The efficacy of xylitol based oral hygiene products on salivary parameters – An invivo study

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ABSTRACT

Xylitol, a five-carbon sugar polyol, is a white crystalline carbohydrate known since a century ago. The objective is to assess the efficacy of xylitol based oral hygiene products (chewing gum, mouthwash, and toothpaste) on salivary parameters - pH, Resting Salivary Flow Rate (RFR) and Stimulated Salivary Flow Rate (SFR) among subjects with medium cariogenic risk. The study recruited sixty participants who were divided into 3 groups of 20 individuals each. Subjects in Group I, Group II, Group III were given xylitol toothpaste, xylitol mouthwash & toothpaste, and xylitol chewing-gum & toothpaste respectively for 3 weeks. The salivary parameters - RFR, SFR, and pH were assessed before and after the use of xylitol-based products. All three groups showed an increase in the RFR, SFR, and pH after three weeks. RFR was found to be statistically significant in Group I (p=0.006), Group II (p=0.000), and Group III (p=0.000). SFR was found to be statistically significant in Group II (p=0.000) and Group III (p=0.000). pH was found to be statistically significant in Group I (p=0.002) and Group III (p=0.003). Xylitol is a well-known anti-caries agent, and it has been well documented in the prevention of caries. The present study was conducted in the light of these facts to compare the efficacy of different xylitol products concludes that chewing-gum is comparatively more effective than mouthwash and toothpaste.

INTRODUCTION

Dental caries is one of the common preventable oral diseases which is identified as the main etiology of toothache and edentulousness. It is one of the biggest public health oral illness which hampers the attainment and preservation of oral health in all age groups. Dental caries refers to the localized destruction of enamel by the production of acids from the bacterial agitation of carbohydrates. It is a long-standing disease that advances at a slow pace in most of the people, which results from an ecologi-
Biofilm imbalance in the equipoise between minerals in tooth and oral biofilms (Milgrom et al., 2009).

Saliva is one of the important intra-oral host factors that promotes caries development. Saliva is the compound mixture of intraoral fluids that spreads in the oral cavity and is secreted from major and minor salivary glands and non-glandular sources such as gingival crevicular fluids, oral microflora and host cells (Marghalani et al., 2017).

Many things in recent years have been developed the way oral hygiene care is given. Children who are free from caries in their early age, but by their adulthood, nearly 100% of them have suffered from dental diseases. If we look closely, traditional preventive practices such as tooth-brushing, inter-dental flossing, and fluoride dentifrices isn’t acting very well. This is where xylitol is a biggest game-changer than all the other conventional practices. Xylitol boosts the remineralization both by increasing the salivary flow rate and hampers the bacteria growth (Humphrey and Williamson, 2001).

Xylitol is a white crystalline carbohydrate known since a century ago. It has been widely researched in the last 45 years for its efficacy on dental decay. It is present naturally in fruit, vegetables, and berries and also artificially produced from xylan-rich plants such as birch and beechwood. Since research conducted in Turku, Finland, assessing the efficacy of xylitol on dental plaque reduction in 1970, xylitol has been widely researched and universally accepted as a natural sweetening agent which was approved by the US FDA and the American Academy of Pediatric Dentistry (Surdacka and Stopa, 2005).

Currently, more than 40 countries have accepted the use of xylitol in foods, pharmaceutical products, and oral hygiene products, mainly in chewing gums, dentifrices, mouthwashes, syrups, and confectioneries (Burt, 2006).

Hence, this study was conducted to assess the efficacy of different xylitol based oral hygiene products like xylitol toothpaste, mouthwash, and chewing gums on salivary parameters like salivary pH, Resting salivary flow rate (RFR) and Stimulated salivary flow rate (SFR).

**MATERIALS AND METHODS**

The present study is a clinical in-vivo study conducted among subjects visiting the dental college between the ages group of 18 – 25 years during the month of January – March 2019. The study was performed on 60 subjects based on convenience sampling method. Subjects who are willing to participate in the study and with medium cariogenic risk (not less than 4 decayed tooth) were included in the study, whereas subjects with a history of antibiotics usage, undergoing orthodontic treatment or with extensive intraoral prosthesis were excluded from the study. Ethical clearance was obtained from the Institutional Review Board of Coorg Institute of Dental Sciences, Virajpet (IRB/CIDS1185/2018) and written Informed consent was obtained from all the study subjects. The samples were equally divided into 3 groups of 20 individuals each.

**Figure 1: Digital pH Meter**

**Figure 2: collection of saliva samples**
weeks. They were also given xylitol toothpaste for daily use for 3 weeks Figure 4.

**Group III** - were given xylitol chewing gums and were instructed to chew 2 pieces, 3 times daily for 3 weeks. They were also given xylitol toothpaste for daily use for 3 weeks Figure 5.

The following salivary parameters RFR, SFR, & Salivary pH were assessed prior to the usage and after 3 weeks usage of xylitol-based products.

The RFR was measured by asking the subjects to rinse their mouths with water and to rest for 1 min. After swallowing their saliva they were given a piece of paraffin wax for chewing and then asked to spit the saliva at each 2 minutes in a graded tube for 5 minutes Figure 2.

The salivary pH was recorded by using digital saliva pH meter Figure 1.

**Statistical analysis**

Descriptive statistics were prepared using Microsoft excel 2007 version. The data obtained was coded and fed into the SPSS (Statistical Package for Social Sciences) version 17 for analysis. Categorical data were presented as numbers and percentages by using contingency tables and continuous data as mean and standard deviation. Data was analyzed using the Chi-square test. One way analysis of variance was used to compare the efficacy of xylitol based oral hygiene products between each groups. All statistical tests were performed at a 95% confidence interval. A p-value of less than 0.05 was considered statistically significant.

**RESULTS AND DISCUSSION**

Sixty subjects with a mean age of 22.03 and those who had medium cariogenic risk were recruited in the present study. They comprised of 34 males and 26 females (Table 1) in which 10 males and 10 females were distributed in Group 1, whereas 11 males and 09 females were distributed in Group 2, and 13 males and 07 females were distributed in Group 3.

**Comparision of salivary parameters before and**
Table 1: Distribution of study subjects based on gender

| Gender   | Frequency (%) |
|----------|---------------|
| Group 1  |               |
| Males    | 10 (50%)      |
| Females  | 10 (50%)      |
| Group 2  |               |
| Males    | 11 (55%)      |
| Females  | 09 (45%)      |
| Group 3  |               |
| Males    | 13 (65%)      |
| Females  | 07 (35%)      |
| Total    |               |
| Males    | 34 (56.7%)    |
| Females  | 26 (43.3%)    |

Table 2: Comparison of salivary parameters before and after the use of XYLITOL Tooth paste

| Group 1 | Mean   | Standard deviation | T value | Significant (2-Tailed) |
|---------|--------|--------------------|---------|------------------------|
| RFR Pre | 0.70   | 0.191              | 3.114   | 0.006*                 |
| Post    | 0.84   | 0.305              |         |                        |
| SFR Pre | 1.36   | 0.334              | 1.704   | 0.105                  |
| Post    | 1.45   | 0.374              |         |                        |
| pH Pre  | 6.24   | 0.239              | 3.609   | 0.002*                 |
| Post    | 6.43   | 0.227              |         |                        |

Table 3: Comparison of salivary parameters before and after the use of XYLITOL mouth wash

| Group 2 | Mean   | Standard deviation | T value | Significant (2-Tailed) |
|---------|--------|--------------------|---------|------------------------|
| RFR Pre | 0.68   | 0.218              | 6.381   | .000**                 |
| Post    | 0.83   | 0.260              |         |                        |
| SFR Pre | 1.29   | 0.256              | 6.691   | .000**                 |
| Post    | 1.54   | 0.306              |         |                        |
| pH Pre  | 6.10   | 0.176              | 1.584   | .130                   |
| Post    | 6.17   | 0.209              |         |                        |

Table 4: Comparison of salivary parameters before and after the use of XYLITOL chewing gum

| Group 3 | Mean   | Standard deviation | T value | Significant (2-Tailed) |
|---------|--------|--------------------|---------|------------------------|
| RFR Pre | .74    | .296               | 5.819   | .000**                 |
| Post    | .91    | .271               |         |                        |
| SFR Pre | 1.41   | .416               | 5.299   | .000**                 |
| Post    | 1.62   | .319               |         |                        |
| pH Pre  | 6.21   | .393               | 3.404   | .003*                  |
| Post    | 6.36   | .274               |         |                        |

after the use of xylitol tooth paste

The mean RFR before and after the use of xylitol toothpaste were found to be 0.70 ml and 0.84 ml, respectively. The mean SFR before and after the use of xylitol toothpaste were found to be 1.36 ml and 1.45 ml, respectively. The mean pH before and after the use of xylitol toothpaste were found to be 6.24 and 6.43, respectively.

Comparison of salivary parameters before and after the use of xylitol toothpaste for 3 weeks showed that RFR (p = 0.006) and pH (p = 0.002) were found to be statistically significant; whereas SFR (p = 0.105) was found to be statistically non-significant (Table 2 & Graph 1).

Comparison of salivary parameters before and after the use of xylitol mouthwash

The mean RFR before and after the use of xylitol mouthwash were found to be 0.68 ml and 0.83 ml,
Comparision of salivary parameters before and after the use of xylitol toothpaste and xylitol chewing gum for 3 weeks showed that RFR (p = 0.000) and SFR (p = 0.000) were found to be statistically highly significant; whereas pH (p = 0.003) was found to be statistically significant (Table 4 & Graph 3).

The key role of fermentable sugars in the cause of dental caries has been well documented. Xylitol enhances mineralization by increasing the salivary flow (Giertsen et al., 1999). Hence this study was conducted to assess the efficacy of different xylitol oral hygiene products (chewing gums, xylitol mouthwash, and xylitol chewing gums) on the salivary parameters (pH, RFR, SFR) for a period of 3 weeks.

Xylitol toothpaste were given to all the participants of all three group in order to maintain the uniformity of tooth brushing with the same toothpaste among the study participants.

In the present study, male participants were more – 34 (56.7%) compared to females – 26 (43.3%) which is in accordance with the study conducted by (Llop et al., 2010) in Spain, wherein majority were males (53%) compared to females (47%).

In the present study, the mean RFR, SFR, and pH increased after the use of xylitol toothpaste (Group I), which is in accordance with a study conducted by (Pancu et al., 2017) in Romania, wherein the mean RFR increased from 0.5 ml to 1.15 ml, SFR increased from 0.85 ml to 1.17 ml, and pH increased from 6.48 to 6.73.

In the present study, it was found that mean RFR, SFR, and pH levels increased after the use of xylitol mouth wash. The results are in accordance with (Jaidka et al., 2015) in Uttar Pradesh, wherein the mean RFR increased from 0.74 ml to 0.96 ml, SFR increased from 1.36 ml to 1.65 ml, and the pH increased from 6.54 to 6.88. However, the results are in contrast with the study by (Giertsen et al., 1999) in Norway, wherein they have stated that there were no statistically significant differences in mean unstimulated, paraffin-stimulated salivary flow rates and pH levels after the use of xylitol mouth rinse.

In the present study, it was found that mean RFR, SFR, and pH levels increased after the use of xylitol chewing gum.
chewing gum. The results are in accordance with a study by (Fraga et al., 2010) in Brazil, wherein the RFR increased from 0.96 ml to 1.24 ml, SFR increased from 1.60 ml to 1.86 ml, and the pH level increased from 7.02 to 7.65.

Xylitol chewing gum showed better results, wherein RFR (p=0.000), SFR (p=0.000) and pH (p=0.003) values were found to be statistically significant when compared to the subjects who used xylitol mouthwash and xylitol toothpaste. The results are in accordance with (Söderling, 2009; Isokangas et al., 2000; Tanzer et al., 2006; Alenén et al., 2000; Fraga et al., 2010) wherein they have shown that chewing a xylitol-sweetened chewing gum increases the salivary flow rate thereby reduces the levels of S. mutans in saliva. The results are also in accordance with a review by (Honkala et al., 2006) wherein chewing gum containing xylitol produces the best results in terms of the salivary parameters such as salivary flow, pH, and low Mutans streptococcus counts in saliva. The results are in contrast with (Llop et al., 2010) in Spain, where they have stated that no statistically significant differences were observed between the salivary flow rate in baseline conditions and after chewing xylitol-sweetened chewing gums.

Oral hygiene products containing non-cariogenic sweeteners causes the pH to rise after eating carbohydrates due to the stimulation of salivary flow, with a resulting increase in bicarbonate levels as reported by Edgar et al., (2014) and this also leads to a reduction in the incidence of caries as reported by (Scheinin et al., 1975).

Wang et al., (2016) and Mäkinen (2016) in their reviews reported milder diarrhoea and flatulence in study subjects. In the present study, no stains or irritated gingival tissue was observed on the teeth at any of the follow-up periods in either of the Toothpaste, Mouth wash, and Chewing gum group. Diarrhoea was also not reported in any of the subjects in all three groups.

Even in a short period of time (3 weeks), which is the limitation of this study, these xylitol based oral hygiene products proved to be effective as observed in the results achieved. Although the results of the present study are promising, a longer follow-up is required for this type of preventive procedure in high-risk caries subjects who are at the initial stage of caries development.

Despite the literature data related to xylitol, new researches, and further studies are needed to determine the efficacy of xylitol on salivary parameters, its optimal dosage, and the daily frequency supply for effective action against cariogenic bacteria as well as the administration ways and its adverse effects.

**CONCLUSIONS**

Xylitol is a well-known anti-caries agent, and it has been well documented in the prevention of caries. The present study was conducted in the light of these facts to compare the efficacy of different xylitol products concludes that chewing-gum is comparatively more effective than mouthwash and toothpaste. Considering convenience and affordability for the subjects, chewing-gum may not always be preferred, and in that case, mouthwash or toothpaste can be used for the promotion of better oral health.

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