DELTA DENTAL

DELTA DENTAL PLANS ASSOCIATION
NATIONAL SCIENCE ADVISORY COMMITTEE REPORT

Questions on xylitol to be investigated: Does the use of xylitol products as recommended (a) reduce acid production; (b) reduce S.mutans counts; (c) Reduce plaque accumulation; and (d) aid enamel remineralization?

Executive Summary

Xylitol has most commonly been studied in chewing gum, with just a few studies looking at its action in toothpaste, mouthrinse, or tablets. Most of the studies have been done in children, with fewer studies in adults. Very little has been done to look at effects of xylitol in patients over 65 or root surfaces (Makinen, et.al 1995b). There is an abundance of available evidence on xylitol's action in caries, so conclusions can be reached with confidence. There is strong evidence that xylitol, in sufficiently high dosage (5-10 g/day), consistent and prolonged use, and with three or more exposures per day, reduces the incidence of caries. Classifying the evidence as strong, moderate, or weak, there is strong evidence that the consistent use of xylitol reduces interdental acid production, and strong evidence that it reduces bacterial counts of the mutans streptococci. There is also moderate evidence that xylitol promotes enamel remineralization, though only weak evidence that it reduces plaque accumulation.

Research Sources and Thoroughness Estimate:

A MEDLINE search supported by handsearching was carried out. This search was restricted to English language publications in view of time restraints and the likelihood that few original articles would be published in languages other than English. In order to keep the evidence base up to date, the search was confined to original studies in articles published from 1995 and addressing directly the questions to be investigated.

The initial search turned up over 100 articles published from 1995 to the present which included the search terms *xylitol* and *dental caries*. A perusal of titles and abstracts identified those articles which were clearly not original research papers on the subject of this review (e.g., literature reviews, policy statements). This reduced the working database to 37 articles which looked to be original research, and which directly addressed one or more of the four questions posed above. The conclusions from this review are based on those articles.

Strength of Evidence

The findings were overwhelmingly in favor of a non-cariogenic role for xylitol. Since only studies with established research designs were included in this review, and there was a good number of them with similar findings, the evidence in favor of a non-cariogenic role for xylitol was strong

Homogeneity of Findings

High

Findings and Conclusions

A good number of reviews, published before and after 1995, clearly supported the conclusion that xylitol was effective in inhibiting caries (Anderson 2003; Bar 1988; Birkhed 1994; Edgar 1998; Gales and Nguyen 2000; Hayes 2001; Lynch and Milgrom 2003; Tanzer 1995; Trahan 1995). None were found with an opposing conclusion, though some called for more research.

i. Xylitol Reduces Acid Production:

Five studies were found which directly measured acid production in plaque following use of a xylitol-containing product. One Swedish study found that chewing xylitol gum twice per day, for a daily total xylitol intake of of 5 g/day, reduced lactic acid production in the plaque of preschoolers when compared to a sorbitol gum control (Twetman et al 2003). Similar effectiveness in reducing plaque pH was found with the use of xylitol gum among fixed-appliance orthodontic patients (Sengun et al 2004). Reductions in plaque formation and salivary lactic acid counts were found among schoolchildren who chewed a pellet of xylitol gum twice per day for a daily total ingestion of 6.18 g of xylitol (Holgerson et al 2007).

Two other studies, however, did not achieve such clear-cut results. One found the value of a high single daily xylitol dose (6.0 g) to be limited in reducing acid production, though more effective than a single low xylitol dose of 2.0 g (Lif Holgerson et al 2005). This suggests that in addition to sufficient total dosage of xylitol, fairly continuous exposure gives better results that one large single dose. Another study found no change in interdental acid production among 15-year-old orthodontic patients. The maximum daily dose of xylitol in one test group in this study was 3.4 g/day, and another test group ingested 1.7 g. At this level of exposure no reduction in plaque acid production could be found (Stecksen-Blicks et al 2004).

Conclusion: There is strong evidence that xylitol reduces plaque acid production. The studies that did not demonstrate this may have used too low an exposure or short duration of use.

ii. Xylitol Reduces Plaque Formation

Only a few studies which directly measured plaque formation have been reported. One found that daily use of xyllitol gums in kingergarten children reduced plaque formation when compared to the outcome with a passive control (Makinen et al 2005). Another study, conducted with disabled people, also found plaque quantity reduced when compared to a passive control group (Shyama et al 2006). On the other hand, a protocol of three daily rinses with a xylitol-containing mouthrinse in adults had no effect on plaque quantity when compared to a passive control (Giertsen et al 1999).

Conclusion: There is as yet insufficient evidence that xylitol reduces plaque formation to any significant extent.

iii. Xylitol Reduces mutans streptococci counts

There is abundant evidence that regular chewing with xylitol gum reduces the counts of mutans streptococci (MS) in both plaque and saliva. This was clear well before 1995 (Tanzer 1995), and research since then has confirmed this relationship.

Studies with children predominate. In a dose-response study, Milgrom and colleagues concluded that doses of 6-10 g/day reduced MS counts in both plaque and saliva (Milgrom et al 2006). As part

of the Belize studies, a dosage of 4.5-5.0 g/day for 5-year-old children had been shown to reduce MS counts (Makinen et al 2005), and similar results with older children had been found earlier with exposure to 10.7 g/day (Makinen et al 1996). Other researchers reported positive results in studies with adults (Haresaku et al 2007; Hillebrandt et al 2000; Simons et al 1997); teenagers with daily dose of 7.0 g/day (Makinen Saag et al 2005), and school-age and preschool children (Autio 2002; Holgerson et al 2007; Thaweboon et al 2004). Immediate reductions in MS counts have also been demonstrated to still be evident up to six years later (Soderling et al 2001).

Not all studies provided positive results. A study using xylitol tablets (not gum) with a maximum dose of 3.4 g/day, found only a temporary drop in salivary MS (Stecksen-Blicks et al 2004), and consumption of three xylitol lozenges per day did not change salivary MS counts over the long-term (Tenovuo et al 1997). Children taking 0.5-1.0 g/day of xylitol in tablet form did not lower salivary MS counts (Oscarson et al 2006). More evaluation is needed in delivery vehicles (gum, tablet, lozenge, mouthrinse), in frequency of exposure, and in daily dosage.

Having mothers chew xylitol gum (4.2 g/day) several times per day over 2 years has also been shown to reduce the mother-to-child transmission of MS (Thorild et al 2003; Isokangas et al 2000; Soderling et al 2000).

Conclusion: There is strong evidence that when xylitol is taken consistently over prolonged periods of time, in dosages of 5-10 g/day, in several different exposures rather than in just once, it is effective in reducing MS counts. This same usage also looks to be effective in reducing MS transmision from mother to child.

iv. Xylitol promotes remineralization

In vitro studies to examine xylitol's role in remineralization have been positive (Amaechi et al 1999; Miake et al 2003; Suda et al 2006). A study with rats concluded that a toothpaste containing both xylitol and sodium fluoride was more effective than one containing only fluoride, and it was concluded that this result was due to the remineralizing action of xylitol (Gaffar et al 1998).

In research with humans, there is evidence from the Belize studies that part of xylitol's action is in inducing remineralization (Makinen Makinen et al 1995; Makinen Hujoel et al 1998; Makinen et al 1998).

Conclusion: There is moderate evidence that xylitol gum, when chewed several times per day, assists the process of remineralization.

NSAC member's Conclusions and Comments.

The evidence is strong that xylitol, when used consistently over prolonged periods of time to provide a daily dosage of 5-10 g, is effective at all ages in reducing MS counts and thus exerting a non-cariogenic effect. The evidence is also strong that xylitol reduces plaque acid production, and moderate that it aids remineralization. Xylitol may also reduce plaque bulk, though the evidence for this is weak. The evidence suggests also that xylitol is most effective when taken in several exposures per day rather than one.

Further research should be directed at whether chewing gum is the most effective delivery mode, or whether there is also a role for lozenges, chewable tablets, or toothpaste which contain xylitol.

Listing of Resources Reviewed

Amaechi BT, Higham SM, Edgar WM. Caries inhibiting and remineralizing effect of xylitol in vitro. Journal of Oral Science 1999;41:71-6.

Anderson M. Chlorhexidine and xylitol gum in caries prevention. Spec Care Dent 2003;23:173-6.

Autio JT. Effect of xylitol chewing gum on salivary *Streptococcus mutans* in preschool children. J Dent Child 2002;69:81-6.

Bar A. Caries prevention with xylitol. A review of the scientific evidence. World Rev Nutr Dietet 1988;55:183-209.

Birkhed D. Cariologic aspects of xylitol and its use in chewing gum: a review. Acta Odont Scand 1994; 52:116-27.

Edgar WM. Sugar substitutes, chewing gum and dental caries--a review. Br Dent J 1998;184:29-32.

Gaffar A, Blake-Haskins JC, Sullivan R, Simone A, Schmidt R, Saunders F. Cariostatic effects of a xylitol/NaF dentifrice in vivo. Int Dent J 1998;48:32-9.

Gales MA, Nguyen TM. Sorbitol compared with xylitol in prevention of dental caries. 2000;34:98-100.

Giertsen E, Emberland H, Scheie AA. Effects of mouth rinses with xylitol and fluoride on dental plaque and saliva. Caries Res 1999;33:23-31.

Haresaku S, Hanioka T, Tsutsui A, Yamamoto M, Chou T, Gunjishima Y. Long-term effect of xylitol gum use on mutans streptococci in adults. Caries 2007;41:198-203.

Hayes C. The effect of non-cariogenic sweeteners on the prevention of dental caries. J Dent Educ 2001;65:1106-9.

Hildebrandt GH, Sparks BS. Maintaining mutans streptococci suppression with xylitol chewing gum. J Am Dent Assoc 2000;131:909-16.

Holgerson PL, Sjostrom I, Stecksen-Blicks C, Twetman S. Dental plaque formation and salivary mutans streptococci in schoolchildren after use of xylitol-containing chewing gum. Int J Paediatr 2007;17:79-85.

Isokangas P, Soderling E, Pienihakkinen K, Alanen P. Occurrence of dental decay in children after maternal consumption of xylitol chewing gum, a follow-up from 0 to 5 years of age. J Dent Res 2000;79:1885-9.

Lif Holgerson P, Stecksen-Blicks C, Sjostrom I, Twetman S. Effect of xylitol-containing chewing gums on interdental plaque-pH in habitual xylitol consumers. Acta Odont Scand 2005;63:233-8.

Lynch H, Milgrom P. Xylitol and dental caries: an overview for clinicians. J Calif Dent Assoc 2003;31:25-9.

Makinen KK, Chen CY, Makinen PL, Bennett CA, Isokangas P J, Isotupa K P, Pape HR, Jr. Properties of whole saliva and dental plaque in relation to 40-month consumption of chewing gums containing xylitol, sorbitol or sucrose. Caries Res 1996;30:180-8.

Makinen KK, Chiego DJ, Allen P, Bennett C, Isotupa K P, Tiekso J, Makinen PL. Physical, chemical, and histologic changes in dentin caries lesions of primary teeth induced by regular use of polyol chewing gums. Acta Odont Scand 1998;56:148-56.

Makinen KK, Hujoel PP, Bennett CA, Isokangas P, Isotupa K, Pape HR, Jr, Makinen PL. A descriptive report of the effects of a 16-month xylitol chewing-gum programme subsequent to a 40-month sucrose gum programme. Caries Res 1998;32:107-12.

Makinen KK, Isotupa KP, Makinen PL, Soderling E, Song KB, Nam SH, Jeong SH. Six-month polyol chewing-gum programme in kindergarten-age children: a feasibility study focusing on mutans streptococci and dental plaque. Int Dent J 2005;55:81-8.

Makinen K K, Makinen PL, Pape HR Jr, Allen P, Bennett CA, Isokangas PJ, Isotupa K P. Stabilisation of rampant caries: polyol gums and arrest of dentine caries in two long-term cohort studies in young subjects. Int Dent J 1995;45(1 Suppl 1):93-107.

Makinen KK, Pemberton D, Cole J, Makinen PL, Chen CY, Lambert P. Saliva stimulants and the oral health of geriatric patients. Adv Dent Res. 1995b;9:125-126.

Makinen KK, Saag M, Isotupa KP, Olak J, Nommela R, Soderling E, Makinen PL. Similarity of the effects of erythritol and xylitol on some risk factors of dental caries. Caries Res 2005;39:207-15.

Miake Y, Saeki Y, Takahashi M, Yanagisawa T. Remineralization effects of xylitol on demineralized enamel. J Electron Microscop 2003;52:471-6.

Milgrom P, Ly KA, Roberts MC, Rothen M, Mueller G. Yamaguchi DK. Mutans streptococci dose response to xylitol chewing gum. J Dent Res 2006;85:177-81.

Sengun A, Sari Z, Ramoglu SI, Malkoc S, Duran I. Evaluation of the dental plaque pH recovery effect of a xylitol lozenge on patients with fixed orthodontic appliances. Angle Orthodont 2004;74:240-4.

Shyama M, Honkala E, Honkala S, Al-Mutawa SA. Effect of xylitol candies on plaque and gingival indices in physically disabled school pupils. J Clin Dent 2006;17:17-21.

Simons D, Kidd EA, Beighton D, Jones B. The effect of chlorhexidine/xylitol chewing-gum on cariogenic salivary microflora: a clinical trial in elderly patients. Caries Res 1997;31:91-6.

Soderling E, Isokangas P, Pienihakkinen K, Tenovuo J. Influence of maternal xylitol consumption on acquisition of mutans streptococci by infants. J Dent Res 2000;79:882-7.

Soderling E, Isokangas P, Pienihakkinen K, Tenovuo J, Alanen P. Influence of maternal xylitol consumption on mother-child transmission of mutans streptococci: 6-year follow-up. Caries Res 2001;35:173-7.

Stecksen-Blicks C, Holgerson PL, Olsson M, Bylund B, Sjostrom I, Skold-Larsson K, Kalfas S, Twetman S. Effect of xylitol on mutans streptococci and lactic acid formation in saliva and plaque

from adolescents and young adults with fixed orthodontic appliances. Euro J Oral Sciences 2004;112:244-8.

Suda R, Suzuki T, Takiguchi R, Egawa K, Sano T, Hasegawa K. The effect of adding calcium lactate to xylitol chewing gum on remineralization of enamel lesions. Caries Res 2006;40:43-6.

Tanzer JM. Xylitol chewing gum and dental caries. Int Dent J 1995;45(1 Suppl 1):65-76.

Tenovuo J, Hurme T, Ahola A, Svedberg C, Ostela I, Lenander-Lumikari M, Neva M. Release of cariostatic agents from a new buffering fluoride- and xylitol-containing lozenge to human whole saliva in vivo. J Oral Rehab 1997;24:335-41.

Thaweboon S, Thaweboon B, Soo-Ampon S. The effect of xylitol chewing gum on mutans streptococci in saliva and dental plaque. Southeast Asian J Tropical Med Public Health 2004;34:1024-7.

Thorild I, Lindau B, Twetman S. Effect of maternal use of chewing gums containing xylitol, chlorhexidine or fluoride on mutans streptococci colonization in the mothers' infant children. Oral Health Prev Dent 2003;1:53-7.

Trahan L. Xylitol: a review of its action on mutans streptococci and dental plaque--its clinical significance. Int Dent J 1995;45(1 Suppl 1):77-92.

Twetman S, Stecksen-Blicks C. Effect of xylitol-containing chewing gums on lactic acid production in dental plaque from caries active pre-school children. Oral Health Prev Dent 2003;1:195-9.