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The effect of chewing gum's flavor on salivary flow rate and pH

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ABSTRACT

Background: Chewing sugar-free gums is a convenient way to increase salivary flow. Salivary flow increases in response to both gustatory (taste) and mechanical (chewing) stimuli, and chewing gum can provide both of these stimuli. The aim of this study was to compare the effect of five different flavors of sugar-free chewing gum on the salivary flow rate (SFR) and pH.

Materials and Methods: Fifteen dental students volunteered at the same time on six consecutive days, to collect one minute unstimulated saliva. After five minutes, while some volunteers continued to collect only unstimulated saliva, the others asked to start chewing one of the five flavored gums randomly. The flavors were spearmint, cinnamon, watermelon, strawberry, and apple. The whole saliva was collected over time periods of 0 – 1, 1 – 3, and 3 – 6 minutes, and the SFR and pH were also measured. The data were subjected to pair *t*-test, repeated-measures analysis of variance, and Duncan tests.

Results: Compared to the unstimulated rate, all five different flavored gums significantly increased the SFR within six minutes. Although the flow rate peaked during the first minute of stimulation with all five products, it reduced gradually, but still remained above the unstimulated saliva, after six minutes. In the first minute, the strawberry-flavored gums showed the highest weight, yet, it only induced a significantly higher SFR compared to the cinnamon-flavored gums. During one to three minutes, strawberry and apple-flavored gums showed significantly higher SFR, respectively, compared to cinnamon-flavored gums. There were no significant differences in the flow rates elicited by each flavored gum through the three-to-six minute interval, although the spearmint-flavored gums induced slightly higher SFR. Only the spearmint and cinnamon-flavored gum significantly increased the salivary pH.

Conclusion: Gum flavor can affect the SFR and special flavors may be advised for different individuals according to their oral conditions.

Key Words: Chewing gum, flavor, pH, salivary flow rate

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INTRODUCTION

Hyposalivation is defined as a diminished salivary flow and may lead to xerostomia, which refers to a subjective experience of mouth dryness.[1] Usually when resting (unstimulatory), the salivary flow rate (SFR) decreases to half of its normal values (0.30 ml/minute), and an individual will begin to experience xerostomia.[2] Approximately 20% of the general population complains of dry mouth or symptoms associated with xerostomia during their life,[3] which include cheilosis, glossopyrosis, glossodynia, thirst, dysphagia, dysphonia, and problems with mastication.[4] Chewing sugar-free gums is a convenient way to increase salivary flow. Salivary flow increases in response to both gustatory (taste) and mechanical (chewing) stimuli, and chewing gum can provide both of these stimuli.[5] It has been shown that on chewing flavored gum, the SFR increases initially, but declines as the flavor is lost from the

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gum, and as the gum softens with chewing.[6,7] After approximately 20 to 30 minutes of chewing, the SFR slows to a level around two to three times the resting rate.[6] In addition to stimulating the salivary flow, gum chewing raises salivary and plaque pH and promotes enamel remineralization, but unlike the flow, the salivary pH remains elevated after a 15 to 20 minute stimulation.[5,6,8-10] Nowadays, many kinds of chewing gum, with different flavors, shapes, and commercial packages are available, and are selected according to personal taste. It has been seen that chewing gum taste is an important factor in an individual's preference and gum selection, and can influence long-term compliance.[11] The aim of the present study is to compare the effect of different flavors of sugar-free gum on the salivary flow rate and pH.

MATERIALS AND METHODS

The design of the study was approved by the Faculty of Dentistry Ethics Committee of Islamic Azad University, Khurasgan Branch, Isfahan, Iran (No. 23810201872011); all the subjects signed the consent forms and the research was conducted in full accordance with the World Medical Association Declaration of Helsinki.

Fifteen volunteer dental students (seven males and six females, of age 20.3 (±1.4) years) participated in this cross-over clinical study. The participants were in good general health and oral hygiene, with normal chewing ability and had no evidence of dry mouth or salivary gland disorders. Neither took any medications nor wore any intraoral appliances, and did not smoke. The participants were asked not to eat, drink, or chew gum for at least one hour prior to the saliva collection time.

The five flavored chewing gums were spearmint, cinnamon, watermelon, strawberry, and apple (Orbit, Wrigley Poland Sp. z o.o, Poznan, Poland). Each pellet weighed 1.4 g. In order to avoid the possible confounding effects of circadian rhythms in the SFR, the study was performed at the same time on six consecutive days (9–11 a.m.).[12] In each session before chewing any gum, one-minute unstimulated saliva was collected. After five minutes, while some volunteers still continued to collect only unstimulated saliva, the other participants were asked to start chewing one pellet of the five flavored gums, at their natural chewing frequency. The whole saliva was collected over time periods of 0 – 1, 1 – 3, and 3 – 6 minutes in separate containers. For each subject, the order in which the five flavored gums were used was randomized, so every participant, over the six days, chewed all five flavors and collected his/her whole unstimulated saliva over the same time periods.

To calculate the weight of the saliva, the containers were weighed before and after gathering saliva, using digital scales, with a precision of 0.01 g (Escali Y01-ESCL125, eGeneral Medical Inc., Raleigh NC, USA), and converted to flow rate per minute. The pH of the sampled saliva was also measured before and after chewing gum. The pH was measured immediately after saliva collection in order to minimize any time-based pH changes, using a calibrated pH meter (Corning-450, Corning NY, USA). The electrode was placed in the sample and the pH recorded to two decimal places.

For statistical data analysis, the unstimulated salivary flow and pH data were analyzed with a paired *t*-test. Stimulated flow and pH data were compared with the corresponding data for unstimulated saliva, by one-way analysis of variance (ANOVA). The Duncan New Multiple Range test was employed to determine whether or not there were significant differences in the flow rate.

RESULTS

The comparison of mean unstimulated salivary weight and pH in the participants, in a six-day period of study showed no significant differences between the groups (*P* value=0.495 for a SFR and *P*=0.844 for salivary pH), indicating that a significant salivary flow and pH, which is described herewith, is directly associated with the effects of chewing gum [Table 1].

The results for unstimulated and stimulated salivary flows, with different flavors of gum, are shown in [Figure 1].

Table 1: Mean salivary weight and pH before stimulation

Group	Mean salivary weight before stimulation (gr) (Mean±SD)	Mean salivary pH beforestimulation (gr) (Mean±SD)
Cinnamon	0.79 (±0.33)	6.20 (±0.52)
Spearmint	0.85 (±0.35)	6.40 (±0.47)
Strawberry	0.78 (±0.45)	6.16 (±0.67)
Watermelon	0.88 (±0.39)	6.16 (±0.55)
Apple	0.71 (±0.33)	6.23 (±0.70)
No gum	0.63 (±0.36)	6.11 (±0.76)

All five flavored gums significantly increased salivary secretion and pH. With respect to salivary weight, the mean SFR for the initial one minute collection showed significant differences between the six groups (P<0.001). Among these, the strawberry-flavored gum showed the highest weight (approximately 7.5-fold to unstimulated salivary weight); the apple-, watermelon-, spearmint-, and cinnamon-flavored gums followed, respectively. The Duncan test revealed that the strawberry-flavored gum only induced significantly higher SFR compared to the cinnamon-flavored gum, but not with other flavored gums.

The comparison of salivary weight changes in the 1–3 minute and 3–6 minute periods after chewing gum, showed significant differences between the groups (P<0.001). During 1–3 minutes, the strawberry and apple-flavored gums showed only significantly higher SFR compared to the cinnamon-flavored gum. There were no significant differences in the flow rates elicited by each flavored gum in the third-to-sixth minute interval, although the spearmint- and strawberry-flavored gums induced higher and lower SFR, respectively.

On the other hand, SFR in the first minute of chewing the gums showed significant differences from the SFR collected in the 1–3 and 3–6 minute periods after chewing (P<0.001) them. The average SFR (SFR: Weight/minute) in the first minute after chewing gum was two-folds greater than the mean SFR in 1–3 minutes and 2.5–3 folds greater than the mean SFR in 3–6 minutes, so the peak SFR achieved in the first minute after stimulation by chewing gum, fell slightly with time, to levels which were still significantly above the unstimulated salivary rate.

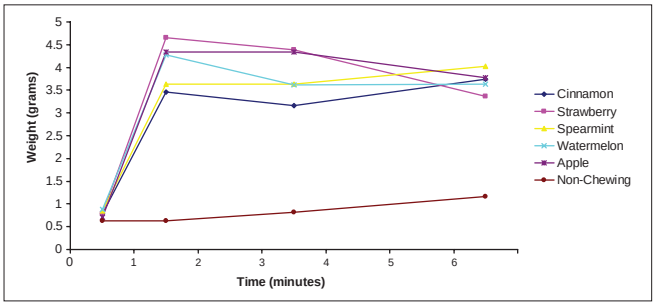

Figure 1: Mean salivary weight after chewing different flavored gums compared to non-chewing gum salivary weight in the first, 1–3 minute and 3–6 minute periods

Even though all different flavored chewing gums increased the salivary pH, only with cinnamon and spearmint-flavored gums, the pH values increased significantly (P<0.001) [Table 2].

Moreover, comparison between the five gum groups, according to the pH changes after chewing gum, showed a significant difference between all groups (P<0.001), via the significant difference between the cinnamon and spearmint, compared to apple-, strawberry-, and watermelon-flavored gums.

DISCUSSION

In this study we compared five different sugar-free chewing gum flavors (cinnamon, spearmint, strawberry, watermelon, and apple) with regard to the effects on the SFR and pH. All tasted gums stimulated the SFR significantly during the first, 1 – 3, and 3 – 6 minute intervals, even though a significant progressive decline of the flow rate was observed [Figure 1]. A progressive fall in flow rate, with time, has been shown in the previous studies.[5-7,11,12] Bots has hypothesized that the initial increase in flow rate is probably induced by the gustatory stimulus by chewing gums; however, during the continued chewing of gums, the loss of flavor and also softening and size reduction of the gum, can lead to a reduced stimulation of periodontal mechanoreceptors, which may contribute to the decrease in flow rate.[11] Adaptation to the tastants, reduction in the frequency or intensity of chewing, and a reduction in the secretory capacity of salivary glands with time, may also play a role.[6]

Dawes explained a flow rate peak at about 6 ml/minute in the first minute of chewing gum.[3] The salivary flow peak in our study reached to 4.65 g/minute (assuming 4.65 ml/minute) for strawberry-flavored gum, even though for spearmint- and cinnamon-flavored gums this amount was lower (3.63 and 3.46 ml/minute, respectively). It should be pointed out that in this study, the measurement of the salivary rate was reported in

Table 2: PH differences before and after chewing gum

Groups	Cinnamon	Spearmint	Strawberry	Watermelon	Apple
Mean pH before chewing gum	6.20	6.40	6.16	6.16	6.23
Mean pH after chewing gum	7.40	7.51	6.30	6.50	6.26
P value	0.000	0.000	0.710	0.319	0.890

weight/minute, but according to Bots' article.[11] the results were reported in milliliter/minute. Our findings were more consistent with the values achieved by Polland and Anderson.[5,13] It could be attributed to the variant size of gum pellets used in different studies; Rosenhek *et al*. showed that both the tastant in the gum and the size of the bolus chewed were significant factors in determining the SFR, and the peak SFR was four times the mean unstimulated rate of salivary flow for 1 g of gum base, while a 13-fold increase was observed with 9 g of chewing gum.[7]

Although Dawes demonstrated very little difference in variant flavored chewing gums and the ability to stimulation of flow,[6] and Bots suggested that stimulation flow rate by chewing gum is not related to differences in gum taste, size, shape, or weight,[11] we found a significant higher stimulation of SFR with chewing strawberry-flavored gum compared to cinnamon-flavored gum (7.4-folds to unstimulated salivary flow in the first minute). Jensen *et al*. too demonstrated 8% higher stimulated and SFR in the peppermint-positive gum group than in the peppermint-negative gum group, and suggested that nasal chemosensory afferents play a role in the salivary reflexes.[14] Moreover, Shannon and Frome reported that in five subjects, a cinnamon-flavored gum elicited more saliva than the one flavored by peppermint.[15]

On the other hand, although all different flavored chewing gum increased salivary pH, these values were significant only with cinnamon- and spearmint-flavored gums. The increase in salivary pH on stimulation was due to the increase in bicarbonate concentration, which was proportional to the flow rate.[16] Our findings were consistent with the results of other studies,[5,6,12,13] which had evaluated mint or cinnamon-flavored gums. Ingredient comparison of five flavored gums used in this study, demonstrated that fruit-flavored, but not spearmint and cinnamon-flavored gums, contained citric and maleic acids, which could be responsible for less pH increase after chewing these fruity gums; as Dawes found a transient decrease in salivary pH in one subject who chewed a test gum containing 1.5% citric and tartaric acids.[6]

On the other hand, the presence of these two acids in fruity gums can lead to more salivary secretion after chewing these gums, compared to cinnamon- and spearmint-flavored gums.

Several investigators suggested the clinical use of sugar-free chewing gums for the relief of patients with xerostomia/hyposalivation.[17-19] Although all chewing gums investigated in our study stimulated the SFR significantly, the strawberry-flavored gum showed the highest weight (approximately 7.5-fold) compared with the unstimulated salivary weight in the first minute; apple- and watermelon-flavored gum followed it, respectively. Moreover, at the end of six minutes after chewing strawberry-flavored gum, the mean SFR was yet 3.1 times greater than the unstimulatory flow rate. Thus, it could be suggested that in patients with xerostomia/hyposalivation, strawberry, apple, and watermelon-flavored gums could be advised for use, because they helped in more stimulation of salivary secretion. On the other hand, in patients who were more susceptible to pH fall and dental caries, the use of spearmint and cinnamon-flavored gums, which could raise the salivary pH significantly, was advisable.

CONCLUSION

A gum's taste can affect the SFR and pH, and the highest increase in SFR was observed in the first minute of chewing gum, in relation to strawberry-flavored gum. The highest enhancement in chewing stimulated salivary pH was observed in cinnamon- and spearmint-flavored gums.

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