

Polyols: Sweet Oral Benefits

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Abstract:

Polyols or sugar alcohols are a group of low-digestible carbohydrates with unique health and functional benefits. They are recognized worldwide as safe for teeth, by product labeling such as “tooth friendly” and “does not promote tooth decay” Most recently, in 2011 the European Food Safety Authority’s Panel on Dietetic Products, Nutrition and Allergies (NDA) concluded that the consumption of products containing polyols may maintain tooth mineralization when compared with sugar-containing foods.

Keywords: Dental education, Dental Health, Dental health promotion, Oral health

Introduction:

Polyols, a group of versatile, reduced-calorie sweeteners, can be used to reduce the calories and reduce or replace the sugar in a variety of foods and beverages. Their use is increasing due to the unique health and functional benefits that these bulk sweeteners offer for food production and design. Of particular importance, polyols do not promote tooth decay. Polyols have fewer calories than sugars and, when used alone or with intense sweeteners, food and beverages sweetened with polyols may be labeled “toothfriendly” or “does not promote tooth decay.”

Polyols are a group of low-digestible carbohydrates, which are similar in structure to sugar molecules, except for the substitution of a hydroxyl group in place of the aldehyde or ketone group found on sugars. This substitution retains some of the chemical structure of sugar to give polyols many of the physical properties of sugars so that polyols (often in combination with intense sweeteners) can effectively replace sugar and corn syrups in many food and beverage

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applications. In addition to taste and functionality, polyols also contribute to excellent oral hygiene. A large body of research, including numerous human studies conducted over the past three decades, confirms that polyols do not cause dental caries. This research has been reviewed by numerous scientific and regulatory bodies, most recently by the European Food Safety Authority's (EFSA) Panel on Dietetic Products, Nutrition and Allergies (NDA).

Polyols are generally made by the hydrogenation of sugars and sugar syrups and are used commercially in foods and pharmaceuticals. In food applications, polyols are considered bulk sweeteners, as they can be used as equal volume or equal weight replacements for sucrose or corn syrups. Therefore, polyols serve as useful alternatives to sugars in a wide range of products including chewing gums, candies, ice creams, baked goods and fruit spreads. In addition, they function well in fillings and frostings, canned fruits, beverages, yogurts and tabletop sweeteners. They are also used in toothpastes, mouthwashes and pharmaceutical products, such as cough syrups and throat lozenges.

In addition to providing sweetness, polyols can help retain moisture in food products, lower water activity to help protect against spoilage, impart smoothness and creaminess by inhibiting sugar crystallization, provide viscosity, and assist in retaining flavor at high temperatures. Taste, appearance, nutritional quality, storage and shelf-life can be positively influenced by the addition of polyols to foods and beverages.

There are eight polyols in general use: erythritol, hydrogenated starch hydrolysates (HSH) (also known as polyglycitol, maltitol syrup or polyglucitol), isomalt, lactitol, maltitol, mannitol, sorbitol and xylitol. Since polyols are only partially digested, they provide less than the traditional four calories per gram assigned to carbohydrates, including sugars. The United States Food and Drug Administration (FDA) allows the

use of the following caloric values: HSH 3.0, sorbitol 2.6, xylitol 2.4, maltitol 2.1, isomalt 2.0, lactitol 2.0, and mannitol 1.6. The European Union has been established a value of 2.4 calories per gram for all polyols except erythritol. Erythritol has zero calories.

In addition to their sweet taste and unique functional properties, polyols offer important health benefits. For example, they are reduced in calories and do not cause sudden increases in blood sugar levels. Importantly, polyols are not readily converted to acids by bacteria in the mouth and, therefore, do not promote tooth decay.¹

Polyols are widely recognized as non-cariogenic or tooth friendly alternatives for sugar replacement in chewing gum, candies and other confectionery products. Their dental properties have been well described and reviewed^{2,3}, based on numerous studies on the various aspects of the development of dental caries. The fermentation of polyols by oral bacteria is quite low so polyols are classified as low- or non-acidogenic. Plaque formation is low as polyols do not provide a substrate for the production of extracellular polysaccharides. Plaque pH telemetry studies confirm in situ that polyols are essentially non-acidogenic and thus are not associated with demineralization of tooth enamel. The non-cariogenicity of polyols has been confirmed in vivo in animal models and in intra-oral cariogenicity studies. Although in vitro adaptation of *Streptococci mutans* by frequent subculturing occurs with sorbitol, maltitol and lactitol, it is unlikely to be important in vivo where polyols are consumed with sucrose. It does not occur with isomalt or xylitol.

A number of clinical studies of polyols have been conducted. Most of these utilized sugar-free xylitol and/or sorbitol containing chewing gums, as these were the first available polyols. Sugar-free chewing gum use was compared to sugar-containing chewing gum or no gum. For example, early human studies with xylitol, known as the Turku Sugar Studies, found that the decayed,

missing, and filled (dmf) incidence in teeth in the xylitol chewing-gum group was 1.04, compared to 2.92 in the sucrose gum group.⁴ In a two-year study conducted at the Ylivieska Health Center in Finland, children aged 11-12 who consumed seven to 10 grams of xylitol daily in chewing gum showed a 30 to 60 percent reduction in new dental caries development compared to the control group not chewing gum.⁵ In a follow-up study, the subjects were re-examined two to three years after discontinuation of the use of xylitol, revealing a continued reduction in caries increment in the post-use years of about 55 percent. In teeth erupting during the first year of the use of xylitol chewing gum, the long-term caries preventative effect was over 70 percent. The results suggest that the value of xylitol may be highest during periods of high dental activity such as eruption of new teeth.⁶

Studies have also been conducted with sugar-free chewing gums containing sorbitol/mannitol combinations^{7,8} or chewing gum with maltitol⁹. These studies suggest that the use of gum containing polyols rather than sugar after meals has a caries preventive effect leading to less cariogenic lesions compared to no use of gum or sugar-containing gums.

In recent years, systematic reviews of the effects of sugar-free gums have been published, concluding that sugar-free chewing gum has a caries-reducing effect which can be ascribed to saliva stimulation through the chewing process, particularly when gum is used immediately after meals, with the absence of sucrose and the inability of bacteria to metabolize polyols into acids.^{10,11} There is consistent evidence to support the use of polyol-containing chewing gum as part of normal oral hygiene to prevent dental caries.¹² Furthermore, sugar-free candies too have been shown to be effective.¹³

In recognition of this, the FDA has authorized the use of the “does not promote tooth decay” health claim for “Dietary noncariogenic carbohydrate sweeteners and dental caries.” The regulation requires that when carbohydrates other than those

listed in the regulation (i.e., the polyols listed above, plus tagatose, isomaltulose and sucralose) are present in the food, “the food shall not lower plaque pH below 5.7 by bacterial fermentation either during consumption or up to 30 minutes after consumption, as measured by the indwelling plaque pH test found in “Identification of Low Caries Risk Dietary Components,” by T. N. Imfeld, in Volume 11, *Monographs in Oral Science*, 1983.”¹⁴

In Europe, the “tooth friendly” concept was developed more than 25 years ago by the University of Zurich in Switzerland. It was the basis for a common initiative of the University of Zurich and the Swiss Ministry of Health to found Tooth friendly International, a Switzerland-based non-profit association of dental professionals, dental institutions and food manufacturers, to increase public awareness for the connection between diet and oral health, with the aim to promote a tooth friendly diet, and to describe and promote those food and beverage products that have been demonstrated to be safe for teeth. The “tooth friendliness” of a product is tested by means of intraoral pH telemetry and must meet the same criteria as that required by the FDA. Tooth friendly International created the “Happy Tooth” symbol to signify that a product has been tested in an accredited laboratory and guarantees that it imposes no risk to teeth. Currently, more than 50 manufacturers offer brands that carry the symbol worldwide. A variety of “toothfriendly” products made with polyols, including sugar-free chewing gum and pastilles, are available in the Asian market.

In October 2010, the European Food Safety Authority's (EFSA) Panel on Dietetic Products, Nutrition and Allergies (NDA) adopted two opinions related to sugar free chewing gum and [1] reduction of tooth demineralisation and [2] the neutralisation of plaque acids. The NDA Panel concluded, after reviewing multiple pertinent studies, that a cause and effect relationship has been established between the consumption of

sugar-free chewing gum and reduction of tooth demineralisation and a reduction in incidence of caries.¹⁵ The Panel also concluded that “a cause and effect relationship has been established between the consumption of sugar-free chewing gum and plaque acid neutralisation and a reduction in incidence of caries.”¹⁶ These opinions confirm those of many other regulatory authorities and scientists.

In April 2011, EFSA’s NDA Panel further substantiated health claims regarding the positive effects related to the consumption of polyols and dental health. After a review of research on the consumption of polyols and maintenance of tooth mineralization, the Panel concluded, “The consumption of foods/drinks containing xylitol, sorbitol, mannitol, maltitol, lactitol, isomalt and erythritol, instead of sugar in sugar-containing foods/drinks, may maintain tooth mineralization compared with sugar-containing foods, provided that such foods/drinks do not lead to dental erosion.”¹⁷

The American Dental Association’s (ADA) position statement acknowledging the “Role of Sugar-Free Foods and Medications in Maintaining Good Oral Health” recognizes that “it is neither advisable nor appropriate to eliminate from the American diet sugar-containing foods that provide necessary energy value for optimal nutrition.” The ADA strongly recommends, however, “that major efforts be made to promote the use of sugar-free foods or chewing substances in place of sugar containing foods that involve a frequent intake or repeated oral use . . . use of these sugar-free foods will contribute to improved oral health without any deleterious nutritional consequences.”¹⁸

The ADA also has granted use of its Seal of Acceptance for a select few sugar-free chewing gums for their ability to improve oral health, “based on its findings that the physical action of chewing sugar free gum for 20 minutes after eating stimulates saliva flow, which helps prevent cavities

by reducing plaque acids and strengthening teeth.”¹⁹

Chewing sugar-free gum has also proven to have benefits beyond oral health. U.S. researchers from the Pennington Biomedical Research Center and Louisiana State University in Baton Rouge, Louisiana, found that both men and women who chewed sugar-free gum three times hourly in the afternoon consumed fewer snacks, specifically, fewer sweet snacks than when they did not chew gum. These participants, 115 men and women between the ages of 18 and 54, were all regular gum chewers and reported perceived feelings of hunger, cravings for snacks and energy levels. Significantly decreased feelings of hunger and cravings for sweets were reported from participants who chewed gum. Further, gum chewers reported heightened energy levels throughout the afternoon and significantly less feelings of drowsiness.²⁰ This study replicates the findings from two studies in the UK by Hetherington and co-workers which showed that chewing gum helped reduce snack intake and suppress hunger and desire for sweet snacks.^{21,22}

In addition, EFSA’s NDA Panel issued an Opinion in April 2011 related to the effects of polyols on blood glucose levels, stating, “On the basis of the data presented, the Panel concludes that a cause and effect relationship has been established between the consumption of foods/drinks containing xylitol, sorbitol, mannitol, maltitol, lactitol, isomalt and erythritol instead of sugar and reduction in post-prandial blood glucose responses (without disproportionately increasing post-prandial insulinaemic responses) as compared to sugar-containing foods/drinks.”²³

Conclusion:

In conclusion, the many functional benefits of polyols expand the possibilities for reduced-calorie and sugar-free food and beverage applications. The additional health benefits of these ingredients can increase consumer desirability for products with reduced-calorie, sugar-free, and non-

cariogenic claims. Polyols are significantly less cariogenic than sugars and other fermentable carbohydrates. Their rate and amount of acid production is so much less than that of sucrose and other fermentable carbohydrates that polyols do not cause the loss of minerals from tooth enamel.

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