EFFECT OF SOFT DRINKS ON THE RELEASE OF CALCIUM FROM ENAMEL SURFACES

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Abstract. Continuous consumption of soft drinks is the main cause of potential oral health problems, including dental caries and erosion. The purpose of this study was to compare the effect of three different types of soft drinks on the release of calcium from the enamel surface of teeth. Forty bovine teeth were selected for the experiment. They were divided into four groups (n=10/group): Group 1 (Coke™), Group 2 (Pepsi™), Group 3 (Sprite™), and Group 4 (distilled water, the control). The pH of each beverage was measured using a pH meter. The release of calcium ions was measured using an atomic absorption spectrophotometer at baseline, 15, 30, and 60 minutes. The results were assessed by analysis of variance and then by the Tukey test ($p< 0.05$). Coke, with a pH of 2.39, was the most acidic among the soft drinks. Coke, Pepsi, and Sprite showed no significant mean differences in the calcium released, but there was a significant mean difference of these soft drinks with distilled water at 60 minutes. We concluded that prolonged exposure to soft drinks could lead to significant enamel loss.

Keywords: soft drinks, calcium, tooth enamel, dental erosion, atomic absorption spectrophotometer

INTRODUCTION

Over the previous decades, there has been a significant worldwide increase in the consumption of soft drinks (Tahmassebi *et al*, 2006). The greatest increase in soft drink consumption has occurred among children and adolescents (Owens, 2007). Soft drinks have many potential oral health problems, including dental caries and erosion (Majewski, 2001), because soft drinks containing interact acids and sugars have both acidogenic and cariogenic potential (Cheng *et al*, 2009).

Compared with caries, dental erosion seems to have a much stronger relationship with soft drinks (Bassiouny, 2013). The erosive potential of such drinks is primarily in their pH and the buffer capacity. Excessive and continuous consumption of soft drinks is the main cause of enamel erosion (Cheng *et al*, 2009).

Wongkhantee *et al* (2006) and Panich and Poolthong (2009) found that the effect of Coke™ reduced hardness of enamel. However, no study, that we are aware of, has addressed the effect of different types of soft drinks that are manufactured in Thailand on enamel erosion at different times by atomic absorption spectropho-

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tometer. The objective of this study was to investigate the effect of different types of soft drinks on the release of calcium from the enamel surface at different times.

MATERIALS AND METHODS

Forty bovine teeth were selected and cleaned prior to use in the experiment. They were divided into four groups, labeled as Group 1 (Coke), Group 2 (Pepsi), Group 3 (Sprite), and Group 4 (distilled water). For each tooth in the respective groups, three coats of nail varnish were applied to whole area of teeth except only 5x5 mm on the labial surface. The pH of each beverage was measured by connecting a pH electrode to an Orion710A® (Orion Research, Boston, MA). The pH electrode was calibrated immediately prior to measurements using standard buffers of pH 4.01 and 7.01.

Then, 2 ml of a freshly opened drink at room temperature was placed in a beaker and left for 24 hours. Three pH measurements were taken, with a mean obtained from each of them. The teeth in each group were placed in a beaker containing 500 ml of each beverage and kept at room temperature. At 0, 5, 15, 30, and 60-minute intervals, 1 ml of each beverage was pipetted and used for the determination of calcium. The release of calcium ions was measured using an atomic absorption spectrophotometer (AA280FS, Varian, CA). The conditions for use of the appliance were determined following the manufacturer's instructions. Lanthanum chloride solution at concentration 10 g/l was used to eliminate the interference of phosphate and sulfates and the possibility of formation of refractory oxides. The results were assessed by analysis of variance (ANOVA) and then by the Tukey test for individual comparisons ($p<0.05$).

Table 1
Beverage pH values.

Beverages	pH
Coke	2.39 ± 0.00
Pepsi	2.49 ± 0.00
Sprite	2.96 ± 0.00
Distilled water	7 ± 0.00

RESULTS

Table 1 shows the pH of the beverages. Coke with a pH of 2.39 was the most acidic among the beverage, while distilled water was recorded at about neutral.

Table 2 shows the mean and standard deviation of the calcium released from enamel surface of the teeth immersed in beverages. All soft drinks showed significant mean differences from distilled water at 60 minutes.

DISCUSSION

Pepsi, Coke, and Sprite were found to be demineralizing solutions; this is at least partially due to their low pH value. Previous research has reported that a food or beverage with acidity below a threshold of pH 5.5 is an etiologic factor in the formation of dental caries and erosion (Bamise *et al*, 2007; Wild *et al*, 2011). Most soft drinks contain one or more acidulants; phosphoric and citric acids are common, but malic, tartaric, and other organic acids also may be present (Cairns *et al*, 2002). The presence of polybasic acids in beverages is important because of their ability to chelate calcium at higher pH values, which could be very erosive to dental enamel (Bamise and Oderinu, 2013).

In this study, we used the bovine teeth for testing. Yassen *et al* (2011) suggested

Table 2
The mean and standard deviation of calcium (g/ml) dissolved in four beverages at 0, 5, 15, 30, and 60 minutes.

Time /Beverages	0 min	5 min	15 min	30 min	60 min
Coke	0.00 ± 0.00	0.05 ± 0.00	0.08 ± 0.02	0.27 ± 0.05	0.71 ± 0.05[a]
Pepsi	0.00 ± 0.00	0.06 ± 0.00	0.09 ± 0.01	0.36 ± 0.06	0.67 ± 0.07[a]
Sprite	0.00 ± 0.00	0.05 ± 0.00	0.10 ± 0.02	0.32 ± 0.04	0.77 ± 0.04[a]
Distilled water	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00[b]

[a]Indicate significant difference in different periods ($p<0.05$).
[b]Indicate significant difference in different beverages ($p<0.05$).

using bovine teeth as an alternative to human teeth in dental erosion. The result of this study suggested that the calcium release of all soft drinks were significantly different from distilled water at 60 minutes. Similarly, Jain *et al* (2007) and Torres *et al* (2010) have suggested that the erosion of the surfaces exposed to the soft drinks was directly proportional to the exposure time. However, this *in vitro* study was limited due to the experimental design and artificial time of exposure (Coombes, 2005).

This study design had the tooth exposed to the soft drinks for a defined time period without consideration of rate of soft drink consumption, duration of swallow, movement within the mouth during swallowing, clearance by saliva, and remineralization of saliva. From the limited of this study, the further *in vivo* study should be considered. Based on the results of this study, it can be concluded that, prolonged exposure to soft drinks could lead to significant enamel loss.

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