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Research Article

Enamel Solubility Potential of Commercially Available Soft Drinks and Fruit Juices in Ethiopia

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Abstract

The enamel solubility potential of some soft drinks used in Ethiopia was assessed. The common consumed carbonated soft drinks, cola and non-cola, and fruit juices were selected. Their Initial PH was measure, upon opening their bottles. The volume of 1.0 M sodium hydroxide needed to raise the PH of 50 ml the drinks to the PH 5.5 and 7.0 were determined. For cola, non-cola and fruit juice drinks the PH range from 2.43 to 2.48, 2.74 to 3.19 and 3.12 to 3.75 respectively during before titration. All the tested soft drinks upon opening the bottle were found to be below the critical PH 5.5 for enamel dissolution. The volume of 1.0 M sodium hydroxide required to bring the drinks to PH 5.5 and 7.0 the mean ranges from 0.7 to 1.5 and 1.5 to 2.9 ml respectively. The highest volume of base were required in most non-cola drinks to neutralize its acidity whereas, lowest volume of base consumed in cola drinks during their lower initial PH. In this study concludes that all the tested soft drinks had significant erosion potential. The erosion potential of non–cola drinks was more than cola drinks and fruit juices. Clinicians can take advantage of this information when counselling patients with tooth surface loss.

Keywords: Dental erosion; Soft drinks; Titrable acid; Acidulants; PH; Ethiopia

Abbreviations: TA: Titratable Acidity.

Introduction

Soft drinks are non-alcoholic, flavoured, carbonated beverage, commercially prepared and sold in the bottles or cans. Soft drinks have been suggested to cause damage to the teeth for two reasons. First, the low PH and high titrable acidity of some drinks may lead to erosion of the enamel surface. Secondly, the sugar in these drinks is metabolized by plaque micro-organism to generate organic acids that bring about demineralization, leading to dental caries. In contemporary society,there is an increasing concerning onthe effect of consumption of acid drinkssuchas:softdrinks, sportdrinks,fruitjuices and fruit teas on dental erosion (Lussi et al., 2004) intake of soft drink, even for short duration, candiminish enamel micro–hardness (Van Eygen et al.,2005) [1]. In this respect, some epidemiological and clinical studies have associated carbonated drinks, particularly cola drinks, with dental erosion attribute to their low PH (Dugmor and Rock, 2004) [2] Jensdottir et al., 2004).Other studies have also revealed the potential erosion nature of fruit juices because of their high content of titrable acid (Larsen and Nyvad, 1999; Jensdottir et al., 2005) [3-7]. Various features of soft drinks pertaining to dental health had been recognized. Low PH and high content of titrable acid are known to cause the erosion capacity of the fruit juices and beverages (Grenby et al., 1990; Lissera et al., 1998; Zero and Lussi, 2005) [8]. For example, a study conducted by Hughes et al (2000) showed that decreasing PH and increasing acid concentration were found to correlate with increased dental erosion. Titratable acidity (TA) is a measure of total acid content. Beverage with a lower PH typically have greater erosion effects on the teeth, but the TA level is the more accurate way to determine the erosion potential in a certain beverage. PH measures acid strength and TA measures the amount of acid present. The greater the TA, the long-time it will take for the saliva to restore the mouth to a neutral PH value. A neutral PH is where acid cannot attack and damage tooth structure. Carbonated cola beverages sports and high - energy drinks have been reported to have a low PH and high TA.

Among the other factors that can modify development of dental erosion include: the total acid level, acid types, concentration of phosphate, calcium and fluoride in the food drinks (Grenby et al., 1990; Lissera et al; 1993; Behrendt et al; 2002) [9]. Temperature and exposure time had also an important factor to the erosivity of beverages (Zero, 1996 West et al., 2000) [10, 11]. Some researchers suggested that the effect of total acid level (Titrable acid) on dental erosion predominates over that of PH (Grenbyet al., 1990; Zero, 1996), for a more reason that it will determine the actual H+ available to interact with the tooth surface degree of saturation with respect to tooth mineral and thus the driving force for its dissolution (Zero and Lussi, 2005) [12, 13]. Acidulants are additive that a sharp tastes to foods. They also assist in the setting of gels and to act as preservatives. One or more common food acidulants - phosphoric and citric acid [14] are used in most soft drinks sometimes, others acidulans such as malic acid or tartaric acid are also used. Acid is used in soft drink products to accomplish two main functions. Firstly, it is used so as to balance the sweetness because people generally prefer more acidic foods and drinks. Secondly, it hinders microbial growth. This is because main food poisoning organism require near neutral condition to grow and multiply. Therefore an acidic environment ensures the safeties of products by providing conditions which do not allow pathogenic organism survive.

Animal's studies have shown that phosphoric acid is very erosion at PH 2.5 but much less so at PH 3.3. Citric, malic and tartaric acids are considered to be especially erosion because of acidic nature and the ability to chelate calcium at higher PH (Rugg-Gunn and Nunn, 1999) [15]. Citric acid was more erosion than malic acid when formulated to experimental drinks at higher PH (Meuman et al., Hughes et al., 2000). The number of carbonated drinks and fruits juices has recently grown in the Ethiopian market possibly due to the expansion of production companies and the available free market for a large number of foreign products. This coupled with the rise in consumption of soft drink especially among children and adolescent was our main concern. The aim of this study was to evaluate PH, titratable acidity and to provide base line information on the Enamel solubility potential of some common soft drinks in Ethiopia.

Material and Methods

In this project work, eleven soft drinks were tested. A mong these, 8 of them were carbonated drinks (2 cola and 6 non- cola) while three of them were fruit juices. The carbonated soft drinks were manufactured by the two famous bottling companies, Moha soft drinks factory and East Africa bottling company, supplying the country with a range of soft drink products for several decades. On the other hand, the fruit juices were imported from the middle-east. All the selected drinks had been in the market for at least 5 years.

Table 1: Tested soft drinks; their manufacture, packaging and acidulants.

S.no	Soft drink	Manufacture	Packaging	Acidulants
Cola drinks				
1	Coca –cola	East Africa bottling company	Glass bottle	Phosphoric acid
2	Pepsi – cola	Moha soft drink factory	Glass bottle	Phosphoric acid
Non-Cola drinks				
3	Seven up(7-up)	Moha soft drink factory	Glass bottle	Malic, Citric acid
4	Mirinda apple	Moha soft drink factory	Glass bottle	Citric acid
5	Mirinda orange	Moha soft drink factory	Glass bottle	Citric acid
6	Sprite	East Africa bottling company	Glass bottle	Citric acid
7	Fanta orange	East Africa bottling company	Glass bottle	Citric acid
8	Fanta ananas	East Africa bottling company	Glass bottle	Citric acid
Fruit juices				
9	Mango Mizzo	Arrow juice factory for bottling and production	Plastic bottle	Citric acid
10	Mango Fakher	AUJAN soft drink industry	Plastic bottle	Citric acid
11	Mango Rani	AUJAN soft drink industry	Glass bottle	Citric acid

Table 1 showed the investigation soft drinks with their manufacture, packaging and acidulants. The laboratory procedure was carried at the department of chemistry laboratory, university of Gondar. Before conducting the analysis, the type of acid used for each drink was recorded from the label of the packaging. Then, the PH was determined with a digital PH-meter (Mettler–Toledo, MP220, Schwerzenbern, Switzerland) by pouring about 100 mls of each drink in a conical flask and inserting the probe of the PH-meter. Immediately after determining the initial PH of each soft drink upon opening the bottle, the volume of 1.0 M sodium hydroxide consumed to raise the PH of 50ml of the drinks to PH 5.5 and 7.0 was also determined. All the glassware and materials used for the analysis were first immersed in dilute HCl for 12 hours, washed with detergent, and then rinsed with deionized water. De–ionized water was used during the entire procedure .The PH meter was calibrated regularly with buffer solutions. Moreover; all the analyses were performed in triplicated. Data were recorded, organized and summarized in simple descriptive statistics methods. Results were analysed using Microsoft Excel. Generally, statistical parameters, average, were calculated for each triplicate measurement.

Results

The table given below (**Table 1**) showed that phosphoric acid was used as an acidulant in the cola drinks, while citric acid was used in most non- cola drinks and all fruit juices. Seven up, one of the most commonly consumed non-cola drinks, contained malic acid and citric acid as acidulants. Assessment of the PH upon opening the drinks revealed that cola- cola had the lowest PH (2.43) where as one of the fruit juice under study, Mango Fakher, had the highest average PH (3.75). In general, the cola drinks had the lowest average PH while fruit juices had the highest average PH (please look at table 2 for detail).

Table 2: PH on opening the bottle; volume of 1M sodium hydroxide required to raise the PH to 5.5 and 7.0.

S.no	Soft drinks	PH on opening the bottle	Volume (ml) of base required to increase PH to	
Cola drinks				
1	Coca -cola	2.43	0.7	1.5
2	Pepsi –cola	2.48	0.7	1.6
Non –cola drinks				
3	Seven up(7-up)	3.19	1.4	2.6
4	Mirinda apple	3.09	0.9	2.2
5	Mirinda orange	2.74	1.5	2.9
6	Sprite	3.02	1.0	2.3
7	Fanta orange	2.81	1.5	2.5
8	Fanta ananas	3.01	1.3	2.5
Fruit juices				
9	Mango Mizzo	3.12	1.5	2.0
10	Mango Fakher	3.75	1.4	1.8
11	Mango Rani	3.70	1.4	1.9

From **Table 2** we can see that the amount of sodium hydroxide consumed to raise the PH of soft drink to 5.5 varied from 0.7 to 1.5 ml. Similarly, 1.5 to 2.9 of 1M sodium hydroxide was required to brining the PH of 50ml soft drink samples value of 7.0. Mirinda orange consumed the highest volume of base to raise its PH to 5.5 and 7.0. In contrast, coca –cola required the lowest volume of base to increase its PH to 5.5 and 7.0. Most non-cola drinks generally needed the highest average volume of sodium hydroxide to raise their PH to 5.5 and 7.0; cola drinks, despite their lowest average PH up on opening, consumed the lowest base.

Discussion

There are several factors affecting the erosion potential of a soft drink. These include the immediate effect of the drink on the tooth surface, the time taken to clear the drink from the mouth, the drinking method, the protective effect of saliva, the amount of residual drink after swallowing, the actual amount of beverage consumed and the frequency of consumption [16] (Johansson et al., 2004; Jensdottir et al., 2005; Jain et al., 2007) [17]. A review literature (Lussi and Jaeggi, 2007) [18, 19] has suggested that PH value of soft drinks and food stuff is more crucial than other factors in determining their erosion potential. In this respect, other researches (Jensdottir et al., 2006) also indicated that the PH of drinks determines their erosive potential with in the first minutes of exposure. The PH of all the drink tested, upon opening, was occurs. It was quite in agreement with other research works conducted in Canada and Nigeria (Touyz, 1994; Cornelius, 2007) [20]. A number of studies have explained the fact that soft drinks with low PH can cause dental erosion in permanent and deciduous teeth [21] (Grando et al., 1996; Lissera et al; 1998; Larsen and Nyvad, 1999; Hughes et al., 2000; Seow and Thong, 2005; Brown et al., 2007) [22-25].

In this case, increasing in dental erosion something related to decrease in PH (Hughes et al., 2000). Other clinical studies showed that decrease in salivary PH, and induction of a prolong drop in oral PH observed after consumption of the drinks could exacerbate dental erosion [26] caused by acidic drinks (Edwards et al., 1999; Banana and Hedge, 2005) [27]. Titrable acid also affected the erosion potential of soft drinks as explained in several studies (Edwards et al., 1999; Jensdottir et al., 2005) [28], and its effect is more important than PH as suggested by Zero (1996). This research work revealed that non- cola drinks consumed relatively of the largest volume base to neutralize 50ml of soft drink samples. Hence, they are believed to cause greater erosion potential than both cola drinks and fruit juices.

In spite of the lowest PH of cola drinks upon opening their bottle, they are easily neutralized with small amount of base. This was in agreement with other findings (Jensdottir 2002; Jensdottir et al., 2005; Cornelius et al., 2007). The type of acidulant used in the formulation of soft drinks could possibly be linked to the ability of non-cola drinks to resist change In PH as observed in this study where citric acid predominated in non- cola drinks and fruit juices ;however, phosphoric acid was the only acidulant in cola drinks. Finding in a related and other in vitro study have shown that citric acid caused far more erosion than phosphoric acid (West et al., 2001; Cornelius et al., 2007). Citric acid was considered to be more erosion than phosphoric acid, due to their acidic nature and its ability to chelating calcium at higher PH (Rugg-Gunn, 1999).

Conclusion

In light of the data obtained in these studies, we can conclude that all the tested soft drinks had PH below the critical PH of enamel dissolution, leading to significant erosion potential. The erosive potential of non- cola drinks were the highest in contrast to carbonated cola drinks which showed the least erosive potential.

Recommendations

Despite the growing consumption of soft drinks in Ethiopia, nothing has been studied on the erosion potential of soft drinks available in the market. Thus the information provided by this project work can be used as baseline study. Moreover, this information will be of use to clinicians when counselling patients with tooth surface loss. We, therefore, recommend that appropriate modification of soft drinks ingredients without necessarily compromising the vital role of acidulation is critical to the erosive of soft drinks. Moreover, parents should be informed about the detrimental effects of excessive consumption of these beverages.

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