

MOULDS AND THEIR TOXINS

Mycotoxin competence
in education, research and business



Mycotoxins – toxins produced by moulds – are a great problem for the safety of food and animal feed. A globally unique concentration of competence in this topic has formed at the Technopol Campus Tulln: research, education and entrepreneurial activities act together to provide solutions for the entire food chain.

Photo: iStockphoto.com/Tomml

Although moulds have accompanied humans as long as they have produced food, the research into compounds which cause the toxic effects of these fungi is a relatively recent field of research. Only in the 1960s, aflatoxins were the first class of compounds to be discovered after they had previously caused thousands of turkeys in England to die from feed poisoning.

Moulds consist of a network of hyphae (called the mycelium), which grow on organic substrates when mould spores fall on them. To produce spores they form specialised organs (conidiophores or sporangiophores), which are often pigmented and form the main part of what is visible of the fungus to the naked eye ("mould").

To adapt to various different environments where they can grow, moulds produce countless metabolites with special functions. The mycotoxins known to date also belong to these metabolites (so-called secondary metabolites). If crops or foods are attacked by moulds, these toxins enter the food chain.

Some of the more than 300 known compounds may have toxic, carcinogenic or mutation-causing effects as well as hormone-like effects even if they only occur in very small quantities. The European Union has defined limits for the maximum permissible concentration of mycotoxins in food. According to estimates of the FAO, however, approximately 25 percent of all cereal products are contaminated with mycotoxins. ■

MOULDS AND THEIR TOXINS

What it's all about



Examples of important mycotoxins

INFO

Aflatoxins:

extremely toxic compounds, which cause major problems especially in hotter climates

Trichothecenes:

are formed by types of the *Fusarium* species, which also occurs in our part of the world; one of them is deoxynivalenol, which has a strongly irritating effect on the stomach and intestines.

HOW MUCH OF WHAT?

Chemical analysis of mycotoxins

Photos: Fungal Genetics and Genomics Unit/BOKU Vienna

In order to enable taking the appropriate measures to reduce mycotoxin contamination along the entire food and feed chain, these toxins have to be determined qualitatively (which mycotoxins are present?) and quantitatively (how much is present?). That's the job of chemical analysis.

At the **Department for Agrobiotechnology (IFA-Tulln)** of the University of Natural Resources and Life Sciences, Vienna (BOKU), a Center for Analytical Chemistry has been established, which is globally leading in the determination of mycotoxins. The Department Head, Rudolf Krska, is the most frequently quoted authors worldwide in this area in the last decade.

Today, a combination of liquid chromatography and mass spectrometry is the state of the art for this task. Equipped with high-performance instruments, Krska's team has made a name for itself above all in the fields of highly accurate mycotoxin determination and multi-toxin analysis. It has proven its capabilities in interlaboratory comparisons on multiple occasions.

With this know-how, the Center for Analytical Chemistry has equally supported research for breeding types of grain which are resistant to moulds, and the development of feed additives by Biomin, a company which has been a partner on the topics of mycotoxin research and mycotoxin metabolism in two Christian-Doppler Laboratories at the IFA-Tulln since 2002. In the EU projects MYCORED and MYCOSPEC, some of the world's largest research projects on mycotoxins, Krska has supervised major work packages.

The analytical determination of mycotoxins and other secondary metabolites also plays an important role for basic research. Krska and his colleague Rainer Schuhmacher, Head of the working group Metabolomics at the IFA, investigate the interaction between plants and fungi at the level of all metabolites using highly sophisticated mass spectrometry within the Special Research Programme (SFB) FUSARIUM at the BOKU Campus Tulln which is funded by the Austrian Science Fund (FWF) and coordinated by Gerhard Adam. ■ www.ifa-tulln.ac.at

"In Tulln, you find a unique mix of different fields of expertise complementing each other, ranging from basic research to industrial applications."

Univ.-Prof. Dr. Rudolf Krska,
Head of IFA-Tulln, University of Natural Resources and Life Sciences



In many cases, agricultural crops are attacked by moulds in the field already. Especially the *Fusarium* species, which is a source of important mycotoxins, is very difficult to fight with fungicides. Therefore, an important approach is to breed crops that are resistant to such attacks. This is what the **Institute for Biotechnology in Plant Production** at the IFA-Tulln specialises in.

Special attention is paid to wheat, which is crucial to food supply. For growers, this crop presents particular challenges. Due to its long history of cultivation, wheat has a very large genome. In addition, there is no central genetic starting point for breeding: "Many different genes are involved in the resistance reaction to fusaria", explains Hermann Bürstmayr, Head of the Institute. Bürstmayr's working group develops methods which can nevertheless shorten the breeding of resistant varieties. In this process, so-called genetic markers are used to show the presence of genes which contribute to the development of resistance in the lines selected for cross-breeding. In the case of durum wheat, an ingredient in the production of pasta, an even more difficult path has to be taken: As hardly any resistance to moulds can be found in the cultivars that are in common use today, researchers look for it in local cultivars or even wild varieties.

The group's know-how can also be applied to questions of basic science. In order to understand the processes occurring in an infection at the molecular level, the team examines which genes are translated (i.e. transcribed) into RNA when a plant is infected. ■

CROPS IN RESISTANCE

Breeding resistant grains

Mycotoxin-free raw materials

Zuckerforschung Tulln, the R&D subsidiary of the Agrana Group, is also responsible for the assessment of raw materials such as maize and wheat, which may potentially be affected by a contamination with mycotoxins. Therefore, a specific chemical analysis has been developed to detect the presence of mycotoxins in these special product groups. Particular attention is paid to a possible enrichment through processing steps.

INFO



ADDED VALUE THROUGH KNOWLEDGE

Companies use know-how of location

Photos: iStockphoto.com/ClaudiaKnieling, Erber Group

Sometimes it is difficult to prevent the contamination of feed with mycotoxins. In such cases, additives may help protect the livestock.

Biomin, a company of the **Erber Group**, which was founded by Erich Erber, has been a pioneer in healthy animal nutrition since the 1980s. "We were one of the first companies to scientifically explore the topic of mycotoxins in animal feed, and today we are the technology leader in this field", says Eva Maria Binder, who coordinates research tasks within the Group. Mycotoxins can be bound through adsorbents; micro-organisms and specially developed enzymes help reduce toxicity. The most recent research efforts address second generation enzymes, which combine higher specificity towards certain toxins with improved stability.

Since 1995, the Erber Group has cooperated with the IFA-Tulln in mycotoxin research; in 2006, the research activities were concentrated in Tulln.

"The support through public funding instruments enabled showcase projects of cooperation between business and research."

Dr. Eva Maria Binder,
Chief Research Officer, Erber Group

"Another important factor was the support through funding instruments of the federal government and the federal province of Lower Austria, which created a higher level of freedom in enterprise-related research", Binder emphasises.

Romer Labs has been a company of the Erber Group since 1999 and offers analysis products and services for the food and feed industry. In the area of mycotoxins, the range extends from rapid tests for incoming goods to highly specific test kits and analytical services. The highly pure mycotoxin standards marketed under the "Biopure" brand were taken over for calibration purposes from a spin-off, which had been established together with the IFA-Tulln. ■

🌐: www.biomin.net

🌐: www.romerlabs.com

🌐: www.erber-group.net



When moulds infect a plant, this is associated with complex molecular events.

By far not all processes have been studied in detail. A **special research programme (SFB Fusarium)** funded by the Austrian Science Fund (FWF) was established for the important mould species *Fusarium* at the BOKU Campus Tulln.

The programme is headed by Gerhard Adam of the **Department for Applied Genetics and Cell Biology (DAGZ)**, who himself focuses on the genes that are involved in the processes. On the side of the moulds, numerous genes which are responsible for the biosynthesis of metabolites have already been discovered, but these compounds themselves have not yet been identified. Here it is important to clarify the biological function of the metabolites. On the plant side, Adam's team investigates which genes are involved in keeping mycotoxins in check. To find out, candidate genes are built into simpler model systems (such as yeasts) in order to make it easier to analyse them.

Not everything that is stored in DNA is effective at all times. Joseph Strauss holds a professorship for fungal genomics at BOKU and heads a working group at the **AIT-Austrian Institute of**

Technology, which also has a location in Tulln; his research group studies how genes can be silenced and reactivated through modifications in the chromatin structure, in which the genome is present in the nucleus (so-called epigenetic changes). In addition, his group also works with bioactive substances from moulds which have properties that benefit humans.

Apart from the DAGZ, the IFA also plays a leading role: in the special research programme *Fusarium*, the inter-university research centre covers both the level of transcription and the analysis of metabolites. The Christian Doppler Laboratory of Franz Berthiller focuses on the special aspect of masked mycotoxins. ■

www.ait.ac.at

www.dagz.boku.ac.at

HIGH-TECH IN THE SERVICE OF SCIENCE

Genes, genomes, metabolites



Foto: AIT Austria

"Moulds produce harmful and useful bioactive substances."

Univ.-Prof. Dr. Joseph Strauss,
BOKU and AIT-Austrian Institute of Technology



A NEW GENERATION FOR BIOTECHNOLOGY

UAS studies at Campus Tulln

Education also benefits from the unique expertise at the Technopol Campus Tulln. The branch of the University of Applied Sciences Wiener Neustadt located in Tulln offers a bachelor and master studies programme in biotechnological processes with a strong focus on chemical analysis and molecular biology. During their bachelor studies already, students not only learn the basics of natural science, but also how to experiment independently in the laboratory and how to work with microorganisms that can carry out so many useful tasks for humans.

Based on the bachelor studies, skills can be developed further in a variety of directions in master study programmes. The elective "Quality in food and feed products", in which modern methods of examining food are taught, has a strongly analytical focus. In the specialisation course "Cell factory", students are given the opportunity to optimise microorganisms in such a way that they produce certain amounts of a specific product in industrial production processes. The elective "Biogenic agents" focuses on ways to obtain active ingredients from plants and on the dosage form in which they are best absorbed by the body. In the elective module "Environmental technology" in turn, the focus is on studying the ability of microorganisms to break

down contaminants and to produce energy.

Masked mycotoxins

INFO

One of the strategies plants use as a defence mechanism against mycotoxins is to turn them into less toxic variants. Such "masked mycotoxins" are not harmless as they can be released in the free, toxic form in the organism of humans and animals. It is, however, difficult to verify them analytically. A CD laboratory headed by Franz Berthiller, IFA-Tulln, examines, by feeding marked mycotoxins, which way they take in the organism and which compounds can be used to counteract the toxic effect. New production methods for masked mycotoxins, which were so far hardly available, are developed in a project funded by the Vienna Science and Technology Fund WWTF (Gerhard Adam, Franz Berthiller).

The master study programme is by no means restricted to students who completed their bachelor's degree in Tulln, but is open to all graduates of relevant bachelor or diploma studies of natural sciences. ■

www.tulln.fhwn.ac.at

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, the University of Applied Sciences Wiener Neustadt (FHWN) Tulln Campus with the study programme "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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