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Sugar Alcohols Efficacy on Dental Caries Incidence: A Review Article.

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ABSTRACT

Some common sugar alcohols are :xylitol, mannitol, sorbitol, maltitol, erythritol, etc. The most common is a five carbon sugar alcohol named xylitol claimed to have a significant correlation with reduction of caries incidence by different mechanisms that we will discuss at this study. Also we have focused on the effect of various sugar alcohols at different ages. Study about the relation between sugar alcohols and caries can convince the public health authorities to use the products with these sweeteners much more than usual to promote dental health.

Keywords: sugar alcohol, dental caries, xylitol, erythritol

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INTRODUCTION

Dental caries is basically the production of oral biofilms and it is induced by an external source such as sucrose [1]. Oral bacteria like *Streptococcus mutans* can produce acid from sucrose, glucose and lactose. Some studies had shown that sucrose, maltose and lactose in rats with *S. mutans* can induce dental caries [1]. It would cause demineralization of tooth enamel and would destroy the tooth structure. There are four conditions should occur at the same time so that lead to caries: 1. a susceptible tooth 2. Oral bacteria such as *S. mutans* 3. Presence of fermentable carbohydrates in diet 4. The duration which bacteria can metabolize the carbohydrates usually in a few minutes. Unfortunately 20-25% of American children have dental caries [3] and of course dental caries is developing in many adults and it is as wide as children and adolescence. However public oral health programs focused on children in comparison to adults. One reason for this subject can be the lack of enough knowledge of the preventive methods for adults [4]. Having *S. mutans* in early years of childhood is a major risk factor for caries in future [5].

Clinical studies have shown that sugar alcohols especially xylitol and sorbitol in a diet can reharder caries lesions. In this study we will also discuss about the cariostatic ability of erythritol [6]. The most common sugar alcohols are: xylitol, erythritol, sorbitol, mannitol. It is believed that xylitol is the most effective way to prevent dental caries among other sugar alcohols [7]. The word sugar alcohols refers to the reduction products of sugars and form a hydroxyl group in the molecule [6]. There is noticeable evidence that shows using gums or sweets with xylitol or a mixture of xylitol and sorbitol can prevent dental caries by using several times a day [5]. Xylitol decreases the level of *S. mutans* which is in saliva and plaque; this is done by interrupting the bacteria's energy production so that they will die and it reduces the adherence of the bacteria to the teeth and reduces acid release. Xylitol can help the mineralization. Xylitol is a non-fermentable sugar and the habit of consuming xylitol can decrease the M.S levels [8]. Still there is much more need to research about xylitol mechanisms and its effects on saliva and plaque. The mechanism which is proposed is in this way: *S. mutans* transfer sugar to cell by using energy. Xylitol changes to xylitol-5-phosphate by phosphoenolpyruvate and *S. mutans* dephosphorylates xylitol-5-phosphate by then this molecule comes out of the cell in an energetic way. So xylitol can inhibit the growth of cariogenic bacteria like *S. mutans* by starving them [8]. Erythritol is a teritol type of sugar alcohols and has four hydroxyl groups. It was first investigated in the rats that erythritol is noncariogenic [9]. It is predicted that power of caries incidence reduction is relevant to number of OH group that determines the efficacy as follows; erythritol \geq xylitol $>$ sorbitol [10].

METHODOLOGY

This review research aims to look into different effects of various sugar alcohols on prevention dental caries and its mechanisms. The inclusion criteria were: written in English, being indexed in PubMed or Science Direct, researches were in vitro and in human beings. We entered all research types such as clinical trials, review articles, meta analyses, etc. In order to investigate the key word 'sugar alcohols and dental caries' was used.

In a review article published by Mickenautsch et.al the latest researches about therapeutic and anticariogenic effect of sugar free alcohol were investigated. The research demonstrated chewing xylitol, sorbitol or sorbitol/xylitol gums have anticariogenic effects through two mechanisms; first stimulate saliva by chewing process instantly after meals and second lack of bacterial source like sucrose to metabolize polyols to acids. No evidence showed that sorbitol or xylitol have direct therapeutic effects [11].

Another review article conducted by Mäkinen at year of 2009 investigated on effect of sugar alcohols on caries incidence and remineralization of caries lesion. This review expresses that caries are reversible and normal physiological process of remineralization can be facilitated by oral hygiene and nutrition especially if treated immediately. Xylitol and sorbitol can raise remineralization of enamel and dentin so reduce incidence of dental caries. Based on this articles caries incidence reduction is relevant to number of OH group that determine the efficacy as follows; erythritol \geq xylitol $>$ sorbitol [6].

Another review research carried out by Loveren et al. aimed to collect the evidences for caries prevention and caries therapeutic to check the effects of sugar alcohols. The result of this review article showed that regular use of xylitol have reduction effect on numbers of *S. mutans* and it is more effective at caries prevention than sorbitol but sometimes at some studies it's not clear caries therapeutic effects of

xylitol. Other gums containing polyols seems to decrease caries rate through stimulation of saliva. It has expressed that chewing sugar free gums, candies, tablets 3 or more times per day for a long time can reduce caries incidence irrespective of type of sugar alcohol added [7].

In their investigation Hildebrandt et al. examined maintaining suppression of streptococcus mutans by xylitol chewing gum among 15 subjects with elevated oral M.S levels more than 105 CFU/ml which had been rinsed with 0.12% CHX for 14 days. They were divided randomly in 3 groups: test group who were chewing xylitol three times daily, placebo group used sorbitol gum and control subjects did not chew gum. Samples were collected using paraffin stimulation after enumerating colonies of S.mutans they realized that after 3 months chewing gum the subjects of test group showed remarkable low M.S levels while the M.S levels of two other groups were more .so they found that xylitol can increase lasting effect of CHX on oral M.S [12].

In an review article conducted by Mäkinen et al. to investigate about sugar alcohol sweeteners like xylitol and alternative sugars he expressed that partial sugar substitution with polyols especially xylitol is an efficient way to prevent dental carries through reducing the growth of dental plaque and also can enhance the remineralization of caries lesion according to his research xylitol is a carries limiting agent and other sugar alcohols didn't show remarkable effect on mass and adhesiveness and growth of bacteria plaque [10].

In their study, Cardoso et al. investigated on remineralization of artificial enamel in vitro by xylitol or xylitol with fluoride together. Seven groups of bovin enamel accreted and after conducting carries lesion the enamel treated by different percentages of xylitol and NaF the varnish remained 6 hours and then they examined pH, hardness and transversal microradiography. They realized that the remineralization significantly increased by Durphat which its formation is 10% xylitol + F and 20% xylitol + F so 20% xylitol varnishes were obtained as an alternative to increase remineralization in vitro [13].

In a randomized control trial research carried out by Bader et al. , 691 adults at the age of 21- 80 years used five 1 g xylitol or placebo lozenges per day for 33 months after 3 times examination at 12, 24, 33 months they knew that carries increase can be 10% reduced by xylitol lozenges. This reduction was not statistically significant. Daily use of xylitol lozenges did not show a reduction in 33 months carries increase among adults. It didn't show a dose response effect [4].

Runnel et al. investigated on 7 to 8 years old subjects using candies containing polyols such as xylitol and sorbitol for 3 years. After different analysis they conclude that using erythritol was more efficient on reduction of plaque growth, levels of plaque acetic acid and propionic acid and numbers of S. mutans than xylitol and sorbitol [14].

In a study conducted by Söderling et al. on growth inhibition and adherence of S. mutans and poly saccharide-forming oral streptococcus mutans, they found out glass surface adhesion of most poly saccharides forming streptococcus except mutans and Sorbinus decrease with 4% xylitol and erythritol. This reduction with this polyols was 36-77 % for Sorbinus and 13-73% for Mutans and only for Sanguis was 45-50 %. In this study they concluded that Erythritol and xylitol can play a role in plaque accumulation and reduction of polysaccharides through an irrelevant mechanism with growth inhibition [15].

In a research carried out by Chalmers et al. about decreasing dentistry intervention in older patients said that polyols such as xylitol are anti-cariogenic and do their function through reduction of acid fermentation by S.mutans. Also it reduces S.mutans transmission from mother to child [16].

In their study, Makinen et al. investigated on 30 subjects consuming pastilles containing Erythritol or xylitol for 2 months. The mean weight of total plaque mass and salivary levels of Strep Mutans had much more decrement in xylitol than Erythritol and polyol regimen had no effect on plaque of Sorbinus [17].

The aim of the study carried out by Honkala et al. was to evaluate the long term efficacy of daily consumption of erythritol and xylitol candy in comparison with sorbitol candy on the development of enamel and dentin caries lesions. In a period of 3 years intervention, 485 primary school children consumed one of erythritol, xylitol or sorbitol (control) candies three times per school day (7.5 gr daily). The examination was at 12, 24 and 36 months. The follow-up examination showed lower dentin and surface caries in erythritol group

than other groups, time of enamel/dentin and dentin caries lesion to progress was significantly longer and also the increment of caries score was lower in erythritol group in comparison with other groups [18].

CONCLUSION

Approximately all of the articles reviewed showed anti-cariogenic effect of xylitol. Most of them either showed this characteristic for other sugar alcohols such as sorbitol and erythritol [3,11,14]. Several mechanisms are claimed to show this effect especially for xylitol, but the main mechanism is unknown. Some of these mechanisms are: increasing saliva secretion [11], decrement on number of *S.mutans* (7), decrement on bacteria plaque growth, Inhibition cell adhesion [10, 14, 15], reducing the acid production by bacteria because of absence of sucrose [11,16], increasing caries lesion remineralization [10, 13], increasing lasting effect of CHX on oral MS [12], reducing mother to child bacteria transmission [16].

Some studies indicated polyol efficiency depends on number of OH groups so that erythritol as a tritol type of sugar alcohol must have the most anti-cariogenic effect [3]. Based on our research, erythritol is more efficient on reduction of plaque growth, levels of plaque acids and number of *S.mutans* in comparison with xylitol [14]. Also in another study erythritol group cause much more decrement on caries incidence and progression rate of caries lesion than xylitol and control group [18].

Considering that daily consumption of sugar alcohols in several studies in adults and children were not equal (adults 1gr/day, children 7.5 gr/day), we cannot conclude that these sugars are more suitable for what age group. Consequently, we suggest further research to determine the age sugar is more effective at type and effective amount of sugar in each age group.

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