A CLASSIC SUGAR, TREHALOSE OFFERS NEW SOLUTIONS

A CHANCE ENCOUNTER WITH A SOIL BACTERIUM has led to international research on the food and pharmaceutical roles of a disaccharide.

In 1994, Japanese company Hayashibara Co., Ltd. developed a way to mass produce trehalose, a naturally occurring, energy-producing sugar found in many plants, algae, fungi, bacteria, and insects. Since then, the company's research, and work by scientists around the world, reveals wide-ranging benefits. Currently used to prolong food or vaccine shelf life, Hayashibara hopes trehalose could also be used to help prevent and treat some metabolic, cardiovascular, neurodegenerative and infectious diseases.

Early methods for trehalose manufacturing produced low yields, making the product prohibitively expensive for commercial use. In 1992, Kazuhiko Maruta, a glycoscientist at Hayashibara discovered two enzymes produced by a soil bacterium, *Arthrobacter* species strain Q36. These enzymes, together with a starch-degrading enzyme discovered in 1966, can repeatedly react with maltodextrin to produce high yields of trehalose.

TREHALOSE AND THE FOOD INDUSTRY

"Hayashibara began trehalose mass production following studies that showed it provides excellent hydration, is only half as sweet as table sugar, and is stable, making it suitable for use in a wide range of foods," says Maruta.

CURRENT INFORMATION ON TREHALOSE IS JUST THE TIP OF THE ICEBERG

Now widely used in Japan to prolong food shelf life, trehalose protects foods from drying out, starch-containing products from going stale, and fruits and vegetables from discolouring. It also suppresses ice crystal growth in frozen foods, reducing food loss.

"Trehalose has been safely used as a food ingredient in Japan for more than 20 years," says Takanobu Higashiyama, senior scientist at Hayashibara, who has researched trehalose since 1999.

Higashiyama is establishing international research collaborations to investigate trehalose's health benefits. He also plans to examine its potential to preserve enzymes in the food and pharmaceutical industries.

"Enzymes can become unstable and easily denatured by heating or drying, losing their activity. This makes them difficult to preserve without a properly maintained cold chain. If trehalose can be used as an enzyme stabilizer, it has huge potential for extending their shelf life and reducing energy costs of cold chains," he says. This potential could also extend to vaccines and remove the need for cold chain storage, a major hurdle in vaccine distribution and stockpiling.

METABOLIC SYNDROMES

"The current information on trehalose is just the tip of the iceberg," says Higashiyama.

In 2010, Hayashibara veterinary scientist, Chikako Arai, demonstrated that trehalose suppressed fat cell growth and mitigated insulin resistance in obese mice given high fat diets.

She also found that trehalose increased the production of energy-consuming beige fat cells within white fat tissue and reduced glucose levels in healthy mice. "Use of trehalose as a supplement could help increase energy expenditure and has potential to prevent obesity," she says.

Moreover, daily intake of trehalose in humans facilitated postprandial blood glucose return, suggesting it could help prevent the progression of type II diabetes.

AUTOPHAGY INDUCER

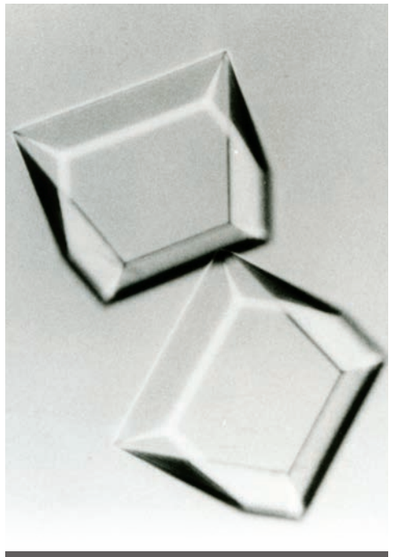
Scientists elsewhere identified health potential in trehalose through its role in activating autophagy, the body's natural process for removing damaged cells. "Most current autophagy inducers are chemical synthetics, so it is interesting to see how trehalose, as a natural substance, contributes to human well-being," says Higashiyama.

Trehalose's role as an autophagy activator was first reported by UK researchers whose research in mice showed that trehalose, through its activation role, helped clear mutant proteins that have been associated with Huntington's and Parkinson's disease.

Other researchers found that this autophagy-inducing role prevented neural tube defects in the developing foetuses of mice models of diabetics; elicited a cardioprotective effect that could improve cardiac remodelling following heart attacks; and attenuated atherosclerosis and fatty liver in mice fed high fat diets. Scientists have even speculated that trehalose's autophagy-dependent antiviral actions could be used to help prevent infection and transmission of viruses.

"With the ageing global population, many people are worried about their health. We hope people's healthy life expectancy will be extended by daily consumption of trehalose," says Arai. ■

Early research suggests that trehalose, a widely-used food ingredient, may also have health benefits.



Trehalose is a naturally occuring sugar (crystalline form).

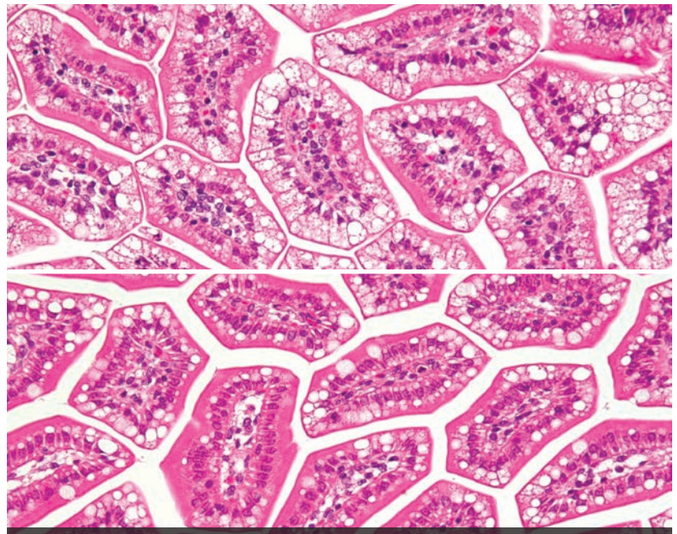
SUPPRESSING OBESITY

A 2020 study on mice showed that trehalose ingestion could prevent metabolic syndrome by trapping fat droplets within the intestinal epithelium and suppressing their rapid migration into the blood.

Hayashibara's Chikako Arai conducted an experiment in which normal mice or trehalase knockout mice (lacking ability to decompose trehalose) were given a high-fat diet and water with or without trehalose.

Results showed trehalose suppressed the hypertrophy of fat cells in both types of mice and increased lipid droplets in the intestinal epithelium: these were excreted in the mice's faeces.

"Trehalose may be a lipid metabolism regulator that has potential to suppress obesity," says Arai.



Trehalose increases cytoplasmic lipid droplets in the jejunum (above), compared to water (below).

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