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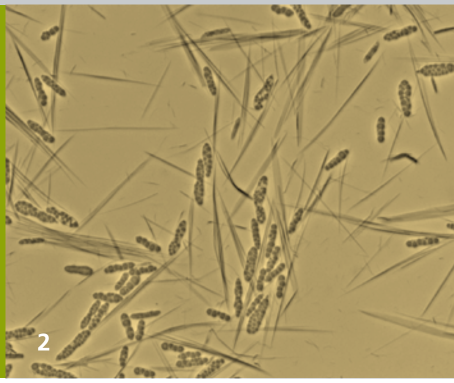

1 *Domestic plant oils as a feedstock for the production of biosurfactants.*
2 *Microscope images of U. maydis and needle-shaped CL crystals.*
3 *Surfactants may create foams.*

PRODUCTION OF OPTIMIZED BIOSURFACTANTS

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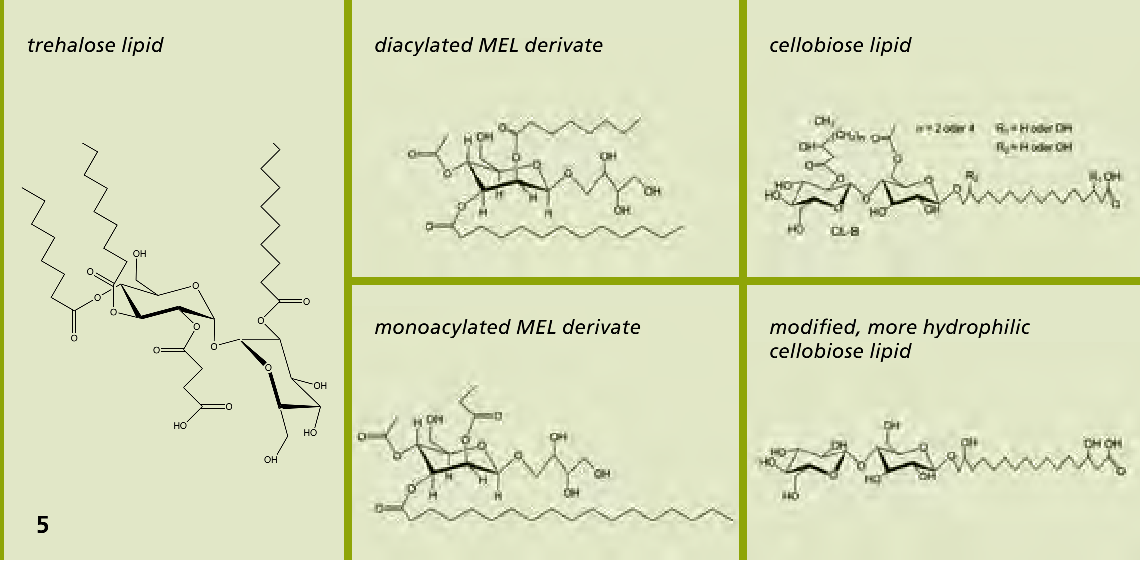
Surfactants – surface-active substances – are an integral part of our everyday life and have a wide range of effects. In cleaning agents, for example, they have dirt-binding properties, as emulsifiers they are to be found in cosmetics and foodstuffs. Large quantities of surfactants are also used in industrial production. Due to the demand for environmentally friendly products and manufacturing processes that are independent of crude oil, renewable resources are increasingly being used for the chemical synthesis of surfactants. However, the variability of the molecule structure of these biobased surfactants and the range of utilizable raw materials are limited. Tropical oils such as palm kernel and coconut oil are most commonly used. To an increasing extent their cultivation in enormous monocultures is viewed critically from the ecological standpoint.

Biosurfactants, the sustainable alternative

As an alternative to synthetic surfactants the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB is researching microbial biosurfactants. These are natural surface-active molecules from fungi and bacteria that have various advantages over conventional surfactants. Their fermentative production is resource-flexible, they are completely biodegradable, as a rule non-toxic, biocompatible and display interesting additional properties such as skin regeneration effects. The biosurfactants that are most successful commercially include the sophorose lipid from the yeast *Starmerella bombicola*, a glycolipid that is now produced by various surfactant manufacturers, in part as an additive for household cleaners and dishwashing liquids.



Aims and strategies

The Fraunhofer IGB is working on the biotechnological production of mannosylerythritol lipids (MEL), cellobiose lipids (CL) and trehalose lipids (TL). These are glycolipids that, in addition to their surfactant effect, showed promising bioactive characteristics as additives for cosmetics and personal care products. Various fungi (*Ustilago* sp. and *Pseudozyma* sp.) and bacteria (*Rhodococcus* sp.) are used for the fermentation processes.

Our work focuses on the following objectives:

- Resource-flexible production processes with a high space-time yield
- Fermentation products with customized surfactant properties for
  - cosmetics and personal care products
  - detergents and cleaning agents
  - biological plant protection products
  - microbial soil decontamination

Optimization of the production process

At the Fraunhofer IGB we currently achieve product concentrations of 30 g/liters for CLs and 120 g/liters for MELs by means of fermentation optimization. For this purpose, we use various production strains, each forming derivatives of the two glycolipids with specific surfactant properties. The use of special substrates such as hydroxylated fatty acids or an enzymatic after-treatment are a further way of influencing the chemical structure of the surfactant molecules. Sample quantities are obtained in a purity of up to 98 percent and a yield of over 90 percent by means of optimized processing methods.

Metabolic analysis

Our aim is to understand the biosurfactant metabolism better in order to achieve good process control and reproducibility of the fermentation processes. For this purpose, first the genomes of the especially efficient producers *P. aphidis* and *U. maydis* were sequenced at the Fraunhofer IGB. By means of expression analysis of the MEL metabolism it was possible to select – in addition to the MEL biosynthetic pathway – further metabolic pathways that may play an important role in the glycolipid synthesis.

Our range of services

- Screening for biosurfactants and biosurfactant producers from environmental samples
- Analysis of the bioactive and surface-active properties
- Metabolic analyses
- Fermentation optimization (batch/fed-batch process) and scale-up
- Supply of microbial biosurfactant samples
- Processing of crude extracts
- Chemical or enzymatic modification of biosurfactants

Projects and funding

- First results for the production of glycolipids (cellobiose lipids, mannosylerythritol lipids) were obtained in the PolyTe Project (coordination: Cognis GmbH) funded by the German Federal Ministry of Food and Agriculture represented by the Agency for Renewable Resources (Fachagentur für Nachwachsende Rohstoffe, FNR).
- Crucial research work for the optimization and metabolic analysis of the biosurfactants was carried out as part of the EU-funded project BioSurf
  www.biosurf.eu
- In the EU-funded BioConSepT project, processes for the production of biobased polymers from second generation renewable raw materials such as non-edible oils and wood have been developed.
  www.bioconsept.eu
- The German Federal Foundation for the Environment (Deutsche Bundesstiftung Umwelt, DBU) supported our research with a doctoral scholarship and the current funding of the project "Reducing environmental impact by using microbially produced biosurfactants in personal care products and cleaning agents".

4 *Fermentation in the 40-liter reactor.*

5 *Molecule structure of different biosurfactants.*