International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

Dolna 17, Warsaw,
Poland 00-773
+48 226 0 227 03
editorial_office@rsglobal.pl

ARTICLE TITLE	IMPACT OF SUGAR ALCOHOLS ON ORAL HEALTH – A LITERATURE REVIEW
DOI	https://doi.org/10.31435/ijitss.3(47).2025.4000
RECEIVED	24 August 2025
ACCEPTED	28 September 2025
PUBLISHED	30 September 2025
LICENSE	The article is licensed under a **Creative Commons Attribution 4.0 International License.**

IMPACT OF SUGAR ALCOHOLS ON ORAL HEALTH – A LITERATURE REVIEW

Michalina Więckowska *(Corresponding Author, Email: misia.wieckowska@gmail.com)*
Medical University of Warsaw, Warsaw, Poland
ORCID ID: 0009-0000-5440-9985

Katarzyna Skorupa
Medical University of Warsaw, Warsaw, Poland
ORCID ID: 0009-0007-4085-9054

Agnieszka Zakrzewska
Medical University of Warsaw, Warsaw, Poland
ORCID ID: 0009-0009-9649-8299

Karolina Hetmanek
Medical University of Warsaw, Warsaw, Poland
ORCID ID: 0009-0001-8092-4988

Edyta Szlęzak
Medical University of Warsaw, Warsaw, Poland
ORCID ID: 0009-0009-8907-4295

Julia Mroczkiewicz
Medical University of Warsaw, Warsaw, Poland
ORCID ID: 0009-0000-0290-4060

Aleksandra Szczepanik
Medical University of Warsaw, Warsaw, Poland
ORCID ID: 0009-0007-6239-0533

ABSTRACT

Introduction and Purpose: Dental caries is one of the most common chronic diseases worldwide, with sucrose recognized as a key dietary factor in its development. As a result, sucrose substitutes have gained increasing attention as potential tools in caries prevention. Among them, xylitol, sorbitol, and erythritol are the most extensively studied. Xylitol is not fermented by Streptococcus mutans and may help reduce bacterial growth and adhesion. Sorbitol is less cariogenic than sucrose, but can still be slowly fermented by certain microorganisms. Erythritol is not fermented at all and may even help reduce plaque and improve the balance of the oral biofilm.
The aim of this study is to summarize what is currently known about sucrose substitutes in relation to oral health, with a particular focus on xylitol, sorbitol and erythritol.
Materials and Methods: The review is based on throughout analysis of the materials selected from PubMed, Cochrane and Google Scholar using the following keywords: xylitol, sorbitol, erythritol, sucrose substitutes, sugar alcohols, oral health.
Conclusions: The available evidence indicates that xylitol and erythritol are the most beneficial sucrose substitutes for oral health. Erythritol reduces plaque most effectively, inhibits Streptococcus mutans, and slows caries progression, while xylitol lowers bacterial levels with less consistent effects on plaque, and sorbitol is the least protective. To strengthen these findings and develop clear guidelines for polyol use in dentistry, further well-designed long-term trials are necessary.

KEYWORDS

Xylitol, Sorbitol, Erythritol, Sucrose Substitutes, Sugar Alcohols, Oral Health

CITATION

Michalina Więckowska, Katarzyna Skorupa, Agnieszka Zakrzewska, Karolina Hetmanek, Edyta Szlęzak, Julia Mroczkiewicz, Aleksandra Szczepanik. (2025) Impact of Sugar Alcohols on Oral Health – A Literature Review. *International Journal of Innovative Technologies in Social Science*. 3(47). doi: 10.31435/ijitss.3(47).2025.4000

Introduction

Dental caries is one of the most widespread chronic diseases in the world, and sugar, especially sucrose, plays a major role in causing it. (1, 2) Sucrose is uniquely cariogenic because it serves as a substrate for acid production by oral bacteria and also as a precursor for extracellular polysaccharides that enhance dental plaque accumulation and biofilm stability. (1) Frequent exposure to sucrose leads to a persistent drop in oral pH, favoring the demineralization of tooth enamel and dentin. (1, 2) This low pH environment encourages the growth of acid-producing bacteria like S*treptococcus Mutans*. (2)

In recent decades, growing public health awareness of sugar-related diseases, has led to an increasing interest in sucrose substitutes. (3) Currently they are widely used as alternatives in food and beverages and also in dental care products such as chewing gums, lozenges, and oral rinses. (4, 5) These substitutes have a sweet taste with fewer calories and a lower risk of tooth decay compared to traditional sugars. Sucrose substitutes are broadly categorized into low-intensity types, like sugar alcohols (e.g., xylitol, sorbitol, erythritol), and high-intensity types (e.g., stevia, sucralose, aspartame), which are used for their sweet taste without the caloric content or cariogenic potential of sugar. (3, 6)

This paper will focus on xylitol, sorbitol, and erythritol as the most important sucrose substitutes in the context of oral health. Studies have shown that xylitol is not fermented by Streptococcus mutans and have an inhibitory effects on Streptococcus Mutans in dental plaque and saliva. (7) Sorbitol is less cariogenic than sucrose, but can still be slowly fermented by oral bacteria, including *Streptococcus Mutans* and *Lactobacillus spp.*, which can lead to acid production. (5, 8, 9) Erythritol, on the other hand, is not readily metabolized by oral microorganisms and is effective in reducing plaque accumulation, inhibiting harmful bacteria, and lowering the occurrence of dental caries. High-intensity sweeteners, although largely non-cariogenic due to their extremely low required doses, require further long-term evaluation in the context of oral health. (10-13)

Understanding the impact of sucrose substitutes is of great importance for both clinical dentistry and public health policy. Using non-cariogenic sweeteners in the diet and in oral care products may help lower the risk of cavities, especially in people at high risk. At the same time, scientific evidence regarding their long-term effects, safety, and relative effectiveness remains variable. The aim of this paper is to review current knowledge on the impact of sucrose substitutes on oral health, with a particular focus on xylitol, sorbitol and erythritol.

Sugar Alcohols as Sucrose Substitutes

Sugar alcohols, also known as polyols, are low-calorie sweeteners derived from monosaccharides. (14) They are used in foods, beverages, and dental care products. (14) Unlike sucrose, many sugar alcohols are not metabolized by oral microorganisms, making them significantly less cariogenic and beneficial for dental health. (14) Among them, xylitol, sorbitol, and erythritol are the most important in the context of oral health.

Xylitol

Xylitol is a five-carbon sugar alcohol (Figure 1.) naturally occurring in small amounts in fruits and vegetables. (15, 16) It tastes and looks like sucrose. (17) Xylitol is available in various forms, including chewing gum, lozenges, candies, syrups, wipes, and toothpaste. (15, 16) Xylitol is thought to reduce caries in three ways: by passively substituting for sugars like sucrose, by stimulating saliva secretion which aids in mechanical cleansing and remineralization, and through a specific anti-caries effect by inhibiting the growth of oral bacteria. (15) *Streptococcus mutans* cannot effectively ferment xylitol, instead this bacteria metabolizes it into xylitol-5-phosphate, which disrupts its normal metabolic processes, reduces plaque acid production, and inhibits its growth. (15) Xylitol also reduces the ability of *S. mutans* to adhere to tooth surfaces, possibly by interfering with the production of extracellular polysaccharide (EPS). (18) Xylitol has also positive metabolic effects. (19) Research in humans shows that eating xylitol raises blood sugar and insulin much less than sucrose or glucose. (19) Xylitol stimulates the release of hormones like GLP-1 and cholecystokinin (CCK), which prolongs gastric emptying and can reduce subsequent food intake. (19) A 2024 study on cell lines found

that xylitol had dose-dependent cytotoxic effects on healthy human keratinocytes (HaCaT) and osteosarcoma (SAOS-2) tumor cells. (20) It also induced apoptosis-related changes in cancer cells, that suggest potential therapeutic benefits alongside its use in oral hygiene. (20) Unfortunately, xylitol is known to cause gastrointestinal side effects such as bloating, wind, and diarrhea. (15)

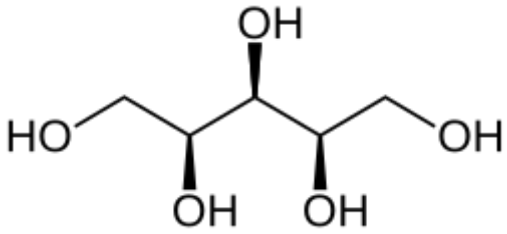

Fig. 1. *Structural formula of xylitol*

Sorbitol

Sorbitol is a six-carbon sugar alcohol (Figure 2.) that is widely used as a sugar substitute in foods. (5) It is about 60% as sweet as sucrose and has a much lower potential to cause cavities. (5, 21) Unlike xylitol or erythritol, sorbitol can be fermented by oral bacteria such as *Streptococcus mutans* and *Lactobacillus spp*., although this process is slower than with sucrose. (5) The initial catabolism of sorbitol in oral streptococci involves a phosphoenolpyruvate (PEP)-dependent phosphotransferase system (PTS). (22) This system transports sorbitol into the cell and phosphorylates it to sorbitol-6-phosphate (S6P). (22) Sorbitol-6-phosphate is then oxidized to fructose-6-phosphate by the enzyme sorbitol-6-phosphate dehydrogenase (S6PDH). (22) The enzymes required for sorbitol metabolism are inducible, meaning they may not be fully expressed unless the bacteria have been growing in a sorbitol-rich environment. (22) With frequent or prolonged exposure, bacteria adapt and metabolize sorbitol, leading to low-level acid production. (22) As a result, sorbitol is often regarded as "low-cariogenic" rather than completely non-cariogenic. While sorbitol can help reduce plaque and gingivitis similarly to xylitol, its effectiveness in reducing *S. mutans* and preventing caries is generally considered inferior to that of xylitol and erythritol. (5, 21)

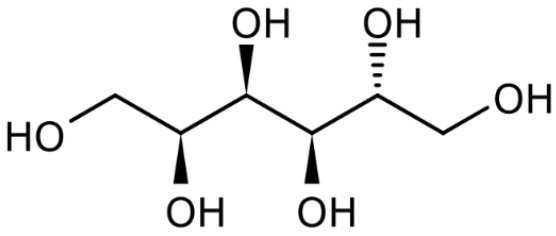

Fig. 2. *Structural formula of D-sorbitol*

Erythritol

Erythritol is a four-carbon sugar alcohol (Figure 3.). It is found in fruits, vegetables, and fermented foods, and also produced endogenously in humans and animals during the pentose phosphate pathway. (7, 11) Commercially, it is produced through the fermentation of substrates like glucose by yeast or yeast-like fungi. (23) Erythritol has about 60-80% sweetness of sucrose and is considered non-caloric. (23) Unlike other sugar alcohols, erythritol is almost completely absorbed from the small intestine and excreted unchanged in the urine, with minimal amounts that reach the colon. (11) Due to its efficient absorption and excretion, it has a high digestive tolerance and is less likely to cause gastrointestinal side effects compared to other sugar alcohols like sorbitol and xylitol. (11) Erythritol is more effective than xylitol and sorbitol in managing oral health endpoints. (11, 13) Studies show it is not easily metabolized by oral microorganisms and is effective in reducing the amount of dental plaque, inhibiting harmful bacteria like *Streptococcus mutans*, and lowering the risk of dental caries. (10-13) In vitro studies have shown, that erythritol is more effective at inhibiting *S. mutans* growth than xylitol or sorbitol. (11) A six month human study showed that erythritol reduced plaque weight more significantly than xylitol and sorbitol. (11) It also inhibits the formation of biofilm by various oral streptococci

and reduces the accumulation of bacteria like *P. gingivalis* onto *S. gordonii* substrata. (10) Erythritol has been shown to decrease the adherence of common oral streptococci to tooth surfaces. (10) Long-term human studies have demonstrated that routine consumption of erythritol leads to a lower overall number of dental caries. (10) In a 3-year study, children consuming erythritol candies had a slower and lower development of caries compared to those consuming xylitol or sorbitol candies. (11) Because of its fine particle size and gentle, non-abrasive nature, erythritol is often used in air-polishing powders for subgingival cleaning during periodontal therapy. (11) Erythritol does not cause spikes in blood sugar or insulin, which makes it a safe choice for people with diabetes. (11) It may also work as an antioxidant and help blood vessels function better, offering potential cardiovascular benefits, particularly for those with type 2 diabetes. (11) Animal studies suggest that long-term intake could help reduce body weight, although human clinical trials are still needed to confirm this effect. (7) Additionally, erythritol has also shown a bacteriostatic effect against *Porphyromonas gulae*, a periodontal disease-related bacteria in canines, suggesting its potential for veterinary dental care. (12)

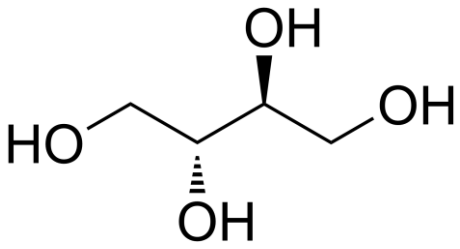

Fig. 3. *Structural formula of erythritol*

Safety and regulatory status

The U.S. Food and Drug Administration (FDA) approved xylitol for use in food in 1963. (5, 24) It is generally recognized as safe for humans when consumed at the recommended dose of about 6 grams per day. (24) The most commonly reported side effect of xylitol is its laxative effect. (15) High ingestion of xylitol, about four to five times the recommended dose (reaching 50 g per day), has been associated with side effects such as stomach disturbance and diarrhea. (24) A review of 10 studies found mixed results: four reported no side effects, two found similar rates of side effects in xylitol and control groups, while the others provided limited or no data. (15) The side effects described in some studies included sores in the mouth, cramps, bloating, constipation, flatulence, and loose stool or diarrhea. (15)

Sorbitol is considered a safe sugar replacer and is generally well-tolerated. (13) The most common side effect of sorbitol, as with other polyols, is its laxative effect. (15) Other possible symptoms include bloating, gas, and diarrhea. (5)

Erythritol is a sugar alcohol with a significant history of safe use, having been consumed in products since 1990. (7, 13) It is approved for use in foods and beverages in over 60 countries. (7, 13) Extensive toxicological and safety studies have demonstrated its safety, leading to its classification as a 'Generally Recognized As Safe' (GRAS) substance by the U.S. (7, 13) Food and Drug Administration (FDA) and an 'Acceptable Daily Intake (ADI) not specified' by the Joint Expert Commission on Food Additives (JECFA). (7, 13) The European Food Safety Authority (EFSA) approved erythritol as a food additive in 2003. (7) In 2000, the Joint Expert Commission on Food Additives of the World Health Organization and the Food and Agriculture Organization established the ADI for erythritol as 'not specified', indicating a high level of safety. (7) A comprehensive body of toxicology and safety studies shows a lack of adverse effects associated with erythritol consumption. (13) A long-term (2-year) study in rats found no signs of toxicity, tumor-inducing changes, or effects on survival even at high dietary concentrations. (7) Compared to other polyols, erythritol is well-tolerated, because approximately 90% of ingested erythritol is absorbed from the small intestine and excreted unchanged in the urine, with minimal amounts reaching the colon. (11, 13) The No Observed Effect Level (NOEL) for laxation is at least 0.7 g/kg body weight, which is 2 to 4 times higher than that of other polyols like xylitol and sorbitol. (11, 13) Global consumption of erythritol reached approximately 25,500 metric tons in 2012, with the United States being the primary consumer, growing from 1,800 metric tons in 2007 to over 13,000 in 2012. (11)

Conclusions

Available evidence clearly shows that polyols can serve as effective sucrose substitutes, with varying degrees of impact on oral health. (7) Clinical studies confirm that erythritol reduces dental plaque weight more effectively than xylitol and sorbitol and significantly inhibits the growth and adhesion of *Streptococcus mutans*. (7, 11) Long-term trials in children further support these findings, showing that erythritol not only decreases the number of tooth surfaces affected by caries but also slows the progression of existing lesions, outperforming both xylitol and sorbitol. (11) Xylitol also offers notable oral health benefits. It has been shown to lower *S. mutans* levels in plaque and saliva and to reduce bacterial adhesion (7, 25) However, its ability to reduce plaque mass appears less consistent compared to erythritol. (11) Sorbitol, while safer than sucrose, shows the weakest cariostatic potential, with limited effects on plaque accumulation and bacterial counts. (7, 11) Overall, the body of evidence indicates that erythritol is the most effective polyol in caries prevention, followed by xylitol, while sorbitol is comparatively less protective (10-13, 23) Importantly, both erythritol and xylitol are non-cariogenic and also offer favorable metabolic properties, including a low glycemic response, making them suitable for individuals with diabetes and for broader preventive health strategies. (14, 16-19) In conclusion, while all three polyols represent safer alternatives to sucrose, erythritol currently stands out as the most promising agent for caries prevention and overall oral health promotion.

Disclosure: Authors do not report any disclosures.

Author's Contribution:

Conceptualization: Michalina Więckowska, Katarzyna Skorupa, Julia Mroczkiewicz, Aleksandra Szczepanik; methodology: Michalina Więckowska, Agnieszka Zakrzewska, Edyta Szlęzak; check: Julia Mroczkiewicz, Karolina Hetmanek, Edyta Szlęzak; data curation: Agnieszka Zakrzewska, Julia Mroczkiewicz; investigation: Michalina Więckowska, Julia Mroczkiewicz, Karolina Hetmanek; resources: Karolina Hetmanek, Agnieszka Zakrzewska; writing-rough preparation: Michalina Więckowska, Katarzyna Skorupa, Aleksandra Szczepanik, Edyta Szlęzak, Karolina Hetmanek; writing-review and editing: Michalina Więckowska Katarzyna Skorupa, Agnieszka Zakrzewska; visualization: Michalina Więckowska; supervision: Julia Skowrońska-Borsuk, Adam Borsuk; project administrator: Michalina Więckowska

All authors have read and agreed with the published version of the manuscript.

Funding Statement: The study did not receive special funding.
Institutional Review Board Statement: Not applicable.
Informed Consent Statement: Not applicable.
Data Availability Statement: Not applicable.
Conflict of Interest Statement: The authors declare no conflicts of interest.

REFERENCES

1. Sheiham A. Sucrose and Dental Caries. Nutrition and Health. 1987;5(1-2):25-9.
2. Touger-Decker R, van Loveren C. Sugars and dental caries. Am J Clin Nutr. 2003;78(4):881s-92s.
3. Liang NL, Luo BW, Sun IG, Chu CH, Duangthip D. Clinical Effects of Sugar Substitutes on Cariogenic Bacteria: A Systematic Review and Meta-Analysis. International Dental Journal. 2024;74(5):987-98.
4. Luo BW, Liang NL, Townsend JA, Lo ECM, Chu CH, Duangthip D. Sugar substitutes on caries prevention in permanent teeth among children and adolescents: a systematic review and meta-analysis. Journal of Dentistry. 2024;146:105069.
5. Oza S, Patel K, Bhosale S, Mitra R, Gupta R, Choudhary D. To determine the effect of chewing gum containing xylitol and sorbitol on mutans streptococci and Lactobacilli count in saliva, plaque, and gingival health and to compare the efficacy of chewing gums. Journal of International Society of Preventive and Community Dentistry. 2018;8(4):354.
6. Matsukubo T, Takazoe I. Sucrose substitutes and their role in caries prevention. Int Dent J. 2006;56(3):119-30.
7. Mazi TA, Stanhope KL. Erythritol: An In-Depth Discussion of Its Potential to Be a Beneficial Dietary Component. Nutrients. 2023;15(1):204.
8. Chan A, Ellepola K, Truong T, Balan P, Koo H, Seneviratne CJ. Inhibitory effects of xylitol and sorbitol on Streptococcus mutans and Candida albicans biofilms are repressed by the presence of sucrose. Arch Oral Biol. 2020;119:104886.

9. Burt BA. The use of sorbitol- and xylitol-sweetened chewing gum in caries control. J Am Dent Assoc. 2006;137(2):190-6.
10. Drago L, Bortolin M, Taschieri S, De Vecchi E, Agrappi S, Del Fabbro M, et al. Erythritol/chlorhexidine combination reduces microbial biofilm and prevents its formation on titanium surfaces in vitro. Journal of Oral Pathology & Medicine. 2017;46(8):625-31.
11. de Cock P. Erythritol Functional Roles in Oral-Systemic Health. Adv Dent Res. 2018;29(1):104-9.
12. Tochio T, Makida R, Fujii T, Kadota Y, Takahashi M, Watanabe A, et al. The bacteriostatic effect of erythritol on canine periodontal disease–related bacteria. Polish Journal of Veterinary Sciences. 2022:75-82.
13. De Cock P, Mäkinen K, Honkala E, Saag M, Kennepohl E, Eapen A. Erythritol Is More Effective Than Xylitol and Sorbitol in Managing Oral Health Endpoints. International Journal of Dentistry. 2016;2016:1-15.
14. Štšepetova J, Truu J, Runnel R, Nõmmela R, Saag M, Olak J, et al. Impact of polyols on Oral microbiome of Estonian schoolchildren. BMC Oral Health. 2019;19(1).
15. Riley P, Moore D, Ahmed F, Sharif MO, Worthington HV. Xylitol-containing products for preventing dental caries in children and adults. Cochrane Database Syst Rev. 2015;2015(3):Cd010743.
16. Featherstone JD. Delivery Challenges for Fluoride, Chlorhexidine and Xylitol. BMC Oral Health. 2006;6(S1):S8.
17. Kitchens DH. Xylitol in the prevention of oral diseases. Spec Care Dentist. 2005;25(3):140-4.
18. Salli KM, Forssten SD, Lahtinen SJ, Ouwehand AC. Influence of sucrose and xylitol on an early Streptococcus mutans biofilm in a dental simulator. Arch Oral Biol. 2016;70:39-46.
19. Wölnerhanssen BK, Meyer-Gerspach AC, Beglinger C, Islam MS. Metabolic effects of the natural sweeteners xylitol and erythritol: A comprehensive review. Critical Reviews in Food Science and Nutrition. 2020;60(12):1986-98.
20. Breban-Schwarzkopf D, Chioibas R, Macasoi I, Bolintineanu S, Marcovici I, Draghici G, et al. Comprehensive in vitro and in ovo assessment of cytotoxicity: Unraveling the impact of sodium fluoride, xylitol, and their synergistic associations in dental products. Biomolecules and Biomedicine. 2024;24(4):923-38.
21. Gales MA, Nguyen T-M. Sorbitol Compared with Xylitol in Prevention of Dental Caries. Annals of Pharmacotherapy. 2000;34(1):98-100.
22. Svensäter G, Edwardsson S, Kalfas S. Purification and properties of sorbitol-6-phosphate dehydrogenase from oral streptococci. Oral Microbiology and Immunology. 1992;7(3):148-54.
23. Regnat K, Mach RL, Mach-Aigner AR. Erythritol as sweetener—wherefrom and whereto? Applied Microbiology and Biotechnology. 2018;102(2):587-95.
24. J AL, Bamashmous M. Meta-analysis on the Effectiveness of Xylitol in Caries Prevention. J Int Soc Prev Community Dent. 2022;12(2):133-8.
25. Salli KM, Gürsoy UK, Söderling EM, Ouwehand AC. Effects of Xylitol and Sucrose Mint Products on Streptococcus mutans Colonization in a Dental Simulator Model. Current Microbiology. 2017;74(10):1153-9.