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The Role of Sugar-Free Products in Oral Health

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It is estimated that nearly 20% of young children, almost 80% of young adults, and approximately 95% of older adults have experienced dental decay.[1] While children and adults with craniofacial problems, neurological abnormalities, or impaired cognitive abilities are at greater risk for such oral infectious diseases, diet and nutrition directly influence its progression in many other people.[2] A recent study suggests that obese people between the ages of 18 and 34 have a 76% higher risk of developing periodontal disease.[3] The researchers reason that these young adults consume too little of the nutrients important for good oral health, including vitamin C and calcium.

In May 2003, the American Dietetic Association released its position on oral health and nutrition, specifically that nutrition is an integral part of oral health.[4] In the association's opinion, nutrition and diet may affect the development and integrity of the oral cavity in that they affect the development or prevention of dental caries, as well as the progression of other diseases of the oral cavity. The role of sucrose and other fermentable carbohydrates in the etiology of dental caries has been well established. This development of dental decay is modulated by the type of food that contains the sugars or starches consumed, the frequency of intake of such foods; oral hygiene status; availability of fluoride, salivary gland function, saliva composition, and other host factors.[5]

Over the past century, advances in science have lead to the availability of sugar replacers in food products. Clinical studies have demonstrated a consistent 30–60% decrease in dental caries among subjects using sugar replacers as compared to subjects in control groups.[6] Many of these sugar-free products incorporate polyols, or sugar alcohols. Polyols are a group of low-digestible carbohydrates derived from the hydrogenation of their sugar or syrup source (e.g., lactitol from lactose). Polyols are carbohydrates but are not sugars. Most polyols are not as sweet as sugar and are sometimes used in combination with other polyols and/or low-calorie sweeteners approved by the U.S. Food and Drug Administration (FDA).

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Polyols are metabolized differently from sugars and from one another. They are generally incompletely absorbed. Absorbed portions are either metabolized (most often by insulin-independent mechanisms) or excreted in urine. A significant amount of the unabsorbed portion is metabolized to short-chain fatty acids and gases by bacteria in the large intestine. Due to their different metabolic fate, polyols provide significantly less than the traditional four calories per gram assigned to carbohydrates in general.

In some people, overconsumption of polyol-containing foods may cause gastrointestinal symptoms, including laxative effects—similar to reactions following the consumption of beans, cabbage, and certain other high-fiber foods. Such symptoms depend on both an individual's sensitivity and the other foods eaten along with the polyol-containing product. Any gastrointestinal symptoms (such as a feeling of fullness) from consuming foods with polyols, if they occur at all, are usually mild and temporary. Most people will adapt to polyols after a few days, the same way they do to high-fiber foods. Food manufacturers are advised by either FDA or the ingredient manufacturer to inform consumers of these possible effects through product labeling.

Polyols serve as a useful alternative to sugars in a wide range of products including chewing gums, candies, ice cream, baked goods, and fruit spreads. In addition, they function well in fillings and frostings, canned fruits, beverages, yogurt, and tabletop sweeteners. They also are used in toothpastes, mouthwashes, and pharmaceutical products such as cough syrups and throat lozenges. Polyols generally available for use include erythritol, hydrogenated starch hydrolysates (including maltitol syrups), isomalt, lactitol, maltitol, mannitol, sorbitol, and xylitol.

Erythritol's taste makes it suitable for a variety of reduced-calorie and sugar-free foods. It blends well with other polyols and can mask unwanted flavors such as bitterness. It has a caloric value of 0.2 calories per gram, five percent of the calories of sucrose. Additionally, erythritol is easily tolerated by the digestive system and eliminated in urine within 24 hours. Thus, foods containing this substance are unlikely to cause gaseous and laxation side effects.

Likewise, Hydrogenated Starch Hydrolysates (HSH) blend well with flavors and other sweeteners and are synergistic with low-calorie sweeteners. They are exceptionally well suited for sugar-free candies because they do not crystallize. Like the polyols discussed below, HSH are absorbed slowly in the body and metabolized in the large intestine. Therefore, the caloric contribution of HSH is not more than 3.0 calories per gram, compared to sugar's 4.0 calories per gram.

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According to a Recent Survey 79% of Americans Use Sugar-Free Products and 76% of Those Want More.

Sugar-Free Polyol Sweetened Products are Reduced-Calorie and Do Not Cause Tooth Decay.

The U.S. Food and Drug Administration has approved a "does not promote tooth decay" health claim for sugar-free products sweetened with polyols.

The American Dental Association "strongly recommends 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... ."

Isomalt is a sugar-free sweetener that is derived from sugar and tastes like sugar. It is used in products such as hard candies and other candy, wafers, cough drops, and throat lozenges. While it has the same texture as sugar, it does not absorb water the same way, so products made with isomalt tend not to be sticky. Isomalt enhances flavor transfer in food, dissolves in the mouth, and does not have the "cooling" effect characteristic of some other polyols. Its caloric contribution is 2.0 calories per gram, or half that of sugar.

Lactitol has a mild sugar-like taste that permits perception of other flavors. Its stability, solubility, and reduced caloric content make it suitable for a variety of low-calorie, low-fat, and/or sugar-free foods including ice cream, chocolate, hard and soft candies, baked goods, and chewing gum. Lactitol prevents products from absorbing moisture, thus it allows crispness to be maintained and extends the shelf life of cookies and chewing gum. Its caloric contribution, like isomalt, is 2.0 calories per gram.

Maltitol has a sweet taste with no off flavors, similar to sucrose in intensity; thus, it can be used without other sweeteners. It does not brown or caramelize as sugars do, and it is especially useful in the manufacture of sucrose-free chocolate. Maltitol contributes 2.1 calories per gram.

Mannitol is about 50% as sweet as sucrose and has a "cooling" effect desirable in the masking of bitter tastes. It is widely used in the food and pharmaceutical industry because of its nonhygroscopic properties (it does not pick up moisture). For this reason, it is frequently used as a dusting powder for chewing gum. Its caloric contribution is 1.6 calories per gram.

Clinical studies have demonstrated a consistent 30–60% decrease in dental caries among subjects using sugar replacers as compared to subjects in a control group.

Sorbitol provides a clean and cool taste. It can be used in a wide variety of products because it protects against the loss of moisture and maintains the product's initial freshness. Sorbitol is very stable and chemically unreactive, thus it combines well with other food ingredients such as sugars, gelling agents, proteins, and vegetable fats. It contributes 2.6 calories per gram.

In products such as mints and chewing gum, xylitol's sweetness and cooling effect stimulate salivary flow and help clean teeth and protect them from decay. Xylitol, therefore, is increasingly popular in foods, pharmaceuticals, and oral health products. Blending xylitol with other polyols and low-calorie sweeteners offers additional taste and function possibilities. Xylitol contributes 2.4 calories per gram.

Xylitol is not the only polyol with noncariogenic properties; in fact, all polyols are noncariogenic. Unlike sugar, polyols are not readily converted to acids by bacteria in the mouth; therefore they do not promote tooth decay. Oral bacteria such as *Streptococcus mutans* convert sugars into polysaccharides that are deposited on the teeth.[7] These plaque sugars, including dextran, are then fermented into acids that, if present in sufficient quantity, will demineralize the tooth enamel. When the oral environment is at a pH level below 5.7 for prolonged periods, calcium dissolves from the tooth surface and holes and cavities develop.[8,9] Although these microorganisms easily ferment carbohydrates like sugar or glucose into decay-causing acids, polyols are not effective substrates for plaque bacteria, and since they cannot be converted, no acid is produced.[8,9]

In October 1998, the American Dental Association's House of Delegates approved a position statement acknowledging the role of sugar-free foods and sugar-free medications in maintaining good oral health. The organization 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." However, the association strongly recommends 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 products will contribute to improved oral health without any deleterious nutritional consequences."[5]

The noncariogenic property of polyols and their benefit to oral health has been recognized in many countries including the United States. Terms such as "does not promote tooth decay" and "may reduce risk of tooth decay" have long been used on "sugar-free" chewing gums and candies sweetened with these sugar replacers. In the United States, these products can only be labeled "sugar-free" if the food contains less than 0.5 grams of sugar per reference amount. "Sugar" includes only mono- and disaccharides. Foods sweetened with polyols or polyols in combination with low-calorie sweeteners may be described as "sugar-free." If a "sugar-free" product does not qualify as being low- or reduced-calorie, it must bear a disclaimer that it is not for weight control.[10]

Following the 1993 publication of the new food labeling regulations, FDA declared that the noncariogenicity claim was an unauthorized health claim.[11] However, FDA acknowledged that there is substantial evidence that polyols do not cause tooth decay. In 1996, FDA authorized the use of a "does not promote health decay" health claim on food products containing xylitol, sorbitol, mannitol, maltitol, isomalt, lactitol, hydrogenated starch hydrolysates, and hydrogenated glucose syrups or a combination of these. In December 1997, FDA amended the regulation to include erythritol and, in July 2003, published a final rule permitting a "does not promote tooth decay" health claim for products sweetened with D-tagatose, a novel sugar.[12] (Products that contain D-tagatose may not be labeled "sugar-free.")

The regulation provides that when carbohydrates other than those listed above 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 test found in 'Identification of Low Caries Risk Dietary Components, dated 1983, by T.N. Imfeld, Volume 11, *Monographs in Oral Science*, 1983.'" Furthermore, FDA regulations prohibit the expansion of the health claim beyond the parameters set by FDA, and the health claim may not

attribute any degree of the reduction of risk of dental caries to the use of the noncariogenic carbohydrate sweetener-containing food.[12] The claim may not imply that consuming noncariogenic carbohydrate sweetener-containing foods is the only recognized means of achieving a reduced risk of dental caries.

Numerous individual countries, as well as international regulatory and health agencies, also have approved use of these sugar replacers. Canada allows for the use of isomalt, lactitol, maltitol, maltitol syrup, mannitol, sorbitol, and xylitol. The maximum level of their use in unstandardized food is limited only by good manufacturing practices.[13] Additionally, all have been carefully reviewed by the Joint Expert Committee on Food Additives of the United Nations' Food and Agriculture Organization and the World Health Organization (JECFA) and deemed safe. JECFA has assigned an acceptable daily intake (ADI) of "not specified"—the most favorable assignation—to each of the polyols mentioned. An ADI "not specified" means that, on the basis of the available data, the total daily intake of the substance does not, in the opinion of the committee, represent a hazard to health, provided that it is used at the levels necessary to achieve the desired effect in food.[14-18]

There are currently five low-calorie sweeteners—acesulfame potassium, aspartame, neotame, saccharin, and sucralose—approved for use in the United States, all of which are noncariogenic. These sweeteners, too, may be used in sugar-free products and provide no calories to foods and beverages containing them. Each of these sweeteners has been carefully reviewed and deemed safe by FDA and numerous other regulatory bodies and expert committees around the world, including JECFA. They have been determined safe by health organizations such as the American Diabetes Association and the American Dietetic Association as well. While the polyols are as sweet as sucrose, or slightly less sweet, the low-calorie sweeteners are intensely sweet. Acesulfame potassium and aspartame are about 200 times as sweet as sugar, saccharin 300 times sweeter, sucralose 600 times sweeter, and neotame 7,000 to 13,000 times sweeter. The polyols are often used in products sweetened with low-calorie sweeteners to provide the bulk needed when sugar has been removed.[19-23]

In addition to their noncariogenic properties and reduced caloric values, polyols do not cause sudden increases in blood glucose levels; therefore, they are recognized as useful in the diets of obese people and those with diabetes. For example, the American Diabetes Association recognizes that polyols "produce a lower postprandial response than fructose, sucrose, or glucose, and have lower energy values." [24]

With their safety confirmed, and their health benefits supported by scientific research, food products containing polyols have created a niche in the marketplace. Recent consumer research suggests that 79% of adult Americans consume low-calorie/sugar-free products. While it was once the case that a large percentage of consumers of sugar-free products were people with diabetes, this increased number of consumers using sugar-free foods corresponds to an increased concerned about obesity, health, and fitness in general.[25] With the current consumer interest in low-calorie, sugar-free products, as well as the increased availability of polyols and innovations in food technology, additional good-tasting sugar-free products bearing the "does not promote tooth decay" health claim are expected to be available. These products can assist consumers in maintaining good oral health.

Polyols generally available for use include erythritol, hydrogenated starch hydrolysates (including maltitol syrups), isomalt, lactitol, maltitol, mannitol, sorbitol, and xylitol.

References

1. National Institutes of Health: *Diagnosis and Management of Dental Caries Throughout Life*. NIH Consensus Statement 2001;18:1-30.
2. Position of the American Dietetic Association: Nutrition services for children with special health care needs. *Journal of the American Dietetic Association* 1995; 95:809-812.
3. Al-Zahrani MS, Bissada NF, Borawski EA: Obesity and periodontal disease in young, middle-aged, and older adults. *Journal of Periodontology* 2003;74:610-615.
4. Position of the American Dietetic Association: Oral health and nutrition. *Journal of the American Dietetic Association* 2003;103:615-625.
5. American Dental Association: *Position Statement: Role of Sugar Free Foods and Medications in Maintaining Good Oral Health*. Adopted October 1998. Available at http://www.ada.org/prof/resources/positions/statements/sugarfre.asp
6. Hayes C: The effect of non-cariogenic sweeteners on the prevention of dental caries: A review of the evidence. *Journal of Dental Education* 2001;65:1106-1109.
7. Mesters PHJ, van Velthuijsen JA, Brokx S: Lacticol: A reduced-calorie sweetener. In Nabors LO (ed.): *Alternative Sweeteners*, 3rd ed. New York, Marcel Dekker, Inc., 2001, pp. 297-315.
8. Kato K, Moskowitz AH: Maltitol. In Nabors LO (ed.): *Alternative Sweeteners*, 3rd ed. New York, Marcel Dekker, Inc., 2001, 283-295.
9. Wijers M-C, Sträter PJ: Isomalt. In Nabors LO (ed.): *Alternative Sweeteners*, 3rd ed. New York, Marcel Dekker, Inc., 2001, 265-282.
10. Office of the Federal Register, General Service Administration: *Code of Federal Regulations*. Title 21, Section 101.60. Washington, DC, U.S. Government Printing Office, 2002.
11. U. S. Food and Drug Administration. *Federal Register* 58:2326 (January 6, 1993).
12. U. S. Food and Drug Administration. *Federal Register* 68:39831 (July 3, 2003).
13. Canada Gazette Part II. Food and Drug Regulations, amendment, Vol. 127, No. 12, pp. 2601-2608. Ottawa, June1993.
14. Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives: Thirty-third Report, "Evaluation of certain food additives

and contaminants," Maltitol and Maltitol Syrup. WHO Technical Report Series, No. 776, 1989, pp. 19-20.
15. Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives: Thirtieth Report, "Evaluation of certain food additives and contaminants," Mannitol. WHO Technical Report Series, No. 751, 1987, pp. 25-26, 52.
16. Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives: Twenty-ninth Report, "Toxicological evaluation of certain food additives and contaminants," Isomalt. WHO Food Additive Series, No. 20, 1985, pp. 207-237.
17. Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives: Twenty-seventh Report, "Toxicological evaluation of certain food additives and contaminants," Xylitol and Lactitol. WHO Technical Report Series, No. 696, 1983, pp. 82-94, 161-174.
18. Food and Agriculture Organization/World Health Organization Expert Committee on Food Additives: Twenty-sixth Report, "Toxicological evaluation of certain food additives and contaminants," Sorbitol. WHO Technical Report Series, No. 683, 1982, pp. 218-228.
19. von Rymon Lipinski G-W, Hanger L: Acesulfame K. In Nabors LO (ed.): *Alternative Sweeteners*, 3rd ed. New York, Marcel Dekker, Inc., 2001, pp. 13-30.
20. Butchko HH, Stargel WW, Comer CP, et al.: Aspartame. In In Nabors LO (ed.): *Alternative Sweeteners*, 3rd ed. New York, Marcel Dekker, Inc., 2001, pp. 41-61.
21. Stargel WW, Mayhew DA, Comer CP, et al.: Neotame. In Nabors LO (ed.): *Alternative Sweeteners*, 3rd ed. New York, Marcel Dekker, Inc., 2001, pp. 129-145.
22. Pearson RL: Saccharin. In Nabors LO (ed.): *Alternative Sweeteners*, 3rd ed. New York, Marcel Dekker, Inc., 2001, pp. 147-165.
23. Goldsmith LA, Merkel CM: Sucralose. In Nabors LO (ed.): *Alternative Sweeteners*, 3rd ed. New York, Marcel Dekker, Inc., 2001, pp. 185-207.
24. American Diabetes Association: Position Statement. Evidence-based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications. *Diabetes Care*. 2002;25(1),:202-212.
25. Calorie Control Council: Light Products Usage and Weight Control Habits Survey. (Unpublished) 2000.

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