Environmentally friendly cleaning and washing

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The researcher takes samples from the bioreactor. Credit: Fraunhofer IGB/Frank Kleinbach

More and more everyday products are based on renewable resources, with household cleaners now containing active cleaning substances made from plant oils and sugar. These fat and dirt removers are especially environmentally friendly and effective when produced using biotechnology, with the aid of fungi and bacteria.

Detergents are everywhere – in washing powders, dishwashing liquids, household cleaners, skin creams, shower gels, and shampoos. It is the detergent that loosens dirt and fat, makes hair-washing products foam up and allows creams to be absorbed quickly. Up until now, most detergents are manufactured from crude oil – a fossil fuel of which there is only a limited supply. In their search for alternatives, producers are turning increasingly to detergents made from sustainable resources, albeit that these surfactants are usually chemically produced. The problem is that

the substances produced via such chemical processes are only suitable for a small number of applications, since they display only limited structural diversity – which is to say that their molecular structure is not very complex. Now researchers at the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB are taking a different approach: they are manufacturing surfactants using biotechnological methods, with the assistance of fungi and bacteria. "We produce biosurfactants microbially, based on sustainable resources such as sugar and plant oil," says Suzanne Zibek, a technical biologist and engineer at the IGB in Stuttgart. The scientist and her team use cellobiose lipids (CL) and mannosylerythritol lipids (MEL) because testing has shown these to be promising for industrial application. They are produced in large quantities by certain types of smut fungus, of the kind that can affect corn plants. What is more, CL also has antibacterial properties.

What marks biological surfactants out from their synthetic competitors is their increased structural diversity. In addition, they are biodegradable, are less toxic and are just as good at loosening fats. But despite all this, to date they are used in only a few household products and cosmetics. The reason is that they are costly and difficult to produce, with low yields. One substance that has been successfully brought to market is the sophorose lipid made by Candida bombicola, which is used by a number of manufacturers as an additive in household cleaning products. This biosurfactant is produced by a yeast that is harvested from bumble-bee nectar.

"If we want natural surfactants to conquer the mass market, we need to increase fermentation yields," says Zibek. To this end, the scientists are optimizing the production process in order to bring down manufacturing costs. They cultivate the microorganisms in a bioreactor, where they grow in a continuously stirred culture medium containing sugar, oil, vitamins and minerals salts. The goal is to achieve high concentrations in as short a time as possible, so they need to encourage as many

microorganisms as possible to grow. There are numerous factors with a bearing on the outcome, including the oxygen supply, the pH value, the condition of the cells, and the temperature. The composition of the culture medium itself is also crucial. It is not just a question of how much sugar and oil go into the mix, but also the speed at which they are added. "We have already achieved concentrations of 16 grams per liter for CL and as high as 100 grams per liter for MEL – with a high production rate, too," the group manager is happy to report.

The next step is to separate the biosurfactants from the fermentation medium and to characterize them with the help of industrial partners, determining which surfactants are suitable for use in dishwashing liquids, which are more suited to oven cleaning products, and which are ideal for use in cosmetics. The substances can finally be modified or improved at the enzymatic level. "For instance, we managed to increase wa-ter solubility. After all, the biosurfactant shouldn't form an oily film over the surface of the dishwashing liquid," explains Zibek. The experts have even managed to produce biological surfactants using waste products, by obtaining the sugar needed for the culture medium from straw. The researchers will be presenting biosurfactants they have produced themselves at HANNOVER MESSE from April 23 to 27, 2012 (Hall 2, Booth D22).

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