



## **Effects of Different Beverages on Salivary pH and Time Taken by Saliva to Regain Normal pH among Teenagers**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. The concept of study, drafting, and finalizing of the results were done by author HH. Data analysis was performed by author NJB. The article was critically reviewed and finally drafted by authors HH and NJB. Finally reviewed and approved by author ANB. Laboratory / instrument-based work was performed under the supervision of author NI and assisted by authors SK and UPH. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Introduction:** Status of oral health depends on diet that we consume on daily basis. Diet does not predispose tissues of oral cavity at risk but it's the change in pH that leads to acidic oral environment causing dry mouth, tooth decay, erosion and bad breath. Potential role of various

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foods in enamel demineralization has been evaluated. The decreased pH for longer durations ultimately leads to enamel dissolution and lesion formation. The current study is aimed to evaluate the change in pH in oral cavity after consumption of Milk, Milk with added sugar, carbonated drink and fresh lemon juice.

**Methodology:** It was a cross sectional study conducted at tertiary care hospital of Karachi from November 2020 to January 2021. An elementary school was contacted for permission access to recruit the teen aged students (13-16year) of either gender. The total calculated sample size at 50% proportion of school strength was 140 students that were further divided into 4 groups i.e., 35 students / group. Recruited participants were educated regarding the study protocols and aims moreover they were divided into groups (Group A, B, C and D) randomly and milk, milk with added sugar, carbonated drink and fresh lemon juice was given to participants to drink in respective order of grouping. After consumption of specific drink pH readings were recorded after 15 minutes, 30 minutes, 1 hour and 2 hours. Saliva was obtained in sterile container for 5 times from one participant. The salivary pH was directly estimated using the digital pH meter (SIGMA pH meter: model number 131) calibrated with buffers of pH 4 and 7.

**Results:** The mean age of participants was  $13.9 \pm 2.3$  years. There were 89 (63.5%) females and 51 (36.4%) males. Most of the participants were from 8<sup>th</sup> and 9<sup>th</sup> class. The decrease in pH of saliva after consumption of either drink was observed in all groups when compared to controls. The paired t test analysis revealed a significant ( $p$ -value=0.002) decrease in pH after 15 minutes and that acidic level of pH was maintained for 30 minutes ( $p$ -value=0.037). ANOVA analysis showed insignificant relation among all groups after having beverages. As after two hours salivary pH returned to normal range when compared to control.

**Conclusion:** There was no any difference in salivary pH after consuming milk, milk with added sugar, carbonated drink and fresh lemon juice after 15 minutes. After 2 hours pH of saliva reverts to its normal value.

*Keywords: Salivary pH; beverages; time interval; teenagers.*

## 1. INTRODUCTION

Status of oral health depends on diet that we consume on daily basis. Diet does not predispose tissues of oral cavity at risk but it's the change in pH that leads to acidic oral environment causing dry mouth, tooth decay, erosion and bad breath [1]. Decrease in pH due to intake of sugary diet leads to carious lesion that which is thought to be a result of acid produced by the *Streptococcus mutans* and erosion is result of acid production by other organs [2]. Currently it is highlighted that it requires a constant change or longer duration of acidic environment to demineralize the enamel [3]. Decrease in pH in oral cavity for short duration does not attribute to pathogenesis as major risk factor any more however, development of lesion and its progression depends on the properties of constituents of diet i.e., adhesion and chelating properties, pKa values, calcium, phosphate, and fluoride content [4].

Potential role of various foods in enamel demineralization has been evaluated, among all the most common source of dietary sugars in children include cold drinks, confectionaries,

biscuits, and breakfast cereals that not only contain sucrose but due their sticky nature consumption of these foods decreases the pH for longer durations that ultimately leads to enamel dissolution and lesion formation [5,6]. Besides carious potential it is also important to identify the erosive potential of various foods. According to Barbour, M.E., et al. citrus fruits, tomatoes, chillies, fruit flavoring chemicals have equal erosive potential as that of cola beverage [7]. It was observed in a case control study that consumption of four dietary acids i.e. Citrus fruit juices, Carbonated beverages sweets and chocolates in between or after the meal can lead to formation of erosive lesion [8].

Dietary habits and consumptions of different foods depends upon culture and socioeconomic status of a population [9]. Identification of acidic potential of certain foods that are most commonly consumed in a population may help in prevention of dental diseases as well as data regarding the association of acidic foods with dental diseases may help in educating the people to decrease the disease burden at population level [10,11]. The most consumed drinks in Pakistan among teenagers are Milk, Milk with added sugar,

carbonated drink and citrus fruit juice [12]. In this regard the current study is aimed to evaluate the change in pH in oral cavity after consumption of Milk, Milk with added sugar, carbonated drink and fresh lemon juice.

## 2. METHODOLOGY

It was a cross sectional study conducted at tertiary care hospital of Karachi from November 2020 to January 2021. An elementary school was contacted for permission access to recruit the teen ager students (13-16year) of either gender. The total calculated sample size at 50% proportion of school strength was 140 students that were further divided into 4 groups i.e., 35 students / group. Recruited participants were educated regarding the study protocols and aims moreover they were divided into groups (Group A, B, C and D) randomly and milk, milk with added sugar, carbonated drink and fresh lemon juice was given to participants to drink in respective order of grouping. Prior to experiment all participants were instructed to brush their teeth and they were prohibited from consumption of food or any drinking product throughout the time of experiment. At the start of experiment a controlled sample of saliva was obtained from all the participants than they were given different drinks according to grouping criteria. After consumption of specific drink pH readings were recorded after 15 minutes, 30 minutes, 1 hour and 2 hours. Saliva was obtained in sterile container for 5 times from one participant. The salivary pH was directly estimated using the digital pH meter (SIGMA pH meter: model number 131) calibrated with buffers of pH 4 and 7. The accuracy of pH meter was checked at

regular intervals to ensure that readings were correct. Data was recorded on proforma. Paired t test was applied to check the mean difference between pre and post pH values of all groups and ANOVA followed by post hoc tukky's test was applied to compare the difference among groups at 95% confidence interval with p-value <0.05 as significant.

## 3. RESULTS

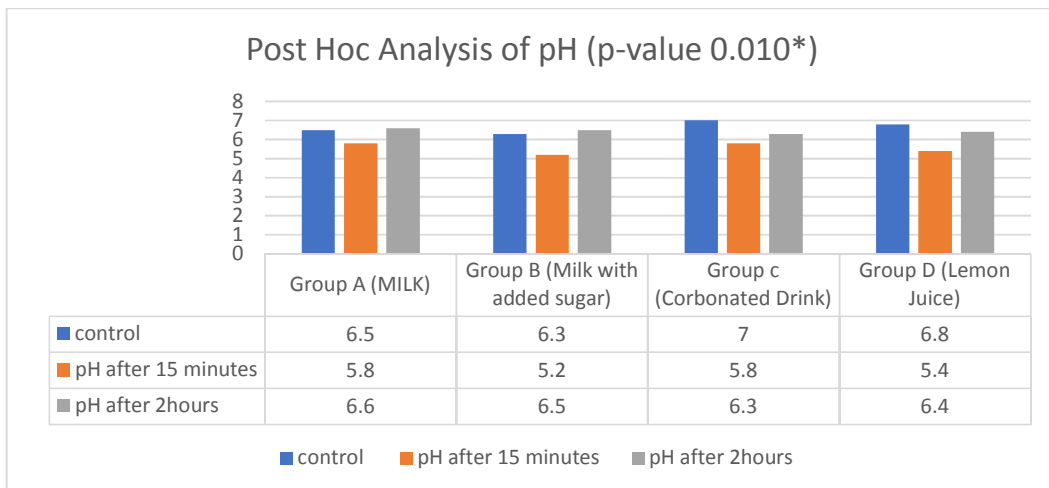
The mean age of participants was  $13.9 \pm 2.3$  years. There were 89 (63.5%) females and 51 (36.4%) males. Most of the participants were from 8<sup>th</sup> and 9<sup>th</sup> class. There was no any history regarding habit in students. However, on examining oral cavity class I dental carries lesion was observed in 40 (28.5%) participants. Pre and post analysis of salivary pH showed decrease in pH of saliva after consumption of either drink in all groups when compared to controls. The paired t test analysis revealed a significant (p-value=0.002) decrease in pH after 15 minutes and that acidic level of pH was maintained for 30 minutes ((p-value=0.037). However, after one hour the recorded pH came in normal ranges when compared to controls. Table 1. Shows the Pre and post comparison of saliva among groups after different time intervals. ANOVA analysis showed insignificant relation among all groups after having beverages. As after two hours salivary pH returned to normal range when compared to control. Furthermore, when the pH at base line was compared with the readings after 15 minutes and readings at 15 minutes were compared with the readings at 2 hour we found significant (p-value=0.010) results as shown in Fig. 1.

**Table 1. Pre and post comparison of saliva among groups after different time intervals**

Groups	Control	15 minutes	30 minutes	1 Hour	2 Hours
A	6.5±0.50	5.8±0.32	6.1±0.45	6.4±0.31	6.6±0.23
B	6.3±0.34	5.2±0.50	5.6±0.61	6.0±0.39	6.5±0.41
C	7.0±0.26	5.8±0.20	5.8±0.52	6.1±0.52	6.3±0.49
D	6.8±0.4	5.4±0.50	5.6±0.19	6.2±0.61	6.4±0.38
p-value		0.002*	0.037*	0.089	0.134

**Table 2. Intra-group comparison of pH at different time intervals**

Groups	Control	15 minutes	30 minutes	1 Hour	2 Hours	p-value
A	6.5±0.50	5.8±0.32	6.1±0.45	6.4±0.31	6.6±0.23	0.0083
B	6.3±0.34	5.2±0.50	5.6±0.61	6.0±0.39	6.5±0.41	0.076
C	7.0±0.26	5.8±0.20	5.8±0.52	6.1±0.52	6.3±0.49	0.067
D	6.8±0.4	5.4±0.50	5.6±0.19	6.2±0.61	6.4±0.38	0.155



**Fig. 1. Comparison of pH among at baseline(control) after 15 minutes and after 2 hours)**

#### 4. DISCUSSION

Saliva has potential to maintain its pH at normal levels however consumption of food and beverages leads to decrease in pH near critical limits i.e., 5.5 at which demineralization of dental tissue may occur [13,14]. As observed in our study after consumption of beverages there was fall in pH level in all groups including Group A in which Milk was given to students. Though milk have buffering ability but after its consumption the decrease in pH value similar to our study has been observed. Dissimilar to our results in a study it was highlighted that plain milk may decrease pH more than the milk with sugar. Along with these findings at 15 minutes were also in opposite to it as they reported that after 15 minutes the salivary pH returns to normal level as that of control however in our result we found that there was continuous decrease in pH till 15 minutes [15]. Similar to our study the drop in salivary pH from 7.01 to 5.56 was observed by R Hans., et al. [16]. The drop in salivary pH after consumption of carbonated drink is attributed to its acidic contents and this decrease in pH is maintained by other ingredients including percentage of carbohydrates. This not only increases the chances of carries but also if persisted for longer duration may lead to erosive lesion [17]. However, salivary flow rate and subsequent drinking of water or rinsing oral cavity after consumption of carbonated drink may alter the pH and may decrease the chances of erosion [18]. Demineralization of enamel was identified when extracted human teeth were immersed in orange juice for 5 minutes [19]. This was associated with change in pH of media. It is

reported that at 5.5 pH hydroxyapatite content of enamel starts demineralization [20]. In our study we found that the decrease in pH of oral cavity remained till 15 minutes followed by increase in pH in subsequent readings. Which is indicating clearly that having citrus juices may increase the chances of enamel demoralization and may be erosion [21].

#### 5. CONCLUSION

There was no significant difference in salivary pH after consuming milk, milk with added sugar, carbonated drink and fresh lemon juice after 15 minutes which concludes that there is no any association of nature i.e., either it has buffering ability (milk) or it is acidic (carbonated drink or lemon juice) the decrease in pH will be observed followed by recovery in 30-60 minutes. After 2 hours pH of saliva reverts to its normal value.

#### CONSENT

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

#### ETHICAL APPROVAL

The study was approved by Baqai University Karachi, Pakistan

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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