

honey

Bees rely on enzymes to create the **WORLD'S FIRST** ready-to-eat sweetener

FLOWERS, BEES, and biochemistry: these are three of the essentials for making floral honey—one of my favorite foods.

Bees produce and store honey as a food source. The final product is made of roughly 80% sugar, 17% water, and a hodgepodge of trace compounds that are critical to the honey's varied flavors and colors. The most abundant sugars in honey are fructose and glucose. Among the myriad minor complex sugars in the goo are maltose, sucrose, and other disaccharides, as well as trisaccharides such as erlose.

To make this delicious treat, foraging bees start out by guzzling nectar, a dilute solution of sugars in flowers. Then, they mix the nectar with enzymes in their stomachlike honey sacs. Back at the hive, the foragers pass the digested material to house bees who reduce the moisture content of the mixture by ingesting and regurgitating it. They then deposit concentrated drops into honeycomb cells. Over the next few days, bees fan the fluid with their wings to further concentrate it, and finally, they cap the cells with wax. At the same time, enzyme-mediated changes produce a range of sugars and acids in the honey.

Bee enzymes also show up in the finished product. Invertase is the most critical. It splits the sucrose in the nectar into fructose and glucose and also produces some erlose. Another enzyme, glucose oxidase, converts glucose to gluconolactone, which is then hydrolyzed to give gluconic acid, the principal acid in honey. Formic, acetic, butyric, and lactic acids are also found in honey, which explains why its pH typically measures 3.8–4.0 and bacteria have a hard time growing in it.

Honey also contains small amounts of minerals and proteins.

About 0.2% of honey is ash, probably originating in the flower nectar. Potassium accounts for about

one-third of the ash. Other trace elements in honey include iron, manganese, copper, and silicon. The sweetener also contains up to 1% nitrogen, which comes principally from proteins. These proteins can cause honey to foam and form tiny air bubbles.

Of the more than 100 compounds found in honey, many are volatile organic compounds, such as phenylethyl alcohol, that contribute to flavor. "The honey flavor is dependent on the flavor compounds and aroma compounds that come from a flower," explains William F. Huser, vice president of Sioux City, Iowa-based Sioux Honey Association, which has 300 beekeeper members in North America and markets U.S. clover honey under the SueBee brand.

Because weather and geography affect flowers, Huser notes, each batch of, say, clover honey can have a slightly different makeup of flavor chemicals. And clover honey has a distinctly different flavor than, for instance, orange honey found in California and Florida or cranberry honey found in New England.

IF NECTARS from a single flower species vary from plant to plant, region to region, and season to season, how does a brand maintain a uniform taste? Processors usually mix different batches of the same variety of floral honey. "We are constantly doing a blend to get the proper moisture, the proper color, and the proper flavor," Huser explains. For example, he notes, "We'll blend clover honeys from Montana, which have one set of characteristics, with clover honeys from Minnesota, which have a different set of characteristics."

To grade the color of honey, many in the industry still use traditional colorimetric analysis, which relies on matching color by sight. Nowadays, however, many processors rate color by using various electronic colorimetric analyzers. Color generally equates

HONEY AT A GLANCE

China is the largest producer of honey, churning out about 700 million lb each year. The U.S. is the largest honey consumer, using about 300 million lb per year.

A bee makes less than one-twelfth of a teaspoon of honey in its lifetime.

Erlose was discovered at and named after the USDA Eastern Regional Research Center, in Pennsylvania, where it was first isolated from honey.

to price in the honey business. Light honeys sold by the bottle have a more popular flavor and are more expensive than strongly flavored, darker honeys used in industry as food ingredients.

Honey's cachet as an ingredient in food products has fueled an increased demand worldwide, says Jerry Probst, a consultant for the National

Honey Board and a former president of the Sioux Honey Association. As a result, honey fraud exists. In fact, "much of what has been learned about the composition and properties of honey has resulted from research aimed at verifying its authenticity," according to Landis W. Doner, one of the investigators in a pioneering honey research program during the 1960s to '80s at the Department of Agriculture's Eastern Regional Research Center, in Pennsylvania.

Analytical techniques, including liquid chromatography, thin-layer chromatography, and mass spectrometric stable carbon isotope ratio analysis, can help assess whether honey has been adulterated with corn syrup or cane or beet sugars. Doner and associates at USDA created many of the first methods to analyze honey with these techniques. At certain levels, however, these additives are virtually undetectable because all of their major components also occur naturally in honey.

Huser adds that U.S. researchers commonly test for both legal and illegal residues. They rely on gas chromatography to test for pesticides in honey, and they turn to enzyme-linked immunosorbent assays to detect antibiotics. He notes that adulteration can also result from the removal of key components from honey. For example, processors that use ultrafiltration to remove problematic residues may inadvertently extract some of honey's higher sugars and possibly even all of its flavor compounds.

And without the flavor, honey essentially becomes just another sugary syrup.—
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