



## Effect of Different Sugar Free Flavoured Chewing Gums on Salivary pH- a Double Blinded, Parallel Arm Randomized Clinical Trial

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### Authors' contributions

This work was carried out in collaboration between all authors. Authors SNM and GMP designed the study and wrote the protocol. Authors PGNK and VHS supervised and coordinated the work. Authors MI and RR assembled the data and performed statistical analysis. Author SNM wrote the first draft of the manuscript. Author GMP managed the literature searches and edited the manuscript. All authors read and approved the final manuscript.

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### ABSTRACT

**Aim:** To evaluate and compare the effect of four different sugar free chewing-gums on salivary pH at 0, 10, 20, 30 minutes.

**Study Design:** Double blinded, parallel arm Randomized Clinical Trial.

**Place and Duration of the Study:** Department of Public Health Dentistry, College Of Dental Sciences, Davangere, India. Jan-Feb 2015.

**Methodology:** Forty healthy dental students, aged 21 -25 years, mean age- 20.3 years were randomly allocated into 4 different study groups: Licorice group, Ginger group, Cinnamon group, and Xylitol group. Unstimulated saliva was collected from the participants at baseline, following which the participants were given respective gums to chew and the subsequent salivary samples were collected at intervals of 10, 20 & 30 minutes and pH was analyzed using pH meter. Statistical analysis was done using repeated measures ANOVA and One way ANOVA followed by Tukey's post-hoc test.

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**Results:** Intergroup comparison showed, statistically significant difference between the groups at ten minutes ( $P=0.025$ ), twenty minutes ( $P=0.004$ ) and thirty minutes ( $P=0.001$ ). At the end of thirty minutes, Ginger group showed maximum increase in salivary pH followed by Xylitol. When intragroup analysis was done, there was statistically significant difference in Licorice ( $P=0.033$ ), Cinnamon ( $P=0.034$ ) and Xylitol group ( $P=0.041$ ) at different time intervals.

**Conclusion:** The above results showed that, Ginger flavoured gum followed by Xylitol gum significantly increases salivary pH, as a means of caries prevention; it can be a good way to promote dental health. Hence, it can be suggested that the ginger flavoured gums can be advised in the subjects who are more susceptible to salivary pH fall and dental caries.

*Keywords: Chewing gum; cinnamon; flavours; ginger; licorice; salivary pH; sugar free; Xylitol.*

## 1. INTRODUCTION

Saliva, an important component of oral cavity is essential for maintaining oral and dental health [1]. Stimulation of saliva increases its flow rate which in turn increases the level of bicarbonate ions in the oral cavity, which results in increase of the salivary pH and plaque pH [2] with enhanced buffering capacity, which in turn prevents enamel demineralization and promotes remineralization [3]. Chewing the gums is a common habit in many countries and a belief exists among the general public that, like fibrous foods, chewing gums also has a cleansing effect on teeth and gingiva [4].

Chewing sugar free gum is one of the convenient ways to increase salivary flow and is promoted as an oral health care aid [1,5]. It has been claimed to remove food debris and plaque from the teeth [6]. Chewing sugar free gums would be beneficial as it is devoid of sucrose. The salivary flow is increased through a combination of gustatory and mechanical stimulation [5]. They have been studied and used as a delivery vehicle for a host of dental substances that could potentially provide direct oral care benefits [7], such as chlorhexidine (CHX), fluoride and polyol sweeteners, as well as medicinal substances, such as nicotine, methadone, aspirin, antifungal agent, caffeine and vitamins [2]. It has been proved that differences in individuals preference of chewing different flavoured gums is one of the important factor and gum selection can influence on long term compliance [5,8]. There is dearth of information on the effect of different flavoured chewing gums and its effect on whole mouth Salivary Flow Rate (SFR) and pH in healthy individuals [5]. Salivary pH increases but unlike the flow, it remains elevated upto 15-20 min after stimulation [1]. Therefore sugar free gums might be beneficial in preventing the shift of salivary pH towards acidity. Hence the aim of this study was to assess the effect of different flavoured sugar free chewing gums on salivary pH.

## 2. MATERIALS AND METHODS

### 2.1 Subjects and Study Design

A single-center double-blinded parallel group randomized clinical trial was conducted in 40 healthy dental students of College Of Dental Sciences, Davangere (17 males, 23 females) with mean age of 20.3 years.

Participants who were free from any systemic disease, non-smokers and DMFT less than 3, formed the criteria for inclusion whereas, subjects suffering from any oral and dental disease, taking any medication which may likely to interfere with salivation, allergies to gum ingredients and wearing any intra oral appliance were excluded from the study. The subjects who fulfilled the inclusion and exclusion criteria were selected for the study.

The study was approved by Ethics committee of College of Dental Sciences, Davangere. A voluntary written informed consent was obtained from all the participants. Pilot study was conducted on 12 subjects to test the feasibility of the study. These subjects were not included in the main study. Sample size estimation was done from the results of the pilot study. The power of the study was 80%.

### 2.2 Chewing Gum

The different flavours of chewing gums used in the study were Licorice, Ginger and Cinnamon (Simply gum 100%, Natural chewing gum; New York, NY). Xylitol gum (Miradent 100% Xylitol dental health chewing gum: Hager Pharma) was used as a control. The gums were similar in size, shape, volume and weight which were purchased from the local store each weighing approximately 2.4 grams. They were wrapped in a foil to ensure blinding. Also, the examiner was blinded regarding the allocation of subjects to the test groups.

### 2.3 Study Protocol, Saliva Collection and pH Measurements

The subjects were instructed to refrain themselves from eating, drinking or chewing the gum for at least 1 hour prior to the saliva collection. They were seated comfortably and allowed to relax during the experiment. In order to avoid any confounding effects of circadian rhythm in salivary flow rate, saliva collections were performed at the same time for 4 consecutive days (9-11 am) for four different groups. Unstimulated and gum stimulated whole mouth saliva were collected from each participant. Before chewing any gum, unstimulated saliva was collected from each participant. After 5 minutes, while few participants still continued to collect only unstimulated saliva, others were asked to start chewing the gums at their own natural chewing frequency. A stop watch was used for every participant in order to control the chewing time. The whole mouth gum stimulated saliva was collected at the intervals of 10, 20 and 30 minutes in separate containers.

Saliva was collected in a disposable container using spitting method (Fig. 1). The pH of saliva was measured immediately after saliva collection in order to minimize any time based pH changes (Fig. 2) using a calibrated pH meter (Eutech instruments, Cole Parmer India). pH meter was calibrated before each use with a standard buffer solution. The pH was recorded to two decimal places. The study design is illustrated in Fig. 3.



Fig. 1. Saliva collection using spitting method



Fig. 2. Measuring saliva pH using calibrated pH meter

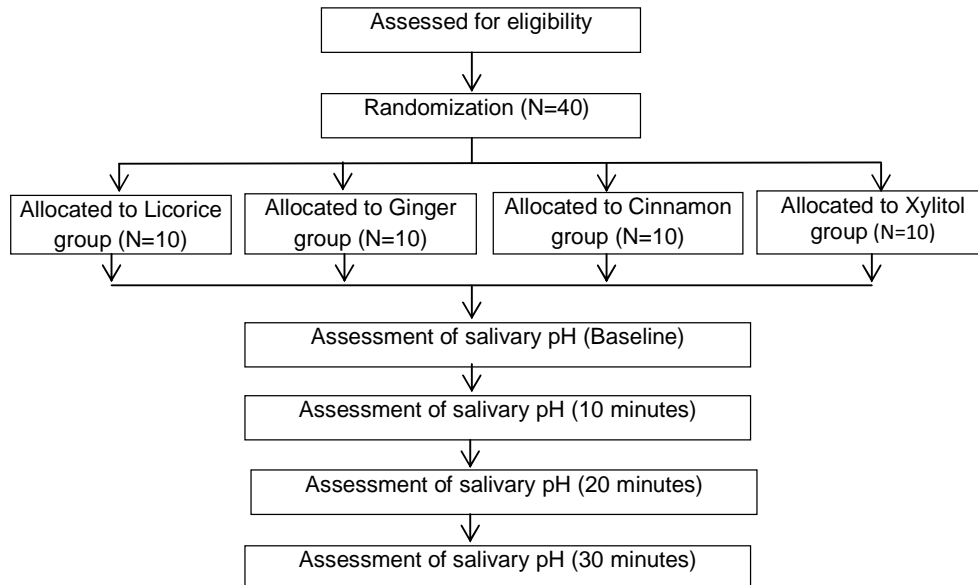


Fig. 3. Flow diagram of study design (CONSORT 2010)

## 2.4 Statistical Analysis

Data was compiled and statistically analyzed using SPSS windows version 16.0 (SPSS, Inc., Chicago, IL, USA). The results for the various groups were subjected to analysis using one way ANOVA and repeated measures ANOVA followed by Tukey's post-hoc test ( $p \leq 0.05$  was considered statistically significant).

## 3. RESULTS AND DISCUSSION

All the participants completed the trial and had good compliance. At baseline there was no statistically significant difference ( $p=0.207$ ) in pH of unstimulated saliva in between different groups. At the end of 10 minutes, Xylitol gum and Ginger gum showed increase in salivary pH and the difference was statistically significant ( $p=0.025$ ). As the time elapsed, at the end of 20 and 30 minutes, maximum increase in salivary pH was seen in Ginger group followed by Xylitol group. However, in Cinnamon and Licorice group there was a fall in pH below the baseline values (Table 1 and Fig. 4).

The greatest success so far has been in the chewing gum market; there is no doubt that chewing sugar free gum benefits dental health [9]. The benefit of easy availability, universal acceptability and well tolerance of these four gums, made us to select them for the study. In this study, four different sugar free gums were compared with regard to the effect on salivary pH. The present study showed no significant difference in salivary pH between the gums at baseline. The study results were in agreement with a previous study conducted on other gums done by Karami et al. [5].

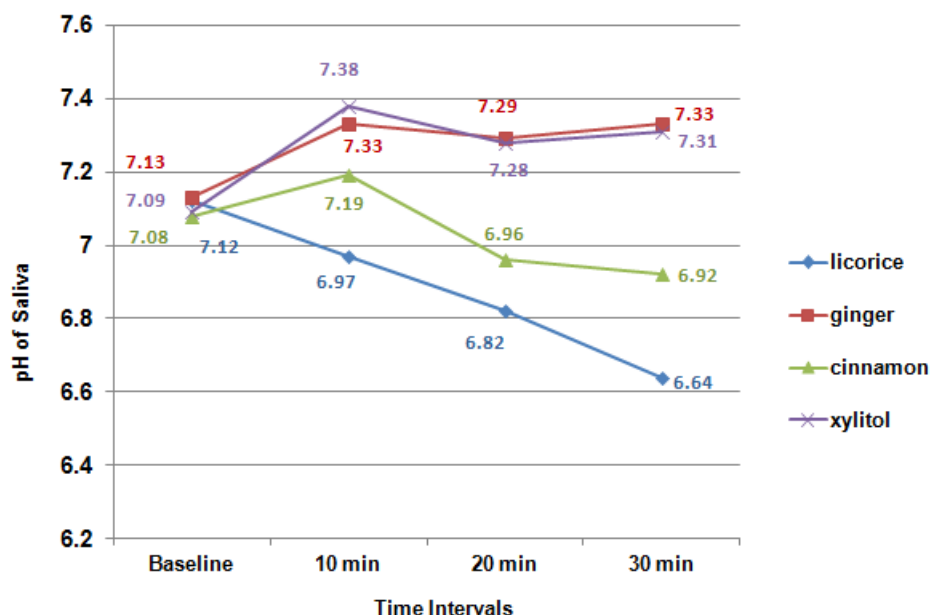
In the present study, with Licorice gum, the salivary pH showed a shift towards acidity

consistently throughout the 30 minutes study period. The pH shift was in fact lesser than the baseline. The reason for this might be due to the presence of glycyrrhizic acid which is an extract of glycyrrhiza (licorice) which has contributed in its pH drop. Similar results were observed in a study done by Toors and Herczog [10] in which the interdental plaque pH showed a critical drop after consumption of experimental licorice and is evidenced to be relatively well fermentable by both *S. mutans* and plaque saliva mixture. Another study by Nidal et al. [11] investigated the effect of grape juice and licorice juice on salivary pharmacokinetics of paracetamol which reported that licorice consumption did not produce any significant changes in parameters tested, which may be somehow attributed to the present study results of licorice. On the other hand, the present study results of licorice was in contrast with the a study done by Eesha Jain et al. [12] which reported that licorice extracts showed antimicrobial efficacy and contributed to a rise in the pH of saliva.

Ginger (*Zingiber officinale*) has been used for medicinal purposes since antiquity [13]. In the present study chewing of ginger gums contributed to increase in salivary pH at the end of 20 and 30 minutes when compared with other gums. The reason for this might be due to different herbal constituents of ginger (gingerol and shagelol). A similar study done by Chamani et al. [14] to evaluate the effect of seven different herbal extracts on rate of salivation in rats confirmed that the rate of salivation increased significantly in response to injection of *Zingiber officinale* (ginger). However, the literature hardly contains any study that analyses the salivary pH using ginger flavoured gums. So the discussion on this point is limited and focusses primarily on the results of the trial.

**Table 1. Mean salivary pH (Mean  $\pm$ SD) of different chewing gums (Licorice, Ginger, Cinnamon and Xylitol gums) are shown at baseline, 10, 20, 30 minutes**

	Groups				Tukey's Post Hoc	
	I Licorice	II Ginger	III Cinnamon	IV Xylitol	p value	
Mean baseline (1)	7.12 $\pm$ 0.48	7.13 $\pm$ 0.35	7.08 $\pm$ 0.28	7.09 $\pm$ 0.32	0.207	I = II = III = IV
Mean 10 min (2)	6.97 $\pm$ 0.18	7.33 $\pm$ 0.40	7.19 $\pm$ 0.38	7.38 $\pm$ 0.18	0.025	I < III < II < IV
Mean 20 min (3)	6.82 $\pm$ 0.25	7.29 $\pm$ 0.41	6.96 $\pm$ 0.38	7.28 $\pm$ 0.19	0.004	I < III < IV < II
Mean 30 min (4)	6.64 $\pm$ 0.43	7.33 $\pm$ 0.35	6.92 $\pm$ 0.44	7.31 $\pm$ 0.28	0.001	I < III < IV < II
p value	0.033	0.088	0.034	0.041		
Pair wise comparison	4>3>2>1	1=2=3=4	2>3,4	2>1,3,4		



**Fig. 4. Changes in mean salivary pH (Mean ± SD) before and after receiving the sugar free flavored chewing gums**

For Cinnamon gum, there was a rise in pH of saliva only at 10 minutes interval which later showed gradual drop in salivary pH as the time elapsed. These results were in contrast with the study carried out by Karami Nogourani et al. [5] which reported increase in salivary pH value with the use of cinnamon gum compared with other gums.

Xylitol gum in the present study showed an increase in salivary pH at 10 minutes and at 30 minutes, which was second only to ginger gum. A study by Kumar et al. [15] reported that sugarfree (xylitol) chewing gum showed a marked increase in the pH of saliva and plaque when compared to their counterparts which are similar to the results of present study.

#### 4. CONCLUSION

The use of sugar free gum has a longer period of exposure to the surface of teeth than a dentifrice or mouth rinse; hence it can be a useful adjunct for maintaining oral health. The present study was done to know the effect of different flavoured sugar free chewing gums on salivary pH. The study results have shown that Ginger flavoured gum significantly increases salivary pH. As a means of caries prevention, ginger chewing gum has been substantiated to be a good way to promote dental health. Furthermore, exploration

of these synergistic effects of sugar-free chewing gum, together with the specific benefits of xylitol, may offer hope in era of caries prevention.

#### 5. RECOMMENDATIONS

Ginger flavoured gums can be advised in the subjects who are more susceptible to salivary pH fall and dental caries along with an added benefit of ginger as a herbal remedy for motion sickness, to reduce nausea and emesis caused by pregnancy.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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