Original Article

Plaque pH Changes Following Consumption of Two Types of Plain and Bulky Bread

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ABSTRACT

Background: Consistency, backing process and content differences could influence cariogenic potential of foods. The aim was to compare plaque pH changes following consumption of two types of bread with different physical characteristics.

Methods: In this clinical trial, interproximal plaque pH of 10 volunteers with high risk of dental caries (saliva *Streptococcus mutans* > 10^5, high dental caries experience, and average DMFT =6.10 ± 1.56) was measured. Plain traditionally backed "Sangak bread" and soft bulky "Baguette bread" and %10 sucrose solution were tested in a cross over designed experiment. Baseline plaque pH was recorded and followed by 1, 5, 10, 15, 20, and 30 minutes intervals. Data was analyzed using ANOVA and Tukey test ($\alpha = 0.05$).

Results: Sucrose solution caused the most pronounced pH and ΔpH drop from 7.15 ± 0.33 at baseline to 6.78 ± 0.29. Means plaque pH of 10% sucrose solution and Baguette were not statistically different at 1, 20 and 30 minutes ($P > 0.05$). Mean plaque pH of Sangak and Baguette showed significant differences at 0, 1, 20 and30 minutes ($P < 0.05$). Sucrose solution caused a dramatic plaque pH drop during first 10 minutes and then within 30 minutes returned to baseline pH. For two bread samples within first 10 minutes, pH increased and then started to decrease during tenth to fifteenth minutes.

Conclusion: During all experiment phases, the mean pH of Baguette with less consistency and carbohydrate content and higher rate of starch gelatination was lower compared to Sangak.

Keywords**:** Bread, Cariogenic agents, Dental plaque, Hydrogen-ion concentration.

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Introduction

Bread is one of the major contributors of human diet. It is not only caloric but affordable by people. Bread and cereals have the most suggested servings per day in Food Guide Pyramid in individuals with higher daily exercise.[1] Today, people are being encouraged to consume more starches and fibers instead of fat for both body and oral health benefits.[2,3] Bread is a suitable source of both starches and fibers.[2]

Sugars, especially foods containing sucrose, are identified consumables in lowering dental plaque pH and therefore increasing dental caries incidence.[4] Although, some sweet products have anticaries effects.[5] Other carbohydrates play different role in dental caries etiology. Cariogenicity of sucrose 10%, starch solution 2%, and starch 2% + sucrose 10% was compared in an in-vitro study. Higher levels of demineralization and more Lactobacillus colonization were observed when starch added to sugar; also, pH drop following consumption starch solution was still higher than critical pH (5.5) although this drop was not significant.[6] In another trial, foods with lower acidogenic potential, such as whole meal bread, increased pH even more than baseline.[7] The pH dropped below than 4.75 in 4-7 day old dental plaque attributed to the starch presented in bread.[8] Adding even minute amounts of starchy foods cause considerable changes in glucose and insulin post prandial responses.[9]

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Some researchers have revealed that glycemic index (GI) have a direct relation with plaque acidity. The higher degrees of GI were seen with more pronounced pH drop.[10] Food characteristics such as taste, acidic content, surface texture, and food contents are important variables in mouth biological responses.[11,12] Needed chewing intensity, when a food is consumed, determines the oral clearance, duration of acid attack, and pH drop.[13-15]

There are different methods for evaluating cariogenic potential of foods and drinks.[6,16] One of them is acidogenicity assessment of consumed food. Three methods have been described for measuring acidogenicity: sampling, touch-on/microtouch, and telemetric indwelling electrode. Touch-on after telemetric method is introduced as the more reliable one.[13,17-20]

Bread is an important part of Iranians' diet[21] and there is no data about the cariogenicity of Iranian breads. The aim of this study was to compare pH change pattern following consumption of two popular types of bread with different consistencies, backing methods, and dough context.

Materials and Methods

This study was performed on ten, 27-32 year-old postgraduate dental students. The study design was single blind cross over clinical trial. Volunteers that were at high risk of dental caries development were participated in the study for assessing foods cariogenicity.[22] Inclusion criteria for selecting subjects were as: healthy individuals that were not under any special diet and medication, restored all active dental caries, saliva *Streptococcus mutans* colonies more than 10^5, normal saliva buffering capacity (final pH $\geq$ 6), and stimulated saliva flow rate more than 5 ml/5 minutes.[23]

Mean DMFT of participants in the study was 6.10 ± 1.56. Number of saliva *Streptococcus mutans* colonies count was performed using side-mount (SM) strip (Dentocult-SM, Orion diagnostica Spoo, Finland). Based on manufacturer instructions, 15 minutes before using SM strip for collecting mutans streptococei, a 5 mg Basitrasin tablet was added to a vial containing Broth cultural media. The saliva contaminated SM strip transferred to this vial and incubated for 48 hours in 35-37°C temperature. Number of SM colonies was classified according to manufacturer scores available in the Dentocult-SM kit. Utilizing chair side Dentobuff strip (Dentobuff, Orion diagnostica Spoo, Finland) saliva buffering capacity was evaluated. Based on the color change after 5 minutes, the application of saliva buffering capacity was classified to low (yellow), medium (green) and normal (blue). Stimulated saliva flow rate was collected for 5 minutes while subjects were chewing a piece of Paraffin. The volume of collected saliva was measured using a scored syringe. The recorded volume was reported as ml/5 minutes.

Subjects were refrained from any oral hygiene (brushing teeth, fluoride products) for 2 days (48 hours) and they did not drink or eat for at least 3 hours before pH measurements. Two types of bread, plain traditionally backed "Sangak bread" and soft bulky "Baguette bread", without backing soda as well as 10% sucrose solution were tested with a cross over trial design during a 4-week interval with one week washout period between different samples tests. All the test steps were performed between 10-12 a.m. by one practitioner who was blind for tested samples. Plaque pH was measured by a NMPH3/PH-microelectrode (Beetrode, WPI Instruments Inc., New Haven, CT) and a DRI REF-2, as reference electrode (Beetrode, WPI Instruments Inc., New Haven, CT), that were attached to a digital pH-meter (Hana Instruments Co, USA). A Salt bridge was formed by placing subject's Finger in 3 molar KCl solution. pH-microelectrode was inserted at proximal site between first molar and second premolar in each quadrant. In case of presence of any restoration, measurements were done in first and second premolars inter proximal area. For each subject, a baseline plaque pH was recorded and followed by 1, 5, 10, 15, 20, and 30 minutes intervals after 1 minute chewing 10 g of any bread sample or rinsing of 10 ml 10% sucrose solution. All pH recordings were performed 10 seconds after electrode insertion. For each product, pH curve was drawn by mean pH values in all 10 subjects.

Minimum pH and ΔpH-change between baseline and minimum pH were obtained from the curve. Mean ΔpH for test products was analyzed by ANOVA for each jaw. Variance analysis followed by Tukey test was performed to compare recorded pH between different times and groups. P value < 0.05 was considered statistically significant.

Results

In this study, plaque pH was measured after consumption of 3 products, in-vivo. Table 1 shows mean pH values at different times of experience for all three tested samples. Mean plaque pH of 10% sucrose solution and Baguette was not statistically different at 1, 20, and 30 minutes ($P > 0.05$). Mean plaque pH of Sangak and Baguette showed significant difference at 0 ($P < 0.001$), 1 ($P = 0.002$), 20 ($P = 0.01$), and 30 ($P = 0.05$) minutes. Two way ANOVA test revealed significant differences in mean pH values among three samples ($P < 0.05$). One way ANOVA demonstrated significant difference between mean pHs of sucrose solution and Sangak bread in all test intervals but 30th minute ($p=0.056$). The variance analyses followed by Tukey test were utilized to compare inter groups mean recorded pH values during different time intervals. The differences between mean pH of 1st ($P = 0.575$), 20th ($P = 0.983$), and 30th ($P = 0.149$) minutes recorded following consumption of Baguette bread and sucrose solution were not significant ($P > 0.05$). However the pH values of 1st ($P = 0.006$), 20th ($P = 0.009$), and 30th ($P = 0.017$) minutes of Sangak and Baguette were significantly different ($P < 0.05$).

Figure 1 illustrates the mean plaque pH at 0, 1, 5, 10, 2, and 30 minute intervals after consumption of 3 types of tested samples.

Table 1. The mean and standard deviation for the plaque pH in different minutes following consumption bread samples and sucrose solution

Test time	10 % Sucrose solution (mean pH ± SD)	Traditional Sangak bread (mean pH ± SD)	Baguette bread (mean pH ± SD)	Inter sample ANOVA (P-value)
Minute 0	7.15 ± 0.33	6.94 ± 0.3	6.78 ± 0.2	< 0.001
1st minute	6.94 ± 0.29	7.14 ± 0.29	6.97 ± 0.2	0.002
5th minute	6.82 ± 0.4	7.16 ± 0.25	7.05 ± 0.15	< 0.001
10th minute	6.78 ± 0.29	7.21 ± 0.3	7.11 ± 0.17	< 0.001
15th minute	6.79 ± 0.37	7.11 ± 0.29	7.04 ± 0.22	< 0.001
20th minute	6.95 ± 0.41	7.15 ± 0.29	6.96 ± 0.24	0.01
30th minute	7.06 ± 0.35	7.15 ± 0.32	6.99 ± 0.24	0.056

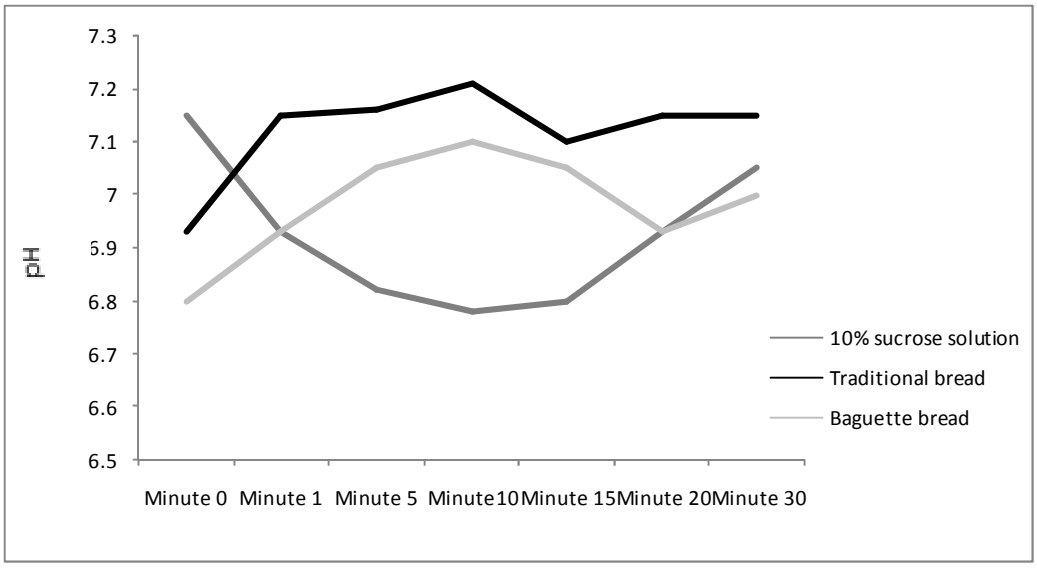

Figure 1. The mean plaque pH during different times following consumption of Sangak and Baguette bread samples and 10 % sucrose solution.

10% sucrose solution caused the most pronounced pH, then ΔpH dropped and reached to its lowest level at 10th minute, and then returned to its baseline level within next 20 minutes (30th minute). The pattern of plaque pH changes in both Sangak and Baguette samples was similar, although for all time intervals the pH produced by Sangak bread was higher than Baguette. In both bread samples, plaque pH increased during first 10 minutes then for Sangak bread a temporally pH drop happened during five minutes. By both bread types, after 30 minutes, plaque pH increased to amounts more than baseline pH. The duration of pH drop for Baguette bread was more than Sangak. There were no significant differences between two jaws, nor by ANOVA, neither by Tukey test ($P > 0.05$). No side effects were observed or reported with samples consumption.

Discussion

In our study, no plaque pH drop below 5.5 (critical pH) was recorded in any group. The pronounced pH drop could only be seen in 3-day or older dental plaque.[17] For "good brushers", more rigorous conditions would be required to terminate to lowest plaque pH.[8,17] Although all subjects were refrained from oral hygiene for 48 hours, no pH drop was seen below 6 in all steps of the experiment. All the participants in the study were postgraduate dental students and it seems to be at highest oral hygiene standards so not falling pH to the values less than 6 despite being at high risk of caries could be expected. It has been revealed that acidogenicity, aciduricity, and producing polysaccharide of SM strains of caries active individuals are higher than SM strains isolated from caries free persons. However this difference is more prominant in very low pH environments.[24]

During all study intervals, the mean pH values following consumption Sangak bread were higher than Baguette. Higher consistency of Sangak bread needs more intense chewing which leads to more oral clearance, more saliva secretion, and higher buffering capacity comparing to soft Baguette bread. On the other hand, there is an inverse relation between carbohydrate content and extraction degree of applied flour.[25] The extraction degree of flour used for preparation of Sangak and Baguette bread is 97% and 75%, respectively; for so it seems that carbohydrate content of Baguette is more than Sangak.[26] In addition, higher temperature and shorter baking time of traditional breads, such as Sangak, results in incomplete starch gelatination and as a consequence less degradation by salivary amylase.[27] In this study, both breads made rise in plaque pH in 30 minutes which is similar to what have been reported in some other studies.[28] Lingström et al reported that breads made of wheat or barely flour cause pH drop in first 15 minutes.[27] A group of studies found all baked wheat products cariogenic.[29,30] However, some other researches introduced starchy foods as less cryogenic foods.[22,31]

A food product could be identified safe for teeth or dentally approved which makes no plaque pH drop below 5.7 during first 30 minutes of pH assessment.[32] Increasing pH more than baseline could be a characteristic of a noncariogenic food. So these two types of bread (Sangak and Baguette) that tested in this study could be described dentally safe foods.

Conclusion

This study was done to assess the perceived sources Higher consistency of traditional breads such as Sangak, the flour used in traditional bread preparation which is less refined than flour used in bulky modern breads and higher temperature and shorter baking time of traditional bread seems to make traditional breads more "tooth friendly" than modern ones.

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