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ORIGINAL ARTICLE

The effect of Four Fruit Juices on the Ph of Dental Plaque - A Four Period Cross-Over Study

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ABSTRACT

Background: The concept of health has prevailed for centuries and dietary habits are changing with modernization. "Healthy eating" is perceived to be important and fruit juices are marketed and promoted aggressively as a "Health drink".

Objectives: 1. To estimate the endogenous pH and titratable acidity of four fruit juices. [Freshly prepared- Apple and Sweet lime, Ready to drink- Frooti and Pulpy orange] 2. To assess the effect of these test drinks on the pH of the plaque in two groups. [DMFT, Decayed Missing Filled Teeth=0 and DMFT, Decayed Missing Filled Teeth >3] 3. To compare between the juices for the two groups.

Methodology: 24 volunteers aged 20–30 years from the College of Dental Sciences, Davangere, were included and divided into 2 groups, based on the caries experience. The groups were randomly allocated for fruit juices and a four period cross-over study was designed. The endogenous pH of the fruit juices and plaque samples were collected at the baseline and after consumption of the fruit juices at 1, 5, 10, 15 and 30 minutes and was assessed by a digital pH meter. Statistical analysis was done by using the Student's t-test, ANOVA and Tukey's post hoc.

Result: Four fruit juices were acidic and reduced the pH of the plaque. The maximum pH drop was observed in the ready to drink juices as compared to the fresh fruit juices in both the groups, but in group B, it dropped below the critical pH.

Conclusion: The ready to drink juices have more cariogenic potential as compared to fresh fruit juices, especially for the caries active group.

Key Words: fruit juice, plaque pH, cariogenic, acidogenic.

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Introduction

The concept of health has prevailed for centuries and dietary habits are apparently changing with modernization. "Healthy eating" is now perceived to be important. Changes in diet have included a substantial increase in the consumption of beverages and acidic drinks [1],[4]. People are aware of the deleterious effect caused by carbonated beverages on the teeth and they prefer more natural and healthy products such as fresh fruit juices, which are conveniently prepared at home and are considered to be healthier, as it provides a good source of vitamins [2]. The desirability of a healthy lifestyle along with the so called dieting has led to an increased consumption of juices. Drinking large amounts of fruit juices is frequently practiced these days and the consumption of these juices is considered to be healthy as compared to other carbohydrate beverages. Even fruit juices are marketed aggressively and are promoted as "Health drinks" [4]. Fruit juices are popular with people of all ages worldwide as

they are sweet and are perceived to be healthy. [7]. However, claims of its safety for the teeth are unsubstantiated due to inadequate reports in the literature.

A vast amount of laboratory research has been carried out on the effects of carbohydrate foods with respect to dental caries, but very much less has been done on fruit juices which also contain fermentable carbohydrates. Hence, the present study was formulated to evaluate the plaque pH changes after exposing it to 4 different commonly consumed fruit juices.

Objectives

1] To estimate the endogenous pH and titratable acidity of four different commonly consumed fruit juices.

[Freshly prepared- Apple and Sweet lime juice, Ready to drink- Frooti and Pulpy orange]

2] To assess the effect of these test drinks on plaque pH at various time intervals in two groups.

[DMFT = 0 and DMFT > 3]

3] To compare between the juices for the two groups.

Methodology

Based on a simple market survey, four commonly consumed fruit juices i.e., 2 freshly prepared, Apple and Sweet lime [Mosumbi] and 2 ready to drink, Frooti and Pulpy orange were included as test drinks in the study. Twenty four subjects aged 20-30 years [4], who were volunteers from J.J.M. Medical College, Davangere, were considered as study subjects. People with satisfactory gingival / periodontal health and those who were not on any medication were included and they were divided into 2 groups, based on the caries experience, following the WHO 1997 criteria,

Group A; 12 adults [DMFT Decayed Missing Filled Teeth = 0] i.e., caries resistant and

Group B; 12 adults [DMFT Decayed Missing Filled Teeth > 3] i.e., caries active group.

Ethical clearance was obtained from the ethical committee of J.J.M.Medical College, Davangere and informed consent was obtained from all the participants.

Method:

The volunteers were asked to refrain from oral hygienic procedures for 24 hours and from having food or drinks for at least 2 hours prior to the procedure. On the examination day, the groups were allocated randomly for 2 different test drinks and the intrinsic pH of the test drinks was measured by the Digital pH meter by using a combination of a glass electrode in the Department of Biochemistry, JJM Medical College. For the measurement of the titratable acidity of each of the test drinks, 0.1M sodium hydroxide was titrated against 10ml of the drink until a pH of 7 was obtained. The volume of sodium hydroxide required for this was noted and this gave an indication of the buffering potential of the drinks. A four period cross over study was designed.

Plaque collecting [Sampling] method [3],[9],[15]:

Plaque was collected at the baseline with a spoon excavator from all accessible surfaces of the upper central incisors, the buccal surfaces of the upper first molars and premolars, the lingual surfaces of the lower molars and the incisors. The collection was done within a period of 30 – 60 seconds. Then, the subjects were asked to drink 100ml of the test drink in one minute and to swish the drink carefully around the teeth before swallowing in order to maintain a uniform method in drinking. Post consumption, the plaque samples were collected at 1, 5, 10, 15 and 30 minutes and the pH was estimated.

The sample was pooled in 5ml of distilled water and was kept in a dappen dish and the pH was determined immediately after collection using a digital pH meter (Systronics 335, GI 631 stirrer) with a glass combination electrode, which was previously calibrated and standardized with pH 7 and pH 4 buffer solutions.

After the collection of the last sample, the subjects were allowed to brush and a 3 day wash out period was given, after which a similar experiment as detailed above, was done for the next test drinks. The collected data was

then analyzed by using the Student's t-test, ANOVA and Tukeys post hoc by using the SPSS 10 software. P-values of less than 0.05 [P < 0.05] were considered to be statistically significant.

Results

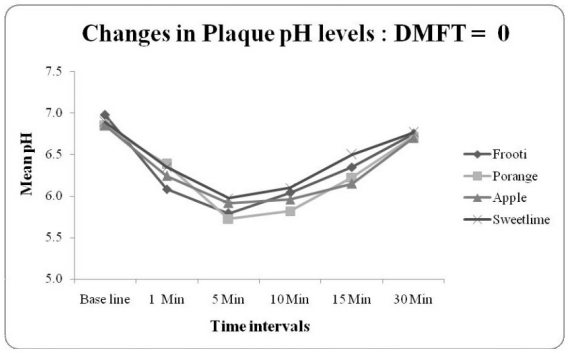
24 subjects were divided into 2 groups [12 in DMFT = 0 i.e., in Group A and 12 in DMFT > 3 i.e., Group B] based on the caries experience. Their ages ranged from 20-30 years in both the groups. There was no gender difference. The resting plaque pH in group A was found to be higher [6.9±0.4 to 7.0±0.5] than that in group B [6.3±0.4 to 6.5±0.5], which was statistically significant after the unpaired t test [Table/Fig 1].

(Table/Fig 1) Endogenous pH of fruit juices

Sl no	Fruit juices	Intrinsic pH	Titratable acidity (in ml of N/10 sodium hydroxide required to bring pH to 7)
1	Frooti	3.43	3.5
2	Apple	4.52	1.4
3	Pulpy orange	2.31	4.6
4	Sweet lime [Mosumbi]	3.76	1.4

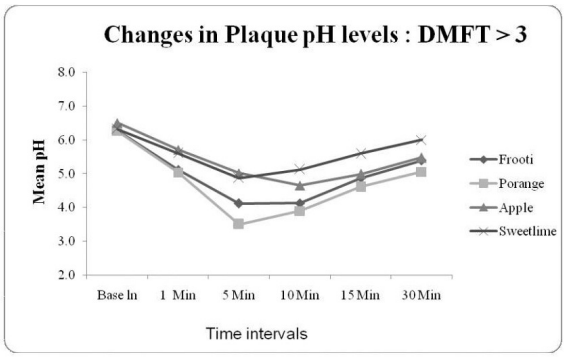
The endogenous pH of all fruit juices was estimated to be acidic. Among that, Pulpy orange showed the least pH, followed by Frooti, Sweet lime and Apple juice [Table/Fig 2] .

(Table/Fig 2) Changes in Plaque pH levels Group A



In group A, the mean pH values remained below baseline values, but not below critical pH for all the test drinks and attained a value which was not significantly below the baseline values at 30 minutes [Table/Fig 3].

(Table/Fig 3) Changes in Plaque pH levels in Group B



In group B, the mean pH drop was below the critical pH of 5.5 for all the test drinks and it remained below baseline values even after 30 minutes.

In both the groups, the maximum plaque pH fall was noted at 5 minutes, the maximum being for Pulpy orange and Frooti, followed by Sweet lime and Apple juice [Table/Fig4] and [Table/Fig 5]

(Table/Fig 4) Changes in Plaque pH levels after consumption of four different fruit juices at different time intervals in Group A

Sl no	Fruit juices	Base line	1 Minute		5 Minute		10 Minute		15 Minute		30 Minute	
		Mean±SD	Mean ±SD	Mean Diff	Mean ±SD	Mean Diff	Mean ±SD	Mean Diff	Mean ±SD	Mean Diff	Mean ±SD	Mean Diff
1	Frooti	7.0 ± 0.5	6.1±0 .5	0.9±0 .5	5.8 ±0.3	1.2±0 .6	6.0 ±0.4	0.9±0 .6	6.4 ±0.4	0.6±0 .7	6.8 ±0.5	0.2±0 .4
2	Pulpy orange	6.8 ± 0.4	6.4±0 .4	0.4±0 .2	5.7 ±0.2	1.1±0 .3	5.8 ±0.2	1.0±0 .2	6.2 ±0.3	0.6±0 .2	6.7 ±0.4	0.1±0 .1
3	Apple	6.9 ± 0.6	6.2±0 .4	0.6±0 .4	5.9 ±0.3	0.9±0 .5	6.0 ±0.3	0.9±0 .5	6.2 ±0.4	0.7±0 .8	6.7 ±0.5	0.2±0 .2
4	Sweet lime	6.9 ± 0.5	6.4±0 .4	0.5±0 .2	6.0 ±0.4	0.9±0 .2	6.1 ±0.4	0.8±0 .2	6.5 ±0.5	0.4±0 .1	6.8 ±0.6	0.1±0 .1

Mean Difference = Baseline pH – pH at specific time interval.
Intra group comparison with paired t-test was significant at all time intervals. [p < 0.05]
Intergroup comparison with ANOVA was not significant.

(Table/Fig 5) Changes in Plaque pH levels after consumption of four different fruit juices at different time intervals inGroup B

Sl no	Fruit juices	Base line	1 Minute		5 Minute		10 Minute	
		Mean±SD	Mean±SD	Mean Diff	Mean±SD	Mean Diff	Mean±SD	Mean Diff
1	Frooti	6.9±0.4	5.1±0 .6	1.2±0. 7 S	4.1±0. 8	2.2±0. 8 S	4.1±0. 9	2.2±1. 0 S
2	Pulpy orange	6.3±0.4	5.0±0 .5	1.2±0. 4 S	3.5±0. 6	2.8±0. 4 S	3.9±0. 5	2.4±0. 5 S
3	Apple	6.5±0.5	5.7±0 .8	0.8±0. 8 S	5.0±0. 5	1.5±0. 7 S	4.7±0. 7	1.9±0. 8 S
4	Sweet lime	6.3±0.4	5.6±0 .3	0.7±0. 3 S	4.9±0. 4	1.4±0. 5 S	5.1±0. 4	1.2±0. 5 S
Tukeys Post hoc			2 >3		2 >1,3,4		1,2 >3,4	

Mean Difference = Baseline pH – pH at specific time interval.
Intra group comparison with paired t-test was significant at all time intervals.
[p < 0.05]
S = Intergroup comparison with ANOVA was significant.

The data of this study was analyzed and the pH values were estimated with respect to 100% of that of the baseline pH. Intra group comparison by the paired t test was significant for all the fruit juices, at different time intervals for both the groups.

Inter group comparison by ANOVA showed no significance at different time intervals in group

A, whereas in group B, ANOVA was significant at 5, 10, 15 and 30 minutes. Pairwise comparison by Tukeys post hoc showed that Pulpy orange and Frooti significantly reduced plaque pH as compared to Sweet lime and Apple juice.

Discussion

Acidified sugar containing drinks have been found to be cariogenic and erosive in rats [4]. Foods and beverages, especially fruits and fruit juices, can contain a variety of acids that have the potential to damage the teeth [8]. Excessive use of the drinks has been attached on two main dental grounds:

1] They may be acidic enough to damage [erode] surfaces of the teeth which are not covered by dental plaque.

2] Those which contain fermentable carbohydrates may serve as a source of substrate, diffusing into the dental plaque from which micro-organisms inhabitating the plaque can generate the acid that brings about the destructive process of dental caries, initially in the sub-surface of the enamel beneath the plaque [11].

The time scales of the two processes will differ however, with erosion immediately on contact of the drinks with unprotected tooth surfaces and pre carious changes taking place in the plaque over a period of a few minutes upto possibly 1 hour or more [11]. Some authors suggest that the pH of the oral cavity affects the solubility of dental tissues. The consumption of low pH fruit juices causes a drop in the oral pH below critical pH and if it persists even for few minutes, it causes a potential damage to the teeth [13].

Edger et al showed in 1975, that carbonated beverages were more efficiently buffered by contact with saliva than with fruit juices. It was the buffering capacity of the fruit juices which rendered them more able to combat salivary buffers and hence, they further lowered the plaque pH. [12]. Hence, titratable acidity was measured along with the intrinsic pH of the fruit juices in the present study.

A variety of factors come into play in determining the cariogenicity of sugar containing drinks [1]. The fall in pH produced in the plaque is dependent on the sugar content, intrinsic pH and also the buffering capacity and the manner in which a drink is consumed. The resting plaque pH usually ranges from 6-7. When a low pH drink is consumed, it causes a fall in this resting plaque pH. The length of the time for which this low pH remains at its minimum is important, since if it reaches the so called critical pH value, it initiates the dissolution of the enamel [4].

The finding of the present study i.e., in a caries free person, the pH doesn't drop below critical pH after exposure to different drinks was similar to the observation made by Stephen in 1944, who found that in caries free individuals, plaque pH didn't fall below critical pH after a glucose rinse [5]. Plaque from caries resistant subjects exhibited an initial higher pH, a modest fall in pH after consumption of different fruit juices and a more rapid return to resting levels as compared to caries susceptible subjects. This finding was similar to a study conducted by Vrastsanos and Mandel in 1982 after a sucrose challenge [6]. This can be attributed to the neutralizing effects of saliva by virtue of its buffering system which gets activated with increasing salivary secretion and occurs due to acidogenic challenge [4].

Pulpy orange and Frooti showed more cariogenic response to plaque pH. These drinks contain citric and ascorbic acids and had higher buffering capacity. All these factors contributed to a decrease in pH [4]. Sweet lime also contains citric acid and had an intrinsic pH similar to Frooti, but had a lower buffering capacity than Frooti. The drinks which consistently produced minimal acidogenic response are Sweet lime, followed by Apple. Similar results were obtained in rat studies, where it was found that canned apple and grape juice were more destructive than pineapple or orange juice [11].

A single acidic attack is of minor importance, but if repeated, the ability of the saliva to deal with the acid decreases. Hence, the danger is the frequent use of these fruit juices over time. With the frequent consumption of acidic, sugar rich soft drinks, people are at a high risk of acid demineralization, ultimately leading to erosion and caries development. If the challenge is frequent enough and there are few or no protective factors as in caries susceptible people, this can be quite aggressive.

Conclusion

All the fruit juices used in the present study were acidic in nature and reduced plaque pH below critical pH, especially in the caries active group. Hence, it becomes mandatory for us as preventive dentists, to provide appropriate diet counseling which is tailored for a particular individual to maximize the compliance. At the same time, negative admonitions to stop using these drinks are not likely to be successful. Instead, certain guidance for dental health should follow AAP [American Academy of Pediatrics] guidelines[17] to limit the intake of these juices.

Guide lines [2],[17]:

- Ideally serve drinks only at mealtimes.
- Keep drinking times short.
- Use a straw whenever possible.
- Chilled fruit juices should be avoided.
- Fresh fruits can be preferred in places of juices.

Plaque pH methods alone can only indicate a food stuffs acidogenic potential and possibly the cariogenic potential [3]. Hence, a further in-depth study by a combination of plaque pH model with controls and an insitu i.e., Intraoral Cariogenicity Test [ICT] method is recommended to assess the cariogenic potential.

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Conflicts Of Interest

NIL

References

[1] G. Lehl, J.R Taneja, S L Chopra., Evaluation of the cariogenicity of sugar containing drinks by estimating changes in pH of human dental plaque and saliva. J Indian Soc Pedo Prev Dent. March 1993:9-14.
[2] J F Tahmassebi, MS Duggal et al., Soft drinks and dental health: A review of the current literature. Journal of dentistry. 2006(34):2-11.
[3] MEJ Curzon and JJ Hefferren., Modern methods for assessing the cariogenic and erosive potential of foods. British Dental Journal, 2001(19):41-46.
[4] Kiran Banan, Amritha M Hegde., Plaque and salivary pH changes after consumption of fresh fruit juices. The journal of clinical pediatric dentistry. 2005(30):9-13.
[5] Stephen R M., Intraoral hydrogen ion concentration associated with dental caries activity. J Dent Res.1944;23:257-66.
[6] Vratsanos SM, Mandel ID., Comparative plaque acidogenesis of caries resistant vs caries susceptible adults. J Dent Res. 1982;61(3):465-68.
[7] Mainwaring PJ., A relationship between plaque pH and caries increment in 11-12 year old boys. Caries Res.1981(15):206
[8] Birkhed D., Sugar content,acidity and effect on plaque pH of fruit juices, fruit drinks, carbonated beverages and sport drinks. Caries Res 1984(18):120-27
[9] M E J Curzon, M A Pollard., Integration of methods for determining the Acido/Cariogenic potential of foods: A Comparison of several different methods. Caries Res.1996(30):126-131.
[10] Toumba KJ, Duggal MS., Effect on plaque pH of fruit drinks with reduced carbohydrate content.Br Dent J. 1999 Jun 26;186(12):626-9.
[11] T H Grenby, A Phillips, T Desai and M Mistry., Laboratory studies of the dental properties of soft drinks. British Journal of Nutrition.1989;62:451–64.
[12] W.M Edgar, B G Bibby, S Mundorff, J Rowley., Acid production in plaques after eating snacks: modifying factors in foods. JADA 1975;Vol 90:418-25.
[13] Gregory – Head B, Curtis D., Erosion caused by gastroesophageal reflux:diagnostic considerations. J Prosthodont 1997;6:278-85.
[14] Mc Cay Om, Will L., Erosion of molar teeth by acid beverages. J Nutr 1949;39:313-324.
[15] M A Pollard., Potential cariogenicity of starches and fruits as assessed by the plaque sampling method and intraoral

cariogenicity test. Caries Res 1995;29:68-74.

[16] M S Duggal, J F Tahmassebi, M A Pollard., Effect of addition of 0.103% citrate to a blackcurrent drink on plaque pH in vivo. Caries Res 1995;29:75-79.

[17] American Academy of Pediatrics: The Use and Misuse of Fruit Juice in Pediatrics. Pediatrics. May 2001; Vol. 107 No. 5:1210-13