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Original Research

Assessment of enamel demineralization after exposure to sugar free vs. regular soft drinks: an in vitro study

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ABSTRACT

Aim
The aim of this study is to determine in vitro the degree of enamel demineralization caused by exposure to a sugar free vs. regular soft drinks.

Materials and Methods
Commercially available soft drinks were selected for pH analysis and the titratable acidity test (Coca Cola (zero), Coca Cola, Coffee without sugar, Coffee with sugar, Artificial Saliva). Fifty freshly extracted sound teeth were kept in artificial saliva at 37 degrees Celsius. It was examined by DIAGNODENT KaVo to ensure that the enamel is sound. The teeth were divided into 5 groups (n= 10). Control group were kept only in artificial saliva and the remaining four groups were subjected to (Coca Cola -zero- , Coca Cola, Coffee without sugar, Coffee with sugar). Then teeth were immersed for 24 hrs and the demineralization of enamel were measured again using DIAGNODENT Kavo. Data were analyzed using SPSS Version 23.

Results
The amount of demineralization were compared between sugar free vs regular soft drinks and coffee. Friedman test showed a statistically significant difference in the value between types of drinks (except artificial saliva) and exposure time ($p<0.05$). On the other hand, Kruskal Wallis test showed statistically significant difference in the value between all exposure time except 30 mins and types of drink including artificial saliva ($p<0.05$).

Conclusions
More community awareness programs about the demineralization effects of sugar free foods/drinks and maintaining oral health through diet modification and regulation of sugar free foods/drinks intake to reduce the prevalence of dental caries and tooth loss among the Saudi population.

INTRODUCTION

Consumption of soft drinks and coffee has become very popular in Saudi Arabia. Evidence suggest that there is a considerable increase in consumption of acidic beverages such as commercial soft drinks in young children worldwide.[1-3] An in vitro study on the effect of a common diet and regular beverage on enamel erosion reported that diet coca cola is more erosive than the

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regular type.[4] Most soft drinks are acidic in nature. Regular consumption of these drinks may result in dental erosion.[5] Recently there has been an increase in researches studying the role of commercial soft drinks in dental diseases such as dental caries and erosion.

Many refreshment drinks such as carbonated drinks, sugar or fructose, sugar free soft drinks, fruit juices, and energy drinks were found to be associated with erosion of enamel and dentine in vitro and in situ resulting from severe demineralization that eventually lead to the development of dental caries which is the main cause of tooth loss. Diet soft drinks would be erosive which may enhance enamel demineralisation.[3] Moreover, many sugar free products remain potentially harmful to teeth due to their chemical composition. The aim of this study was to determine in vitro the degree of enamel demineralization caused by exposure to a sugar free vs. regular soft drinks.

METHODS

Fifty freshly extracted sound maxillary premolars were obtained from Riyadh Elm University (REU) clinics and cleaned using pumice powder and slow speed brush. The teeth were kept in artificial saliva at 37ºC and all teeth surfaces were exposed to the DIAGNODENT KaVo for initial measurement of enamel mineralization values to ensure that the enamel is sound. All surfaces of the premolars were painted with nail polish except their buccal surface. Four commercially popular soft drinks were selected for our experiment Coca cola (pH = 2.50) Coca cola zero (sugar free) (pH= 3.18), Starbucks double shot espresso with milk sugar regular (pH=6.30), and Starbucks double shot espresso with milk sugar (sugar free) (pH=6.30). The teeth were randomly divided into 5 groups (n= 10), Group 1(G1): control group was kept only in artificial saliva; Group 2 (2): was subjected to regular Coca Cola; Group 3 (G3): was subjected to sugar free coca cola (Coca cola zero); Group 4 (G4): was subjected to regular Starbucks double shot espresso with milk sugar regular; Group 5(G5): was subjected to Starbucks double shot espresso with milk sugar regular (sugar free)

Then teeth were immersed for 30, 60, 90, and 120 minutes respectively and after immersion they were rinsed with deionized water and the buccal surface of the teeth were subjected again to the DIAGNODENT KaVo 2190 pen to assess the enamel demineralization post immersion. After the measurement the teeth were kept in artificial saliva for 30 minutes before the next immersion cycle. The results obtained by the DIAGNODENT KaVo 2190 pen were subjected to statistical analysis using SPSS.

RESULTS

The median values of enamel demineralization in relation to time of exposure to the types of drinks and artificial saliva (control). At 30 mins of exposure, the median value was 1 for all the drinks and artificial saliva. At 60 mins of exposure, the median value increased to 1.5 in Coca cola (zero) and Coca cola. The value remained the same for the rest of the drinks and artificial saliva. At 90 mins exposure, the median value further increased to 3 in Coca cola (zero) and coca cola. However, the value for the rest of the drinks and artificial saliva remained unchanged. At 120 mins of exposure, the median value increased to 4.5 in Coca cola, increased to 2 in coffee without sugar and coffee with sugar. The value in Coca cola (zero) remained the same as it was at 60 min exposure and artificial saliva remained unchanged (Figures 1-6).

Friedman test showed a statistically significant difference in the value between types of drinks (except

artificial saliva) and exposure time ($p<0.05$) (Table 1). On the other hand, Kruskal Wallis test showed statistically significant difference in the value between all exposure time except 30 mins and types of drink including artificial saliva ($p<0.05$) (Table 2).

Table 1: The values of the enamel demineralization in relation to the type of drinks

	30 mins	60 mins	90 mins	120 mins	p value
(G1) Artificial Saliva	1	1	1	1	1.000
(G2) Coca Cola	1	1.5	3	4.5	0.000
(G3) Coca Cola (Zero)	1	1.5	3	3	0.000
(G4) Coffee with sugar	1	1	1	2	0.000
(G5) Coffee without sugar	1	1	1	2	0.000

Table 2: The values of the enamel demineralization in relation to time of exposure to drinks

	Coca Cola (Zero)	Coca Cola	Coffee Without Sugar	Coffee With Sugar	Artificial Saliva	p value
30 mins	1	1	1	1	1	1.000
60 mins	1.5	1.5	1	1	1	0.008
90 mins	3	3	1	1	1	0.000
120 mins	3	4.5	2	2	1	0.000

DISCUSSION

In the present study the demineralization potential of regular Coca cola, Coca cola (zero), regular Starbucks double shot espresso with milk and (sugar free), and Starbucks double shot espresso with milk were evaluated. The DIAGNODENT KaVo 2190 pen was used to measure the values of enamel demineralization after immersion cycles of (30, 60, 90, and 120 minutes). We have decided to use the DIAGNODENT KaVo 2190 pen which is a laser fluorescence-based instrument used for early caries detection to assess the amount of enamel demineralization after immersion in regular and sugar free soft drinks.

In this study in relation to time of exposure at 30 minutes immersion cycle all median values of enamel surface remained the same for all groups. At 60 minutes immersion cycle both G2 and G3 showed the same median value of demineralization However, the median values for G1, G4 and G5 remained 1. At 90 minutes the median value of enamel demineralization increased further in groups 2 and 3 showing highest demineralization median values of 3. Meanwhile the median values for groups G1, G4, and G5 remained unchanged. At 120 minutes of exposure, the median value increased to 4.5 in G2 and increased to 2 in G4 and G5. The value in G3 remained the same as it was at 60 min immersion cycle and artificial saliva remained unchanged.

The findings of our study are in consistent with previous study which reported a significant differences in the demineralization abilities among different kinds of soft drinks. [6] Furthermore, another study showed that high acidity of the beverages showed prism changes in the enamel surface and structural loss of the enamel leading to structural disintegration. [7] Our finding demonstrate that the effect of these beverages on enamel is also influenced by other factors outside the sugar content, such as pH levels of the beverage, exposure time, acid type (e.g., phosphoric acid or citric acid), salivary buffer, adhesion, and chelating effect.

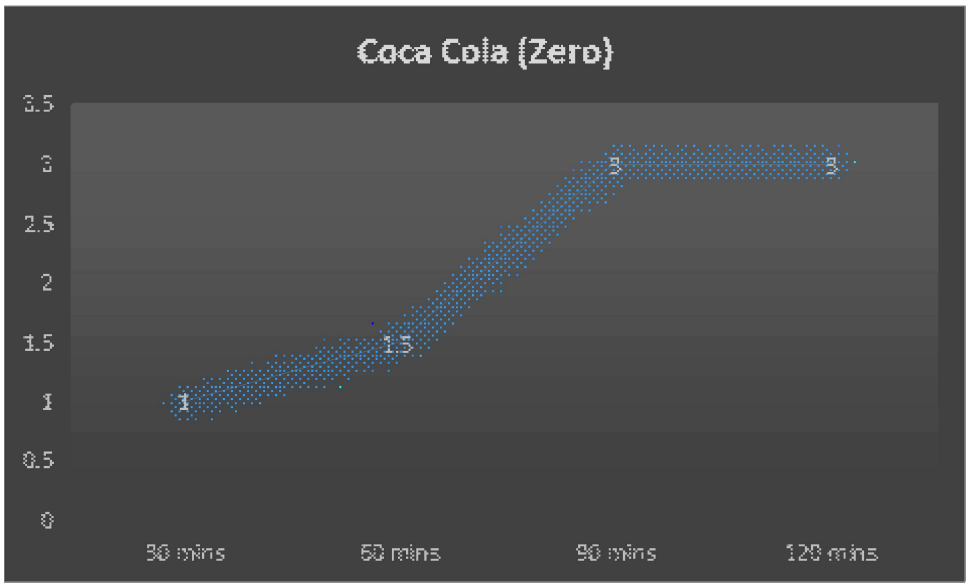

Figure 1. The values of the enamel demineralization in relation to time of exposure to Coca Cola (Zero)

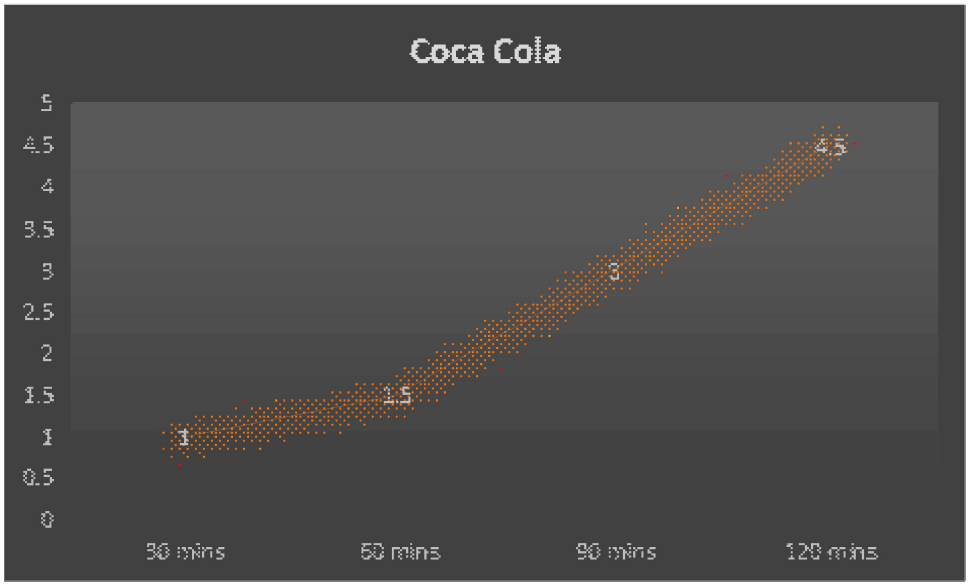

Figure 2. The values of the enamel demineralization in relation to time of exposure to Coca Cola

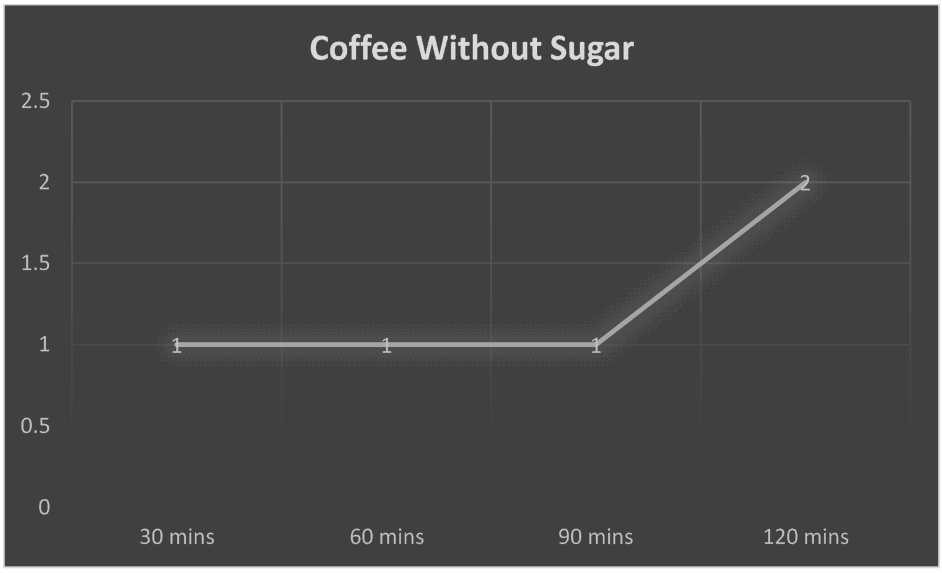

Figure 3. The values of the enamel demineralization in relation to time of exposure to Coffee without sugar

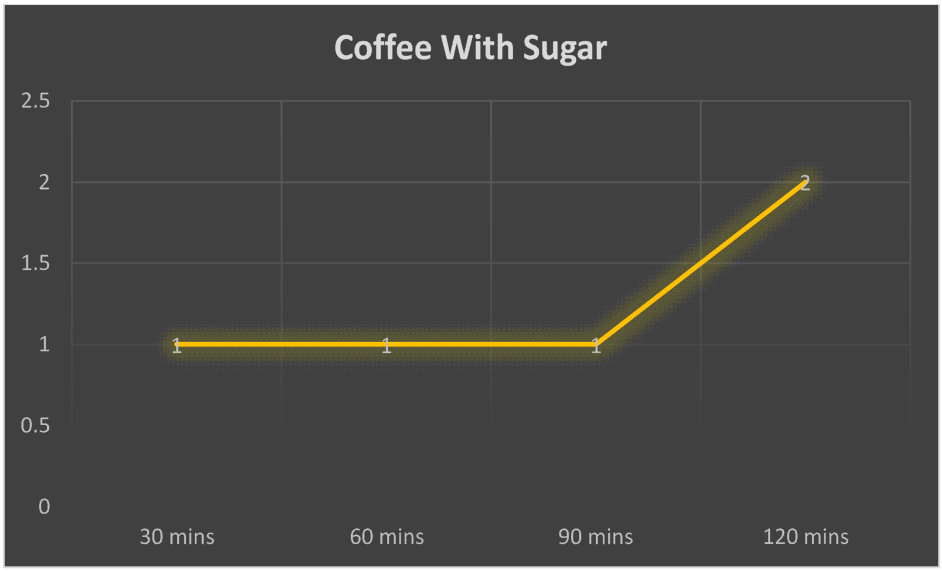

Figure 4. The values of the enamel demineralization in relation to time of exposure to Coffee with sugar

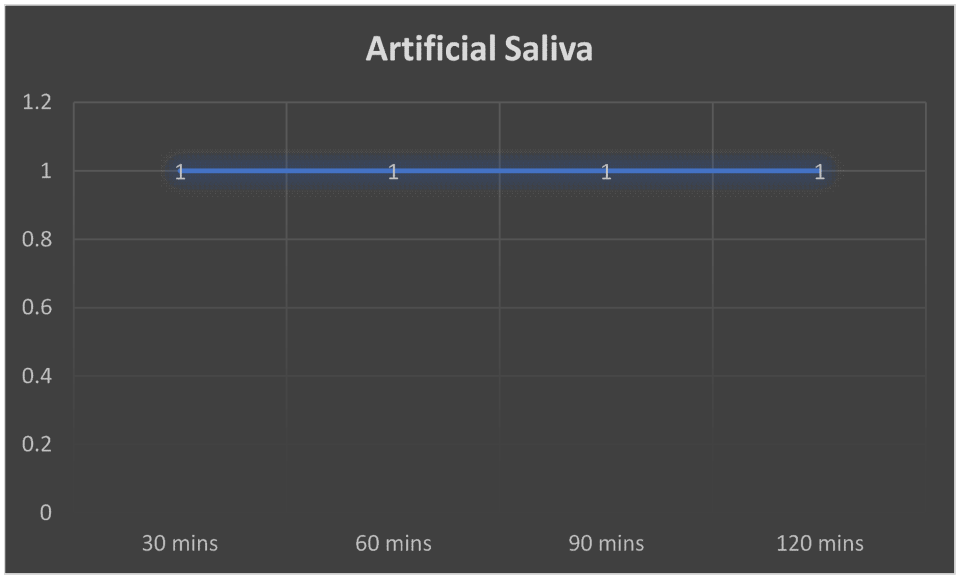

Figure 5. The values of the enamel demineralization in relation to time of exposure to artificial saliva

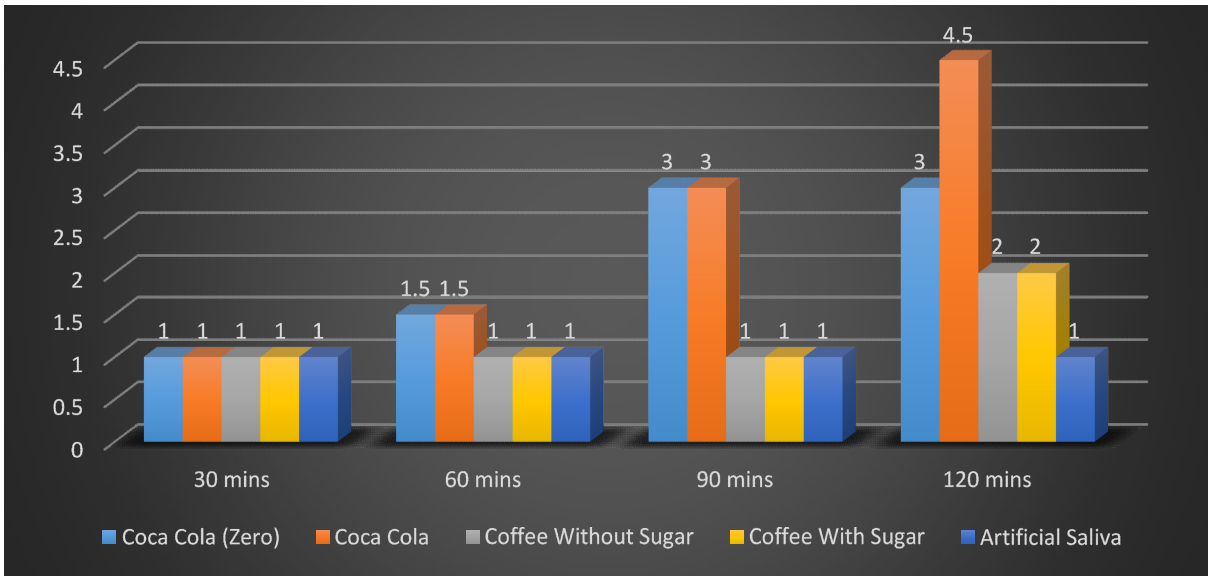

Figure 6. Comparison of the values of the enamel demineralization in relation to time of exposure to the types of drinks and artificial saliva

CONCLUSION

Based on our findings, more community awareness programs about the demineralization effects of sugar free foods/drinks and maintaining oral health through diet modification and regulation of sugar free foods/drinks intake to reduce the prevalence of dental caries and tooth loss among the Saudi population.

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