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Research Paper

"An Insight Into The Role Of Sugar Substitutes In Public Health"

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Abstract:
Although suitable sugar substitutes were found to have much superior dental characteristics than sucrose and glucose, substituting them for sugar to prevent dental cavities is a viable approach. These days, it's typical to hear or see the words "sugar-free," "zero-calorie sweets," or "calorie-free" on billboards. Instead of being used more for tooth health, these zero-calorie sweeteners are becoming more popular due to rising body image awareness and weight loss programs. Manufacturers recommendations for sugar alternatives may be appealing and persuasive, but the public still has many misconceptions and myths about them. The false information that is readily available online could be the cause of this confusion. This review narrates about the common misconceptions about sugar replacements and their use in maintaining oral health.

Keywords: *sugar free, sweetening agents, dental caries, sucrose,non-caloric.*

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I. Introduction:

The dental profession shares an interest in the hunt for safe, palatable sugar backups, as there's established substantiation suggesting the unproductive relationship between sugar and dental caries. Dentistry has evolved through times from conventional" drilling and filling" stage to" preventative" stage following the notorious saying" Prevention is Better than Cure". Replacing sugar with a suitable sugar cover to combat dental caries is an option wide open as significantly better dental parcels were observed when compared to sucrose and glucose.[1] Biting xylitol gum caused significantly lower net progression of decay[2] and had inhibitory effect on mutans streptococci in saliva and dental plaque and also on lactobacilli in saliva was observed.[3] Acceptance of new products by people is most important and delicate aspect in their success. Studies were done between sugar substitutes and other preventative measures but no statistically significant difference in caries increment was observed between sealant and xylitol groups.[4] 10% xylitol, when added to a triclosan containing dentifrice reduced the number of MS in saliva and dental plaque.[5] Acid production by bacteria, which is the main cause for dental caries was inhibited by xylitol.[6] Sugar substitutes like xylitol when combined with other compounds like fluoride showed synergistic effect in inhibiting the acid production by mutans streptococcus(MS).[7] Remineralization eventuality of xylitol chewing gum when compared to mastic chewing gum was attributed to increased expectoration,[8] but mean degree of remineralization was lesser when combined with calcium lactate[9]

or funoran and calcium hydrogen phosphate.[10] Antimicrobial exertion of stevioside against periodontal pathogens like Porphyromonasgingivalis and AggregatibacterActinomycetemcomitans was significant.[11]

The words," sugar-free"," zero- calorie sugars" or" calorie-free" are generally heard or seen on announcement hoardings now-a-days. A food may have the words' sugar-free' on the frontal marker, but that doesn't mean the food is carbohydrate-free or calorie-free. The use of these zero- calorie sugars is adding, as a result of increased body constitution knowledge and weight reduction programs, rather than dental health.

History of Sugar Consumption

By 1500 AD, the industrialization of sugar production was limited and only wealthy people could consume enough sugar to develop tooth decay. Elizabeth I of England (1533-1603) was known for her dark teeth due to the consumption of sweets. By 1800 AD, sugar production and consumption were cheap and large enough to cause tooth decay in more than 50% of the UK population.[12]

The classic evidence supporting the role of sugar (soluble carbohydrates) in dental caries

The role of sugar (soluble carbohydrates) in dental caries in man is well documented by some of the studies listed in Table-1, Table 2.

Table 1: Classic evidence from human supporting the role of sugar in dental caries:

Study	Reference(s)	Main conclusions
Vipeholm Study	Gustafsson et al.[1954]	The more frequently sugar is consumed the greater the risk; sugar consumed between meals has much greater caries potential than when consumed during a meal.
Turku Sugar Study	Scheininet al.[1976]	When sugar iscompletely replaced by non-fermentable sugar substitutes (Xylitol) caries increment is dramatically reduced; fructose is less cariogenic than sucrose.
World War II	Toverud [1957a, b] Takcuchi [1961]	Caries decreases and increased with sugar consumption during and after war, respectively.
Hopewood House	Harris (1963]	Modern diet more cariogenic than vegetarian low sugar diet.
Tristan da Cunha	Holloway et al. [1963] Fisher [1968]	Introduction of a modern diet including sugar and refined carbohydrates to this remote island greatly increased caries prevalence.
Hereditary Fructose Intolerance	Marthaler [1967] Newbrun et al. [1980]	less caries in individuals that must avoid sucrose and fructose, but not other sugars and complex carbohydrate
Experimental Caries in Man	von der Fehr et al. (1970] Geddes et al. [1978]	Incipient caries can be rapidly induced by frequent rinsing with high concentration sucrose solutions in the absence of oral hygiene.
Siephan Plaque pH Response	Stephan [1940, 1944]	Response demonstrated the relationship between sugar exposure resulting in the acidification of dental plaque and caries experience.

Table 2: Review articles on the relationship between sugar (diet) and dental caries.[13]

Authors	Main conclusions
Marthaler [1967]	Foodstuff's containing simple sugars are for more cariogenic than common starchy foods
Newbrun (1969)	The specific elimination of sucrose or sucrose containing foods rather than restricting total carbohydrate consumption.
Bobby [1975]	Snack foods share importance with sucrose in caries causation.
Sreebny [1982a]	Total consumption and frequency of sucrose contribute to dental caries; Lacking evidence about the precise definition of the relationship.
Newbrun [1982a]	Compelling evidence that the proportion of sucrose in a food is one important determinant of its carcinogenicity
Sheiham [1983a]	Sugar is the cause of caries in industrialize countries; sugar consumption be reduced to 15 kg / person / year or below.
Shaw [1983]	Studies in animals consistent with the clinical evidence on the relationship between sugar and caries.
Rugg-Gunn [1986]	Carcinogenicity of staple starchy foods is low, the addition of sucrose to cooked starch is comparable to similar quantities of sucrose; fresh fruits appear to have low carcinogenicity.
Bowen and Birkhed [1986]	Frequency of eating sugars is of greater importance than total sugar consumption.
Walker and Cleaton-Jones [1989]	Degree of incrimination of sugar as a cause of caries is grossly [1989] exaggerated; questioned predictions of reductions in caries from decreases in sugar and snack intakes.
Marthaler [1990]	In spite of dramatic reductions in caries due primarily to widespread use of fluoride, sugars continue to be the main threat to dental health.
Rugg-Gunn [1990]	Dietary modification involving restriction on the frequency and amount of extrinsic sugars can be more effective than other control measures.

Koing and Navia [1995]	Acknowledged the relationship between frequency and sugar intake and caries; elimination of sugar and improved oral hygiene and use of fluoride toothpaste.
Ruxton et al. [1999]	Evidence strongly supports formulation of advice on frequency of consumption, not amount.
Koing [2000]	Dental health problems do not require any dietary recommendations.
Van Loveren [2000]	Oral hygiene is maintained and fluoride is supplied frequently, teeth will remain intact even if carbohydrate containing food is frequently eaten.
Sheiham [2001]	Sugarsare the cause of caries; the intake of extrinsic sugars>4times/day increases caries risk; sugar consumption should not exceed 60 g / day for teenagers andless for younger children and adults.

Classification of sugar susbstitues[14]

Based on sugar substitute being Caloric or Non-caloric

Caloric/nutritive sweetener	**Non-caloric/non-nutritive sweetener**
1. Poly alcohols/sugar alcohols • Xylitol • Sorbitol 2.Hydrogenated starch hydrolysates • Lycasin • Palatinit 3. Coupling sugars • Sorbose • Palatinose	1. Cyclamate 2. Saccharin 3. Aspartame 4. Sucralose 5. Neotame

Based on their origin

1. Natural sugar substitute
2. Artificial sugar substitute.

Natural sugar substitutes (plant origin)

Brazzein	Glycyrrhizin
Mannitol	Glycerol
Miraculin	Hydrogenated starch
Monatin	Hydrolysates
Monellin	Inulin
Pentadin	Isomalt
Sorbitol	Lactitol
Stevia	Mabinlin
Tagatose	Maltitol
Xylitol	Maltoligosaccharide

Artificial sugar substitute

AcesulfameAlitame	Neohesperidin
Aspartame	Dihydrochalcone
Cyclamate	Neotame
Dulcin	Saccharin
Glucin	Sucralose
potassium	

Dental Aspect of Nutritive and Non-Nutritive Sweeteners

A. Nutritive Sweeteners[15]

Nutritive sweeteners are called as carbohydrate sweeteners. Provides a high-quality sweet taste and has an acceptable texture and shape and thus remains the most popular sweetener.

I. Monosaccharide Polyols

Monosaccharide alcohol is the general term for the chain – like polyalcohol obtained by reducing the carboxyl group of sugars.

a. Sorbitol (D-glucitol): Sorbitol occurs naturally in cherries, plums, apples, many berries, seaweeds and algae. It is sweet,inexpensive and has less shelf life because of hygroscopic property.

Dental Aspect: Fermentation by oral microorganisms: Practically all strains isolated from caries inducing mutans group of Streptococci will ferment sorbitol and should be considered a low cariogenic sweetener rather than a non-cariogenicbecause consumption of larger amount increases the acid producing microorganism in plaque.

b. Xylitol: Xylitol is a pentose alcohol with sweetness found naturally in a variety of fruits, vegetables and also available as gums, lozenges, syrups and snack foods.

Dental Aspect: Xylitol sweetened gum offers more benefit in terms of reducing caries risk than does sorbitol-sweetened gum. Patients who chew gum regularly should be encouraged to chew gums sweetened with sorbitol or xylitol.

c. Mannitol: Mannitol is a polyol made by hydrogenation of fructose. It included in chocolate-flavored coating agents for ice cream and sweets due to its high melting point and does not discolor at high temperatures, which makes it ideal for use in pharmaceuticals and nutritional tablets.

Dental Aspect: Edwardsson (1970) obtained spontaneous mutants of SM which had lost their ability to ferment mannitol and sorbitol but retained their caries inducing ability when tested in hamster.

d. Erythritol: The sweetness is 70-80% that of sucrose. Erythritol is predominantly absorbed from the small intestine and most of the absorbed sugar are excreted in urine without being metabolized.

Dental Aspect: Erythritol is a non –cariogenic sweetener. According to Kawanabeetal. (1992) SM and streptococcus sorbinus did not attach to smooth solid surface associated with GTase in the presence of erythritol, indicating that it does not appear to be used by mutans streptococci for synthesis of water insoluble glucans.

II. Disaccharide polyols

a) Isomalt (Palatinit): Palatinit is obtained by the dehydrogenation of palatinose. The sweetness of palatinit is 45% that of sucrose.

Dental Aspect: Karl (1978) conducted a study on rat model and suggested that palatinit are non-cariogenic in nature, where caries scores were found to be significantly lower in those rats fed palatinit compared with rats fed sucrose and lactose.

b) Maltitol: Maltitol, is a disaccharide alcohol of glucose and sorbitol. The sweetness of maltitol is 75-80% that of sucrose and its quality of taste resembles that of sucrose.

Dental Aspect: Ooshima (1992) have shown that maltitol is non-cariogenic in nature as it does not lower plaque pH and a significantly lower caries score was reported for rats fed with maltitol compared with those fed with sucrose.

c) Isomaltulose (Palatinose): Palatinose is a disaccharide of glucose and fructose. The sweetness of palatinose is 42% that of sucrose. Excellent sweetener for infants, children and diabetic patients.

Dental Aspect: According to Takazoe (1985), Palatinose is considered as non – cariogenic because little or no acid was produced by a number of serotypes of mutans streptococci and other oral streptococci following fermentation of palatinose as compared with glucose.

B. Non-Nutritive Sweeteners[15]

i) Saccharin: Saccharin was first developed in 1878; oldest approved artificial sweetener. It is 300 times as sweet as sucrose by weight, non-cariogenic and non- caloric but can have a slightly bitter or metallic taste.

Dental Aspect: Saccharin, when used as a supplement to a cariogenic diet significantly, reduced both fissure and smooth surface caries in rats, apparently interfering with the growth of Streptococcus mutans.

ii) Acesulfame – K: Hoechst (1967), found that compounds with the dihydro – oxthiazinone dioxide ring system had a sweet taste. In terms of sweetness, Acesulfame – K is about 130 times as sweet as sucrose.

Dental Aspect: Non-cariogenic, but no active cariostatic properties have been reported aside from a positive synergistic effect on inhibition of acid production by oral microorganisms when combined with cyclamate and saccharine (Ziesenitz and Siebert, 1988).

iii) Aspartame: Aspartame was discovered in 1965 by Searle Research Laboratories, about 180 times sweeter than sucrose in aqueous solution, known under the brand name "NutraSweet". Used in noncarbonated fruit juices, fruit drinks, frozen stick type confections, breath mints and sweetening agents in drug products.

Dental Aspect: Accordingto Richard (1992) the lower level of aspartame may be more effective in reducing cariogenicity in the presence of a lower level of sucrose.

iv) Thaumatin: In West Africa the inhabitants used an extract "thaumatin" derived from fruits of a shrub, Thaumatoccusdaniellii to sweeten foods such as bread and palm wine. It is 100,000 times sweeter than sucrose on molar basis and 3,000 times sweeter on weight basis.

Dental Aspect: According to Ikeda (1982), anticariogenic property of thaumatin is due to inability of mutans streptococci to liberate acid or insoluble glucan.

v) Sucralose: Sucralose is non-caloric trichlorinated derivative of sucrose. It is 600 times sweeter than sucrose. The sweetener is marketed under the brand name SPLENDA® is a blend of sucralose and malt dextrin.

Safety of Sugar Substitutes

Sugar substitutes are food complements that are sweet yet contain significantly lower calories than sugar. These substitutes may be derived from natural or synthetic sources. Naturally occurring sugar substitutes include stevia and sugar alcohols. Artificial sweeteners are generally calorie-free and at least 30 times sweeter than sucrose. There presently are six indispensable sweeteners approved for use in the United States saccharin, acesulfame- K, sucralose, aspartame, neotame, and advantame.[16]

Many people question the safety of artificial sweeteners. still, at this time there's no scientific substantiation that they pose a threat to human health. inordinate consumption of artificial sweeteners can cause

undesirable side effects, like diarrhoea and headaches. Consumption of artificial sweeteners is associated with higher weight status. still, this could be due to the fact thatnon-caloric sweeteners are consumed in lesser amounts by individualities who are fat. Studies have shown that artificial sweeteners may contribute to weight gain and associated health issues. still, substantiation is inconclusive and the use ofnon-caloric sweeteners is still supported by multitudinous estimable associations, including the Academy of Nutrition and Dietetics and the American Diabetes Association.[16]

For each sweetener, the FDA establishes an Acceptable Daily Intake, (ADI) in mg/ kg body weight, which is the amount of sweetener thought to be safe to consume every day for life time. The ADI is typically 100 times lower than the dose of the sweetener that caused toxicity in animal studies. The acceptable daily intake ADI for sucralose in the US is 5mg/kg body weight/day. The ADI for neotame in the US is 18mg/person/day.[17]

Approved and Non- Approved Sweeteners

Aspartame

In 1981, aspartame received first approval. It is 200 times sweeter than sugar and has a similar calorie content (4 kcal/gram). Though it is thought to be basically calorie-free because only trace amounts are utilized in meals.

Saccharin

Before the FDA suggested a ban on saccharin in 1977 owing to worries about rats that developed bladder cancer after getting large doses, the compound was discovered in 1879 and was regarded as harmless. Later research revealed that the bladder tumors in the rats were connected to a rat-specific mechanism that is absent in humans.[18]

Acesulfame-K

Acesulfame-K has no calories and is 200 times sweeter than sugar. It received FDA approval for beverage usage for the first time in 1988. It was permitted for use in general food applications in December 2003, but not in meat or poultry.

Neotame and Tagatose

It was the most recent low-calorie sweetener to get FDA approval as a general-purpose sweetener in 2002. Nearly 7000 times sweeter than sugar, it. From lactose, a carbohydrate present in many dairy products, tagatose was produced.[19]

Sucralose

Only sucralose, a calorie-free sweetener derived from actual sugar, is available. Scientists modify the sugar molecule's structure to make it far sweeter than sugar. Dental cavities are not brought on by it because, unlike sugar, the body does not perceive it as a carbohydrate. People with phenylketonuria can take it without risk.[19]

Polyols[20]

The five polyols that are most often used are erythritol, lactitol, mannitol, sorbitol, and xylitol. Benefits of polyols are numerous. They contain less calories than sugar yet have a similar flavour. Their poor glycaemic response and lack of tooth decay prevention benefits. As a result, customers, particularly those who have diabetes, may decide to utilise them.

Unapproved Sweeteners[20]

Other sugar substitutes not yet approved by the FDA include the following:

Alitame (Aclamate)

The sweetener is 2000 times sweeter than sugar.

Cyclamate

This sweetener, 30 times sweeter than sugar, was banned in 1970 after that there is a petition with the FDA for reapproval.

Stevia

Stevia is a calorie-free plant and a natural alternative sweetener that is considerably sweeter than sugar. It is heat stable, 300 times sweeter than sucrose, and has little to no metallic flavour. The FDA approved the use of Rebaudioside A, a chemically purified stevia derivative, as a general-purpose sweetener in 2008. Stevia has not been demonstrated to be mutagenic and is safe for diabetic patients.

Public Health aspect of Sugar Substitutes[19]

Even if all sugar alternatives or artificial sweeteners received the safety all-clear tomorrow, they would still fall short in terms of providing a balanced diet. Similar to sugar, sugar substitutes and many of the foods that contain them provide little to no nutrition and replace more nutrient-dense meals in the diet. Leaving safety concerns aside, can sugar replacements aid in weight loss? Despite significant evidence to the contrary, most experts concur that sugar replacements in general neither promote nor treat obesity.

In order to avoid all NCDs, dietary counselling to minimize free sugar intake is an essential component of patient treatment. However, this advice should be offered in the context of a balanced diet. Regarding this, dental health professionals should advise patients to: I reduce the amount of free sugars they consume; (ii) think

about their overall health and tailor their advice to their body mass status; (iii) encourage the consumption of all kinds of fresh fruits and vegetables, nuts, seeds, and wholegrain foods that are high in starch; and (iv) avoid foods high in fat, particularly saturated fats and salt. (v) promote the consumption of water and milk without added sugars; (vi) discourage the consumption of all drinks with free sugars; (vii) discourage the consumption of beverages sweetened with artificial sweeteners because of the risk of acid erosion; and (viii) be patient-tailored and use evidence-based behavioural change techniques to encourage patients to change.[21]

II. CONCLUSION

The relevance of sugar replacements in preventative dentistry is growing. In order to meet a number of sugar's beneficial features, it faces several practical challenges (sucrose).[22]

The oral health professional has the chance to assist patients in lowering their intake of free sugars and to encourage a healthy, balanced diet as part of preventative treatment.[21]

If the food sector wants to keep innovating and pleasing customers, it must take on the task of creating new products using natural functional sweeteners.

REFERENCES

[1]. Isokangas P. Tickso J, Alanen P, Makinen KK. Long-term effect of xylilol chewing gum on dental caries. Community Dent Oral Epidemiol 1989; 17: 200-03.

[2]. Kandelman D. Gagnon G. A 24-month Clinical study of the Incidence and progression of dental caries in relation to consumption of chewing gum containing Xylitol in school Preventive Programs. J Dent Res. 1990; 69(11): 1771-75

[3]. Wennerholm K, Arends J, Birkhed D. Effect of Xylitol and Sorbic in Chewing Gums on Mutans Streptococci, Plaque pH and Mineral loss Enamel. Caries Res. 1994; 28: 48- 54.

[4]. Alanen P, Holsti ML, Pienihakkinen K. Sealants and xylitol chewing gum are equal in caries prevention. Acta Odontol. Scand. 2000; 58: 279-84.

[5]. Jannesson L, Renvert S, Kjellsdotter P, Nabi N, Birkhed D. Effect of a Triclosan- containing toothpaste supplemented with 10% Xylitol on mutans streptococci in saliva and dental plaque. Caries Res. 2002; 36: 36-39.

[6]. Miyasawa H, Iwami Y, Mayanagi H, Takahashi N. Xylitol inhibition of anaerobic acid production by streptococcus mutans at various pH levels. J. Oral Microbiol. 2003; 18: 215-19.

[7]. Makinen KK, Saag M. Isotupa KP, Olak J. Nommela R, Soderling E, et.al. Similarity of the effects of erythritol and Xylitol on some risk Factors of Dental Caries. Caries Res. 2005; 39: 207-15.

[8]. Biria M, Malckafzali B, Kamel V. Comparison of the effect of Xylitol gum- and Mastic. chewing on the remineralization rate of caries-like lesions. Joumal of Dentistry.Tehran University of Medical Sciences, Tchran, Iran. 2009; 6 (1): 6-10.

[9]. Suda R. Suzuld T, Takiguchi R Egewa K, Sano T, HasegewaKal The effect of adding calctum lactate to zytitol chewing gum on remineralimtion of emel lesions Carics Res 2006; 40: 43-46.

[10]. Thaweboon S, Nakornchai S, Miyake Y, Yanagisawa T. Thaweboon B, Soo-Ampon S, tal. Remineralization of enamel subsurface lesions by Xylitol Chewing gum containing Funoran and Calcium Hydrogen phosphate. J Trop Med public Health 2009; 40 (2) 345-353.

[11]. Subramaniam R. Antimicrobial activity of Stevioside on Periodontal pathogens and Candida Albicans- An invitro study. J Indian Assoc 329.

[12]. Zohoori FV, Duckworth RM (eds): The Impact of Nutrition and Diet on Oral Health.

[13]. Monogr Oral Sci. Basel.Karger. 2020; 28:68–76.

[14]. Roshan NM, Sakeenabi B. Practical problems in use of sugar substitutes in preventive dentistry. J Int Soc Prevent Communit Dent. 2011;1:1-8.

[15]. Sharma1 VK, Ingle NA, Kaur N, Yadav P, Ingle E, Charania Z.Sugar Substitutes and Health: A Review.J. Adv. Oral Res.2015; 6: 2.

[16]. Jacob M, Tripathi AM, Yadav G, Saha S. Nutritive and Non-Nutritive Sweeteners: A Review. Int J Oral Health Med Res. 2016;2:149-53.

[17]. Colorado State University.Food and Nutrition Series: Health Sugar and Sweeteners. Colorado State University. USA, 2016.https://extension.colostate.edu

[18]. Gupta M. Sugar Substitutes: Mechanism, Availability, Current Use and Safety Concerns-An Update. Open Access Maced. J. Med. Sci. 2018; 25:1888-94.

[19]. University of Arizona. Sugar substitutes- Are they safe? University library. Tucson, 2008. https://repository.arizona.edu/handle/10150/146461

[20]. Singh V, Bhaskar DJ, Kadtane S,Chaudhary V.Nutrition Fact Sheet Polyols: Sweet Benefits .J Am Diet Assoc.2008;108:5:909-10.

[21]. . U.S. Food and Drug Administration. Artificial Sweeteners: No Calories Sweet. U.S. Food and Drug Administration. USA, 2006. http://www.fda.gov/fdac/features/2006/406_ sweetners. html

[22]. Machiulskiene V, Nyvad B, Baelum V. Caries preventive effect of sugar-substituted chewing gum. Commun Dent Oral Epidemiol 2001;29:278-88.

[23]. Roshan NM, Sakeenabi B. Practical problems in use of sugar substitutes in preventive dentistry. Int.Soc.Prev. Community Dent. 2011; 1:1-8.