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REVIEW ARTICLE

Role of Sugar Free Chewing Gums in Oral Health

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ABSTRACT

Dental caries and periodontal diseases have historically been considered the most important global oral health burdens. Hence, the dental health care needs to apply strategies for prevention of oral health problems. Chewing gum gained interest due to its ability to stimulate salivation and accelerate the clearance of fermentable carbohydrates from the dietary intake. Chewing gum with Xylitol has received special attention due to its mechanical cleaning together with saliva stimulation. These actions could lead to a therapeutic, caries lowering action and various other oral health benefits.

Keywords: Aspartame, Chewing gum, Prevention, Sorbitol, Sugar-free, Xylitol

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INTRODUCTION

Despite great achievements in oral health of populations globally, problems still remain in many communities all over the world - particularly among underprivileged groups in developed and developing countries. Dental caries and periodontal diseases have historically been considered the most important global oral health burdens. At present, the distribution and severity of oral diseases vary among different parts of the world and within the same country or region. The significant role of sociobehavioral and environmental factors in oral disease and health is evidenced in an extensive number of epidemiological surveys (1).

Dental caries is a significant public health problem for a large segment of society. The role of sucrose and other fermentable carbohydrates in the etiology of caries has been well established. Several strategies are proposed for controlling dental caries like dietary modification, enhancing host resistance and improvement of oral hygiene through various measures. Despite the evidence of caries therapeutic measures it is clear that caries persists as the major dietary conditioned chronic infectious disease. Hence the dental health care team needs to apply care strategies beyond restoration placement (2).

Chewing gum gained interest due to its ability to stimulate salivation and accelerate the clearance of fermentable carbohydrates from the dietary intake. It has also been associated with many physiological attributes, including increased blood flow in the cerebral and orofacial region which may account for increased alertness and improved memory (3). Recently, the least acidogenic sucrose substitutes played an important role in diet recommendations. Substitution of sugars by non-sugar sweeteners reduced the sucrose load of the diet (4). It has been proposed that the replacement of sucrose with sugar substitutes such as Xylitol and Sorbitol may contribute to caries prevention. The mechanism of caries inhibition by polyols has not been well established but it can be attributed to effects on saliva (composition and flow rate), dental plaque (growth of microorganism, plaque pH) and effect on enamel demineralization and remineralization (5). Chewing gum with Xylitol has received special attention since me-

chanical cleaning together with saliva stimulation is very likely to further benefit over and above the antibacterial effects of the polyol (6).

Stimulation of saliva by chewing gums alters the composition. Dawes noted that increasing the rate of salivary flow increases the concentration of protein, sodium, chloride and bicarbonate decreases the concentration of magnesium and phosphorus. Perhaps of greatest importance is the increase in the concentration of bicarbonate, which increases progressively with the duration of stimulation. The increased concentration of bicarbonate diffuses into plaque acids, neutralizes plaque acids, increases the pH of the plaque and favours remineralization of damaged enamel and dentin (7). Recently emphasis has been given to incorporation of herbal extracts into various plaque control materials to extend their benefits. Few studies have revealed the antibacterial effect and enhancement of salivary anti cariogenic properties of mint (8).

Gum chewing is a common habit amongst many people as it provides great pleasure; it is also a nemesis for countless parents, school teachers and building custodians because this sticky intruder is often found in child's hair, under tables, chairs and desks. However, chewing gum has two characteristics which are important in considering its effect on dental health. First, it has proved possible to replace the "sugar" in chewing gum with sugar substitutes, without diminishing its consumer appeal. Indeed the development of sugar free gums with optimal taste characteristics has opened up new markets. Second characteristic is that all gums- sugared and unsugared-stimulate the saliva flow about 3-10 times higher than resting values. The stimulation of saliva leads to an increase in potentially protective properties. Both of these characteristics of chewing gum could be responsible for the non-cariogenicity of sugar free chewing gums. Furthermore, if the gum chewing were to be carried out after meals and if the sugar substituted had beneficial properties, these actions could lead to a therapeutic, caries lowering action and various other benefits (9).

HISTORY OF CHEWING GUM

Chewing gum has an age old history. In 50 AD, the Greeks sweetened their breath and cleansed their teeth by using mastiche, a resin from the bark of mastic tree. (Masticate word has derived from mastiche). Spruce gum, which was manufactured in 1848, became the first chewing gum product to be manufactured commercially called "State Of Mainepure Spruce Gum." However its use was eventually replaced by paraffin, which is still being chewed in some areas. Then the packaging in attractive packets in New York began. The first patent for chewing gum was filed in U.S., 1869, by Dr. William F Sample, a dentist from Ohio. In 1892 William Wrigley launched his first chewing gum products, LOTTA and VASSAR. A year later he developed JUICY FRUIT and shortly thereafter, WRIGLEY's Spearmint Gum (10). Several studies have assessed the effect of the chewing of sugar containing chewing gum which lowers the plaque pH and increases the amount of plaque which on habitual use increases caries. Thus there was a need to substitute the sugar with sugar substitute (11).

Sugar substituted or sugar free gum is produced by replacing sucrose and other readily fermentable carbohydrates by sugar alcohols also called as polyols. The microorganisms are unable to ferment these compounds, disturbs bacterial metabolism, adhesion or growth thus inhibiting plaque accumulation. The most widely used sugar substitutes are sorbitol, mannitol, xylitol, maltitol and lactitol (10).

COMPOSITION OF CHEWING GUM

A typical chewing gum consists of powdered cane or beet sugar (50-65%), chewing gum base (18-30%), corn syrup (12-20%), color and flavoring agents (1-2%) and softeners (0.3-3%). Noticeably, more than half of its constituent is sugar, which is responsible to enhance flavor and enrich the texture of gum. Sugar in sugared gum can be sucrose, fructose or hydrogenated glucose but sugar free gum has sugar substitute. Use of term sugar free is somewhat misleading because all carbohydrates provide about 4 Kcal/g, so the amount of calorie provided is the same but the difference is in the quantity which will depend on the sweetness. Thus sweeteners can be divided into two groups- bulk sweeteners and intense sweeteners. Bulk sweeteners are almost always carbohydrates and carbohydrate derivatives like sucrose, fructose or polyols etc while intense sweeteners are either synthetic or natural substances like saccharine, cyclamate, aspartame and acesulfame-K (9).

DESCRIPTION OF FEW MOST COMMONLY USED SUGAR SUBSTITUTES

Sorbitol

It is widely distributed in the plant kingdom, in berries, apples, plums, pears and algae. It was introduced in the diet of diabetics as early as 1929. It is slowly and incompletely absorbed from the intestine which results in osmotic diarrhea. Most microorganisms lack the enzymatic make up to utilize sorbitol. An important exception is S. mutans. However the fermentation of sorbitol by S.mutans is slow and hence the drop in the pH of dental plaque is also little. The slow rate of fermentation of sorbitol allows acid to diffuse out of plaque at a rate almost equal to the rate of formation. Nevertheless, the utilization of sorbitol by microorganisms provide them with a substrate that may contribute to their survival but does not directly contribute to their cariogenicity (12). Because of the results of in vitro fermentation experiments and animal studies, concern has been expressed that the oral flora may adapt to sorbitol so that it loses its "safe

for teeth" property (13).

Xylitol

In September 1890, the German chemistry professor Emil Herman Fischer and his assistant Stahel, separated from breech chips a new compound which was named Xylit, the German word for Xylitol. Simultaneously with Fischer the French chemist M.G. Bertrand had managed to isolate xylitol syrup by processing wheat and oat straw. The history of Xylitol was indeed quite eventless for the first 50-60 years after its first description in 1891. By mid 1950's Dr Touster's and his co-workers concluded that xylitol is formed in the human body. This discovery stemmed from investigation on L-xylulose, the characteristic urinary sugar in essential pentosuria. This is a harmless, rare, recessive genetic disorder initially found in Jews and Arabs. It was recognized that in pentosuria involved the accumulation and excretion of a metabolite which is readily disposed of in normal, but not in pentosuric, individuals. Eventually the product was isolated and characterized as Xylitol (14). It has an ability to form complexes with certain cations such as Ca, Cu and Fe and to displace water molecules from the hydration layers of proteins and

S. No.	Author and year of publication	Parameter assessed	Plaque / Saliva	Chewing gum type	Frequency & duration of Chewing	Results	Conclusion
]1.	C.P Bots, H.S Brand, E.C.I Veerman (15)	Flow rate, pH and acceptability	Saliva	Orbit winterfresh Extra winterfresh Freedent winterfresh Orbit peppermint Extra peppermint Freedent peppermint Freedent sweetmint Original liquorice	Once	Average increase in flow rate was 187% during first minute. Difference in preference for chewing gum related to taste and gum shape.	All chewing gum stimulate salivary flow rate equally
2.	C. Dawes, L.M.D Macpherson (16)	Flow rate and pH	Saliva	Gum base Extra peppermint Extra cinnamon Extra bubblegum Extra peppermint Doublemint Big Red(cinnamon) Certs(peppermint) Breathsavers (peppermint)	Once	Stimulated flow rate with flavored gums was about 10-12 times greater than unstimulated saliva. pH peaked in 4-6 minute	All chewing gums stimulated flow rate initially but with the loss of taste salivary flow rate fell down
3.	K Sjogren P. Lingstorm A.B Lundberg D. Birkhed (17)	pH, salivary fluoride concentration	Plaque	Fluorette	6 times	Immediately after 5-10 times chewing, pH dropped while on chewing for 30-45 min pH stayed above 6.5 throughout 60 minute. Fluoride concentration was constantly higher on chewing side than non chewing side.	Prolonged chewing time is favorable to the plaque pH recovery after sucrose rinse and salivary F concentration.
4.	O. Aguirre Zero D.T Zero H.M Proskin (18)	Salivary flow rate and plaque pH	Saliva and plaque	No gum, sorbitol gum, sugar gum and Xylitol gum	One chewing gum 5 times per day for 2 weeks.	No statistically significant mean change in either unstimulated or stimulated salivary flow rate associated with use of any of the gum chewing regimens. At baseline, 5 and 45 min xylitol gum presented a statistically significantly higher pH than no gum, sucrose gum and higher than sorbitol gum	Xylitol may have anticariogenic properties in addition to being a noncariogenic sugar substitute. Thus with caries active individuals with increased caries decreases susceptibility to caries.

also from cations. This pentitol occurs widely in fruits (strawberries, plums, raspberries) and vegetables (lettuce, cauliflower, mushrooms) and is commercially prepared from coconut shells and birch trees. The absorption of xylitol, while slow and incomplete is greater than that of sorbitol and mannitol. Thus it is associated with less severe diarrhea. Xylitol is metabolized as a carbohydrate by entering the pentose phosphate pathway through the glucoronic acid cycle. It has been used by diabetics because its metabolism is considered to be insulin independent.

The caries preventive effect of total substitution of dietary sugars by xylitol could be explained by the exclusion of fermentable sugars from the diet. Xylitol is not fermented by dental plaque as the activity of xylitol dehydrogenase in human dental plaque or whole saliva is practically nil. Human oral microorganisms and specifically S.mutans do not have enzymes to utilize xylitol as a source of energy for acid production or for synthesis of extracellular polysaccharides and thus no fall in plaque pH occurs.

But the major disadvantage associated with the use of xylitol is the cost which suggests that it is unlikely to replace more than a small portion of the sucrose intake (12,13).

Aspartame

Aspartame was developed by G.D Searle laboratories as nutritious sweetener and flavor enhancer. It is about 180-200 times as sweet as sucrose. It is composed of two amino acids: L-aspartic acid and the methyl ester of L-phenylalanine. Although aspartame has a caloric value of about 4 Kcal/g which is similar to that of proteins and carbohydrates, it is consumed in such a small amount that its caloric contribution is negligible. Because of its relatively greater sweetness, the addition of aspartame to foods can result in sweetness equivalent to that obtained from sucrose and yet reduce calories by over 95%. Aspartame is effective in enhancing acid fruit flavors and extending sweet taste as in chewing gum. If aspartame replaces even some part of the sugar in the diet, it would be expected to reduce caries simply by limiting the amount of frequency of fermentable sugar in the diet. Aspartame reduces caries as might raise plaque pH by forming amines by decarboxylation. Ingestion of aspartame should be avoided by individuals with phenylketonuria who have a genetic defect of phenylalanine metabolism (12,13).

EFFECTS OF CHEWING GUM BASED ON THE PHYSICAL PROPERTIES OF THE PRODUCT (11)

- Remove food debris and plaque from teeth
- Stimulate the salivary flow
- Raise plaque pH
- Stops demineralization/promote remineralization.
- Reduce gingivitis
- Effect on the TMJ and masticatory muscles

TYPE OF CHEWING GUMS (11)

- Medicinal – chewing gum can be used for a local delivery of therapeutic agents such as sulfonamide, neomycin-gramicidin, miconazole and nistatin.
- Dental
  - Fluoride containing
  - Chlorhexidine containing
  - Enzyme containing
  - Mineral salts
  - Carbamide ion
  - Metal ions

It is well established that dietary sugars play a crucial role in the development of dental caries. However, there are various factors which play an important role in deciding the susceptibility of an individual to develop caries such as, tooth resistance, use of fluorides, salivary properties and composition of plaque. In the past few decades there has been decline in the prevalence of dental caries in few countries which could be due to the effective use of preventive measures particularly fluoride application in combination with oral hygiene maintenance which has led to deceased concern regarding adverse oral effects of sugars. Therefore dietary counseling still remains important for caries prevention in addition to instructions regarding oral hygiene and use of fluorides (19).

EFFECT OF CHEWING SUGAR FREE GUMS ON PLAQUE pH

Sweeteners also stimulate the flow of saliva and elevation of pH which differs from dietary sugars, as the sweeteners have a smaller or no effect on bacterial glycolysis. As a consequence, plaque pH usually decreases with sugars and rises with sweeteners. The latter is possible because saliva enters the plaque readily, the pH of the saliva increases with the increase in flow rate and plaque bacteria produces base from the substrates by the saliva. In sugared gum as sugar is slowly released into saliva, the pH remains acidic despite the salivary stimulation that takes place because stimulation of glycolysis exceeds the pH elevating effect of saliva. However, once there is no sugar left, acid formation ceases and the pH of the plaque rises, as the effect of saliva on the pH continue. The effects with the gum containing the sugar substitute are different as there is little or no stimulation of plaque glycolysis. As a consequence the plaque pH usually rises and remains raised as long as the gum is chewed, whether any sweetener is still present or not.

EFFECT OF CHEWING SUGAR FREE GUMS ON BUFFEREING CAPACITY OF SALIVA

Solutions containing both weak acids and their salts are referred to as buffer solutions. These solutions have the capacity of resisting changes of pH when either acids or alkalies are added to them. The buffering capacity of human saliva is regulated by three buffer systems- the carbonic acid, phosphate

system and proteins. Carbonic acid rapidly decomposes into water and carbon dioxide which leaves the solution. In contrast to most buffers the net result is therefore not an accumulation of a weaker acid but a complete removal of acid. This change of phase for carbon dioxide from dissolved state to gas phase for which is essential for bicarbonate system. The phosphate system also functions similar to bicarbonate except for the fact that no phase change is involved. The salivary proteins are usually not considered to have any significant buffer capacity (20).

Stimulated saliva has an increased bicarbonate concentration and therefore increased buffering capacity in dental plaque while concurrently promoting clearance of fermentable substrate and provides more urea for base production.

Advice on changing dietary patterns has traditionally concentrated on the frequency of intake of sugar containing foods. Thus it appears logical to emphasize the importance of replacing sugars with noncariogenic sweeteners. Studies evaluating cariogenic potential of sweeteners yielded substantial evidence that xylitol is most promising sweetener. Several aspects should be considered when evaluating a sugar substitute from a cariologic point of view. The most important issues are metabolism of oral microorganisms, metabolism by dental plaque, influence on plaque quantity and adhesion, effects on counts of S.mutans, microbial adaptation, role in de and re mineralization and influence on plaque pH and salivary parameters.

Further research can be conducted by taking into account the following considerations:

- Effect of using chewing sugar free gums for longer duration can be studied.
- Effect of chewing sugar free gum on micro organisms can be seen.

PRECAUTIONS TO BE TAKEN:

- If chewed for a longer duration it may lead to muscle fatigue and TMJ pain.
- As chewing gum becomes habituated then it is difficult to restrict chewing at disciplinary places like class rooms, temples etc.
- As chewing of gum may create nuisance so the disposal of the gum should be done carefully.

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