Published online: 2019-10-04

Original Article

Effect of dietary combinations on plaque pH recovery after the intake of pediatric liquid analgesics

Shaam Saeed[1], Nada Bshara[1], Juliana Trak[2], Ghiath Mahmoud[3]

[1]Department of Pediatric Dentistry, School of Dentistry, Damascus University, Damascus, Syrian Arab Republic,
[2]Department of Analytical and Food Chemistry, School of Pharmacy, Damascus University, Damascus, Syrian Arab Republic,
[3]Department of Orthodontics and Orofacial Orthopedics, Damascus University, Damascus, Syrian Arab Republic

Correspondence: Dr. Shaam Saeed
Email: drshaamsaeed@gmail.com

ABSTRACT

Objectives: To study the effect of water, halloumi cheese and sugar-free (SF) chewing gum on plaque pH recovery after the intake of sweetened PLAs. **Settings and Design:** A randomized clinical trial was conducted on 17 children (10 females, 7 males) aged 11–12 years with DFT/dft of more than 3. **Materials and Methods:** Each volunteer tested paracetamol and ibuprofen suspension alone or followed with water, halloumi cheese or SF gum, as well as 10% sucrose and 10% sorbitol as controls. Plaque pH was measured using the sampling method before and after 5, 10, 15, 20, 30 min of ingestion. **Statistical Analysis:** Statistical analysis was performed using analysis of variance followed by least significant difference test to assess minimum pH (min pH), maximum pH drop (ΔpH), and the area under baseline pH, and *P* value was set as 0.05. **Results:** Both ibuprofen and paracetamol were not significantly different from 10% sucrose in terms of min pH, ΔpH, and area under baseline pH except for min pH of ibuprofen ($P = 0.034$). Water and halloumi cheese did not have a significant effect on plaque pH recovery after the intake of both analgesics as min pH, ΔpH, and area under baseline pH were similar to 10% sucrose except for min pH of ibuprofen + water ($P = 0.048$). However, plaque pH variables after chewing SF gum for 20 min were similar to 10% sorbitol. **Conclusion:** Chewing SF gum immediately after the intake of sweetened PLAs for 20 min restores plaque pH and could be recommended as a complementary aid in caries prevention.

Key words: Halloumi cheese, pediatric liquid analgesics, plaque pH, sugar, sugar-free gum, water

INTRODUCTION

Pediatric liquid medicines one of which are analgesics/nonsteroidal anti-inflammatory analgesics can be part of the daily routine of children with chronic diseases as well as those with recurrent benign pathologies such as flu, tonsillitis, allergic rhinitis, etc.[1]

However, sugars added to medicines can be fermented by oral bacteria leading to acid formation and a drop in intraoral pH,[2] especially when the use of sweetened medications is not associated with effective oral hygiene measures to eliminate residues of the medication after ingestion of each dose.[3] Many foods have been reported to have a protective effect on oral health such as chewing of hard cheese, particularly cheddar cheese,[4] or chewing sugar-free (SF) gum.[5] On the other hand, many pediatricians encourage their patients to rinse with water immediately after the intake of medication.

The aim of the present study was to evaluate the effect of water, halloumi cheese, and SF chewing gum on the recovery of dental plaque pH after the intake of sweetened pediatric liquid analgesics (PLAs).

How to cite this article: Saeed S, Bshara N, Trak J, Mahmoud G. Effect of dietary combinations on plaque pH recovery after the intake of pediatric liquid analgesics. Eur J Dent 2015;9:340-5.

DOI: 10.4103/1305-7456.163220

MATERIALS AND METHODS

Test products

Two liquid analgesics were chosen for this study (Brufen Suspension, Unipharma, Syria) and (Ben U Ron Suspension, Avenzor, Syria) since they had the highest viscosity and total sugar content among a variety of local PLAs in the Syrian market (unpublished data) Table 1. Foods used in combination with PLAs were water, halloumi cheese (Draee, Syria), and SF chewing gum (Extra, Wrigley, USA). Solutions of 10% sucrose and 10% sorbitol were used as positive and negative controls, respectively.

Study design

We conducted a randomized controlled crossover single-blinded study. Ethical approval for the study was obtained from the Institutional Ethical Committee. Sample size calculations were made using the results of a pilot study of five subjects. The mean maximum pH (ΔpH) drop was calculated for the ten tests. Using G power (version 3.1.2) where alpha-error probability was 0.05, a power of study was 95%, and an effect size was 0.5, a minimum sample size of 140 tests (14 subjects) were determined.

Subject selection

Seventeen healthy children (10 females and 7 males) aged 11–12 years having DFT/dft of more than 3 were enrolled in the study. The participants and their parents or guardians were informed about the study and procedures, and written assent was obtained from all subjects. Exclusion criteria included children with orthodontic appliances, clinically detectable caries or restorations at sampling sites or allergies to any of the medicines or test foods. Volunteers were requested to abstain from tooth brushing for 48 h and from eating or drinking for at least 2 h prior to each appointment according to the guidelines of the Plaque Acidity Working Group of the Food, Nutrition, and Dental Health Committee of the American Dental Association.[6] Each subject participated in 10 test sessions in a randomized order with a washout period of at least 1-week between tests. All test sessions were carried out in the morning to minimize variations in salivary flow and composition.

Plaque sampling and pH measurement

Plaque pH was measured using the sampling method.[7] On each test session, a sample of approximately 1 mg of plaque was taken from the buccal surfaces of the subject's first permanent molars using a sterile excavator, mixed with 50 μL of distilled water and the resting pH was determined *ex vivo* using a glass combination microelectrode (Perphect™ Ross™ 8220BN, Thermo Scientific, USA) which had been previously calibrated with pH 7 and pH 4 buffer solutions. Each subject was asked to rinse with 15 mL of medicine/for 1 min alone or followed immediately by rinsing with 15 mL of water for 1 min, chewing 10 g of halloumi cheese for 1 min, chewing SF gum for 20 min, and the plaque pH was measured at time intervals of 5, 10, 15, 20, and 30 min of ingestion in each test session. Solutions of 10% sucrose and 10% sorbitol were used as controls. Salivary contamination of plaque sample was avoided by asking subjects to swallow just before plaque collection as well as blood contamination was also avoided during sample collection. Plaque was collected from the gingival margin of each of the four teeth sampled at each time interval, and the collection time for each sample was standardized (30 s).

Statistical analysis

Before performing the test of significance, normality of variables was tested by Kolmogorov-Smirnov test. We calculated the mean and standard deviation of pH values for all participants for each test group and for each time point. For each test group, we calculated the minimum pH (min pH) value obtained during 30 min (min pH), the difference between resting pH and min pH which is known as ΔpH drop and the area under baseline plaque pH. Statistical analysis was performed using analysis of variance followed by least significant difference (LSD) test to assess the differences in min pH, ΔpH drop, and the area under baseline pH, and *P* value was set as 0.05. The statistical analyses were performed with SPSS software (SPSS Inc., Chicago) (release, 13.0).

RESULTS

The resting (baseline pH) of the test/control groups ranged between 6.47 and 6.62 with no statistical

Table 1: Physicochemical properties of PLAs studied

Product	Company name	Analgesic group	pH	Viscosity (cP)	Sucrose concentration (g/100 mL)
Ben U Ron	Avenzor, Syria	Paracetamol	5.5±0.02	641	49.64±1
Brufen	Unipharma, Syria	Ibuprofen	3.93±0.02	389	65.94±1.76

PLAs: Pediatric liquid analgesics

difference among groups (P = 0.811). Water and halloumi cheese did not have a significant effect on plaque pH recovery after the intake of both analgesics as min pH, ΔpH, and area under baseline pH were similar to 10% sucrose except for min pH of ibuprofen + water (P = 0.048).

The mean age of participants was 11.5 ± 0.5 years. The mean pH values for the ten groups are illustrated in Figures 1 and 2, and plaque acidogenicity variables are summarized in Table 2. The LSD test showed that both ibuprofen and paracetamol were not significantly different from 10% sucrose in terms of min pH, ΔpH, and area under baseline pH except for min pH of ibuprofen group which was greater than sucrose (P = 0.034). No significant difference was found between both analgesics in terms of min pH, ΔpH, and area under baseline pH (P = 0.138, P = 0.479, P = 0.789), respectively. The intake of both water and halloumi cheese did not have a significant effect on plaque pH recovery after the intake of both PLAs as all acidogenic parameters were not significantly different from 10% sucrose except for min pH of ibuprofen + water group which was <10% sucrose (P = 0.048). However, chewing SF gum had a significant effect on restoring plaque pH as min pH, ΔpH, and area under baseline pH were not significantly different from 10% sorbitol (Tables 3 and 4 show mean difference, standard error, and P values for comparison of min pH, ΔpH, and area under baseline pH between test groups and control solutions).

DISCUSSION

Dental caries is a multifactorial disease caused by the interaction between cariogenic bacteria with the appropriate substrate, in a susceptible host, within a certain time.[8]

Plaque pH has become an important tool in assessing the caries risk and evaluating food cariogenicity as well as SF substances.[9] The evaluation of caries risk helps improve oral hygiene, diet, and implement preventive measures among high risk subjects.[10] However, fewer attempts have been made to investigate the effects of choice, combinations and sequence of ingested foods, and beverages on dental plaque pH.[11]

Several methods of plaque pH measurement were used in previous studies of which each method has its strength and weakness.[6] The sampling method included the collection of a plaque sample from several teeth, dispersing it in a diluent, and measuring plaque pH *ex vivo*.[6] The microtouch method allows intermittent and direct readings of interdental plaque pH through a microelectrode.[6] The telemetric method allows continuous monitoring of plaque pH changes through a miniature microelectrode embedded in a partial removable denture.[6] However, the sampling method was chosen in the present study as it had been the method usually used among children.[12]

Table 2: Minimum pH, maximum pH drop and area under baseline pH in the test and control groups

Test/control group	Mean±SD		
	Minimum pH	Maximum pH drop	Area under baseline pH
Sucrose 10%	5.86±0.34	0.63±0.2	6.32±2.86
Ibuprofen	6.07±0.24	0.55±0.32	9.95±7.95
Ibuprofen + water	6.05±0.34	0.53±0.26	8.22±5.3
Ibuprofen + cheese	5.99±0.16	0.49±0.18	6.78±4.27
Ibuprofen + SF gum	6.29±0.19	0.19±0.21	2.52±3.43
Paracetamol	5.92±0.44	0.61±0.33	9.48±5.81
Paracetamol + water	5.95±0.36	0.61±0.33	9.25±5.89
Paracetamol + cheese	6.03±0.22	0.54±0.29	9.76±6.38
Paracetamol + SF gum	6.34±0.26	0.18±0.2	2.14±3.78
Sorbitol 10%	6.40±0.22	0.19±0.15	2.48±2.8

SD: Standard deviation, SF: Sugar-free

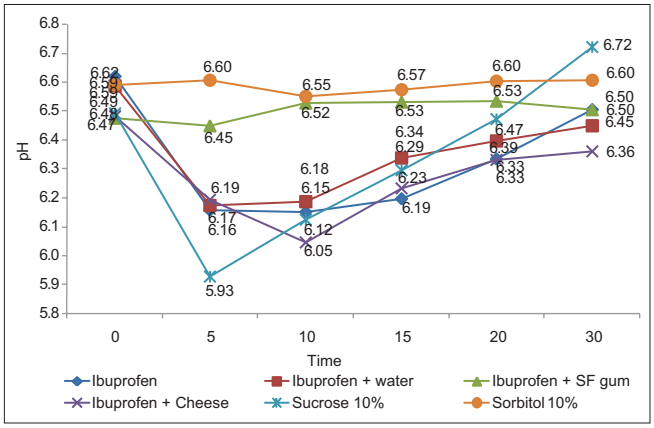

Figure 1: Mean plaque pH response to ibuprofen groups, 10% sucrose and 10% sorbitol solutions

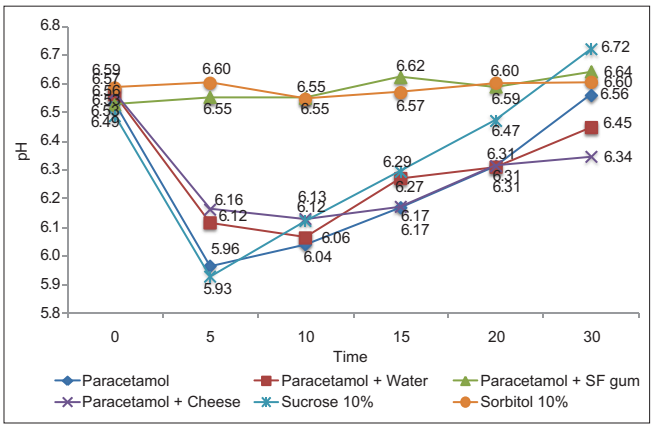

Figure 2: Mean plaque pH response to Paracetamol groups, 10% sucrose and 10% sorbitol solutions

Table 3: Comparison of minimum pH, maximum pH drop and area under baseline pH between test groups and 10% sucrose

Test group versus 10% sucrose	Minimum pH			Maximum pH drop			Area under baseline pH		
	Mean difference	SE	*P*	Mean difference	SE	*P*	Mean difference	SE	*P*
Ibuprofen	0.21	0.10	0.034	−0.08	0.09	0.339	3.64	1.75	0.039
Ibuprofen + water	0.20	0.10	0.048	−0.10	0.09	0.250	1.91	1.75	0.278
Ibuprofen + cheese	0.14	0.10	0.175	−0.14	0.09	0.099	0.47	1.75	0.791
Ibuprofen + SF gum	0.43	0.10	<0.001	−0.45	0.09	<0.001	−3.80	1.75	0.031
Paracetamol	0.06	0.10	0.520	−0.02	0.09	0.803	3.17	1.75	0.072
Paracetamol + water	0.09	0.10	0.342	−0.02	0.09	0.808	2.94	1.75	0.095
Paracetamol + cheese	0.17	0.10	0.087	−0.09	0.09	0.287	3.45	1.75	0.051
Paracetamol + SF gum	0.49	0.10	<0.001	−0.45	0.09	<0.001	−4.18	1.75	0.018

SE: Standard error, SF: Sugar-free

Table 4: Comparison of minimum pH, maximum pH drop, and area under baseline pH between test groups and 10% sorbitol

Test group versus 10% sorbitol	Minimum pH			Maximum pH drop			Area under baseline pH		
	Mean difference	SE	*P*	Mean difference	SE	*P*	Mean difference	SE	*P*
Ibuprofen	−0.33	0.10	0.001	0.36	0.09	<0.001	7.47	1.75	<0.001
Ibuprofen + water	−0.35	0.10	0.001	0.35	0.09	<0.001	5.74	1.75	0.001
Ibuprofen + cheese	−0.41	0.10	<0.001	0.30	0.09	0.001	4.30	1.75	0.015
Ibuprofen + SF gum	−0.11	0.10	0.252	0.00	0.09	0.989	0.03	1.75	0.984
Paracetamol	−0.48	0.10	<0.001	0.43	0.09	<0.001	7.00	1.75	<0.001
Paracetamol + water	−0.45	0.10	<0.001	0.43	0.09	<0.001	6.77	1.75	<0.001
Paracetamol + cheese	−0.38	0.10	<0.001	0.35	0.09	<0.001	7.28	1.75	<0.001
Paracetamol + SF gum	−0.06	0.10	0.551	0.00	0.09	0.989	−0.34	1.75	0.845

SE: Standard error, SF: Sugar-free

Moreover, it may highlight the role of salivary flow and buffer capacity since plaque is sampled from accessible tooth surfaces. In addition, the inability to sterilize microelectrodes makes the sampling method more preferable from an ethical point of view.[6]

It is worthy that plaque pH readings in the present study tended to be higher than in previous studies, and this could be attributed to the difference in the age of participants, selection criteria, and the method of measurement used. Although the sampling method gives higher readings in comparison with the other methods, all plaque pH methods had proved to rank products in the same manner.[13]

The protocol used in this study followed the guidelines of assessing the acidogenicity/cariogenicity of foods set at the San Antonio Conference.[6] It was stated that a food may be considered to be acidogenic if it had a similar plaque pH response to 10% sucrose solution, and hypoacidogenic if its response was similar to 10% sorbitol. However, subjects were not selected according to their ability to produce a drop in plaque pH below 5.5 with a 10% sucrose solution as in adults because plaque pH response to an acidogenic challenge is significantly less acidic compared with adults.[14]

Our results showed that both analgesics tested were acidogenic as they caused an immediate and prolonged pH drop which is in accordance with other studies.[15-19] An interesting note that there were no significant differences in area under baseline pH between analgesics and 10% sucrose, and both products had a similar plaque pH response despite the different in total sugar content. This may be explained by the findings of Linke and Birchmeier[20] Ingestion of solutions with higher sucrose concentrations (>15%) produced similar amounts or less of lactic acid during oral clearance than solutions containing lower sucrose concentrations (<15%).[20] Moreover, the sweet taste of medicines would have stimulated the salivary flow, which may increase the oral clearance of the available carbohydrates and acidic by-products. However, it is noteworthy that the medicines tested are complex products that are made up of variable excipients. However, food characteristics such as oral retention, physical form, acidogenic properties, protective effect of food ingredients, and quantity and type of carbohydrate may modify its acidogenic potential.[19]

However, the sugar content is not the only factor responsible for the detrimental effects on dental health. Frequency of intake, bedtime ingestion, high

viscosity, and low intrinsic pH also increase the risk for caries.[21]

Water did not have a significant effect on plaque pH recovery. This result is in accordance with Hoshino *et al*.,[22] Sofrata *et al*.,[23] Wang *et al*.,[24] Naval *et al*.[11] Although subjects in the present study rinsed immediately after the intake of medication, that is, within the crucial time of pH depression in contrast to previous studies; yet it was an ineffective protocol. It is possible that rinsing with water was not able to dislodge and eliminate such viscous liquids.

Halloumi Cheese also did not prove to be effective in restoring plaque pH after the intake of sweetened PLAs. Our results are different from Rugg-Gunn *et al*.,[25] Imfeld *et al*.,[26] Jensen *et al*.,[27] Jensen and Wefel,[28] and Sönmez and Aras.[4] The difference may be attributed to the type of cheese and its maturity. Previous studies had used aged cheddar cheese which has a strong taste and serves as a potent salivary stimulant. Although Sönmez and Aras[4] used white Turkish cheese, it proved to be effective. However, it was used after a relatively low concentration of sucrose of 10% compared to high sugar concentrations of the liquid medicines tested. In the present study, we had used unsalted halloumi cheese which was not aged and probably did not have a strong taste. Moreover, most of the children mentioned that they did not use to like cheese, and therefore, it probably was not an effective salivary stimulant. Jensen *et al*., stated that halloumi cheese caused an intermediate drop in plaque pH.[27] It is noteworthy that cheese consumption had caused a delay in pH drop as the ΔpH drop occurred after 10 min. Therefore, it seems that the high concentration of sugars in medicines exceeded the possible pH buffering by cheese.

On the other side, when the intake of both sweetened liquid analgesics was followed by chewing SF gum, all acidogenic parameters including min pH, ΔpH, and area under baseline pH were not significantly different from 10% sorbitol. Therefore, chewing SF gum proved to be an effective choice in restoring plaque pH after the intake of highly sweetened liquid medicines.

It was suggested that the use of SF gum after meals can increase salivary flow, increase the oral clearance of dietary substances and micro-organisms, promote the buffer capacity to neutralize plaque pH.[29]

Our results are in accordance with previous studies.[30-36] On the other hand, our findings were different from those of Lee and Schachtele.[37] study which showed that chewing sucrose or sorbitol containing gum after eating sugar coated cereal with milk caused a transient increase in plaque pH. Differences may be attributed to the delayed time of gum chewing. Although subjects chewed both gums for 20 min, they initiated chewing after 20 min of the acidogenic challenge. Park *et al*.[32] stated that gum chewing should start soon after the acidogenic challenge and should last for at least 15 min to obtain the maximum benefit.

Pediatricians, dentists, and other health providers should be aware about the cariogenic effect of long-term use of sugar-containing medicines, and chewing SF gum should be recommended as a complementary aid to oral hygiene measures especially among children with long-term treatment, hospitalized, or disabled children where tooth brushing may not be feasible or even effective.

CONCLUSION

Sweetened PLAs are acidogenic and possibly cariogenic when consumed frequently. Chewing SF gum immediately after the intake of sweetened liquid analgesics for 20 min could be an effective way in plaque pH recovery and should be recommended for children as a complementary aid in caries prevention especially among children with long-term treatment, hospitalized or disabled children where tooth brushing may not be feasible or even effective. Further studies are warranted to test the effect of different kinds of sugared/flavored chewing gums on plaque pH recovery following the intake of sweetened PLAs.

Financial support and sponsorship
Damascus University.

Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Cavalcanti AL, Sousa RI, Clementino MA, Vieira FF, Cavalcanti CL, Xavier AF. *In vitro* analysis of the cariogenic and erosive potential of paediatric antitussive liquid oral medications. Tanzan J Health Res 2012;14:1-8.
2. Subramaniam P, Nandan N. Cariogenic potential of pediatric liquid medicaments – An *in vitro* study. J Clin Pediatr Dent 2012;36:357-62.
3. Bigeard L. The role of medication and sugars in pediatric dental patients. Dent Clin North Am 2000;44:443-56.
4. Sönmez IS, Aras S. Effect of white cheese and sugarless yoghurt on dental plaque acidogenicity. Caries Res 2007;41:208-11.
5. Oztas N, Bodur H, Olmez A, Berkkan A, Cula S. The efficacy of a fluoride chewing gum on salivary fluoride concentration and plaque pH in children. J Dent 2004;32:471-7.
6. Edgar W, Geddes D. Plaque acidity models for cariogenicity testing-some theoretical and practical observations. J Dent Res 1986;65:1498-502.

7. Harper DS, Abelson DC, Jensen ME. Human plaque acidity models. J Dent Res 1986;65:1503-10.
8. de Souza PM, Mello Proença MA, Franco MM, Rodrigues VP, Costa JF, Costa EL. Association between early childhood caries and maternal caries status: A cross-section study in São Luís, Maranhão, Brazil. Eur J Dent 2015;9:122-6.
9. Caruana PC, Mulaify SA, Moazzez R, Bartlett D. The effect of casein and calcium containing paste on plaque pH following a subsequent carbohydrate challenge. J Dent 2009;37:522-6.
10. Pannu P, Gambhir R, Sujlana A. Correlation between the salivary *Streptococcus mutans* levels and dental caries experience in adult population of Chandigarh, India. Eur J Dent 2013;7:191-5.
11. Naval S, Koerber A, Salzmann L, Punwani I, Johnson BR, Wu CD. The effects of beverages on plaque acidogenicity after a sugary challenge. J Am Dent Assoc 2013;144:815-22.
12. Scheie AA, Fejerskov O, Lingström P, Birkhed D, Manji F. Use of palladium touch microelectrodes under field conditions for *in vivo* assessment of dental plaque pH in children. Caries Res 1992;26:44-51.
13. Lingström P, Imfeld T, Birkhed D. Comparison of three different methods for measurement of plaque-pH in humans after consumption of soft bread and potato chips. J Dent Res 1993;72:865-70.
14. Tahmassebi JF, Duggal MS. Comparison of the plaque pH response to an acidogenic challenge in children and adults. Caries Res 1996;30:342-6.
15. Feigal RJ, Jensen ME, Mensing CA. Dental caries potential of liquid medications. Pediatrics 1981;68:416-9.
16. Rekola M. *In vivo* acid production from medicines in syrup form. Caries Res 1989;23:412-6.
17. Marathaki E, Pollard MA, Curzon ME. The effect of sucrose in medicines on plaque pH. Int J Paediatr Dent 1995;5:231-5.
18. Sunitha S, Prashanth GM, Shanmukhappa, Chandu GN, Subba Reddy VV. An analysis of concentration of sucrose, endogenous pH, and alteration in the plaque pH on consumption of commonly used liquid pediatric medicines. J Indian Soc Pedod Prev Dent 2009;27:44-8.
19. Sharma A, Deshpande S. Effect of sucrose in different commonly used pediatric medicines upon plaque pH in human subjects. J Indian Soc Pedod Prev Dent 2011;29:144-8.
20. Linke HA, Birchmeier RI. Effect of increasing sucrose concentrations on oral lactic acid production. Ann Nutr Metab 2000;44:121-4.
21. Cavalcanti AL, Fernandes LV, Barbosa AS, Vieira FF. pH, titratable acidity and total soluble solid content of pediatric antitussive medicines. Acta Stomatol Croat 2008;42:164-70.
22. Hoshino E, Sato M, Sasano T, Kota K. Plaque pH recovery by mouth-rinses with water. Shika Kiso Igakkai Zasshi 1989;31:218-23.
23. Sofrata A, Lingström P, Baljoon M, Gustafsson A. The effect of miswak extract on plaque pH. An *in vivo* study. Caries Res 2007;41:451-4.
24. Wang XL, Cheng CY, Peng D, Wang B, Gan YH. Dental plaque pH recovery effect of arginine bicarbonate rinse *in vivo*. Chin J Dent Res 2012;15:115-20.
25. Rugg-Gunn AJ, Edgar WM, Geddes DA, Jenkins GN. The effect of different meal patterns upon plaque pH in human subjects. Br Dent J 1975;139:351-6.
26. Imfeld T, Hirsch RS, Mühlemann HR. Telemetric recordings of interdental plaque pH during different meal patterns. Br Dent J 1978;144:40-5.
27. Jensen ME, Harlander SK, Schachtele CF, Halambeck SM, Morris HA. Evaluation of acidogenic and antacid properties of cheese by telemetric recording of plaque pH. In: Hefferren JJ, Ayer WA, Koehler HM, McEnery CT, editors. Foods, Nutrition and Dental Health. Vol. 4. Chicago: American Dental Association; 1984. p. 31-47.
28. Jensen ME, Wefel JS. Effects of processed cheese on human plaque pH and demineralization and remineralization. Am J Dent 1990;3:217-23.
29. Keukenmeester RS, Slot DE, Putt MS, Van der Weijden GA. The effect of sugar-free chewing gum on plaque and clinical parameters of gingival inflammation: A systematic review. Int J Dent Hyg 2013;11:2-14.
30. Park KK, Schemehorn BR, Bolton JW, Stookey GK. The impact of chewing sugarless gum on the acidogenicity of fast-food meals. Am J Dent 1990;3:231-5.
31. Frohlich S, Maiwald HJ. Reversal of food induced plaque acidity by chewing gums. J Dent Res 1992;71:1309.
32. Park KK, Schemehorn BR, Stookey GK. Effect of time and duration of sorbitol gum chewing on plaque acidogenicity. Pediatr Dent 1993;15:197-202.
33. Manning RH, Edgar WM. pH changes in plaque after eating snacks and meals, and their modification by chewing sugared- or sugar-free gum. Br Dent J 1993;174:241-4.
34. Imfeld T, Birkhed D, Lingström P. Effect of urea in sugar-free chewing gums on pH recovery in human dental plaque evaluated with three different methods. Caries Res 1995;29:172-80.
35. Gopinath VK, Tandon S, Shirwaikar A. The effect of chewing gums on acidogenicity of plaque after a sucrose challenge. J Clin Pediatr Dent 1997;22:77-81.
36. Koparal E, Ertugrul F, Sabah E. Effect of chewing gum on plaque acidogenicity. J Clin Pediatr Dent 2000;24:129-32.
37. Lee IK, Schachtele CF. Effect of gum chewing following food ingestion on the pH of interproximal dental plaque. Quintessence Int 1992;23:455-9.

Access this article online	
Quick Response Code:	Website: www.eurjdent.com