Genetically modified bacteria became efficient sugar producers

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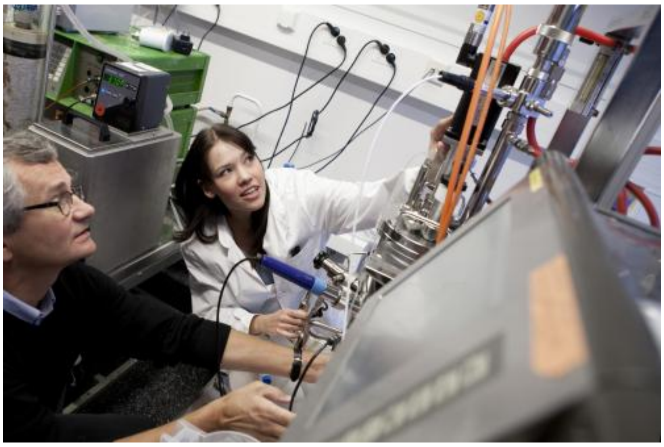

Heikki Ojamo, Professor of Bioprocess Engineering, and Anne Usvalampi.

The production of rare sugars has been very costly until now. A recent doctoral study indicates that their production can be made significantly more efficient with the help of genetically modified bacteria. This reduces prices and allows for their more versatile use in medicine, for example, says doctoral candidate Anne Usvalampi from the Aalto University in Finland.

Industry is already making use of rare sugars as low-calorie sweeteners, and as precursors of anti-cancer and antiviral medicines. However, their high cost has impeded research and use: it is not possible to isolate significant amounts of rare sugars directly from nature, and consequently their production has been expensive.

The efficiency of sugar production can be increased through gene technology. In her recent doctoral dissertation Anne Usvalampi, Lic.Sc. (Tech.), studied the microbial production of three rare sugars - xylitol, l-xylulose and l-xylose with the help of genetically modified bacteria.

"We added certain genes to the bacteria, making them produce the enzymes that we wanted, and with their help, the desired rare sugars. The results were promising. The production of xylitol was considerably more efficient than what has previously been achieved by using bacteria, and L-xylose was manufactured for the first time without large amounts of by-products. Compared with chemical synthesis, bacteria proved to be significantly better in the production of l-xylulose and l-xylose", Anne Usvalampi says.

Genetic engineering has taken great strides in the past decade, but it is still not simple.

"On paper the process looks good: the DNA is isolated and the desired gene is replicated and attached to a vector which is used to transform bacteria. It sounds straightforward, but things do not always go like one would expect", she admits.

DNS, or 3.5 dinitrosalicylic acid.

Sugar for wounds

As a precursor Usvalampi and her group used d-xylose, which is a part of hemicellulose, which can be extracted from hardwoods. It was used for the manufacture of xylitol with the help of Lactococcus lactis, to which the xylose reductase gene of Pichia stipitis was spliced. Next, xylitol was used to produce l-xylulose with Escherichia coli, to which the xylitol-4-dehydrogenase of Pantoea ananatis was added. Finally, l-xylulose was used to produce l-xylose with the help of E. coli, in which the l-fucose isomerase gene from the bacterium had been overexpressed.

So is it true that xylitol, which is familiar to all Finns, does not come directly from birch?

"It does not", Anne Usvalampi notes with a smile.

"The idea, nurtured in Finland, of xylitol as birch sugar is incorrect. The precursor d-xylose can be extracted from birch, but it can come from other hardwoods, and also from maize, for instance."

Xylitol is known for its preventive effect against caries, but new studies indicate that it is also useful in preventing ear infections in children. Anne Usvalampi believes that plenty of new uses can be found for rare sugars, especially in the pharmaceutical industry, once their prices can be brought down thanks to new and more efficient methods of production. Already now there is evidence that the rare sugar mannose can be used in the treatment of various infections and wounds.

Provided by Aalto University
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