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ARTICLE REVIEW

Influence of the use of sweeteners on the development of tooth caries

Influencia del uso de edulcorantes en el desarrollo de caries

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ABSTRACT

Introduction: oral health has an impact on an individual's state of health. There is a high incidence of dental caries, where factors such as the consumption of sugary foods favor its appearance.
Objective: to describe the influence of sweeteners on the development of dental caries.
Methods: A narrative review of the literature was carried out by means of a search for information in the SciELO and PubMed databases. The terms caries AND sweetener were used. Twenty-two documents were identified between the years 2017 - 2023, including only one article of Ecuadorian authorship.
Result: The appearance of caries is favored by the consumption of sugar, which is a substrate for bacteria. There are compounds with similar properties that can be used as substitutes. The literature shows sweeteners as an alternative to replace sugar, where some of them have a caries preventive effect.
Conclusions: sweeteners generally have a low cariogenic potential, having some preventive effects. Depending on the sweetener, its form of presentation and chemical composition, the effects may vary, with polyols having a greater preventive potential. Stevia rebaudiana is a suitable candidate to replace sucrose and exhibits potential properties to reduce the incidence of caries.

Keywords: Dental Caries; Sugars; Sweetening Agents; Oral Health.

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RESUMEN

Introducción: la salud bucal repercute en el estado de salud del individuo. Las caries dentales presentan una elevada incidencia, donde factores como el consumo de alimentos azucarados favorece su aparición.
Objetivo: describir la influencia de los edulcorantes en el desarrollo de caries dental.
Métodos: se realizó una revisión narrativa de la literatura mediante una búsqueda de información en las bases de dato SciELO y PubMed. Se utilizaron los términos caries AND edulcorante. Se identificó 22 documentos comprendidos entre los años 2017 – 2023, dentro de los cuales se incluye sólo un artículo de autoría ecuatoriana.
Resultado: La aparición de la caries está favorecida por el consumo de azúcar, que es sustrato de la bacteria. Existen compuestos con propiedades similares, que pueden ser usados como sustitutos. La literatura muestra a los edulcorantes como alternativa para sustituir el azúcar, donde algunos poseen efecto preventivo para las caries.
Conclusiones: los edulcorantes presentan de forma general un bajo potencial cariogénico, teniendo algunos efectos preventivos. En dependencia del edulcorante, su forma de presentación y composición química, los efectos pueden variar, teniendo los polialcoholes mayor potencial preventivo. La *Stevia rebaudiana* es una adecuada candidata para reemplazar la sacarosa y exhibe propiedades potenciales para disminuir la incidencia de las caries.

Palabras clave: Caries Dental; Azúcares; Edulcorantes; Salud Bucal.

INTRODUCTION

According to the World Health Organization (WHO),[1] in its Report on the Global Oral Health Situation published on November 18, 2022, nearly half of the world's population suffers from oral health diseases. Similarly, three out of four affected individuals live in low and middle-income countries. Global cases of oral health diseases have increased by about a billion in the last 30 years, indicating a lack of access to prevention and treatment of oral health diseases. The report also states that the most common oral health diseases include dental caries, severe periodontitis, tooth loss, and oral cancer, with untreated dental caries being the most prevalent condition worldwide, affecting an estimated 2,5 billion people.

Dental caries is a highly prevalent infectious disease, especially concerning in countries with fewer resources that struggle to address it. It significantly affects a substantial number of children at early ages, during the turnover of baby teeth.[1,2]

Caries formation occurs through the bacteria Streptococcus mutans, which ferments dietary sugar, producing lactic acid that lowers pH, promoting the appearance and subsequent demineralization of dental enamel. Once the enamel is perforated, infection sets in the pulp. It is also caused by the accumulation of dental plaque, which, through the action of the enzyme alpha-amylase in saliva and other bacteria, converts sugars into simpler compounds, leading to increased acidity in the oral cavity, causing enamel integrity destruction.[2]

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The emergence of caries involves microorganisms such as Streptococcus Mutans (SM), Sobrinus (SS), Actinomyces, Lactobacillus, Veillonella, and Scardovia wiggsiae. In healthy and balanced diets with a low sugar concentration, physiological mechanisms in the mouth (such as saliva) stop the development of tissue lesions at the hydroxyapatite crystal level before cavitation by restoring pH and remineralizing. Excessive consumption of sugar-rich foods creates an imbalance in oral microbiota (dysbiosis), promoting bacterial competition in dental biofilm (a cluster of bacteria and food deposits). Fructans and glucans are polymers produced from sucrose that stimulate microbial cohesion and adhesion. Major and minor salivary glands secrete saliva, playing a crucial role in oral flora.[3]

Changes in saliva composition indicate health status and/or predisposition to caries development. Saliva's protective functions include dilution and cleansing of the oral cavity, buffering, and facilitating ionic exchange. Its pH level determines how ionic exchange occurs during enamel remineralization and demineralization processes. Bicarbonate concentration increases salivary pH, which can drop below five to three when salivary flow is very low, with seven to eight being preferable values.[3]

Sucrose (table sugar) is attributed with the highest cariogenic capacity, serving as a bacterial substrate and contributing to plaque accumulation. To reduce caries incidence from sugar consumption, the WHO has issued guidelines on sugar intake for children and adults, suggesting a higher threshold when free sugar intake exceeds 10 % of total energy intake. Sugar-free chewing gum with sweeteners can prevent dental caries. The sweet taste and chewing stimulate saliva flow, contributing to caries prevention, and these gums may also contain minerals that aid remineralization.[4]

As sugar is cheap and widely available worldwide, in middle and high-income countries, sugar consumption far exceeds WHO recommendations. In many low-income countries, sugar consumption is also steadily increasing. Recent concerns have been raised about very high levels of free sugars found in commercial foods for infants and young children, leading to WHO guidelines.[5,6,7]

From the above, it can be deduced that cariogenic capacity depends on the amount of sweetener consumed by individuals of different ages, as caries can occur regardless of age and gender. For this reason, this study aims to describe the influence of caloric and non-caloric sweeteners on caries development.

METHODS

This study is a narrative literature review conducted between February and March 2023. Bibliographic searches were performed using the keywords "sweeteners" AND "caries." Search engines used were SciELO and PubMed. The search was limited to the period 2017–2023 and the languages Spanish, English, and Portuguese.

Open access articles on the topic were included, excluding studies addressing other dental conditions even if associated with the use of caloric and non-caloric sweeteners.

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DEVELOPMENT

Caries is a highly prevalent global disease, with evidence suggesting familial and dietary factors related to increased caries levels in children.[8]

Sucrose has been linked to health problems like caries; hence, there's a desire to replace it with sweeteners with fewer adverse effects, contributing to overall oral and general health.[9]

It's essential to note that administering medications in specific pharmaceutical forms, such as syrups, can cause caries in pediatric patients for whom such pharmaceutical forms are intended, as reported in the literature.[10]

Sucrose is attributed with the highest cariogenic capacity, serving as a bacterial substrate and contributing to plaque accumulation.[2] Thus, the need for non-caloric or non-nutritive sweeteners arises. Qualitative studies suggest they are an alternative to fermentable carbohydrates like sucrose, but they still have the ability to alter oral biofilm and dental tissue pH.[11]

Xylitol consumption has been significantly associated with lower caries development, even in cases where participants already had good dental hygiene. Xylitol consumption inhibits the growth of Streptococcus mutans, the main caries-causing agent. Xylitol's benefits also extend to inhibiting the transfer of cariogenic bacteria from mothers to children, a significant transmission route. Xylitol reduces plaque accumulation and prevents its regrowth, more effective when combined with sorbitol than sorbitol alone, though xylitol is the most effective.[12,13]

Another benefit of xylitol in relation to tooth decay is the caries, is the inhibition of the transfer of the cariogenic Streptococcus mutans bacteria from mother to child, being this the main mutans from mother to child, this being the main route of contagion. The xylitol also has the ability to reduce plaque accumulation and prevent plaque re-growth. plaque re-growth, more effective in mixtures of sorbitol and xylitol than sorbitol alone, although the more sorbitol alone, although xylitol is the most effective.[2,14]

Sorbitol also does not promote caries development, reducing bacteria metabolism in the mouth but not preventing its occurrence like xylitol. Other sweeteners are considered to have no cariogenic potential; they are not bacterial substrates.[2,15]

Some non-caloric sweeteners recommended to avoid problems related to caries development include sugar alcohol derivatives (erythritol, D-tagatose, sucralose, and isomaltulose), naturally occurring in plants and cereals. They generally contain fewer calories per gram than sugar and are not associated with dental caries development.[16]

Sorbitol, mannitol, and maltitol are substances with a less sweet taste than xylitol and are considered anticariogenic agents. They promote early remineralization, stimulate salivary flow, increase salivary and biofilm pH.[17] The use of xylitol is more beneficial because most cariogenic bacteria do not ferment it.

The antibacterial activity of Stevia extracts on microorganisms related to dental caries has been studied, showing low acidogenic potential and a decrease in dental biofilm formation due to decreased cellular hydrophobicity and inhibition of extracellular polysaccharide synthesis.[9]

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The alcoholic extract of Stevia has been found to inhibit Streptococcus mutans, and its use in mouthwash with 10,6 % stevioside has significant anti-plaque and anti-gingivitis properties.[18] Stevia's use in chewing gum reduces bacterial concentration.[19]

Stevia is composed of a large number of natural products. More than 100 compounds have been isolated from this plant; among its most important components are diterpene glycosides also known as steviol glycosides.[18] Glycosides are molecules composed of a carbohydrate (generally monosaccharides such as glucose) and a non-carbohydrate compound; among these are: stevioside, steviol, steviolbioside, rebaudioside A, B, C, D, E, F and dulcoside A. Of these, stevioside (110 to 270 times sweeter than sucrose) and rebaudioside A (180-400 times sweeter than sucrose) are the most important. The difference between these glycosides is found only in the presence of a glucose and its weight fraction in the plant tissues, which is 5 % - 10 % for stevioside and 2 % - 4 % for rebaudioside A.[9]

The components of Stevia have not been fully described, but much of its composition has already been established. The fresh leaves contain a high percentage of water ranging from 80 to 85 %, a substantial amount of proteins, fiber, amino acids, free sugars, lipids and essential oils. In addition to the glycosides mentioned above, the leaves contain ascorbic acid, ß-carotene, chromium, cobalt, magnesium, iron, potassium, phosphorus, riboflavin, thiamine, tin, zinc, among others.[18]

While sweeteners have shown a lower incidence of dental caries, they still have the ability to alter oral biofilm and dental tissue pH. The sweetener format, whether pure or commercial, is crucial in determining its effect on the oral environment, potentially initiating or preventing caries lesions. When tested as pure chemical compounds, sweeteners do not induce dental caries; thus, they are not inherently cariogenic.[11]

According to the review, Stevia rebaudiana exhibits certain anticariogenic and antiperiodontopathic properties, making it a suitable candidate for replacing sucrose and potentially reducing caries incidence.

Alejos,[2] in evaluating the health effects of sweeteners and processed sugars, observed how dental caries occurrence is favored by sugar consumption, which serves as bacterial substrate, while alternatives to artificial sweeteners prevent its occurrence.

Caries problems do not solely arise from excessive consumption of sugary foods. Patients with multiple caries associated with medication consumption have been reported, often prescribed in the form of syrups or suspensions containing sucrose for a pleasant taste.[20]

Evidence of sugar's role in dental caries etiology has played a crucial role in WHO sugar guidelines, recommending that free sugars be less than 10 % of total daily energy intake and conditionally recommending further reductions to 5 % of total energy. Increasingly recognized as a public health issue, the consumption of free sugars includes all added monosaccharides and disaccharides in foods and beverages by manufacturers, cooks, or consumers, as well as natural sugars in honey, syrups, fruit juices, and fruit concentrates.[21]

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CONCLUSIONS

Sweeteners generally present low cariogenic potential, with some preventive effects. Depending on the sweetener, its presentation, and chemical composition, effects may vary, with polyols having greater preventive potential. Stevia rebaudiana is a suitable candidate to replace sucrose and exhibits potential properties to reduce caries incidence.

Conflict of Interest
The authors declare no conflict of interest.

Authors' Contributions
All authors participated in conceptualization, formal analysis, project administration, original draft writing, review writing, editing, and approval of the final manuscript.

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BIBLIOGRAPHIC REFERENCES

1. Organización Mundial de la Salud. Informe sobre la situación mundial de la salud bucodental: hacia la cobertura sanitaria universal para la salud bucodental de aquí a 2030: resumen ejecutivo [Internet]. Ginebra, Suiza; 2022 [citado 05/06/2023]. Disponible en: https://www.who.int/es/publications/i/item/9789240061569

2. Alejos de Domingo A. Edulcorantes o azúcar: efectos sobre la salud [Internet]. Madrid: España. Universidad Complutense de Madrid; 2018 [citado 05/06/2023]. Disponible en: https://hdl.handle.net/20.500.14352/15283

3. Lima Illescas MV, Jiménez Jaramillo DJ, Porras Polo CA, Maurat Argudo AK, Álvarez Álvarez DP. Efectos de azúcares totales sustitutos de sacarosa en la salud bucal. Revisión bibliográfica. Rev EUGENIO ESPEJO [Internet]. 2022 [citado 05/06/2023]; 16(2):101–13. Disponible en: https://eugenioespejo.unach.edu.ec/index.php/EE/article/view/331

4. Wadia R. Impact of artificial sweeteners on caries. Br Dent J [Internet]. 2023 [citado 05/06/2023]; 234(12): 923–923. Disponible en: https://www.nature.com/articles/s41415-023-6015-2

5. Salas GG, Quesada DQ, Chinnock A, Previdelli AN, ELANS G. Consumo de azúcar añadido en la población urbana costarricense: estudio latinoamericano de nutrición y salud ELANS-Costa Rica. Acta Médica Costarric [Internet]. 2019 [citado 05/06/2023]; 61(3): 111–8. Disponible en: https://actamedica.medicos.cr/index.php/Acta_Medica/article/view/1038

6. Rodríguez Cairoli F, Guevara Vásquez G, Bardach A, Espinola N, Perelli L, Balan D, et al. Carga de enfermedad y económica atribuible al consumo de bebidas azucaradas en El Salvador. Rev Panam Salud Pública [Internet]. 2023 [citado 05/06/2023]; 47:1. Disponible en: https://iris.paho.org/handle/10665.2/57443

7. Sandoval RC, Roche M, Belausteguigoitia I, Alvarado M, Galicia L, Gomes FS, et al. Excise taxes on sugar-sweetened beverages in Latin America and the Caribbean. Rev Panam salud publica [Internet]. 2021 [citado 05/06/2023]; 45: e124. Disponible en: http://www.ncbi.nlm.nih.gov/pubmed/34539768

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2023; 27(S2): e6227

8. Borrell García C, García Miralles E, Marqués Martínez L. Association between eating behavior pattern and caries in a population of children aged 3 to 9 years in the province of Alicante. Nutr Hosp [Internet]. 2021 [citado 05/06/2023]; 39(1):33–8. Disponible en: https://www.nutricionhospitalaria.org/articles/03729/show

9. Paredes Vélez AE, Naranjo Sierra MC. La Stevia rebaudiana como coadyuvante en la prevención y el control de la caries dental: una revisión de literatura. Acta Odontol Col [Internet]. 2016 [citado 05/06/2023]; 6(2):45–60. Disponible en: https://repositorio.unal.edu.co/bitstream/handle/unal/61332/61751-313873-1-SM.pdf?sequence=1&isAllowed=y

10. Bamonde Segura LK. Consumo de medicinas pediátricas como factor de riesgo de caries dental – Lima 2018 [Internet]. Universidad Nacional Daniel Alcides Carrión; 2021 [citado 05/06/2023]. Disponible en: http://repositorio.undac.edu.pe/handle/undac/2266

11. Aravena Orellana BE, Meza Cáceres DC. Potencial cariogénico de endulzantes no calóricos de uso común: revisión sistemática de la literatura [Internet]. Universidad de Talca. Chile; 2020 [citado 05/06/2023]. Disponible en: https://repositorioslatinoamericanos.uchile.cl/handle/2250/4433124

12. Krupa NC, Thippeswamy HM, Chandrashekar BR. Antimicrobial efficacy of Xylitol, Probiotic and Chlorhexidine mouth rinses among children and elderly population at high risk for dental caries - A Randomized Controlled Trial. J Prev Med Hyg [Internet]. 2022 [citado 05/06/2023]; 63(2): E282–7. Disponible en: http://www.ncbi.nlm.nih.gov/pubmed/35968060

13. Kõljalg S, Smidt I, Chakrabarti A, Bosscher D, Mändar R. Exploration of singular and synergistic effect of xylitol and erythritol on causative agents of dental caries. Sci Rep [Internet]. 2020 [citado 05/06/2023]; 10(1): 6297. Disponible en: http://www.ncbi.nlm.nih.gov/pubmed/32286378

14. ALHumaid J, Bamashmous M. Meta-analysis on the Effectiveness of Xylitol in Caries Prevention. J Int Soc Prev Community Dent [Internet]. 2022 [citado 05/06/2023]; 12(2):133–8. Disponible en: http://www.ncbi.nlm.nih.gov/pubmed/35462747

15. Runnel R, Mäkinen KK, Honkala S, Olak J, Mäkinen PL, Nõmmela R, et al. Effect of three-year consumption of erythritol, xylitol and sorbitol candies on various plaque and salivary caries-related variables. J Dent [Internet]. 2013 [citado 05/06/2023]; 41(12): 1236–44. Disponible en: https://linkinghub.elsevier.com/retrieve/pii/S0300571213002455

16. García-Almeida JM, Casado Fernandez GM., Garcíaa Alemán J. Una visión global y actual de los edulcorantes: aspectos de regulación. Nutr Hosp [Internet]. 2013 [citado 05/06/2023]; 28(S4): 17–31. Disponible en: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S0212-16112013001000003&nrm=iso

17. Cocco F, Cagetti MG, Livesu R, Camoni N, Pinna R, Lingström P, et al. Effect of a Daily Dose of Snacks Containing Maltitol or Stevia rebaudiana as Sweeteners in High Caries Risk Schoolchildren. A Double-blind RCT Study. Oral Health Prev Dent [Internet]. 2019 [citado 05/06/2023]; 17(6): 515–22. Disponible en: http://www.ncbi.nlm.nih.gov/pubmed/31641701

ISSN: 1561-3194 **RNPS:** 1877
Rev Ciencias Médicas. 2023; 27(S2): e6227

18. Augustinho do Nascimento C, Kim RR, Ferrari CR, de Souza BM, Braga AS, Magalhães AC. Effect of sweetener containing Stevia on the development of dental caries in enamel and dentin under a microcosm biofilm model. J Dent [Internet]. 2021 [citado 05/06/2023]; 115:103835. Disponible en: https://linkinghub.elsevier.com/retrieve/pii/S030057122100258X

19. Mota KR, da Silva JVF, Borges CD, Leite de Marcelos PGC, Alvares PR, Santos Júnior VE Dos. Effectiveness of the use of xylitol chewing gum in prevention of dental caries: A systematic review. J Indian Soc Pedod Prev Dent [Internet]. 2021 [citado 05/06/2023]; 39(2): 113–9. Disponible en: http://www.ncbi.nlm.nih.gov/pubmed/34341229

20. Siu ASC, Chu FCS, Yip HK. Cough syrup addiction and rampant caries: a report of two cases. Prim Dent Care [Internet]. 2002 [citado 05/06/2023]; 9(1): 27–30. Disponible en: http://www.ncbi.nlm.nih.gov/pubmed/11901787

21. Jiménez-León M, Ordoñez Araque R. Consumo de azúcares libres y sus efectos negativos en la salud. Qual Rev Científica [Internet]. 2021 [citado 05/06/2023]; 22(22). Disponible en: https://revistas.unibe.edu.ec/index.php/qualitas/article/view/94