Title: Xylitol for caries prevention. (Literature Review).

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Xyitol is a naturally occurring sweetener which is essentially not fermentable by the caries-inducive oral microflora. When tested as a sucrose replacer, or even as a small dietary addition, systematic xylitol use leads to impressive reductions in caries incidence. Xylitol is compatible and complementary with all current oral hygiene recommendations. The appealing sensory and functional properties of xylitol facilitate a wide array of applications that promote oral health.

Keywords. Xylitol, tooth decay prevention, artificial sweeteners, sugar substitutes, noncariogenic sugars.

Introduction

Maximized prevention of dental caries presumes simultaneous and continuous exploitation of several strategies. Fluoride-based procedures are the cornerstone of successful prevention. Strict, long-term restriction of cariogenic sugars undoubtedly also results in significant caries reduction. However, considering the human preference for sweet food items, restriction of cariogenic sugars without offering alternatives is impractical. (1) Therefore, in clinically difficult situations, such as in cases of rampant caries, profoundly caries-susceptible tooth structure, poor diet, hyposalivation, amelogenesis imperfecta, etc., the use of noncariogenic sugar substitutes should automatically be considered.

Clinical studies conducted over the past 25 years strongly indicate that xylitol--a naturally occurring carbohydrate sweetener--can decisively enhance caries prevention. The purpose of this article is to briefly review the most important clinical studies on xylitol and to discuss practical aspects of the usage of xylitol for caries limitation. The aim is to emphasize the strong position the xylitol-based prevention concept has attained, and the endorsements this strategy has received within the public health sector in leading countries in this field.

What is xylitol?

Xylitol is a sweet crystalline carbohydrate which has been known to science for some 100 years. The name xylitol relates to the word xylose (wood sugar) from which xylitol was first made, and which is in turn derived from the particular structure (xylem) of hardwood from which xylose can be obtained. Later studies showed that xylitol also occurs freely in fruits and other plant parts. Xylitol is present in human metabolism as a normal metabolic intermediate (in the glucuronatexylulose cycle). In chemical nomenclature, xylitol is classified similarly to sorbitol and mannitol, i.e., as a sugar alcohol or a polyol. The theoretical caloric value of xylitol is about 4 kcal/g, the same as other dietary

carbohydrates. However, in practice, the caloric utilization of xylitol by the human body may be lower. On food labels, the U.S. Food and Drug Administration (FDA) allows a reduced-calorie claim for xylitol (2.4 kcal/g).

Xylitol is currently manufactured from various xylan-rich plant materials; xylan is the natural polysaccharide that consists of xylose units. Although xylitol occurs freely in nature, it is more economic to use certain plant parts as starting material. Examples of suitable raw materials are birchwood, corn residues, straw, seed hulls, and nut shells.

Medical Uses of Xylitol

Xylitol can help prevent ear infections and thereby reduce the need for antibiotics. Use of xylitol chewing gum or syrup medications by children in daycare centers was associated with a reduced rate of acute otitis media (middle ear infections) and a lowered nasopyharyngeal carriage rate of pneumococci in the subjects. (2-4) According to one study, saline nasal spray with added xylitol helped reduce growth and adherence of pathogenic bacteria. (5) Preliminary reports from another study indicated fewer upper respiratory and ear infections. (6,7)

Because xylitol is as sweet as regular refined table sugar and because its initial utilization by the human body does not require insulin, xylitol has gained acceptance as a sweetener in the diabetic diet. (8) This practice is relatively common in several European countries, and Chinese and Japanese researchers also are aware of it. Compared with glucose in healthy subjects, xylitol intake causes a much smaller increase in serum insulin and blood glucose levels with no "rebound" hypoglycemia (glycemic index: xylitol=7, glucose=100). (9)

Another important application of xylitol is as a source of energy in parenteral nutrition (infusion therapy). (10) German physicians have used xylitol in substantial quantities for intravenous feeding of patients with impaired glucose tolerance. When used intravenously, xylitol was found to have an anti-catabolic muscle-sparing effect. Whether dietary intake (such as current use in formulas for athletes) would have this same benefit is highly speculative.

Ingested xylitol has been found to delay gastric emptying and increase satiety. (11) Animal experiments have shown that dietary xylitol improves calcium absorption and prevents osteoporosis. (12-14) Xylitol is thought to affect bone and connective tisssue metabolism in other ways. (15) Although these and other xylitol-related observations are exciting, this review will deal with only the oral health aspects of xylitol use.

Oral Health Effects

More than a quarter of a century ago, researchers at the University of Turku, Finland, began to study xylitol as a potential anticariogenic dietary sweetener. The initial results of simple plaque studies were encouraging. Subsequent clinical trials during the past 25 years have demonstrated that systematic usage of xylitol chewing gum and related

xylitol-sweetened products can be associated with an impressive reduction of caries incidence both in juvenile and adult populations. These clinical trials, laboratory experiments, and outlines of the mechanism of xylitol action--including discussions related to the public health aspects of this approach--have been reviewed. (16-18)

Clinical Evidence

Several long-term clinical caries studies have been completed by independent research teams working on different human populations. (19-27) These clinical trials have shown conclusively that the consumption of a xylitol diet or the usage of xylitol-containing saliva stimulants (chewing gum and candy) reduces the incidence of dental caries significantly. Several of these studies included special features which may be important to consider in clinical practice and in disseminating information about xylitol to patients. Important aspects are the long-term effect of xylitol, hyposalivation relief, stabilization of rampant caries, prevention of root caries, the mother-child cariologic relationship, and implementation of school prevention programs. It is also important to emphasize the advantage individuals with low caries incidence will gain from systematic usage of xylitol-containing saliva stimulants.

Special Observations Made in Selected Trials

Full substitution of xylitol for sucrose

In the first clinical caries study, adult volunteers were given xylitol to replace sucrose in their diet over a two-year period (19) The second study added only a small amount of xylitol in chewing gum to the usual diet. Both studies provided a similar result in that caries incidence was strongly reduced in xylitol-using subjects, regardless of whether xylitol diet or xylitol gum was used.

These studies, collectively called Turku Sugar Studies, indicated that significant additional protection against dental caries could be achieved by merely using a xylitol-containing chewing gum as a saliva stimulant. (19) Some of the advantages of the full-substitution trial were the experience obtained regarding the manufacturing of various xylitol foods, and the confirmation of the safety of xylitol in human use. After 25 years of confirmatory trials, all of the most important observations of the Turku studies have been verified. (20-32) Specific new information obtained in some of these trials will be discussed in the following paragraphs.

The long-term effect of xylitol

One of the confirmatory studies was carried out in the central Finland town of Ylivieska. (26) The oral health care professionals and school authorities believed that since caries prevention among the area school children had been well executed--mostly based on the use of fluorides, systematic checkups, and regular oral hygiene and dietary instructions at school--the addition of xylitol to the existing preventive program would have little or no effect. However, the results showed that chewing xylitol gum two to three times a day

significantly increased the protection against caries in 10 to 11 year-old subjects. (26) Teeth that erupted during the trial were especially well protected.

After usage of the xylitol gum was stopped, the subjects were reexamined by the same dentists three and five years later, when the subjects were 15 and 18 years old, respectively. The preventive effect noted at the end of the five-year trial had persisted, although the subjects no longer used xylitol gum. (27,28)

Children in the Belize study were reexamined five years after the xylitol gum chewing ended. Teeth that erupted after at least one year of xylitol use had impressive reductions in caries risk (33) (Figure 1).

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Such long-term benefits of xylitol use should be considered in cost/benefit analysis of dental public health initiatives. These results have been applied in some countries, such as Finland, to develop new prevention programs for kindergartens, childrens' day care centers, military personnel, etc. (17)

Remineralization--stabilization of rampant caries

Dentists have historically restored even small, initial carious lesions to prevent further decay. However, millions of people throughout the world receive no oral health care. In some areas, the only oral health "care" people receive is tooth extraction. On the other hand, it is known that even advanced dentin lesions can remineralize. (34-38) A thin apatite-like layer containing a high concentration of calcium salt largely derived from salivary calcium and phosphorus forms an effective barrier, which prevents bacteria in the underlying lesion from receiving nutrients. This happens especially if the cavity is well open and kept free of food residues.

Recent clinical trials in Belize, Central America, confirmed this type of caries arrest. (39) A large number of Belizean children had open dentin and enamel carious lesions. Long-term usage of xylitol chewing gum was associated with significant stabilization of these lesions. (30) It is possible that such programmed usage of xylitol gum could alleviate pain and suffering and improve the quality of life of children and prolong retention of the permanent teeth, perhaps even until proper restorative care was available. (39)

Mother-child transmission of Streptococci mutans

A newborn baby normally receives the first cariogenic organisms from the mother through normal infant-care, such as kissing and food-tasting. A long-term clinical study in Finland several years ago measured the effect of mothers' xylitol gum usage on the transmission rate of Streptococcus mutans to their babies. When the children were about 3 years old, the childrens' risk of having Streptococcus mutans colonization was 2.3-fold in the fluoride-treated group, compared with the xylitol group. (40,41) The difference was statistically significant. Even at six years of age, the salivary Streptococci mutans

levels were significantly lower in the xylitol group than in the other groups, which were treated either with fluoride varnish or chlorhexidine varnish (42) (Figure 2). It is important to point out that these children did not chew gum or receive fluoride varnish treatments--only their mothers did.

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The same children also were examined annually regarding their caries status. At the age of five, the caries rate in the xylitol group was reduced by about 70%, as compared with the fluoride or chlorhexidine groups (43) (Figure 3). Therefore, it may be concluded that maternal use of xylitol chewing gum can prevent dental caries in children by prohibiting the transmission of Streptococcus mutans from mothers to their children. This mother-child study continues in Finland and should provide additional data in the future.

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School-based xylitol programs

The use of xylitol in individual caries prevention is easy; the products are attractive and their use can be controlled by the subjects themselves, or in the case of small children, by guardians. (44,45) Xylitol gum usage has been tested as part of school-based public health programs. In Finland, more than 40,000 elementary school children and now an increasing number of preschool-age children, have been involved in supervised, systematic xylitol gum usage at school. Such efforts were initially partly based on positive observations made earlier within university and college students' health foundations, which found that students generally approved of this type of caries prevention. (46) Therefore, xylitol gums are currently routinely recommended by public health centers in Finland for young children as an important caries-prevention procedure.

Root surface caries

Prevention of cervical and root caries may constitute an overwhelmingly difficult task among certain institutionalized geriatric patients with poor oral hygiene and change-resistant attitudes. An exploratory study carried out in the Dayton, Ohio, Veterans Affairs Medical Center indicated that it may be worthwhile to offer adult and geriatric patients xylitol-based saliva stimulants, preferably hard candy. (31) Many of these patients abused drugs, alcohol, or they smoked. The study suggested that it may be possible to reduce the craving for tobacco, or the frequency of smoking, among such patients by having them use xylitol-containing saliva stimulants to replace tobacco. In this study, xylitol was found to be more effective in preventing new root surface caries than sorbitol.

Xerostomia

Some adult and geriatric patients suffer from hyposalivation and the resulting xerostomia because of certain medications they take that affect the amount and quality of saliva. Although the usage of xylitol-containing saliva stimulants does not offer a cure for

xerostomia, systematic use of xylitol products can nevertheless lesson the clinical symptoms without causing harm to the teeth, which could occur if regular sucrose products were to be used. Although no clinical trials have been conducted on this question, it is obvious that patients with conditions such as Sjogren's syndrome or those who receive radiation therapy to the head and neck will also benefit from systematic use of xylitol-containing saliva stimulants.

Periodontal health and xylitol

Xylitol has been found to specifically interfere with the metabolism and the adherence of S. mutans, and possibly of lactobacillus. Although xylitol inhibits the growth of several organisms active in periodontal diseases, clinical studies have not shown that it is effective in preventing periodontal disease. On the other hand, short-term studies indicate that xylitol does not pose a threat to periodontal health and may be beneficial. (31,47,48) A recent exploratory study in Dayton, Ohio, showed that systematic use of xylitol and sorbitol saliva stimulants was associated with improved gingival health. (31) Long-term clinical studies should be conducted to answer questions about the effect of xylitol on periodontal health.

Several indirect observations do suggest that xylitol usage may promote gingival and periodontal health. For example, systematic xylitol consumption generally reduces the amount of dental plaque by up to 50%. (18) Also, the dental plaque of xylitol-using subjects has been found to be less inflammatory than plaque obtained from sucrose-using individuals. (18,48,49) Such observations may indicate a type of "inflammation-dampening" effect of programmed xylitol usage. (49) Further study is needed.

Public health evaluation of xylitol

The use of xylitol as a caries-preventive agent can no longer be regarded as experimental. Several national dental associations, as well as regulatory agencies in Scandinavia and elsewhere, have endorsed the use of xylitol against dental caries. (50)

Authorities in several other nations are planning to include systematic xylitol usage in various public health programs to promote better oral health. (17) The safety of xylitol has been intensively studied in the United States (51) and internationally. (52) The FDA classifies xylitol as a special dietary sweetener that can be consumed at levels necessary for the intended use of those products. (53) Xylitol has been similarly approved in all industrialized nations for various medical, dietary, and cosmetic uses. (50)

Why is xylitol effective?

Several texts have outlined the action of xylitol in preventing dental caries. (15-18) Bacterial adherence seems to be a prerequisite of dental caries. Xylitol exerts a specific inhibitory effect on S. mutans cells, which thrive best in acidic media and have a "sticky" surface or outer layer which enables the organism to adhere to tooth surfaces. Xylitol does not acidify dental plaque. Consequently, xylitol reduces the occurrence and

adherence of S. mutans in the oral cavity, especially on tooth surfaces. Certain bio-inorganic properties of xylitol also have been implicated as possible causes of its anticariogenicity, but for the time being, the oral health effects of xylitol can most easily be attributed to its interference with the metabolism and adherence of S. mutans and other cariogenic bacteria. (15,16) Since the mechanism of action of fluorides and xylitol on dental caries differ they can be used simultaneously in a caries preventive approach with an additive effect.

Applications

Commercial sweeteners: an overview

There are two main categories of sweeteners: intense (high-potency) sweeteners and bulk sweeteners. The intense sweeteners--aspartame, neotame, acesulfame K, sucralose, and saccharin--are many times sweeter than sucrose. They are sometimes referred to as noncaloric or nonnutritive sweeteners because of their negligible caloric contribution. Intense sweeteners are favored for use in sugar-free beverages where water supplies volume. They are all considered nonacidogenic and noncariogenic.

In addition to sweetness, bulk sweeteners also provide useful functional properties such as volume, appearance, mouth-feel, viscosity, hygroscopicity, crystallinity, and food preservation. In the broadest chemical definition, bulk sweeteners are all "sugars" or sweet crystalline carbohydrates. The main groups of bulk sweeteners are sugars (mono- and disaccharides) and polyols. Sugars, particularly sucrose, are readily fermented by S. mutans and other plaque organisms, which are capable of acidifying plaque and considered cariogenic. (54) An exception is the sugar D-tagatose, which is nonacidogenic.

Polyols are hydrogenated reduction products of sugars, where the reducing carbonyl (C=O) aldehyde or ketone functional group is converted to a less reactive hydroxyl (C-OH) or "alcohol" group, hence the name "sugar alcohols." Theoretically, the higher hydrogen to carbon ratio of polyols results in less acid production than their aldose or ketose counterparts. Although the Streptococci mutans is capable of fermenting mannitol and sorbitol, acid production is very slow and less lactic acid is produced. However, both sorbitol and mannitol do support and stimulate the growth of these bacteria, whereas xylitol does not.

In 1998, the FDA approved health claims linking the prevention of dental caries to the consumption of polyol-sweetened substitutes for cariogenic snacks. (53) Statements for small snack food packages include: "May reduce the risk of tooth decay." These claims apply to all polyols and are not specific to xylitol.

Polyols are slowly absorbed by the small intestine and metabolized along established carbohydrate pathways, mainly in the liver. The unabsorbed portion reaches the large intestine where fermentation can occur. An exception is erythritol, a four-carbon polyol that is rapidly absorbed and largely excreted unchanged in the urine. Overconsumption of

any slowly absorbed food can result in gastrointestinal discomfort, flatulence, and osmotic diarrhea. The laxation threshold for mannitol is low and requires a warning label for anticipated ingestion of 20 grams per day. But the caution level for sorbitol is 50 grams per day. Xylitol is generally tolerated better than other polyols and requires no warning label.

Most dietary sugars and polyols are structurally based on a six-carbon hexose or hexitol unit. However, xylitol is a five-carbon acyclic polyol or pentitol. This five-carbon versus the six-carbon structure theoretically explains the various clinical advantages of xylitol. (15) The five-carbon xylitol structure is stoichiometrically unfavorable for extensive acid, especially lactic acid fermentation. The structural conformation makes xylitol hydrophilic and capable of forming weak interactions with calcium in solution. These complexes, also formed by sorbitol and mannitol, are believed to stabilize the calcium phosphate systems present in saliva, but are not strong enough to dissolve solid calcium salts.

Crystalline xylitol dissolves rapidly and is higher in solubility than sucrose at 37[degrees]C. Xylitol is the sweetest polyol and has the greatest cooling effect. In most applications, it has the same sweetness as sucrose. Although xylitol is versatile and sweet enough to be used as a general-purpose sucrose replacer, not all applications are rational for commercial and oral health purposes. It is not necessary to replace all dietary sugars. For significant oral health benefits, small amounts of xylitol can be used daily as a dietary addition or in substitutes for a few sucrose treats.

Xylitol combinations

Some sweetened products, such as those that contain fermentable carbohydrates, are not ideal candidates for added xylitol. Xylitol is more expensive than sucrose and is used mainly where oral health benefits can be expected. Higher xylitol concentrations tend to give a better plaque pH response. (54) Xylitol is not always able to entirely blunt a drop in pH when simply mixed in with rapidly fermentable carbohydrates. (55)

Xylitol combines well with other noncariogenic ingredients for finished products that retain oral health benefits at acceptable cost and functionality. Unsweetened bulking agents that are dentally safe include celluloses, pectins, gums, polydextrose, and gelatin. Intense sweeteners can be blended with xylitol where high levels of sweetness are desired. A small percentage of xylitol can be added to beverages, usually in conjunction with an intense sweetener, to improve flavor and mouth-feel. Xylitol is added to other polyols--commonly sorbitol--for a synergistic sweetness and flavor improvement, as well as for better plaque pH response. Dentally safe syrup medications can be prepared with xylitol, usually along with thickeners and flavorings. The freshness and flavor impact of mint and fruit flavors are enhanced by the cooling sensation provided by the addition of xylitol. (56)

How to Use Xylitol Effectively

Product selection

The best oral applications for xylitol are in products that encourage chewing or sucking, where xylitol is present as the sole or principal bulk sweetener. (57) Lower levels of xylitol also are effective provided that the other ingredients are dentally inert. Although surprisingly small amounts of xylitol decreased caries in the Canadian study, the lower limit for xylitol content is not well-defined, and dentally insignificant levels of xylitol could be added just to boost sweetness and improve flavor and texture. (24,25)

Chewing gum is considered an ideal "delivery system" for xylitol, and is the leading application worldwide. Chewing gums which are exclusively xylitol-sweetened are most effective for remineralization and caries prevention (29) (Figure 4). In recent trials, pellet-type gum with a nearly pure xylitol candy coating produced the best results, perhaps because high xylitol concentrations are delivered immediately. This suggests that products other than gum are also effective, which has recently been confirmed with xylitol candy (32) (Figure 5). Chewy, hard, or tablet candy can be made with a high percentage of xylitol. (56) This allows the xylitol to be kept in contact with the teeth for those who have trouble chewing or in situations where gum residue would be a nuisance. The dental benefits are similar. Breath mints, antacids, calcium supplements, chewable medications, cough drops, and vitamins also are effectively formulated with xylitol. Compressed tablets can be almost entirely xylitol. Breath spray, oral moisturizers, and saliva substitutes also are convenient vehicles to deliver small amounts of xylitol throughout the day to help relieve symptoms of xerostomia. Oral hygiene products can be sweetened with xylitol. For example, fluoride toothpaste was found to be more effective with a 10% or greater xylitol content. (58,59)

[GRAPHICS OMITTED]

How Much?

When used properly, very little xylitol is needed for dental benefits. A suggested range is on the order of 4 to 12 g per day, which is 1 to 3 tsp., or less than one-half ounce. (This amount parallels the amount of xylitol generated daily in the gluconurate-xylulose metabolic cycle.) Each "high-content" xylitol gum or mint contains 1 g of xylitol or less, so a xylitol preventive maintenance program could be as basic as chewing one piece of gum four times a day. Impressive results have been obtained in recent trials using two pieces of gum five times each day, for a daily xylitol intake of approximately 10 g. (26,29)

How often?

Frequency of xylitol use is more important than absolute amounts, although five times every day is recommended. Three times is considered a minimum for effective caries prevention (26,29) (Figure 6).

When?

While xylitol can be used effectively throughout a lifetime, some key times have been identified as particularly important. These offer special opportunities to decisively establish a nonpathogenic oral flora.

An ideal time to begin habitual xylitol gum chewing is at least one year prior to the eruption of permanent teeth. These teeth are most likely to be well-mineralized and maintain long-lasting protection. (33)

In adults, xylitol can be recommended after oral prophylaxis procedures. For example, following full-mouth disinfection or chlorhexidine use, xylitol can help maintain the supression of pathogenic bacteria. (60,62) New parents who use xylitol are less likely to transmit the S. mutans infection to their children.

Timing

Xylitol should be used immediately after every meal and snack and is also encouraged for use between meals. It is recommended that gum should be chewed for at least three to five minutes, after which time the xylitol content is practically nil. High peak concentrations of xylitol may be more important than the amount of time xylitol persists at lower concentrations. (63)

Consistent use

Regular xylitol use should be encouraged as a routine healthy habit, a continuing part of a normal oral hygiene regimen. These are guidelines for xylitol use. Ideally caries prevention and xylitol use would be individualized. Individuals who do not eat between meals, have low caries rates, low S. mutans counts, and demonstrate good oral hygiene should do well with the minimum xylitol recommendations. "High-risk" patients could benefit by using xylitol more often than the standard recommendations. Xylitol use is individually adjustable. Levels can be increased when other usual routine oral hygiene procedures become difficult to maintain, such as during illness or injury, while traveling, at school or work, and throughout orthodontic therapy. A basic xylitol program easily can be implemented in facilities, such as hospitals, nursing homes, day care centers, school cafeterias, sporting events, and in the military. (64,65)

Recurring questions about xylitol

Are all sugar-free products the same?

The American Dental Association (ADA) "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 improve oral health." (66) A recent literature review on behalf of the National Institutes of Health (NIH) also supports the use of sugar-free substitutes for frequently consumed sucrose items. Evidence for sorbitol and xylitol was

positive, with the stronger benefit shown for xylitol. (67) In several other countries, professional dental organizations have issued specific endorsements for xylitol. (50)

Is xylitol only recommended exclusively for children?

Xylitol can be used by people of all ages. Prevention efforts should adjust to the changing age distribution of caries onsets.

Is xylitol recommended only for patients with active caries?

Mechanical plaque removal, fluoride, and xylitol are routinely recommended for all dentulous patients. Xylitol is also a valuable noncariogenic saliva stimulant for relief of xerostomia.

Who are "high-risk" patients that could benefit from intensive xylitol use?

More frequent use of xylitol should be recommended based on clinical observation and patient history. Children who do not have dental sealants can have similar protection with xylitol. (68) Patients with rampant caries, poor oral hygiene, and a history of oral health neglect are obvious candidates for a maximum prevention effort that includes the use of xylitol. Xylitol can be very helpful in promotion of oral health in special needs patients who lack manual dexterity or have an illness or injury that makes traditional home care difficult. (69)

Extensive restorations, bridges, removable partial dentures, cosmetic retorations, orthodonic appliances, and dental implants could also make mechanical plaque removal more challenging. (70) Consideration should also be given to patients with secondary caries, incipient caries, and gingival recession. Also, athletes who use sports beverages during workouts are subjected to dental erosion and may warrant more frequent use of xylitol.

Within the same category are certain factory workers who may be subjected to occupational oral diseases after long-term inhaling of detrimental vapors and particles, such as acids in car batteries and industrial manufacturing plants, and sugar dust in food manufacturing plants. Intensive usage of xylitol gum has been suggested in such situations.

The label states "sugar alcohol." Does it mean this xylitol products contain both sugar and alcohol?

Unfortunately, the majority of consumers surveyed believe this. (71) It does seem confusing to claim "sugar-free" and "alcohol-free" on the same label that lists a "sugar alcohol" like xylitol. Labeling regulations distinguish between sugar alcohols, other sugars, and ethanol. Manufacturers understandably prefer to use the term "polyols" on food labels, while the FDA maintains that "sugar alcohols" is the proper term. The term

"sugar alcohol" simply pertains to organic chemistry nomeclature and is, therefore, frequently used by scientists.

Are there concerns about safety?

Xylitol consumption has a long history of safety. The only side effects of ingesting too much xylitol are soft stools (osmotic diarrhea) in sensitive individuals. (72) This is a limited temporary condition as dosage is self-adjusted and tolerance increases rapidly. Because individual responses vary widely, it is reasonable to begin using xylitol at the lower effective amounts. The laxation threshold, generally more than 20 g per meal and 60 g per day, is not approached by the small amounts of xylitol needed for oral health protection.

Can xylitol simply replace brushing, flossing, and fluoride?

The best use of xylitol is as an addition to other oral hygiene recommendations. Xylitol is only one part of a multiple intervention approach for the prevention of dental caries along with fluoride, chlorhexidine, dental sealants, mechanical plaque removal, and regular professional care.

Is the use of xylitol limited to chewing gum?

Xylitol is a versatile sweetener and can function as a sucrose replacer in a wide array of applications. Oral health benefits have been similar in studies using xylitol candy or chewing gum. (32)

Can oral bacteria adapt to xylitol?

With habitual xylitol use there is a shift in the bacterial flora to a xylitol-tolerant population. This is a favorable change because "xylitol-resistant" bacteria tend to be harmless. (73-75)

Is xylitol practical?

In some European countries, xylitol use is a standard government-supported preventive measure. (76) Xylitol products can replace some sucrose products already being regularly consumed. Targeting xylitol programs at the age when permanent teeth erupt results in long-lasting, cost-effective protection.

Conclusions

Although underutilized and often overlooked, xylitol use is compatible and complementary to current oral hygiene recommendations. Xylitol is not a panacea, but it is a practical and effective adjunct to "state of the art" caries prevention programs.

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