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Xylitol: A Novel Remineralizing Agent: A Review

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Abstract
Despite paramount advancement in preventive strategies, dental caries still remains a global health problem for both children and adults. Traditionally, caries have been treated by removing the affected tooth structure and then restoring the cavities. But the focus in caries has recently been shifted to the conservation of the natural tooth structure. Using remineralizing agents is one such method of halting the caries progression at an earlier stage. Sugar substitutes like Xylitol have gained importance in preventive dentistry. The use of chewing gum carrying xylitol increases the salivary flow rate and enhances the protective property of saliva.

Keywords: dental caries, remineralizing agents, sugar substitutes, xylitol, salivary flow rate

Introduction
Despite paramount advancement in preventive strategies, dental caries still remains a global health problem for both children and adults [1]. If diagnosed at an earlier stage it can be arrested and potentially reversed [2].
Traditionally, caries have been treated by removing the affected tooth structure and then restoring the cavities. But the focus in caries has recently been shifted to the conservation of the natural tooth structure. So if we can diagnose a carious lesion at the initial stage and device some method to arrest its progression we would be able to achieve our goal of conservation for prevention. Using remineralizing agents is one such method of halting the caries progression at an earlier stage. Sugar substitutes like Xylitol have gained importance in preventive dentistry. The use of chewing gum carrying xylitol increases the salivary flow rate and enhances the protective property of saliva [3].

History
Schnein A, Makinen KK gave the first scientific report on the remineralizing potential of xylitol in enamel caries as a part of the Turku Sugar Studies in 1975. The result showed that subjects who replaced fructose and sucrose in their diets with xylitol had an 85% reduction in caries [4].

Fig 1: Xylitol chewing gum

In 1980, Leach S.A and Green R.M studied the effect of xylitol-supplemented diet (3% or 5%) on the regression of fissure caries in rat. Continued exposure to a xylitol-starch diet produced a successive regression of caries rate, which the authors interpreted as remineralization and as a therapeutic effect [5].
In 1985, Vissink A *et al* had found the rehardening of artificially softened human enamel by carboxymethylcellulose- containing saliva substitutes having 2% xylitol.
Arends J *et al* (1990) evaluated the combined effect of xylitol and fluoride on enamel demineralization produced by lactic acid solution. They noticed that xylitol and sodium fluoride when used individually had comparable effects on lesion reduction and the combined effect was all the more additive [6].
In Belize Study in 1995, Mikenen K.K found that the number of early enamel caries lesions detected at baseline reduced and remineralized in xylitol-using subjects during the 40 month follow-up [5].
In 2001, Shen P *et al* noticed that addition of CPP-ACP to xylitol-based gum resulted in a dose-related increase in enamel remineralization, with 0.19, 10.0, 18.8, and 56.4 mg of CPP-ACP producing an increase in enamel remineralization of 9, 63, 102, and 152%, respectively, relative to the control gum [7].
In 2006, Honkana S, studied caries prevention in physically disabled children, who received about 2.3kg xylitol in the form of hard candies in three daily episodes. The authors concluded that xylitol has a strong and clear remineralizing effect on caries [8].

Fig 2: Xylitol candy

Souza J G (2010) studied the effect of xylitolvarnish and solution on bovine enamel erosion and found that 10% xylitol solution and 20% xylitol varnish produced a smooth layer on eroded dentinal surface and significantly reduce the enamel erosion [9].

In 2011, Rochell ID, studied the effect of xylitol and fluoride containing dentifrices on enamel erosion with abrasion and has noticed that inclusion of 10% xylitol increased the effect of fluoridated dentifrice against enamel erosion and abrasion [10].

Structure

Xylitol is a natural sugar alcohol of the pentilol type i.e., the xylitol molecule contains fivecarbon atoms and five hydroxyl groups. Xylitol belongs to the polyalcohols group. They form certain type of complexes with calcium and other polyvalentcations. These calcium-xylitol complexes contribute to the remineralization of demineralized enamel and dentin carious lesions [8].

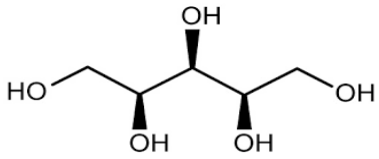

Fig 3: Structure of xylitol

Mechanism of action

Xylitol works in three major ways:

1. Xylitol acts on the mitochondria of streptococcus mutans and inhibit the process of glycolysis of these microrganisms, thus interfering their growth and metabolism.
2. Xylitol works by making the pH alkaline. When S. mutans bacteria ferment sugar, they produce acids, which lower the pH level below 7 and slowly weakens the protective tooth enamel by increasing the dissolution of calcium and phosphate ions. When xylitol is ingested, the acid attack is reduced because the caries producing bacteria are unable to ferment xylitol. As a result the growth of these bacteria and simultaneous production of acid is reduced and oral pH stays higher. At the high pH, the hydrophilic molecule of xylitol is able to form complexes with calcium in solution, thus stabilizing the calcium and phosphates found in saliva. The saturation of calcium ions in saliva promotes the remineralization of dental tissues by deposition of calcium ions [4].
3. It stimulates the salivary flow rate which increases the salivary clearance, buffering power and degree of saturation with calcium and phosphates thereby, neutralizing the decrease in plaque pH/salivary pH that occurs after meals [8].

Indications

- In moderate or high caries risk patients.
- Periodontal disease
- Erosion
- As a non-caloric sweetener

Contraindication

Use of xylitol containing chewing gum, mints, or hard candy are contraindicated in children less than 4 years of age due to the risk of choking [11].

Dosage

There is accumulating evidence that total daily doses of 3 to 8 grams of xylitol are required for a clinical effect with the currently available delivery methods of syrup, chewing gum, and lozenges. Dosing frequency should be a minimum of 2 times a day, not to exceed 8 grams per day.

Advantages

- Decrease in caries rates, increment, and/or onset.
- Maternal consumption of xylitol reduces the acquisition of mutans streptococci (MS) and dental caries by their children [12].
- Have pleasant taste and a sweetness which equals that of sucrose
- It does not raise blood pressure or blood glucose levels as most sugar substitutes do.
- Easy to use anywhere and anytime.

Fig 4: Advantages of xylitol

Disadvantages

At higher dose, xylitol use is associated with symptoms like gas and osmotic diarrhea because of slow rate of absorption of xylitol through the gut wall [11].

Uses

- In gum diseases
  - ✓ Reduce dental plaque formation
  - ✓ Make plaque less adhesive
- Moderate or high caries risk patients
  - ✓ Reduce the levels of S.mutans
  - ✓ Remineralization of tooth enamel
- Dry mouth and bad breath

Commercial products

1. Xylitol chewing gum
2. Spry Xylitol Toothpaste
3. Happy Morning® Xylitol Single-Use Toothbrush With Xylitol Toothpaste
4. Dry Mouth Drops---Xylitol

1) Xylitol chewing gum

It is available in Spearmint, Peppermint, Cinnamon, Fresh fruit and Cranberry flavours.

Composition

- Gum base
- Xylitol 0.75 gm

Instructions for usage

- Use immediately after eating and clear the mouth with swishing water.
- Adults: 3 to 5 times/day × 2 tablets
- Children: 3 to 5 times/day × 1 tablet
- Chew Xylitol Chewing gum until the taste disappears.

Fig 5: Xylitol chewing gum

2) Spry xylitol toothpaste

It is a regular toothpaste with 25% xylitol and no fluoride. Brush thoroughly after meals or atleast twice a day.

Fig 6: Xylitol toothpaste

3) Happy Morning® Xylitol Single-Use Toothbrush with Xylitol Toothpaste

These toothbrushes pre-pasted with mint flavored Xylitol toothpaste and should be used every morning.

Fig 7: Xylitol toothbrushes

4) Dry mouth drops---xylitol

Composition

Xylitol 2g, Gum Arabic, Natural Flavour, Malic Acid, Magnesium, Stearate, Artificial colour.

Instructions

- Adults 4 drops a day
- Children 2 drops a day
- Unsuitable for children under the age of three years.

Fig 8: Xylitol dry mouth drops

Conclusion

Minimal intervention dentistry is not a strategy, it is a philosophy. The future of dentistry will rely on regeneration of tooth structure. Understanding the remineralization process allows dentist to treat the lesion before cavitation. The scientific and clinical information available today indicates that habitual use of xylitol, a sugar alcohol of the pentitol type, can be associated with significant reduction in the incidence of dental caries and with remineralization of both enamel and dentin caries lesions.

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