This series of essays explores lessons and observations from fieldwork that might be of interest to the integrative medical community. In this context, the authors discuss "new" or less celebrated botanical medicines and unique healing practices that may contribute to the further development of contemporary integrative medical practices. Perhaps this column can facilitate an appreciation for our own roots and those of other cultures, before such ancient wisdom disappears forever.

WITHOUT SUGAR, WOULD THE HOLIDAYS BE AS SWEET? EXPLORING ETHNOBOTANICAL ALTERNATIVES TO SUCROSE

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What would the season's holiday event, or even an ordinary dinner for that matter, be without sugar? We are a culture that loves sweet-tasting foods, especially after meals, despite the fact that these are well-known empty calories. Do we differ that much from other cultures, especially traditional cultures? The answer is probably not. When I (M. B.) lived in Costa Rica in the early 1970s, our small, remote village had little in the way of food other than beans, rice, and an occasional meat by-product. Harvesting of sugar cane was an important event that drew small crowds as soon as the juice was pressed. Children, especially, would drink the sweet fluid of the sugar cane stem with gusto, faces bright with smiles.

Sugar cane is a recent immigrant to the New World, however, arriving with Columbus on his second voyage in the late 1400s. It is native to the South Pacific, but has been a crop in India for centuries. Arab traders distributed this member of the grass family throughout the Near East and Mediterranean, where it became a global voyager, with plantations established in numerous tropical countries around the world.

In many areas, people have relied on honey to sweeten their palate. Neolithic rock paintings show people preparing sweet foods from honey, as was the case in ancient Egypt.[1] The date palm, one of the earliest of the domesticated plant species, provided a rich source of sugar: up to 70% or 80% of its total fruit weight when ripe.[2]

In many parts of the world, traditional cultures have identified plants that provide a sweet taste, sometimes by masking all other tastes. In consideration of the health problems associated with overconsumption of refined sugar, it may be useful to turn our attention to some of the natural, nonsucrose sources of sweeteners.

During his studies in Samoa, ethnobotanist Paul Cox found that ancient people there once prepared a sweet candy and sugar substitute from the roots of the ti plant (*Cordyline terminalis*). In his attempt to investigate this traditional food, Dr Cox found that local people generally had forgotten how to prepare this sweetener. Using historical records, he recreated an oven used to prepare the plant, and produced, for the first time in generations, sugar from this indigenous plant.[3]

Other plant species contain sucrose, such as the common reed, *Phragmites australis*.[4] The juice of this member of the grass family is sweet and can be used to produce sugar. A pine tree, known as the sugar pine (*Pinus lambertiana*), found in southwestern North America, has been used to produce sugar by boiling the water off from its sap. The American basswood (*Tilia americana*) yields sap that can be concentrated into a sweetening agent.[5]

Probably the best-known plant with sugary properties is stevia (*Stevia rebaudiana*), a member of the daisy family that is becoming a natural noncaloric sweetener that is easier to find in health food stores. This plant, native to eastern Paraguay, Brazil, Colombia, and Venezuela, has been used for more than 600 years in South America.[6] Approximately 100 species of stevia grow in tropical South America, but only 1 species has the incredibly sweet leaves.[7] Discovered by the Guarani Indians of Paraguay, it was used to sweeten Yerba Mate tea (*Ilex paraguariensis*) and otherwise unpalatable medicinal drinks.[8] One source noted that "about 7 large leaves immersed in a tea bob" could be used to sweeten a cup of tea or coffee.[9] Another source reported that the traditional use was treating diabetes.

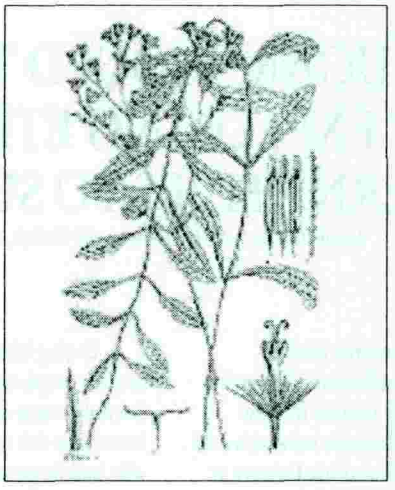
The useful part of stevia is the leaf, which contains the glycoside stevioside. This is a noncaloric compound stable to heat and acid. It does not darken with cooking. A dry stevia leaf is up to 30 times sweeter than sucrose. The sweetness is attributed to 2 compounds, stevioside and rebaudioside A, and can be up to 200 or 300 times (respectively) sweeter than sucrose. For the sake of comparison, 1 teaspoon of sugar is equivalent to one-eighth teaspoon of stevia leaf powder, which is equivalent to a few crystals of stevia extract on a spoon.[6] The whole plant is harvested all at once just before flowering to obtain the maximum glycoside content.

Currently the main producers of stevia are Japan, China, Taiwan, Thailand, Korea, Brazil, Malaysia, and Paraguay. Stevia has

been used for more than 30 years in Japan[8] and has captured more than 40% of the Japanese market. In the United States, stevia sales jumped from $150 000 in 1997 to $5 million in 2000.[10]

In the 1970s, the Japanese government approved the use of this plant as a sweetener, and many common foods employed its use, from soy sauce to diet cola. It initially was introduced into foods in the United States via teas. In the 1990s the Food and Drug Administration (FDA) imposed a ban on imports, calling it an unapproved food additive. The FDA felt that its safety as a food had not been sufficiently proven. Later, in the early 1990s, 2 petitions to the FDA called for recognition of stevia as safe, but the agency did not agree. However, many other organizations felt that there was weak scientific evidence supporting the FDA's position against approval.

In its ruling on September 18, 1995, the FDA finally lifted its 4-year import ban of stevia, approving its use as a dietary supplement or as a dietary ingredient of a supplement, but not as a food additive or ingredient. The current ruling now allows the sale as long as it is clearly labeled as a dietary supplement. The key is that companies cannot refer to stevia as a sweetener.



Stevia rebaudiana *from Hooker's* Icones Plantarum, *1909. London, England: Dulau & Co. Courtesy of the LuEster T. Mertz Library, The New York Botanical Garden.*

Stevia has been used by indigenous people in Paraguay and Brazil to lower blood glucose. However, the mechanism for achieving this has not completely been elucidated. Recent in vitro studies indicate that stevioside and steviol stimulate insulin secretion via direct action on beta cells.[11] Despite stevia's sweetness, testing in rats reveals that stevioside and rebaudioside A did not generate caries.[12] Animal studies on rats evaluating renal function indicate that if stevia is taken orally, systemic and renal vasodilation causing diuresis, hypotension, and natriuresis occur.[13] One rat study showed that an aqueous stevia extract reduced sperm production and testis weight.[14]

Stevioside shows no evidence of mutagenic, genotoxic, or teratogenic effects. Another constituent, steviol, has been shown in vitro to have some mutagenic potential.[15] Despite similar reports in animals, few adverse case reports have been noted in humans, even with widespread use in many Asian countries for decades.

In tropical West Africa, an evergreen bush, growing to 5 or so meters in height, is referred to as the miracle fruit or miracle berry. It is known botanically as *Synsepalum dulcificum*, with the species name referring to its sweetening properties. It has been used by traditional peoples in this area to mask bitterness of beverages and foods. The fruits that form on this bush year round are red, ellipsoid in shape, and 2 to 3 cm in length. Each fruit contains a small seed. If you taste the fruit, you will not notice any sweet sensation. However, for the next 30 minutes, any sour food eaten is perceived as sweet—hence the "miracle." A protein substance contained in the fruit is responsible for modifying sweet receptors in the mouth, allowing them to be stimulated by acidic substances.[16] This taste-altering protein is known as a taste-modifying protein (TMP). The TMP isolated from *S dulcificum* is called miraculin.

Attempts in the 1970s to introduce this plant into US commerce were unsuccessful. At the moment, researchers are attempting to develop it into a commercial crop, so it lags behind stevia in the public eye. One of the major obstacles to its commercial development has been the protein's instability during processing. Any damage to the fruit quickly denatures the protein. Similarly, the protein in crude extracts is equally sensitive to degradation. The development of TMPs in the United States began in 1969, when cyclamate was banned and the public became disillusioned with synthetic substances. Several other plants have been explored for similar reasons; however, all have had difficulty in isolating and stabilizing the proteins that produced this taste-modifying effect.

In reviewing the properties of hundreds of plants that can provide either caloric or noncaloric sweetness, it is clear that, whatever the source, the demand for all things sweet is here to stay. Today, world consumption of sucrose now amounts to an annual average of 21 kilos per person, and appears to be rising steadily. For healthcare providers who are eager to steer their overweight, sugar-addicted patients—or themselves—away from caloric sources, stevia and perhaps other TMP-containing plants may be the answer.

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