

## Acidity and effect on enamel dissolution of ten commonly consumed soft drinks/beverages in Myanmar

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### Abstract

Recently, soft drinks become more and more popular among teenagers and young adults. The concern is raised on the potential risk of developing tooth erosion and accelerated attrition due to concomitant drinking of beverages with high acidity during meal or with snacks. A study was carried out to measure pH and to evaluate the effect on enamel dissolution of ten common soft drink and beverages in Myanmar. Enamel dissolution was measured as weight loss of enamel discs immersed in each soft drink for one hour. All tested soft drinks and beverages had acidic pH: 1.8 - 3.5 much lower than critical pH of tooth enamel. Enamel dissolution in terms of weight loss was ranged between 1.2% for Myanmar Beer and 4.7 % for Coca Cola. There was significant difference between weight loss among the tested drinks (one-way ANOVA,  $p < 0.001$ ) and linear regression analysis showed that pH of the drink was inversely related with weight loss ( $R = 0.728$ ,  $p < 0.001$ ). In conclusion, the commonly consumed soft drinks and beverages in Myanmar are dangerous for the dental health and soft drinks with lower pH caused more enamel dissolution.

### Introduction

Tooth wear is one of the most common dental problems encountered in daily clinical practice. It is attributed to either physical factor or chemical agent or combination of both. With increasing availability of various soft drink beverages, there is more frequent consumption of these drinks by the people especially younger age groups in recent days. Recently, soft drinks become more and more popular among teenagers and young adults. Some of the soft drinks such as peps and coca cola have been reported to be acidic in nature and exposure to these beverages may result in enamel erosion<sup>2, 3, 4</sup>. For this reason, it is necessary to study the locally available soft drink beverages for the acidity, type of acid content and the effect on enamel solubility. This is the first study in Myanmar about the potential health hazards of soft drink beverages. With increasing availability and mass media advertisement, the public consumption of these beverages is increasing and there is potential for a public health problem in the future. There is no warning about the potential health hazards of these beverages and therefore the results of this study will be helpful in educating the public.

The aim of this study was to measure the pH

of 10 commercial soft drinks and beverages produced in Myanmar and evaluate the effect of these beverages on dissolution of enamel.

**Materials and methods**

Ten most commonly consumed commercial soft drinks and beers produced in Myanmar were collected. The pH was measured immediately after opening, 5 minutes and one hour after opening with pH meter (MT- 8060, Shenzhen Baoan, China)(figure 1). The type of acid content was recorded according to manufacturer’s description. Fifty five enamel slices (5x5x1mm) was prepared from buccal and lingual surfaces of extracted teeth using a rotary cutting machine. They were randomly divided into 11 groups (n=5). Each enamel slice was weighed using a digital weighing balance. Then each slice was immersed in 5 ml of each beverage in a capped plastic vial for 1hr. One group was kept as control and immersed in compound sodium lactate solution. The samples were kept on continuous shaker during immersion. After 1 hr, the enamel slices were removed from vials and blotted dry and weighed. Enamel dissolution in terms of % weight loss was calculated. The effect of pH and type of acid content on enamel dissolution was evaluated. One Way Analysis of Variance Test (ANOVA) was employed to test the difference in weight loss of the samples. Regression analysis was performed to examine if a linear relationship exists between pH values and % weight loss.



Figure 1. Measuring pH of the soft drink with digital pH meter

**Results**

**1. Acidity of tested soft drinks/beverages**

Figure 2 illustrates the acidity of tested soft drinks/beverages according to their respective pH values. The data was shown for pH values of each soft drink, immediately after opening the container, five minutes after opening and one hour after immersion of enamel discs. The Coca Cola and Pepsi have the lowest pH of 2 among the tested soft drinks and Blue mountain cola and VeVe passion juice have pH of 2.3 and 2.2, Shark, Redbull, 100 Plus, Sunkist and 7 up have pH 3, and Myanmar beer has pH 3.7. Interestingly, pH values further decreased 5 minutes and one hour after opening for cola-based soft drinks, Shark, Sunkist and Myanmar beer.

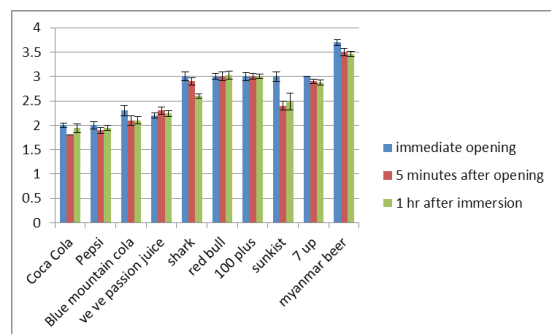


Figure 2. The acidity of tested soft drinks/ beverages

**2. Type of acid content in various beverages**

Phosphoric acid	Citric acid	Ascorbic acid	Malic acid
Pepsi	100 Plus	Sunkist	VeVe passion juice
Coca Cola	VeVe passion juice		7 up
Blue mountain cola	Blue mountain cola		
	Sunkist		
	7 up		
	Red Bull		
	Shark		

Table 1. Type of acid containing in tested soft drinks

Table 1 denotes type of acid containing in tested soft drinks according to their manufacturer description. Phosphoric acid and citric acid are common ingredients. Sunkist, 7 up and VeVe passion juice contain ascorbic acid and Malic acid in addition to citric acid. Blue mountain cola contains both phosphoric acid and citric acid.

### 3. Weight loss of enamel disc samples one hour after immersion in the soft drinks/ beverages

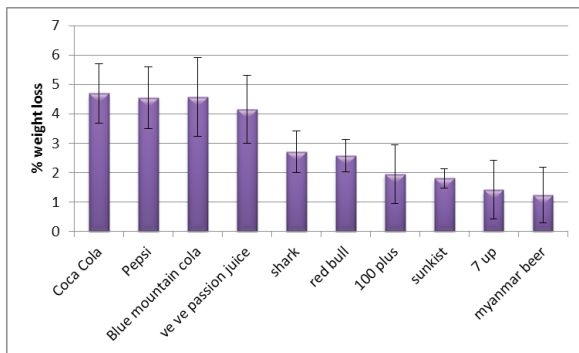


Figure 3. Percentage weight loss of enamel samples after one hour immersion in the drinks

Figure 3 demonstrates the % weight loss after one hour immersion of enamel disc samples in the drinks. Weight loss ranged between 1.2% for Myanmar Beer and 4.7 % for Coca Cola. There was significant difference between weight loss among the tested drinks (one-way ANOVA,  $p < 0.001$ ).

### 4. Relationship between pH and % weight loss of enamel disc

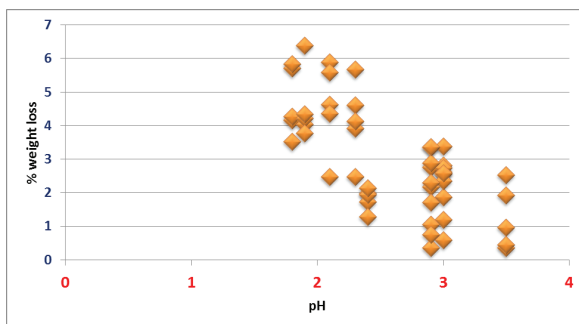


Figure 4. Relationship between pH and % weight loss of enamel disc

Figure 4 revealed the relation between pH of the soft drinks and % weight loss of the enamel samples. Simple linear regression analysis showed that pH of the drink was inversely related with weight loss ( $R=0.728$ ,  $p < 0.001$ ): the lower the pH of the drink, the higher the dissolution of enamel in terms of % weight loss.

### Discussion

Recently, the consumption of soft drinks and other beverages becomes increasing in Myanmar, especially among children and youth with increasing availability of these products in local market. The concern is raised especially because the erosive potential of these drinks on tooth structures. Numerous reports on tooth erosion by soft drinks have been published in the literature<sup>2-10</sup>. Many of these studies have demonstrated enamel softening and/or loss of tissue after exposure to various soft drinks. Enamel erosion is measured by various methods including loss of enamel weight, SEM or light microscope, microradiograph or image analysis, electron probe analysis and profilometry. In the present study, acidity of ten selected common soft drinks and beverages and the effect of pH on enamel dissolution were evaluated by enamel weight loss method.

All tested soft drinks and beverages have acidic pH, lower than critical pH for enamel dissolution. Further decrease in pH 5 minutes and one hour after opening for cola-based soft drinks, Shark, Sunkist and Myanmar beer is thought to be due to liberation of carbon dioxide from carbonated drinks and subsequent formation of carbonic acid which might contribute partly to further pH reduction.

Although enamel slices of equal size were immersed in the soft drinks for one hour to standardize the exposure time and to simulate prolonged contact of soft drinks to enamel, it may be very difficult to calculate the actual amount of time that the human teeth are exposed to these acidic beverages. The total exposure time would be related to the actual amount of beverage consumed, the frequency

of consumption (small sips taken at frequent intervals of time or the whole can/bottle drunk at once, whether a straw is used or not, which would reduce exposure of enamel to the drinks).

When comparison is made between cola and non-cola drinks, the cola-based drinks had significantly lower pH values and caused significantly higher mean % weight loss than non-cola drinks. It is not clear, however, whether the type of acid has effect on the enamel dissolution or not because it is impossible to make comparison between two different soft drinks containing two different acid types with different pH. Some studies have shown that soft drinks containing citric acid are more erosive than those containing phosphoric acid,<sup>11-13</sup> while others showed the opposite was true.<sup>14,15</sup> Nevertheless, many studies reported the more erosive effect of cola-based soft drinks on enamel. Interestingly, Blue Mountain Cola contains both phosphoric acid and citric acid.

According to our results, the more acidic the drinks, the more erosive they are ( $R=0.728$ ,  $p<0.001$ ). This data agrees with the results of other study (Sales-Peres et al., 2007) which concluded that the pH seems to have more influence on the erosive potential in respect to the chemical characteristics tested such as concentrations of fluoride and phosphate, buffering capacity and pH.<sup>10</sup>

Some studies claimed that not only the pH of the beverages but the titratable acidity i.e. the capacity to maintain a low pH influence their erosive potential.<sup>16-19</sup> Tenuta et al. found that the titratable acidity of commercial beverages was shown to affect the salivary pH for a longer time than their initial pH value. Thus, despite the lower pH of the cola-based soft drink compared to that of the orange juice, the lower titratable acidity of the former resulted in a faster neutralization of the pH due to salivary clearance and buffering. However, during intraoral exposure (while the beverage was in the mouth), the volume of residual saliva present and/or secreted was too small to induce a significant

change in the beverage pH. Therefore, the beverage pH influences the erosive potential of the beverage while it is being consumed; whereas after ingestion, the titratable acidity is responsible for the time that the salivary pH is maintained at a low level in the mouth.<sup>20</sup> These findings indicate the necessity of in vivo studies in the mouth where salivary flow and buffering capacity influence the clearance rate of acidic beverages, which could reduce the impact of these exogenous acids.

In conclusion, the tested common soft drinks and beverages available in Myanmar have acidity well below the critical pH of enamel and cola-based ones have lower pH (more acidic) and cause more enamel dissolution. Community should be informed about potential oral health risks of frequent and prolonged consumption of soft drinks and beverages and further research should be aimed at finding ways to enhance the enamel surface resistance against the acidic attack from food and drinks.

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