

RESEARCH NEWS

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Healthy eating

Protein-Based Sweeteners as Sugar Substitutes

Worldwide, consumption of sugar has risen steadily in recent decades even though this food contributes to cavities, high blood pressure and widespread health issues such as type 2 diabetes and cardiovascular disease. In the joint research project NovelSweets, researchers at the Fraunhofer Institute for Molecular Biology and Applied Ecology IME have teamed up with partners to use methods derived from biotechnology to produce innovative, protein-based sweeteners. Their goal is to replace sugar and existing sugar alternatives, especially in beverages.

The World Health Organization (WHO) recommends a maximum daily intake of 25 grams of table sugar per person, which is equivalent to about five to ten teaspoons. Staying within these limits is not easy, as many convenience foods, sauces, dressings, preserved forms of fruit and vegetables, breakfast cereals, smoothies, fruit juices, fruit-flavored yogurts and soft drinks are packed with sugar. A single glass of cola (250 milliliters) contains 27 grams of sugar — more than a person should consume in an entire day. In the NovelSweets project, researchers from Fraunhofer IME are working with two partners, metaX Institut für Diätetik GmbH and candidum GmbH, to support the German Federal Ministry of Food and Agriculture (BMEL) in its efforts to reduce the sugar content of ready-made products and beverages in a bid to counteract the rise of health issues caused by improper nutrition. Based on sweet-tasting proteins (SPs), molecules that naturally occur in some plants and fruits, the researchers are using biotechnology methods to produce protein-based sweeteners as future sugar substitutes. Due to their structure, the SPs bond very readily — like sugar — to the receptors on the tongue through which humans perceive flavors as sweet.

Brazzein as basis of new protein varieties

One of the best-known SPs is brazzein, a protein found in the African plant *Pentadiplandra brazzeana*. Extracting it from the plant would be possible, but it is a lengthy and laborious process with little yield. With this in mind, the project partners are developing protein varieties based on the protein sequence of brazzein, optimizing them with an eye to pH and temperature stability and then using biotechnology tools to produce them. They are also improving the new varieties in terms of sweetness and flavor. “Brazzein feels scratchy in the throat. We’re changing the protein sequence to prevent this kind of undesirable effects. The goal is a better sensory experience, without any unpleasant flavor or aftertaste,” explains Dr. Stefan Rasche, a researcher at Fraunhofer IME in Aachen.

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10 000 times sweeter than table sugar

Biotechnology is used to produce the improved candidates through a process known as microbial fermentation. The gene that encodes the sweet-tasting protein, meaning that it contains a description of the protein's amino acid sequence, is implanted into yeast cells, which are then multiplied inside a bioreactor under controlled conditions to produce as much of the SP as possible. After a purification and drying process, the protein-based sweetener is ready. The researchers call the sugar substitute produced using this method X3. "A single gram of the substitute is as sweet as about 10 kilograms of sugar. This means that by working with our partners, we have managed to develop an SP that is about 10 000 times sweeter than table sugar," Rasche says. It is three to four times sweeter than natural brazzein. The innovative sweetener is a true alternative to sugar for consumers who are watching their intake: "A typical cola contains about 106 grams of sugar per liter. That's equivalent to 1 800 kilojoules (kJ). Just a few milligrams of our SP is enough to achieve the same level of sweetness, so the calorie content can be significantly reduced."

X3 featuring honey-like flavor profile

In addition, X3 tastes a little like honey, which makes it an ideal sweetener candidate. "X3 is impressive for its improved taste compared to the artificial sweeteners that have been available to date, as our tastings with test subjects have shown. Since it is entirely sugar-free in addition to having practically no calories, our modified brazzein version does not cause cavities or increase people's blood sugar levels," Rasche continues. The first plan is to add the substitute to drinks. Project partner metaX is currently testing and developing the first range of products containing X3, such as a low-protein beverage powder made with cocoa. However, before the approval process can start, the manufacturing process needs to be optimized along with further product validation measures so the full potential of the X3 protein version can be tapped into.



Fig. 1 Excessive sugar consumption contributes to health issues including excess body weight and obesity in children and adults.

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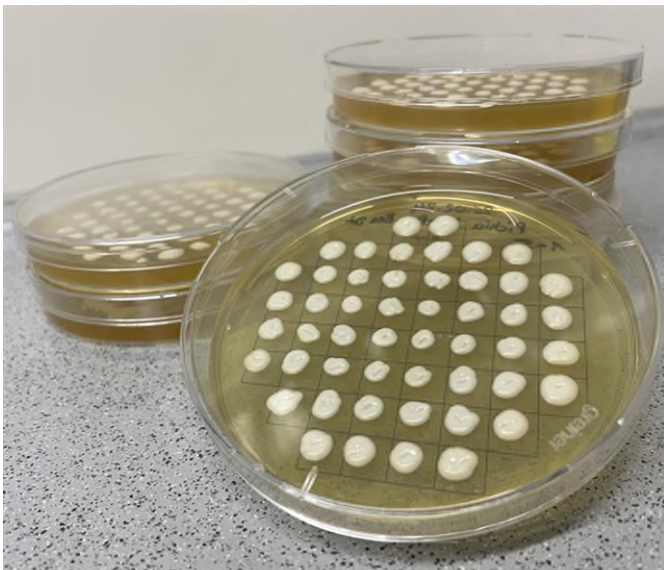


Fig. 2 Yeasts on agar plates. The gene that encodes the sweet-tasting protein is implanted into yeast cells. The cells are then multiplied inside a bioreactor under controlled conditions in such a way as to produce as much of the sweet-tasting protein as possible.

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Fig. 3 Bioreactor for microbial fermentation

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