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 (Holgersen 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 Holgersen et al 2005). This suggests that in addition to sufficient total dosage of xylitol, fairly continuous exposure gives better results than 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 xylitol gums in kindergarten children reduced plaque formation when compared to the outcome with a passive control (Makininen 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 (Giertsens 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, it is effective in reducing MS counts. This same usage also looks to be effective in reducing MS transmission 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


Makinen KK, Chen CY, Makinen PL, Bennett CA, Isokangas PJ, Isotupa KP, Pape HR, Jr.

Makinen KK, Chiego DJ, Allen P, Bennett C, Isotupa KP, Tiekso J, Makinen PL.

Makinen KK, Hujoel PP, Bennett CA, Isokangas P, Isotupa K, Pape HR, Jr, Makinen PL.

Makinen KK, Isotupa KP, Makinen PL, Soderling E, Song KB, Nam SH, Jeong SH.

Makinen K K, Makinen PL, Pape HR Jr, Allen P, Bennett CA, Isokangas PJ, Isotupa KP.

Makinen KK, Pemberton D, Cole J, Makinen PL, Chen CY, Lambert P.


Miake Y, Saeki Y, Takahashi M, Yanagisawa T.

Milgrom P, Ly KA, Roberts MC, Rothen M, Mueller G, Yamaguchi DK.


Shyama M, Honkala E, Honkala S, Al-Mutawa SA.

Simons D, Kidd EA, Beighton D, Jones B.

Soderling E, Isokangas P, Pienihakkinen K, Tenovuo J.

Soderling E, Isokangas P, Pienihakkinen K, Tenovuo J, Alanen P.

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.


