EFFECT OF FRESH FRUIT JUICES ON pH OF DENTAL PLAQUE

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ABSTRACT

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

Objectives: 1. To estimate endogenous pH and titratable acidity of four freshly prepared fruit juices. 2. To assess the effect of fruit juices on plaque pH in two groups. (DMFT=0 and DMFT≥1)

Material and Methods: Forty Volunteers were divided into two groups based on caries experience. Endogenous pH and titratable acidity of fruit juices; pH of plaque samples collected at different time interval was assessed. Statistical analysis was done by using ANOVA and Tukey's post hoc.

Result: Endogenous pH of all fruit juices was acidic. Titratable acidity was maximum for sweet lime. In group B for Mango and Sweet lime plaque pH was below critical value till 30 minutes.

Conclusion: All the fruit juices tested in present study were acidic in nature and reduced plaque pH below critical pH in caries group.

KEY WORDS: *Fruit juice, Plaque pH, Dental caries, Acidogenic.*

INTRODUCTION

The concept of health has prevailed for centuries and the dietary habits are apparently changing with modernization. "Healthy eating" is now perceived to be important. [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 so called dieting has led to an increased consumption of juices. [4,5] However, claims of their 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 in relation 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 to four commonly consumed fresh fruit juices.

Objectives:
1. To estimate the endogenous pH and titratable acidity of four freshly prepared fruit juices.
2. To assess the effect of these test drinks on plaque pH at various time intervals in two groups. *i.e.* DMFT=0 and DMFT≥1

Materials and Methods

Based on a market survey four commonly consumed freshly prepared, Apple, Sweet lime, Sugar cane and Mango juices were included as test drinks in the study. Forty subjects aged 20-30 year, who were volunteers from People's College of Dental Sciences & Research Centre, Bhopal, India were considered as study subjects. People with satisfactory gingival / periodontal health and not on any medication were included and they were divided into two groups based on caries experience following WHO 1997 criteria,

    Group A; Caries Free (DMFT = 0): 20 adults
    Group B; With Caries (DMFT≥1): 20 adults

Ethical clearance was obtained from the ethical committee of People's College of Dental Sciences

and Research Centre, Bhopal, India and informed consent was obtained from all the participants. This study was conducted from 1st May 2010 to 30th May 2010 in two independent phases. In the phase I, fruit juices were characterized based on analysis of pH and titratable acidity. In phase II analysis of plaque pH was done.

Phase I: **Characterization of fruit juices**

(a) Endogenous pH measurement:-The endogenous pH of each fruit juice was measured by a calibrated digital pH electrode. 20 ml of a freshly prepared fruit juice (all at room temperature) was placed in a beaker and stirred until a stable reading was obtained.

(b) Titratable acidity:- 10 ml of freshly prepared fruit juice was placed in a beaker, titrated with 0.10 M sodium hydroxide (NaOH) added in 0.25 ml increments and stirred until the pH reached 5.5 (measured by calibrated digital pH electrode). Values were expressed as amount of NaOH required (in ml).

(c) **Phase II:- Measurement of Plaque pH.** After the prophylaxis volunteers were asked to refrain from oral hygiene procedures for 24 hours and from eating food or drink for at least two hour prior to the procedure. On examination day, groups were allocated randomly for a freshly prepared fruit juice.

Plaque collecting [Sampling] method: [3,6,7] Plaque was collected at baseline with a spoon excavator from all accessible surfaces of upper central incisors, buccal surfaces of upper first molars and premolars, lingual surfaces of lower molars and incisors. Then the subjects were asked to drink 100 ml of the test drink in one minute and to swish the drink carefully around the teeth before swallowing to maintain uniform method in drinking. Post consumption plaque samples were collected at immediately (at one minute), 5, 10, 15, 30, and 60 minutes and pH was estimated.

The plaque sample was pooled in 5ml of distilled water kept in a glass dish and the pH was determined immediately after collection using calibrated digital pH meter.

After collection of the last sample, subjects were allowed to brush and seven days wash out period was given after which the similar experiment as detailed above was done for the next fruit juice. The collected data was then analyzed using ANOVA and Tukeys post hoc by using SPSS 16 software. P-value of less than 0.05 is considered statistically significant.

Results

The endogenous pH of all fruit juices was acidic. It was minimum for sweet lime (3.80 ± 0.01) and maximum for sugar cane juice (4.89 ± 0.02). Titratable acidity was minimum for sugar cane (1.18 ± 0.08 ml) and maximum for sweet lime juice (2.48 ± 0.09). (Table 1)

SI. No.	Fruit juices	Endogenous pH Mean ± SD	Titratable acidity (in ml) Mean ± SD
Table 1: **Endogenous pH and titratable acidity of fruit juices**		
1	Apple	4.02 ± 0.02	2.00 ± 0.10
2	Sweet Lime	3.80 ± 0.01	2.48 ± 0.09
3	Mango	4.70 ± 0.02	2.12 ± 0.08
4	Sugar cane	4.89 ± 0.02	1.18 ± 0.08
ANOVA P value		3313.18 P<0.001	194.64 P<0.001
Tukey Post Hoc		1>2 3>1,2 4>1,2,3	1,3>4 2>1,3,4

Difference with respect to age and gender was statistically not significant between group A and group B. The resting plaque pH in group A was found to be slightly higher than group B which was statistically not significant. After five minutes plaque pH falls below critical pH (5.5) for all the fruit juices in group B. For all the time intervals plaque pH for sweet lime in group B was lower than any other fruit juice in both the groups. For Mango and Sweet lime (group B) plaque pH was below 5.5 till 30 minutes. (**Table 2, Fig.1**)

Fig.1: **Changes in Plaque pH after consumption of fruit juices at different time interval**
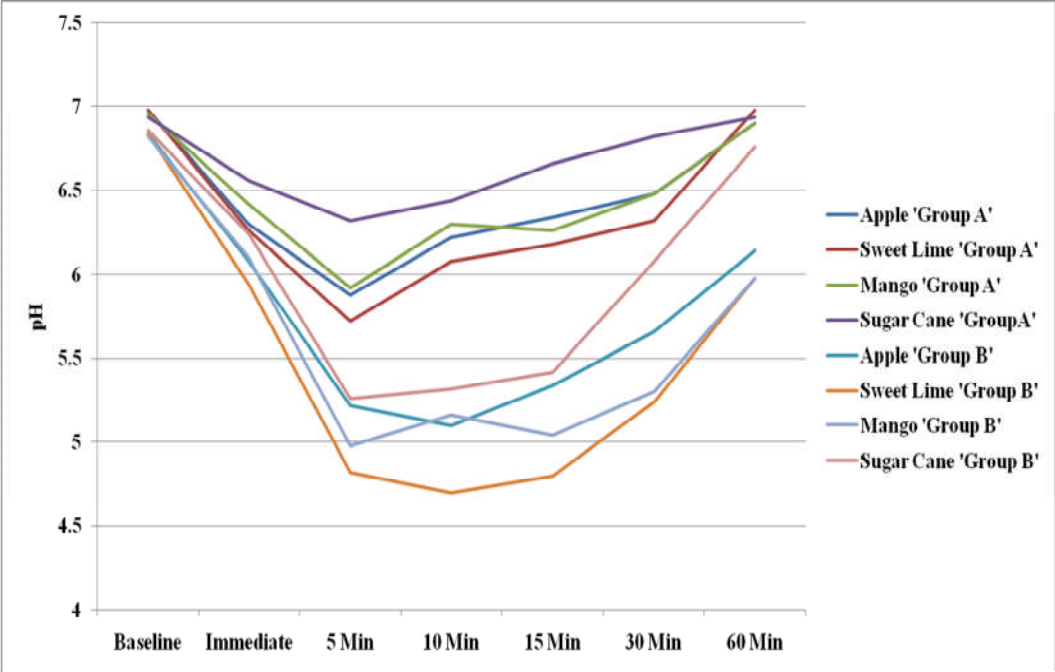

Table 2: **Changes in Plaque pH after consumption of fruit juices at different time interval**

Fruit Juices		Plaque pH (Mean ± SD)						
		Base line	Immediate	5 min	10 min	15 min	30 min	60 min
Group A	Apple	6.98 ± 0.08	6.30 ± 0.07	5.88 ± 0.08	6.22 ± 0.08	6.34 ± 0.09	6.48 ± 0.08	6.90 ± 0.07
	Sweet Lime	6.98 ± 0.08	6.26 ± 0.09	5.72 ± 0.11	6.08 ± 0.08	6.18 ± 0.08	6.32 ± 0.14	6.98 ± 0.08
	Mango	6.96 ± 0.11	6.42 ± 0.08	5.92 ± 0.08	6.30 ± 0.07	6.26 ± 0.15	6.48 ± 0.08	6.90 ± 0.04
	Sugar cane	6.94 ± 0.11	6.56 ± 0.11	6.32 ± 0.08	6.44 ± 0.05	6.66 ± 0.09	6.82 ± 0.08	6.94 ± 0.05
Group B	Apple	6.84 ± 0.05	6.08 ± 0.08	5.22 ± 0.08	5.10 ± 0.07	5.34 ± 0.05	5.66 ± 0.05	6.14 ± 0.05
	Sweet Lime	6.84 ± 0.05	5.94 ± 0.05	4.82 ± 0.08	4.70 ± 0.07	4.80 ± 0.07	5.24 ± 0.05	5.98 ± 0.08
	Mango	6.82 ± 0.04	6.10 ± 0.07	4.98 ± 0.08	5.16 ± 0.05	5.04 ± 0.05	5.30 ± 0.07	5.98 ± 0.08
	Sugar cane	6.86 ± 0.05	6.24 ± 0.08	5.26 ± 0.05	5.32 ± 0.08	5.42 ± 0.04	6.08 ± 0.08	6.76 ± 0.05
ANOVA P value		3.70 P>0.05	27.954 P<0.001	191.33 P<0.001	422.94 P<0.001	320.06 P<0.001	225.49 P<0.001	224.46 P<0.001
Tukey Post Hoc		-	1>5,6,7 2>5,6 3>5-8 4>1,2,5-8 8>6	1,2>5-8 3>2,5-8 4>1-3,5-8 5,8>6,7	1,2>5-8 3>2,5-8 4>1,2,5-8 5,8>6,7	1,2,3>5-8 4>1-3,5-8 5,8>6,7 5,7>6 8>5-7	1,2,3>5-8 4>1-3,5-8 5>6,7 7>6 8>5,6,7	1,2,3,4>5-8 5>6,7 8>5,6,7

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Discussion:

Fruits and fruit juices contain a variety of acids that have the potential to damage the teeth.[8] Excessive use of these drinks has been attached on two main dental grounds:

1. They may be acidic enough to damage (erode) surfaces of the teeth 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.

The time scales of the two processes will differ, however, process may start immediately on contact of the drinks with tooth surfaces.[9] The consumption of low pH fruit juices causes a drop in the oral pH below critical pH and if it is persisted even for few minutes causes a potential damage to teeth.[10]

Edger et al in 1975 showed that carbonated beverages are more efficiently buffered by contact with saliva than fruit juices. It was the buffering capacity of fruit juices which rendered them more able to combat salivary buffers and hence lower the plaque pH further.[11] Hence titratable acidity was measured along with endogenous 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 plaque is dependent on the sugar content, endogenous pH and also the buffering capacity and the manner in which a drink is consumed. The resting (baseline) 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 time for which this low pH remains at its minimum is important, since if it reaches the so called critical pH value, it initiates dissolution of enamel.[4]

The finding of the present study i.e., in caries free person the pH doesn't drop below critical pH after exposure to different fruit juices were similar to the observation made by Stephen in 1944 who found that in caries free individuals plaque pH did not fall below critical pH after a glucose rinse.[12] Plaque from caries free subjects exhibited a higher

initial 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 was similar to a study conducted by Vrastsanos and Mandel in 1982 after a sucrose challenge.[13]

Drinks containing citric and ascorbic acids and had the higher titratable acidity. Beverages with high titratable acidity can have a strong buffering capacity and may resist pH changes brought about by salivary actions.[14,15] This could be possible reason for prolong low plaque pH of sweet lime and mango juice.

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 drinks people are at high risk of acid demineralization and 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.[9]

CONCLUSION:

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

- Ideally serve 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.[2,16]

Plaque pH methods alone can only indicate a food stuffs acidogenic potential. Further studies are needed to study other factors that pertain to the erosive and cariogenic potential of a fruit juice including type of acid, chelating properties, temperature, and protective action of saliva.

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