HOW BACTERIAL MUTANTS COULD BOOST BIOPLASTICS

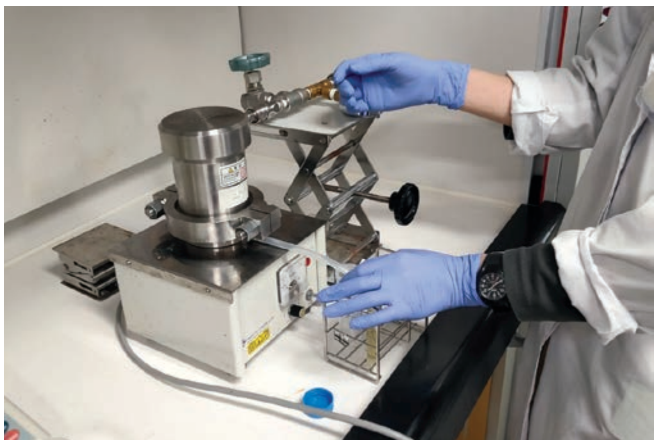
Researchers are using RADIATION AND FERMENTATION techniques to improve the microorganism-driven production of cellulose for bioplastics.

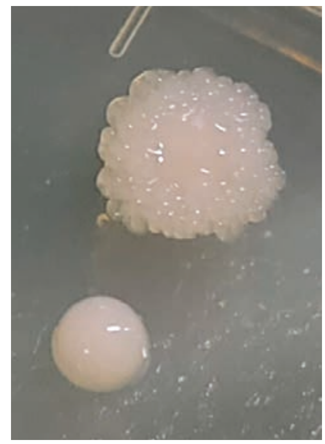
Cellulose polymers are being produced by bacterial fermentation of organic matter, and used to create strong bioplastics. Researchers in Japan are now looking to improve polymer production levels by optimizing bacterial strains using radiation and fermentation.

Unlike plant-derived cellulose, bacterial cellulose nanofibres (BCNFs) are extremely long, small in diameter, and have a high surface-area-to-volume ratio. These properties give BCNFs high mechanical strength, stability, biocompatibility and biodegradability, says Chiaki Ogino, a chemical engineer and microbiologist from the Engineering Biology Research Center at Kobe University in western Japan.

To produce more of this hardy material, Ogino's team has adopted a new approach. The researchers cultivate highly productive bacteria by increasing the mutation rate with room temperature plasma irradiation, and then tweak the fermentation process to best suit these optimal bacteria, making them the dominant strain in a fermentation environment.

Exposing bacteria to plasma irradiation can be quicker and easier than genetic engineering, explains Ogino.





▲ **Efficiently making bioplastics using bacteria involves processing raw plant materials, such as sugar beet molasses (left), and harnessing bacteria colonies (right) that produce high levels of bacterial cellulose nanofibres.**

MICROBE-MADE

Using an accelerator and room-temperature plasma to generate a mutant microbe library, Ogino's team have been able to foster a 100-fold increase in the rate of bacterial mutations. "The goal is to find a strain of bacteria that has better properties for industrialization," he explains.

The team use a number of techniques — including mass spectrometry and genome sequencing — to analyse the resulting changes to DNA and metabolism in the bacteria, identifying critical mutants and key enzymes that result in higher nanofibre production.

Chemical engineering is then applied to make sure that the process of fermentation allows the bacteria with the most adaptive mutations to survive, so the strains that are able to produce high quantities of nanofibres become dominant.

If successful, this technique could lower the cost and carbon emissions associated with bioplastics made from plant-based cellulose that requires grinding and other energy-intensive processing techniques, argues Ogino. Once the most productive bacterial strains have been identified, the production of nanofibres could be as simple as using filtered organic agricultural waste products, and applying bacteria-driven fermentation to them.

FEEDSTOCK FROM FARMS

This method could help solve a problem for farmers on the island of Hokkaido in northern Japan. There has been steeply declining demand for sugar beets due to government policies aimed at reducing sugar consumption, along with slowing global demand.

But molasses — a by-product of sugar beet processing — becomes a viable feedstock for cellulose-producing bacteria after it is filtered through industrial membranes similar to those used in water purification.

Ogino and his team's new techniques could therefore help to create new markets for manufacturers and sugar beet farmers in Hokkaido.

Their project is also part of a wider collaboration led in the region by chemist, Kenji Tajima, at Hokkaido University, in association with sugar manufacturer, Kusano Sakko Inc. Their project, in turn, is part of the Japanese-government's nationwide COI-NEXT bioplastic project, which is working to improve the production of plant-based bioplastics to complement attempts to create a more sustainable, circular bioeconomy. ■

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