Introduction

Dental erosion is defined as loss of tooth substance by chemical processes, not involving bacteria. It can be caused by variety of intrinsic and extrinsic factors. Intrinsic factors are the result of endogenous acid, generally gastric acids that contact teeth especially in patients suffering from anorexia, bulimia and gastrointestinal disturbances. Extrinsic factors are related to frequent consumption of acidic foodstuffs or beverages and exposure to acidic contaminants in the working environment. Dietary acids present in low pH soft drinks are presumably the major erosive ingredients. The consumption of citric fruits juices and acidic beverages, especially soft drinks, has been associated with an increase in the prevalence of dental erosion. Thus the modification of the formula of acid beverages is one of the possible methods of minimizing their erosive effect. Some decrease the mineral loss of enamel and dentine under conditions of erosion. One of such compound used is calcium lactate. Calcium Lactate is a tasteless, nontoxic, and fairly soluble compound. So the basic purpose of this study was to evaluate if the addition of Calcium Lactate to soft drinks to know whether there is a decrease in the amount of erosion.

Materials and Methodology

Three soft drinks (Maaza, Appy Fiz and Pepsi) were taken and normal water was taken as control group. Forty dental blocks were taken based on inclusion and exclusion criteria. Inclusion criteria includes intact tooth surfaces without any lesions, teeth extracted for orthodontic treatment and teeth extracted from healthy child and teeth were excluded with signs of trauma, caries, trauma, erosion, restorations or any malformations. All the teeth were thoroughly cleaned and polished and then stored in distilled water until use. The teeth were sectioned below cement-enamel junction using double sided diamond disk in a micro motor hand piece. The tooth specimens were placed in chemically activated chemical acrylic resin. After they were placed in the resin an 8mm window was created using tape on two sides in the specimens.

Forty dental blocks were randomly allocated in four different groups.

- **Group1-** ten teeth specimens exposed to group A containing Maaza with and without 5% calcium lactate.
- **Group2-** ten teeth specimens exposed to group B containing Appy Fiz with and without 5% calcium lactate.
- **Group3-** ten teeth specimens exposed to group C containing Pepsi with and without 5% calcium lactate.
- **Group4-** ten teeth specimens exposed to group D containing normal water with and without 5% calcium lactate.

Each soft drink was initially checked for their respective pH. The initial pH of each drink was measured using a pH meter (ELINCO PHX-1400 pH METER). Later the prepared dental blocks were inserted in the respective soft drinks for fifteen cycles with 3 seconds of exposure time for each cycle. 1 minute gap was maintained between two consecutive cycles. Surface loss was assessed using digital surfometry (Mitutoyo Surftest SJ-201P) which was present at Department of Mechanical Engineering, G Mallikarajuna Institute of Technology, Davangere. Surfometry also known as Profilometry has been extensively used to characterize surface roughness caused by erosion. The date obtained from surfometry was recorded in micrometres (µ). After the first step all dental blocks were rinsed by distilled water.

Respective soft drinks containing 5% calcium lactate was prepared using a customized mixer. Again pH of the respective soft drinks was checked. Again the dental blocks were kept in the newly
prepared soft drinks solution for fifteen consecutive cycles with three second of exposure time. Between the cycles 1 minute time gap was again kept. Surface loss was again reassessed using Digital Surfometry. Temperature was kept constant for the entire procedure constant as temperature does have a significant effect on the pH of the solution. The data was analysed using SPSS vs 22. ANOVA was used to assess separately degree of erosion of tooth blocks in all the soft drinks samples with and without 5% Calcium Lactate as shown in graph 1 and 2. Paired T test was used to determine the degree of surface loss within each group before and after adding 5% Calcium Lactate shown in graph 3.

RESULTS

Surface loss and roughness
The SL values after erosive challenges before and after adding 5% calcium lactate are shown in graph1.

Graph 1- Surface loss (SL) of dental blocks after exposure to each solution.

p value ≤0.05 was taken significant.

Initially, surface loss was assessed after the dental blocks were kept in respective soft drinks for consecutive 15 cycles for 3seconds exposure with 1 minute time gap between the cycles. The highest degree of surface loss was shown by group C which contained Pepsi with mean surface loss value of 1.55µ.

Graph 2-Surface loss (SL) of dental blocks after exposure to each solution after adding 5% Calcium Lactate.

p value ≤0.05 was taken significant.

In graph 2 surface loss of dental blocks after adding 5% Calcium Lactate was evaluated. Highest mean surface loss was again shown by Group C with a mean value of 1.36 µ.

Graph 3-Surface loss (SL) values of dental blocks after exposure to each solution before and after adding 5% Calcium Lactate in their respective groups.

p value ≤0.05 was taken significant.

In graph 3 each dental blocks surface loss was assessed before and after adding 5% Calcium Lactate in their respective pairs and the highest mean surface loss gradation was seen in Group B which had Appy Fiz(0.22µ). This correlates with previous table that as higher the acidic pH greater the degree of dental erosion.

Table 1 shows the pH values of respective soft drinks before and after adding 5% Calcium Lactate.

<table>
<thead>
<tr>
<th>Samples</th>
<th>pH</th>
<th>Rise in pH</th>
<th>pH after adding 5% Calcium Lactate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A- Maaza</td>
<td>3.5</td>
<td>1.06</td>
<td>4.56</td>
</tr>
<tr>
<td>Group B- Appy Fiz</td>
<td>3.2</td>
<td>1.25</td>
<td>4.45</td>
</tr>
<tr>
<td>Group C- Pepsi</td>
<td>2.7</td>
<td>2.32</td>
<td>5.02</td>
</tr>
<tr>
<td>Group D- Normal water</td>
<td>6.4</td>
<td>0.31</td>
<td>6.71</td>
</tr>
</tbody>
</table>

The pH values among the experimental juices are shown in table. The pH value gradually increased with the addition of 5% calcium lactate. Group C containing Pepsi had the highest acidic pH value of 2.7. By the addition of 5% Calcium Lactate there has been a considerable reduction of acidic pH. Group C had the highest rise in pH of 2.32 to show a final pH value of 5.02. After the addition of 5% Calcium Lactate the highest acidic pH was shown by group C which contained Appy Fiz with a value of 4.45. So from this table it can be said that pH of the soft drinks had a significant change by the addition of 5% calcium lactate.
DISCUSSION

The main aim of this study was to determine the degree of erosion by low pH soft drinks and water before and after adding 5% Calcium Lactate to it respectively. The study employed in situ methodology developed to study dental erosion by extrinsic agents.

Study by Dr. Beiraghi et al on erosion which was conducted on rat molars demonstrated that by the addition of 5% calcium lactate to Coca-Cola, significantly reduced erosion in rat molars. Whether this inhibiting action of Calcium Lactate is due to the calcium ion or lactate, or both, is not clear, since no attempt has been made to determine the mechanism of action in this study. However, it seems likely that the effect was due mainly to reduction of enamel dissolution by calcium ions.

In the present study pH of soft drinks and normal water was checked both before and after adding 5% Calcium Lactate. It showed that Pepsi had the highest acidic pH of 2.7 followed by Appy Fizz [3.2] before the addition of 5% Calcium Lactate. After the addition of 5% Calcium Lactate pH of all the soft drinks had significant changes. pH of Pepsi got increased to 5.02 whereas that of Appy Fizz to 4.45. Similar study results were obtained by the study conducted by Neha Awasthi et al. The study demonstrated the erosive potential of five commercially available flavoured drinks in India. The drinks used were Pepsi, Apple juice, Appy Fizz, Gatorade (sports drink) and flavoured milk.

The pH of all drinks investigated in this study ranged from 2.75-7.30 on opening, amongst which Pepsi (pH-2.7), Apple juice (pH-5.2) and Gatorade (pH-4.2) had values below the critical pH at which enamel dissolution occurs (9,10).

In the in vitro study by Hitomi Mita et al., adding 1.5% to 2.0% PO4-Ca slightly increased the initial pH of apple juice to reach approximately 3.8, and the enamel erosion caused by the juice could be decreased. This study showed similar positive results to that of the current study stating that lower pH of the drinks higher the erosive power of the drinks. An adding basic adjuncts to the respective solution considerably reduced the acidic pH as in turn reduced the erosion of the tooth surface (9,10).

CONCLUSION

Although the erosion and caries processes are different in their histological appearance, the two conditions occurring concurrently could be deleterious to dental hard tissues. It is necessary to educate patients about the harmful effects of excessive consumption of soft drinks and should advise them (9).

Over past 2 years, soft drink industry has seen a value growth of 11%. In total 1.3 billion people in India drink nearly 5.9 billion litres of soft drinks per year making it one of the highest soft drink consuming country in the world. So products like calcium lactate which efficiently reduce the erosive action of drinks should be incorporated in soft drinks to limit its adverse effects.

RECOMMENDATIONS

Together with the modification of the formula of acid beverages, which is one of the possible methods of minimizing their erosive effect some other for the safer use of soft drinks are:

Follow the manufacturer’s instructions on usage and dilution, ideally serve soft drinks only during mealtime, keep drinking times very short and use a straw whenever possible. Cooled soft drinks have less erosive potential. So consume soft drinks when it is cold. Drinks should not be swished around the mouth or held in contact with tooth surfaces for a longer period. Avoid tooth brushing immediately following consumption of an acidic drink. After meals consume something to neutralise the acid present in soft drinks e.g. cheese or milk. Low erosive beverages may be a valuable alternative to other acidic soft drinks.

LIMITATION OF THE STUDY

By the addition of 5% calcium lactate there might be some amount of taste alteration for which further studies must be done.

REFERENCES