



HEALTH

Sugar and Sweeteners

no. 9.301

by J. Anderson and L. Young ¹

Quick Facts...

The desirable taste for sugar is innate.

The body does not distinguish between natural sugars and processed sugars.

All sugars contain four calories per gram.

The average person consumes over 100 pounds of sugar per year.

Sugar is natural and nontoxic. The only disease associated with sugar is tooth decay.

The Dietary Guidelines advise Americans to use sugar only in moderation.

History is full of references of the use of sweeteners. One of the earliest is a Spanish drawing of a man harvesting honey, dated around 7000 B.C. We know that the Egyptians kept bees for honey, as depicted in tomb drawings as early as 2600 B.C. Research proves something that most of us are already aware of – people are born with a desire for sweet taste.

Sugar provides quick energy and a concentrated source of calories. This benefit has its downside, however, because consuming too many calories, regardless of the source, contributes to obesity. And sugar is a major contributor to tooth decay.

Nutritive Sweeteners

Sugars. Sugars (saccharides) are widespread in nature and are the building blocks of carbohydrates – monosaccharides, disaccharides and polysaccharides. The monosaccharides, glucose, fructose, and galactose are composed of just one sugar molecule, and are known as the “simple sugars.” Glucose and fructose are abundant in fruits, honey, and processed foods. Galactose is found only in milk.

Disaccharides are formed from two simple sugar units that are chemically attached, and include sucrose, lactose, and maltose.

Sucrose comes from sugar beets or sugar cane, and is more commonly known as table sugar. Sucrose is composed of the two simple sugars, glucose, and fructose. It is the most abundant sugar in nature, important for its palatability, availability, low cost, and simplicity of production. Additional products from the refinement process of sucrose are molasses, brown sugar, and confectioners sugar.

Lactose also is referred to as milk sugar. Lactose is made of the two simple sugars glucose and galactose. Maltose, two glucose units, is the result of the fermentation of the starch in grains by yeast or enzymes, as in bread-making or brewing.

The polysaccharide family includes starch, cellulose, pectin, and glycogen. These complex carbohydrates are chains of glucose molecules. Starch, cellulose, and pectin are found in plants. Glycogen is the storage form of glucose for humans and animals.

The simple sugars and many foods with large amounts of simple sugars provide energy (calories), but contain few other nutrients. They may replace other foods that are high in vitamins, minerals and other important nutrients in the diet. However, while fruits are sweet because of the sucrose and fructose they naturally contain, they are excellent sources of vitamins and fiber. Starch is abundant in nutrient-rich foods such as vegetables, grains, beans, and potatoes. Carbohydrates, regardless of the form, are important for providing energy to the body.

Corn Syrup. Corn syrup is a glucose derivative of corn starch, popular in the brewing, canning, and baking industries because it lends texture and body to these types of products.

High-fructose corn syrup (HFCS) takes the processing of corn syrup one step further, by converting much or all of the glucose to fructose. The resulting product is sweeter than sucrose, allowing less of it to be used. HFCS is the main nutritive sweetener in the soft drink industry.

Sugar Alcohols. Sugar alcohols are sometimes used as a substitute for sucrose. Mannitol, sorbitol, and maltitol occur naturally in fruits. Xylitol is a normal intermediate product in the metabolism of carbohydrates in fruits and vegetables. Sugar alcohols add bulk and texturizing to food such as chewing gum and hard candies. Because they are metabolized by the body more slowly than sucrose, they are useful in foods for people following special diets, such as a diabetic diet.

Metabolism and Digestion

The body is unable to distinguish between natural sugar found in fruit, honey or milk, or processed sugar. All sugars are digested in the same manner. Although carbohydrate digestion starts in the mouth, the small intestine is the major area of digestion and absorption. Here, polysaccharides are broken down to disaccharides and then monosaccharides, which are shunted to the liver. Both the liver and small intestine are able to convert the monosaccharides galactose and fructose, to glucose. Energy needs of the body determine if the glucose will be shipped out to the brain, muscles, kidneys or heart for immediate use, or stored as glycogen in the liver or skeletal muscles for later use. Glucose that exceeds immediate need and temporary storage capacity is converted to fat and stored.

While all sugars contribute four calories per gram, some foods contain more concentrated sources of calories than others. For example, a teaspoon of table sugar contains 16 calories. Honey is a more dense calorie source – a teaspoon contains 22 calories. But a teaspoon of orange juice or applesauce has just four calories, and also contains vitamins, minerals, and fiber.

Food Labels

The Dietary Guidelines advise to consume sugar only in moderation, but much of the sugar in our diets is hidden, as it is already added to the foods we eat. By reading food labels and becoming more aware of the sugar content of every day foods, it is easier to reduce the total amount of sugar in our diets. Food labels list ingredients in order of amount present in the food, from most to least. If sugar is listed as one or more of the first three ingredients, the product is considered high in sugar.

Some foods contain several different types of sugar in various forms. Table 1 lists different types of sugars.

Table 1: Types of sugars.

dextrose	lactose
sucrose	levulose
fructose	maltose
corn syrup	turbinado
maple sugar	mannitol
glucose	milk sugar
granulated sugar	xylitol
molasses	maltitol
sorbitol	honey
invert sugar	
high fructose corn syrup (HFCS)	

Alternative Sweeteners

Alternative sweeteners are essentially calorie-free and at least 30 times sweeter than sucrose. There currently are five alternative sweeteners approved for use in the United States: saccharin, acesulfame-K, sucralose, aspartame, and neotame. Cyclamates were considered safe for use at one time in this country, but were banned in the 1970s.

Saccharin. Saccharin actually is a petroleum derivative that is 200 to 700 times sweeter than sucrose. It is sold as a white powder for use as a table-top sweetener, and used in a variety of foods such as beverages, jams, and baked goods. It has a bitter aftertaste at high concentrations. Despite controversy over its safety, it remains on the generally-recognized-as-safe (GRAS) list.

Acesulfame-K. Acesulfame-K is similar to aspartame in sweetening power, but holds up better to heat and costs less. Marketed as Sunette Sweet One and Diabetisweet, the sweetener was approved by the Food and Drug Administration (FDA) in 1988 for limited use in products such as chewing gums and dry beverage mixes. In 1998, the FDA approved acesulfame-K for use in soft drinks.

Sucralose. Approved by the FDA in 1998, sucralose is the only alternative sweetener made from sugar. It is 600 times sweeter than sucrose. Sucralose is derived from sugar through a patented, multi-step process that creates an extremely stable substance unable to be absorbed by the human body. It is excreted in the urine virtually unchanged. Manufactured under the name Splenda, sucralose can be found as a tabletop sweetener and in a variety of products including desserts, confections, and nonalcoholic beverages.

Aspartame. Commercially available as Equal, Nutrasweet and Spoonful™ (a product designed to measure like sugar), aspartame is composed of two naturally occurring amino acids (the building blocks of protein) – phenylalanine and aspartate. Aspartame has a flavor similar to sucrose, and also functions as a taste intensifier and enhancer. Aspartame is 200 times sweeter than sucrose and has no aftertaste. After nearly two decades of safety testing, aspartame was approved by the FDA in 1981 for use in a variety of products, as a table-top sweetener and in carbonated beverages. In July 1993, approval was made for use in hard and soft candies, baked goods and mixes, nonalcoholic beverages, and malt beverages. A packet of this sweetener is equivalent in sweetness to two teaspoons of sugar (32 calories), for just four calories.

Products that contain aspartame must carry a warning to people with phenylketonuria, a rare genetic disorder that prevents proper metabolism of phenylalanine. Unlike the alternate sweeteners saccharin, cyclamate acesulfame K, neotame and sucralose, which have no nutritional value, aspartame contributes calories. This is due to the fact that it can be used by the body just as any other protein, but the amounts are so small that its caloric value is insignificant. Aspartame does not contribute to tooth decay.

Neotame. Neotame is 7,000 to 13,000 times sweeter than sugar. It was approved for use as a general-purpose sweetener by the FDA in 2002. To date, there are no consumer products available containing neotame.

Stevia. Stevia, also referred to as stevioside or steviol, is 250 to 300 times sweeter than sugar. It is made from a shrub that is commonly grown in South America and contains zero calories per gram. The FDA has not approved stevia for use as a sweetener in the United States due to limited scientific research; however, stevia may be sold as a dietary supplement.

Cyclamates. Cyclamates are 30 times sweeter than sugar, leave little aftertaste, and are heat stable. Cyclamate was banned in the U.S. in 1970 after a study where it was fed to rats in combination with saccharin implicated it as a possible cancer-causing agent. (Subsequent research failed to replicate this finding.) Cyclamates have been pending re-approval by the FDA since 1982, and are approved for use in 50 other countries including Canada. Use of cyclamates in Canada is restricted to table-top sweeteners and in pharmaceuticals.

A few tips for healthier teeth and gums:

- *limit between-meal snacks that contain sugars and starches.*
- *brush with fluoride toothpaste and floss regularly.*
- *ask your dentist about fluoride supplements, especially for children.*
- *don't use a nursing bottle with any beverage other than water for a pacifier.*
- *For more information, see fact sheet 9.321, Nutrition and Dental Health.*

Sugar and Your Health

Obesity. Eating sugar does not cause obesity. Obesity is the result of consuming calories in excess of need, regardless of their source. By reducing the amount of sugar, and thus calories, in your diet, it is possible to lose weight without compromising intake of essential nutrients.

Diabetes. A diet that is high in sugar has not been proven to cause diabetes. The most common type of diabetes occurs in overweight adults.

Table 2: Hidden sugars in foods.

	Portion Size	Approximate Sugar Equivalent
Sweeteners		
honey	1 tsp	1 1/2 tsp
table sugar	1 tsp	1 tsp
Beverages		
orange soda	12 oz	12 tsp
cola	12 oz	10 tsp
Kool-Aid w/sugar	12 oz	8 1/2 tsp
tonic water	12 oz	8 tsp
Candy		
Milky Way	2.1 oz	9 tsp
hard candy	4 pcs	3 1/2 tsp
bubble gum	1 pc	2 tsp
Dairy		
low fat yogurt,		
fruit	1 cup	11 tsp
plain	1 cup	4 tsp
Baked Goods		
oatmeal cookies	2	1/2 tsp
graham crackers	2	1 tsp
Twinkies	1 pkg	8 1/2 tsp
sponge cake	1 slice	4 tsp
Canned Fruit		
pears, hvy. syrup	1/2 cup	5 tsp
pears, lt. syrup	1/2 cup	3 1/2 tsp
pears, water	1/2 cup	1 1/2 tsp

References

Franz, M.J., Maryniuk, M. D. *Position of The American Dietetic Association: Use of nutritive and non-nutritive sweeteners.* J. Am. Dietetic Assn. 93 (7), 816-821, 1993.

Geise, J. H. *Alternative Sweeteners and Bulking Agents.* Food Technology. pp. 114-126. 1993.

United States Department of Agriculture, Human Nutrition Information Service. *Dietary Guidelines and Your Health.* Publication 1490. 1992.

Whitney, E. N., Rholes, S. R. *Understanding Nutrition.* pp. 93-130. 1993.

FDA website: www.fda.gov

National Cancer Institute website: www.cancer.gov

Heart Disease. Sugar intake is not a risk factor for developing heart disease. The primary risk factors are a high blood cholesterol, obesity, smoking, inactivity, and being male.

Tooth Decay. We know that sugars and starches are major contributors to tooth decay. Risk for developing dental caries (cavities) goes up with the frequency of consumption of foods containing these nutrients, and the longer they remain in the mouth without brushing the teeth.

Sugars in the mouth are digested by bacteria on the tooth surfaces. Acid produced by the bacteria causes the enamel to break down, leading to cavities and gum disease. Sugar that remains on the teeth is actually of more concern than amount of sugar consumed. The acid produced by the bacteria lasts for about 20 minutes each time carbohydrate is eaten. This is true regardless of which carbohydrate-containing food is eaten. Bacterial acid production is present whether the carbohydrate is glucose from concentrated sweets, starches, lactose from milk, or fructose from fruit. The stickiness of the sugar also supports bacterial growth.

Reducing Sugar Intake

Learn to enjoy foods that are naturally sweet, without added sugar. Below are shopping and cooking suggestions to help meet the Dietary Guidelines goal of using sugars in moderation.

In the kitchen:

- Use 2/3 to 3/4 cup of sugar for each cup in a recipe.
- Replace omitted sugar with an equal amount of non-fat dry milk to increase nutritional value.
- Use spices and herbs such as cinnamon, nutmeg, cloves and ginger to enhance the flavor of foods.
- Make homemade sauces and toppings with less sugar.
- Use dried or fresh fruit or frozen fruit juice concentrates to sweeten cereals and baked goods instead of table sugar.

Shopping:

- Take your time. Read labels not only to reveal hidden sugar, but to gain information on the overall nutritional value of foods. See Table 2 for hidden sugars in foods.
- Buy fresh fruits or fruit packed in water.
- Buy fewer foods high in sugar such as cookies, candies, soft drinks, and prepared baked goods.
- Be aware – don't replace foods high in sugar with foods high in fat and sodium.

Snacks:

- Unsweetened, lowfat yogurt flavored with nutmeg, cinnamon or fresh fruit.
- Popcorn, raw vegetables or lowfat cheese instead of cookies and candy.
- Graham crackers or vanilla wafers instead of cookies.
- Top cakes with fresh fruits instead of frosting.
- Drink 100 percent fruit juices, water or unsweetened sparkling and mineral waters, instead of Kool-Aid, fruit flavored drinks, or soda pop.

¹J. Anderson, Ph.D., R.D., Colorado State University Cooperative Extension food and nutrition specialist and professor; and L. Young, M.S., former graduate student