

Loss of Enamel Structure of Primary Teeth on Exposure to Various Commercial Solution Available in Mosul, an in vitro study

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ABSTRACT

Background/purpose: The drinking of acidified drinks, accompanied by having a lower mineral content in case of enamel of deciduous teeth, is considered as a perfect mixture for the progression of dental erosion. Current study was aimed to evaluate the pH of the most common presented Beverages in Mosul city markets and to measure the detrimental effects of commercial beverages on the enamel surface in vitro by assessing the loss of weight of the tooth.

Materials and Methods: The study was performed with seven different kinds of available drinks commercially present in Mosul: 2 carbonated drink, packet fruit juices, packet milk, tea, coffee and bottled water available in the Mosul markets. The pH of each solution was estimated and weighted of all teeth samples (40 extracted primary teeth). Weight of all samples was measured with a 24-hour interval for a period of 5 days changing each drink with a new one of the same type each day.

Result: There was change in the mean percent weight loss amongst the different beverages with Pepsi showing a high decrease in comparison to other beverages. The mean weight reduction of Pepsi, i.e., 0.158 ± 0.100 , 0.238 ± 0.171 , 0.284 ± 0.168 , 0.332 ± 0.201 and 0.388 ± 0.217 respectively and least in Packet milk, i.e., 0.000 ± 0.000 , 0.000 ± 0.000 , 0.000 ± 0.000 , 0.000 ± 0.001 , 0.001 ± 0.001 respectively.

Conclusion: There was a significant weight loss with most Commercial Beverages. All the Commercial beverages showed dissolution at different rates with time.

Key words: Beverage's solution, Primary teeth, Erosion.

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INTRODUCTION

Tooth is considered as the hardest component of the human body that has specific characteristics and components. The most highly mineralized component of the tooth is enamel, and it is firm more than iron [1]. Enamel is the superficial layer of the tooth, and it is considered as the hardest tissue in the human body. The integrity of the enamel as an inorganic tissue is greatly under the effect of pH and the inorganic components that are present in the saliva. Though, temporary variations of pH of the oral ecosystem may be enhanced by the factors related to the type of foods consumed and other factors related to saliva. Recurrent and continuously being exposed to low pH may cause a marked drop in pH and demineralization of the surface of the enamel [2].

Dental erosion can be defined as the long-lasting loss of tooth surface substance due to the presence of acids, in the absence of the participation of microorganisms [3] clinically recognized as corrosive-abrasive wear [4]. It has a multifactorial origin and is a continues process throughout the life and is mainly irreversible and it is due

to either intrinsic or extrinsic causes, intrinsic causes include repeated vomiting, which is a part of eating disorders for example anorexia nervosa or bulimia nervosa. The extrinsic causes are for example acidic substances, medication, beverages and environmental exposure to acidic agents [5]. The drinking of acidified drinks, accompanied by having a lower mineral content in case of enamel of deciduous teeth, is considered as a perfect mixture for the beginning and progression of dental erosion. Enamel in the primary dentition is less calcified and permeable, and this leads to being more readily dissolved by acids. Therefore, erosion can be a big problem for young children [6].

The ingestion of Sugary or Sugar-sweetened Beverages like carbonated sports and energy drinks, fruit drinks, soda, soft drink, and sweetened bottled waters have become greater than before dramatically [7, 8]. Various carbonated beverages are available all over the world. Some are multinational with their products being marketed in different countries of the world whereas some are regional, confined to certain regions of countries. Most of these drinks neither specify their contents nor do they have strict food regulations. They are consumed frequently especially by children because of their easy availability and low cost [9]. Repeated consumption of fermentable carbohydrates, such as sweetened and acidic

beverages, induces the mineral loss of dental tissues lead to dental erosion. The effect of carbonated drinks which have a carbonic acid content due to the presence of carbon dioxide in them [10]. The dentition can get eroded when it became in recurrent contact with extrinsic acids of acidic food and drinks. Recurrent exposure to acid beverages alters the intraoral pH to lower than the critical pH (PH 5.5) which allows the development of frangibles (erosion, abrasion, attrition, and decay) [11].

Coffee is one of the most popular drinks in the world. It contains chlorogenic acid in its composition, which assume that this beverage might cause an acid pH. Furthermore, effects on the surface roughness of enamel [12].

As dentists, a method must be devised to produce consciousness among the individuals regarding the harmful effects of these beverages on teeth enamel. An importance must be made on alteration of these commercial beverages, in addition to standardization of the usage quantity that is recommended to be consumed [13].

The leaves of tea have one of the largest natural amounts of fluoride concentration, therefore, it is possible to use it as a remineralizing agent like green tea and black tea however black tea, being less effective in remineralization in comparison with green tea as preparation of the tea extract, might result in inactivation or removal of some of the constituents of black tea responsible for remineralization [14]. The milk has a protective effect against dental erosion, because of its high concentration of calcium and phosphate ion which may have a protective effect against erosion. Commonly, the ingestion of milk mixed with other foods like chocolate or coffee could affect its protective effect against dental erosion [15]. Numerous preventive approaches have been suggested for the control of enamel erosion and application of fluoride is one of them. Fluoride rise the hardness of tooth surface and decreases the erosive lesions depth [16].

Regarding children, additional care should be taken because the acidified drinks and foods accompanied by demineralization of enamel of primary teeth result in increased the prevalence of dental erosion. Clinically, early diagnosis and identification of the causative factors involved is the first step in prevention [7]. The present in-vitro study conducted in primary teeth in order to analyze the tooth weight loss caused by the consumption of six different commercially Beverage's solution available in Mosul market.

MATERIALS AND METHODS

Seven various types of commercially available beverages in the Mosul market: carbonated drinks (pepsi and energy drink-Tigger), packet orange juices drink, packet milk, coffee, black tea and commercially available bottled water in addition to tape water were achieved, evaluated

and the pH was assessed immediately upon opening by a pH meter (Systronics digital PH meter 335).

In order to estimate mineral weight loss, thirty-five upper and lower primary teeth without dental caries and micro fracture were collected, cleaned of debris then stored in thymol with distilled water.

Before beverage immersion initial weight of all sample were measured with calibrated digital balance. Each one of the drinks and other beverages was divided into set of 8 containers containing the five teeth of each group for a total of 24 hours.

Weight of the entire thirty-five samples was measured at 24-hour intervals for a period of 5 days after alternating every solution at a period interval of 24 hours. Between each measure the teeth samples were removed and rinse with tap water and left to dry for 10 minutes then weighted again.

RESULTS

The physiochemical properties of drink classes are presented in (Table 1). The entire drinks studied had a low pH on opening, even though the PH of Packet milk was more than the PH of the rest of the drinks (6.71). PH of Pepsi was lower than the pH of the remaining drinks (3). The PH of bottled water was found to be 6.58 and 6.59 in tap water.

Among bubbly beverages, the mean weight loss after all cycle time (24, 48, 72, 96 and 120 hours) was highest in Pepsi, i.e. 0.158 ± 0.100 , 0.238 ± 0.171 , 0.284 ± 0.168 , 0.332 ± 0.201 and 0.388 ± 0.217 respectively and least in Packet milk, i.e. 0.000 ± 0.000 , 0.000 ± 0.000 , 0.000 ± 0.000 , 0.000 ± 0.001 , 0.001 ± 0.001 respectively. as see in table 2. Hence the beverages with the lowest PH (Pepsi) caused the greatest enamel losses.

(Figure 1) displays that there was significant amount of loss of minerals of the teeth in every drink after every 24 hours. The diagram shows that the weight loss was largely in the Pepsi drink. The loss of tooth was significantly greater in Pepsi after 24, 48, 72, 96, and 120 hours when compared with tap water.

The (Figure 1) also shows that the erosivity of the acidic beverages on enamel developed in a different way with time. In contrast to the current study, the erosivity of Pepsi still greater than those of other beverages at the end of the study. There is a significant difference between all groups exits at five different time.

Tooth loss with other drinks was greater when compared with tap water, but values of loss were not statistically significant. The loss of enamel increases with the increase in the time of exposure to all types of beverages and water as shown in (Table 3).

Table 1: compositions of all the beverages as marked on the original packaging and mean pH of the beverages.

Type of solution	Composition	Mean pH of drinks
Tap water	water	6.59
Bottled water	Water, Ca 24.2mg/l , No3 0.5 mg/l , F 0.03 mg/l , C 11.5 mg/l , Mg 4.4 mg/l , T- Hardness 40 mg/l , So4 16.8 mg/l , Na 2.0 mg/l	6.58
Pepsi	Carbonated water, Sugar, high fructose corn syrup Caffeine, Caramel color, Phosphoric acid, Citric Acid, and natural flavors.	3
Energy drink-Tigger	Carbonated water, Sugar, Citric Acid, Trisodium Citrate, Caffeine 0.03 % , Taurine 0.37%, Glucuronolactone 0.24%, B Vitamins (B2,B6,B12,Pantothenic Acid , Niacin) , Colars (Caramel positive E150C), benzoic Acid and Flavorings.	3.71
Tea	Black tea, sugar	6.2
Coffee	Coffee, sugar	6.24
Packet milk	pasteurized cow's milk, Sugar, Flavors (banana), colorant (lutein)	6.71
Packet orange juices	Water, Sucrose, Mixed fruit juice compound, Citric acid, Thickeners (E-415, E-466), Nature Identical passion fruit flavor ,Beta carotene nature color .TSS 11 % , Juice content 10 % .	3.32

Table 2: Comparison of mean tooth loss after immersion into each drink in an interval of 24, 48, 72, 96, and 120 hours.

Type of solution	Tooth loss after 24 hours Mean $\pm$ SD	Tooth loss after 48 hours Mean $\pm$ SD	Tooth loss after 72 hours Mean $\pm$ SD	Tooth loss after 96 hours Mean $\pm$ SD	Tooth loss after 120 hours Mean $\pm$ SD
Pepsi	0.158 $\pm$ 0.100	0.238 $\pm$ 0.171	0.284 $\pm$ 0.168	0.332 $\pm$ 0.201	0.388 $\pm$ 0.217
Packet orange juices	0.126 $\pm$ 0.086	0.200 $\pm$ 0.144	0.252 $\pm$ 0.157	0.298 $\pm$ 0.182	0.362 $\pm$ 0.209
Energy drink	0.115 $\pm$ 0.081	0.188 $\pm$ 0.143	0.236 $\pm$ 0.152	0.280 $\pm$ 0.173	0.352 $\pm$ 0.209
Tea	0.007 $\pm$ 0.002	0.008 $\pm$ 0.002	0.010 $\pm$ 0.003	0.011 $\pm$ 0.003	0.012 $\pm$ 0.004
Coffee	0.007 $\pm$ 0.003	0.008 $\pm$ 0.003	0.010 $\pm$ 0.004	0.011 $\pm$ 0.004	0.013 $\pm$ 0.004
Bottled water	0.000 $\pm$ 0.000a	0.000 $\pm$ 0.000a	0.001 $\pm$ 0.000	0.001 $\pm$ 0.000	0.001 $\pm$ 0.000
Tap water	0.000 $\pm$ 0.000a	0.000 $\pm$ 0.000a	0.001 $\pm$ 0.000	0.001 $\pm$ 0.000	0.001 $\pm$ 0.000
Packet milk	0.000 $\pm$ 0.000a	0.000 $\pm$ 0.000a	0.000 $\pm$ 0.000	0.000 $\pm$ 0.001	0.001 $\pm$ 0.001

Table 3: Comparison of tooth loss among different solutions when compared with tap water.

Beverages	After 24 hours		After 48 hours		After 72 hours		After 96 hours		After 120 hours	
	Mean difference water vs type of solution	P-value	Mean difference water vs type of solution	P-value	Mean difference water vs type of solution	P-value	Mean difference water vs type of solution	P-value	Mean difference water vs type of solution	P-value
Pepsi	0.158	0.025*	0.238	0.036*	0.282	0.020*	0.33	0.021*	0.386	0.017*
Packet orange juices	0.126	0.031*	0.2	0.036*	0.25	0.023*	0.296	0.022*	0.36	0.018*
Energy drink	0.115	0.034*	0.188	0.042*	0.234	0.026*	0.278	0.023*	0.35	0.020*
Tea	0.007	0.002*	0.008	0.001*	0.008	0.007*	0.009	0.004*	0.011	0.003*
Coffee	0.007	0.007*	0.008	0.004*	0.009	0.007*	0.009	0.007*	0.011	0.003*
Bottle water	0	0.000*	0	0.000*	0	0.545	0	0.733	0	0.725
Packet milk	0	0.000*	0	0.000*	0	0.096	0	0.372	0	0.649

* Significantly different at $p \leq 0.05$

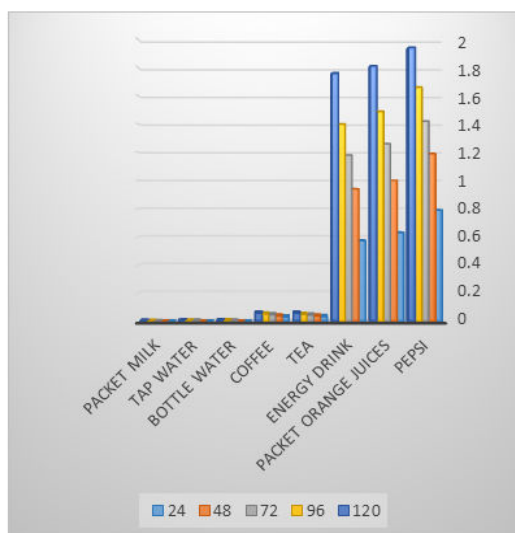


Figure 1: Tooth loss after immersion into each beverage in an interval of 24, 48, 72, 96, and 120 hours.

DISCUSSION

Carbonated beverages and Fruit juices are commonly consumed inside Mosul city mainly by children and adolescents. This rising range of ingestion of these commercially presented beverages acquire an ability to cause dental erosion. Therefore, the goal of this study was to estimate the loss of mineral from the primary teeth structure and to determine the erosive potential of available juices and soft beverages broadly existing in Mosul city, as well deals with loss of tooth mineral once exposed to the drinks for different times.

This study revealed that 3 of the 7 tested beverages (Pepsi, energy drink-Tigger and packet orange juices) had a PH value below critical (PH 5.5), on the other hand PH of saliva lies in a range of 5.5 to 6.5, with a PH of 5.5 or less, being defined as the threshold level for destruction of tooth, that is to say caries and erosion [17].

Therefore, it was possible to expect the early demineralization of enamel, Pepsi had the lowest PH values (3) estimated to acquire a stronger erosive effect than other drinks as it had a lesser initial pH.

This result is well recognized that recurrent consumption of soft drinks leads to dissolution of enamel due to acids, as most of them have pH below the critical level [18].

The massive sample percent weight loss demonstrated by the Packet orange juices and energy beverages compared to the pepsi beverages suggests that the increased potential for enamel dissolution or weight loss caused by direct action of these solutions other than actual PH, maybe by the chelation or binding and final calcium ions loss.

Thus, this result goes in line with Yamamoto et al. who estimated that the carbonated beverage creates a significant erosive challenge on enamel [19]. The erosive potential of Pepsi may be because it contains phosphoric acid and citric acid, phosphoric acid are highly erosive acids PH= 2.6. Also supported the results of Simonetti et al. (2010) who shown that the phosphoric acid has more capability to cheleate calcium, therefore phosphoric acid had a more erosive potential than other types of acids like citric and tartaric acids [20].

The significant difference among all test groups occurs at five various times because the groups with erosive dental enamel surface were eroded by beverages, which is considered as an acidic beverage. Therefore, the recurrent ingestion of acid-containing beverages can increase their erosive effects on enamel. Current result agrees with Johansson et al. (2004) who estimated that the risk of erosion increased as the time of enamel exposure with a low initial PH (PH 2.0 – 4.0) [21].

This study also shows that coffee, tea, water, and packet milk acquire tiny or no potential for causing erosion. The bottled drinking water samples had PH values adjacent to 7. Bottled water seems to have lower TA and neutral PH and thus, lesser possibility of dissolving tooth structure. Yet, most of the bottled water displayed an exceptionally low saturation level, which shows that repeated ingestion may enhance removal of mineral from the tooth structure through leaching. Elevating the saturation level of specific beverages may prevent dissolution to a specific degree. Therefore, protection of drinks with calcium and phosphate can decrease the effect of the acidity of the beverages [22].

Packet milk less possible to dissolve enamel, this may be due to milk has higher level of calcium ion compared with other drinks. Which cause reduction of enamel dissolution. Milk may have a role in the control of teeth erosion [23].

In certain countries, it is public to flavor milk especially for pediatric consumption. However, the impact of adding sugars and other flavorings to these healthy foods may affect child health specially when the added sugar is sucrose. Addition of flavors that attract children, for example: chocolate, strawberry, vanilla and banana and be more prevalent and popular in the current years. Flavored milk is a drink rich in nutrient and it provides essential nutrients resembling that provided by unflavored milk except for the sugar content, which may add additional calories per serving [24].

Study observed that a common practice to flavor milk with sugar so it will become more pleasant for infants. They established that it was obviously apparent that supplementation of milk with an additional sucrose improved the carcinogenicity of milk also exhibited that

flavored milks (strawberry, chocolate or banana) were more cariogenic than plain milk because it contains 5-6% added sucrose or addition of 5% and 10% sucrose [25]. Flavored milk should not be a substitution and replace ordinary natural unrefined milk.

Coffee contain chlorogenic acid in its composition which leads to assume that this beverage could cause an acid pH. Moreover, the influences of certain beverages on the enamel surface roughness, including coffee, established that it was not capable of causing significant variations in enamel roughness, although it contains ascorbic acid in its composition, suggesting that there is no erosive potential [12].

Black tea has the capacity to produce tooth remineralization, but certain brands of sweetened teas contribute to dental erosion because of their sugar content on the other hand this may be because in the current study tea extract was utilized, rather than the commercially available bags of tea, which is in agreement with study which concluded that in the preparation of the extract, and due to heat there might have been a diminished effect or removal of some ingredients present in black tea that are responsible for remineralization [14].

Current study concludes that the loss of enamel increases with the increase in the time of exposure to all types of beverages and water. Persistent contact between the enamel surface and the drink increases the opportunity of occurrence of erosion. For that reason, the time that the enamel samples are being exposed to the beverage is an important point to be considered. Moreover, when the tooth was saved in these drinks for a longer period the amount of tooth loss increased. This shows the bad influences of increased frequency of consumption. On the other hand, study show that, the drinks were refilled after every 24 hours. Therefore, the solution stays unsaturated at every time a person drinks an unsaturated drink [13]. Thus, the decreasing the frequency of soft drink consumption and the usage of straw when possible can help in decreasing dental erosion.

CONCLUSION

Within the limitations of the current study, Pepsi displayed significantly greater levels of enamel mean percent weight loss in comparison with the rest of the commercial drink solutions, also erosion increase with extended periods of time. Minimum mineral content loss was seen in packet milk.

LIMITATION OF STUDY

Surface roughness due to enamel loss, in vitro may be different if compared to the dynamic conditions that exist in in vivo and for that reason, direct extrapolations to clinical conditions should be exercised with caution because the difficulty in simulating the oral environment.

AREAS FOR FURTHER STUDY

Further research is recommended to investigate the various commercial beverages solution available in Mosul city on enamel structure of permanent teeth.

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