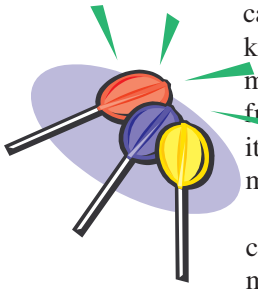
Using Bacteria To Make a Sweet, Minty-Tasting Compound

Even if you haven't heard of mannitol, chances are you've eaten this minty-tasting sugar alcohol as a powdery coating on chewing gum, candies, or pills. It's also used as a low-calorie sweetener, a diuretic, and an agent to add body to foods.

Mannitol is produced naturally by certain plants, though not to a degree that satisfies humankind's myriad uses for it. Now, rather than chemically manufacturing mannitol, a Peoria, Illinois, scientist is using a *Lactobacillus* bacterium steeped in high-fructose syrup to do the job inside fermentation flasks.

Agricultural Research Service chemist Badal Saha developed the biobased approach as a more efficient alternative to industrial methods now used. "Our goal is to replace these chemical processes with biobased methods," says Saha, at ARS' National Center for Agricultural Utilization Research, in Peoria. "We can use just about any kind of carbohydrate material containing fructose and convert it to mannitol by this method," he adds.



Manufacturers currently produce mannitol by subjecting a 50-50 mixture of fructose and glucose to a nickel catalyst and high-pressure hydrogenation (HPH). But in addition to generating chemical wastes, says Saha, HPH converts only 25-30 percent of these sugars into mannitol, which sells for $3.32 a pound. The rest is mostly sorbitol, a lower-priced sugar alcohol (73 cents a pound).

In a paper accepted for publication in *Biotechnology and Bioengineering,* Saha reports that his biobased method converts up to 72 percent of fructose into mannitol.

Central to this approach is *L. intermedius* NRRL B-3693, a strain the scientist chose from 72 other bacteria specimens in ARS' Culture Collection, also in Peoria.

Nature endowed this strain with a powerful metabolic enzyme that enables it to free up the sugars' carbon as food. Mannitol, lactic acid, and acetic acid are the byproducts of this action.

In the lab, Saha grows the *Lactobacillus* strain inside a fermentation flask containing a broth of fructose, glucose, or other carbohydrates. Later, he refrigerates the broth and removes the bacteria's "leftovers"—white, needle-like crystals of mannitol.

In trial runs, he observed that on average, the *Lactobacillus* strain will convert 250 grams of corn fructose to 175 grams of mannitol. Saha says fructose is the strain's main carbon source. But up to two thirds of it can be replaced by other sugars, including maltose and sucrose.

"With a fructose/glucose mixture of 2 to 1 (100 grams to 50 grams), we get almost 100 percent conversion of fructose to mannitol," says Saha. "With a sucrose/fructose mixture of 2 to 1, we get a conversion yield of 85 percent mannitol from fructose."

Saha also compared the *Lactobacillus* strain's performance with 11 other bacteria, yeast, and fungi. One top-performing rival given 100 grams of fructose took 120 hours to convert about 73 percent of it into mannitol. The *Lactobacillus* strain, given 150 grams of fructose, converted about the same amount (72 percent) in just 15 hours.

Such speed may bolster its commercial prospects: USDA has patented the strain along with Saha's methods of using it, and a company is now collaborating with him to further evaluate the technology.—By **Jan Suszkiw,** ARS.

This research is part of Quality and Utilization of Agricultural Products, an ARS National Program (#306) described on the World Wide Web at www.nps.ars.usda.gov.

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Chemist Badal Saha (left) discusses control parameters of mannitol production by fermentation with technician Greg Kennedy (center) and student aide Ohiole Ake.