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Bioeconomy BW

Rhapynal for a better environment - innovative, biobased and sustainable

Biotensidon GmbH is on the up. Rhapynal is about to be placed on the market. The company is involved in a 100-million-euro joint venture and was nominated for the German Next Economy Award in 2016. Rhapynal has three components and offers virtually unlimited possibilities for application in the agricultural, pharmaceutical and many other sectors.

Biotensidon GmbH, which is headquartered in Karlsruhe, has been selling biological, oil-based detergents since 2011. In 2015, Biotensidon founded a white biotechnology subsidiary to develop a fermenter prototype for producing rhamnolipids using bacteria. The fermenter prototype was developed in cooperation with a team of Ukranian scientists. The team of seven specialists was led by Dr. Alexander Shulga, microbiologist and scientific project manager at Biotensidon.

Rhamnolipids are a class of biosurfactants produced by various bacterial species. Surfactants are surface-active chemical substances that reduce the surface tension of a liquid, thereby changing its properties. Surfactants are therefore used in a wide range of areas, including the food industry, and in detergents and cosmetics. In addition to the wide range of applications, biosurfactants have an antimicrobial effect, making them suitable for use as additives in cosmetics, agriculture and the pharmaceutical industry. According to the market research company Ceresana, surfactants achieved global revenues of 33.2 billion U.S. dollars in 2014. Total revenues of around 40.4 billion U.S. dollars are expected by 2022.[1]

Surfactants need not be based on fossil raw materials

Surfactants are still largely petroleum-based, and are slow to decompose and therefore damaging to the environment. Surfactants are produced from fossil raw materials, but can also be synthesised chemically from renewable raw materials such as palm and coconut oil. Unlike the petroleum-based versions, they are fully biodegradable. However, the process raises issues of sustainability, as tropical vegetable oils are used for the chemical processes.

Biotensidon GmbH has been manufacturing 100% biobased and biodegradable surfactants since 2015. "The rhamnolipids are produced by a non-pathogenic strain of Pseudomonas aeruginosa," explains Jörg Jögel, head of the company's research department. This wild-type strain achieved promising laboratory-scale rhamnolipid yields. "We took the risk of entering completely uncharted territory and starting small-scale production of rhamnolipids with a 100-litre reactor," explains Hartmann, marketing director of Biotensidon.

Jörg Jögel, Dr. Alexander Shulga, Rolf Hartmann, Ilona Karpenko, Dr. Oleksandre Karpenko (from left to right) in front of the new 500-litre reactor.

Much has happened since the first bioreactor started operating in 2015. The company now uses large 500-litre bioreactors that are modular. "The module we are building at the moment will be a combination of four 500-litre bioreactors, which of course takes us into an entirely different dimension," said Jögel. A new hall is already in use and will be equipped with 40 to 50 500-litre reactors. This project is ultimately also made possible through a joint venture costing 100 million euros. In addition to increasing the size of the reactors to 500 litres, the company has also succeeded in increasing the rhamnolipid yield. Jögel indicates that the rhamnolipid yield in the cell-free supernatant has gradually increased from 15 g/litre to 30 g/litre. Reactors with capacities of 2,000 to 3,000 litres will be used in the future. The company hopes to increase rhamnolipid yields to 50 g/litre by optimising the production process and through a bioreactor volume scale-up to 2,000 litres. Because of the excellent results, Biotensidon GmbH will also in the future focus on research into rhamnolipid production.

Three components - one product

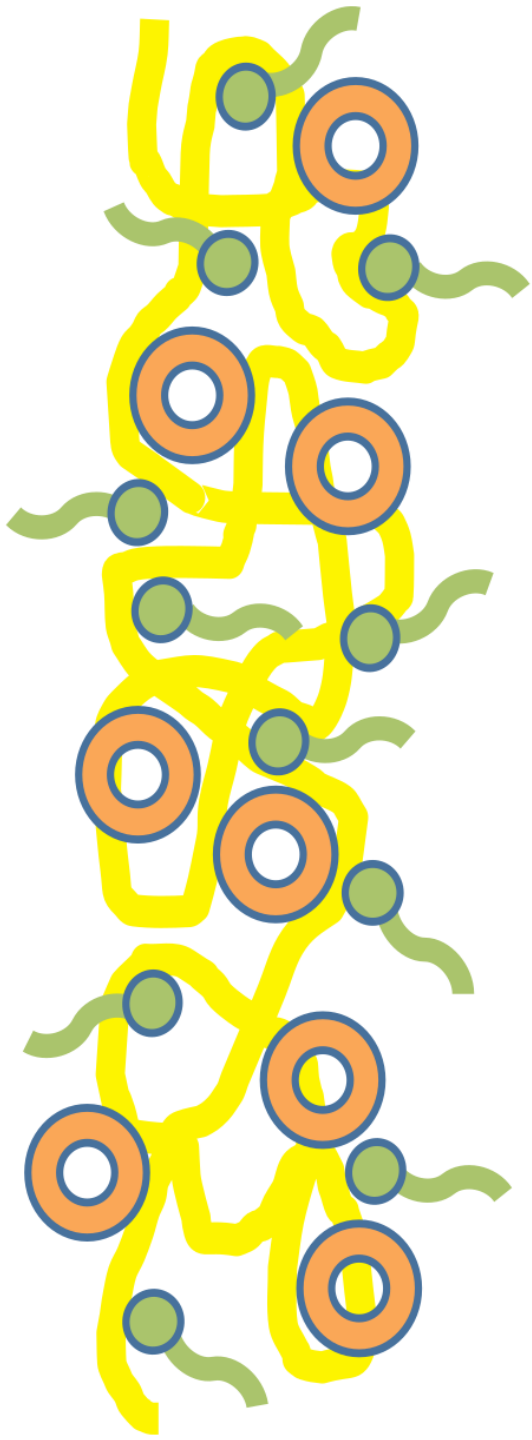
In early September 2016, everything was ready and Biotensidon GmbH filed a patent application for Rhapynal. The name of this supramolecular complex comes from its three components: rha = rhamnolipids, pyn = pyoverdines, al = alginate. A non-pathogenic strain of Pseudomonas aeruginosa releases all the components into the medium in the fermenter, which are then isolated. Rhapynal can be used for a broad range of applications, e.g. as an extinguishing agent additive, for soil regeneration, environmental protection, agriculture or in the pharmaceutical sector.

Rhamnolipids

In agriculture, Rhapynal is used, for example, as a component in seed coatings. The seeds are sprayed with Rhapynal solution prior to sowing in order to increase crop yield. The seeds treated with Rhapynal can bind more moisture. In addition, rhamnolipids facilitate nutrient transport, resulting in earlier and better germination. The seedlings grow faster and produce bigger roots.

When added to animal feed, Rhapynal improves nutrient uptake. Chicken fed with feed with just a few milligrammes of Rhapynal added, put on weight much more quickly, and are fleshier, healthier and more resilient than conventionally fed animals. The rhamnolipids enable the animals to make use of food much better than without them, and they also excrete lower quantities of unused nutrients," says Shulga.

These investigations were carried out in a laboratory in Berlin. In terms of pharmacology, the researchers examined whether the Rhapynal rhamnolipids lead to the more effective absorption of active ingredients. Jögel explains that the use of Rhapynal enables the active ingredient concentration of a drug to be reduced by up to 80 percent. As Rhapynal significantly reduces the amount of active substances required, it also helps reduce adverse drug effects. As this was the finding of a test trial, further research needs to be carried out to substantiate the results.

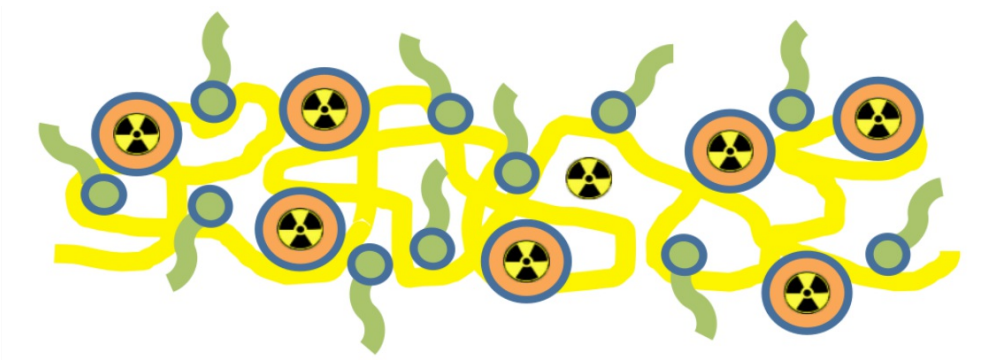


Schematic illustration of the new product, Rhapynal. The alginate (yellow) serves as a carrier material, so that the three components together form a complex. The pyoverdines are represented as red rings, the rhamnolipids are shown in green.

Pyoverdines

Pyoverdines are fluorescent siderophores, which make the cells fluoresce green under UV light. The pyoverdines in Rhapynal seem to be able to bind radioactive particles. This property could be particularly beneficial when nuclear power stations have to be dismantled or when radioactive accidents such as Chernobyl or Fukushima occur.

Alginates



Decontamination with pyoverdines - the pyoverdines of Rhapynal can scavenge radioactive particles.
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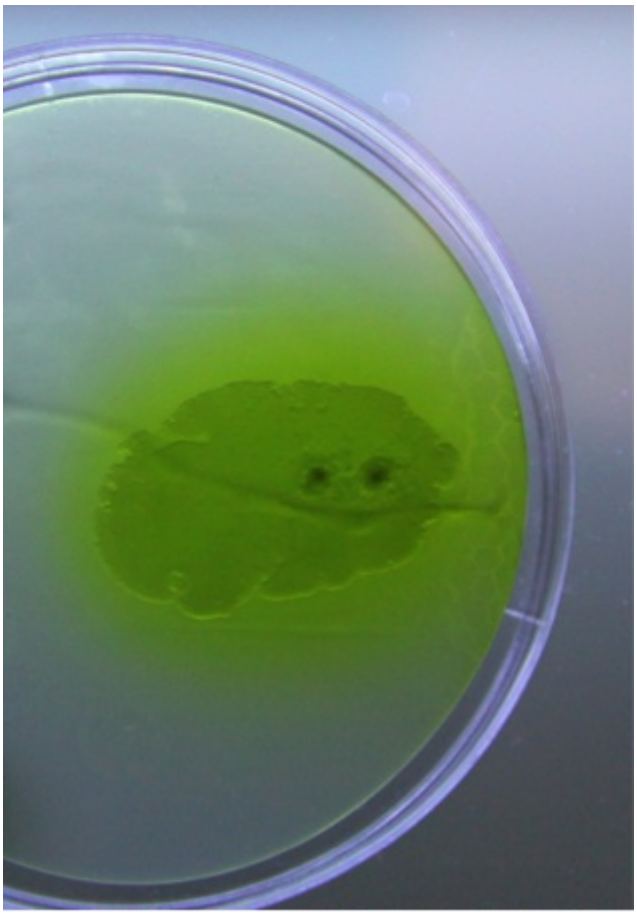
Alignate is the third Rhapynal component. The polysaccharide binds the pyoverdines and the rhamnolipids on its surface, thus forming a big complex. "This complex, with alginate as carrier matrix, has better properties than each individual component on its own. Individual pyoverdines only have a limited shelf life, the complex makes them more stable," said Shulga. In addition, the complex can be isolated directly from the cell culture medium, rendering costly separation procedures obsolete.

With joint ventures to new development opportunities

Rhapynal will now be sold as a part of joint ventures with other companies, thus giving Biotensidon further development opportunities. Hartmann explains: "We are selling our product to industrial users who can enrich and therefore improve their products. We see ourselves as a pure raw material manufacturer that supplies the industry." In terms of price, the biological product competes very well with traditional products.

In addition to focusing on research and development, Biotensidon GmbH submitted Rhapynal to the Next Economy Award competition in 2016. The Next Economy Award is given to start-ups that focus on social and environmental sustainability. Biotensidon and two other sustainable start-ups were shortlisted in the 'Nature' category. Biotensidon was awarded second prize at the award ceremony in November 2016.

The possibilities offered by Rhapynal are far from exhausted. Further research needs to be carried out in order to open up as many areas of applications as possible.



Pseudomonas aeruginosa culture plate. The pyoverdines formed by the cells fluoresce when exposed to UV light.
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Literature:

[1] Market report about surfactants, Ceresana brochure: http://www.ceresana.com/de/marktstudien/chemikalien/tenside/

Article

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