Original Research

Comparison of the Effect of Natural Turpentine and Synthetic Sugar Free Gums on Dental Plaque pH Recovery

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Abstract

Introduction: Many different kinds of chewing gum can increase the flow of saliva, and they have been proven to have anti-bacterial effects as well. The aim of this study was to compare the effect of natural turpentine and synthetic sugar-free gums on dental plaque pH after a sucrose challenge. **Methods:** This randomized clinical trial was conducted on 15 subjects, who refrained from oral hygiene for two days and rinsed with 10% sucrose solution. Then for 30 minutes, they chewed one of three sugar-free gums: Van (natural), Orbit Complete, Orbit (synthetic), or one sugar-containing chewing gum (Banana). One group did not receive any gum (control group). Plaque pH was measured by the plaque sampling method before rinsing with sucrose, and 5, 10, 15, 20, and 30 minutes after chewing. **Results:** The lowest plaque pH drop was seen in the Orbit Complete group, and the highest was in the Banana group. The pH increased faster with Van and Orbit Complete gums. The plaque pH was more than baseline pH after 20 minutes in the Van and Orbit Complete groups ($P<0.001$). **Conclusion:** All the three sugar-free gums were effective, although the pH recovery was higher and faster in the Van and Orbit complete groups.

Key words: dental plaque pH, natural turpentine, synthetic sugar-free gum.

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Introduction

Dental caries is a bacterial disease caused by the dissolution of tooth mineral by acids from bacteria in dental plaque followed by the destruction of the organic matrix (1). It is a preventable disease that can be effectively controlled. Saliva is considered protective against dental caries; serving to flush away non-adherent bacteria and other debris while neutralizing damaging fluids and acids. Saliva is also a reservoir for ions (i.e., calcium, phosphorus), increasing the ikelihood of remineralization, and containing antimicrobial and anti-plaque agents (2, 3).

The caries process begins with the fermentation of carbohydrates by bacteria, followed by the production of organic acids which in turn ends up with pH reduction. As the reduction in pH continues to the critical level, dental enamel starts to dissolve (4). Dental caries is a dynamic process and a continuum of many cycles of demineralization and remineralization. The occurrence of remineralization depends on two factors: dental plaque pH and saturation of mineral materials in plaque (5). As mentioned above, saliva stimulation can play a major role in both items and chewing gum is an efficient and pleasant way to increase saliva. Salivary flow increases as a result of both gustatory and mechanical (chewing) stimuli produced by chewing gum. At the same time, chewing gum increases salivary and plaque pH levels and promotes enamel remineralization (6) .

Nowadays, many different kinds of chewing gum in various forms and flavors and commercial packages are available. It has been reported that chewing any of the sugar-free gums after meals can decrease the

acidogenicity of dental plaque, increase the flow of saliva, and the remineralization of the incipient caries (7, 8). Studies indicate that the sugar-free gums can decrease dental caries by 40%(9). Sorbitol and xylitol are two kinds of non-cariogenic sugars; the anti-cariogenicity of the former is lower than the latter(10). The continuous consumption of xylitol gums reduces the streptococcus mutans of saliva (11, 12). In contrast, the use of sugar-containing chewing gum lowers plaque pH and increases the amount of plaque, and habitual use increases carie (13).

Van sugar-free gums, which are the product of the Van factory, contains xylitol and has the medical benefits of Baneh tree extract. This ingredient is used in the medical, chemical, and food industry (14). Gum produced from Baneh tree extract have numerous usages in medicine and has been consumed for over 2500 years for gastrointestinal problems, such as gastralgia, digestion disorders, and peptic ulcers (15). It has been shown that this gum has anti-bacterial, anti-inflammatory, anti-fungi, and anti-cancer features(16). Moreover, its anti-bacterial effects on the accumulation of streptococcus mutans of dental plaque has been proven (17).

Therefore, the objective of this study was to examine the effects of natural gum produced from Baneh tree extract and two artificial sugar-free gums on dental plaque acidity.

Material and Methods

This randomized, controlled, single-blind, crossover, clinical trial was approved by the research and ethics committee, of the School of Dentistry, of the Mashhad University of Medical Sciences, and experiments were performed at the pediatric department of the Mashhad Dental School (Mashhad, Khorasan Razavi Province, Iran). The study has been conducted according to the Declaration of Helsinki principles.

Selection

The study was conducted on 15 subjects, consisting of healthy dental students (3 males, 12 females, age: 20 to 25 years), after signing an informed, written consent form. The average of the decay-missing-filled-teeth (DMFT) was 7.7. The criteria for inclusion were: being healthy with a normal unstimulated salivary flow rate, not taking any medication that may interfere with salivary flow rate, and not having cavitated lesions.

Intervention

The present study was conducted during five 48-hour periods (one control and four experimental) with a one-week washout interval between the sessions (Fig. 1). The subjects were trained to remove their dental plaque completely by tooth brushing and dental floss at the beginning of each 48-hour period. They were also asked to check if they removed plaque successfully using disclosing tablets. Subjects were instructed not to practice any kind of oral hygiene measures or chew gum for the next 48 hours and on day three, when they had not consumed anything except water for four hours, plaque sampling was done.

The subjects, according to chewing gums used, and the control group were randomized into five groups, through which they passed in a randomized sequence. The amount of gum used in all groups was equal to 1.3 g. The synthetic gums were banana-flavored gum (sugar-containing gum), Orbit and Orbit Complete (sugar-free gums), and Van (natural sugar-free gum). The components of each chewing gum are given in Table 1.

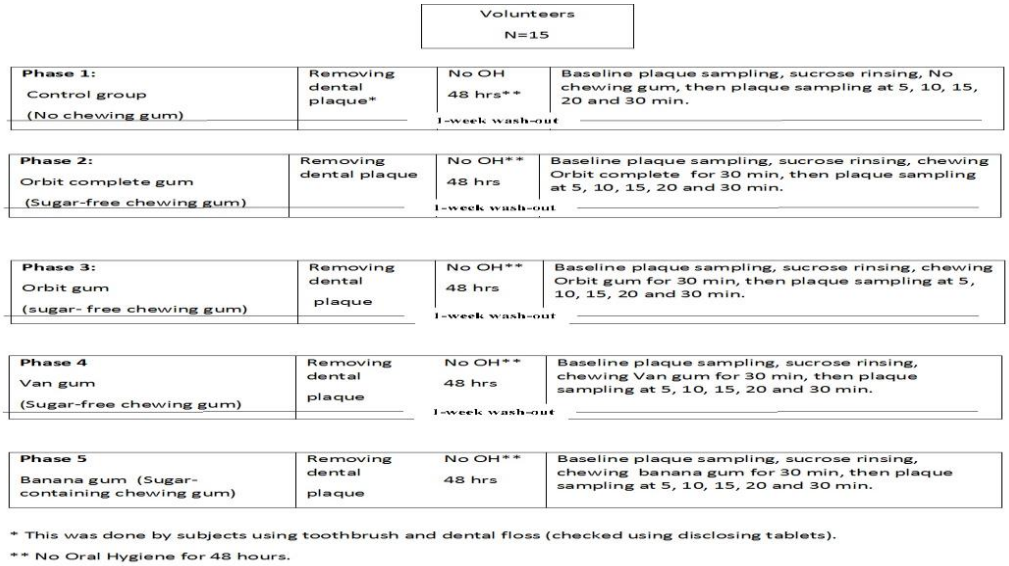

Figure1. Flowchart of the phases of study (sequences of the 5 phases was randomly determined for each volunteer)

Table 1. Chewing gums used in the study

Chewing Gum	containing Sugar	Ingredients	Manufacturer
Orbit complete	No (Sugar-free)	Sorbitol, Xylitol, Mannitol, Maltitol, Aspartame, Asesulfam, Glycerin, gum base, sodium hydrogen carbonate, flavoring agent, anti-oxidan, fenil-alanin, Lesitin	Wrigley UK
Regular Orbit	No (Sugar-free)	Isomalt, sorbitol, Mannitol, aspartame, asesulfam, gum base, Lesitin, flavoring agent, anti-oxidan, substratum agent, glisirol, dyeing agent, transparent	Wrigley UK
Van	No (Sugar-free)	Natural Saghez, xylitol, Maltitol, Glycerin, Lesitin, Arabic extract	Van company
Banana gums	Yes (sugar-containing)	Sugar, gum base, glucose, flavoring agent, dye, corn extract	Orion Vina

Control group: At first, the baseline dental plaque pH was measured, and then the subjects were asked to keep 10 cc sucrose syrup (10%) in their mouth for 30 seconds and then spit out. The plaque pH values were then measured at 5, 10, 15, 20, and 30 minutes after rinsing with sucrose solution.

Experimental (chewing gum) groups: After measuring the baseline dental plaque pH and rinsing with sucrose 10% solution, each subject was asked to chew the assigned gum for 30 minutes. Afterward, the pH was recorded at the mentioned intervals. There were four chewing gum groups and four studied chewing gums.

Determination of acidity of dental plaque

In each of the groups, dental plaque was measured by the "plaque sampling" method. To minimize the salivary contamination, the subjects were asked to swallow their saliva before sampling and a lip retractor was used. The plaque samples were collected from whole (mesial, middle, distal) buccal surfaces of all maxillary and mandibular teeth (up to the first molar) with the help of a sterile amalgam carver for 30 seconds. The plaque pH was then immediately measured by a pH meter Sentron (type Argus X, Sentron Inc.) in conjunction with a CupFET micto-combination electrode (ISFET, Sentron Inc, Gig Harbor, Wash., USA). The pH values were recorded after stirring the sample in distilled water in the electrode for 30 seconds and after the readings stabilized within four minutes. The pH meter was calibrated with standard buffers at pH 4, pH 7, and pH 9 before the beginning of each experimental day, and between each reading the electrode was cleaned with a stream of distilled water and placed in a standard solution of pH 7.0 to ensure that the calibration of the pH meter remained constant.

Randomization and blinding

The patients were randomized into one of five treatment sequences. The randomization process was performed using the Research Randomizer Program, available at www.randomized.org (copyright©1997-2012 by Geoffrey C. Urbaniak and Scott Plous). The principal investigator did the randomization process before beginning the study. The principal operator and the patients could not be blinded, but the assessor who did the plaque sampling and determination of dental plaque pH was blinded.

Sample size

Sample size calculation was based on a previous study.(18) With a confidence level of 95% and a power of the statistical test of 80%, 15 samples were calculated.

Ethical approval

All procedures performed in our study were in accordance with the research and ethics committee of the School of Dentistry, of the Mashhad University of Medical Sciences, Number: 89629 and with the 1964 Helsinki Declaration and its later amendments for comparable ethical standards.

Statistical analysis

The results were analyzed using ANOVA, LSD and repeated measure tests. P-value < 0.05 was considered significant.

Results

There was no significant interaction between the two variables "time" and "group" (p=0.21). The mean plaque pH of samples at different time intervals (before and after chewing gum) in the studied groups is shown in Table 2 and the changes of mean plaque pH compared to baseline pH at different time intervals after chewing gum are presented in Table 3.

As shown in Table 2, the baseline pH values in the five groups were not significantly different (p=0.15). Table 3 shows that the least plaque pH decrease was seen in the Orbit Complete group and the most was in the banana-flavored group. The pH increased faster with the natural gum (Van) and Orbit Complete gum. After 5 and 10 minutes of sucrose challenge, it was observed that the pH changed with natural and

synthetic sugar-free chewing gums, which were not statistically different. However, at 15 and 20 minutes, Van increased plaque pH statistically more than Orbit (p=0.04), while it was almost the same as Orbit Complete. The plaque pH was more than baseline pH after 20 minutes in the Van and Orbit Complete groups. At 30 minutes, the final plaque pH in the control group was not statistically different from its baseline pH, like the three sugar-free chewing gums, while plaque pH in the banana-flavored group was significantly less than its baseline pH (p=0.001) .

Table 2. Mean plaque pH of subjects (±SD) at different time intervals (before and after chewing gum) in the studied groups

Treatments Intervals	Control	Orbit Complete	Orbit	Van	Banana
	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
Before (min)	7.35 ± 0.22 [a]	7.23 ± 0.24 [a,b,c,d]	7.38 ± 0.18 [a]	7.31 ± 0.19 [a,b,c]	7.25 ± 0.15
After 5 (min)	6.71 ± 0.33	7.06 ± 0.19 [e]	7.15 ± 0.17 [b,c]	7.06 ± 0.24 [d]	6.27 ± 0.43 [a]
After 10 (min)	6.99 ± 0.26 [b]	7.10 ± 0.16 [a,e,f]	7.14 ± 0.15 [b,d]	7.18 ± 0.19 [d]	6.31 ± 0.39
After 15 (min)	7.12 ± 0.34 [b,c]	7.18 ± 0.13 [b,f]	7.19 ± 0.15 [c,d]	7.25 ± 0.12 [a]	6.45 ± 0.33 [a]
After 20 (min)	7.17 ±0.24 [c]	7.24 ±0.13 [c]	7.26 ± 0.15	7.34 ± 0.12 [b]	6.74 ± 0.21
After 30 (min)	7.30 ± 0.20 [a]	7.34±0.16 [d]	7.40±0.20 [a]	7.43±0.15 [c]	6.95±0.19
Repeated measure test	F= 23.57 P<0.001	F= 7.81 P<0.001	F= 19.40 P<0.001	F= 15.29 P< 0.001	F= 45.51 P= 0.001

Within each column, means with the same superscript letters a,b,c,d,e or f are not statistically different from each other

Table 3. Mean plaque pH changes compared to baseline pH at different time intervals after chewing gum in the studied groups

Treatments Intervals	After5 (min)	After10 (min)	After15 (min)	After20 (min)	After30 (min)
	Mean± S.D	Mean± S.D	Mean± S.D	Mean± S.D	Mean± S.D
Control	-0.63± 0.31	-0.36± 0.20	-0.22± 0.30 [a]	-0.17± 0.15 [a]	-0.04± 0.13 [a]
Orbit Complete	-0.16± 0.22 [a]	-0.12± 0.26 [a]	-0.04± 0.23 [a,b,c]	0.01± 0.22 [b,c]	0.11± 0.23 [a,b]
Orbit	-0.22± 0.13 [a]	-0.23± 0.14 [a]	-0.19± 0.13 [a,b]	-0.11± 0.15 [a,b]	0.02± 0.13 [b,]
Van	-0.25± 0.18 [a]	-0.14± 0.12 [a]	-0.06± 0.14 [a,c]	0.02± 0.18 [c]	0.12± 0.21 [b,]
Banana	-0.97± 0.43	-0.94± 0.37	-0.79± 0.32	-0.50± 0.21	-0.30± 0.21
ANOVA test	F= 13.78 P<0.001	F= 15.54 P<0.001	F= 12.37 P<0.001	F= 10.14 P< 0.001	F= 16.67 P< 0.001

Within each column, means with the same superscript letters a,b or c are not statistically different from each other

Discussion

The literature shows that the three methods of testing the acidogenic potential of dental plaque (plaque sampling, touch electrode, and telemetry) are equally valid and the plaque sampling method is the most practical one (M. E. J. Curzon, 1 and J. J. Hefferren) (19, 20). Moreover, the age of plaque is an important factor for plaque pH measurement. Therefore, in such studies, it is important to reduce dental plaque to almost zero before each experimental period and this is routinely achieved by prophylaxis with a rubber cup (21). However, in this study, oral prophylaxis was not performed and the subjects were instructed to completely remove their dental plaque themselves with brushing and flossing. The results showed no significant difference between baseline pH values from day-to-day for five separate days, indicating that this method was successful. Hence, it seems that in similar studies, when the subjects are dental students who are experts in proper oral hygiene techniques, researchers can save time by leaving dental plaque removal to the students.

The baseline plaque pH values in this study were between 7.23-7.38; while these values in Gopinath and Tandon (1997) (22)and Mantes's (2001) (23) studies were 6.8 and 6.2, respectively. The variations in the results could be attributed to differences in an

individual's characteristics and diets, and the method of pH measurement.

The results of the present study revealed that the lowest level of pH was seen after 5 minutes in all groups. The highest to the lowest pH drop after exposure to sucrose at this interval was observed in the banana-flavored (0.97 ± 0.43), control, Van, Orbit, and Orbit Complete groups, respectively. However, the pH drops in the three sugar-free gums (synthetic and natural gums) were not significantly different from each other. The values of minimum pH in our study (6.27) were higher than those obtained in Gopinath (1997) (22), Manning and Edgar's (1993)(24) studies (5.46 and 5.3 respectively). In our study none of the pH values were below the critical pH of 5.5. This might have been due to the time of sucrose rinsing, which in the two latter studies (3 and 2 minutes respectively) was more than our study (30 seconds). Also, the subjects in our study were dental students with good oral hygiene. Researchers have also reported that acidogenicity, aciduricity, and polysaccharide synthesis in strains of streptococci mutans may be different in caries-active subjects compared to caries-free ones (25).

As the most decrease in pH values generally occurs during the first 5 minutes, it is recommended to use sugar-free gums or other methods of caries prevention during this period to help reduce caries potential. The decrease in plaque pH within 10 minutes after sucrose rinsing was similar to the 5-minute interval. At the 15-minute interval, natural and synthetic gums raised plaque pH near to the baseline values; Van natural gum led to a significantly higher pH than synthetic Orbit gum. The pH increased slightly higher than baseline pH values after 20 minutes in Van and Orbit Complete groups, and both of them raised pH significantly more than the control group. Again pH values in Van natural gum were significantly higher than those in synthetic Orbit gum. Finally, after 30 minutes the pH values in Van and Orbit Complete groups were still higher than the baseline values and significantly higher than the control group.

The order in which the groups returned to the baseline levels were as follows: Orbit Complete (10 minutes), Van (15 minutes), Orbit, and control (30 minutes). The pH values in the banana-flavored group remained under the baseline values even after 30 minutes.

Chewing generally has a direct effect on the stimulation of saliva (3, 26). So, it is obvious that the three sugar-free gums increase the plaque pH at a faster rate compared to the control group (without chewing any gums). The result of Kaporal et al.'s study (2000) (27) that compared one kind of natural gum and an artificial sugar-free gum (Vivadent) containing sorbitol and xylitol, indicates that natural gum increases the pH plaque drastically, compared to the artificial one. They reported that the findings can be explained by the harder substratum of the natural gum. In the present study, Van gum had greater substratum compared to the other gums; therefore, more chewing was required and the pH increased remarkably.

Hayes (2001)(28), examined the effect of the non-cariogenic sweeteners on dental caries. The results showed that the cariogenicity amount is greater in those who consume xylitol and sorbitol in their daily diets compared to the sole users of xylitol. In this research, Orbit Complete, which contains 15% xylitol in addition to sorbitol occasionally, was better than Orbit Regular gum, which just contains sorbitol.

In a study by Karami et al. (2009)(29), the effect of Olips gums (containing sucrose) and Orbit (without sucrose) on plaque accumulation was examined. The findings indicated that chewing these two gums reduced plaque accumulation. However, plaque reduction in the Orbit gum (sugarless) was considerably low. In contrast to a number of studies that suggest chewing gums containing sugar is better than the control group (sugar-free) (29), the present study has shown that the control group has a better result.

In general, Orbit Complete and Van gums, considering the increase in pH rate, have been more effective compared to the other groups. Van gum has been shown to be the best in increasing pH rate. Therefore, Van chewing gums, which are produced from natural ingredients and are cheaper than Orbit Complete gums and have positive effects on the digestive system, seems to be better compared to the other groups of gums.

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