

# The Color of Honey

## A sweetener that bee-devils food spoilage

By JANET RALOFF

Many people—including a number of nutritionists—“dismiss honey as nothing more than sugar water,” says May R. Berenbaum. “Biologically, however, that makes no sense.”

A concentrated form of nectar, honey is the principal source of nutrition for adult bees, observes Berenbaum, an entomologist at the University of Illinois at Urbana-Champaign. Mixed with pollen, it also serves as the dietary staple of bee larvae. Indeed, honey supplies the insects with a wealth of vitamins, minerals, and other plant-derived nutrients.

Chemical analyses by Berenbaum's team now show that some honeys also possess surprising quantities of antioxidants—non-nutritive agents that can retard biologically destructive chemical reactions that cause rancidity in foods and that have been linked to many chronic diseases. When honey is cooked, it appears to acquire additional, functionally important antioxidants, according to related studies now under way at Clemson (S.C.) University.

These new data suggest that substituting honey for refined sugar in foods might provide health and storage benefits. Honey also offers a natural source of antioxidants to manufacturers of skin-care products such as sunscreens.

All of this sounds mighty sweet to the United States' beleaguered beekeepers. As their hives have succumbed to blights, the cost of honey production has skyrocketed ([SN: 8/8/98, p. 84](#)). At the same time, foreign honey has flooded the U.S. market, keeping the commodity's wholesale price relatively low.

If findings from the antioxidant studies are confirmed, U.S. producers may see substantially greater demand—and prices—for their honey, especially the darker varieties that have often been considered second-rate.

The low status of one honey provided a major impetus for the Urbana studies.

The state of Illinois issues grants for research into ways of increasing the value of existing crops and commodities. “Soybean honey, which is what a lot of Illinois beekeepers produce, is not highly prized,” Berenbaum notes. It tends to be darker than honeys from bees foraging on clover or orange blossoms, and it lacks their fruity taste. “It has no cachet,” she adds, which may explain why this sweetener is usually labeled as deriving from wildflowers, which the bees also visit.

Although honey has been used as a folk remedy for burns, cataracts, ulcers, and wounds—all conditions in which oxidation can play a role—no one had systematically surveyed different honeys to determine whether the antioxidant capacity varies with the nectar source, the Illinois team observes, or even whether antioxidant concentrations in honey are sufficiently high to be of biological significance.

So Berenbaum's group assayed 19 honeys from bees in widely varying geographic locations: Hawaii, Florida, Arizona, Illinois, California, and Washington State. The syrupy sweeteners represented 14 different primary floral nectars—from fireweed and mesquite to star thistle and sunflowers.

The activity of all water-soluble antioxidants in each honey was compared to that of ascorbic acid, or vitamin C—the gold standard. Because one molecule of ascorbic acid can neutralize two molecules of an oxidant, a micromole of vitamin C is defined as having a potency of 2 microequivalents ( $\mu\text{eq}$ ).

In the summer *JOURNAL OF APICULTURAL RESEARCH*, Berenbaum and her Illinois colleagues Steven

M. Frankel and Gene E. Robinson report finding a clear trend. Although honeys vary widely in the quantity of water-soluble antioxidants they contain, the scientists found that the darker a honey's color, the higher its antioxidant activity.

A milliliter of Illinois buckwheat honey, by far the darkest tested, contained  $4.32 \times 10^{-3}$   $\mu\text{eq}$ , which is 20 times the antioxidant activity in the same quantity of California sage honey, one of the lightest-colored samples. Sunflower, christmasberry, and water-tupelo honeys, also at the dark end of the color range, were the next richest sources of antioxidants, although their antioxidant content was only 25 to 40 percent as high. Soybean and clover honeys, which fall in the middle of the color range, had only 10 to 12 percent of buckwheat's antioxidant potential.

A few honeys buck the trend, however. Though fairly light, sweet-clover honey is antioxidant-rich, while a darkly golden mesquite version possesses relatively little antioxidant activity. Overall, however, the analysis concludes that color predicts more than 60 percent of the variation in a honey's antioxidant capacity.

While the Illinois scientists did not identify the antioxidants in any given honey, previous studies have shown that nectar tends to contain large quantities of flavonoids—plant pigments and flavoring compounds with antioxidant properties. "My guess is that these flavonoids are not only contributing to the honey's antioxidant activity but are probably the principle contributors," Berenbaum told SCIENCE NEWS.

Most fruits and vegetables contain antioxidants. Though the average honey's ascorbic-acid equivalency,  $0.8 \times 10^{-3}$   $\mu\text{eq}$  per milligram, comes close to that of tomatoes, Berenbaum's group notes that many fruits and vegetables possess far more. Orange pulp, for instance, has  $5.7 \times 10^{-3}$   $\mu\text{eq}/\text{mg}$ , and broccoli and sweet peppers show  $13.0 \times 10^{-3}$   $\mu\text{eq}/\text{mg}$ . Dried tea, renowned for its antioxidants, can run to  $220 \times 10^{-3}$   $\mu\text{eq}/\text{mg}$ .

Moreover, Berenbaum is quick to point out, these figures may actually underestimate those foods' oxidant-quashing activity, since many of them—unlike honey—also contain large quantities of fat-soluble antioxidants such as vitamin E and carotenoids. People also tend to eat far smaller quantities of honey than they do most fruits and vegetables.

Still, she notes, per capita sugar consumption in the United States "is enormous"—roughly 150 pounds per year, according to the latest Department of Agriculture statistics. "If you were to substitute honey for all that sugar," she surmises, "the contribution of its antioxidants might become substantial."

Although the presence of antioxidants suggests that honey might be able to limit the ravages of biologically destructive agents, the proof is in the pudding, or muffins, or sausage, notes Nicki J. Engeseth, a food scientist at the University of Illinois.

In one set of experiments, she therefore added honey to fruits and vegetables that turn brown upon exposure to air. In such foods, an enzyme in the plant tissues triggers a reaction between oxygen and phenolic chemicals. The resulting browning not only makes the food unappealing but also uses up its vitamin C.

For this test, she put freshly cut apples, pears, potatoes, or yams into a blender—grinding them into a soupy homogenate—then mixed in one of six different types of honey. Though the light colored acacia honey offered no protection against browning, the darker honeys did.

Christmasberry honey retarded the browning enzyme's activity by up to 50 percent, for example. While the honey didn't match the potency of ascorbic acid or sulfites—two commercially popular antioxidants—it did lengthen the time before browning occurred.

Soy honey also greatly reduced the rate at which the foods turned brown. Indeed, it proved far more effective than the clover honeys, even though all possessed similar antioxidant ratings. This suggests, Engeseth says, that for certain applications, which antioxidants are present may be as important as their quantity.

Though buckwheat honey's high antioxidant content suggested it probably would have had

the best chance of retarding enzymatic browning, “we couldn’t use it,” Engeseth says, because its “tarry” color would have darkened foods even in the absence of any oxidation.

In a second experiment, the group investigated honey’s ability to slow the oxidation of fats. A form of food spoilage, this process turns fats rancid (SN: 2/9/85, p. 88) and may transform them into a potent risk factor for artery-clogging heart disease (SN: 5/4/85, p. 278).

In this test, the food scientists added honey to ground turkey, making the sweetener 5 percent of the total weight. “We picked poultry,” she notes, “because honey is already used in a number of recipes such as honey-smoked turkey.” Because lipid oxidation accelerates dramatically once a meat is heated, the Illinois team panfried the concoction.

Three days later, they assayed the meat for oxidation products. Compared to unhoneyed poultry that had been similarly cooked and refrigerated, the honeyed meats exhibited far less rancidity. Again, the darker honeys performed best. Buckwheat honey, permitted in this test, cut oxidation by 70 percent, roughly twice as much as the light-colored acacia honey did. The amount of honey added to the meat was not enough to make it taste sweet, Engeseth notes.

The researchers presented preliminary findings from both studies in June at the Institute of Food Technologists annual meeting in Atlanta.

At the same meeting, Paul Dawson’s team from Clemson presented data on an alternative use of honey—not as a source of antioxidants but as a raw ingredient in their production.

While some foods brown upon exposure to air through a series of enzyme-driven reactions, others brown in cooking via a heat-activated transformation of sugars. Known as a Maillard reaction, this browning causes bread crusts to turn golden, the surface of broiled meats to become dark and crispy, and the tops of custards to caramelize. In moderation, the browning enhances both the appearance and flavor of foods.

“Another byproduct of this Maillard reaction is the creation of antioxidant compounds,” notes Dawson. Because extra sugar can foster the reaction, his group mixed a large amount of honey into the batter that binds small pieces of turkey into a restructured turkey roll. The honey made up 15 percent by weight of the ingredients but did not impart a sweet flavor to the finished product.

When they assayed the rate of oxidation in slices of the cooked meat after 2 days of refrigeration, the honeyed turkey exhibited only 15 percent as much fat oxidation as the untreated meat.

These data indicate that adding honey “probably would extend the shelf life of such deli-type products by several weeks to a month,” Dawson says. Moreover, the honey treatment also appeared to reduce bacterial growth in the product. “We’re not sure why,” Dawson says, though it may reflect the sweetener’s ability to tie up water—as sugars do in jam—rendering it unavailable to microbes.

Though the Clemson studies have focused on techniques likely to aid commercial food processors, Dawson notes that some of the findings might offer ideas to home cooks interested in extending the life of their leftovers. For instance, applying a honey glaze to a roast may retard the oxidation of the uncut meat. Similarly, adding honey to recipes for sausage, meat loaves, and other entrees that include ground meat should retard the rate at which rancid off-flavors develop, he says.

Antioxidant-rich honeys may also find a role in skin-care products, according to David Ropa of Thomas J. Payne Market Development. The Chicago-based consultant prepared a study last year for the National Honey Board in Longmont, Colo.

Honey “can be used to produce alpha hydroxy acids (AHAs), a vital ingredient in the growing market for skin creams and moisturizers,” he says. Indeed, manufacturers are currently developing commercial methods to make honey-derived AHAs. The AHAs work, Ropa explains, “by exfoliating the skin and increasing the rate of cell renewal.”

Several manufacturers already tap honey in the preparation of moisturizers. Honey “retains

moisture and resembles the skin's natural moisturizing factor," notes David Chin, manager of technical marketing in the Somerville, N.J., office of Laboratoires Serobiologiques. Indeed, he says, that's why the French company has used a honey extract in one of its moisturizers for more than 20 years.

Because antioxidants can protect key components of the skin's cells from damage, many firms now add antioxidants to their products, especially sunscreens, Ropa reports. "If honey can act as both an antioxidant and a moisturizer in sunscreens and other skin-care products," he told SCIENCE NEWS, "the potential for this natural ingredient is enormous."

Though Laboratoires Serobiologiques employs antioxidants in many of its products, it has never considered honey as a possible source, Chin says. If, however, manufacturers can look to this natural product for both moisturizing and antioxidant functions, he told SCIENCE NEWS, "demand for honey could go flying out of sight—just like a bee." □