A DOCTOR'S GUIDE TO SWEETENERS

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Humans have always had a sweet tooth. Our attraction to sweetness begins at birth and may be a vestige of our distant, arboreal past when we were all fruit-eaters. Even our terms of endearment—honey, sweetheart—embody that fascination.

This article is an overview of the myriad and ubiquitous sweeteners your patients may be using—and in many cases, without even being aware of it. Knowing the names and characteristics of the caloric sweeteners in food products may help you identify what's behind your patient's problem with weight, fatigue, or dental caries. And knowing the names and characteristics of the seemingly endless list of reduced- or low-calorie sweeteners may help you sort out other problems, particularly gastrointestinal complaints. Table 1 is a relative sweetness chart.

Natural Sweeteners

Sugars belong to the family of carbohydrates (sugars and starches), the body's main source of fuel. Table sugar—and other closely-related sugars—are simple carbohydrates composed of short molecules of carbon, hydrogen, and oxygen.

Sugars are either monosaccharides (fructose, galactose, or glucose), or 2 monosaccharides joined together to form disaccharides (sucrose, lactose, or maltose):

- sucrose = glucose + fructose
- lactose = glucose + galactose
- maltose = glucose + glucose

Sucrose is what we know as table sugar, but sucrose is also found naturally in certain fruits and vegetables; lactose is the sugar found in milk; fructose is the sugar found in fruit and honey.

Until table sugar was first developed about 600 years ago, most people got their sweet fixes from honey or sugary fruits like berries, dates and figs. A 20,000-year-old cave painting even shows a human figure robbing a wild bees' nest for its honey.

Honey

Revered for millennia as a natural source of sweetness, honey is manufactured by busy bees from flower nectar. And busy they are: 1 pound of honey is the end result of bees traveling up to 55,000 miles while visiting 2,000,000 flowers.

The monosaccharides glucose and fructose are the primary sugars in honey, but other disaccharides, such as maltose and sucrose, and even some oligosaccharides make up a minor portion of its composition. Small or trace amounts of vitamins (B-6, thiamin, riboflavin, and pantothenic acid), minerals (calcium, copper, iron, magnesium, manganese, phosphorus, potassium, sodium, and zinc), several amino acids, and certain antioxidants are also present.

Ounce for ounce, honey and table sugar have almost the same nutritional value. But because honey is heavier than table sugar, a teaspoon of honey has 21 calories compared to sugar's 16 calories. On the other hand, honey is up to 1.5 times sweeter than sugar, so less is needed to sweeten foods.

And honey can synergistically enhance sweetness (up to a limit) if added to items with low levels of sweetness. For example, adding a 25% honey solution to a 5% sucrose solution doubles the intensity of sweetness—an effect that might be useful for limiting calories while increasing sweetness levels.

Addition of similar honey solutions also decreases the perception of the other three basic tastes: sourness, bitterness, and saltiness. Taking advantage of this fact, manufacturers of salt-cured products such as ham or bacon have long masked the high saltiness of their products by adding honey.

Parenthetically, honey has other interesting characteristics. You may have noticed that honey never gets moldy. Used as a salve, honey's antibiotic properties have been successfully used in the treatment of bed sores, burns, and other assorted wounds. And recent studies are examining the assorted antioxidants found in honey and their bioavailability.

TABLE 1
RELATIVE SWEETNESS OF NATURAL AND ARTIFICIAL
SWEETENERS COMPARED TO SUCROSE

SWEETENER	SWEETNESS/SUCROSE
NEOTAME	13,000
THAUMATIN	3,000
ALITAME	2,000
DHC	2,000
SUCRALOSE	600
SACCHARIN	300
STEVIA	300
ACESULFAME-K	200
ASPARTAME	180
GLYCYRRHIZIN	100
CYCLAMATE	30
HFCS	1.5
HONEY	1.5
SUCROSE	1.0
TAGATOSE	1.0
XYLITOL	1.0
HSH	0.9
MALTITOL	0.9
ERYTHRITOL	0.7
ISOMALT	0.65
MANNITOL	0.5
TREHALOSE	0.5
SORBITOL	0.6
LACTITOL	0.4

Sugar

The most common source of sugar is sugar cane, a giant grass resembling bamboo (sugar beets are a second, more recent source). First cultivated in Asia thousands of years ago, sugar cane probably originated in New Guinea. People have always enjoyed gnawing on sugar cane because its juice (90 percent of sugar cane's weight) contains up to 17 percent pure sucrose.

By 500 B.C., sugar cane juice was boiled down to a crude, solid sugar that resembled dark brown sugar. In another 1200 years, Persians were refining a much whiter "loaf sugar" by using lime and bull's blood. Loaf sugar, which looked like a conical loaf of bread, was so hard consumers had to break off chunks with a hammer before they could use it.

When table sugar was first introduced to Europe, it was so expensive only the upper classes could afford it. Sugar was so much in demand that sugar cane plantations sprang up around southern Europe (even Christopher Columbus' mother-in-law owned a sugar plantation). On his second voyage to the New World in 1493, Columbus planted sugar cane on Santa Domingo Island. Shortly thereafter, sugar cane—also a source of rum—was the main crop in the Caribbean. Pure sugar then became available to the upper classes who could

afford sweetmeats, but they soon fell victim to the dark side of sugar: rampant tooth decay.

A German visitor in 1598 described Queen Elizabeth, who loved sweets, "Next came the Queen, . . . her Lips narrow, and her Teeth black; (a defect the English seem subject to, from their too great use of Sugar). . . ."

By the 19th century, the price of sugar dropped to where almost everyone could afford it. Today, it's so cheap, it's frequently used as a cheap filler in products such as breakfast cereals.

The modern method of refining sugar begins with crushing sugar cane to obtain its juice. The juice is heated with lime and evaporated several times, converting it to a thick, dark sludge. The sludge is run through a centrifuge, throwing off a syrup called blackstrap molasses and leaving raw sugar behind. The raw sugar is then chemically decolorized and filtered through charcoal to yield pure white sugar.

Sugar plays an important role in widespread obesity because of its 4 empty calories per gram (about 16 calories per teaspoon)—empty calories because table sugar is 99.8 percent sucrose, which leaves virtually no room for vitamins, minerals, or fatty acids. Astonishingly, the average North American eats 170 pounds of sugar annually—roughly 300,000 calories, equivalent to about 100 pounds of body weight.

Many varieties of sugar are available to the consumer. Short descriptions of the most common follow. A common thread (with 1 exception) is that they all are seriously lacking in nutritional content, supplying only energy and virtually nothing else.

- **Blackstrap molasses**, a final by-product of sugar refining, is the darkest and strongest tasting of the sugar syrups.
- **Muscovado sugar** is a raw, dark-brown sugar that has been separated from molasses syrup.
- **Demerara sugar** and other similar light-brown sugars have relatively hard crystals. Incidentally, brown sugar is not crude, unrefined sugar, but only white sugar with a little molasses stirred back into it.
- **Granulated white sugar**, with medium-size crystals, is the most familiar sugar.
- **Caster** (aka **castor** or **superfine**) **sugar** has fine-sized crystals designed for quick dissolving.
- **Powdered** or **confectioner's sugar** is crushed white sugar mixed with a small amount of cornstarch to keep it dry.

- **Rock candy** crystals are made from evaporating a supersaturated sugar solution.
- **Barley sugar**, which has a slightly brown tint, is made from white sugar that has been liquified by heating it to 320°F, allowed to cool, and mechanically crushed.
- **Sucanat™**, a recent addition to the sugar family, is a modern reincarnation of the original sugar made thousands of years ago. Fresh juice from crushed sugar cane is dehydrated by a special crystallization process. The resultant free-flowing, light-brown granules have a rich smell and taste, and are a 1-to-1 replacement for white sugar, brown sugar, or honey. Developed by the Swiss, Sucanat's name is derived from SUGAR Cane NATural. Sucanat contains some proteins, vitamins, and minerals because it has a lower sucrose content (only 88.3 percent compared to table sugar's 99.8 percent).
- **High Fructose Corn Syrup (HFCS)** is a fructose/dextrose combination that's about 1.5 times as sweet as sucrose. As its name implies, HFCS is made from corn, not sugar cane. Discovered in the late 1800s, HFCS became a major product in the 1970s. Since then, HFCS has largely replaced cane sugar in many products because of its sweetness and lower cost. It contains the same number of calories per gram as does sucrose (4 calories/gram) and the body metabolizes it the same as sucrose.

Artificial Sweeteners

To satisfy consumers' quest for sweetness, manufacturers have synthesized sweeteners with few or no calories that don't promote obesity or tooth decay, and are acceptable in diabetic diets.

All artificial sweeteners undergo many years of rigorous testing because the FDA is prohibited from approving any food ingredient not shown to be safe. The burden of such proof falls upon the manufacturer, who must provide extensive data, including the name, chemical identity and composition of the sweetener, the physical or other technical effects, comprehensive reports of safety research and project consumption levels. Also, the Delaney Clause requires any carcinogenic food ingredient to be pulled from the food supply.

Some people remain suspicious about artificial sweeteners, though, and claim adverse reactions after having used them. Most claims are anecdotal and have not been substantiated, but studies and testing always continue.

- **Cyclamate**, discovered in 1937, was first used in the United States in the early '50s. Cyclamate is only about 30 times as sweet as sucrose, the least powerful of the high-intensity sweeteners, but it's heat and cold stable, and has synergistic sweetening power with other sweeteners. Cyclamate is not metabolized in most people, but a small percentage does metabolize some of what they consume. Cyclamate was implicated as a possible carcinogen and banned in the United States in 1970. However, more than 50 countries worldwide still use cyclamates as an approved substance. The FDA has been petitioned since the mid '80s to reinstate them, but the ban is still in place.
- **Saccharin**, discovered in 1879, is still being used to sweeten food and beverages (in the '70s, it was the *only* low-calorie sweetener available in the U.S.). Three hundred times sweeter than sugar, saccharin tastes sweet at very low concentrations, but may have a marked, metallic aftertaste at higher concentrations. Sweet 'N Low™ is a popular trademarked version, but saccharin is used in a wide variety of food and health products, including soft drinks (Tab), toothpastes (Colgate, Crest, Pepsodent, etc.) and mouthwashes (Rembrandt, Plax, Scope). One of the most studied ingredients in the food chain, saccharin was the focus of a bladder cancer controversy 2 decades ago. But saccharin is absent 2 major carcinogenic characteristics: it's not metabolized nor does it react with DNA. The controversy rested upon studies in which cancer-sensitive rat strains were fed the human equivalent of hundreds of cans of soft drinks per day for a lifetime. Even then, only some of the male rats developed bladder tumors. Regardless, saccharin was banned in the United States in 1977. Considerable research on saccharin indicates safety at human levels of consumption (average users ingest less than an ounce per year). The American Medical Association (AMA), American Diabetes Association, American Cancer Society, *et al.* believed that saccharin posed little or no risk, resulting in its removal from the federal National Toxicology Program's carcinogen list in 2000. Saccharin's mandatory warning label requirement was also repealed.
- **Aspartame**, 180 times sweeter than sugar, was discovered in 1965 and approved by the FDA in 1981 after 16 years and more than 200 human and animal studies. Trademarked as NutraSweet™, aspartame is made by joining two amino acids (L-phenylalanine and L-aspartic acid) that are found naturally in meat, milk, fruit, and vegetables. When aspartame is digested, the body treats it like any other amino acid.

However, persons born with the rare disease phenylketonuria (PKU) can't metabolize phenylalanine properly and must avoid any foods and beverages containing aspartame. Warning labels stating, "Phenylketonurics: Contains Phenylalanine" must be affixed to aspartame-containing products.

Aspartame is found in more than 1,500 products, including baked goods, cereals, chewing gum, desserts, soft drinks, breath mints, cough drops, yogurt products, frozen dairy products, candies, and pharmaceuticals. Because aspartame is not heat stable, it loses its sweetness at cooking temperatures and is not suitable for cooking or baking unless it's added after the product has cooled. Aspartame's sweetness also diminishes after long storage periods.

Some consumers have complained of adverse reactions after eating aspartame, generally centering on potentially harmful effects of its breakdown components: methanol, aspartic acid, and phenylalanine. The Center for Disease Control (CDC) reviewed 517 complaints in 1984 and found "[no] evidence of serious, widespread, adverse health consequences. . . ." In 1985, the AMA came to the same conclusion.

The FDA has noted, however, that with any food, "there is the possibility [of an] occasional sensitivity. . . ." Focused clinical studies and the FDA continue to review consumer complaints, but no causal link has been found to date. More than 100 countries have found aspartame safe to use.

The Acceptable Daily Intake, or ADI, (the amount that can be safely consumed every day for a lifetime) of aspartame is 50 mg/kg of body weight. Aspartame's ADI is based on human tests where subjects received single doses 4 times the ADI (the equivalent of 70 cans of soft drinks), and animal tests that used 160 times the ADI (2800 cans of soft drinks) every day for more than 2 years.

- **Acelsulfame-K** (or Acelsulfame-Potassium) is 200 times sweeter than sugar. Discovered in 1967, it was approved by the FDA in 1998 after more than 90 studies demonstrated its safety and lack of adverse health effects.

Trademarked as Sunett™, acelsulfame-K is used in thousands of foods and beverages, including sweeteners, desserts (Jello), baked goods, soft drinks (Pepsi One), candies, cough drops (Halls), chewing gum, dairy products, toothpastes, mouthwashes, and pharmaceuticals. Acelsulfame-K has a clean, quick taste that doesn't linger or have an aftertaste. It's not metabolized by the body and contributes no calories.

One advantage of acelsulfame-K is that it remains sweet even at oven temperatures. It doesn't pro-

mote tooth decay, and its sweetness is synergistic when used with other artificial sweeteners.

- **Sucralose**, one of the newest artificial sweeteners, was discovered in 1976, approved by the FDA in 1998, and made available to the consumer as Splenda™ in October, 2000. Sucralose is the only artificial sweetener made from sugar: 3 chlorine atoms are substituted for 3 hydroxyl groups on the sugar molecule, which yields a no-calorie sweetener that's 600 times sweeter than sugar.

Sucralose underwent more than 100 studies over 20 years, demonstrating no safety risks related to cancer, genetic effects, reproduction and fertility, birth defects, immunology, the central nervous system, or metabolism.

Sucralose has a taste profile very similar to sugar, with no aftertaste, yet does not promote tooth decay. It's not metabolized by the body, it doesn't accumulate in the body, and it passes through the body virtually unchanged. Because it's not recognized by the body as a sugar or carbohydrate, sucralose has no effect on glucose levels in either type 1 or type 2 diabetes.

The granular version of Sucralose pours, measures, and—because it's exceptionally heat-stable—cooks the same as sugar. Sucralose is currently used in soft drinks, hot chocolate, fruit drinks, maple syrup, and apple sauce.

- **Neotame**, the newest no-calorie sweetener, was approved by the FDA in July, 2002 after reviewing data from more than 113 animal and human studies. Manufactured by the NutraSweet company, neotame is composed of 2 amino acids, L-aspartic acid and L-phenylalanine, and combined with a methyl ester group and a neohexyl group. The result is a heat-stable, free-flowing white crystalline powder that is 7,000 to 13,000 times sweeter than sugar.

Neotame's sweetness profile displays a clean, sweet taste similar to sucrose, and enhances other flavors in certain applications. Neotame's high-intensity sweetness allows the use of significantly less total sweetener(s), either on its own or blended with other nutritive or non-nutritive sweeteners.

Neotame is rapidly metabolized by the body, is completely eliminated in urine and feces, and does not accumulate in the body. Metabolic by-products include de-esterified Neotame and methanol, but the amount of methanol is exceedingly small compared to methanol derived from ordinary fruits and vegetables. By comparison, about 200 times more methanol is provided by tomato juice than by a beverage sweetened with Neotame.

Polyols

A group of reduced-calorie sweeteners called *polyols* (or sugar alcohols) provide the bulk of sugar, but fewer calories than sugar. In the United States, they're used in a wide range of products, including chewing gums, confections, ice creams, toothpastes, mouthwashes, pharmaceuticals, and baked goods.

Polyols do not promote tooth decay. Nor do they cause spikes in blood glucose levels because they're slowly and incompletely absorbed into the blood by the small intestine, where they are converted into energy with little or no use of insulin. Portions of the polyol that are not absorbed are broken down in the large intestine.

In some people, excessive consumption may cause gastrointestinal symptoms such as diarrhea or gas. Symptoms in polyol-sensitive people are usually mild and temporary, and they can usually adapt to polyols by gradually increasing amounts in their diet.

Polyols are generally heat-stable, so they can be used to flavor hot beverages and baked products, but they do not caramelize to produce a crisp, brown surface on baked products, which may make them unsuitable for certain applications.

Polyols used in the United States include:

- **Erythritol**, a white crystalline powder with a clean, sweet taste similar to sucrose. Available since 1990, erythritol is about 70 percent as sweet as sucrose. Its caloric value is 0.2 calories/gram, compared to sucrose's 4 calories/gram. Erythritol has a high digestive tolerance. Most is rapidly absorbed and excreted unchanged in urine. Only about 5 percent of erythritol reaches the large intestine where it can ferment and cause gas or laxative problems. Erythritol has been part of the human diet for millennia because it occurs naturally in a number of foods, such as fruits, mushrooms, wine, soy sauce, and cheese. Erythritol is synergistic with other sweeteners, such as aspartame and acesulfame-K, and can mask bitter flavors sometimes associated with certain low-calorie sweeteners.
- **Mannitol**, an isomer of sorbitol, is produced by hydrogenating glucose syrup. About 50 percent as sweet as sucrose, mannitol has a cool taste that can be used to mask bitter tastes. It contains 1.6 calories/gram. Mannitol is only partially digested; the non-absorbed portion is metabolized by colonic bacteria

in the lower intestine, which may cause softer stools and gas in some people. Because mannitol is slowly absorbed, the rise in blood glucose and insulin demand is much less than after ingesting sucrose.

Mannitol is nonhygroscopic, which makes it useful as a dusting powder for chewing gum to prevent it from sticking to wrappers, and it does not discolor at high temperatures, which makes it useful for pharmaceuticals. It also does not support tooth decay.

- **Isomalt**, an excellent tasting sweetener discovered in the 1960s, is made from sucrose. A crystalline white substance with 45 to 65 percent of the sweetness of sucrose, it looks much like table sugar and products that use it have the same appearance and texture as those that use sugar. Isomalt doesn't promote tooth decay or increase blood glucose or insulin levels. It contains 2 calories/gram.
- **Lactitol**, a bulk sweetener with a mild and clean sugar-like taste, was discovered in 1920 and first used in foods in the '80s. Because it's only 40 percent as sweet as sucrose, it may be partnered with other non-nutritive sweeteners. Lactitol is not hydrolyzed or absorbed in the small intestine, but is metabolized in the large intestine where it's converted into biomass, organic acids, carbon dioxide, and a trace of hydrogen. It doesn't contribute to tooth decay or an increase of blood glucose or insulin levels. Lactitol contains 2 calories/gram.
- **Maltitol**, with a pleasant sweet taste very similar to sucrose, is about 90 percent as sweet as sucrose. It contains 2.1 calories/gram. Derived from starch, maltitol is also useful as a fat replacement because it gives a creamy mouthfeel to food, making it particularly useful for sugar-free or reduced-calorie chocolate confections. Maltitol does not promote tooth decay, but may produce a laxative effect when consumed at very high levels.
- **Xylitol**, a bulk sweetener, was discovered in 1891 by a German chemist. Used as a sweetener in food since the 1960s, xylitol has the same sweetness as sucrose with no aftertaste, and produces a cooling sensation in the mouth. Xylitol, found in many fruits and vegetables, is produced from hardwood trees and fibrous vegetation. It doesn't promote tooth decay and is a useful sweetener for diabetics. Xylitol contains 2.4 calories/gram.
- **Sorbitol**, a bulk sweetener with good taste has been used for a half century in numerous food

products for providing sweetness, texture, and humectant properties. Discovered in mountain ash berries by a French chemist in 1872, Sorbitol is about 60 percent as sweet as sucrose and has a sweet, cool taste. Sorbitol contains 2.6 calories/gram, does not promote tooth decay, and is a useful alternative to sugar for diabetics.

- **Hydrogenated Starch Hydrolysates (HSH)** are a family of bulk nutritive sweeteners, including hydrogenated glucose syrups, maltitol syrups, and sorbitol syrups, developed in Sweden in the 1960s. Used by the food industry for many years, HSH are produced by partial hydrolysis and hydrogenation of corn, wheat, or potato starch. Depending upon the formula, the sweetness of HSH varies from 40 to 90 percent of sucrose. HSH contains 3 calories/gram, compared to sucrose's 4 calories/gram. HSH do not promote tooth decay, and have a reduced glycemic potential relative to glucose. HSH blend well, can mask off-flavors, and are synergistic with other non-nutritive sweeteners.

Miscellaneous Other Reduced- or Low-Calorie Sweeteners

- **Tagatose** is a naturally-occurring bulk sweetener that is almost as sweet as sucrose, but contains only 1.5 calories/gram. Tagatose improves the flavor profile and mouthfeel of products when combined with other low-calorie sweeteners. The metabolism of tagatose is identical to fructose, but it's not completely absorbed, which may cause gas and mild laxative effects. Tagatose does not cause tooth decay and is suitable for diabetics.
 - **Trehalose**, a naturally-occurring sweetener that's about half as sweet as sucrose is commercially produced from starch by an enzymatic process. Trehalose elicits a very low insulin response. Trehalose is also heat-stable and helps preserve the texture of food products by protecting cell structures in freezing and thawing cycles.
 - **Alitame™**, a sweetener that's 2,000 times sweeter than sucrose (trademarked as Aclame), is produced by joining 2 amino acids, L-aspartic acid and D-alanine, and an amine. The L-aspartic component is metabolized normally, whereas the D-alanine component passes through the body virtually unchanged. Because it's so intensely sweet, Alitame contributes virtually no calories. Alitame has a clean, sweet taste that's synergistic with other sweeteners. It has a good shelf life and is stable at elevated temperatures, but prolonged storage under some acidic conditions may produce off-flavors.
- Alitame is approved for use in several countries around the world and is presently awaiting approval for use in the United States.
- **Dihydrochalcones (DHCs)** are a family of non-caloric sweeteners that range from 300 to 2,000 times sweeter than sucrose. Derived from citrus fruits, DHCs have a delayed sweet taste with a licorice aftertaste.
 - **Glycyrrhizin** is a non-caloric extract of licorice root that is 50 to 100 times sweeter than sucrose, but has a pronounced licorice flavor, which limits widespread use. It's used as a flavor or flavor enhancer and even as a foaming agent in non-alcoholic beverages.
 - **Stevioside** (or stevia) is an extract from a South American herb called *Stevia rebaudiana Bertoni* that is 300 times sweeter than sucrose. Stevia is stable and has a long-lasting sweet taste, although some users experience a bitter aftertaste. Although stevia is approved for use in 10 countries and has been used for many years (centuries in some areas) by millions of people without any apparent ill effects, it still remains a controversial sweetener. The FDA, in the mid-1980s, labeled stevia as an "unsafe food additive," and in 1999, the Joint Expert Committee on Food Additives of the World Health Organization and the Scientific Committee for Food of the European Union determined that stevia was unacceptable as a sweetener. However, legislation in 1994 allowed stevia to be legally marketed in the U.S. as a "dietary supplement." Dietary supplements are defined as products that are intended to supplement the diet and contain one or more vitamins or minerals; herbs or other botanicals; amino acids; a dietary substance to supplement the diet; a concentrate, metabolite, constituent, extract; or any combination of the preceding. Dietary supplements do not include food products or products intended to replace a meal. Consequently, according to the FDA, if stevia is used in a dietary supplement for "a technical effect, such as use as a sweetener or flavoring, and is labeled as such, it considered an unsafe food additive." In other words, stevia can be sold as long as there is no mention of its possible use as a sweetener or even if it refers to itself as "sweet."
 - **Thaumatococin** (trademarked as Talin™) is a mixture of proteins from a West African fruit that is 2,000 to 3,000 times sweeter than sucrose, with a taste that develops slowly and leaves a licorice aftertaste. Thaumatococin acts synergistically with saccharin, acesulfame-

K, and stevioside. Its not heat-stable and can't be used in boiled or baked products.

- **Trutina Dulcem**, defined by the FDA as a "functional food," is a natural fruit concentrate sweetener primarily derived from kiwi fruit. It's 15 times sweeter than sucrose.

Trutina Dulcem has a clean, sweet taste similar to sucrose. It's heat stable and very hygroscopic. Metabolized by the body, Trutina Dulcem does not

overly elevate blood glucose and has a very low glycemic index.

- **Lo Han** is a natural sweetener derived from the fruits of a Chinese perennial vine, *Lo Han Guo* *Siraitia grosvenorii*. Lo Han has a pleasant, sweet taste, but differences in fruit and formulations vary Lo Han's sweetness from about 12 times to 500 times sweeter than sucrose. It has a low glycemic index and is both heat and cold stable.