A Randomized Controlled Trial to Evaluate the Effects of Different Forms of Orange Juice on Dental Plaque Ph

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ABSTRACT

Aim: To study the acidogenic response in human dental plaque in vivo with fresh orange juice compared to orange fruit drink with no added sugar and regular orange fruit drink that were currently available in the market.
Materials and Methods: Ninety subjects aged 18-30 years were allocated randomly into 3 groups. 10 ml of each experimental drink was given to the subjects in each group and instructed to keep in mouth for 2 minutes before swallowing. Intrinsic pH of the test drinks was measured by the Digital pH meter. Plaque pH was measured at the baseline, immediately after consumption and at 1,15 and 30minutes post consumption.

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Result: Inter group comparison by ANOVA showed significant difference among mean pH values and time intervals. There was significant drop in plaque pH in all the three groups after 1minute. Tropicana group showed drop in pH even after 30 minutes while in other two groups, pH returned to initial levels at the end of 30minutes.

Conclusion: The results of our study showed that, plaque pH dropped rapidly after 1 minute of consumption of all the three fruit juices. Plaque pH returned to initial levels in two groups while in tropicana group, it declined.

Keywords: Fruit juice; dental plaque; tooth erosion; pH; Cariogenic.

1. INTRODUCTION

Even though there has been a noticeable reduction in dental caries over the past decades, its prevalence increased in countries where there is increased intake of sugary diet. Consumption of sugars or refined carbohydrates leads to drop in dental plaque pH due to production of organic acids, which increases enamel solubility and causes demineralisation of tooth. Diet has a local effect on oral health including teeth, pH, and composition of the saliva and plaque. Evidence from many studies has shown that dietary sugars have important role in tooth decay [1].

Fruits consist of many essential nutrients which are beneficial to health. Fructose is the major sugar found in fruit juice. All fruit juices contain fructose, but vary in their amount of sucrose, glucose, and sorbitol. Many people consume fruit juices as an easy alternate to whole fruit, unaware of the fact that fructose can be equally harmful as sucrose [2].

Towards the end of twentieth century when Early Childhood Caries got more attention, many mothers started using fruit drinks containing natural sugar or with no added sugar as they were believed to be safe. On the contrary, Frostell [3] proved that all sugars have similar potential to reduce plaque pH as sucrose. Further research by Duggal and Curzon [4] proved that these drinks had similar cariogenic potential as those contained sucrose.

Many in vivo studies have shown that with the intake of sugar containing drinks, there is a drop in the pH of the dental plaque. This acid is neutralised by saliva within 20-30 minutes, pH returns to normal levels [5]. With the frequent intake of soft drinks, saliva ability to neutralize the acid reduces. Hence, the danger is the frequent use of soft drinks over time [6].

Another study by Birkhed, assessed the total sugar and acidity concluded that fruit juices, fruit drinks, and carbonated drinks have the same carcinogenic potential, when testing the total amount of sugar and acidity [2].

The aim of the present study was to study the acidogenic response in human dental plaque in vivo with fresh orange juice compared to orange fruit drink with no added sugar and regular orange fruit drink that were currently available in the market.

2. MATERIALS AND METHODS

This study is a randomized controlled clinical trial. The study subjects involved in this study are dental students who volunteered after being thoroughly informed about our study protocol.

After clinical examination, 90 healthy subjects without any systemic illnesses, who were not under any medications for the last two weeks and not any type of specific diet, without dry mouth, without fixed orthodontic appliances or dental prosthesis, without dental caries or periodontal diseases and non-smokers were included in the study.

The examination site for the study was the distal surface of upper right second premolar and mesial surface of upper molar. If these surfaces were restored, then surface between the two upper premolars was used as substitute. If these teeth were also restored, the study subject was excluded.

The study procedure was thoroughly explained to the study subjects and a signed informed consent was obtained prior to the start of the study. For the determination of dental plaque pH, the participants were asked to refrain from using fluoridated tooth paste or antimicrobial mouth washes. Before starting the study, oral prophylaxis was performed in all the study participants. Study participants were informed to refrain from oral hygiene practices including

mechanical as well as chemical plaque control materials for the next 48 hours following the oral prophylaxis. Subjects were also informed not to eat or drink (except water) for 2 hours prior to the experiment.

Three experimental drinks i.e., orange fruit drink without added sugar (Tropicana 100%) and Pulpy orange juice (Minute maid) and freshly prepared orange juice were coded as Drink A, B, and C respectively. The study participants were randomly divided in to three groups (n=30). Bottle of each experimental drink was shaken before opening, and 10ml of juice was poured in to disposable cup. Baseline dental plaque pH was measured and then teach participant was given the disposable cup containing 10ml of experimental drink and were asked to hold the juice in their mouth for 2 minutes before swallowing. Then the dental plaque pH was measured immediately and at time intervals 1, 15 and 30 minutes after drinking the juice. Dental plaque pH measurements were done using digital pH meter with Metrohm glass electrode connected to the pH meter facilitating the microtouch method. In this method, thin glass probe will penetrate the depth of the dental plaque and comes in contact with the tooth surface, and the digital pH meter displays the reading. Each measurement was repeated thrice, and the mean of the three readings was considered as the final measurement value.

Before the experiment, the glass electrode was calibrated using KCl solution with neutral pH (pH 7). 2% glutaraldehyde solution was used to disinfect the electrode after each use.

The dental plaque pH (minimum pH) after consuming each experimental drink and the difference between the base pH and the minimum pH were determined for all the study participants. Same procedure was repeated on the other two groups using the other two experimental drinks.

The data thus collected was then analyzed by using the one-way ANOVA, bonferroni post hoc test using the SPSS version 10. P-value of less than 0.05 [P < 0.05] was considered to be statistically significant.

3. RESULTS

The total number study participants were 90, randomly divided into 3 groups. Out of 90, 26 were male and 64 were female, with the mean age of 24±1.64 years. Our data analysis of dental plaque pH at time intervals 0 and 30 minutes were significantly different (p=0.035). The baseline and final pH in three groups also showed significant difference. (p=0.02).

The dental plaque pH levels in tropicana group showed lowest value at 30 min with 12.46% decrease (p=0.02). In minute maid group, the drop in pH at 1 min post consumption was 19.2%, after which the pH started to rise, while in the fresh juice group, the pH showed a drop of 4.3% at 1 minute. These findings were summarized.

The endogenous pH of all the three fruit juices was estimated to be acidic. Among that, Pulpy orange showed the lowest pH, followed by Fresh orange juice, and Tropicana [Table 1].

4. DISCUSSION

Frequent consumption of the soft drinks has major role in dental health: (1) that as majority of them are fruit-based or carbonated or both, they may be acidic enough to cause dental erosion (2) that those which contain fermentable carbohydrates (i.e., generally speaking, sugars) may serve as a source of substrate diffusing into the dental plaque, which can generate the acid that brings about the destructive process of dental caries [7]. The aim of our study was to assess the changes in dental plaque pH in vivo, after consumption of three types of orange juices.

Citrus fruits are well endowed with a variety of phytonutrients that are vital in both health promotion and disease prevention. Also they are

Table 1. Endogenous pH of fruit juices

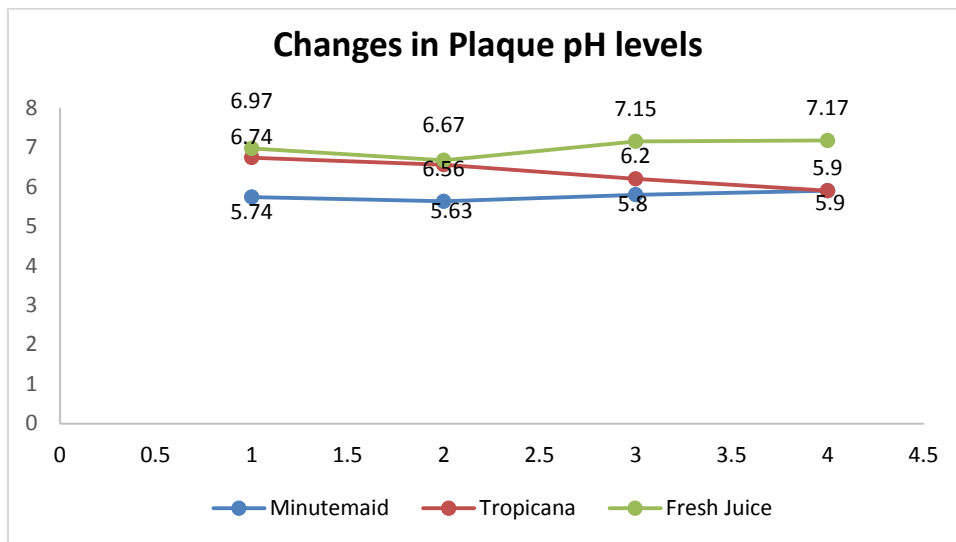| S.No.	Fruit Juices	Endogenous pH
1.	Fresh orange juice	3.4
2.	Tropicana orange juice	3.8
3.	Minute maid pulpy orange juice	3.2

P=0.004; significant*

Fig. 1. Changes in Plaque pH levels

the main sources of citric acid in one's diet [8]. The demineralising effect of citric acid is exceptionally great because of its chelating action on enamel calcium continues even after rise in plaque pH on the tooth surface [9].

Citrus fruits usually contain 7-8% of sugar, selenium, iron, and manganese which has cariogenic effect. But the high content of fluorides and phosphorus makes it cariostatic [10]. When citrus fruits were consumed more than twice a day, it was associated with an erosion risk 37 times greater than those consumed less often [11].

Three types of orange juices used in this study were: freshly prepared orange juice, Tropicana and minute maid pulpy orange. After exposure to the fruit juice, initially there was a drop in dental plaque pH at 1 minute in all the three groups. Maximum drop in pH was observed in Minute maid group followed by Tropicana group, while in fresh orange juice we observed least reduction. This was similar to results obtained by H Mythri et al. [12] and Preethi et al. [13] in their studies using Minute maid pulpy orange. After 15 minutes there was gradual rise in plaque pH of subjects exposed to fresh orange juice and minute maid pulpy orange juice**.** In subjects exposed to Tropicana orange juice the plaque pH did not rise even after a period of 30 minutes.

In a study by Moeiny et al, changes in dental plaque pH were assessed using orange juice, orange concentrate and pineapple concentrate. Highest change in plaque pH was observed after the consumption of orange concentrate with pulp, compared two other juices [13].

In a study by Toumba et al changes in dental plaque pH with four different mixtures of black currant juice were compared. It was reported that, out of the four juices, black currant drink (new formula) had lower acidogenic potential and prevented the drop in pH to below the critical level [14].

Chaly et al evaluated the effect of four types of packaged and fresh fruit juices on plaque pH and reported that there was no drop in pH below the critical level [15].

In the study by Toumba et al, the maximum drop in plaque pH was observed following the consumption of mixture of juices from citrus fruits at the 5 minutes interval and remained below critical level of pH for five minutes [16].

In another study, Azrak et al observed that, maximum fall in pH occurred between fifth and 10th minutes except mineral water, which maintained high pH at all the recorded time intervals [17].

In the present study, at 30minute time interval, the plaque pH raised above the initial levels in except in tropicana group. This finding was in accordance with those of two other studies. Johansson and colleagues observed that, significant fall in plaque pH occurs after the consumption of acidic drinks, as well sugar free variants of these drinks [18].

Similarly, Beighton states that rapid initial fall of plaque pH with 5 minutes after the consumption of fruit juices is due to the acidic content of those drinks rather than fermentation of sugars by plaque bacteria [19].

In the present study, even though all the experimental juices were sugar free, caused a significant drop in plaque pH. This might be due to the fact that, after the salivary clearance of the acidic content of fruit juices, acids produced by fermentation of sugars by plaque microorganisms reach the maximum concentration, leading to the fall in pH.

It has been stated that exposure of bacteria to food stuff with low pH decreases their ability of carbohydrate fermentation and acid production [19].

The pH measurement method used n the present study is a reliable technique, which implies that the result produced in this study are highly reliable. Our study has a limitation, which is the selection of the experimental drinks. The results of this study are valid for these three fruit juices of specific brands.

5. CONCLUSION

The results of our study showed that, plaque pH dropped rapidly after 1 minute of consumption of all the three fruit juices. Plaque pH returned to initial levels in two groups while in tropicana group, it declined.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

Ethical clearance was obtained from the ethical committee of Sathyabama Dental College and Hospital, Chennai (IHEC/Study No 14).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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