

Polyols: Beyond Sweet Taste

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Polyols are neither sugars nor alcohols. They are a group of low-digestible carbohydrates, similar in structure to sugar molecules, except for the substitution of a hydroxyl group in place of the aldehyde group found on sugars. This substitution is the reason polyols are commonly referred to as sugar alcohols. The substitution of a single hydroxyl group preserves enough of the chemical structure of sugar to give polyols many of the physical properties of sugars, so they can often replace sugar and corn sweeteners in many applications.

The structural differences also impart special functional and health benefits to polyol-containing products. The health benefits were discussed in the April 2007 issue of *Food Product Design*. This provides an overview of the functional benefits of polyols.



Physical properties

Polyols and sugars have several physical properties that are important in food processing. Understanding the different physical and functional characteristics among polyols is key to selecting the best polyol for a food application.

Sweetness. Ingredient sweetness is usually measured in relation to sucrose, which has a sweetness reference value of 1 or 100%. Polyol sweetness varies and depends in part on the application. Generally, polyols vary in sweetness from about half as sweet to equally as sweet as sucrose.

Taste and flavor. Other components of flavor are the persistence of sweetness, presence or absence of aftertaste, and the sweetness profile. Polyols are nonreactive and easily combine with high-intensity sweeteners in sugar-free chewing gums, candies, frozen desserts and baked goods. Polyols contribute mild sweetness, as well as the bulk and texture of sugar, while low-calorie sweeteners increase sweetness.

Cooling effect. All polyols exhibit negative heats of solution. Energy is needed to dissolve the crystals; thus, they absorb the surrounding energy, which lowers the temperature or cools the solution. In the mouth, this produces a pleasant cooling effect. Each polyol has a different level of cooling sensation. Maltitol and isomalt exhibit minimal cooling effects, making them more similar to sucrose. Erythritol, mannitol and sorbitol all have moderate cooling effects; xylitol has the highest cooling effect and is often used to enhance mint flavors.

Molecular weight. Molecular weight can impact the viscosity, texture, temperature stability, crystallization and osmolality of the polyol. Generally, as molecular weight decreases, osmolality and

boiling point increases, and viscosity and freezing point decreases. This can alter cookie spread, cake volume, ice cream texture, shelf life, beverage stability and mouthfeel.

Texture and appearance. Polyglycitols exist primarily as syrups, so they frequently replace corn syrups and maltodextrins. Polyglycitols include hydrogenated glucose syrups, maltitol syrups and sorbitol syrups. Their wide range of molecular weight gives them many functional roles, including use as bulk sweeteners, and as sugar-free carriers for flavors, colors and enzymes. The other polyols—sorbitol, xylitol, maltitol, isomalt, lactitol, mannitol and erythritol—have a white crystalline appearance and texture similar to sucrose.

Solubility. In general, polyol solubility increases with temperature. Many are soluble in water, due to their many hydroxyl groups. However, their molecular configuration and conformation cause solubility differences. For example, sorbitol, lactitol, maltitol and xylitol are highly soluble in water, but mannitol (an isomer of sorbitol), erythritol and isomalt (a mixture of sorbitol and mannitol) are not.

Hygroscopicity. Hygroscopicity is the ability of a substance to absorb water from the atmosphere and is influenced by the presence or absence of hydroxyl groups. Polyols that are highly water-soluble also tend to be very hygroscopic, and thus add and retain moisture in food products. Sorbitol, xylitol and many polyglycitols have high degrees of hygroscopicity, whereas mannitol, isomalt and erythritol have very low degrees of hygroscopicity. Replacing all or part of the sugar in baked products like wafers and cookies with low-hygroscopic polyols will produce improvements in both shelf life and crispness. In baked goods, nutritional bars and confectionary applications where moistness is desired, a highly hygroscopic polyol, such as sorbitol, will ensure these products retain the appropriate moistness and mouthfeel during storage.

Crystallization. The ease with which a substance crystallizes is also related to its solubility. The greater the solubility of the polyol, the lower its tendency to form crystals. In sugars, heat and super saturation combined with careful, controlled cooling inhibits crystal formation. However, if temperature is not carefully controlled, super-saturated solutions are unstable and will crystallize rapidly. Certain polyols inhibit crystal formation, imparting smoothness and creaminess. In confections, sorbitol or polyglycitols can act as interfering (doctoring) agents that modify crystal formation by influencing crystallization rate, crystal size and crystal-syrup balance. Sorbitol can inhibit crystallization in liquid sugar systems.

Viscosity. Viscosity varies, depending on the type of polyol. Higher numbers of molecules create more viscous solutes. Isomalt provides bulk, texture and mild sweetness. Maltitol's anhydrous crystalline form, low hygroscopicity, high melting point and stability can replace sucrose in many applications. Sorbitol, though not as viscous, acts as a bodying agent in beverages and liquids by eliminating a watery, or thin, organoleptic sensation.

Heat stability. Polyols generally do not lose sweetness when heated. However, polyols lack aldehyde groups, and do not undergo the Maillard reaction. Polyols are very heat stable over a pH of 2 to 10 and can prevent over-browning and preserve lighter colors during exposure to high temperatures.

Stability in cold and frozen products. Because they do not form crystals, polyglycitols can replace sugar in a variety of frozen desserts, and act as mild freezing point depressants to increase freeze/thaw stability. Similar to sucrose in freezing point depressing effect, hygroscopicity and solubility, lactitol is uniquely suited as a sugar replacer in frozen products. Sorbitol is used in surimi products to provide optimal sweetness level, protect the muscle fibers and, due to its ability to lower the freezing point of water, prevent texture deterioration from moisture loss.

Market Snapshot

Polyols, reduced-calorie bulk sweeteners, assist manufacturers in meeting consumers' continuing demand for great tasting, low-calorie products. The Calorie Control Council's 2007 Light Product Survey* found that 87% of light product users want additional light, sugar-free products. Following are more results from the survey.

Most popular low-calorie, reduced-sugar, sugar-free foods and beverages (among those who use these products):

- Non-carbonated soft drinks60%
- Soft drinks59%
- Reduced-sugar frozen desserts, ice cream or frozen yogurt50%
- Sugar substitutes49%
- Sugar-free gum48%

*Survey conducted by Booth Research Services, Inc., Atlanta, GA, June 2007. More information is available on the Calorie Control Council's website, caloriecontrol.org.

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