pollen allergen, cereals, pseudocereals, polymorphism

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**EFFECT OF *CORNUS MAS L.* FRUIT ETHANOL EXTRACT ON THE YEAST
*SCHIZOSACCHAROMYCES POMBE***

Klongová L.^{*1}, Kovár M.², Navrátilová A.³, Požgajová M.¹, Fialková V.¹, Speváková I.¹

¹*AgroBioTech Research Centre, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic*

²*Institute of Plant and Environmental Science, Faculty of Agrobiological and Food Resources, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 94976 Nitra, Slovakia*

³*Institute of Nutrition and Genomics, Faculty of Agrobiological and Food Resources, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 94976 Nitra, Slovakia;*

** klongova@uniag.sk*

The Cornelian cherry, scientifically known as *Cornus mas* L., is a small tree in the dogwood family *Cornaceae* that grows in central and southern Europe, as well as in the Middle East. The tree is known for its nutritional and therapeutic properties. The extract of this fruit consists of various substances with bioactive properties such as phenolic compounds, anthocyanins, vitamins, flavonoids, carotenoids, and ursolic acid. These components are associated with antimicrobial, antioxidant, anticancer, and anti-inflammatory effects. In this study, we used *Schizosaccharomyces pombe* as a promising unicellular model organism to examine the effect of *Cornus mas* L. fruit ethanol extract at concentrations of 0.5 % and 2 % on antioxidant capacity of the cell. Our research involved quantification of intracellular reactive oxygen species (ROS) and malondialdehyde levels (MDA). Moreover, activity of superoxide dismutase (SOD) and catalase (CAT) have also been evaluated to determine the *Cornus mas* L. extract-induced oxidative stress. Additionally, we assessed whether the extract had an impact on cell viability and analyzed the expression of selected genes (SOD1, SOD2, CTT1, PGR) related to oxidative stress response using qPCR techniques. The data suggests that a higher dose of the extract (2%) could lead to an increased oxidative stress response in yeast cells, subsequently resulting in lower cell viability compared to the untreated cells. This study can provide a view on cellular responses to oxidative stress and the potential antimicrobial effects of *Cornus mas* L. fruit ethanol extract.

Keywords: *Cornus mas*, *Schizosaccharomyces pombe*, oxidative stress, cell viability, gene expression

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APPLICATION OF THE BBAP TECHNIQUE TO DISTINGUISH BLUEBERRY SPECIES AND THEIR VARIETIES

Urbanová L.^{*1}, Žiarovská J.²

¹ AgroBioTech Research Centre, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic

² Institute of Plant and Environmental Sciences, Faculty of Agrobiological and Food Resources, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic

* lucia.urbanova@uniag.sk

DNA-based marker techniques are used in molecular biology to understand plant relationships and gene differences. For a deeper insight into the relations between the genes encoding the Bet v 1 allergens, the BBAP (Bet v 1 Based Amplicon Polymorphism) technique was used on 13 varieties of two species of blueberries - *Vaccinium corymbosum* L. and *Vaccinium myrtillus* L. BBAP was able to create polymorphic profiles like interspecies that among varieties. DNA fingerprints showed 69 alleles which were distributed into 14 different loci, in a range from 65 bp to 1550 bp of amplicon lengths by both primer sets – degenerated and their non-degenerated versions. As a unique proved to be ‘Duke’ variety of *Vaccinium corymbosum* L., whose profile amplified the length of 183 bp by degenerated primer set. A dendrogram of genetic distance with the Jaccard index was created from the DNA profiles using the UPGMA method. Varieties were separated into 4 main subbranches. UPGMA evaluated the profiles of species *Vaccinium myrtillus* L. and *Vaccinium corymbosum* L. as absolutely dissimilar, on the contrary, the two varieties (JE2 and genotype from Peru) of species *Vaccinium corymbosum* L. as 100% similar in analysed region. BBAP proved to be an effective DNA-based fingerprinting technique to differentiate blueberry genotypes.

Keywords: allergen, BBAP, blueberry, *Vaccinium myrtillus* L., *Vaccinium corymbosum* L.

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IN VITRO PROPERTIES OF ESSENTIAL OILS FROM AROMATIC PLANTS

Pinto B.^{*1}, Rodriguez Fernandez V^{1,2}, Piaggi S.¹¹Department of Translational Research, Faculty of Medicine, Italy
University of Pisa, via Roma 55, 56126 Pisa, Italy²Department of Infection Disease, Microbiology and Public Health
University of Roma La Sapienza, Roma, Italy* barbara.pinto@unipi.it

Several natural products of plant origin have proved to be effective in prevention and therapy of several diseases such as bacterial and parasitic infections, chronic diseases including cancer. In the search for alternative therapies, essential oils (EOs) can represent an excellent source of mixtures of biologically active natural products also because the clinical efficacy of conventional drugs used in chemotherapy is sometimes reduced due to collateral adverse effects. In the present study, we investigated a panel of biological activity of some EOs extracted from aromatic plants including their antiparasitic property against *Toxoplasma gondii* tachyzoites: *Rosmarinus officinalis*, *Salvia somalensis*, *Thymus vulgaris*, *Achillea millefolium*, *Helichrysum italicum*, *Pistacia lentiscus*, and *Myrtus communis*.

Previously, the cytotoxicity in a human ovarian carcinoma cell line (A2780) and in Vero cells (African green monkey kidney fibroblast-like cells) and the estrogenic and antiestrogenic activity in recombinant yeast strain expressing the human estrogen receptor alpha (ER α) were evaluated. The cytotoxic effect of the EOs on the cell lines used was evaluated by using a WST-1 colorimetric assay. Based on the results of their *in vitro* cytotoxicity, three EOs with low, medium, and high cytotoxicity (*Salvia somalensis*, *Rosmarinus officinalis*, and *Helichrysum italicum*) were chosen and tested for their anti-parasitic property against tachyzoites of a *Toxoplasma gondii* RH strain. For all the three EOs, two safe concentrations for cells were chosen. Our results showed that EOs may express a high to moderate cytotoxic effect on A2780 and Vero cells and a marked antiestrogenic activity that could potentially be used in anti-estrogenic therapy. In addition, some EOs showed to influence at different degree the ability of *T. gondii* tachyzoites to infect Vero cells.

Keywords: essential oils, cytotoxicity, parasite, *Toxoplasma gondii*

**ASSESSMENT OF TILLAGE STRATEGIES AND THEIR IMPACT ON SOIL HEALTH AND SUSTAINABILITY ON ARABLE LAND**

Modiba M.M.^{*1}, Dekemati I.¹, Tharwat M.I.H.², Ocansey C.M.², Keleti J.R.², Birkás M.¹, Simon B.²

¹ Institute of Crop Production

² Institute of Environmental Sciences

^{1,2} Hungarian University of Agriculture and Life Sciences, H-2100, Hungary

* mmodibawell@gmail.com

The adverse effects of traditional tillage aggravate soil degradation through soil compaction and soil organic matter (SOM) loss consequently affecting crop yield. The objective of the study was to evaluate different soil physical, chemical, and biological alterations as impacted by three tillage treatments on an Endocalcic Chernozem soil. A two-year investigation of three tillage treatments, ploughing (P), shallow cultivation (SC) and no-till (NT) was conducted from a long-term study set up in Hungary. Soil bulk density (BD) samples were collected from 0-5 cm depth before planting in autumn. Earthworm abundance was sampled *in situ* by hand-sorting 20 × 20 × 30 cm soil blocks method, soil penetration resistance (SPR), and soil moisture content (SMC) values were collected on a 30-day interval unless weather did not permit sampling. Our preliminary results indicated that in the 2020 cropping season, no significant changes in pH in the three contrasting tillage treatments and among different soil depths were observed. Soil organic matter (SOM) was higher in SC (4.6%) and NT (4.6%) compared to P (3.5%) at 0-5 cm depth. As predicted NT had higher BD followed by SC compared to P in the 2020 and 2021 study periods. SMC was increased in both NT and P compared to SC at 0-20 cm with the highest (23.6 m/m%) moisture recorded at 20 cm. SPR values of 2.6 MPa and 2.38 MPa were observed in March 2019 and September 2020 respectively compared to P at 5 and 9 cm depth respectively. SC (153.5 ind m⁻²) and NT (218 ind m⁻²) had higher earthworm abundance and biomass in the 2020 spring compared to P (40 ind m⁻²). We can conclude that minimum soil disturbance tillage improved the soil's physical, chemical, and biological properties. Therefore, more efforts should be made to promote and implement conservation tillage practices in crop production to prolong production without overwhelming natural resources.

Keywords: Tillage; Soil penetration resistance; Bulk density; Soil moisture content; earthworm abundance; Food security



ENVIRONMENTAL AND FOOD SAFETY ASPECTS OF HOME-MADE BOTANICAL INSECTICIDES

Klátyik Sz.^{*1}, Takács E.¹, Mörtl M.¹, Székács A.¹

¹ *Agro-Environmental Research Centre, Institute of Environmental Sciences, Hungarian University of Agriculture and Life Sciences, Páter Károly u. 1, 2100 Gödöllő, Hungary*

^{*} klatyik.szandra@uni-mate.hu

Botanical pesticides are derived from plant-based sources and typically consist of simple preparations containing plant extracts, essential oils, or herbal mixtures. In home-made botanical insecticides, aqueous extracts of ground or whole plant materials are commonly used for pest control utilizing to the insecticidal, repellent, or antifeedant properties of the plant-derived active ingredients. These home-made botanical insecticides find wide application among farmers and households alike. Botanical insecticides are, often erroneously, considered safer and more environmentally friendly compared to synthetic chemical pesticides. However, the efficacy and safety of applying botanical insecticides, especially home-made preparations, are often not scientifically proven, or the results of efficacy assessments are not readily accessible.

There is a high degree of variability in the effectiveness of homemade botanical insecticides due to differences in preparation processes, variable active ingredient content and concentration in plant materials, as well as variations in the use of adjuvants. Despite their benefits, the application of these formulations is associated with several environmental and food safety risks. Unlike commercial chemical pesticides, most applied botanical insecticides are not subject to strict regulation. While several studies have demonstrated the lower toxicity of botanical insecticides to non-target organisms compared to synthetic active ingredients, adverse effects have been observed in some cases.

Therefore, environmental risk assessments, including effects on non-target organisms (e.g., pollinators), biodiversity, soil ecosystems, and water quality, should be conducted also for botanical insecticides. Similarly, as with environmental risks, prescribed assessments for food safety and human health safety are generally lacking for botanical pesticides, except for neem products. However, evaluating residues of botanical pesticide components on crops and their potential transfer to the food chain, considering possible harmful effects on human health, is essential. Assessing the risk of home-made botanical insecticides is even more challenging due to variations in composition and the unknown properties of the formulations.

To ensure the sustainability and safety of agricultural practices, it is crucial to establish guidelines, educate practitioners, and conduct further research to better understand and manage the potential risks and benefits of homemade botanical insecticides.

Keywords: home-made pesticides, botanical insecticides, environmental safety, food safety, risk assessment

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SMALL-SCALE EXPERIMENTS OF PM₁₀ DISPERSION AROUND OBSTACLESQor-el-aine A.^{*1}, Benécs J.², Béres A.³, Géczi G.⁴¹Doctoral School of Mechanical Engineering²Department of Building Engineering and Energetics, Institute of Technology³University Laboratory Center⁴Department of Environmental Analysis and Technologies, Institute of Environmental Science
^{1,2,3,4} Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary* gorelaine.achraf@gmail.com

Particulate matter (PM) is a primary determinant of air pollution caused by various natural and human-caused sources. Because it can be suspended in the atmosphere for long periods and travel long distances, it can cause a significant health crisis for humans and damage the environment. Studies are still required to understand how the PM moves around obstacles, especially in urban areas. This study conducted small-scale experiments to examine the effects of simple obstacles, heights and distance from the source on the PM₁₀ concentration. Results revealed a moderately significant positive connection between the dependent variable (PM₁₀ concentration after the obstacle) and the set of independent factors, as indicated by the correlation coefficient (R) of 0.89. Moreover, the independent variables in the model collectively explained approximately 79% of the variation in the dependent variable, as reflected by the coefficient of determination (R²) of 0.79. Overall, the research provides valuable insights into the impact of obstacle height, distance from the source, and wind speed on PM₁₀ concentration and confirms the transport behaviour of PM particles in both small-scale experiments and larger-scale urban settings. In addition, using incense sticks as a source of PM pollution illustrated that moderate burning of incense sticks indoors can skyrocket the PM₁₀ concentration to an unhealthy level. Knowing how simple obstacle height and placement can affect the PM₁₀ concentration can help defend agricultural areas close to industrial regions to limit the damage that can affect agricultural products.

Keywords: PM₁₀ concentration; PM₁₀ dispersion; Incense sticks; Obstacles; Wind speed



BALANCING FOOD SECURITY AND CARBON SEQUESTRATION - THE COMPLEXITIES OF CULTIVATING SPHAGNUM MOSS-DOMINATED PEATLANDS

Keleti J.R.*¹, Döbröntey R.¹, Fuchs M.¹, Szegi T.¹, Simon B.¹, Ocansey C.M.¹, Michéli E.¹

¹*Department of Soil Science, Institute of Environmental Sciences,
Hungarian University of Agriculture and Life Sciences, Gödöllő Hungary.*

*Keleti.Judit.Rita@uni-mate.hu

Peatlands seen as potential agricultural assets pose complex risk factors to global food security. This review aims to strike a balance between the goals of global food security and the preservation of *Sphagnum* moss peatlands. The study highlights the dynamics of cultivating peatland ecosystems, with a particular focus on *Sphagnum* moss-dominated peatlands and their distinctive functional and morphological properties. Disturbing *Sphagnum* moss and the peat material disrupts the delicate balance of these ecosystems, resulting in soil erosion, loss of habitat, and altered nutrient cycles. We explored their dual role in agriculture, presenting images of thriving crops against this unique carpet. The negative aspect of cultivating these soils were indicated unveiling the consequences of drainage on greenhouse gas emissions, ecosystem degradation, and land subsidence. We outlined an innovative action plan for mitigation that suggests a comprehensive approach that includes restoration, sustainable practices, agroforestry, carbon farming, public awareness activities, collaborative efforts, motivation, and adaptive management. The review underscores the pressing need for a balanced scientific, and sustainable approach to cultivating *Sphagnum* moss-dominated peatlands. It emphasizes the importance of addressing the complexities of global food security while safeguarding these vital ecosystems.

Keywords: agriculture, carbon farming, carbon sequestration, ecosystem degradation, food security, horticulture, vertical farming, restoration, sustainable practices



HARNESSING SOLAR THERMAL ENERGY FOR SUSTAINABLE INDUSTRIAL AND AGRICULTURAL DEVELOPMENT IN THE V4 REGION

Ghabour R. ^{*1}, Korzenszky P. ²

¹*Doctoral School of Mechanical Engineering,*

²*Department of Farm and Food Machinery, Institute of Technology*

^{1,2}*Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.*

* rajab.gh.eng@gmail.com

The utilization of solar thermal energy has emerged as a promising solution for sustainable energy systems worldwide. This article highlights the importance of integrating solar thermal energy technologies into the industrial and agriculture sectors within the Visegrád Group (V4) region, which is witnessing rapid industrial and agricultural growth. The article presents compelling statistics demonstrating the potential of solar thermal energy in the V4 region. It showcases the substantial energy demand within the industrial and agriculture sectors, emphasizing the need for alternative and environmentally friendly energy sources. Moreover, it provides quantitative data on the current energy consumption patterns and emissions associated with traditional energy sources in these sectors. Next, the article discusses the advantages of solar thermal energy for industrial and agricultural applications. It explores the potential of solar thermal systems to provide process heat, space heating, cooling solutions, crop drying, water heating, and greenhouse climate control for industrial facilities, such as manufacturing plants and food processing units. The article then examines the policy frameworks, financial incentives, and support mechanisms required to promote the adoption of solar thermal systems in industrial and agricultural settings.

Additionally, it discusses the importance of collaboration among stakeholders, including government agencies, industry players, and research institutions, to foster knowledge sharing and development in the field. Furthermore, the article presents practical case studies and success stories from both international and regional contexts, which demonstrate the economic, environmental, and social benefits achieved through the integration of solar thermal technologies. Finally, the article concludes with a call to action, urging policymakers, investors, and stakeholders in the V4 region to recognize the immense potential of solar thermal energy and actively support its deployment. It emphasizes the need for tailored policies, financial mechanisms, and capacity-building initiatives to accelerate the adoption of solar thermal technologies, contributing to a sustainable and prosperous future for the V4 region.

Keywords: Solar thermal energy, V4 region, Industrial sector, Food processing

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MITIGATING ENVIRONMENTAL RISK FACTORS AND PROMOTING SUSTAINABLE AGRICULTURE THROUGH PÁLINKA SPENT WASH COMPOSTING

Silva L.R.B.^{*1}, Sipos E.¹, Kardos L.¹

¹*Department of Agro-environmental Studies, Institute of Environmental Sciences, Hungarian University of Agriculture and Life Sciences, Budapest, Hungary*

* borgesrubialara@gmail.com

This article explores the intricate dynamics involved in mitigating environmental risk factors associated with the Pálinka distillery industry in Hungary, while concurrently advocating for sustainable agriculture through the practice of composting Pálinka spent wash. Pálinka production, a beloved Hungarian hard liquor, generates substantial volumes of organic waste in the form of spent wash. This spent wash, characterized by its high organic load, low pH, and significant content of recalcitrant compounds, presents a substantial environmental challenge. Composting has emerged as a sustainable solution for effectively managing Pálinka spent wash. This transformative process not only converts it into humified material but also neutralizes phytotoxic substances. In this study, we delve into the environmental risk factors linked to the Pálinka distillery industry, with a particular emphasis on metals, notably copper, found in Pálinka spent wash. We investigate the potential of Pálinka spent wash compost as a dual-purpose solution: mitigating environmental hazards and serving as a soil organic amendment for sustainable agriculture. Our examination encompasses the copper content within the residue as a significant concern, tracking its reduction over time through co-composting with garden compost, diatomaceous earth, and wood ash. Additionally, we employ anaerobic composting of spent wash in sealed jars with Bokashi compost. Our methodology includes an array of analyses, encompassing assessments of physicochemical parameters and germination tests, to provide insights into the suitability of Pálinka spent wash compost for fostering seed growth. This research underscores the pressing need to address environmental and health risks associated with Pálinka spent wash, simultaneously highlighting the untapped potential of this waste stream as an effective soil amendment, capable of enhancing soil health and fertility. By embracing composting as a sustainable waste management practice in traditional food and beverage industries, we contribute to the broader discourse on risk factors in the food chain, offering an innovative approach to safeguarding the environment and supporting sustainable agriculture.

Keywords: Pálinka spent wash, composting, co-composting, environmental risk factors, heavy metal accumulation, sustainable agriculture, soil amendment.

Acknowledgments: This research was supported by the project 'Preparation for the transition to a circular economy in the case of agricultural and green waste' of the Environment and Energy Efficiency Operational Program grant scheme of the Ministry of Technology and Industry Hungary under grant no.: KEHOP-3.2.1-15-2021-00037.

**EFFECT OF RESORCINOL ADMINISTRATION ON MOTILITY PARAMETERS
AND MORPHOLOGY OF RABBIT SPERM *IN VIVO***

Zemanová J.*¹, Massányi P.¹, Ondruška L.²

¹*Institute of Applied Biology, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic*

²*Institute of Small Farm Animals, Research Institute for Animal Production Nitra, Hlohovecká 2, 951 41 Lužianky, Slovak Republic*

*krockovaj@uniag.sk

In present study we analysed the effect of resorcinol on motility and morphology of rabbit sperm *in vivo*. We created two groups of animals - control group (K, n=5) without the addition of resorcinol and group A (n=5), to which we applied the resorcinol solution intraperitoneally into the abdominal cavity at a dose of 25 mg of resorcinol per kilogram of body weight. We applied the second dose 5 days after the first dose. The resorcinol solution was prepared immediately before application by dissolving 1250 mg of resorcinol in 5 ml of physiological solution. The ejaculate was collected using an artificial vagina 3 times - before the application of the first dose, before the application of the second dose and 5 days after the application of the second dose. Motility and progressive motility of sperm we evaluated using CASA (Computer Assisted Semen Analyser) immediately after arrival at the laboratory. For morphological analysis of spermatozoa, we created microscopic preparations which were analysed at the magnification 500x. For each slide of rabbit semen at least 500 spermatozoa were evaluated and the percentage of pathological spermatozoa was recorded in three replications. Sperm motility significantly decreased in the K group during the experiment. Conversely, in experimental group A, motility increased from 53.61% at the beginning of the experiment to 86.40% at the end of the experiment. This difference was statistically significant ($p < 0.0001$). Similarly, the progressive motility in the K group decreased during the experiment and in the A group it increased again from 32.10% at the beginning of the experiment to 75.64% at the end of the experiment ($p < 0.0001$). Morphological analysis showed a very similar occurrence of morphologically changed sperm in both groups. The total number of morphologically changed spermatozoa was on average 9%, while the most represented change was knob-twisted flagellum. From these results it can be concluded that the administration of resorcinol intraperitoneal increases the motility and progressive motility of rabbit sperm however, it does not have a significant effect on the percentage of morphologically altered sperm.

Keywords: rabbit, spermatozoa, CASA, resorcinol

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ENERGY ANALYSIS OF REFRIGERATION CYCLES IN THE FOOD INDUSTRY

Hermanucz P.^{*1}, Herzallah L.¹, Korzenszky P.²

¹ *Department of Building Engineering and Energetics, Institute of Technology*

² *Department of Farm and Food Machinery, Institute of Technology*

^{1,2} *Hungarian University of Agriculture and Life Sciences, Gödöllő Hungary.*

^{*} hermanucz.peter@uni-mate.hu

Refrigeration is vital in the food industry because it preserves perishable products, inhibits bacterial growth, and maintains food quality and safety. This technology extends shelf life, reduces food waste, and ensures that consumers receive safe and fresh products, all of which are critical aspects of the food supply chain. To achieve these cooling processes, different types of cooling systems are used. Their operation not only has a significant impact on food quality, but also plays a significant role from an energy and environmental point of view. The energetics of cooling circuits are crucial because they directly impact energy efficiency and operating costs in refrigeration systems. Understanding and optimizing these energetics help reduce energy consumption, lower greenhouse gas emissions, and improve the sustainability of cooling processes, aligning with environmental and economic goals. In the food industry, various types of refrigerators are employed to cater to different needs. These include walk-in coolers and freezers for large-scale storage, reach-in refrigerators for easy access, blast freezers for rapid cooling, and display refrigerators to showcase products. The choice depends on specific requirements and product characteristics.

In this paper, we investigate the widely used compressor refrigeration system. Our aim is to investigate the energetics of a system with two compressors, so that the cooling power can be controlled simply by switching the compressors on and off, rather than using the modern technology of a frequency converter. The evaporating and condensing pressures of the system are the same as those used in standard refrigerators in the food industry. During the test, we measured the electrical power absorbed by the compressor and the thermal power absorbed by the evaporator, as well as the heat dissipation through the condenser. From the measurement results we determined the coefficient of performance (COP) of the system both when one compressor was running and when two compressors were running.

The results showed unexpected variations in cooling performance and hence coefficient of performance. It can be concluded that in certain operating conditions, the use of modern compressors with variable frequency drives would be significantly more favourable. Naturally, this will require further changes and improvements in the cooling system.

Keywords: refrigeration cycle, COP, energy efficiency

**EFFECT OF IRRIGATION METHODS ON ARSENIC CONCENTRATION OF RICE CROP**Szalóki T.^{*1}, Székely Á.¹, Tarnawa Á.², Jancsó M.¹¹*Hungarian University of Agriculture and Life Sciences, Institute of Environmental Sciences, Research Centre for Irrigation and Water Management, Szarvas, Hungary*²*Hungarian University of Agriculture and Life Sciences, Institute of Agronomy, Gödöllő, Hungary** szaloki.timea.palma@uni-mate.hu

In Hungary, rice is a unique crop of agricultural production with a wetland agroecosystem and a high percentage of organic cultivation. Rice production provides valuable food products, but because of the tightening food safety regulations, farmers and thus the breeders in the whole of Europe are facing an increasing need to prevent or limit arsenic accumulation in the rice plants with different methods (e.g. development of new technologies, selection of genotypes). Recommended maximum level (MLs) for inorganic arsenic (iAs) in white rice is 0.20 mg.kg⁻¹, in parboiled rice and husked rice 0.25 mg.kg⁻¹ and in rice destined for the production of food for infants and young children 0.10 mg.kg⁻¹ (FAO, 2016). Rice is mainly cultivated in flooded conditions worldwide, where the anaerobic circumstances make the arsenic uptake and transfer more accessible for plant roots, leading to excessive As accumulation in rice grain. In contrast, in aerobic treatments, the bioavailability of arsenic reduces dramatically.

The aim of this study was to compare the accumulation of arsenic in rice crops under two different irrigation methods. Samples were collected from the MATE ÖVKI Rice Research Station and the MATE ÖVKI Lysimeter Station of the Hungarian University of Agriculture and Life Sciences, Szarvas, in 2018. The yield of six rice genotypes ('Tünde', 'Karola', 'Janka', 'Dáma', 'M 488', 'Nembo') was investigated to evaluate the effect of flooded and sprinkler irrigation on arsenic accumulation in white and brown rice seeds, respectively. A Satake rice hulling machine (Japan) was used to prepare cargo rice, and half of the brown rice samples were made into white rice using a laboratory testing mill (Satake, Japan). The arsenic concentration of the seeds was analyzed by ICP-OES, in five repetitions. Basic mathematical analyses were calculated using Microsoft Excel. The collected data were subjected to the analysis of variance (ANOVA) using IBM SPSS Statistics software (version 22.0).

Among the genotypes, no significant differences were found. However, the irrigation method and the seed processing steps showed remarkable effects on arsenic accumulation. Significantly higher arsenic concentration was detected in flooded conditions than in aerobic conditions. The highest value (0.24 ± 0.02 mg.kg⁻¹) in brown rice of 'M 488' was measured under flooded irrigation. The arsenic concentration was lower in polished seeds than in brown rice in all cases. However, the differences were significant only in case of 'Dáma' and 'M 488'. The lowest arsenic content was detected in polished seeds of 'Tünde' under sprinkler irrigation (0.06 ± 0.04 mg.kg⁻¹). The results show that the anaerobic condition can facilitate the mobilization of arsenic into the soil solution, making it more available for uptake by rice. Therefore, water management strategies may decrease arsenic accumulation in rice plants. The accumulation of arsenic is higher in the outer parts of the seeds (bran and germ), so the arsenic content of rice grains can be reduced by removing the seed coat and the germ.

Keywords: arsenic accumulation, water management, rice seed

Acknowledgments: The research was financially supported by the Hungarian Ministry of Agriculture



AGRICULTURAL WASTE AND BY-PRODUCT COMPOSTING AT PROFIKOMP INC.

Fekete Gy.^{*1}, Varga Zs.¹, Aleksza L.¹

¹ *ProfiKomp® Environmental Technologies Inc., Gödöllő, Hungary, Kühne Ede str. 7.*

^{*} fekete.gyorgy@profikomp.hu

Based on data from the European Compost Network e.V. (ECN) in 2019, a survey covering 18 European countries with a population of 407 million showed that out of the annual 208 million tons of municipal solid waste, 47.5 million tons of bio-waste were separately collected and processed in composting or biogas plants. This translates to approximately 117 kg per person per year. In the 18 countries providing this data, a total of 3,403 composting plants are in operation, processing 30.5 million tons of bio-waste.

The ProfiKomp® group has been providing closed and aerated, bio-waste treatment technologies with measuring and control system and semi-permeable membrane covers since 2000. The company has now implemented nearly a hundred bio-waste treatment facilities in 18 countries worldwide, including Hungary, Europe, and several Asian countries. The engineers of the company can tailor and optimize the selected treatment technology to meet the unique requirements of the client, choosing from a wide range of technological solutions. The design of membrane-covered composters ranges from simplified covered windrow units to silo with side-walls solutions and even to the own-developed ProfiKomp® Lifting System, which, through a specially designed lifting device, guarantee odourless operation and offers a significantly longer lifespan for the cover material at favourable costs compared to other technologies at composting industry.

The company manages various types of raw materials at its numerous composting plants, ranging from green waste to various types of animal manure and sewage sludge. In addition, the company has experience in composting special food waste: since 2018, it has been involved in the composting of bio-waste collected separately at festivals and other events, including biopolymers that replace single-use plastics. In 2019, for such a collaborative project, the Sziget Festival won first place in the A Greener Festival Greener Innovations category. In addition, the company was one of the first in the world to carry out the composting of industrial-scale biopolymers in a joint research project with the Hungarian University of Agriculture and Life Sciences, where the company's researchers successfully composted 70,000 kg of production waste of compostable bag.

From these raw materials, valuable compost products with high organic matter content are obtained at the end of the treatment process. These compost products enhance soil water retention, improve soil structure, nutrient-supplying capacity, and stimulate soil life. Thus, more resilient plants are cultivated with less irrigation water, fertilizers, and pesticides. ProfiKomp® also owns composting plants where high-quality compost can be produced in pelletized form, which can be applied to agricultural lands using fertilizer spreaders.

Keywords: composting, agricultural waste, product, biowaste



THE ROLE OF INSECTS IN WASTE MANAGEMENT AND THEIR IMPACT ON THE FOOD CHAIN

Pintér R.^{*1}, Fekete Gy.¹, Aleksza L.¹

¹ *ProfiKomp® Environmental Technologies Inc., Gödöllő, Hungary, Kühne Ede str. 7.*

^{*} pinter.richard@profikomp.hu

The challenge of feeding over 9 billion humans by 2050 requires ‘rethinking’ the current linear nutrient production system. In the view of a circular economy, insects can provide a possible solution to valorize waste to produce new feeds, foods, and materials, as well as the opportunity to solve some environmental problems. ProfiKomp® Environmental Technologies Inc. has set itself the goal of combining high-level composting and circular economic knowledge with the potential of insects. During the research and development, the company examines the breeding parameters of different insect species. During the development of breeding technology, in addition to the impact assessment of different environmental conditions (temperature, humidity, ventilation), the company examines the extent of utilization of different organic matter mixtures at different stages of insect development. The classification, selection and pre-treatment of organic waste is key to its ideal integration into insect farming. However, it is essential that organic by-products from insect breeding (eg insect frass and dead insects) are properly recycled. Another significant possibility is that; insect-derived materials can not only be used as a source of nutrients, but can also serve as a significant source of raw materials for other industries. The aim of this study was to evaluate the effect of different temperature for *Tenebrio molitor* larvae growing rate. The insect larvae were kept in 24, 26, 28, 30, 32°C and investigated the weight and the mortality of the larvae through 60 days. The ideal rearing temperature was 28°C, and the study then focused on how different by-products and waste affect the growth of the larvae at this temperature. The ideal rearing temperature was 28°C, and the study then focused on how different by-products and waste affect the growth of the larvae at this temperature. Based on the results, it can be said that insect biomass can be produced with high efficiency in a suitable housing environment with grain-based by-products. In this way, insects can not only be used to safely handle food by-products, but proteins and fats extracted from them can also be returned to the food chain as raw materials, promoting circular economy in agriculture. However, this is still an industry in its infancy. Because of this, it presents many challenges. During the presentation, we will provide an insight into the difficulties and further opportunities of insect breeding for the food industry.

Keywords: *Tenebrio molitor*, insect rearing, biowaste

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**EFFECT OF BEE BREAD ON REDUCED GLUTATHIONE CONCENTRATION IN THE LIVER OF ZUCKER DIABETIC FATTY (ZDF) RATS.**

Goc Z.^{*1}, Kapusta E.¹, Greń A.¹, Muchacka R.¹, Formicki G.¹, Kalafova A.², Capcarová M.², Schneidgenová M.², Massányi P.²

¹*Department of Animal Physiology, Faculty of Exact and Natural Sciences of the Pedagogical University of Krakow, Podchorążych 2, 30 084 Cracow, Poland*

²*Department of Animal Physiology, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic*

*zofia.goc@up.krakow.com

Available bee products are very popular due to their healing properties and are used in the treatment of many diseases, including type 2 diabetes (DM2T), which has become a pandemic disease. The most popular bee products, whose health properties have been scientifically proven, are: honey, pollen and propolis. However, there are few reports on the healing properties of bee bread. The aim of this study was to analyse the effect of bee bread on reduced glutathione concentration in the liver of Zucker diabetic fatty (ZDF) rats (obese, type 2 diabetes research model). Male ZDF rats (diabetic, n = 20) and their lean controls (non-diabetic, n = 20) in the age of 3 months were used in the experiment. Animals were provided with water and diet on ad libitum base. Rats were divided into four groups as follows: lean untreated rats (I), lean rats bee bread treated (II, bee bread in a dose 700 mg kg⁻¹ of body weight daily using sterile oral rodent gavage), obese diabetic rats without any additives (III, given distilled water daily using sterile oral rodent gavage) and obese diabetic rats bee bread group (IV, bee bread in a dose 700 mg kg⁻¹ of body weight daily using sterile oral rodent gavage). During the study, it was found that the concentration of reduced glutathione in the course of diabetes is significantly reduced. However, the conducted research confirms the antioxidant properties of bee bread, which activates mechanisms that stimulate the synthesis of reduced glutathione. The subjects should be continued in terms of other parameters interfering with the course of the metabolic disease.

Keywords: reduced glutathione, bee bread, diabetes, rat



ONLINE MARKETPLACE AS A TOOL FOR EFFECTIVE FARMER COOPERATION IN SUPPLY CHAIN MANAGEMENT

Magó L.*¹

¹*Department of Engineering Management, Institute of Technology, Hungarian University of
Agriculture and Life Sciences, Gödöllő, Hungary*

* Mago.Laszlo@uni-mate.hu

Agricultural production is largely carried out by small and medium-sized enterprises and farmers. These enterprises and farmers can accomplish concentration necessary for obtainment of market advantages very hard. Therefore, such a system is necessary, which can coordinate and keep in touch with producers and is self-assertive in an effective way.

Aim of the research work is to introduce a model, which provides effective solutions and support for establishment of the agricultural input and output market systems. Input used in agriculture are mostly technical systems, chemical materials and biological products. The output are the crops, livestock products and energy.

Consequently, profit of agriculture is extremely low and production enlargement is not possible. Possibility to change this situation can be the online marketplace, which can be created at the input or/and output side. These fields could improve procurement and distribution conditions of agriculture and imply chances to enlarge production through better profit.

By using the online marketplace, it will be the producers on the first place who will have advantages since their agriculture can be planned in an easier way and can be transparent. Besides the faster information flow, they can achieve decrease in their cost. Quality assurance and standardization guarantee utility and marketing of quality products.

By inducing this system, cooperation among producers will be fostered. Creation of common utility forms of machines and machine types can increase efficiency regarding machine procurement and utilisation of machines. Cooperational solutions foster use of results achieved due to modern technological solutions. Apart from production devices, access to financial assets can be improved. The method how to obtain market information can be developed, as well. Also, common logistical solutions could be improved.

Besides producers and distributors, the system provides advantages also for the government, authorities, experts and other participants of the R+D+I market.

A field informatics system can be accomplished by which we could get an exact picture and data about utility and time-quality-quantity features of inputs. Collection of data can be provided for the supportive market forecast systems (estimation of production on the basis of structure of inputs and products). It can contribute to optimization of the national and the EU subsidies. Structure of costs and marketing can be monitored at traders and producers implied in the system.

Keywords: farmers cooperation, online-marketplace, procurement, distribution, price competitions

**NUTRACEUTICAL DIETARY BENEFITS
ON GROWING-RABBIT MEAT COMPOSITION.**Vizzarri F.^{*1}, Tirpak F.², Bucko O.³, Ondruska L.¹¹National Agricultural and Food Centre, Department of Nutrition and Small Farm Animals,
Hlohovecká 2, 951 41 Lužianky, Slovak Republic²University of Missouri, Division of Animal Sciences, Columbia, MO, 65211, USA³Slovak University of Agriculture in Nitra, Institute of Animal Husbandry, Faculty
of Agrobiological and Food Resources, Nitra, Slovak Republic*francesco.vizzarri@nppc.sk

Sustainable nutritional strategies able to support animal health and enhance animal productivity are required. In recent years, herbs and spices containing polyphenols have been investigated as feed supplements to improve rabbit welfare, boost productive performances, and enhance the quality of animal products. The aim of the present work was to investigate the effect of *Chlorella* algae (*Chlorella vulgaris*) and bay leaves (*Laurus nobilis*) on meat chemical composition in intensively reared growing rabbits. The first is considered a mini factory, synthesizing important metabolites and nutrients (mainly polyunsaturated fatty acids). The second presents high levels of nutritional support due to the content of proteins, free sugars, organic acids, polyunsaturated fatty acids, and tocopherols together with antioxidant activity, such as scavenging activity, reducing power and lipid peroxidation inhibition. One hundred White New Zealand growing rabbits (35 days old, and 1150 g as average body weight) were enrolled at the National Agricultural and Food Centre (Lužianky, Slovak Republic), and were divided into four experimental groups: the first control group (CON) received a commercial pellet-diet; experimental CHL group received the same diet supplemented with 0.1% of dried *Chlorella* algae powder; experimental LAU group received control diet supplemented with 0.1% of dried bay leaves powder; experimental MIX group received control diet supplemented with a mixture of the same doses of both nutraceutical dried feed additives. After 42 days of the experiment, rabbits were slaughtered and *Longissimus dorsi* muscle were collected from 10 animals per treatment. Determination of the chemical composition of rabbit meat was realized with Nicolet 6700 by FT-IR method (Fourier transformed infrared spectroscopy). Data were processed with one-way analysis of variance (ANOVA), with the dietary treatment as source of variation. The dietary strategy using *Chlorella* algae has determined in rabbit meat a significant reduction in fat amount (0.41 vs 0.66 vs 0.59 vs 0.65 g.100g⁻¹ raw meat, CHL, LAU, MIX and CON, respectively), when compared with other studied groups. Other parameters, such as protein, moisture, and cholesterol contents did not show any differences between groups, reporting average values of 25.58 g.100g⁻¹, 70.66 g.100g⁻¹ and 0.35 g.kg⁻¹, respectively. These preliminary data show the positive effect of nutraceuticals in rabbit nutrition, in particular *Chlorella* algae, for the production of healthier meat with a reduced content of fat. In addition, these results strengthen the concept of rabbit as health-giving meat, a quality already widely appreciated by the consumer.

Keywords: *Laurus nobilis*, *Chlorella vulgaris*, food chain, rabbit meat



INVESTIGATION OF INDOOR AIR QUALITY IN A FOOD STORAGE AREA OF A MILITARY CAMP.

Patonai Z.^{*1}, Barczy A.², Géczi G.²

¹ Ministry of Defence, Defence Economy Bureau

² Department of Environmental Analysis and Environmental Technology, Institute of Environmental Sciences, Hungarian University of Agriculture and Life Sciences, 2100, Páter Károly utca 1, Gödöllő, Hungary

* patonaizoltan77@gmail.com

The aim of our research is to investigate indoor air quality in the military camp kitchen complex and food storage facilities. In this study, we present an investigation of indoor air quality in fruit and vegetable storage, focusing specifically on carbon dioxide (CO₂) concentrations, the risen level may threat human health, but can have a positive effect on the shelf life of fruit and vegetables.

Our first measurements were made to assess the CO₂ concentration variation in the indoor environment of a fruit and vegetable storage in the kitchen of an active military camp. The measurements were continued under laboratory conditions, modelling storage over several days (3-4 days). Finally, observations were made by modelling the respiration of a large quantity (2.5 t) of apples. In longer-term storage (3-4 days), when 600 kg of apples are stored, CO₂ concentrations of up to 1100 ppm can be measured, which has a positive effect on fruit storage. Modelling the storage of 2500 kg Idared apples, CO₂ concentrations varying between 4000 ppm and 1500 ppm were measured. It was found that this value (*between 3000 and 5000 ppm based on literature*) would be expected for fruit storage and that the natural filtration of an ISO storage container building at rest is strongly influenced by external environmental effects.

Indoor carbon dioxide concentrations can be described by mathematical models, determining the indoor air point source, the outdoor fresh air concentration and the indoor ventilation air flow rate. Therefore, we observed the external environmental effects (temperature, atmospheric pressure, wind speed) that are relevant for the variation of the interior characteristics. Finally, a multiple linear regression model was constructed to simulate the variation of storage conditions, which provides a good (90%<) estimate of the evolving internal CO₂ concentration.

Keywords: fruit, carbon dioxide, temporary facility, Military DFAC



IMPACT OF POST-HARVEST COLD STORAGE ON ETHYLENE AND CO₂ EMISSIONS FROM GOLDEN DELICIOUS APPLES

Kassebi S.^{*1}, Korzenszky P.²

¹*Doctoral School of Mechanical Engineering*

²*Department of Farm and Food Machinery, Institute of Technology*

^{1,2}*Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.*

* kassebi.salma@phd.uni-mate.hu

This study aimed to evaluate the production of ethylene and CO₂ for Golden Delicious apples stored at (3±1°C; 90RH%) for 13 weeks. The production of ethylene gas was measured using Dräger handheld ethylene gas detector. The production of CO₂ gas was measured using a handheld gas detector and AHLBORN ALMEMO data logger. Before ethylene and CO₂ production measurement, one apple was placed in a 2L hermetically closed plastic container. The measurements were repeated three times, and the results were reported in ppm. Under the 3°C cold storage, the ethylene release increased slowly. It reached the first peak value of 40.5 ppm after seven weeks of storage and the second peak value of 17 ppm after 11 weeks of storage, respectively. Then, it gradually diminished and maintained a low level. These results showed that ethylene production was significantly reduced by cold storage. The post-ripening impact of apple fruit is dramatically delayed because low temperatures may significantly inhibit the release of ethylene. The respiration rate of apples, as a typical respiratory climacteric fruit, is significantly influenced by the physiological state of the apple. After seven weeks, the peak respiratory rate attained its first peak value of 4378 ppm and its second peak value of 2587 ppm after twelve weeks of storage. The fruits' respiration rate was dramatically lowered during cold storage at 3°C and progressively increased following storage. The results showed that low-temperature storage pushed back apple respiration peak value considerably. From these results, it can be concluded that storage temperature and duration had distinct effects on the physiological metabolism of ethylene and respiration in apple fruit.

Keywords: Golden Delicious Apples, storage, ethylene, CO₂, cold storage

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SOLAR ENERGY AND BIOGAS UTILIZATION FOR THE DEVELOPMENT OF SCALABLE CO-GENERATION POWER PLANTS

Korzenszky P.^{*1}, Bártfai Z.¹, Seres I.², Víg P.², Bércesi G.³, Szalay K.³, Gárdonyi P.³, Kurják Z.⁴, Magó L.⁵

¹Department of Farm and Food Machinery, Institute of Technology,

²Institute of Mathematics and Basic Science,

³Agricultural Engineering Laboratory, Institute of Technology,

⁴Department of Building Engineering and Energetics Institute of Technology,

⁵Department of Engineering Management, Institute of Technology,

^{1,2,3,4,5}Hungarian University of Agriculture and Life Sciences, Gödöllő, Hungary.

* korzenszky.peter.emod@uni-mate.hu

In this paper, we present the research results related to the project "Development and implementation of a scalable co-generation power plant solution integrating solar energy and biomass utilisation". Our objective is to develop an integrated solution in the field of local renewable and sustainable energy production, storage and use, where solar energy collected by PV/T collector, hydrogen and oxygen gas production by water decomposition, and biogas production by biomass utilisation are integrated in an innovative process, in different scales (scalable), to produce a compact device, which stores solar energy in the form of combustible gas in a container. Members of our research team are working on different areas of tasks to achieve this goal. This article reviews the results of the first phase of this work, which involved a literature review and a groundwork.

Keywords: solar panel, solar collector, water purification, biogas components, gas mixture

Acknowledgments: The project is implemented with the support of the call for tenders for INCENTIVES OF CORPORATE RESEARCH, DEVELOPMENT AND INNOVATION ACTIVITIES (GINOP_PLUSZ-2.1.1-21) announced within the framework of the Széchenyi Terv Plusz program („Széchenyi” Plan Plusz programme), within the framework of the Economic Development and Innovation Operational Programme Plus (GINOP plusz). Thank you for the financial support. The title of the project: "Scalable cogeneration solution by integrating solar energy and biomass utilization". Project id. number: GINOP_PLUSZ-2.1.1-21-2022-00165

**EFFECTS OF ENVIRONMENTALLY FRIENDLY PLANT CONDITIONERS
ON YIELD AND GRAIN QUALITY OF WINTER WHEAT**

Tury R.^{*1}, Tóth Sz.Zs.², Lehoczky É.³, Láposi R.²

¹Department of Soil Science, Institute of Environmental Sciences,

Hungarian University of Agriculture and Life Sciences, Károly Róbert Campus, Gyöngyös

*²Institute of Agronomy, Hungarian University of Agriculture and Life Sciences, Károly Róbert
Campus, Gyöngyös*

*³Department of Environmental Sustainability, Institute of Environmental Sciences, Hungarian
University of Agriculture and Life Sciences, Georgikon Campus, Keszthely*

** tury.rita@uni-mate.hu*

At the agricultural research institute in Kompolt, we tested two environmentally friendly plant conditioners and examined their effect on the yield of winter wheat (Babona) and on the parameters determining the quality of wheat in 2021, in medium plot experiments (400 m²/plot). At the beginning of ear emergence, we measured the relative chlorophyll content (SPAD value) of the leaves and examined the reflectance of the leaves with the help of a portable spectroradiometer, from which spectral vegetation indices can be produced, and can be used to estimate the effect of the treatments on the chlorophyll, carotenoid, anthocyanin and water content of the leaves, and to draw conclusions from it to photochemical efficiency and plants' stress sensitivity. Based on the results, it can be said that the unfavorable rainfall distribution characteristic of the vegetation period greatly influenced productivity. Due to the lack of precipitation in spring, the development of the plants was weaker, the yield average remained below the national and county levels. The quality parameters also fell short of expectations, the protein and starch content were lower than the national average. However, despite unfavorable weather factors, we found that the 1st treatment resulted in a higher yield average, better quality, higher plant height and spike length compared to the control. At the beginning of ear emergence some spectral vegetation indices indicated the positive effect of the 1st treatment despite the drought: the chlorophyll content and photochemical activity of the leaves were higher, the stress sensitivity and the amount of protective pigments were lower compared to the control.

Keywords: environmentally friendly plant conditioners, quality of wheat, SPAD value, productivity



DETERMINATION OF THE THERMAL ENERGY DEMAND OF PIG FATTENING

Páger Sz.^{*1}, Földi L.², Géczi G.³

¹*Doctoral School of Mechanical Engineering*

²*Department of Farm and Food Machinery, Institute of Technology,*

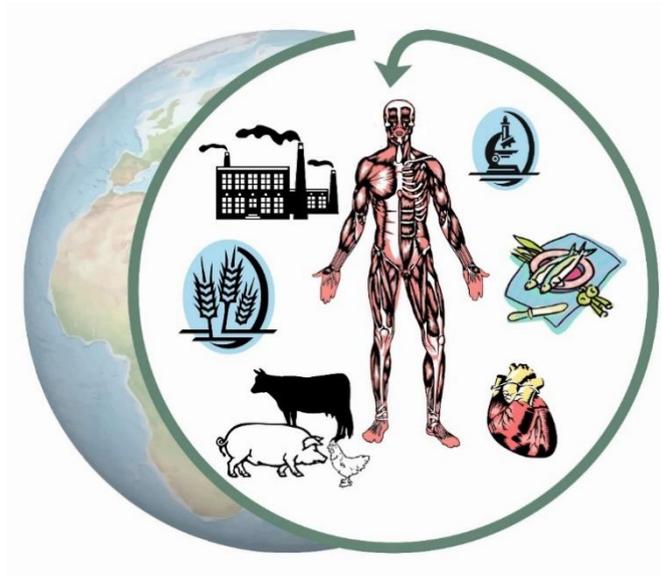
³*Department of Environmental Analysis and Environmental Technology, Institute of Environmental Sciences, Hungarian University of Agriculture and Life Sciences*

^{1,2,3}*Páter Károly utca 1, Gödöllő, Hungary 2100*

* szabolcs.pager@gmail.com

The quality of the food consumed is one of the keystones of a healthy diet. Pork has traditionally been a major source of meat consumption in Hungary; high in protein and vitamins, it is an essential source of protein. Ensuring the proper microclimate is essential to produce pork of high quality. In contrast to conventional facility management, where a wide range of tests are available for various comfort parameters, it is also possible to measure comfort using various PMV and PPD methods. In the case of pig farming, the only indicator of an adequate microclimate is the proper development of the stock. The main parameters are temperature, humidity and airborne pollutants (CO₂, ammonia, etc). For pig farms, it is therefore a matter of optimisation to provide the appropriate microclimate at low operating costs. Among the comfort parameters, the internal design temperature and air exchange were analysed, considering the requirements of the particular lifetime as well as the heat dissipation of the animals.

Keywords: comfort, pig farming, pork, optimisation, air exchange





INDEX

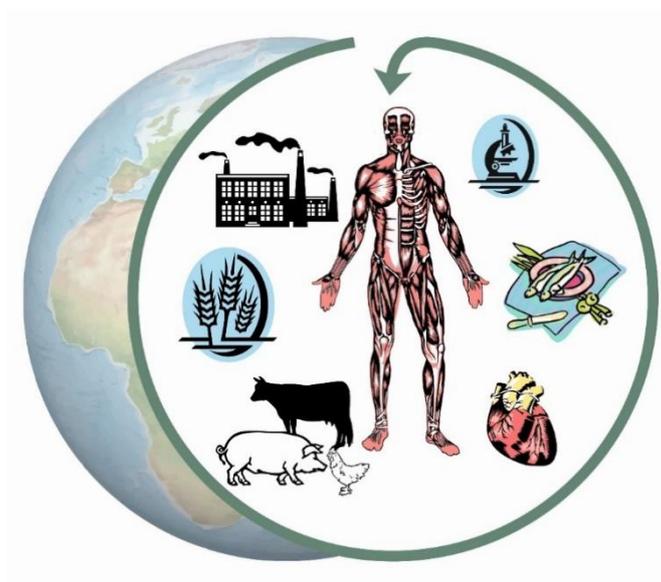
A		Földi L.	59
Albrycht M.	25	Fuchs M.	44
Aleksza L.	28, 50, 51	G	
B		Gajdošová D.	21
Barczy A.	20, 55	Gárdonyi P.	57
Bártfai Z.	57	Géczi G.	19, 20, 23, 43, 59
Bažány D.	17, 29, 32, 36	Gémes B.	27
Bažok R.	27	Ghabour R.	45
Benécs J.	43	Goc Z.	18, 52
Bércesi G.	57	Grabacka M.	33
Béres A.	43	Greifová H.	17, 29, 32, 36
Binkowski Ł.J.	25	Greń A.	18, 52
Birkás M.	41	Grzegorzewska A.K.	22
Bistáková J	17	H	
Bouzghiba H.	23	Hasna S.	26
Bóday Á.J.	16	Hermanucz P.	26, 48
Bucko O.	54	Herzallah L.	48
Bulla J.	21	Hrabia A.	22, 31
C		J	
Capcarová M.	21, 33, 36, 52	Jambor T.	17, 29, 32, 36
Czerniecka-Kubicka A.	30	Jancsó M.	49
Cs		K	
Csorba Á.	19	Kalafova A.	52
D		Kapusta E.	18, 52
Dekemati I.	41	Kardos L.	46
Döbröntey R.	44	Karpl A.	25
Džugan M.	30, 34	Kassebi S.	56
F		Katarzyńska-Banasik D.	22, 35
Farkasová S.	33, 37	Keleti J.R.	19, 41, 44
Fekete Gy.	50, 51	Klátyik Sz.	27, 42
Fialková V.	33, 38	Klongová L.	33, 38
Formicki G.	18, 52	Koppány Gy.	13



Korzenszky E.	14	Q	
Korzenszky P.	26, 45, 48, 56, 57	Qor-el-aïne A.	43
Kováčik J.	21	R	
Kovár M.	38	Richter G.	27
Kowalik K.	22, 31, 35	Rodriguez Fernandez V.	40
Kozubek A.	22, 35	S	
Kramarič M.	27	Schneidgenová M..	52
Kurek M.	25	Sechman A.	22, 31, 35
Kurják Z.	57	Seres I.	57
L		Sidor E.	30
Láposi R.	58	Silva L.R.B.	46
Lehoczky É.	58	Simon B.	19, 41, 44
Lisowska-Lis A.	24	Sipos E.	46
Lukáč N.	17, 29, 32, 36	Speváková I.	33, 38
M		Štefunková N.	17, 29, 32, 36
Magó L.	53, 57	Stolz M.	27
Massányi P.	17, 21, 32, 47, 52	Sz	
Michéli E.	19, 44	Szalay K.	57
Mílek M.	30, 34	Szalóki T.	49
Modiba M.M.	41	Szegi T.	44
Mörtl M.	27, 42	Székács A.	15, 27, 42
Muchacka R.	18, 52	Székely Á.	49
N		T	
Navrátilová A.	38	Takács E.	27, 42
O		Tarnawa Á.	49
Ocansey C.M.	19, 41, 44	Tharwat M.I.H.	41
Ondruška E.	47, 54	Tirpák F.	54
P		Tokárová K.	17, 29, 36
Piaggi S..	40	Tomczyk M.	30
Patonai Z.	55	Tóth Sz.Zs.	58
Páger Sz.	59	Tury R.	58
Pintér R.	51	Tutor L.	20
Pinto B.	40	U	
Potysz A.	25	Urban L.	32
Požgajová M.	38	Urbanová L.	33, 39



V		Z	
Varga Zs.	50	Zemanová J.	47
Víg P.	57	Žiarovská J.	37, 39
Vizzarri F.	54	Zuščíková L.	32
W			
Wiśniowska I.	26		
Wolak D.	31		



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