USEFUL MICRO-ORGANISMS

Competence in microbiology in education, research and business

Photo: iStockphoto.com/anyalivanova

Microorganisms play a more important and more diverse role in nature than assumed until recently. New applications in agriculture, industry and medicine build on this knowledge. A globally unique concentration of competence in microbiology has formed at the Technopol Campus Tulln: research, education and entrepreneurial activities act together to better understand the interrelations and to utilise them commercially.

TECHNOPOL Campus Tulln

USEFUL LITTLE HELPERS

Microorganisms, in nature, agriculture and industry

Research into the interaction of microorganisms with higher forms of life has gained great momentum in the last ten to fifteen years: plant and animal organisms do not live on their own; many functions only become possible through interaction with bacteria or fungi. Interest has increasingly focused on synergies of microorganisms with higher plants due to potential applications in agriculture and industry.

Endophytes live within plants and make them more resistant to pathogens and environmental conditions. Microorganisms living in the root area of plants improve their supply with nutrients. Bacteria or fungi also benefit from the nutrients provided by fruit or leaves.

Using these "little helpers" as a biological alternative to chemical plant protection products is a highly topical field of research. Some of them directly attack pathogens with substances they produce or through parasitism, while others simply deprive them of their basic nutrients. Several products based on these effects have already been developed to market maturity.

Moreover, metabolites with a variety of useful properties (for example for applications in medicine) can also be found in microorganisms. If bacterial enzymes can be produced on a larger scale, their properties can also be utilised as environmentally friendly biocatalysts in industrial applications. ■

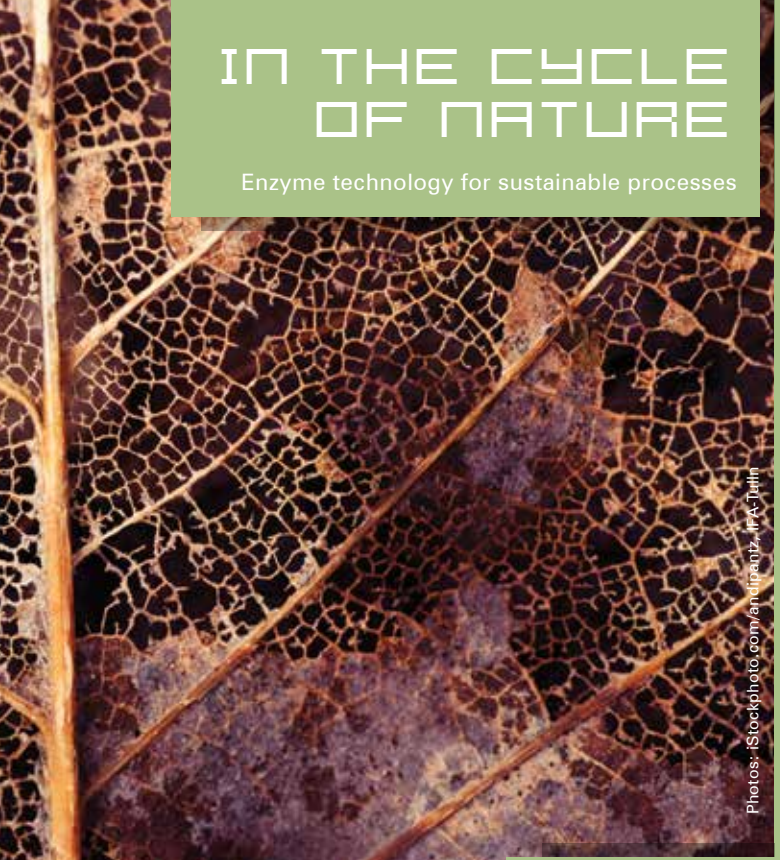
A nursery for young scientists

INFO

The bachelor and master study programme of the University of Applied Sciences Wiener Neustadt, Campus Tulln, also benefits from the competence of the Technopol Campus Tulln. Students learn how to conduct experiments independently in the laboratory and work with microorganisms that can carry out so many useful tasks for humans. As part of the master study programme, one of the specialisation courses offered is "Cell factory", which deals with optimising bacteria and yeasts for the use in industrial production processes. In the elective module "Environmental technology", the focus lies on the ability of microorganisms to reduce contaminants and produce energy.

IN THE CYCLE OF NATURE

Enzyme technology for sustainable processes



Photos: iStockphoto.com/andipantz, IFA-Tulln

In research at the institutes of the University of Natural Resources and Life Sciences (BOKU) at Campus Tulln, the entire cycle of biological resources is examined: sustainable soil quality leads to valuable plant raw material, which in turn can be used for the production of food, materials, chemicals and energy. In order to close the cycle, however, the utilisation of residues must have as little negative impact on the soil, water and air as possible – an issue to which the Institute for Environmental Biotechnology of the BOKU Department IFA-Tulln has dedicated its activities.

Georg Gübitz, Head of the Institute, focuses on microorganisms and their enzymes, which are to be used for this purpose, in his scientific studies. His working group studies the mechanisms of enzyme-catalysed reactions, optimises the structure of enzymes and then produces them biotechnologically. One field of application is the processing and enhancement of polymers of biological or synthetic origin, which can be equipped with additional (antimicrobial, biocompatible) functions through special enzymes. Great potential for application also lies in efficient degradation of biomass (e.g. lignocellulose) under environmentally friendly conditions. This is a key prerequisite for the production of bioenergy, where enzymes also play an important role (working group Bochmann). The potential of microorganisms for water and soil remediation is studied in the working groups Fuchs and Loibner. ■

www.ifa-tulln.ac.at

"Microorganisms can help remove contaminants from soil, water and air."

Univ.-Prof. Dr. Georg Gübitz,
Head of the Institute for Environmental Biotechnology, IFA-Tulln

PLANTS AND THEIR COHABITANTS

Advantages of symbiosis

Certain types of bacteria and fungi (called endophytes) live within plants. Endophytes are not parasites. On the contrary, they fulfil a variety of useful functions: they can enhance the host plant's growth and make it more resistant to diseases and environmental conditions. "We have learned more and more that a plant does not function on its own, but rather together with an associated microflora", explains Angela Sessitsch, Head of the Bioresources Business Unit at AIT Austrian Institute of Technology.

Her research group not only studies such interactions, but also develops applications that utilise them. Two applications in particular are to be considered: improving the stress tolerance of crops to environmental conditions such as dryness or cold ("abiotic stress") and increasing their resistance to pathogens ("biocontrol"). The latter represents a biological alternative to chemical plant protection products, whose utilisation is also problematic because of increasing incidence of resistance. "There are several diseases, for example in viticulture, for which there are no effective plant protection products at all", says Sessitsch. Ragweed, a weed that increasingly occurs over wide areas, could also be kept in check with the help of microorganisms. At the AIT, suitable strains are selected for this purpose, formulations for their application in agriculture are developed and the efficiency of their use is tested. Some companies have already shown interest – however, field efficiency has to be improved and a number of studies have to be conducted to meet all regulatory requirements before the product is marketable. ■

Photo: AIT

"We have learned that a plant does not function by itself."

Priv.-Doz. Dr. Angela Sessitsch,
Head of Bioresources, AIT Austrian Institute of Technology

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LIFE IN THE SOIL

Microorganisms improve plant health

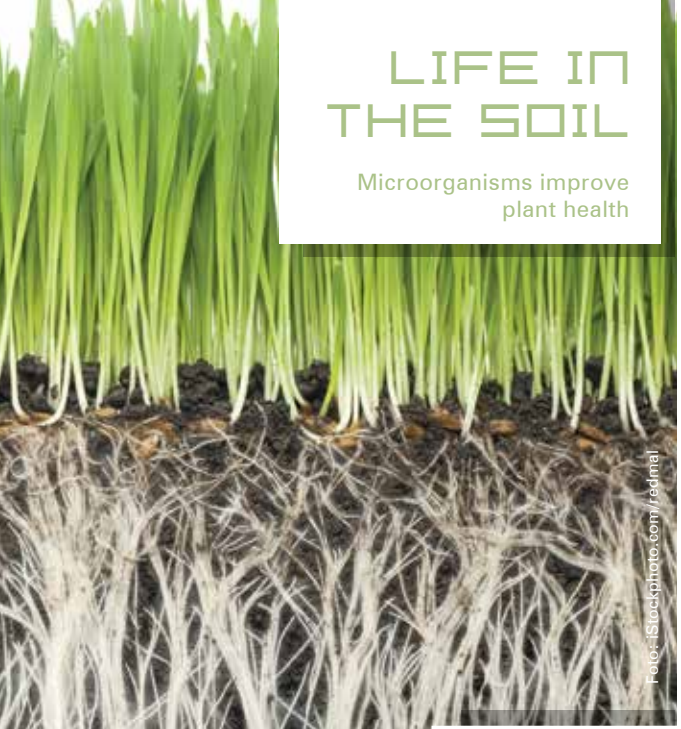

Foto: iStockphoto.com/redmal

In the immediate surroundings of a plant's roots, the composition of the soil differs significantly from adjacent areas. This region of the soil is referred to as rhizosphere. Many of the microorganisms living here work symbiotically with the plant: the plant provides a large part of the absorbed carbon, while the microorganisms improve the plant's supply with nutrients from the soil.

Walter W. Wenzel from the BOKU Institute of Soil Research investigates such interrelations, especially with a view to the biochemistry of nutrients and contaminants. The focus lies on the basic research of root secretions and their effect on the availability of phosphorus and heavy metals. Highly innovative methods of chemical imaging are developed to record the efficiency of nutrient utilisation and applied to matters of rhizosphere management in agriculture and environmental technology.

A special form of symbiosis is mycorrhiza, an association where a fungus lives in close contact with the fine root system of a plant. In addition to improved plant nutrition, this partnership also plays an important role in the defence against plant diseases, in particular those caused by pathogenic soil fungi. The research group of Siegrid Steinkellner from the BOKU Division of Plant Protection studies such interactions using the example of tomatoes. The team demonstrated that the biocontrol effect of arbuscular mycorrhizal fungi is clearly determined by the respective mixed culture partner of the tomato. ■

ш: www.wabo.boku.ac.at
ш: www.dnw.boku.ac.at/ps.html
ш: www.dagz.boku.ac.at/11136.html

INFO

Epigenetic switches

Fungi can create a wide variety of secondary metabolites. Some of them could be highly useful as the can be applied against bacterial infections (antibiotic effect) or cancer (cytostatic effect). The production of such substances, however, is not always consistent: The working group of Joseph Strauss (AIT & BOKU) demonstrated that the required fungal genes can be epigenetically silenced and reactivated (i.e. through subsequent modification of the genome).

ANTAGONISTS OF PESTS

Of “good” and “bad” microorganisms

In a project funded by the federal province of Lower Austria, several research groups of the IFA-Tulln, headed by Marc Lemmens from the Institute for Plant Production, set out to find microorganisms which can be used to fight moulds. In these studies, a special focus was placed on harmful fungi of the Fusarium species, which attack wheat and contaminate it with mycotoxins.

In this process, several mechanisms come to bear, as Lemmens explains: microorganisms may compete with the parasites for the supply of nutrients, they may produce substances that directly attack the harmful fungi or they themselves may act as parasites of the harmful organisms. However, it is also possible that the host plant’s resilience is increased (“induced resistance“) or the release of mycotoxins is prevented by the antagonist.

The group of Markus Neureiter from the Institute for Environmental Biotechnology developed methods to produce the candidates found on a large scale and to apply them to the field. One of the special challenges encountered is to make the formulations durable by drying, while at the same time keeping a large part of the cells alive. Moreover, the group of Rainer Schuhmacher at the Center for Analytical Chemistry examined the most interesting microorganisms for antifungal substances in order to find active ingredient candidates for crop protection.

However, a commercial application of the results realised in the projects is still a long way off as the positive effect is yet to be verified in additional field tests and an extensive procedure is required for the authorisation as a plant protection agent. ■

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The diversity of metabolites

The interaction between plant and microorganism is mediated by a wide variety of chemical compounds (metabolites). There are two strategies to study them, as Rainer Schuhmacher from the Center for Analytical Chemistry of the IFA-Tulln explains: in targeted metabolomics, the focus is already on a specific group of substances. Examples include antifungal peptides or plant-specific chemical messengers which can trigger defence mechanisms against pathogens. In untargeted metabolomics, an attempt is made to record the metabolites formed at a specific time in their entirety. The main analytical challenge is to distinguish a biologically relevant signal from the background. Special methods such as stable isotope labelling have been developed for this purpose.

MARKETABLE BACTERIA

Companies use the functions of microorganisms

Photos: iStock.com/Eraxion, Erber Group

Some products based on microorganisms can already be found in the market. bio-ferm, a company located at the Technopol Campus Tulln, was founded as a spin-off of the University of Natural Resources and Life Sciences in 2004 and is a part of the Erber Group today. The plant protection substances which have since been developed and commercialised are based on bacteria that occur in nature and are biotechnologically reproduced. Products against fire blight (a dangerous disease in pome production), botrytis (a mould that causes major damage in viticulture) and fruit rot, which attacks stored fruit, are offered.

"Here we take advantage of the effect that these microorganisms grow faster on the fruit than the parasites which are supposed to be fought", says Eva Maria Binder, Chief Research Officer of the Erber Group. Therefore, the compounds used do not show any detrimental effect on their environment, which makes it easier to obtain authorisation as an agent to protect plants.

Another application of useful microorganisms was taken to market maturity at Biomin, which is also part of the Erber Group. The company offers a range of feed additives, which also include probiotics, i.e. preparations containing viable organisms with a favourable effect on health. The products, which can strengthen the immune system and drive out pathogens, are used for pigs, poultry and aquacultures. Recently, the first product which makes a combination of three different strains usable was authorised within the EU. ■

"The microorganisms used grow faster on the fruit than the parasites which are supposed to be fought."

Eva Maria Binder,
Chief Research Officer of the Erber Group

www.biomin.net
www.bio-ferm.com
www.erber-group.net

TECHNOPOL CAMPUS TULLN

The Technopol Program of Lower Austria is co-financed by the European Regional Development Fund (ERDF) and the province of Lower Austria.

Internationally renowned top research is conducted at the Technopol Campus Tulln. The research activities focus on the development of biotechnological processes in the fields of plants, animals and the environment. The core elements of Technopol Tulln are the Department IFA-Tulln of the University of Natural Resources and Life Sciences, Vienna in cooperation with the Vienna University of Technology and University of Veterinary Medicine, Vienna, the University of Applied Sciences Wiener Neustadt (FHWN) Tulln Campus with the study program "Biotechnological Processes", Techno-Park Tulln GmbH, which provides space developed for business locations, and the Technology Center Tulln (TZT), which offers space for spin-off and start-up companies.

The University and Research Center Tulln (UFT) has been operating since April 2011. It accommodates research groups of the Austrian Institute of Technology (AIT) and of the University of Natural Resources and Life Sciences.

This brochure is also available as an e-paper. Scan the QR code or download under:

www.technopol-tulln.at

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All gender-specific statements in this brochure refer equally to women and men; the masculine form was only chosen for reasons of simplification.

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