

The Many Roles of Sugars in Baking



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Sugar is the most common organic substance in the world. Every culture has some source of sugar. Sugar is, of course, a member of that large group of organic compounds called carbohydrates. This also includes fibers, maltodextrins, starches, and gums. They all have their own qualities. They all contribute different things to foods, some of which we don't fully understand.

The most common sugar that bakers use is, of course, sucrose, which is made of glucose and fructose units bound together. For measuring sweetness, this is the standard against which all other sugars are compared. Sucrose has a value of 100 "sweet." This measure is

also used with artificial sweeteners. The chart below gives some generally recognized values for sweetness.

There are two kinds of sugars to consider with regard to interactions with protein that produce color in baked products via the Maillard reaction. There are the reducing sugars: dextrose (glucose), lactose, and maltose, which will increase browning and caramelization in the presence of protein during baking. The source of the protein can be from the flour, eggs, or dairy proteins, to name the more common ones. Moisture must be present for this reaction to happen. The other type of sugar is the "non-reducing" type, such as sucrose and trehalose.

Sugar has several functions in baked products. The most common is adding sweetness. Other characteristics that it contributes are crust color, which in turn adds eye appeal and toasted or brown flavor notes to a finished product. Depending on what type of sugar you add and the degree of baking the product receives, sugars can tenderize, help hold moisture, contribute crispness, or make a product chewy, pliable, or tough. It also affects viscosity of the dough or batter, which can affect whether the product expands or collapses.

Sweetness levels

Lactose	40
Maltose	50
Corn syrup	60
Glucose	70
Molasses	70
Honey	80
Sucrose	100
Invert syrup	102
Fructose	110
High fructose corn syrup	150
Aspartame	200
Acesulfame	200
Sucralose	600

Sugar in Yeast-Raised Products

Sugar provides sweetness to most baked products. The exception is yeast-raised products, as the yeast will consume the sugar during the fermentation process. Only if the sugar is used at higher levels than are consumable by the yeast does it add

sweetness to the product. The amount of sugar you can put in a yeast-raised product is limited by the retarding effect it has on yeast activity. This retarding effect is due to increases in osmotic pressure on the yeast cell walls. The higher the level of sugar, the more slowly the yeast ferments. Thirty years ago, it used to be that levels of sugar in excess of 16%, based on true percent, would slow the yeast activity to a point where it could take two or more hours to fully proof a loaf. With modern breeding there are now yeasts on the market that can handle levels of sugar of 30% or more. Genetic manipulation could accomplish the same results, but the industry has chosen to use only conventional breeding techniques for yeast.

Sugar sources for yeast-raised products are those that provide the best cost-per-pound of sugar solids. Regular sucrose and high fructose corn syrup (HFCS) are popular sources. Liquid sugars are often chosen for their ease of metering into mixers.

Typical sugar levels in yeast-leavened formulas:

Hearth-type breads	0.5–4.0%
White pan bread	6.0–12.0%
Sweet doughs	14.0–22.0%

Sugar in Muffins or Quick Breads

The roll of sucrose in quick bread-type products is to add sweetness, tenderness, and to adjust viscosity to allow for expansion. The balance between flour, sucrose, and fat is critical in obtaining the proper texture, volume, and keeping quality. This balancing of the formula goes back to the artistic aspect of baking. It depends upon the flour, the type of fat, the level of eggs, and the amount of sugar. To balance them, you must look at the type and strength of the flour you are using and the type of fat—is the fat system emulsified, is it a shortening or oil or a blend of the three? What is the total fat in the formula? The level of fat and sucrose will be interdependent: if you raise the level of fat, the level of sugar will need to be lowered. The stronger your flour or the better quality protein flour you use, to a point, and the higher the level of egg, the more fat and sucrose you will be able to add to the formula and the richer the product is. It is all a balancing act. Start adding other sources of carbohydrates, such as gums and starches, and the equation becomes even more complicated.

Sweetener syrups, such as HFCS, corn syrup, or fruit fillings with cooked starches or other thickeners will make a quick bread or muffin very moist. Experience has shown that they reduce volume and make the texture thick and gummy. If a way of maintaining the quick bread volume could be found, the shelf life of these products could potentially be significantly increased.

Cakes

Cakes used to be described as low- or high-ratio cakes. This references the ratio of sugar to flour in a cake formula. Formulas containing more than 100% (bakers percent) sugar (more sugar than flour) were considered "high ratio." Today, essentially all cakes are high ratio. Granulated sucrose is added to cream the

shortening to help aerate the batter and help disperse the fat in the batter. The addition of sugar to the batter proportionately reduces the amount of flour in the batter. This frees up more of the water to be absorbed by the remaining flour, allowing it to hydrate more thoroughly and gelatinize during the baking process.

HFCS only works in small amounts in cakes. At higher levels of addition, the cake collapses. I am not sure if it is due to the hygroscopicity of the fructose, interference in the gelatinization of the starches in the flour, or a combination of the two.

In the early 1980s, American sugar prices surged. Tests were done by bakers to determine how much sucrose could be replaced with dextrose. We learned that replacing more than 25% of the sucrose with dextrose generated negative effects. Cakes made with these levels of dextrose did not have the body or sweetness of a cake made with all sucrose. The crust was darker as well, as would be expected.

Cookies

Sugars have a huge effect on cookies, depending on both the type of sugar and granulation. Sucrose is the most common form of sugar used, followed by brown sugar, then HFCS, crystalline fructose, and corn syrup. Each type of sweetener has its own unique effect on cookie formulation. You can also use the short-chain dietary fibers, such as fructo-oligosaccharides and malto-dextrins, to reduce sugar content while contributing sweetness.

Regular granulated sucrose causes spread in the cookie—the higher the level, the more the spread. The level of sugar in a cookie formula correlates inversely to the level of fat in the formula: the higher the fat, the lower the sugar. A typical ratio of sugar to fat in a chocolate chip cookie would be two to one, with fat being approximately 30% of the flour amount.

The finer the granulation of the sugar, the less spread that results. Brown sugar, granulated sucrose back-blended with molasses, or unrefined sucrose contribute flavor and moistness to the cookie in addition to spread. Besides being less expensive than sucrose, HFCS also provides a more intense sweetness. HFCS also helps keep higher moisture cookies softer over a longer period. A cookie with HFCS, if baked to too low of a moisture content, becomes tough. Conversely, corn syrup, also less expensive than sucrose, tends to make cookies hard.

Crystalline fructose contributes crust color, sweetness, and humectancy.

Below is a chart that shows generally how various ratios of sugar and fat contribute to cookie quality. Very few cookies contain just one kind of sugar. Typically, a cookie formula will contain a combination of sugars—in addition to sucrose, it may contain brown sugar, crystalline fructose, HFCS, or corn syrup. The following chart references the effects on cookie quality of varying levels of flour, sugar, and fat. This assumes that the type of sugar used is either granulated sucrose or brown sugar. Add corn syrups into the mix and about every category can be formulated to create the opposite quality.

Sugar Level	Fat Level	Characteristics	Cookie example
High	High	Thin and crisp	Tuile or lace-type cookie
High	Low	Harder, dryer	Sugar cookie
Moderate	Moderate	Tender	Chocolate chip
Low	High	Very tender, short bite	Spritz-type cookie
Low	Low	Cakey, dry	Inexpensive, cake-like cookies

Of the broad and diverse family of carbohydrate ingredients, only sugars have been reviewed in this column. What have not been covered are the starches, gums, and many types of dietary fiber. There is so much yet to be learned about the various kinds of carbohydrates and how they interact with each other and with other ingredients under specific baking conditions. The number of options available for blending, processing, and combining the full spectrum of carbohydrate-based ingredients is limited only by the imagination. The many questions pertaining to how these and other ingredients interact and the thought of so many different combinations is one of the reasons why bakery product development remains so stimulating.

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