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Original Research Article

Effects of carbonated beverage and fruit juice on salivary pH among children in orphanage of Bareilly city: an in vivo study

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ABSTRACT

Background: High degree of urbanization and economic development have resulted in rapid changes in diet and lifestyles, because of which there is a tremendous increase in prevalence of dental caries in developing countries. The aim of the study is to assess the acidogenic potential of commonly consumed carbonated beverage and commercially available fruit juice at various time intervals among orphan children.
Methods: This is an in vivo study in which 60 orphan children were included. Two beverage groups (carbonated beverage and fruit juice) were tested for salivary pH before having respective drinks (baseline) and after having drinks at specific time intervals (immediately after, after 15 min and 30 min). Intra-group and inter-group comparisons were done using Friedman test and Mann Whitney U test.
Results: Both the groups showed decrease in salivary pH after consumption and recovery of salivary pH to baseline value after 30 min.
Conclusions: Beverages produce a remarkable drop in the salivary pH as they contain organic acids and sugars but saliva by virtue of its buffering capacity nullifies this effect and after some time it comes to normal.

Keywords: Carbonated beverage, Fruit juice, Orphaned children

INTRODUCTION

Dental Caries is a chronic omnipresent disease. It is defined as "a microbial disease of the calcified tissue of the teeth, characterized by demineralization of the inorganic portion and destruction of the organic substance of the tooth".[1] Even if dentistry has developed on a very large scale still the problem of dental caries persists. DMFT scores are increasing every year in the developing world.[2] The prevalence of dental caries in India in school children was 53.8% according to National oral health survey.[3] High degree of urbanization and economic development has resulted in rapid changes in diet and lifestyles. Because of this and cultural changes which has happened in the dietary pattern, the beverage industry has grown by 60% in the last 20 years. With a remarkable growth of the advertising industry, children easily fall victim to the lucrative advertisements provided by the beverage companies.[2] Even if people are aware of the harmful effect caused by carbonated beverages and fruit juices on the health still they do prefer to consume these things. The literature reveals that parent's outlook, peer pressure, diet fallacies

which make it look healthier when it is not. Pleasure after consumption and taste are the reasons that lead children to drink these beverages.[4] Parents are the chief caretakers and saviors of a child but sadly thousands of children have to lead their lives without parents. Children living without parents because of their parents being deceased or incapable of bringing up their children, such segment of the society is called as 'orphans'.[5] Behavior and attitude of children are formed and developed from social, cultural, economic and ethnic factors throughout their lives. This process is also influenced by their knowledge of health and prevention of disease which includes oral diseases too.[6] As for all diseases, the maximum load of oral disease is on underprivileged and socially marginalized population. However, disadvantaged children like orphan children are left without access to oral health information due to number of reasons, like inaccessibility to oral health care and education, nature of the disadvantage that may demand participation of specialized professionals.[6] So, being public health professionals it's our duty to make them aware of their oral health related behaviors. Saliva is an important body fluid that is often neglected by dentists and ignored by physicians. Saliva plays a very important role in maintaining health of teeth and gums by way of its buffering action and controlling the demineralization and promoting remineralization continuously at the enamel surface.[1] There will be a drop in salivary pH whenever one consumes sugary foods or drinks. The sweeter a food or a drink is the more will be the degree of the drop in salivary pH. Packaged fruit juices and carbonated beverages are sweeter having elevated sugar content to improve their taste.[7] It is also known that the plaque pH goes from acidic to neutral (or the resting level) within few minutes and it depends on the presence of saliva. This is primarily because of the bicarbonate and phosphate pH buffering agents in the saliva.[8] Thus, the aim of the study is to assess the acidogenic potential of commonly consumed carbonated beverage and commercially available fruit juice at various time intervals among orphan children.

METHODS

This study was conducted at a residential home, Bareilly on 60 orphan children (32 male and 28 female) of 8 to 15 years of age. As there was only one residential home for orphans in Bareilly.

Study design, location and duration

Current study is a randomised controlled trial conducted at residential home for orphans in Bareilly from 18 to 19 June 2015. The study was conducted at 10.00 am to 12.00 pm on each day.

Total number of children in the residential home where the study was conducted was 111 out of which 80 children were eligible to participate in this study. Out of these 80 children, 60 were selected using lottery method. The children were randomly divided into two groups of 30 each. According to the rule, minimum 30 participants are needed in one group and in this study, there were 30 in each group, so the criterion for sample size was fulfilled.[9] Prior permission was obtained from the authorities of the orphanage for conducting the study on 18 and 19th June 2015 on Thursday and Friday, respectively.

Inclusion and exclusion criteria

Subjects with no history of medical illness in last 6 months, having DMFT score of zero and who were ready to give verbal assent were included. Subjects who were medically compromised, were on antibiotic or antiallergic treatment during the last six month and those who failed to give verbal assent were excluded from the study.

Procedure

Two investigators were involved in this study. Intraoral examination was done by first investigator using DMFT index in according to WHO 1997 criteria.[10] Everyday sterilized instruments were taken to the residential home for oral examination of the children. The oral examination is done in daylight. The investigator was calibrated with gold standard investigator in the Department of Public Health Dentistry for DMFT index and the inter-examiner reproducibility was found to be 0.96.

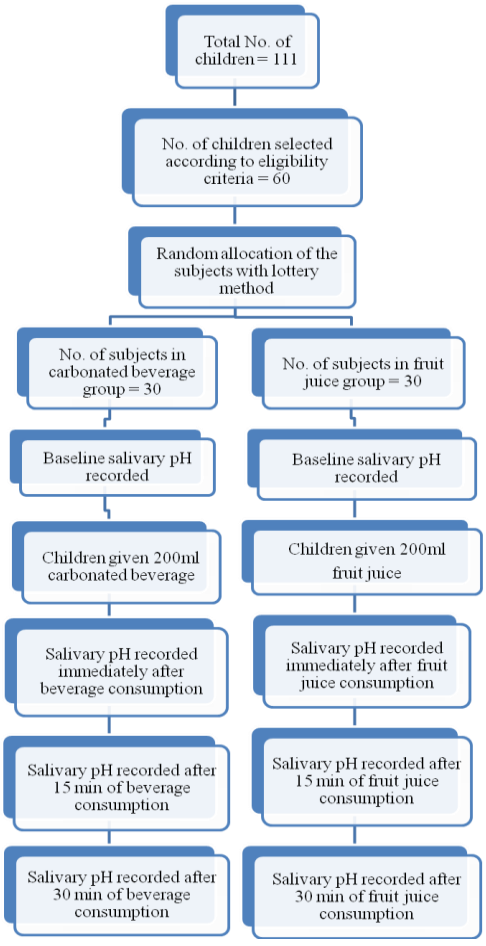

Figure 1: Study protocol.

Test drinks

Test drinks investigated in current study were; Carbonated drink (Fanta)®, Orange juice (Tropicana)®. These drinks were poured in similar shape and size opaque plastic glasses by the second investigator to ensure that the first investigator was blinded to the test drinks given.

Instruments used

The salivary pH is measured using pen type pH meter (PHMETEK). The specifications of the pH meter used in the current study works with the accuracy of ±0.2 pH, range of 0.0 to 14.0 pH and a resolution of 0.1 pH. As instructed in the instruction manual by the manufacturer, the pH reading was recorded after the pH meter was immersed in the collected saliva for one minute.

Saliva collection and pH analysis

Each child was given easy and detailed explanation as to the character and reasons for the test before commencement of the study. The method of collection of saliva was demonstrated on a volunteer (who did not take part in the study) in front of the study population to explain the procedure. Each child was asked not to drink or eat anything on the day of the trial one hour before the collection of saliva. The pre-test salivary sample was collected in a disposable plastic cup. For this the child was asked to sit comfortably with the head slightly inclined forward and to drool saliva from the floor of the mouth into a plastic cup for three minutes. The pH meter was dipped into the cup immediately after collection to record the pH of the saliva. The digital reading was allowed to stabilize in the collected saliva for one minute and the pH reading was recorded. In between readings, the electrode was cleaned with distilled water and placed in a standard solution of pH 7.0. This ensured constant readings and provided a constant check on the drift.

The subjects were then randomly assigned to carbonated beverage or fruit juice group using lottery method by the second investigator. The children were given 200 ml of respected beverages to drink in opaque plastic glasses. Another plastic cup was given to the child immediately after drinking the beverage and the salivary sample was collected for three minutes and the pH was recorded as mentioned above. This was repeated again after 15 and 30 minutes. So totally there were four readings for each child (Baseline, immediately after consumption of the beverage, after 15 minutes and 30 minutes of consumption). On the first day 36 children had participated and on the next day 24 children had participated. The pH meter was calibrated every day prior to measurement for precise reading. The precision of the pH meter was checked at regular intervals to ensure that readings were correct**.** Informed written voluntary consent was taken from the orphanage authorities. Verbal assent was taken from the children.

Statistical analysis

The data obtained was statistically analyzed for intra-group and inter-group comparisons using SPSS version 22.0. Significance level was fixed at $p<0.05$. Intra-group comparison was done at baseline, immediately after drinking the beverage, after 15 and 30 minutes after consumption of the beverages using Friedman test. Inter-group comparison was done using Mann Whitney U test.

RESULTS

The mean age of the study population was 10 years (Table 1).

Table 1: Descriptive statistics.

Parameters	Groups	N	Mean	SD
Baseline	Carbonated beverage	30	7.76	0.43
	Fruit Juice	30	7.71	0.45
immediately after drink	Carbonated beverage	30	6.86	0.51
	Fruit Juice	30	6.85	0.51
15 min. after the drink	Carbonated beverage	30	7.26	0.49
	Fruit Juice	30	7.23	0.52
30 min after the drink	Carbonated beverage	30	7.72	0.46
	Fruit Juice	30	7.69	0.49

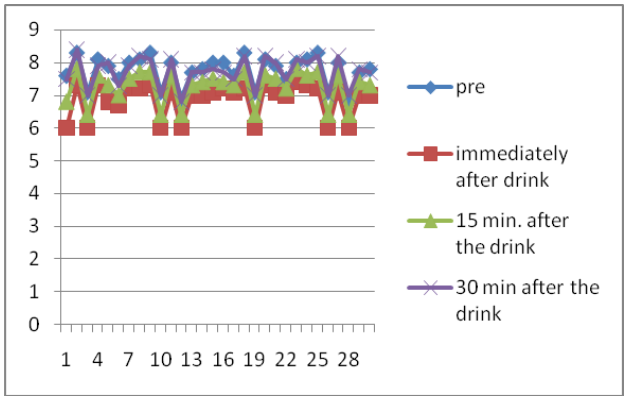

Figure 2: Line graph for carbonated beverage group.

The mean salivary pH of both the groups. The baseline salivary pH for carbonated drink group was found to be 7.76 (±0.43) and for fruit juice group it was found to be 7.71 (±0.45). The maximum drop of pH was observed immediately after drinking and the mean pH of both groups almost returned to the baseline values after 30 minutes of drinking. Test of normality was done to check for the normal distribution. The data was found to be not normally distributed. Hence non-parametric tests were used in the present study.

Table 2: Intra-group comparison for carbonated beverage group.

Groups	Carbonated beverage group		Chi square value	P value
	Median	Range		
Baseline	7.90	1.40	82.19	<0.001
Immediately after drink	7.10	1.40		
15 min. after the drink	7.40	1.40		
30 min after the drink	7.80	1.60		

*Friedman test

Table 3: Intra-group comparison for fruit juice group.

Parameters	Median	Range	Chi square value	P value
Baseline	7.85	1.40	81.81	<0.001
Immediately after drink	7.05	1.40		
15 min. after the drink	7.40	1.50		
30 min after the drink	7.80	1.60		

*Friedman test

Table 4: Inter-group comparison between carbonated beverage group and fruit juice group.

Groups	Carbonated beverage		Fruit Juice Group			
	Median	Range	Median	Range	Z value	P value
Baseline	7.90	1.40	7.85	1.40	-0.492	0.623
Immediately after drink	7.10	1.40	7.05	1.40	-0.052	0.958
15 min. after the drink	7.40	1.40	7.40	1.50	-0.201	0.840
30 min after the drink	7.80	1.60	7.80	1.60	-0.253	0.800
Baseline – immediate	0.90	10.10	0.90	10.00	-0.378	0.706
Baseline - 15 mins	0.50	0.60	0.50	0.50	-0.537	0.592
Baseline - 30 mins	0.10	0.50	0.00	0.40	-0.830	0.407

*Mann Whitney U test

Intra-group comparison for carbonated beverage group is depicted in (Table 2, Figure 2). The salivary pH dropped maximum (Difference 0.80) from the baseline to immediately after consumption of carbonated beverage group. The intra-group comparison values were found to be statistically significant. Intra-group comparison for fruit juice group is depicted in (Table 3, Figure 3).

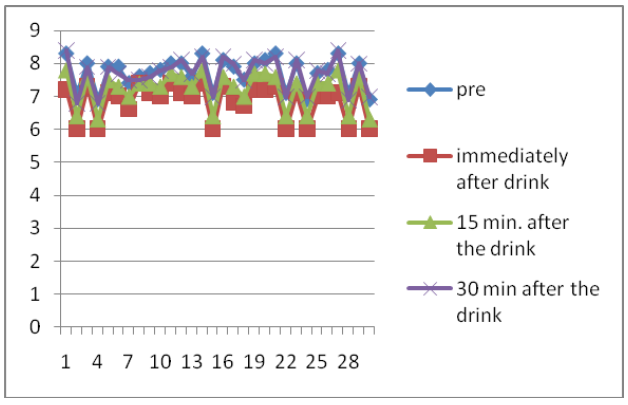

Figure 3: Line graph for fruit juice group.

The salivary pH dropped maximum (Difference 0.80) from the baseline to immediately after consumption of fruit juice group. The intra-group comparison values were found to be statistically significant ($p<0.05$). The inter-group comparison is shown in (Table 4). The data shows no statistically significant difference of salivary pH between the two groups.

DISCUSSION

This study was conducted to assess the acidogenic potential of commonly consumed carbonated beverage and commercially available fruit juice at various time intervals among orphan children. The acidogenic potential of various dietary factors is dependent upon several causative factors. One of them is the presence of organic acids in a variety of fruit juices and drinks which may damage the dentition.[11] The consumption of these drinks leads to fall in pH.[12] The result of the increase in acidic environment makes the tooth surface more susceptible to dental caries attack. After some time of having acidogenic food the pH of saliva returns back to normal. Thus, this study is conducted to find out the time required for the salivary pH to come back to its normal value.

It has been reported that dissolution of dental hard tissue increases by a factor of 7-8 with every drop of pH by one unit thereby significantly increasing the potential risk for

dental caries development.[2] The critical salivary pH for initiation of dental caries is 5.5.[1] In this study the salivary pH was reduced up to 6.86 (±0.51) in carbonated beverage group and 6.85 (±0.51) in fruit juice group, respectively. This is much above critical pH but a single acidic attack is less important; but if repeated again and again, the ability of saliva to deal with the acid decreases. Hence, the danger is the frequent use of these drinks over time. Thus, if the challenge is recurrent enough and there are few or no protective factors as in caries prone people, this can be quite destructive. Oral health care is one of the most common health care need of orphaned children and so they are at increased risk of developing oral diseases.[13] Oral health is an integral part of general health and quality of life. That's why its neglect may give rise to negative health consequences and unpleasant social life of the individuals.[14] Currently, consumption of carbonated drinks is popular among the young population and this deleterious habit generally carries over into adulthood.[15] Acidic foods and beverages are the most common extrinsic factors that cause dental erosion[16] also; so dietary awareness is an important issue in modern society. Thus this study also helps the children to be more aware of the facts about the food that they are consuming.

Valid comparisons could not be made as exploration of available and accessible literature revealed lack of very similar studies. This study showed that there is no difference in the drop of salivary pH after consuming either carbonated beverage or fruit juice. Both the groups showed almost equal drop and recovery of salivary pH after consumption. Similar results were found out by Sudeep et al (apple juice-nectar, apple juice-sugar free and carbonated apple juice); Sardana et al (modified carbonated drink with sodium fluoride and calcium phosphate) and Goel et al (carbonated drink and fruit juice) in their respective studies.[2,17,18] Nonetheless some studies are also in disagreement with our study. The studies conducted by Mojaver et al (soft drinks); Manipal et al (fresh fruit juice, acidic beverage, fortified beverage and milk); Tenuta et al **(**orange juice, cola-based soft drink and 10% sucrose solution) and Takahashi et al (100% orange juice) showed different results than the present study. This might be due to variations in the study design and parameters assessed.[16,19-21] This study has opened new vistas for further research. Study can be repeated using different populations with appropriate sample size; different kind of drinks can be tried; different age groups can also be included as the capacity of saliva to neutralize the acid produced reduces with age and also as it is proven beyond doubt that these drinks are acidogenic; addition of different substances like fluorides or calcium compounds can be tried to reduce their acidogenicity.

CONCLUSION

It could be concluded that these beverages are known to create a remarkable drop in the salivary pH as they contain organic acids and sugars. A few minutes soon after the acidogenic confront, the saliva gets saturated with acid and at this stage demineralization occurs more than that of remineralization, leading to initiation of dental caries. So, to prevent them people should be more careful about the diet they are consuming and the frequency of consumption.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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