REVIEW ARTICLE

Effects of Chewing Gums Containing Xylitol and Sorbitol on Salivary Microflora, Plaque, and Gingiva: A Systematic Review

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Received on: 05 December 2022; *Accepted on:* 01 February 2023; *Published on:* 23 March 2023

Abstract

Aim: This study is targeted to assess the effect of chewing gums containing xylitol and sorbitol on salivary microflora, plaque, and gingiva.

Materials and methods: The literature review was performed using PubMed, Cochrane Central Register of Controlled Trials (CENTRAL), Science Direct, Lilacs, Google Scholar, Gray Literature, and Ovid MEDLINE using MeSH Terms—Chewing gums, xylitol, and sorbitol. Among the total of 870 titles appearing from various sources, 746 records were screened, and 70 were related to the research. This review is described according to PRISMA guidelines for systematic review.

Results: Four randomized control trial articles were included, effects of xylitol and sorbitol chewing gums were compared. Among the four trials, three found statistically significant differences favoring the effects of chewing gums containing xylitol and sorbitol.

Conclusion: Thereby, we can conclude that xylitol- and sorbitol-containing chewing gums affect salivary microflora, plaque, and gingiva.

Clinical significance: Prevention of plaque and salivary microflora using xylitol and sorbitol.

Keywords: Chewing gum, Gingiva, Plaque, Salivary microflora, Sorbitol, Xylitol.

Journal of Oral Health and Community Dentistry (2022): 10.5005/jp-journals-10062-0155

Introduction

The oral cavity has a diverse range of microbes. In most environments, poor oral hygiene leads to the proliferation of microorganisms and ultimately leads to several oral diseases. Hence, maintaining a healthy oral cavity plays an important role in maintaining good oral health and reducing dental plaque accumulation.[1]

Xylitol is one of the proven alternative sweeteners. Chewing gum containing xylitol is often used with claims of positive effects on dental health.[2] Sugar substitutes are such agents that have certain anti-cariogenic properties. Maltitol, xylitol, lactitol, and sorbitol are commonly used in foods to replace regular white sugar.[3]

Sorbitol or polyol is a type of carbohydrate having plasticizing properties. It is absorbed in a slower rate than sucrose. It can be fermented at a lower rate by *Lactobacillus* and *Streptococcus mutans*, serving as a substrate.[3] Sorbitol can be fermented to a small degree, but xylitol is fermented to a large degree.[2]

According to the International Chewing Gum Association, chewing gums are one of the most popular confectioneries around the world. Sugar substitutes are the most used sweeteners in chewing gums in western countries.[4] Xylitol and sorbitol are the most-used sweetening agents in chewing gums. Both polyols have been proven to be noncarcinogenic or less acid-producing substances in plaque telematics studies.

Xylitol is a sugar alcohol and approved for use in food since 1963 by the United States food and drug administration. It has been evident that it reduces *S. mutans* levels in plaque, and saliva and gradually reduces dental caries. Xylitol is one of a kind among sugar alcohols by its unique effect on glycolysis inhibition.[3] Chewing gums containing xylitol is of specific concern since it aids in mechanical cleansing and in salivary stimulation, and is likely to benefit further on the antibacterial effects of polyol.[5]

In many countries, xylitol has been approved to be used in chewing gums as a sweetening agent. The recommended dose is 6–10 gm/day for caries prevention.[5] Xylitol has specific anti-cariogenic properties such as reduction of dental plaque, *S. mutans*, and/or *Lactobacilli*.[6]

The glycolysis inhibitory effects have been related to the uptake of xylitol through the constitutive fructose-specific phosphotransferase system and intracellular accumulation of xylitol-5-phosphate. This in turn leads to a reduced *S. mutans* count and acid formation in the oral cavity.[5]

As xylitol is hypoacidogenic, the pH of saliva does not lower, thereby when the xylitol is dissolved, it slightly lowers the temperature of the oral cavity; therefore, it feels refreshing while eating chewing gums.[2] Sucrose-free chewing gums act as a delivery vehicle.[4]

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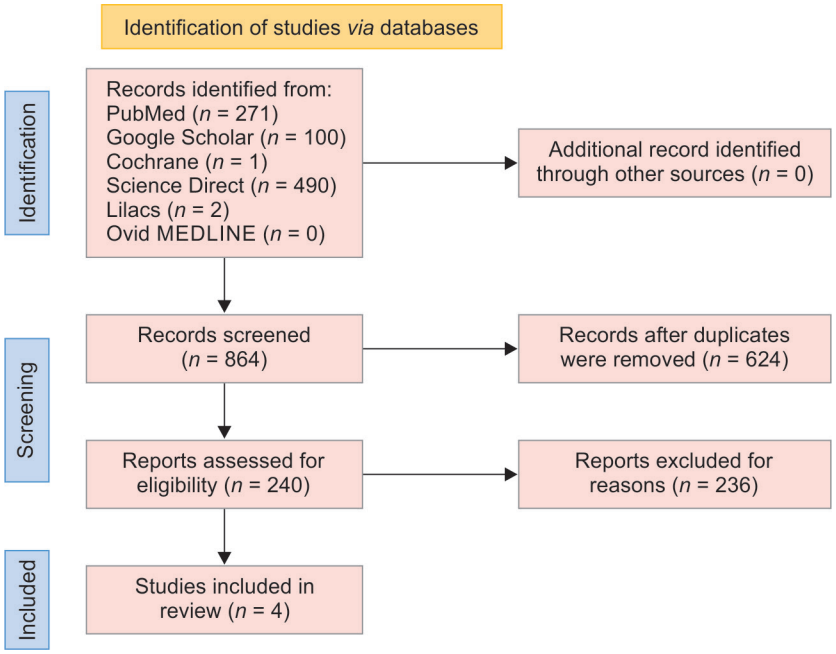
How to cite this article: Maya Sri S, Sindhu R, Nimmy P, *et al*. Effects of Chewing Gums Containing Xylitol and Sorbitol on Salivary Microflora, Plaque, and Gingiva: A Systematic Review. J Oral Health Comm Dent 2022;16(3):138–141.

Source of support: Nil

Conflict of interest: None

Flowchart 1: Flow diagram indicates the number of studies identified, screened, assessed for eligibility, excluded and included in the systematic review



Sorbitol is often used as a substitute for sucrose.[2] One major barrier to using xylitol chewing gum is the requirement of high-frequency administration to acquire therapeutic effects.[3] Xylitol and sorbitol are relatively expensive and often provide better clinical efficacy than pure sorbitol.[5]

Also, the long-term use of xylitol could be an obstacle due to its high cost. Therefore, there is a need for an inexpensive xylitol delivery system that can be adjusted for different age groups.[6] The mechanism of microbial growth inhibition by xylitol has been mainly studied *in vitro*.[7] A number of clinical studies have been conducted to determine the effects of xylitol and sorbitol chewing gum treatment on oral disease outcomes.[8] Hence, the goal of this investigation is to evaluate the effects of chewing gums with xylitol and sorbitol on salivary microflora, plaque, and gingiva.

Objective

To assess the effects of chewing gums with xylitol and sorbitol on the salivary microflora, plaque, and gingiva.

Materials and Methods

Full-text randomized controlled trial articles.

Searched Strategy

Published literature based on chewing gums containing xylitol and sorbitol on salivary microflora, plaque, and gingiva in databases such as Science Direct, Lilacs, Gray Literature, Cochrane, and PubMed were taken into the study. A literature search was performed using the MeSH terms "chewing gums," "xylitol," and "sorbitol."

Eligibility Criteria

Inclusion Criteria

- Randomized clinical trials
- Publications over the years
- *In vitro* studies
- Articles that are in the English language

Exclusion Criteria

- Review articles
- Only abstracts available in articles

Search Engines

- PubMed
- Cochrane
- Science Direct
- Lilacs
- Google Scholar
- Gray Literature
- Ovid MEDLINE

Results

A total of 870 records was obtained, and 70 full-text articles were assessed. Among these 70 articles, four articles were included in this systematic review.

Flowchart 1 exhibits the preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram of the articles incorporated in the review.

Table 1 shows the characteristics of the interventions of the selected studies. In all four studies, the effects of chewing gums with xylitol and sorbitol on salivary microflora, plaque, and gingiva were different. All four studies were performed among school children and adolescent dental and non-dental students. Table 2 shows the outcome data of the selected studies. There was a continuous decrease in the plaque score (PS) and no statistically significant difference in gingival scores in all four studies.[7–10] Table 3 shows the bias assessment for the selected studies. Bias assessment was done using RoB 2—a revised Cochrane risk-of-bias tool for randomized trials.

Table 1: Characteristics of the interventions in the included studies

Authors	*Year*	*Sample size*	*Patient characteristics*	*Duration (weeks)*	*Number (case/control)*
Keukenmeester et al.[9]	2013	55	Adolescent non-dental students of age 19–25 years	3 weeks	Group I (xylitol containing chewing gums) Group II (sorbitol containing chewing gums Group III (gum base) Group IV (no gums)
Chavan et al.[10]	2015	72	School children of age 12–15 years	3 weeks	Group I (study group – xylitol containing chewing gums) Group II (control group – sorbitol-containing chewing gums)
Oza et al.[1]	2018	88	Adolescent dental college students of age 18–24 years	4 weeks	Group I (study group – xylitol containing chewing gums) Group II (control group – sorbitol containing chewing gums)
Rafeek et al.[11]	2018	29	Adolescent dental students of age 20–25 years	4 weeks	Group A (xylitol containing chewing gums) Group B (sorbitol containing chewing gums)

Table 2: Outcome data as reported in included studies

Authors	*Year*	*Effect measure*	*Results*
Keukenmeester et al.[9]	2013	BOMP; PS	An increase in BOMP in the lower jaw area with the experiment was significant in all groups when relating the baseline to 21 days ($p < 0.001$). For non-brushed (lower) jaw, no significant difference ($p = 0.068$) was found between the groups at baseline; however, the increase in the no-gum group being 0.36 was not significantly different from the xylitol and the sorbitol groups. The plaque scores are not significantly different.
Chavan et al.[10]	2015	*S. mutans* count	This Analysis revealed that among all the independent variables, chewing of gums was the only variable that showed a statistically significant ($p < 0.02$) association with the reduction in salivary *S. mutans* counts (dependent variable) in the xylitol groups.
Oza et al.[1]	2018	Gingival index and plaque index	The mean plaque index score between xylitol and sorbitol at baseline was 1.08 ± 0.41 and 1.10 ± 0.47, which reduced to 0.96 ± 0.37 in the xylitol group and 0.96 ± 0.41 in the sorbitol group. In the case of a gingival index, the mean reduction of gingival scores was less. Thereby, it has no statistically significant difference between the xylitol and the sorbitol groups at different study intervals.
Rafeek et al.[11]	2018	DMFT	A total of 29 subjects (15 females and 14 males) with a mean DMFT of 1.59 (range 04) were included in the final analysis.

Table 3: Assessment of the risk of bias in the included studies

Authors	*Random sequence generation*	*Allocation concealment*	*Blinding of outcome*	*Incomplete outcome data*	*Blinding of participants and personnel*	*Selective reporting*	*Judgmental bias*
Keukenmeester et al.[9]	+	+	–	–	+	?	?
Chavan et al.[10]	+	–	+	+	–	–	+
Oza et al.[1]	+	+	?	?	–	?	–
Rafeek et al.[11]	+	+	–	–	+	–	–

+ = low risk of bias; – = high risk of bias; ? = unclear risk of bias

Discussion

Chewing gum is a soft, cohesive chewable substance but it should not be swallowed. Modern chewing gum comprises gum base sweeteners, plasticizers, flavors, colors, and typically hard or powdered polyol coating.

On the basis of dental health, sugar-free chewing gum with xylitol as a sweetening agent has reduced cavities and plaque. The sweetener consists of sorbitol which has the same effect but is only about one-third as effective as xylitol. This research consists of four studies, in which three studies have a statistically significant difference between the xylitol and the sorbitol groups, whereas one study does not have significant differences.

Oza et al.[1] aimed at the effects of chewing gums having xylitol and sorbitol on *S. mutans* and *Lactobacillus* on saliva, gingival health, and plaque. It has the study group as xylitol-containing chewing

gums and the control group as sorbitol-containing chewing gums. The effects are measured by plaque and gingival index. Xylitol and sorbitol groups are not statistically significant. Therefore, the bias assessment of this study has an unclear risk of bias.

Chavan et al.[10] focused on the effects of chewing gums containing xylitol on salivary *S. mutans* count. It consists of two groups, the Study group would be xylitol containing chewing gums, and the control group would be sorbitol containing chewing gums. Furthermore, *S. mutans* count measured the study. On bias assessment, it has a low risk of bias. This analysis revealed that it shows a statistically significant difference in the xylitol group.

Keukenmeester et al.[9] worked on the effectiveness of sugar-free chewing gums containing xylitol on the accumulation of plaque. It possesses group I as xylitol containing chewing gums, group II as sorbitol containing chewing gums, group III as gum base, and group IV as no gums. The bleeding on marginal probing (BOMP) and PS were estimated in this study. This study has significant differences from the xylitol and sorbitol groups, and the PS is insignificant. Therefore, bias assessment shows a low risk of bias.

Rafeek et al.[11] reported xylitol and sorbitol effects on the microbiome of saliva and plaque. Decayed, missing, and filled teeth (DMFT) were measured in this study.

Therefore, this research consists of four studies. Out of the four studies, three studies have a statistically significant difference between xylitol and sorbitol, whereas one study does not have any significant differences.

Clinical Significance

Prevention of plaque and salivary microflora using xylitol and sorbitol.

Conclusion

Since three studies are statistically significant, we can conclude that chewing gums with xylitol and sorbitol affect salivary microflora, gingiva, and plaque.

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