

Effect of Fruit Juices on pH of Dental Plaque – A Clinical Study

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Abstract:

Objective: To evaluate the plaque pH changes after exposing it to 4 commonly consumed fruit juices.

Methods: Two freshly prepared, Lime and Sweet lime (Mosambi) and 2 ready to drink, Mango juice and Apple juice were included as test drinks in the study. Ten subjects aged 20-25 years were the study subjects and were divided into four groups. A four period cross-over study was designed. The pH of the plaque samples were collected at the baseline and after consumption of the fruit juices at 1, 5, 10, 15 and 30 minutes. Statistical analysis was done by using the paired t-test, ANOVA and Tukey's post hoc test.

Results: The maximum pH fall for all four groups was found at the end of 5 minutes being 6.23, 6.09, 6.13 and 5.99 for mango juice, apple juice, fresh lime, sweet lime, respectively. None of the test drinks had a pH drop below critical pH of 5.5 during the time interval of 30 minutes.

Conclusion: All the fruit juices used in the present study were acidic in nature but did not reduce the plaque pH below critical pH. Hence, from the present study it can be concluded that consumption of these fruit juices do not increase the susceptibility for enamel demineralization and dissolution.

Key words: Clinical trials, Dental health, Plaque pH, Fruit juices.

Introduction:

The concept of health has prevailed for centuries and dietary habits are apparently changing with modernization.¹

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The diet we are consuming has become more refined with increased access to readymade fruit juices and high frequency of snacking. Fruit juices have been widely marketed and promoted as “healthy drinks”.² People prefer more natural and healthful products such as fresh fruit juices, which are conveniently prepared at home and are considered to be healthier.³

An acidic environment ensures the safety of a product by providing conditions which do not allow the pathogenic organisms survive.⁴ A pH of 5.5 is considered to be the ‘critical pH’ for enamel dissolution.⁵ The ‘critical pH’ is the pH at which a solution is just saturated to a particular mineral, such as tooth enamel.⁶

The present study was formulated to test the hypothesis that plaque pH changes but not below the critical pH after exposing it to 4 different commonly consumed fruit juices at various time intervals.

Materials and Methods:

Four, commonly consumed fruit juices i.e., 2 freshly prepared, Lime and Sweet lime (Mosambi) and 2 ready to drink, Mango juice (15% mango pulp in 500ml) and Apple juice were included as test drinks in the study. Ethical clearance was obtained from the ethical committee of Meenakshi University, and informed consent was obtained from all the participants. Following a pilot study, using the ‘n’ master software version 1.0©, with the power of the study being set at 90%, alpha error at 5%, the sample size of 9 subjects for each group of fruit juice was decided for this study. Ten subjects aged 20-25 years, who were volunteers from Meenakshi Ammal Dental college, Chennai were considered as study subjects. People who were not on any antibiotic coverage within 3 months of the study and with caries experience, DMFT < 3 (WHO 1997) were selected.

A four period cross-over study was designed. The volunteers were asked to refrain from oral hygiene procedures for 24 hours and from eating food or drinking for at least 2 hours prior to the procedure.

On examination day, the intrinsic pH of test drinks was measured by the pH strips.

From the 10 subjects, 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 by a single examiner calibrated in the Department of Public Health Dentistry.

Then the subjects were asked to drink 100ml of one test drink in one minute by swishing the drink carefully around the teeth before swallowing. Post consumption plaque samples were collected at 1, 5, 10, 15 and 30 minutes and pH was estimated. Each sample taken was pooled in 5ml of distilled water kept in a centrifuge tube and pH was determined immediately after collection using digital pH meter with glass combination electrode, which should be previously calibrated and standardized with pH 7 buffer solutions. After the collection of the last sample, the subjects were allowed to brush. The 2nd, 3rd and 4th test drinks were subjected to similar experiment on the same 10 subjects following washout period of 3 days between each of the tested drinks.

The collected data was then analyzed by using the Paired t-test, ANOVA and Tukeys post hoc by using the SPSS software-version 17[©] (IBM corporation).

Results:

The endogenous pH of all fruit juices was estimated to be acidic. Fresh lime showed the least pH (2.0) and sweet lime showed the highest pH (4.0). The details are shown in table 1.

The mean base line pH values of plaque were found to be 6.49, 6.52, 6.58 and 6.67 for mango juice, apple juice, fresh lime and sweet lime juices, respectively and differences were very highly significant ($p < 0.001$). The maximum pH fall for all four fruit juices were found at the time interval of 5 minutes and the differences were not statistically significant. None of the test drinks had a pH drop below critical pH of 5.5 and it remained below baseline values even after 30 minutes. The details

of mean plaque pH changes noted for each fruit juice at different time intervals is shown in table 2.

Table 1: Endogenous pH of 4 fruit juices

S.no.	Fruit juices	Endogenous pH
1	Mango juice	3.4
2	Apple juice	2.2
3	Fresh lime	2.0
4	Sweet lime	4.0

Table 2: Changes in Mean-plaque pH levels and mean pH difference after consumption of four different fruit juices at different time intervals:

S.No	Fruit juices	Base line	1 min		5 min		10 min		15 min		30 min	
			pH	Diff								
1	Mango	6.49	6.29	0.20	6.23	0.26	6.28	0.21	6.37	0.12	6.45	0.04
2	Apple	6.52	6.18	0.34	6.09	0.43	6.28	0.24	6.40	0.12	6.49	0.03
3	Fresh lime	6.58	6.24	0.44	6.13	0.55	6.26	0.42	6.38	0.30	6.53	0.15
4	Sweet lime	6.67	6.05	0.62	5.97	0.70	6.14	0.53	6.36	0.31	6.50	0.17
P value*		p<0.001	p<0.05		p>0.05		p>0.05		p>0.05		p>0.05	

*** Paired t-test**

Discussion:

The study was conducted to evaluate the plaque pH changes after exposing it to 4 different commonly consumed fruit juices. Foods and beverages, especially fruit juices, can contain variety of acids that have the potential to damage the teeth.

Excessive use of the drinks has been attached on two main dental grounds:

- 1] They may be acidic enough to damage the tooth surfaces.
- 2] Those which contain fermentable carbohydrates may serve as a source of substrate, from which micro-organisms inhabiting the plaque can

generate the acid that brings about the destructive process of dental caries.⁷

Stimulated saliva plays a major role in modifying plaque pH.⁸ If the pH of the solution is above the critical pH, then the solution is supersaturated with respect to mineral (tooth enamel), and more mineral will tend to precipitate out.⁶

All the four fruit juices were found to be acidic. Among them, fresh lime showed the least pH of 2.0 followed by apple juice (2.2), mango juice (3.4) and sweet lime (4.0). Similarly, in the studies conducted by Preethi *et al*¹¹ and Sabyasachi Saha *et al*¹², sweet lime was found to be acidic with the intrinsic pH being 3.76 and 4.59, respectively. Similarly, in a study conducted by G. Lehl *et al*⁹, the mango frooti was found to be acidic with a pH of 3.33. In a study conducted by Alessandro Leite Cavalcanti *et al*⁵, the pH of the fruits (pineapple, acerola, hog plum, cashew fruit, orange, mango, passion fruit, watermelon and grapes) selected for this study ranged from 2.8 (hog plum) to 5.2 (watermelon) and were all acidic in nature. In a study conducted by Erik H Roos *et al*¹⁰, the consumption of a regular soft drink caused a significantly greater decrease in plaque pH at 5, 10 and 20 minute time intervals when compared to the consumption of a diet soft drink.

The resting plaque pH usually ranges from 6-7.¹³ 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.³

The finding of the present study, there was a drop in pH after exposure to different drinks. In a study conducted by Preethi *et al*¹, plaque from caries resistant subjects exhibited an initial higher pH, a modest fall in pH after consumption of different fruit juices (Mango-frooti, Apple, Pulpy orange, Sweet lime) and a more rapid return to resting levels as compared to caries susceptible subjects.

In this present study, the maximum pH fall for all four fruit juices was found at the time interval of 5 min being 6.23, 6.09, 6.13 and 5.99 for mango juice, apple juice, fresh lime and sweet lime, respectively, but not below the critical pH. The mean plaque pH remained below baseline values even after 30 minutes. In a study conducted by Preethi *et al*¹, 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 and the maximum plaque pH fall was noted at 5 minutes, the maximum being for Pulpy orange and Frooti, followed by Sweet lime and Apple. In a study conducted by Lata Kiren Banan *et al*³, the maximum fall was recorded in most of the subjects, within 5 min of consumption of the fruit juices (grapes, orange and pineapple) which was similar to the present study. But the pH level was below the critical pH at the end of 5 minutes, which was different from the present study (above the critical pH). This difference would be because the fruit juices considered were different. The fall in pH produced in the plaque is dependent on the sugar content, intrinsic pH and the manner in which a drink is consumed.³ In a study conducted by K. J. Toumba *et al*¹¹, results showed that the plaque pH drop after the subjects rinsed with the new blackcurrant drinks was higher as compared with all the other test products and significantly so compared with the mixed citrus drink.

There are few factors to be considered while taking fruit juices and they are: the manner in which the juice is taken into the mouth, the tooth surfaces that come in contact with the juices, the duration of contact with the teeth¹². A single acidic attack is of minor importance, but if repeated, the ability of the saliva to deal with the acid decreases. 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.¹

In the present study, clinical trials were carried out using only one type, among the various commercially available ready to drink fruit juices.

As the composition of the ready to drink fruit juices vary (% of fruit pulp) in commercially available drinks, it is not appropriate at this point to extrapolate the results of the present study to all ready to drink fruit juices. The other limitation of the study was that only one group of young adults (20-25 years) were considered.

There is a dynamic, two-way relationship between diet/nutrition and oral health. Hence, it becomes mandatory for preventive dentists, to provide appropriate diet counseling which is tailored for a particular individual to maximize the compliance and to eliminate 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 to limit the intake of this juices.¹

- 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.

To conclude, all the fruit juices used in the present study were acidic in nature but did not reduced plaque pH below critical pH. In recent years, as fruit juices have flooded the markets as a health drink for all age groups, further studies need to be done on other commonly used fruit juices (orange, grape, guava, litchi and mixed fruits) with children and elderly as study subjects.

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