Polyols — Great formulating tools for sugar and calorie reduction

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Polyols — Great formulating tools for sugar and calorie reduction

The drive to curb sugar in consumer products is moderating the approach to sugar and calorie reduction in product development. Especially in categories where serving sizes can be large, replacement of all of the sugar often leads to products that are not appealing to the consumer. A much more moderate approach — a 30–50% reduction in sugar — has led to more consumer-acceptable products, which, like 100-calorie packs, have a better chance of acceptance for weight management.

Polyols: sugar replacements

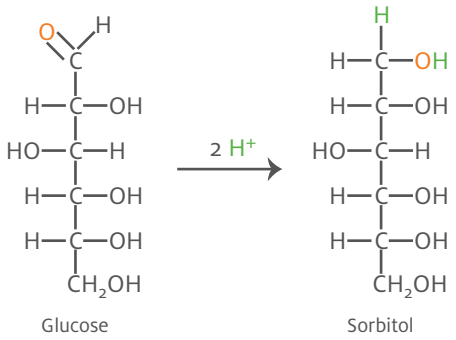
Polyols are a group of sweeteners with a great deal of utility in the trend towards sugar reduction. They have become widely accepted as a sugar reduction tool, especially in confectionery where serving sizes are smaller and sugar-free has become the norm. Consumers expect their chewing gums and breath-fresheners to be sugar-free, and parents encourage their children to chew these products due their cariogenic or cariostatic benefits. Polyols have functional benefits in these products as well — they are excellent plasticizers, keeping the gum soft and pliable over time, and they also work well with high potency sweeteners in establishing the sweetness and flavor profiles which are now expected in chewing gums. In hard-boiled candies, they are the majority of the candy piece, establishing the structure and maintaining that structure through the shelf-life of the candy, but also providing, in combination with other sweeteners, the sweetness and flavor profile. In other confections such as jellies, gummies, taffies, fondants and caramels, some polyols are integral in establishing the crystalline or semi-crystalline structure that defines a particular confection while other polyols serve to control the rate of crystallinity for shelf-life purposes.

Polyols serve these same purposes and more in nutritional bars, baked goods, ice creams, and other products in many ways. First of all, confectionery products, such as those previously mentioned,are often a defining part of products within these categories, serving as inclusions, variegates, toppings, icings, etc. Secondly, the same properties as described for confectioneries also apply to baked goods, dairy products, nutritional bars and other categories.

Defining polyols

Polyols are products created by the hydrogenation of sugars (Figure 1), and they affect polymeric structures in much the same way as their originating nutritional sugars, and often bring more beneficial properties into play as well.

FIGURE 1: GLUCOSE TO SORBITOL



Glucose Sorbitol

Polyols can be divided into three groups: monomers, dimers, and polymeric mixtures. The monomers — consisting of one carbohydrate unit — are erythritol, mannitol, sorbitol, and xylitol. The dimers — consisting of two bonded carbohydrate units — are isomalt, lactitol, and maltitol. And the polymeric mixtures are combinations of polyols — varying in lengths of repeating carbohydrate units — that are identified as polyglycitol syrups, also known as hydrogenated starch hydrolysates (HSHs), and maltitol syrups (most similar to corn syrups). Nomenclature is determined by the amount of maltitol (dry basis) present; a syrup that contains greater than 50% maltitol is considered a maltitol syrup, and anything less is a polyglycitol syrup.

TABLE 1: CALORIES

	U.S.	E.U.
Erythritol	0	0
Mannitol	1.6	2.4
Isomalt	2.0	2.4
Lactitol	2.0	2.4
Maltitol	2.1	2.4
Xylitol	2.4	2.4
Sorbitol	2.6	2.4
Maltitol syrup	3.0	2.4
Polyglycitol syrup	3.0	2.4
Sucrose	4.0	4.0

Polyols are not considered sugars because they are not completely digested or absorbed — the majority reaches the large intestine, where bacteria metabolize what has not been absorbed or excreted previously to short-chain fatty acids. The effect of this is similar to experiences one might have with high fiber foods and the effect is variable depending on what else has been consumed as well as individual sensitivity. The result may be a feeling of fullness, laxation, or gas, and the results are temporary. How do you avoid this? By 1) using polyols as a formulating tool to reduce sugar and calories, not to replace sugars entirely, and 2) knowing which polyol to use to minimize any tolerance issues. Calories and sugar can be reduced substantially in many formulations while using polyols at no more than about 10 grams/serving. By contrast, some of the products on the market 10 years ago contained >20 grams/serving, which probably affected sensitive individuals for one serving, but affected many more who might eat two servings in one meal. Polyols can reduce caloric density in a formulation because often they are ½ the calories of sugar (Table 1).

The portfolio of polyols available offers a wide range of properties, which allows convenient replacement of sucrose and sweeteners in many formulations. These polyols vary in caloric density, tolerance (as briefly discussed), solubility, molecular weight, cooling effects as crystalline forms are solubilized, and regulatory status. Each of the polyols has unique properties, which enhance performance in some applications or require formulation changes in others. In many applications, the molecular weight (MW) of sugar replacers (Table 2) plays a large part in the performance of a product, because the MW influences starch gelatinization temperature, boiling points in fillings and protein denaturation in baked products. In ice creams, the MW of the carbohydrate portion has a major effect on the freezing rate of the mix as well as the freezing point of the final product.

For no-sugar-added ice creams, the sugar-replacement portion is often a mixture of sorbitol, polydextrose, maltodextrin, and high potency sweetener, the sum of which mimics the freezing rate of sucrose in the mix as well as the freeze point of sugar in the final product. Since sorbitol has ½ the MW of sucrose, it depresses the freeze point much more than sucrose does, so higher MW polymers must be added to compensate for this. Maltitol syrups are, like corn syrups, liquid blends with a polymeric distribution that can be modified to fit a need, or easily blended with other polymers such as soluble fibers or high potency sweeteners to increase manufacturing efficiency. In the case of the no-sugar-added ice creams, a maltitol syrup with the correct blend or polymers can easily replace all of the ingredients mentioned above. In baked goods, the MW distribution (and solubility) of the carbohydrate portion will raise or lower the starch gelatinization temperature, which will have an impact on cake volume or cookie spread and height.

Formulation considerations

Polyols are excellent formulation tools to lower sugar and reduced calories. But, formulators need to remember that polyols are low digestible carbohydrates (LDCs), grouped with other LDCs such as resistant starches; oligosaccharides such as polydextrose and fructooligosaccharides; polysaccharides such as pectins, inulin and celluloses; and are sugars such as trehalose. Within this grouping and versus many fibers, many polyols are comparatively well tolerated. Proper use will minimize tolerance concerns, and the correct choice of polyols to accomplish calorie and sugar reduction will result in an end product that processes easily, has a great appearance, and is enjoyed by the consumer. Ingredion's sweetener technical team has the experience and development tools to help you find the right carbohydrate system for your products.

TABLE 2: MOLECULAR WEIGHT

	MOLECULAR WEIGHT (g/mol)
Polyglycitol Syrup	Variable
Maltitol Syrup	Variable
Corn Syrups	Variable
Lactitol	362.3
Isomalt	344.2
Maltitol	344.2
Sucrose	342.0
Mannitol	182.0
Sorbitol	182.0
Xylitol	152.2
Erythritol	122.0

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