# Taking the Mystery Out of Reduced Sugars

Steviva INGREDIENTS
Where Sweeteners Come Naturally

# Taking the Mystery Out of Reduced Sugars

It's easy to find the sweet spot when formulating with sucrose. Its flavor and function are so well known to us, its sweetness most of us grew up with, but, like many of the things we enjoyed in our youth, there are times to set it aside.


Demands to reduce added sugar and lighten calorie loads are at an all-time high. Approximately 13% of adults' total caloric intake comes from added sugars, the Centers for Disease Control reports in their most recent study, Consumption of Added Sugars Among U.S. Adults, 2005-2010. "Recent analyses indicate that children and adolescents obtain approximately 16% of their total caloric intake from added sugars," adds the report. The recommendations set forth in the Dietary Guidelines for Americans, 2010 state that discretionary calories, including both added sugars and solid fats, should be limited to 5% to 15% per day.

Increased consumption of added sugars has been linked to a decrease in intake of essential micronutrients, increase in body weight and higher risk for diabetes and cardiovascular disease. CDC defines added sugars as sweeteners added to processed and prepared foods.

Though aim is clearly directed to industry to reduce added sugar, it's not a simple proposition.

## Consumer expectations

Consumers aren't necessarily willing to forgo a sweet taste, so food developers are challenged to deliver flavor, reduce calories and provide comparable sensory attributes. Knowing precisely what the consumer wants to eat is a bit like timing the stock market. Both are fickle.

Yet when it comes to food choices, the trend towards health and wellness continues to evolve. Organizations like Center for Science in the Public Interest are intent on transforming the American diet. They've launched a petition to ensure the safe use of "added sugars." They include added sweeteners such as fruit juice, evaporated cane sugar, honey and agave syrup as sweeteners that contribute to harm.[1]

[1] *Petition to Ensure the Safe Use of "Added Sugars." Submitted by the Center for Science in the Public Interest February 13, 2013 to United States Department of Health and Human Services Food and Drug Administration. http://cspinet.org/new/pdf/sugar_petition_2-12-13_final.pdf*

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Americans are taking note that moderation is in order. A recent survey from Mintel Research Consultancy suggests that consumers are paying a lot more attention to how much sugar is in their foods.

Interest in natural and clean label products is top of mind. Shoppers are scrutinizing labels for ingredients with names that they understand. Innova Market Insights says the top trend of 2013 is the aware shopper who is more informed and knowledgeable about value and health.

With this, there is a call for transparency and credibility, as evidenced by increased litigation surrounding natural claims and genetically modified organisms (GMO).

Yet it all comes back to sweeteners, at least in terms of Innova Market Insights' top 10 list of 2013 trends. Beating the sugar demon is number 7.

Meeting consumers' desire for natural, reduced sugar foods is the developer's task. Eliminating artificial chemicals like aspartame, acesulfame-K, sucralose, saccharin and neotame narrow the choice of sweeteners.

## Natural nutritive sweeteners

Honey, molasses, agave nectar and fruit juices fall into the natural sweetener category, but they are of little help in reducing calories. Like sugar, these are nutritive sweeteners.

Sugar, or sucrose, contributes 4 calories per gram. It is composed of disaccharides of glucose and fructose units.

Fructose, the form of sugar found in fruit juice, agave and honey, is also nutritive, but it has the advantage of being sweeter than sugar. Of all the nutritive sweeteners, it is the sweetest with 1.2 to 1.8 times the sweetness. The anomeric state of fructose and the extent of mutarotation when the comparison is made will impact relative sweetness.

R.S. Shallenberger explains in the book Taste Chemistry[2], that the relative score "is a judgment by several persons at most, or in a few cases, merely a subjective estimate in place of an actual sweetness comparison." Relative sweetness also increases with concentration, a phenomenon described as self-synergism. Over the range of 5 to 20% fructose in solution, relative sweetness of fructose increases by 8%.

Synergy is also expressed with other sweeteners, including nonnutritive sweeteners. Synergy occurs with starch as well. Compared to sucrose, fructose causes starch to gelatinize at a lower temperature.

Fructose also acts as a bulk sweetener. Mouthfeel and body are attributes that are tied to sensory perception. Along with the sweetness curve, they define our perception of sugar. If bulk is missing, a sweet taste can fall flat. If solids aren't replaced, the beverage is thin. Fructose can stand alone, but slightly less is required to deliver the same sweetness as sugar.

## Polyols

Polyols, or sugar alcohols, are low-digestible carbohydrates. Many occur naturally in foods. Erythritol is present in fruits such as pears, melons and grapes. Xylitol is found in birch. Sorbitol was first discovered in berries.

[2] *Taste Chemistry, by R.S., Shallenberger, 1993. Blackie Academic & Professional*

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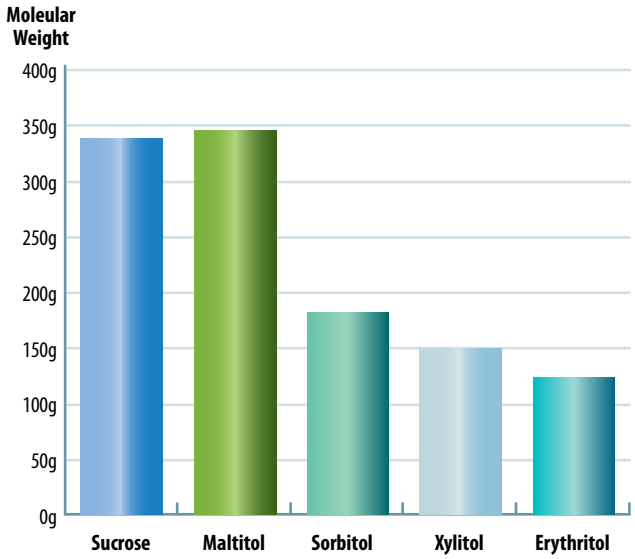
The structure of polyols is similar to sugar molecules, with the exception of the presence of a hydroxyl group substituted for the aldehyde or ketone group. These compounds are linear in structure, so they are less reactive.

As a group, they can be used to provide sweetness and calorie reduction. Great differences exist between individual polyols, in part because of the variances in molecular weight.

Sugar's molar mass is 342.2965 g/mol. Maltitol and isomalt have a molecular weight of 344.3123 g/mol. Their sweetness varies significantly. Maltitol is 90% as sweet as sucrose. Isomalt is 50% as sweet. Each contributes 2 calories per gram. Sorbitol and mannitol each have a molecular weight of 182.1717 g/mol. They are isomers, and the only difference is the orientation of the hydroxyl group. They are about 60% as sweet as sucrose. FDA requires a laxation label claim when formulating with mannitol (20 grams per day daily intake) and sorbital (50 grams per day daily intake). Mannitol provides 1.6 calories per gram. Sorbitol provides 2.6 calories per gram.

Xylitol and erythritol are well tolerated by the digestive system. Xylitol has a molecular weight of 152.1457 and is 100% as sweet as sucrose. Erythritol has the lowest molecular weight of all the polyols with a molar mass of 122.1198. Its weight, plus its reduced sweetness (70% as sweet as sugar) make it ideal for use as a bulking agent.

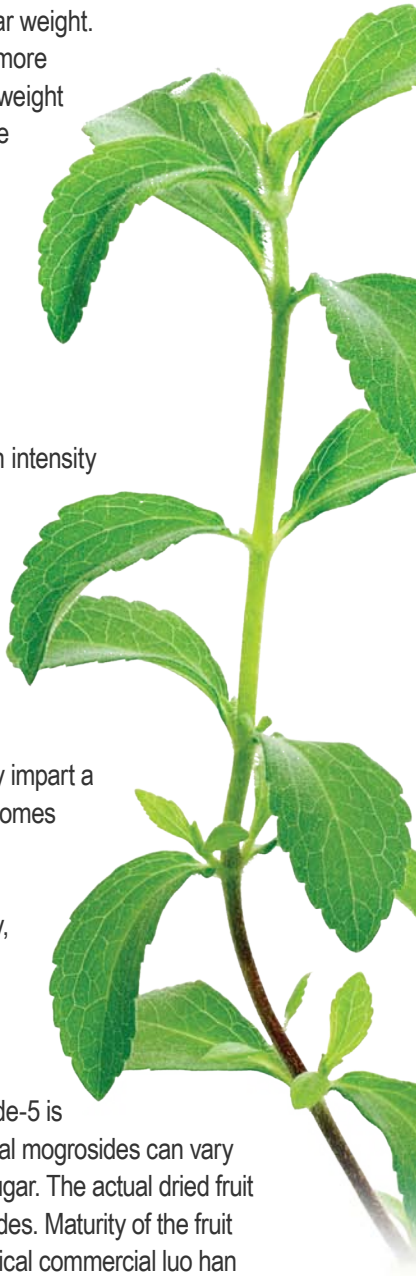
Both xylitol and erythritol exhibit negative heats of solution. Xylitol has a very pronounced cooling effect. Erythritol is mildly cooling. They are both noncariogenic. Their flavor is compatible with mint. Xylitol is often used in candies, breath fresheners and gums. Xylitol contributes 2.4 calories per gram. Erythritol has just 0.2 calories per gram.




None of the polyols participate in the Maillard reaction, so applications that require caramelization or non-enzymatic browning may require additional reducing sugars.

Viscosity is dependent on molecular weight. Maltitol and isomalt will contribute more viscosity than the lower molecular weight polyols. Maltitol and xylitol are more soluble than erthritol, isomalt and mannitol.

Although polyols can be used singly, they are often used in conjunction with other sweeteners.



## Plant based sweeteners

Formulators seeking a natural, high intensity sweetener begin with a simple decision tree: monk fruit or stevia. Both have zero calories.

The sweetener extracted from monk fruit, luo han guo, is the newest entrant to the category. Its flavor is neutral in most applications, although it may impart a slight melon-rind note. Sweetness comes from a group of compounds called mogrisides within the fruit from the Siraitia grosvenorii plant. Chemically, mogrosides are triterpenoidal saponins. There are five numbered mogrosides, as well as other glycosides, and each has distinct sweetness characteristics. Mogroside-5 is predominant. Sweetness of individual mogrosides can vary up to 400 times the sweetness of sugar. The actual dried fruit has up to 1.5% extractable mogrosides. Maturity of the fruit impacts the mogroside content. Typical commercial luo han guo sweeteners are about 200 times sweeter than sugar. FDA recognizes monk fruit extract as GRAS.

[3] *Sweetners and Sugar Alternatives in Food Technology. Kay O'Donnell, Malcolm Kearsley. John Wiley & Sons, Jul 10, 2012*

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Stevia extracts are derived from leaves of the South American plant Stevia rebaudiana. This high intensity sweetener is 200 to 300 times sweeter than sugar. Like luo han guo, sweetness comes from certain components within the plant. More than 10 different steviol glycosides are found within the steviol leaf. Rebaudioside A (Reb A) is the best known. Steviol, Stevioside, Rebaudioside C, Dulcoside A, Rubusoside, Steviolbioside, Rebaudioside B, D, E, and F follow.

Flavor of stevia products varies immensely because of the variations of concentrations and purity of these glycosides. Soil and growing conditions influence the confluence of components. Finally, the means of extraction — natural water extraction or petrochemical extraction — impact the final taste.

Even the cleanest extracts of stevia can have a licorice-like flavor. It can be perceived as slightly bitter. Yet because it is so powerfully sweet, it is used at extremely low levels. A bulking agent, such as erythritol, is required to build body and mouthfeel, but it will also help ameliorate any off note. Masking agents can also be helpful, especially in formulas that contain other bitter components.

## Perfecting the sweetening system

Although there are many sweeteners to choose from, none taste or behave exactly like sugar. Replacing sugar with a single ingredient is unlikely to yield the anticipated result. Sugar free and no sugar added foods won't have the same flavor as their full sugar counterparts.

The goal is more achievable when reducing sugar. Blending sweeteners even further increases the potential for success.

Take the sweetness curve of sugar, for example. It comes on slowly, builds roundness and then slowly abates. This is a reflection of sugar's disaccharide composition. Fructose peaks first, glucose second. Without a gap between them, it's perceived as one.

Removing the glucose will have an abrupt effect. Fructose will build rapidly and then decay very quickly.

High intensity sweeteners also deliver sweetness but they linger. Stevia has a later onset of sweetness than fructose. The extinction time is prolonged, and it is often described as an aftertaste.

Even within a broad category such as stevia, each glycoside will behave differently in their expression of sweetness or off notes. It's important to rely on a supplier who can assure high quality standards, a reliable supply chain and batch-to-batch consistency.

Because stevia products among manufacturers vary in the purity and permutations of glycosides, one product may taste completely different than another. Substituting ingredients may require multiple changes to the formula.

Developing new products is an easier task, although it still may take a few rounds at the bench to optimize flavor and function.

Combining sweeteners can improve the temporal profile. Adding sugar to a formula in which up to 80% of the sweetness is provided by Reb A will exhibit a flavor similar to a 100% sugar sweetened product. Calories are reduced substantially.

Likewise, a blend of fructose and stevia or an agave syrup fortified with stevia will have a pleasing profile while reducing calories.

The flavor outcome is dependent on the application and the other ingredients in the formula. The presence of citric acid, tartaric acid or lactic acid will improve the taste of stevia by cutting the lingering sweetness. Flavors like ginger, cola and root beer diminish the licorice notes of stevia. A flavor such as grapefruit that has an inherent bitter quality will also have a masking effect. Inulin or fructooligosaccharides (FOS) can also reduce aftertaste of high-intensity sweeteners.

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In a sugar-free beverage, the addition of low levels of xanthan gum or FOS will build mouthfeel, thereby giving it a profile more similar to a product sweetened with sugar syrup.

Fructooligosaccharides add bulk with a healthful twist. These non-digestible fructose and glucose molecules are derived from chicowry root. As a prebiotic, fructooligosaccharides support the growth of healthy microflora in the gut. With 70% the sweetness of sugar, the caloric contribution is just 1 calorie per gram. In food products, the fat-mimetic qualities of FOS improve texture and mouthfeel. Its flavor is slightly sweet and neutral. Synergies with other sweeteners improve flavor and cost efficiency.

Besides flavor, the choice of sweetener and/or combination of sweeteners is dependent on their functional contributions. Erythritol, because of its low molecular weight, lowers water activity and thus, extends shelf-life of baked goods. Cookies will maintain crispness. Soft goods like brownies will not harden.

Moisture levels may need to be increased in some formulas. Sugar provides humectancy to baked goods. Stevia alone is incapable of this.

If a golden hue is desired in bread or rolls, erythritol and/or stevia will not be of help. Fructose, nonfat dry milk or small levels of browning sugars such as molasses will be needed.

In frozen foods, freezing point depression is an important consideration. In ice cream, texture, palatability and scoopability are dependent on the dynamics between ice and water. Larger molecular weight carbohydrates are more effective in influencing water behavior. Lower molecular weight sweeteners such as xylitol, depress the freezing points lower than sugar, so they are best used in combination with higher molecular weight ingredients.

Confections are another ball of wax; boiling point is the critical juncture that governs texture. As molecular weight decreases, the boiling point increases.

Every application has its own requirements, so understanding the nuances of sweeteners, alone or in tandem, must be undertaken in the context of the finished product.

Working with a knowledgeable supplier will maximize efficiency in the number of passes at the bench and in the pilot plant, but also in terms of cost savings. Capitalizing on synergies between sweeteners and other ingredients can reduce the use of higher cost ingredients such as flavors.

Partnering with a sweetener expert will bring their intuitive knowledge to your development efforts and will help take the mystery out of reduced calorie formulations.

Steviva Ingredients creates custom sweetening solutions of all particle sizes that function as a plugin to replace sucrose, 10x sugar, invert sugar and high fructose corn syrup. When you collaborate with Steviva Ingredients you can be assured of chemical-free processing, 100% natural products, clean label ingredients, GMO-free, gluten-free diabetic safe and kosher.

**Make Steviva Ingredients your reliable supply chain partner.**

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