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Original Research

Comparison of salivary pH, flow rate and oral clearance rate between packaged fruit drink and fresh fruit juice in young adults: A comparative study

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ABSTRACT

Background: Diet is a major aetiological factor for dental caries and enamel erosion. Dietary habits are apparently changing with modernization. Fresh fruits consumption has tons of benefits but on the other side fresh fruit juices and beverages are acidic in nature and saliva is one of the factors for dental caries. **Objectives**: To assess and compare the salivary pH, flow rate and oral clearance rate between packaged fruit drink and fresh fruit juice among dental undergraduate students. **Methods**: This clinical comparative study was conducted among dental undergraduate students (n=90) at Rajarajeswari Dental College and Hospital, Bangalore. The study subjects were divided into three parallel groups and were given, Group A: Pineapple fruit juice with sugar (30), Group B: Pineapple Fruit juice plain (30) Group C: Packaged fruit drink (30), respectively and then unstimulated saliva samples was collected immediately,5,10 and 15minutes respectively after the test juice consumption. Salivary pH, flow rate was measured at each interval and oral clearance time was estimated. **Results**: The maximum pH drop was observed with packaged fruit drink group immediately after consumption (5.28±0.44) as compared other groups and the salivary flow rate increased after their consumption and was found to be statistically significant ($p<0.001$). The oral clearance rate of pineapple juice without sugar was found to be the least at (9.73±1.55) and was maximum in packaged fruit drink group (16.63±1.35) ($p=0.001$). **Conclusion**: A regular consumption of pineapple juice with sugar should be reduced and packaged fruit drink should be discouraged among young adults as it is found to have cariogenic and erosive potential.

Keywords: fruit juice, salivary pH, dental erosion.

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INTRODUCTION

It is well established that a good diet is essential for the development and maintenance of healthy teeth.[1] The normal pH of saliva is 6.7 to 7.4. When the pH level in mouth goes below 5.5 (i.e., the critical pH value), the acids begin to break down the enamel on teeth. The longer the teeth are exposed to a low salivary pH, the more likely the development of dental caries.[2]

Physical state of food plays a very significant role in its cariogenic potential. Liquid sugars, such as those found in beverages and milk drinks, pass through the oral cavity fairly quickly with limited contact time or adherence to tooth surfaces. The longer the sugar is stuck to the teeth, the longer the bacteria act on sugars and produce acid thus leading to development of dental caries.[3]

The dietary habits are apparently changing with modernization. "Healthy eating" is now perceived to be important. The desirability of a healthful lifestyle has led to an increased consumption of fruit juices.[4] The diet we are consuming has become more refined with increased access to ready-made drink. Also, there has been a substantial increase in consumption of carbonated beverage and fruit juices which is commonly seen in younger age groups and among their peer groups.

Hence, the following study was undertaken with the aim of assessing and comparing the effect of pineapple fruit juice and packaged pineapple fruit drink on salivary pH, flow rate, and oral clearance rate amongst adults.

MATERIALS AND METHODS:

A clinical comparative trial was carried out to evaluate the changes in salivary pH and flow rate after consumption of packaged pineapple fruit drink and fresh pineapple fruit juice and to estimate their oral clearance time.

Before carrying out the present study, the ethical clearance was obtained from institutional ethical clearance committee of Rajarajeswari Dental College and Hospital, Bangalore.

The purpose and study procedure was explained to subjects and informed consent was obtained from each participant. The study was done on August 2019.

Study design: The present study was clinical comparative trial carried out in Dental College and Hospital. 90 randomly selected undergraduate students from the same college were examined. These subjects were selected on the basis of the following inclusion and exclusion criteria.

Study Duration: 3 Months

Study Population: 90 Undergraduate Students from Dental institution (30X3=90)

Inclusion Criteria:

(1) Subjects who were above 18 years of age.
(2) Subjects who were caries-free, that is, with DMFT score = 0.
(3) Subjects who were not suffering from any systemic disease or illness.

Exclusion Criteria:

(1) Subjects who did not give informed consent.
(2) Subjects who were using alcohol or tobacco in any form.
(3) Subjects who were using any medication at the time of study or in the period of the last 15 days prior to the study.
(4) Subjects who were suffering from any systemic illness.
(5) Participants allergic to fruits.

All the study subjects were similar with respect to their age, dietary habits, oral hygiene measures, and other lifestyle factors which could have significant effect on the study results. The time of the day was also standardised for the collection of all the samples.

METHOD OF COLLECTION OF DATA:

Materials:

- Diagnostic Instruments
- pH strips
- pineapple fruit juice
- Packaged pineapple fruit drink
- Sugar
- Graduated saliva Collecting Cups

Methodology:

Unstimulated salivary sample was collected for each study subject at least one hour after their breakfast. After the collection of baseline salivary samples (before the consumption of test fruit juice), the subjects were given pineapple fruit juice to drink and then unstimulated saliva samples was collected at the following fixed time intervals:

(i) 1st follow-up, immediately after test food consumption.
(ii) 2nd follow-up, 5 minutes after the test food consumption.
(iii) 3rd follow-up, 10minutes after the test food consumption.
(iv) 4th follow-up, 15minutes after the test food consumption.

The study subjects were given pineapple fruit juice plain and with sugar and packaged pineapple fruit drink to drink for parallel groups and subsequent salivary samples was collected.

At the baseline, the intrinsic pH of each juice was measured. The amount of sugar added in fruit juice was1 tablespoon each in 100 mL. The fruit juice was consumed as an amount of 200 mL for liquid items.

Packaged pineapple drink contained ingredients of water, pineapple juice concentrate (12.8%), sugar, acidity regulator (INS 330) and antioxidant (ins 300).

Collection of Salivary Samples:

For the collection of unstimulated saliva, subjects seated comfortably on a normal chair. The subjects sitting with their head bent forward and spat into a sterile saliva collecting cups. Unstimulated saliva was collected at baseline and at each time interval after test beverage for up to one minute. The salivary pH was directly estimated using the pH strips buffers of pH 4 and 7.

The pH of saliva was measured as soon as possible and not later than 10 minutes after the collection of the sample. The flow rate was measured directly from the calibrated saliva collecting cups after each sample collection. The oral clearance time was estimated on the basis of time taken for the salivary pH to return to the baseline values.

The recording of the data was done on a proforma containing details on the general information and frequency of uptake of the selected test food of each study subject. To minimise bias or errors in the data, an independent observer, blinded to the study's aim. There was no dropouts and hence no loss of data occurred.

Sample Size Estimations:

The sample size has been estimated using the GPower software v. 3.1.9.2. Considering the effect size to be measured (f) at 34%, power of the study at 80% and

the margin of the error at 5%, the sample size needed is 87, which will be rounded off to 90. Each group will consist of 30 samples. [30 x 3 groups = 90 samples]

STATISTICAL ANALYSIS:
Statistical Package for Social Sciences [SPSS] for Windows Version 22.0 Released 2013. Armonk, NY: IBM Corp., was used to perform statistical analyses.

Descriptive Statistics:
The frequency distribution for categorical data is expressed in terms of number & percentage, whereas for continuous data, it is expressed in frequency, mean, and standard deviation (SD).

Inferential Statistics:
One-way ANOVA test followed by Tukey's HSD Post hoc Analysis was used to compare the mean Salivary Flow Rate, pH & Buffering Capacity between the 03 groups at different time intervals. Repeated measures of ANOVA followed by Bonferroni post hoc analysis was used to compare the mean Salivary Flow Rate, pH & Buffering Capacity between different time intervals in each study group.

The level of significance [P-Value] will be set at P<0.05.

RESULTS
Age and gender distribution among study groups, age ranged from 20-26, 20-25, 21-25 in Group1, Group 2, Group 3 respectively. Majority were females in group 1 (56.7%) and males in group2, 3 (63.3%).
Group 1: subjects who were given pineapple fruit juice with sugar.
Group 2: subjects who were given pineapple fruit juice without sugar.
Group 3: subjects who were given packaged pineapple fruit drink.

Table 1 shows the comparison of mean intrinsic pH of three groups. The intrinsic pH of packaged pineapple fruit drink was least at 4.20, followed by pH of pineapple fruit juice with sugar (4.53±0.16), without sugar (5.24±0.08).it was found that the comparison of mean intrinsic pH of three juices was found to be statistically significant (P< 0.001).

TABLE 1: Comparison of mean Intrinsic pH levels of Juices provided to different groups using One-way ANOVA Test followed by Tukey's Post hoc Test

Groups	N	Mean	SD	*P*-Value†	Sig. Diff	*P*-Value††
Group 1	30	4.53	0.16	<0.001*	G1 vs G2	<0.001*
Group 2	30	5.24	0.08		G1 vs G3	<0.001*
Group 3	30	4.20	0.00		G2 vs G3	<0.001*

† P-Value derived by ANOVA test, †† P-Value derived by Tukey's Post hoc test.

* - Statistically Significant

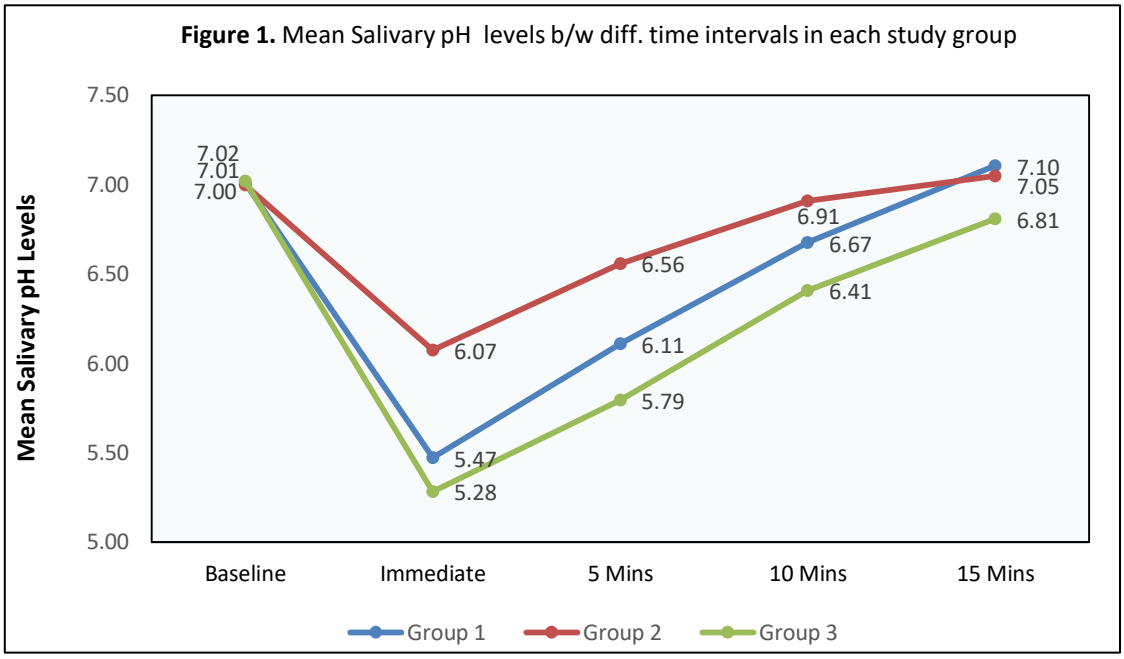

Figure 1 shows mean salivary pH at different interval of time after consumption of different fruit juices. In pineapple juice with sugar, the mean salivary pH of subjects at baseline level was 7.01±0.42, the maximum drop in pH took place at 0 minutes (5.47±0.29) and pH increased gradually reaching 7.01±0.42 at 15 minutes. In case of pineapple fresh fruit juice without sugar, the mean salivary pH at baseline was 7.00±0.33. the maximum drop took place at 0 min (6.07±0.34) and reached to pH of 7.05±0.33 at 15 minutes gradually. In case of packaged fruit drink, the mean salivary pH at baseline was 7.02±0.29. the maximum drop took place at 0 min (5.28±0.44), and reached at 6.81±0.23 at 15 minutes. Although maximum drop in pH was seen in case of packaged fruit drink. *P* value was statistically significant of pH at four time intervals of 0,5,10,15 minutes in all three groups.

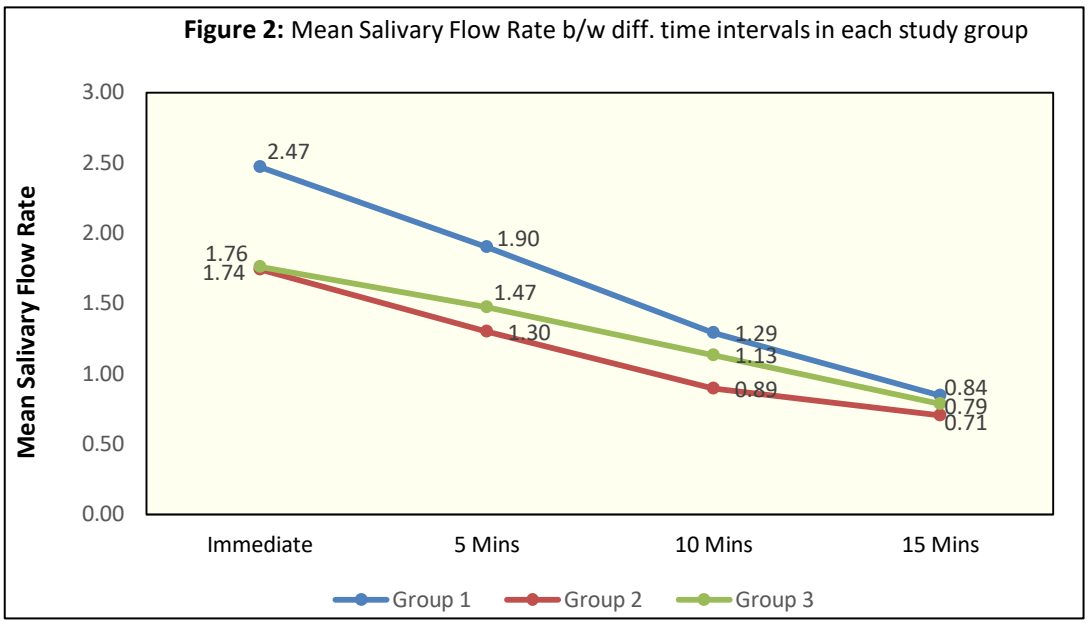

Figure 2 shows the mean salivary flow rate between three groups at different interval of time after consumption of fruit juices. In pineapple fruit juice with sugar, it was observed that mean salivary flow rate was maximum immediately after consumption (2.47±0.52) which reduced eventually at each interval reaching 0.84±0.41 at 15 minutes. In case of pineapple fruit juice without sugar, it was observed that mean salivary flow rate was maximum immediately after consumption (1.74±0.30) which reduced eventually at each interval reaching 0.71±0.29 at 15 minutes. In case of packaged pineapple fruit drink, it was observed that mean salivary flow rate was maximum immediately after consumption (1.76±0.45) which reduced eventually at each interval reaching 0.79±0.23 at 15 minutes. The salivary flow rate was maximum in pineapple fruit juice with sugar group followed by packaged fruit drink and was relatively less in without sugar group and was statistically significant in all three groups at 0,5,10 minutes.

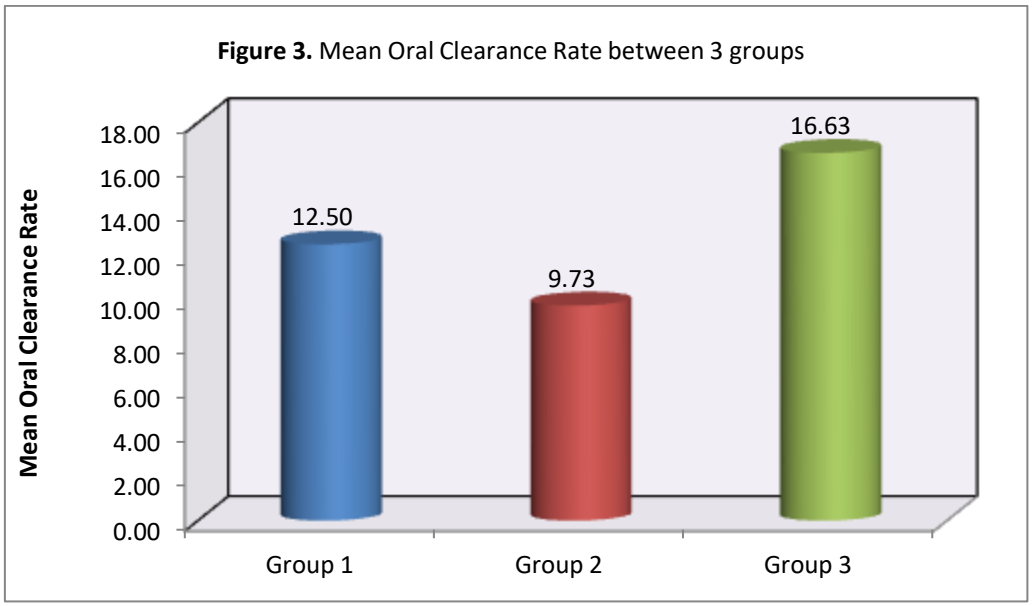

Figure 3 shows comparison of mean oral clearance rate between 3 groups. The oral clearance rate of fruit juice without sugar was found to be least at 9.73±1.55 minute and that of with sugar group was found to be 12.50±1.87. However, oral clearance rate of packaged fruit drink was maximum of 16.63±1.35.

Table 2 Multiple comparison of mean difference in Salivary pH levels b/w time intervals in each group using Bonferroni's Post hoc Test

Groups	Time Intervals				
Group 1	BL vs IM	BL vs 5M	BL vs 10M	BL vs 15M	IM vs 5M
	<0.001*	<0.001*	<0.001*	0.002*	<0.001*
	IM vs 10M	IM vs 15M	5M vs 10M	5M vs 15M	10M vs 15M
	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Group 2	BL vs IM	BL vs 5M	BL vs 10M	BL vs 15M	IM vs 5M
	<0.001*	<0.001*	0.04*	0.07	<0.001*
	IM vs 10M	IM vs 15M	5M vs 10M	5M vs 15M	10M vs 15M
	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Group 3	BL vs IM	BL vs 5M	BL vs 10M	BL vs 15M	IM vs 5M
	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
	IM vs 10M	IM vs 15M	5M vs 10M	5M vs 15M	10M vs 15M
	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*

* - Statistically Significant

Note: BL - Baseline, **IM** - Immediate, **5M -** 5 Mins, **10M -** 10 mins, **15M -** 15 Mins

Table 2 shows comparison of mean salivary pH after juice consumption at different intervals of time. It was found that the difference in the mean salivary pH at baseline and at different intervals of time after juice consumption was found to be statistically significant p<0.001.

Table 3 Multiple comparison of mean difference in Salivay Flow Rate b/w time intervals in each group using Bonferroni's post hoc Analysis

Groups	IM vs 5M	IM vs 10M	IM vs 15M	5M vs 10M	5M vs 15M	10M vs 15M
Group 1	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Group 2	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	0.003*
Group 3	0.003*	<0.001*	<0.001*	0.001*	<0.001*	<0.001*

* - Statistically Significant

Table 3 shows multiple comparison of mean difference in Salivary Flow Rate b/w time intervals and was found to be statistically significant in all three groups (p< 0.001).

DISCUSSSION

In modern society, it has been perceived that prevalence of tooth loss by dental caries or dental erosion is rapidly increasing. The dietary components have been contemplated to be the contributing factor for development of enamel defects. Relation allying diet and nutrition, the oral health and nutrition is a synergistic. Alterations in nutrients consumption

secondary to changes in diet have an effect on the integrity of the teeth.

Fruit juices play a vital role in our healthy diet. One glass of fruit juice is important source of vitamin C, folate, potassium and antioxidants. Some currently available fruit juices contain dietary fibre which can provide an additional fibre source to help optimise overall fibre intake. Because juices taste good, people readily accept them. Although juice consumption has its benefits, yet some potential detrimental effects are also there.[5] The consumption of fruit juices vary greatly among populations. On consumption, they tend to alter pH of oral cavity and shift the equilibrium toward demineralization but data correlating the effect of salivary pH on cariogenicity is scarce in literature. Packaged fruit juices are sweeter having higher sugar content to enhance their taste. It is also known that the plaque pH goes from acidic to normal (or the resting level) within a few minutes and depends on the presence of saliva.[6]

The fruit drink taken in the study was pineapple drink, as it was a seasonal fruit during the study period. The maximum drop in pH took place at 0 minutes It was observed that the mean salivary flow rate was maximum at 0 minutes in all three groups. The oral clearance rate of fruit drink was found to be 15minutes. There have been very few studies done before on pineapple fruit juice and no studies undertaken on packaged pineapple fruit drink.

In present study, the mean intrinsic pH of fruit juice with sugar was 4.53, while baseline pH was 7.01±0.42. These findings are in agreement with the study by Rinki Hans et al, intrinsic pH of fruit drink was 3.89, while baseline pH was 7.05±0.12.[1]

Pineapple juice without sugar group showed a maximum percentage reduction in salivary pH within 5 minutes of 6.07±0.34 in present study and increased eventually at 5,10 and 15 minutes in all three groups . This was in agreement with findings of a study by Ankit Pachori, a maximum percentage reduction in salivary pH within 5 minutes of 6.33.[7] However relatively contradictory by In a study by Sp shetgar et al, showed a drastic drop (3.25)in salivary pH immediately and increased eventually at 10, 30, 60 (4.19, 5.18, 7.51 respectively).[8]

An increase of salivary flow rate was observed immediately after consumption of fruit juices, maximum was seen in with sugar group (1.90±0.57) followed by packaged pineapple fruit drink (1.47±0.40) and was least in without sugar group (1.30±0.38). These findings are in acceptance with study by Rinki Hans et al, the fruit drink taken in the study was mango drink. The mean salivary flow rate was maximum at 0 minutes (1.88±0.04).[1]

The oral clearance rate of fruit juice with sugar was 12.50, without sugar group was 9.73 and fruit drink was found to be 16.63 minutes in this study. This was probably because the liquids tend to clear faster from the oral cavity. These findings are in agreement with a study by Rinki Hans et al, the oral clearance rate of fruit drink was found to be 15 minutes. But contradictory results were seen in a study by Isha Goel et al, the oral clearance rate of fruit juice was found to be 27 minutes.[6] which was probably as a result of the type of acids and sugars and their concentrations in the beverages used in that study. Liquid sugars pass through the oral cavity fairly quickly with limited contact time or adherence to tooth surfaces because of their characteristic readiness to flow, little or no tendency to disperse, and relatively high incompressibility.

Maximum pH decrease after intake of different fruit beverages is an important consideration in dental erosion, as apatite dissolution increases in the lower pH range. The probable reason for the immediate drop in salivary pH in our study could be that the intrinsic acidity of fruit juices rendered it more able to combat salivary buffers.[9]

Though the amounts of a fruit juices normally consumed by population may be insignificant, the presence of immature enamel, inadequate neuromuscular coordination and inability to clear the retentive substrate, along with the deleterious methods of consumption, makes them susceptible to dental erosion.[11] Packaged juices contain high amount of added sugar i.e., sucrose to enhance their taste which is highly cariogenic and have higher acidic content which causes demineralization of enamel tooth surface.[6] Theoretically, the erosive potential of a fruit juices must be dependent upon the immediate effect of the drink & time taken for its clearance on the tooth.

CONCLUSION:

Present study has shown that consuming fruit juice with sugar and packaged fruit drink has major drop in salivary pH and takes more than 17 minutes to attain baseline pH. These beverages are freely available around the educational institutions and are commonly consumed by children and young adults. A regular consumption of fruit juice with sugar should be reduced and packaged fruit drink should be discouraged among young adults as it is found to have cariogenic and erosive potential.

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