Utilization of xylitol as a preventive substance in dentistry

José Roberto de Magalhães Bastos[1*]
Lucilene Sanches Cirilo da Cunha[2*]
Ricardo Henrique Alves da Silva[3*]
Fabíola Elias[4*]
Hilton José Gurgel Rodrigues[5*]
[1]*PhD, Full Professor*
[2]*Specialist in Public Health Dentistry*
[3]*DDS*
[4]*Specialist in Public Health Dentistry and Specialist in Orthodontics*
[5]*Specialist in Public Health Dentistry*
**São Paulo University*

Received for publication: September 15, 2005
Accepted: November 05, 2005

Abstract
Dental caries is an infectious-contagious disease of multifactorial origin, which requires interference in one or more of its etiologic factors for prevention. Within this context, the utilization of xylitol is highlighted, which was initially studied as a sugar substitute because of its similarity as regards the sweetening power and later was also employed in other forms for caries prevention and control. The purpose of this study is to describe, by means of a review of the specialized literature, how xylitol can be used as an anticariogenic agent, demonstrating its properties and possible mechanisms of action in the prevention and control of dental caries. Analysis of many studies on xylitol revealed that it is available in many forms: chewing gums or tablets, mouthrinses, or even associated to toothpastes. Its anticariogenic properties are related to the reduction in plaque adhesion, remineralization of incipient carious lesions, and specific reduction of *S. mutans.*

Key Words:
dental caries, prevention, xylitol

Correspondence to:
José Roberto de Magalhães Bastos
Universidade de São Paulo -
Faculdade de Odontologia de Bauru
Departamento de Odontopediatria, Ortodontia e Saúde Coletiva
Al. Octávio Pinheiro Brisola, 9-75
Bauru - São Paulo - Brasil - 17012-901
Phone: (14) 3235-8256 - Fax: (14) 3223-4679
E-mail: zeromaba@fob.usp.br

Introduction

Dental caries is an infectious-contagious disease of multifactorial origin and requires simultaneous interaction of three factors for establishment: microorganisms, host and diet[1-3]. Prevention of this pathology requires interference on these etiologic factors by means of strengthening of the host, which occurs in the presence of fluorides; control of the microorganisms through professional prophylaxis and antimicrobial agents; and restriction of dietary carbohydrates, especially sugar.

Within this preventive context, the utilization of xylitol is highlighted, which is a polyalcohol known by organic chemistry since 1890. Xylitol may be found naturally in some fruits and vegetables and may also be industrially produced[4].

The dental studies concerning xylitol were initiated in 1969, aiming at a possible substitution of sucrose because of the similar sweetening power. Later it was also employed in other forms for prevention, allowing interference on the metabolism of cariogenic microorganisms and improving the protective mechanisms of the host against tooth decay[5]. Xylitol is currently available in many forms such as chewing gums[6-10],toothpastes[11-13], fluoridated mouthrinses[14-15], milk[16] and it may also be associated to the use of fluoride[17-18].

The utilization of xylitol in chewing gums allows an increase in the salivary flow, yielding an increase in the buffering capacity of saliva and a larger and faster increase in the salivary pH, therefore making the de/remineralization process more favorable[19]. The studies on the literature display possible anticariogenic[20] and cariostatic[21] properties of xylitol, which render this sweetener greatly interesting and important to Preventive Dentistry. However, its utilization in public services is partially impaired by one of its disadvantages, namely the high cost[21]. However, this may be overcome because of the preventive benefits it provides to oral health, reducing the expenses with therapeutic procedures. There is also the gastrointestinal side effect, caused by the intake of doses above 20g, which can lead to osmotic diarrhea. Nevertheless, it is known that high doses of fluoride, which is currently the most widely spread and used preventive method, can bring about even death of individuals, a risk that xylitol[22] does not present.

The aim of this work is to describe how xylitol can be used as an anticariogenic agent by means of a review of the specialized literature, demonstrating its properties and possible mechanisms of action in the control and prevention of tooth decay.

Literature Review

Studies using xylitol in chewing gums revealed a reduction of 40% in dental plaque, compared to a group that used chewing gums containing sugar[6].

When chewed between meals, the gums can stimulate the natural defenses of the organism, which help in the decrease of caries prevalence together with the non-fermentability of xylitol by the bacteria[7], besides the decrease in the speed of progression of the lesion[20] and reduction in the amount of cariogenic bacteria[23].

Comparison of xylitol chewing gums and pit and fissure sealants demonstrated no significant difference between these two preventive methods[24].

The utilization of xylitol was also investigated in toothpastes containing it and NaF/silica, which produced a significant increase in the anti-caries benefit when compared to a similar toothpaste without xylitol[13]. This can be attributed to the remineralization capacity of human enamel surfaces by means of toothpastes with fluoride and xylitol[12], showing that it is an efficient association.

Utilization of xylitol in solutions associated or not to fluoride was also observed, and the results showed that xylitol isolatedly did not reduce the level of demineralization, yet such reduction was present when xylitol was associated to fluoride[14] Therefore, mouthrinses containing xylitol seem not to have anticariogenic effects over the dental plaque[25].

Further benefits were observed when xylitol was used in pills associated to fluoride and sorbitol, which yielded a reduction in the colonization of *S. mutans*, leading to a lesser amount of plaque and less carious lesions in the deciduous dentition. A reduction in the amount of *S. mutans* was also observed when xylitol pills were used in dummies[26].

The utilization of substances to avoid dental plaque formation and adhesion to the dental structure is of great importance for the maintenance of oral health. Within this context, xylitol has been playing an important role because of the following properties: non-fermentability by the cariogenic bacteria, ability to stimulate certain natural defenses of human beings[7], reduction in the amount of bacteria[9] and their adherence[27], which make it a cariostatic and anti-cariogenic agent[3].

Some disadvantages are reported, such as the high cost[28] and possible gastrointestinal alterations when consumed in high doses[1].

The utilization of xylitol as a sugar substitute has been mainly performed in chewing gums, with better results when chewed between meals[2,7] and no differences as to the total or partial substitution of sugar. The main advantages of the chewing gum include the great acceptability by children[29-30], extended period of contact with the teeth and saliva[2] and permanence below the critical pH for a very short period[16].

The reduction in dental plaque was quantitatively demonstrated through the utilization of xylitol chewing gums[6,27], which revealed a reduction of 40%[6], collaborating with the reduction in tooth decay[8] and prevention of periodontal disease[2]. Further, there was remineralization of incipient carious lesions[4,19,21].

Regarding the reduction in the levels of *S. mutans*, some studies demonstrated a positive effect of xylitol[4,27], differently

from another on which such reduction was not observed[11]. Some species of *S. mutans* may adapt themselves to xylitol; however, these are less pathogenic than those that metabolize the sucrose. The reduction in the amount of *S. mutans* and *Lactobacillus* occur either with the isolated utilization of xylitol[28] or in association with chlorhexidine[20].

The fluoride-xylitol complex demonstrated to be beneficial for caries prevention in the deciduous dentition, by means of the utilization of tablets with this complex in babies aged 8 to 16 months old, through the reduction in the amount of *S. mutans*[26,31].

Being fluoride an acknowledged relevant agent for caries prevention, several studies were conducted to compare it to the use of xylitol in toothpastes, which demonstrated the induction of cariostatic mechanisms[10] and provided an optimal concentration of available fluoride[32].

The three-year employment of a toothpaste containing fluoride and xylitol reduced the number of new restored surfaces, presenting to be better than the isolated use of fluoride[13].

When mouthrinses containing xylitol were used, a smaller reduction in salivary pH[3] was observed, however other studies demonstrated that xylitol was not able to reduce the level of demineralization[14] nor did it have any effects on the dental plaque[15].

In conclusion, xylitol can be presented in many forms such as chewing gums, tablets, mouthrinses, and associated to fluoride in toothpastes. Its anticariogenic power is due to the impairment of growth of cariogenic bacteria and consequent reduction in the acidity of plaque. Besides, it helps in the remineralization of initial carious lesions, is specific to *S. mutans*, well accepted by children and may be used with beneficial effects in all ages.

References

1. Bastos JRM, Heintze SD, Prado SV. Contribuição ao estudo da toxicologia do xilitol e do flúor. UFES Rev Odontol. 2000; 2: 78-84.
2. Mäkinen KK. Xilitol: um método de profilaxia das cáries para as novas gerações. Rev Bras Odontol. 1983; 40: 20-3.
3. Luís SL, Osório NM, Ribeiro S, Neves EM, Luís HS. Xilitol e flúor na prevenção da cárie dentária. Rev Port Estomatol. 2001; 42: 35-9.
4. Levine RS. Briefing paper: xylitol, caries and plaque. Br Dent J 1998; 185: 520.
5. Koparal E, Ertugrul F, Sabah E. Effect of chewing gum on plaque acidogenicity. J Clin Pediat Dent. 2000; 24: 129-32.
6. Mouton C, Scheinin A, Makinen KK. Effect of a xylitol chewing gum on plaque quantity and quality. Acta Odontol Scand. 1975; 33: 251-7.
7. Wheyne S. Xilitol - substituto para a sacarose na prevenção da cárie dentária: uma revisão. Rev Bras Odontol. 1980; 37:53-6.
8. Kandelman D, Gagnon G. A 24-month clinical study of incidence and progression of dental caries in relation to consuption of ghewing gum containing xylitol in school preventive programs. J Dent Res. 1990; 69: 1771-5.
9. Isogangas P, Makinen KK, Tiekso J, Alanen P. Long-term effect of xylitol chewing gum in the prevention of dental caries: a follow-up 5 years after termination of a prevention program. Caries Res. 1993; 27: 495-8.
10. Holgerson P, Stecksen-Blicks C, Sjostrom I, Twetman S. Effect of xylitol-containing chewing gums on interdental plaque-pH in habitual xylitol consumers. Acta Odontol Scand. 2005, 63:233-8.
11. Gonçalves BC, Uzeda M, Feitosa A. Avaliação de dentifrícios com xilitol e/ou flúor. RGO. 1993; 41: 267-70.
12. Smits MT, Arends J. Influence of xylitol and/or fluoride-containing toothpastes on the remineralization of surface softened enamel defects in vivo**.** Caries Res. 1985; 19: 528-35.
13. Sintes JL, Escalante C, Stewart B, McCool JJ, Garcia L, Volpe AR, et al..Enhanced anticaries efficacy of a 0.243% sodium fluoride / 10% xylitol / silica dentifrice: 3 year clinical results. Amer J of Dent 1995; 8: 231-5.
14. Amaechi BT, Higham SM, Edgar WM. Caries inhibiting and remineralizing effect of xylitol in vitro. J Oral Sci. 1999; 41: 71-6.
15. Giertsen N, Emberland H, Scheie AA. Effects of mouth rinses with xylitol and fluoride on the dental plaque and saliva. Caries Res 1999; 33: 23-31.
16. Castillo JL, Mijlgrom P, Coldwell SE, Castillo R, Lazo R. Children's acceptance of milk with xylitol or sorbitol for dental caries prevention. BMC Oral Health. 2005, 5:6.
17. Gaffar A, Blake-Haskins JC, Sullivan R, Simone A, Schmidt R, Saunders F. Cariostatic effects of xylitol/NaF dentifrice in vivo. Int Dent J 1998, 48: 32-9.
18. Gonçalves BC, Uzeda M, Feitosa A. Avaliação de dentifrícios com xilitol e/ou flúor. RGO. 1993, 41: 267-70.
19. Edgar WM. The benefits of using sugar-free chewing gum: a proven anti-caries efecct. Br Dent J. 1998, 184: 29-32.
20. Simons D, Kidd EA, Beighton D, Jones B. The effect of chlorhexidine/xylitol chewing-gum on cariogenic salivary microflora: a clinical trial in elderly patients. Caries Res. 1997, 31: 91-6.
21. Basso ML. Gomas de mascar y salud bucal. Rev Asoc Odontol Arg. 1995, 83: 59-68.
22. Andrade JP, Volschan BCG. A praticidade do uso de adoçantes alternativos. Rev Bras Odontol. 1998, 55: 40-4.
23. Kitchens DH. Xylitol in the prevention of oral diseases. Spec Care Dent. 2005, 25:140-4.
24. Alanen P, Hosti ML, Pienihäkkinen K. Sealants and xylitol chewing gum are equal in caries prevention. Acta Odontol Scand. 2000**,** 58: 279-84.
25. Aaltonen AS, Suhonen JT, Tenovuo J, Inkila-Saari I. Efficacy of a slow-release device containing fluoride, xylitol and sorbitol in prevention infant caries. Acta Odontol Scand. 2000, 58: 285-92.
26. Birked D. Cariologic aspects of xylitol and its use in chewing gum: A review. Acta Odontol Scand. 1994, 52: 116-27.
27. Autio JT, Courts FJ. Acceptance of xylitol chewing gum regimen by preschool children and teachers in Head Start program: a pilot study. Pediatr Dent. 2001, 23: 71-4.
28. Oliveira AGRC, Costa ICC, Silva PR, Moimaz SAS. Ação da goma de mascar com xilitol sobre o pH da placa bacteriana após ingestão de sobremesa à base de sacarose. Rev Pos Grad 1998, 5: 7-12.
29. Scheinin A, Bánóczy J. Xylitol and caries: the collaborative WHO oral disease preventive programme in Hungary. Int Dent J. 1985, 35: 50-7.
30. Grillaud M, Bandon D, Nancy J, Delbos Y, Vaysse F. The polyols in pediatric dentistry: advantages of xylitol. Arch Pediatr. 2005, 12:1180-6.
31. Bastos JRM. Prevenção primária-primária. RGO. 1996, 44:182.
32. Cury JA. Avaliação de um gel dentifrício contendo xilitol e flúor. Rev Bras Odontol. 1987, 64: 36-40.