To Assess the Level of Salivary Calcium after the Consumption of Carbonated Soft Drinks

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Authors’ contributions

Author KA carried out the retrospective study by collecting data and drafted the manuscript after performing the necessary statistical analysis. Author NPM aided in the conception of the topic, participated in the study design, statistical analysis and supervised in preparation of the manuscript. Author SR helped in performing the study and has coordinated in developing the manuscript. All the authors have equally contributed in developing the manuscript.

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ABSTRACT

Diet is a major etiological factor for enamel erosion and dental caries. The proportionality of dental caries increases with the increase in duration of food in the oral cavity. This study was undertaken with the aim of assessing the level of salivary calcium with the consumption of beverages. Major chemical constituents of beverages include, carbohydrates, sweeteners, acids (pH-2.5 to 3.5) phenolic compounds, steroids, nitrogen compounds, ethanol (for alcoholic beverages) and carbon dioxide (for carbonated soft drinks). The presence of carbon in the soft drinks reduces the pH leading to demineralisation and erosion of enamel layer when consumed. The sugars and carbon present in the soft drinks are responsible for dissolution of enamel. Thus the aim of the current study is to analyse the effect of carbonated soft drinks on salivary calcium level. In this study 25
1. INTRODUCTION

According to the World Health Organization, oral health is defined as being freed from chronic mouth and facial pain, oral and throat cancer, oral sores, birth defects like cleft lip and palate, periodontal diseases, tooth loss, and other different diseases and disorders that have an effect on the oral cavity. Urbanisation and economic development have resulted in fast changes in lifestyle and diet that have become less nutritional [1]. Also there has been a considerable increase in consumption of effervescent potable & fruit juices [2]. Though individuals are aware of the harmful impact caused by effervescent beverages and fruit juices on the teeth, they tend to choose them [3]. The literature reveals that parent’s influence, peer pressure, diet and lifestyle habits lead youngsters to consume these drinks [4].

Saliva plays a significant role in maintaining the integrity of teeth by means of its buffering action and promotes demineralisation and remineralisation, that occur endlessly at the enamel surface [5]. The pH, the Salivary calcium and phosphate content of a drink or food are the necessary factors to be blamed for the erosive attack and formation of dental caries [6]. The carbon-dioxide reacts with water to produce carbonic acid. The carbonic acid then dissociates into hydrogen and bicarbonate ions. The hydrogen ion is responsible for decrease in the salivary Ph. The traditional pH scale of saliva is 6.7 to 7.4. However as microorganisms break down the carbohydrates, they unharness carboxylic acid, saturated fatty acid, and amino acid that bring down the pH scale of secretion. Once the pH scale level in the oral cavity goes below five, the acids begin to interrupt the enamel. The longer the teeth are exposed to a low salivary pH scale, the additional development of dental caries is [7]. Physical state of food is a significant factor enhancing its cariogenic potential. Slowly dissolving sources of sugars, like hard candies, breath mints, and lollipops, have extended exposure time within the oral cavity as the sugars are cautiously liberated during utilisation [8]. The erosive potential of beverages depends on a complex interaction of factors like acid type, acid concentration, temperature and the buffering capability of the saliva. It is now accepted that both pH scale and titratable acidity are the indicators of the erosive potential of a food or drink [9–11]. The pH scale corresponds to the equilibrium measure of the hydrogen ion concentration, however it provides no indication of the overall acidic content of the food or drink, while titratable acidity provides a measure of all free hydrogen ions accessible to cause erosion. Both the pH scale and titratable acidity are often used to investigate the acidic property of beverages [12,13].

Dental caries remains the foremost chronic disorder in children and adults. The most prone age is 17–25 years. During this stage, use of food items and snacking between meals is usually seen within the younger age groups and among their peer teams [14]. The capability of a beverage or a juice to erode dental enamel depends not solely on the pH scale of the drink, however conjointly on its buffering effect [15]. Dental erosion is the irreversible loss of tooth structure caused due to dissolution of enamel by acids without the involvement of microorganisms [16]. It is related to dietary acids which are consumed through beverages and soft drinks. There is a powerful correlation between the quantity and the frequency of free sugar intake and tooth decay. Refined foods and fermentable carbohydrates increase the danger of dental disease. On the other hand, starchy staple food and fresh fruits have shown to be related to low levels of caries activity. Enamel, the outermost layer of tooth that is visibly seen in the mouth, is a porous, calcified substance made from crystalline calcium phosphate. Enamel is a

Keywords: Enamel; dissolution; beverages; calcium; demineralisation.
uniquely organized nano structured material forming the outer covering of teeth [17]. Enamel is generated by ameloblasts, which are epithelial cells, derived from the enamel organ of developing teeth [18-20]. Prolonged contact with carbonated drinks could destroy the hard tissues of the teeth by erosion [21-22].

Previously our department has published extensive research on various aspects of microbiology [23–37], this vast research experience has inspired us to research the impact of carbonated drinks on salivary calcium level. Thus, the objective of the current study was to assess the effect of carbonated drinks on salivary calcium level.

2. MATERIALS AND METHODS

The current study was a retrospective study conducted to assess the level of salivary calcium after consumption of carbonated soft drinks. In the current study 25 subjects were selected. Subjects were given 200 ml of carbonated soft drinks immediately after opening the soft drink to avoid escaping of carbon dioxide. In the current study a commonly sold carbonated drink that contained 42 gram of sucrose, 60 mg of sodium, 0 g of fats and proteins with a pH of 3.8 was considered. The level of salivary calcium is measured and analysed by paired sampling using commercially available calcium arsenazo kit and the results were statistically analysed, compared and interpreted. Subjects (both Male and females) with sound oral cavity without dental caries or other dental disorders between the age group of 15 to 50 years were included in the study and subjects with dental caries and other dental problems like fluorosis, periodontal diseases etc were excluded from the study.

Once the salivary samples before and after consumption of carbonated soft drink were collected the experiment was initiated. Three test tubes labelled as B (blank), S (standard), T (test) were taken. 500μl of the working reagent that is the calcium arsenazo is added to all the three test tubes. 5μl of the test sample is added to the T test tube. The solution is mixed and incubated for 5 minutes at 37°C. The absorbance of the standard and the test against the blank is noted with a 620 nm filter. The concentration of calcium before and after consumption of carbonated drink was calculated using the formula below:

Concentration of calcium in mg/dl = [optical density of the test/optical density of the standard] x concentration of the standard.

Data for the study was collected. Collected data were tabulated in the excel sheet. This data was then imported to SPSS by IBM after coding. Parametric and non-parametric correlations were done. Following which graphs were made. P value was determined using paired t tests to verify the significance of each of the variables considered and the results were interpreted and analysed statistically.

3. RESULTS AND DISCUSSION

The carbon content in the soft drinks reduces the pH of the oral cavity making the pH acidic. When the pH goes below 5 the acid begins to interpret with the enamel layer and causes demineralisation of the enamel. The constant consumption of such drinks decreases the pH of the oral cavity, making the enamel brittle and susceptible to caries. Additionally, the sugars in the beverages facilitate this process. It is evident from the statistical analysis that the concentration of salivary calcium had increased after the consumption of carbonated soft drinks with a p value of less than 0.005, proving statistical significance (Table 1, Graph 1).

<table>
<thead>
<tr>
<th>Calcium concentration</th>
<th>Paired differences</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Std. Error</td>
<td>95% confidence interval of the difference</td>
<td>Lower</td>
</tr>
<tr>
<td>Mean</td>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before vs after</td>
<td>-5.51640</td>
<td>1.43880</td>
<td>.28776</td>
<td>-6.11031 \ -4.92249</td>
</tr>
</tbody>
</table>

This table reveals that all the association between the salivary calcium level before and after consumption of carbonated soft drinks to be statistically significant with a p value of 0.000 (P<0.005), deliberately proving the significance. Thus the level of salivary calcium is higher after consumption of carbonated soft drinks.
Carbonated soft drinks attack the tooth enamel, the enamel begins when the acids present in the acidic beverages, the surfaces of our teeth begin. When we consume carbonated drinks or other acidic beverages, the surfaces of our teeth begin to soften and dissolve immediately. Erosion of the enamel begins when the acids present in the carbonated soft drinks attack the tooth enamel, which is the outermost protective layer of our teeth. Their effect basically reduces the surface hardness of the enamel. Tooth decay is caused due to the feeding of bacteria on sugar from foods and drinks to produce acids that dissolve and damage the teeth.

Regular soft drinks, sports drinks, energy drinks, fruit juices, fruit drinks and cordials also have high acid levels that can cause tooth erosion. Regular loss of enamel can lead to cavities and exposure of the inner layers of the tooth that may become sensitive and painful. Prevention of enamel loss is very important for the long term health of our teeth. Each acid attack lasts for around 20 minutes. Every time we take a sip of the drink, the acid damage begins all over again.

As stated by Featherstone et al, in 2008 the initiation of the dental caries process is triggered by a rise in the acidity of dental plaque. The process of tooth decay occurs once the acid-producing bacteria found in bacterial plaque on teeth prey on possible carbohydrates and produce organic acids as by-products [39]. The acids diffuse into the tooth surface and dissolve the carbonated hydroxyapatite mineral that

Graph 1. Bar graph showing the association between the concentration of salivary calcium before and after consumption of carbonated soft drinks
Concentration of calcium before consumption of soft drinks is represented in blue and after in red. The X axis shows the number of saliva samples collected for the study and the Y axis shows the percentage concentration of calcium in the samples. It is evident from the graph that salivary calcium had increased in all the subjects after the consumption of carbonated soft drinks. (Paired t test Value: 24; p value=0.000- statistically significant)

From the statistical analysis it is clear that the mean value of the level of salivary calcium had spiked up after the consumption of carbonated soft drinks. This is in accordance to the study conducted by Janet et al in 2006, who stated that the association of Soft drink induced demineralisation of dental enamel has increased sharply over the last decade. This is considered the major predisposition in caries susceptibility in younger individuals. The tooth demineralisation is typically referred to as erosion, that is outlined as the chemical dissolution of dental enamel without microorganism involvement. During erosion, calcium and phosphate are dissolved from the enamel that eventually results in a collapse of the enamel surface structure and loss of the outer enamel layers [38].
consecutively forms a lesion. When food or drinks containing sucrose is consumed, the bacteria in the plaque rapidly convert the sugars into acid. Tooth decay may be managed by modifying behaviour and controlling its contributive factors, i.e. reducing the frequency of intake of fermentable carbohydrates from food and soft drinks. This can cut back the possibility of the dental biofilm developing into cariogenic biofilm. The bacteria in cariogenic biofilm produce organic acids when carbohydrates, particularly sugars are taken, leading to low pH causing demineralisation [40]. The mineral loss may be recovered or remineralised from ions dissolved in the saliva. When the rate of demineralisation exceeds the rate of remineralisation, the lattice is destroyed and progresses to the formation of dental caries [41].

4. CONCLUSION

From the study, it can be documented that the level of salivary calcium had increased after the consumption of carbonated soft drinks, owing to the confirmation of decrease in the pH of the oral cavity after consumption of carbonated soft drinks. The constant reduction of pH will lead to demineralisation (that is the dissolution of inorganic content of the enamel the calcium in dominance) thus increasing the level of salivary calcium that would weaken and abrade the enamel. That in turn would make the enamel brittle leading to easy fracturing of the tooth structure. Thus, the overall impact of carbonated soft drinks on the enamel can be better understood from the current study.

CONSENT

As per international standard or university standard, patient’s written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

Ethical approval for the current study was obtained from the institutional ethical board (Ethical approval number: SRB/SDBDS/18/MICRO/01).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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