Original Article

# To assess the effect of selected locally available beverages on salivary pH, flow rate, and oral clearance rate among adults

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## Abstract

**Aim:** The aim of this study is to assess the effect of selected locally available beverages on salivary pH, flow rate, and oral clearance rate among adults.

**Materials and Methods:** A quantitative diagnostic method for dental caries would improve oral health, which directly affects the quality of life. The pH scale measures how acidic or basic a solution is, with 7 being neutral. When the pH of plaque drops below normal, or <5.5, the acidity starts to dissolve minerals and destroy the tooth's enamel. This clinical trial will be conducted on 40 subjects. Test beverages will be Red Bull, mixed fruit juice, tea, and sweetened milk. Unstimulated salivary samples will be collected for each study subject at least 1 h after their breakfast. After the collection of baseline salivary samples, the subjects will be given one beverage to drink, and then stimulated saliva samples will be collected at fixed time intervals. A digital pH meter will be used to measure the pH at every step.

**Statistical Analysis:** This will be carried out using SPSS version 17, one-way ANOVA, and *post hoc* Tukey's test will be applied in the statistical tests.

**Results**: The maximum drop in pH was seen in the case of carbonated beverage (Red Bull), the oral clearance for all the liquid food items was achieved at 14 minutes.

**Conclusions**: Liquids had a considerable cariogenic and erosive potential despite their quick clearance from the mouth cavity. it is always recommended to limit beverage consumption to maintain good dental health.

**Keywords:** Dental caries; pH; saliva

## INTRODUCTION

According to World Health Organization 2012, oral health is defined as "being free of chronic mouth and facial pain, oral and throat cancer, oral sores, birth defects such as cleft lip and palate, periodontal (gum) disease, tooth decay, and tooth loss, and other diseases and disorders that affect the mouth and oral cavity."[1]

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Saliva is an exocrine solution consisting of 99% water. A range of proteins and electrolytes make up the final 1%. Together, these elements are in charge of the different roles that saliva is said to play. Saliva is formed primarily (approximately 90%) from the secretions of the three paired major salivary glands, the submandibular (around 65%), parotid (around 20%), and sublingual (around 5%7%). These glands are controlled by the autonomic nervous system, while minor glands (labial, lingual, buccal, and palatine), distributed around the oral cavity, produce the remaining saliva (<10%).[2]

Saliva typically has a pH of 6.77.4, but when bacteria break down carbohydrates, they release acids including aspartic,



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lactic, and butyric. These acids lower the pH of saliva. The acids in the mouth start to erode the enamel of teeth when the pH level falls below 5.5, also known as the crucial pH threshold. The longer the teeth are exposed to a low salivary pH, the more likely the development of dental caries.[3]

Among the various protective functions of saliva, including diluting and cleaning the oral cavity, serving as host defense, and buffering and enabling ion exchange, certain salivary characteristics outside this range may contribute to the caries process.[4]

Dental caries is caused by organic acids produced by bacteria fermenting carbohydrates, which dissolve minerals from the tooth's surface. The consistency and flow rate of saliva can affect its ability to flush germs and substrates and preserve dental hygiene.[5] When calcium and phosphate are supersaturated at pH 7 and in the presence of fluoride, salivary pH and buffering capacity can play a role in the ion exchanges that occur during the remineralization and demineralization of enamel. The concentration of hydrogen ions (pH) at the tooth surface also will affect the rate of demineralization.[5]

Food's cariogenic capacity is significantly influenced by its physical state. Sugars that are liquid, like those in milkshakes and other drinks, move through the oral canal very fast and have little opportunity to cling to the surfaces of teeth. Their innate ability to flow, minimal or nonexistent inclination to disperse, and comparatively great incompressibility are the reasons behind this. Solid and sticky sugars get stuck to the tooth surface due to their property of adherence. Dental caries develop as a result of bacteria acting on sugars for longer periods of time and producing acid as the sugar is bonded to the teeth. Since the sugars in slowly dissolving sources of sugar are released gradually during consumption, products such as breath mints, lollipops, and hard candies have a longer oral cavity exposure period.[6] Globalization will inevitably lead to a rise in the accessibility of processed foods and confections. Many cross-sectional, longitudinal, and ecological studies have clearly shown a link between diet – especially sucrose – and dental caries. Based on these findings, researchers have advocated limiting the annual sugar consumption to 15 kg per person, both in developing and in developed countries.[7]

In this modern age, the use of junk food items and snacking between meals is commonly seen in the younger age group and among their peer groups.[7]

Therefore, the need of this study is to evaluate the impact of particular locally accessible beverages on adult salivary pH, flow rate, and oral clearance rate.

## MATERIALS AND METHODS

The study was a clinical trial carried out to evaluate the changes in salivary pH and flow rate after consumption of selected local beverages and to estimate their oral clearance time.

### Sampling

The study was conducted on 40 randomly selected students of age group 1725 years.

### Study design

An unstimulated salivary sample was collected for each study subject at least 1 h after their breakfast. After the collection of baseline salivary samples (before the consumption of the test beverage), the subjects were given one beverage to drink, and then stimulated saliva samples were collected at the following fixed time intervals:

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

The study subjects were given four different beverages to drink for subsequent days and subsequent salivary samples were collected. Carbonated beverages (Red Bull), fruit drinks (mixed fruit juice), tea, and sweetened milk were taken under the liquids category. Before starting, the intrinsic pH of each beverage was measured. The beverages were consumed in an amount of 50 mL for liquid items.

Collection of Salivary Samples – for the collection of unstimulated saliva, subjects were seated comfortably on a dental chair. The subjects sat with their head bent forward and spat into a plastic glass. Unstimulated saliva was collected at baseline and at each time interval after the test beverage for up to 1 min.

The salivary pH was directly estimated using the digital pH meter calibrated with buffers of pH 4 and 7. The accuracy of the pH meter was checked at regular intervals to ensure that readings were correct. To measure the pH of the saliva, the electrode of digital pH is dipped into collected saliva. The digital reading was allowed to stabilize for a few seconds and the pH reading was recorded. In between the readings, the electrode was cleaned with a stream of distilled water and placed in a standard solution of pH 7.

The oral clearance time was estimated on the basis of the time taken for the salivary pH to return to the baseline values.

## RESULTS

The intrinsic pH of several liquid food items is displayed in Table 1.

**Table 1: Intrinsic pH and mean salivary pH at different intervals of time after consumption of different liquid food items**

| Study group | Data size | Baseline | 0 min | 5 Min | 10 Min | 15 Min |
|---|---|---|---|---|---|---|
| Red bull | 10 | 6.218±0.35 | 3.336±0.46 | 5.691±0.50 | 6.339±0.45 | 6.375±0.46 |
| Fruit juice | 10 | 7.086±0.02 | 6.018±0.01 | 6.086±0.02 | 6.602±0.07 | 7.067±0.01 |
| Tea | 10 | 6.958±0.09 | 6.139±0.02 | 6.527±0.11 | 6.881±0.04 | 7.037±0.03 |
| Milk | 10 | 7.125±0.07 | 7.523±0.52 | 5.921±0.04 | 6.212±0.05 | 6.591±0.07 |

**Table 2: Mean salivary flow rate after consumption of different liquid food items**

| | Baseline | Mean ph | *F* | *P* | Significance |
|---|---|---|---|---|---|
| Redbull | 6.218 | 5.43 | 91.01 | 0.0001 | Significant |
| Fruit juice | 7.086 | 6.44 | 1480.2 | 0.0001 | Significant |
| Tea | 6.958 | 6.65 | 393.01 | 0.0001 | Significant |
| Milk | 7.125 | 6.16 | 9.47 | 0.0001 | Significant |

**Table 3: Oral clearance rate of different liquid food iteams**

| Liquid food items | Oral clearance rate in mintues |
|---|---|
| Red bull | 14 Mintues |
| Mixed fruit juice | 15 Mintues |
| Tea | 15 Mintues |
| Sweetend milk | 10 Mintues |

Red Bull had the lowest intrinsic pH (2.04), which was followed by fruit drinks (3.89), tea (6.85), and sweetened milk (7.01). Additionally, it displays the average pH of the saliva at various points in time following the consumption of various liquid foods. In carbonated beverages (Red Bull), the mean salivary pH of the subjects at baseline level was 7.18 ± 0.22. The maximum drop in pH took place at 0 minutes (5.65 ± 0.28). In the case of fruit drink, the mean salivary pH at the baseline level was 7.05 ± 0.12. The maximum drop in pH took place at 0 minutes (6.08 ± 0.09). In the case of tea, the mean salivary pH at baseline was 7.05 ± 0.12. The maximum drop in pH took place at 0 minutes (6.1 ± 0.09). Although the maximum drop in pH was seen in the case of carbonated beverages (Red Bull), the oral clearance for all the liquid food items was achieved at 14 minutes.

Table 2 displays the average salivary flow rate after consuming various liquid foods at various time intervals.

In the case of carbonated beverage (Red Bull), the mean salivary flow rate of the subjects at baseline level was 1 ± 0.13. It was observed that the mean salivary flow rate was maximum at 0 minutes (1.78 ± 0.16) which came back to baseline level at 15 minutes (1.02 ± 0.04). In the case of fruit drink, the mean salivary flow rate of the subjects at baseline level was 0.83 ± 0.15. It was observed that the mean salivary flow rate was maximum at 0 minutes (1.88 ± 0.49). In the case of tea, the mean salivary flow rate of the subjects at the baseline level was 0.8 ± 0.13. The highest recorded mean salivary flow rate of 1.83 ± 0.49 was noted at 0 minutes. The Graph showing mean ph comparison of different study groups at different time interval is shown in Figure 1.

Table 3 shows the oral clearance rate of various liquid food items. The oral clearance rate of sweetened milk was found to be the least at 10 min and that of red bull was found to be 14 min. However, the oral clearance rates of fruit drinks and tea were found to be equal at 15 min.

## DISCUSSION

The beverage market has in recent years seen drastically increased consumption of aerated drinks.[1] Teenagers and children, whom many fizzy drinks are marketed towards, are among the largest consumers and account for 65% of total sales. Parents' influence, peer pressure, diet fallacies, pleasure, and taste are reasons that lead children to consume these drinks.[2] The changes in drinking patterns also have implications for dental health. A common trend has been observed in the drinking habits of children and adults worldwide.[3] The number of sugar-containing snacks and beverages consumed between meals and the late onset of oral hygiene measures correlate positively with plaque accumulation and caries incidence in the primary dentition.[4-5] Soft drinks contain not only sugars but also different organic acids, and they are implicated as an external factor contributing to the formation of dental erosions. Demineralization could occur from extended and frequent consumption of an acidogenic drink, which could cause recurrent bouts of low plaque pH. However, various host factors such as salivary flow rate, buffering capacity, and pH, as well as the concentration of calcium and phosphate in saliva and the frequency of fluid intake, can influence the extent of dental erosion.[6]

Two factors are thought to contribute to the damage that certain drinks due to teeth: First, the low pH and titrable acidity of some drinks can erode the enamel and, second, the fermentable carbohydrate in drinks is metabolized by plaque microorganisms to generate organic acids in the dental plaque, resulting in demineralization and leading to dental caries.[8] The acidogenicity and, hence, the cariogenicity are related to both the extent of acid production and the length of exposure to organic acids.[9,10]

In the present study, the carbonated beverage used was Red Bull which contains carbonated water, sugar, caffeine, coloring agents, and acidity regulator as its ingredients. The quantity of sugar added is 11 g/100 g. It causes an instant decrease in salivary pH of up to 3.336 ± 0.46. The oral clearance rate of soft drinks was found to be 14 min. Continuous pH monitoring revealed that all subjects' mouths were immediately buffered

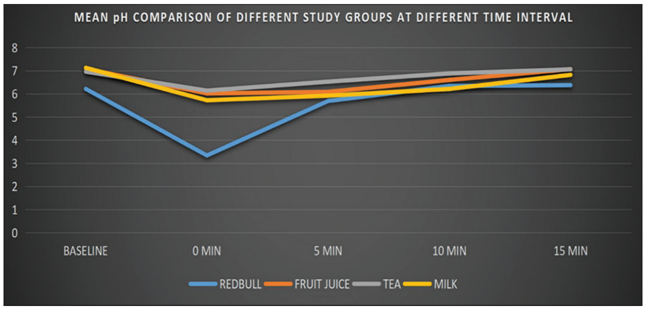


**Figure 1:** Mean PH comparison of different study groups at different time interval

by an acidic beverage in a matter of minutes and that salivary levels swiftly recovered to normal after the drink, in agreement with the findings of Millward *et al*.[1]

Citric acid is a well-recognized stimulant of salivary flow rate, which would be expected to increase salivary washing and oral clearance. The fruit drink taken in the study was mixed fruit juice which is a citric juice. The maximum drop in pH took place at 0 min 6.018 ± 0.01. The clearance rate of fruit drink from the oral cavity was found to be 15 min.

Tea was found to lower the salivary pH but well above the level of critical pH. This may be due to the fact that milk has lactose which has low acidogenicity. The initial rise of the pH of saliva was evaluated by Nielsen and Popkin after consuming milk.[11] The oral clearance rate of tea was found to be within 15 min. Beverages are perceived to be quickly cleared from the oral cavity but, on the contrary, beverages sustain a low pH level for a longer duration of time.[12-13] Same findings have been reported by Ludwig and Bibby they found that the clearance of sugar from the mouth was much more rapid when it was consumed in liquid (beverage) rather than in solid form (snacks).[14]

The affinity toward milk showed a reflex salivation response.[15] According to Jensen, nasal chemosensory afferents play a significant role in the salivary reflexes.[16-19] The reduction in salivary pH of sweetened milk was not significant as at 0 min the pH of milk is very close to the normal (i.e. 7.523 ± 0.52) baseline levels. It was discovered that milk cleared the mouth in 10 min. This is most likely caused by the milk's physical condition, which allows it to quickly exit the mouth. Azrak *et al*., in which the oral clearance rate of milk was found to be 510 min.[2] This result of the present study was in contradiction to the study carried out by Khodadadi *et al*., in which the oral clearance rate of milk was found to be 30 min.[5]

Liquid carbohydrates are not retained in the mouth for very long; however, frequent consumption of carbohydrates throughout the day increases the risk of dental caries. Dental caries and erosion can result from bacteria acids staying in the oral cavity for an extended period of time when teeth are continuously exposed to sugary liquids. Drinking sugary beverages with meals will reduce the chances of developing dental caries and erosion.[19-25]

## CONCLUSION

Liquids had a considerable cariogenic and erosive potential despite their quick clearance from the mouth cavity. it is always recommended to limit beverage consumption to maintain good dental health.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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