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Edible packaging and hydrogen buses. What has Slovak science been up to?

Slovak scientists are tackling current issues.

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Scientists around the world are making the effort to answer the biggest challenges faced by humankind in the 21st century – and Slovak science is part of it.

The Slovak Spectator asked Slovak scientists about their research and how it can contribute to society. In this overview of the successes of Slovak science, you will find what progress they made.

This overview of the successes of Slovak science will be compiled regularly. To stay up to date with what scientists in Slovakia or Slovak scientists around the world are doing, subscribe to the Slovak Science newsletter, which will be sent to readers free of charge four times a year.

Ingredients: meat, packaging. Add both, bring to a boil

Waste, waste, waste. The huge amount of waste not just from food is a global problem. Waste produced by humans has been found even in the most extreme environments such as Antarctica or even at the bottom of the nearly 11 km deep Mariana Trench. Plastic has found its way into our food. Imagine then, if you could one day buy meat in a grocery store, cut the packaging into noodles and cook them with the meat.

Scientist Miroslava Kačániová from the Slovak University of Agriculture in Nitra is developing such packaging in cooperation with a fellow scientist from Minsk, Belarus. They aim to create a new material based on starch, edible polymers, and plant additives. Packaging made from this material should not only be biodegradable, but sustain the longevity of the meat as well.

The idea is to make use of the antimicrobial effects of extracts from herbs such as sage and lemongrass, or even apple or grapefruit juice. The edible packaging could be used not just for meat, but could be specially designed for other foods to complement the taste.

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How to fight antibiotic resistance

Antibiotics are an important pillar of modern medicine and essential to treating many bacterial infections. However, more and more bacteria are gaining resistance to antibiotics, which poses a major threat to public health. Antibiotics have little to no effect on resistant

microorganisms, resulting in prolonged hospital stays, higher mortality, and subsequently higher health care costs.

Research continues searching for ways to overcome antibiotic resistance. A team led by Josef Jampílek at the Department of Analytical Chemistry of the Faculty of Natural Sciences at Comenius University in Bratislava set out to create new small molecules based on cinnamic acid. The molecules they design target the most common resistant bacteria in the world such as *Staphylococcus aureus* (causing skin, bone, or joint infections), *Enterococcu*s (causing urinary infections, for example), and *Mycobacterium tuberculosis* (causing the eponymous infection).

According to their research, the compounds demonstrate a hundredfold higher potency against resistant bacterial strains compared to commonly used antibiotics. Moreover, as their effect is applied in various mechanisms, bacteria find it extremely difficult to develop further resistance.

The developed compounds are not toxic to humans and their nature allows for their inclusion in medicine for both general and topical use. Furthermore, they are proven to possess an anti-inflammatory effect as inflammation often occurs at the infection site.

World leading expertise in honey

Although mostly used as a delicious sweetener, honey has a lot more to offer. The substance has an added value in the form of antibacterial activity. As such it can be used in the treatment of various ailments, such as gastritis or cold sores, to reduce the symptoms of upper respiratory tract infections, or even applied directly to the skin to treat wounds or burns.

Scientists from the Institute of Molecular Biology of Slovak Academy of Sciences have spent years researching honey and its properties, their laboratory among the leading ones not only in Europe, but in the world as well. Now they are the first in the EU to develop a method to assess the antibacterial properties of the delicious substance. The test can be used to determine whether a particular honey has the highest possible antibacterial potential, thus serving as food with a positive effect beyond the provision of nutrients.

As mentioned in the previous section, we are facing a problem in the form of antibiotic resistance. In this regard, the benefit of honey is that its antibacterial activity comes in many mechanisms, not just one as with regular antibiotics. So far, bacteria have not developed a resistance to honey. And even if they managed to do so against one mechanism, there are still more.

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A unique solution for hydrogen buses

Hydrogen is a clean, zero-carbon fuel that can power vehicles such as cars, buses, or even trains. Current Economy Minister Richard Sulík is a proponent of technologies based on hydrogen. His ministry came up with an action plan outlining where the support money should go. The idea is to create an infrastructure made up of thousands of cars, hundreds of buses, and even trains.

Slovak company Rošero-P, in cooperation with scientists from the Technical University of Košice led by Tomáš Brestovič, are developing the very first Slovak low pressure hydrogen bus. Their project is focused on a unique method of hydrogen storage. Usually, the gas is difficult to store in either a high pressure tank or cryogenic tank. However, there is a different way currently being researched and developed, involving metal hydrides. These are materials containing metal bonded to hydrogen under pressure. Slovak scientist have gone about it in this manner.

This method requires a specially designed thermoregulation, as the storage process goes hand in hand with heat emissions. Scientists have devised a special heat exchanger that allows a more effective way of heat distribution in the alloy, thus shortening the time necessary for refuelling.

A prototype of a certified metal hydride tank allows the storage of hydrogen under 30-times lower pressure compared to ordinary high pressure tanks, making the whole system much safer. These tanks have been used in a hydrogen bus prototype presented at the Expo 2020 Dubai.

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Overview of other research and development activities in universities:

- **Nanodi disinfection device design; Slovak University of Technology in Bratislava; lead scientist Michala Lipková.** Nanodi devices represent an ecological alternative to chemical disinfectant products. They rely on diamond nanotechnologies to disinfect water and air, and are designed for public and indoor places with a high frequency of traffic. The design supports the circular economy and emphasizes long-term use in order to eliminate waste.
- **New effective and safe treatment for canine babesiosis; Slovak Academy of Sciences.** Canine babesiosis is a serious infection in dogs that can cause anaemia, and can potentially even threaten the animal's life. A few years ago, another parasite was detected, one leading to a more severe form of the disease. However, usual treatment did not have any effect. Scientists from the Institute of Parasitology and the University of Veterinary Medicine and Pharmacy in Košice developed a treatment that successfully eliminated the parasites. Read more.
- **Convection and phase change in dendritic zones; Comenius University in Bratislava; lead scientist Peter Guba.** The study presents the results of the mathematical modelling of complex physical processes, which affect the solidification of fluids that have implications not only for material science, but geophysics as well. The model offers insight into phenomena observation, which in the real world is a major challenge.
- **A new mineral was discovered in Slovakia; Slovak Academy of Sciences; lead scientist Martin Števko.** In recent years, several new minerals were first identified in Slovakia, the newest one being argentopolybasite, which occurs in Kremnica, Banská Bystrica Region. The discovery significantly improves our understanding of the group it belongs to. Read more.
- **A new biomaterial from Košice promises aid to patients with damaged facial bones; Slovak Academy of Sciences.** A team of scientists developed a new treatment in the form of ceramic plates and self-solidifying biocements. The material was tested and supports the stimulated healing of bones. Read more.
- **Future clean energy needs solid oxide fuel cells; Comenius University in Bratislava; lead scientist Muhammad Bilal Hanif.** This study offers a comprehensive review of perovskite-based materials for solid oxide fuel cells, devices that can potentially supply affordable and relatively clean energy. Such cells can generate electricity at lower prices than the commercial ones in the majority of the

world. SOFCs convert hydrogen, natural gas, or another fuel into electricity via an electrochemical process and emit fewer pollutants than conventional power plants.

- **SlovakION Scientific Research Center of Excellence for Materials and Interdisciplinary Research; Slovak University of Technology in Bratislava; lead scientist Róbert Riedlmajer.** The goal of the project is to create a sustainable research and development, innovation and institutional-management environment for the implementation of activities in the field of materials research, development of new materials, the latest diagnostic methods, simulations and modelling in materials engineering and properties.
- **The Best Philosophical Book of 2021; Slovak Academy of Sciences.** For the first time, an SAS employee has been among the winners of the prestigious international competition PROSE, which awards the best scholarly and scientific works. Jon Stewart from the Institute of Philosophy won for his book Hegel's Century: Alienation and Recognition in a Time of Revolution. Read more.
- **Neurobiology of cancer: Definition, historical overview and clinical implications; Comenius University in Bratislava; lead scientist Boris Mravec.** Neurobiological research into cancer has shown that adverse factors such as stress affect the formation and growth of tumor tissue and are mediated by both the nerves and the endocrine system. The reviews presents the basis of cancer neurobiology, describes recent advances in the field, such as research into the role of nervous system in various types of cancer, and suggests potential clinical implications for oncology.
- **Influence of nanoparticles on protozoa; Comenius University in Bratislava; lead scientist Josef Jampílek.** Parasitic protozoa lead to severe and often life-threatening diseases in animals and humans, such as malaria, sleeping sickness and other. Such diseases are called neglected, because their treatment is absent in the global agenda and little resources are directed to their research as they occur mainly in developing countries. Thus, there are insufficient modern and effective drugs against them. This pilot project studies the conversions of existing drugs into nanoscale dosage forms and materials, which upon such conversion acquire the ability to act against harmful and drug-resistant protozoa.
- **Research and development of a new PLASMABIT BHA plasma milling system; University of Žilina; lead scientist Pavol Rafajdus.** The main goal of the project is the research and development of a plasma milling system called PLASMABIT BHA, performing functional tests of the prototype, and later introducing the idea into the production process. The system is created with the aim of a more efficient, economical, safer, and above all more environmentally friendly way of closing exhausted oil and gas wells.
- **Demand-driven research for sustainable and innovative foods, Drive4SIFood; Slovak University of Agriculture in Nitra; lead scientists Lucia Gabríny and Klaudia Halászová.** The project is focused on research and development of innovative foods create conditions for sustainable health, especially vulnerable groups in population. In May, an important milestone was reached; a food incubator - a licensed space to produce food - was created. Such an incubator is unique in Slovakia.
- **Biomedical and Medical Informatics Training Center; University of Žilina; lead scientist Elena Zaitseva.** The goal of the project is to support education both in Slovakia and abroad, as well as develop subjects and courses focused on current progress in biomedical and medical informatics (BMI). Part of the project is an online BMI Center being set up in order to support the creation of and provision of interdisciplinary courses in BMI. This includes an environment fostering cooperation

between technical and medical universities and companies. The center is being created in cooperation with universities and companies from nine European countries.

- **Mobile robotic systems as support in crisis situations; University of Žilina; lead scientist Rastislav Pirník.** The main idea of the project is to connect the the knowledge of physical laws, information technology, artificial intelligence, and sensor techniques into principles and methods applicable in the development of mobile robots intended to support rescue workers in crisis situations. The intention is to define what data is necessary for collection, how precise the sensors should be, and what measuring principles should be taken into account based on the type ofsituation.
- **Light pollution as a factor in breast and prostate cancer; Comenius University in Bratislava; lead scientist Miroslav Kocifaj.** In 2021, a long-term research was concluded in Slovakia to find out whether there is an association between excessive light emissions at night and some types of cancer. The light emissions were recorded by satellites. Breast cancer incidence demonstrated a positive correlation with light pollution. A relation between prostate cancer and light pollution was not observed. To date, this is the first study to explore the effect of light pollution on cancer in Slovakia.
- **DOLORES.AI: Pandemic protection system; University of Žilina; lead scientist Patrik Kamencay.** The goal of the project is to design a system that, in critical virological situations, will automatically decide who is allowed entry. The main task of the system is to detect whether a person has put on a mask correctly, to take someone's temperature without making contact, and count the number of incoming and outgoing people at entrances or gates. The idea is to create a cheap and affordable system that even small businesses could afford.
- **Microbiocenosis study of dental biofilms in humans and dogs for the selection of oral probiotics; The University of Veterinary Medicine and Pharmacy in Košice; lead scientist Marián Maďar.** The project is based on new directions of possible use of probiotic bacteria and their substances in the treatment of oral diseases not only in humans, but also in veterinary medicine. The aim is to verify and study the effect of commercially available oral probiotics and to select new candidates for potential beneficial bacteria.

Other Slovak science stories on Spectator.sk

REPTILES NAMED AFTER IMPORTANT SLOVAKS: Paleontologist Andrej Čerňanský has named several fossils of prehistoric animals after important historical figures such as the outlaw Jánošík, or the politician and aviator Milan Rastislav Štefánik. His work changes our understanding of prehistoric times.

SLOVAK ASTRONOMERS: At the moment, the design of the European Solar Telescope is being finalized. When done, experts from the Astronomical Institute of the Slovak Academy of Sciences and their observatory at the top of Lomnický štít in the High Tatras will play an important role in the project.

MATERIAL PHYSICS: In an interview, ESET Science Award laureate Ján Dusza talks about the research of ceramics, the current trend in the field, and the achievements of Slovak scientists in the field.

FUSION POWER: The International Thermonuclear Experimental Reactor, or ITER for short, is an experimental reactor that will demonstrate if the idea of fusion power is viable and

test the necessary technologies. Learn more how the Slovak scientist helped in the construction.

BLACK HOLE: After years of indirect evidence, scientist have finally been able to catch a picture of the supermassive black hole in the centre of the Milky Way galaxy. Physicist Vladimír Balek explains what the image can tell us about the black hole itself and what we can learn in the future.

ARTIFICIAL INTELLIGENCE: In an interview, computer scientist Andrej Lúčny talks about how computers and robots see, how they learn, what is machine learning, and explains the basics behind the idea. In doing so, Lúčny also mentions how online translators do their job so quick.

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