Xylitol – A Natural Approach To Caries Prevention

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The modern consumer increasingly demands more from than their diet than energy and satiety, as they look to the foods that they eat to provide tangible functional and health benefits. Sugar substitutes offer product developers the opportunity to not only meet, but hopefully to exceed, the expectations of today's better-informed consumer. Xylitol, a naturally occurring sweetener, is a prime example of the possibilities that the latest generation of sugar substitutes can offer. Xylitol is one of a group of sugar substitutes collectively described as polyols or sugar alcohols, all of which are hydrogenated derivates of fermentable carbohydrates and are classified as "sugar free" ingredients. They all exhibit reduced caloric values and lower glycaemic indices than sucrose or glucose, are suitable for inclusion in diabetic diets and are non-cariogenic (do not promote tooth decay). Xylitol's most significant differential advantage over other sugar free bulk sweeteners is its portfolio of dental benefits, which have been established over three decades of clinical research. These studies have clearly demonstrated that xylitol is cariostatic (i.e. it actively prevents the formation of tooth decay).

Xylitol is known as a highly versatile bulk sweetener, with a distinctive combination of functional, organoleptic and health benefits (Fig. 1). It is as sweet as sucrose, and has a natural, refreshing cooling effect that can be used to enhance the impact and freshness of most flavour systems.

Fig. 1 – Beneficial Properties of Xylitol in Foods

Organoleptic & Functional Properties	Health Benefits
Intense Natural Cooling Effect	Sugar Free
Equal Sweetness to Sucrose	40% Less Calories Than Sucrose
High Solubility	Low Glycaemic Index (8)
Exceptional Taste Masking Properties	Suitable for Carbohydrate Reduced Diets
Excellent Stability Profile	Non-Cariogenic
Low Water Activity	Cariostatic

Xylitol – The Sugar Free Choice for Dental Health

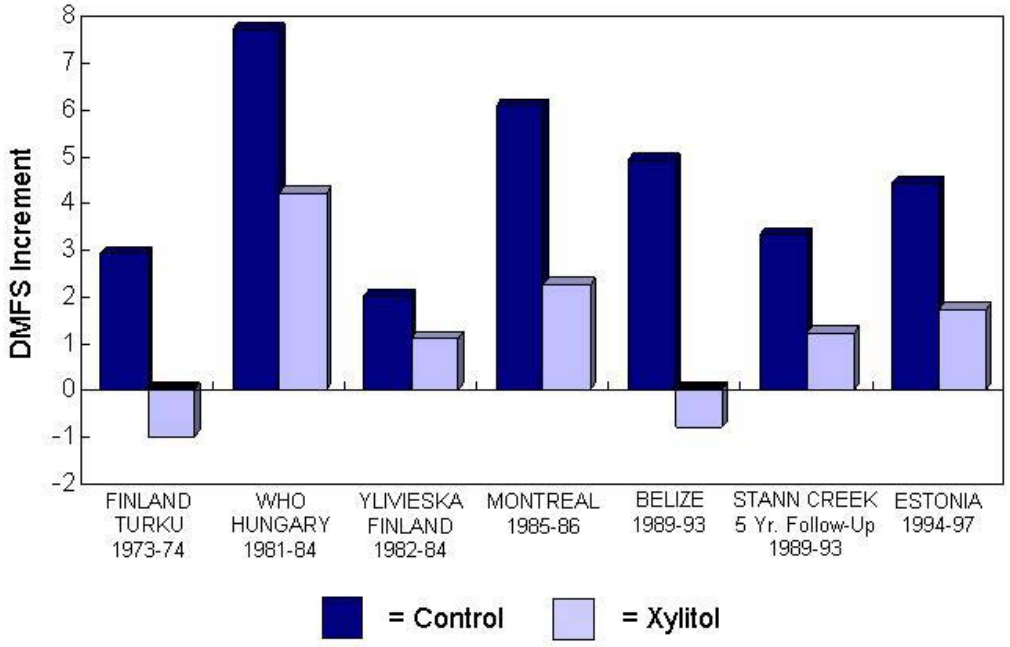
Numerous field studies and clinical trials have demonstrated that the regular use of xylitol in the diet can reduce the occurrence of tooth decay (dental caries) by as much as 100%. These studies, some of which were carried out under the direction of the WHO, have utilised a variety of study populations representing diverse baseline caries rates and a wide range of age groups. The method of delivery utilised in these studies has also varied from total substitution of dietary sugars, to the inclusion xylitol in chewing gum, confectionery and even toothpaste.

The inhibitory effects of xylitol against tooth decay were first demonstrated during the Turku Sugar Studies, at the beginning of the 1970's. The aim of the first study was to evaluate the effect of substituting all sources of dietary sucrose with either a less fermentable (fructose) or non-fermentable (xylitol) alternative. The results of the study were more significant than expected, with the xylitol group exhibiting an average caries increment (a measure of the increase in tooth decay during the study) of 0.0 at the end of the two-year study, compared to 7.2 for the normal sugar containing diet and 3.8 for the fructose diet. This effectively meant that the subjects in the xylitol group had no net increase in tooth decay during the period of the study.
As the use of xylitol proved so effective in this study, the same study group hypothesised that the regular use of xylitol as a supplement to a normal sucrose diet might also have a significant effect upon the incidence of tooth decay. Therefore, they carried out a further study

that evaluated the use of a 100% xylitol sweetened chewing gum consumed four or five times daily. The effect of this intervention was no less significant than the results of the earlier full substitution study, with the subjects in the xylitol group exhibiting an average caries increment of –1.04 after 12 months (i.e. a reduction in the level of tooth decay measured at baseline), compared to an increase of 2.92 in the control group which consumed a normal sucrose sweetened chewing gum.

Such positive results stimulated a great deal of interest and many more studies were carried out during the 1980's and 1990's. Particular interest was shown in the potential of using xylitol chewing gum as a school-based caries preventative tool, and therefore most studies focused upon children aged between 6 and 14 years (the time that the majority of the permanent teeth appear in the mouth). All of these studies have demonstrated a significant role for xylitol in reducing the levels of tooth decay. The results of a number of these studies are summarised in Fig. 2.

Fig. 2 – Summary Of Some Of The Most Significant Studies Of Xylitol's Effect Against Tooth Decay (DMFS Increment = Increase in Tooth Decay)



Xylitol Reduces Plaque

One of the reported mechanisms of xylitol that could explain these dramatic findings is its effect against dental plaque. Plaque contains the bacteria that are responsible for causing tooth decay, via the production of organic acids that demineralise the tooth surface. Several studies have demonstrated that the consumption of xylitol significantly inhibits the growth of plaque, and with regular consumption, can even reduce overall plaque levels.

Xylitol also reduces the proportion of insoluble polysaccharides found in plaque (the adhesive macromolecules that bind the plaque matrix together, and to the surface of the teeth) with a commensurate increase in the proportion of soluble polysaccharides. The resultant plaque is less adhesive, and it is hypothesised that this facilitates its easier removal during brushing and even by the natural washing action of saliva.

Xylitol Reduces Cariogenic Micro-organisms

The effect of xylitol against dental plaque as a whole appears to be explained in part by a specific inhibitory effect against the most cariogenic bacteria found in plaque. These are the bacteria most commonly associated with causing tooth decay, and belong to the family of Mutans Streptococci. Xylitol has been shown to actively inhibit the growth of these bacteria, and over time, to reduce their overall numbers in the plaque. Xylitol also causes a shift in the Mutans Streptococci population; to one that is less virulent, having a reduced ability to ferment sugars to organic acids and exhibiting reduced adhesion characteristics (particularly the ability to adhere to tooth enamel).

The positive effect of xylitol in reducing tooth decay is most likely a combination of its general inhibitory effect against plaque and its more specific effect against the most cariogenic bacteria in the oral flora. Furthermore, additional effects, such as the passive effect of replacing fermentable carbohydrates in the diet (and therefore reducing the overall acid challenge), increased salivary flow and enhanced remineralisation (repair of early acid damage), will also play an important role in achieving the highly significant reductions in tooth decay observed in the aforementioned studies.

Xylitol Offers Third Party Decay Protection

A recent study has shown that xylitol can exert positive effects on the dental health of young children, via the maternal consumption of xylitol-sweetened chewing gum. This remarkable study revealed that if the mothers of newborn children consumed xylitol sweetened chewing gum 4 to 5 times per day for the first two years of the child's life, the child exhibited significantly lower oral colonisation by Mutans Streptococci at the age of two, compared to children whose mothers had not consumed xylitol. Perhaps more significant, is the fact that these children went on to develop over 70% less tooth decay by the age of five years, than the children of mothers who did not receive xylitol. This outstanding result supports the widely accepted theory that oral colonisation by Mutans Streptococci is a reliable indicator of future tooth decay experience, with children who are colonised earlier in life typically exhibiting far higher levels of tooth decay than children who are colonised later in life or not at all.

The mechanism of xylitol's effect in this instance again appears to be its specific effects against the Mutans Streptococci, and in particular its effect in reducing the ability of these bacteria to adhere to the teeth. As the bacteria are passed from mothers to their children through every day contact, the mothers who had been consuming xylitol passed on Mutans Streptococci with reduced adhesion characteristics, which were far less effective in colonising the mouth of the child than the "normal" Mutans Streptococci harboured by the mothers who had not consumed xylitol.

The Future Tastes Sweet

Virtually all forms of traditional confectionery can be offered in a sugar free form, and with the inclusion of xylitol, these products can provide substantial dental health benefits. Some manufacturers have already seized the opportunity offered by xylitol and limited health claims based upon the xylitol content of products are already present in the market.

As consumers increasingly take responsibility for their own health and well being, they may not be willing to wait for less restrictive health claims to become a reality. Instead they can rely upon the huge catalogue of evidence supporting xylitol's effectiveness to make their own dietary choices, particularly when no less an authority than the Harvard School of Dental Medicine recently stated that: "since the evidence suggests a strong caries protective effect for xylitol, it would be unethical to deprive subjects of its potential benefits" (Hayes, C.: *J Dent Educ.* 2001, Oct; 65 (10):1106-9). In such a situation, the credibility and awareness of xylitol's health benefits may far outweigh the present restrictions placed upon the use of meaningful health claims.