

Sugar: More than Just a Sweetener

Robin Eubank, Barber County Family and Consumer Sciences Agent

Sugar is a carbohydrate found in every fruit and vegetable. All green plants manufacture sugar through photosynthesis, but sugar cane and sugar beets have the highest natural concentrations. Beet sugar and cane sugar — identical products that may be used interchangeably — are the most common sources for the sugar used in the United States. Understanding the variety of sugars available and their functions in food will help consumers determine when sugar can be replaced or combined with nonnutritive sweeteners.

Variety of Sugars

Sugar comes in many forms. The following is a list of sugars, mostly made from sugar cane or sugar beets.

Table sugar — granulated white, extra fine or fine sugar — is found in nearly every home. It is the sugar used most because its fine crystals are ideal for bulk handling and not susceptible to caking.

Fruit sugar is slightly finer and has a more uniform crystal size than table sugar. It is used in dry mixes, such as gelatin desserts, pudding mixes, and drink mixes. Its uniformity prevents separation or settling in mixes.

Crystalline fructose is derived from corn. It consists of at least 98 percent pure fructose. Compared to table sugar, it is 20 percent sweeter. Crystalline fructose is considered safe by nutritionists, but the FDA has not yet added it to the list of food additives designated Generally Recognized as Safe.

Superfine or **ultrafine sugar** is the smallest crystal size of all types of granulated sugar. It is ideal for extra-fine textured cakes and meringues. In England, a sugar very similar to superfine sugar is known as caster.



Confectioner's or **powdered sugar** is granulated sugar ground to a smooth powder and then sifted. It contains about 3 percent cornstarch to prevent caking. The type in grocery stores is the finest of three types. The other two are used by industrial bakers.

Coarse sugar is larger than regular granulated sugar. It tends not to change color or break down at high temperatures.

Sanding sugar is another large sugar crystal. It is used mainly in the baking and confectionary industries to sprinkle on top of baked goods or on gelled or gummed candy. This sugar adds sparkle to confections.

Turbinado sugar is raw sugar that has been only partially processed, removing the surface molasses. It is a blond color with a mild brown sugar flavor.

Brown sugar retains some of the molasses syrup, which imparts a pleasant flavor. It tends to clump because it has more moisture than white sugar. Dark brown sugar has more color and stronger molasses flavor than light brown sugar.

Liquid sugars come in several types. Liquid sucrose is essentially water and white sugar and can be used wherever dissolved sugar might be used.

Nonnutritive Sweeteners

The Institute of Medicine of the National Academy of Sciences recommends that no more than 25 percent of calories consumed come from added sugars. These are sugars not naturally occurring in foods. In an attempt to reduce added sugars, more non-nutritive sweeteners are being used.

These sweeteners are considered nonnutritive because few or no calories are absorbed by the body. While some have up to 4 calories per gram (the same as sugar), they are not consumed in large enough quantities to add many calories to food products. According to a 2004 Calorie Control Council survey, 84 percent of consumers use low-calorie, reduced-sugar, and sugar-free foods and beverages.

Sugar Alcohol	Calories per Gram
Erythritol	0.2
Mannitol	1.6
Isomalt	2.0
Lactitol	2.0
Xylitol	2.4
Sorbitol	2.6
Maltitol	2.1

Acesulfame potassium (sold as Sunett) is highly stable and can be used in cooking or baking. It is used in chewing gum, baked goods, dairy products, desserts, sauces, and alcoholic beverages.

Aspartame (sold as Equal and NutraSweet) breaks down when heated and is best used in cold food or beverages. It is used in chewing gum, dairy products, desserts, puddings, jams, jellies, and breakfast cereals. Upon digestion, it breaks down to aspartic acid, a small amount of methanol, and phenylalanine. Therefore, it must bear a label statement that the product contains phenylalanine, which is hazardous for people who cannot process this amino acid.

Neotame (part of the NutraSweet brand, not available commercially) can be used in cooking and baking.

It is often found in chewing gums, soft drinks, frozen desserts, yogurt products, puddings, and fillings.

Saccharin (sold as Sweet'N Low) is highly stable and can be used in cooking or baking. It is used in tabletop sweeteners, beverages, juice, chewing gum, dairy products, desserts, puddings, jams, and jellies. In 1977, the FDA proposed banning saccharin use. After more studies, the FDA approved it, but products must include a label statement that it has caused cancer in laboratory animals.

Stevia (sold as Truvia or PureVia) is highly stable and can be used in cooking or baking. It is used in tabletop sweeteners, beverages, protein drinks, energy bars, and other food products. It comes from the plant leaves of the *stevia rebaudiana* plant. It has a menthol-like bitter aftertaste that diminishes with increasing purity of the extract.

Sucralose (sold as Splenda) is highly stable and can be used in cooking or baking. It is used in tabletop sweeteners, baked goods, desserts, dairy products, beverages, juices, jams, pie fillings, and chewing gum. Sucralose is made from sugar, but it is not absorbed by the body.

Sugar alcohols are hydrogenated from carbohydrates. They are incompletely absorbed in the small intestine, which results in a smaller rise in blood glucose than other sugars. Incomplete digestion of these sweeteners may lead to stomach distress. Some are required to carry the warning "Excessive consumption may cause gastrointestinal problems."

Name	Year Approved	Times Sweeter than Sucrose	Calories Per Gram
Acesulfame Potassium	1988	200	0
Aspartame	1981	200	4
Neotame	2002	8,000	0
Saccharin	1970 – Interim 2000 – Final	300 to 500	0
Sucralose	1998	600	0
Stevia	2008	250-300	0

Cooking with Nonnutritive Sweeteners

Check the food label on sweetener packages for usage. Some can be measured cup for cup like sugar. Others are sweeter and less product is needed.

Recipes prepared with nonnutritive sweeteners may turn out differently than recipes made with sugar. Use any sweetener in recipes that do not require heat — such as cold beverages, salads, chilled soups, frozen desserts, or fruit sauces.

Expect a lower volume and less browning when cooking and baking with intense sweeteners instead of sugar. Sugar adds bulk. Try a half-and-half mix by substituting half the amount of sugar with a nonnutritive sweetener.

Functions of Sugar in Foods

Sugar serves many purposes in a variety of food products. Following is an alphabetical list of the functions sugar has as it interacts with other ingredients.

Caramelization: Sugar caramelizes when heated above its melting point, adding flavor. Caramelization also leads to surface browning, which improves moisture retention in baked products. In baked goods, caramelization takes place under high temperatures. The golden brown, flavorful, and slightly crisp surface of breads, cakes, and cookies not only tastes good, but helps retain moisture. Caramelization also takes place in fruits and vegetables when natural sugars are exposed to high temperatures, such as during grilling.

Color and texture retention: Added sugar helps retain the color of fruit through its capacity to attract and hold water. The sugar prevents fruit from absorbing water, which would cause its color to fade through dilution. Additionally, this keeps the fruit from becoming mushy.

Creaming: When shortening and sugar are creamed together, sugar crystals mix with the shortening molecules. In cakes and cookies, sugar helps promote lightness by

incorporating air into the shortening. The air is trapped in the fat on the face of sugar's irregular crystals. During baking, these air pockets expand. Small bubbles in large quantities contribute to a finer textured cake.

Delayed coagulation: In cakes without shortening, sugar molecules mix with egg proteins to delay bond formation, allowing cakes to rise.

Enhanced flavors: In frozen foods, low temperatures tend to numb the taste buds, and sugar acts to enhance flavors. Also, sugar balances sour, bitter, and spicy flavors.

Enhanced mouthfeel: Sugar increases the thickness of frozen desserts, which helps to create a thick, creamy mouthfeel.

Longer shelf life: Sugar increases the length of time foods remain safe to consume.

Gelatinization: Sugar slows gelatinization by competing with the starch for liquid. By absorbing part of the liquid, sugar allows the volume of a bakery item to increase. The result is a fine, uniform grain with a soft, smooth texture.

Gelling: Sugar is essential in making jams, preserves, and jellies because it attracts and holds water during the gelling process. Gelled fruit juices are trapped in a network of fibers. Pectin can form gel only in the presence of sugar and acid.

Gluten development: Sugar serves as a tenderizing agent in baked products. By preventing gluten development, sugar helps give the final baked product a tender texture and good volume.

Leavening: Sugar increases the effectiveness of yeast by providing an immediate, usable source of nourishment for its growth. With correct moisture and warmth, sugar is broken down by the yeast cells and carbon dioxide gas is released, causing the product to rise.

Lowered freezing point: In mixtures to be frozen, the dissolved sugar's ability to attract and hold water reduces the water available for crystallization during freezing. As a result,

the freezing point of the liquid mixture is lowered. Because less water is available, the ice crystals that form tend to be smaller.

Maillard reaction: At oven temperatures, sugar chemically reacts with protein to brown food surfaces. The higher sugar content of baked food results in a darker golden brown appearance.

Preservation: Sugar delays food spoilage. For example, once the jar of jelly is opened, sugar helps prevent microorganism growth by attracting water to itself. This requires a concentrated sugar solution of at least 65 percent.

Recrystallization: Sugar undergoes physical and chemical changes when used in candy recipes. A supersaturated sugar solution is heated to above the boiling point, forcing water to evaporate. When cooled, sugar molecules crystallize. The type of candy formed depends on temperature and which fat or proteins are added.

Other candies are formed by preventing the recrystallization process. This is done by adding an invert sugar such as molasses, honey, or corn syrup, or by adding an acid such as cream of tartar or lemon juice. Another way to prevent recrystallization is to heat to a higher temperature to reduce the water content to 2 percent or less.

Stabilizer: Sugar helps stabilize beaten eggs. In foam-type cakes, sugar interacts with egg proteins to stabilize the whipped foam structure.

Surface cracking: Sugar helps produce the desirable surface cracking of some cookies. Because of the relatively high concentration of sugar and low water content in cookies, sugar recrystallizes on the surface.

References are available in MF2930, *Sugar: More Than Just a Sweetener, Leaders Guide*.

Reviewers

Mary Meck Higgins, Human Nutrition Specialist, K-State Research and Extension

Karen Blakeslee, Rapid Response Center Coordinator, K-State Research and Extension.

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