



## Effect of Fruit Juices and Other Beverages on Loss of Tooth Structure

Simy Mathew<sup>1</sup>, Alexander Maniangat Luke<sup>2</sup>, Tarun Walia<sup>3</sup>, Anas Ghalib Masri<sup>4</sup>, Hamad Jamal<sup>4</sup>,  
Ajinkya Mansing Pawar<sup>5</sup>

<sup>1</sup>Lecturer, Department of Growth and Development, College of Dentistry, Ajman University, Ajman, United Arab Emirates.

<sup>2</sup>Assistant Professor, Department of Surgical Sciences, College of Dentistry, Ajman University, Ajman, United Arab Emirates.

<sup>3</sup>Associate Professor, Department of Pediatric Dentistry, College of Dentistry, Ajman University, Ajman, United Arab Emirates.

<sup>4</sup>Dental Surgeons, Department of Dentistry, College of Dentistry, Ajman University, Ajman, United Arab Emirates.

<sup>5</sup>Assistant Professor, Department of Conservative Dentistry and Endodontics, Nair Hospital Dental College, Mumbai, Maharashtra, India.

Author to whom correspondence should be addressed: Simy Mathew, Department of Growth and Development, College of Dentistry, Ajman University, P.O Box 346, Ajman, United Arab Emirates. Phone: 0097167056146. E-mail: [drsimy@gmail.com](mailto:drsimy@gmail.com).

Academic Editors: Alessandro Leite Cavalcanti and Wilton Wilney Nascimento Padilha

Received: 12 December 2017 / Accepted: 06 February 2018 / Published: 13 February 2018

---

### Abstract

**Objective:** To determine the effect of seven different beverages on tooth enamel. **Material and Methods:** Human teeth samples were immersed in each beverage (Pepsi, Red Bull, Orange juice, Apple juice, Lemon juice, Coffee and Green tea). Specimens were divided into seven groups by beverage type (n = 5 per group). Weight of the enamel was measured before and after immersion in different beverages daily for at periodic intervals of 24hrs, 7 days, 15 days and 30 days. The data were recorded after weighing the teeth at each time. The beverages were replaced daily. Anova and Tukey post hoc test was performed to compare the differences in percent weight loss. The significance level was set at 5%. **Results:** There was change in the mean percent weight loss amongst the different beverages with orange juice showing a high reduction in comparison to green tea and coffee. The mean weight reduction of orange juice was by 21% followed by Red Bull (13%), Pepsi (11%), Lemon juice (16%), Apple juice (16%), coffee (3%) and green tea (3%). **Conclusion:** This study shows that different beverages have erosive potential on teeth depending on the duration of the exposure.

**Keywords:** Beverages; Tooth Erosion; Dental Enamel.

---

## Introduction

Dental erosion is defined as localized loss of the sound tooth surface by a chemical process of acidic solution of low pH of nonbacterial process [1]. Generally most common cause of dental erosion is by acidic foods and beverages. In general, foods and beverages with a pH below 5.0-5.7 have been known to trigger dental erosion effects more often. Acidic beverages and foods lower the pH level of the oral cavity so consuming those causes the teeth to demineralize and loss of hard structure gradually [2].

Common extrinsic factors like beverages with low pH values that causes erosion include fruit juices, sport drinks, wine, beer, and carbonated drinks [3]; orange, and apple juice are common drinks among fruit juices. Frequency of intake of acidic beverages is a higher factor for dental erosion. The use of fruit juices, especially as pacification and night feeding, increases the risk of dental erosion [4].

Dental erosion can occur by non-extrinsic factors too. Intrinsic factors of dental erosion also known as permolysis, whereby gastric acid from the stomach comes into contact with the teeth. People with diseases such as anorexia nervosa, bulimia and gastro esophageal reflux disease (GERD) often suffer from this. The facial surfaces of upper incisors have higher susceptibility to erosion as they are not prone to the protective action of saliva. The most severe erosive lesions are typically found in the palatal surfaces of the upper teeth because of the abrasive effect of the tongue. Studies have revealed that the tongue is able to remove already softened enamel and dentin [5].

Caloric beverage consumption in the United Arab Emirates has drastically increased over the past few years. A study done in the United Arab Emirates revealed that consumption of caloric beverages like fruit juices and sugared sodas accounted for up to 70% of liquid intake [6]. A study among university students at Ajman revealed that majority of students preferred energy drinks over nutritional health drinks [7]. The relation between excessive consumption of sweetened beverages and tooth erosion has been demonstrated in dental literature [7-9].

A previous study developed in Shanghai among 3 to 6 year old Chinese children revealed 15.1% of dental erosion, with a higher prevalence among the 4 year old. Dental erosion was influenced by habits of vinegar/coffee/tea consumption, mother's educational background, birthplace, and regurgitation [10]. In Saudi Arabia, high erosion rates were associated with high consumption of aerated beverages among young men [11].

Diet plays a major role in the erosion of tooth structure. With a paradigm shift in eating and drinking patterns, there is a considerable effect on the tooth enamel and dentin. There is a transition in the patterns of beverage drinking over the years. A study done in the United Arab Emirates among college students revealed that there is an increase in the consumption of energy drinks after the age of 15 years [7].

A previous research done in Northwest England showed that 81% of the students consumed fizzy drink with the males having high frequency per week than females [12]. An analysis of beverages sold in Australian schools showed that the aerated drinks and fruit juices produced

significant dental erosion in vitro, with weight loss, surface loss and release of calcium ions from the tooth enamel [13]. The percentage of weight loss was higher in the energy drinks although they showed linear progression with time [14].

In bovine teeth the maximum erosive effect was obtained by Coca Cola at 180 minutes in comparison to 3 other soft drinks [14]. Some researchers have shown that all sport beverages have dental erosive effect except the two kinds of the powdered fruit flavoured drinks [15].

Citric acids have more potential in erosion of the teeth than original orange juice and the synthetic orange juice while the synthetic and original orange juices have similar degree of erosive potential [16]. A new trend of flavoured water has been taking the reins over plain water. Research has shown that flavoured waters have similar erosive potential as compared to that of orange juice and may contribute significantly to the tooth erosion in people who consume these beverages on a regular basis [17].

Study showed enamel hardness reduced by Diet Coca-Cola more than regular type and the various temperatures did not show significant difference on the results [18]. The temperature of acidic drinks greatly influences erosion of the tooth structure [19,20]. The effect of high temperatures was seen to have an effect of enamel softening [21].

Various studies have determined the role of pH of the drinks on the erosion of teeth. The lower pH of drinks is a significant contributing factor to erosion [22], however, some authors have demonstrated that dental erosion can be initiated at even higher pH levels [23]. A previous study showed that the low pH of the drinks affected the smear layer and caused significant erosion on application of friction post exposure [24]. Saliva by itself has been identified as one of the potential reducers of enamel loss due to erosion. The action of saliva in addition to fluorides has been known to considerably reduce loss of tooth structure by erosion [25].

It has been shown that green tea supplementation with soft drink can reduce erosive potential against dentin, but the difference was significant only for Coca-Cola [26]. Reduction and prevention of enamel loss was proven associated to extended exposure time to calcium fortified 100 percent juices [27]. On comparing the effects of beverages on tooth enamel and tooth colored restoration showed that the erosion of enamel was higher than tooth-colored restorative materials. Orange juice caused the highest erosion, followed by apple juice [28]. Another study used alcoholic and non-alcoholic beverages that showed a significant amount of erosion of dental composite materials and teeth [29]. Therefore, the objective of this study was to determine the effect of different beverages on tooth enamel.

## Material and Methods

Seven test beverages were used (Pepsi, Red Bull, lime juice, orange juice, apple juice, coffee, green tea) (Table 1).

Thirty-five extracted upper and lower anterior permanent teeth, free of caries and micro fracture, were all cleaned of calculus and debris. Access cavity preparation had been done on the

selected teeth previously as the teeth were obtained from the preclinical endodontic lab at Ajman University, College of Dentistry.

**Table 1. Beverage characteristics.**

Beverages	Grouping	Ingredients List	pH
Pepsi	carbonated soft drink	carbonated water, high fructose corn syrup, caramel color, sugar, phosphoric acid, caffeine, citric acid and natural flavors	2
Red Bull	energy drink	caffeine, taurine, glucuronolactone, B-group vitamins, sucrose, and glucose	3
Orange Juice	fruit juice	Reconstituted orange juice	4
Apple Juice	fruit juice	Reconstituted apple juice	3
Lemon Juice	fruit	Freshly squeezed lemon juice	2
Coffee	hot or cold drink	Instant coffee prepared (Nescafe brand)	5
Green Tea	hot drink	Tea bags dipped in hot water (Lipton brand)	7

The accessed canals were filled with flowable composite and self-cure glass ionomer. The teeth had been previously stored in a sodium hypochlorite with distilled water (1:9) and were distributed randomly. Each group contained five teeth and was placed in separate glass containers. All containers were labeled. Glass containers were chosen as plastic containers may dissolve or leach and produce some material and can cause a change as a result. A hole was made at the end of root for hanging the teeth to immerse the crown only without root within the beverages. Prior to specimen immersion; each beverage was tested for pH using pH-indicator strips (McolorpHast, EMD Millipore, Massachusetts, USA).

Initial weights of all permanent anterior teeth were measured prior to beverage immersion by using calibrated digital balance - KERN 770 (Kern & Sohn GmbH, Balingen, German). The containers were filled with beverages and hot drinks in which the teeth were immersed, and then the containers were placed in an incubator which maintained body temperature at 37°C.

After 24h the teeth were removed and rinsed with tap water then dried for 10 minutes. Next, the teeth were weighed again. The teeth were immersed for the second time in beverages and hot drinks for 1 week and then removed, rinsed, dried and weighed. This process was repeated for the third time, but the teeth were immersed for 15 days and then repeated for fourth time, but the teeth were immersed for 1 month. The data were recorded after weighing the teeth at each time. The beverages were replaced daily. The percentage of weight loss was calculated.

#### Statistical Analysis

The data obtained was entered into excel. Weight differences were calculated and tabulated. The data was then analyzed using SPSS (Statistical Package for the Social Sciences) version 22. ANOVA and Tukey post hoc test was performed to compare the differences in percent weight loss. The significance level was set at 5%.

#### Ethical Aspects

Ethical Approval was obtained from the Research Ethics Committee at the Ajman University, College of Dentistry, Ajman, United Arab Emirates.

## Results

Analyses showed statistical significance in the mean percent weight loss among different beverages at different time intervals. Significant differences were observed among the different groups at intervals of 24hrs, 1 week, 15 days and 1 month. There was a statistically significant reduction of weight of the tooth when immersed in Red Bull energy drink in comparison to all the other beverages at 24hrs time interval. The mean percent weight loss of the teeth immersed in Red Bull energy drink varied from 3% to 7% across the various beverages. Statistical significance in mean percent weight loss at 1 week was seen to be the highest when comparing lemon juice to coffee with 7.23% difference of mean percent of weight loss. At 15 days, Red Bull, orange juice and lemon juice showed 11% difference in comparison to coffee and green tea; which increased further to a maximum of 20% difference seen in teeth immersed in orange juice.

The comparisons of the mean percent weight loss between the different beverages reveals that in a 30 day period the highest loss was in orange juice, followed by Red Bull, apple juice Pepsi, lemon juice, green tea and coffee (Figure 1).

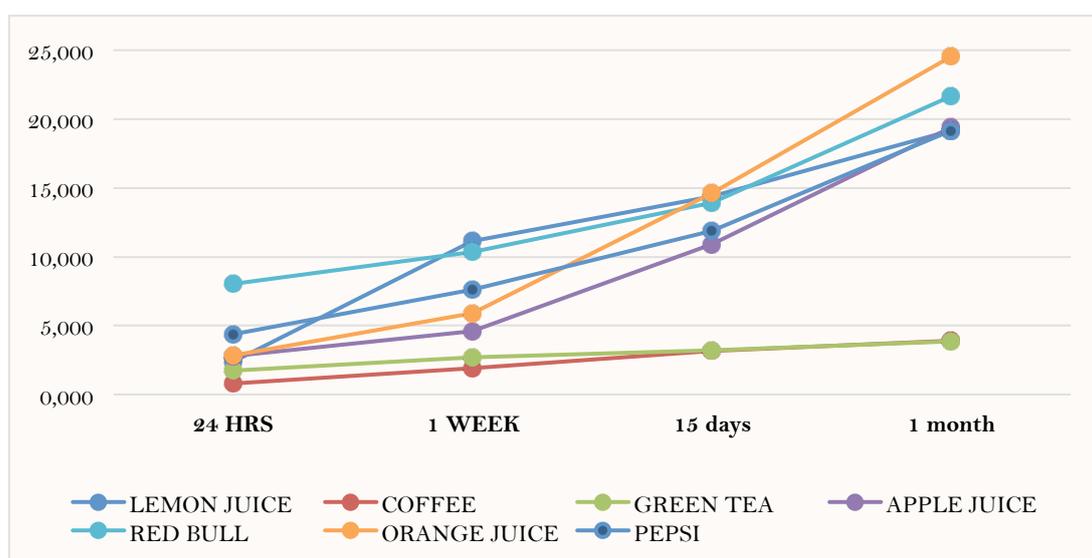


Figure 1. Relation between tooth weight loss and time.

On comparing the difference in the mean percent weight loss of each beverage over time, the ANOVA revealed significant differences between different time periods for all the beverages except green tea (Table 2). Post Hoc tests on each showed that the statistically significant difference in the mean percent weight loss was evident for most beverages at 1 month time period.

The weight loss of the tooth was statistically significant at 7 days, 15 days and 30 days in comparison to 24hrs for lemon juice. Also there was a significant difference at 24hrs compared to 15 days and 1 week compared to 1 month. The mean percent weight loss was statistically significant only between 24hrs and 1 month time periods showing a difference of 3.1% for the teeth immersed in coffee. The weight loss of the teeth immersed in apple juice showed a significant difference at 1 month to 24hr, 1 week and 15 days (16%, 14% and 8.5% respectively). A significant difference at 1

month to 24hr, 1 week and 15 days (13%, 11% and 7% respectively) was noted in the weight loss of the teeth immersed in Red Bull energy drink. The mean percent weight loss of the tooth immersed in orange juice showed a significant difference at 1 month to 24hr, 1 week and 15 days. Pepsi showed significant weight loss at the 1 month period in comparison to each time period. Statistical analysis reveals that the highest mean percent weight loss was seen in orange juice followed by Red bull, Pepsi, Lemon Juice, apple juice, coffee and green tea (Table 2).

**Table 2. Mean weight loss over different periods and among the various beverages.**

Beverage	24 Hrs	1 Week	15 Days	1 Month
Lemon Juice	2.3 (0.9)	11.15 (5.0)	14.39 (3.1) <sup>a</sup>	19.15 (3.7)
Coffee	0.79 (0.4)	1.88 (1.0)	3.14 (1.8)	3.89 (2.0)
Green Tea	1.73 (1.3)	2.69 (1.4) <sup>b,c</sup>	3.22 (1.5)	3.84 (1.9)
Apple Juice	2.77 (1.9)	4.59 (2.2) <sup>b</sup>	10.89 (3.3)	19.41 (5.6)
Red Bull	8.02 (1.5)	10.33 (1.5) <sup>a</sup>	13.93 (3.5)	21.67 (2.9)
Orange Juice	2.81 (3.8)	5.90 (4.1) <sup>a</sup>	14.59 (10.6)	24.53 (9.2)
Pepsi	4.37 (0.8)	7.60 (1.2) <sup>a</sup>	11.89 (2.8)	19.17 (4.1)

Values with different letters indicate statistically different mean percent weight loss among the different beverages.

## Discussion

The present in vitro study shows that there is alteration or reduction of tooth structure on exposure of the tooth to different beverages. Although it correlated the mean percent weight loss, there was no direct correlation performed to loss of hardness or presence of erosion on any of the sample.

The maximum weight loss of teeth structure from the crown in tooth immersed in orange juice over a 1-month period. This is similar to some studies, which also reveal that the lower pH of the orange juice or orange drink could be the contributing factor for the significant reduction of tooth structure [30]. In contrast some authors showed that the orange juice is not a significant factor in tooth erosion as it causes only mild rates of reduction of tooth structure [31]. Further studies on orange juice's effect on tooth hardness revealed that orange juice had milder effect on reduction of surface hardness in comparison to the carbonated soft drinks [32].

This research showed that the carbonated drink showed almost 7% lesser mean weight loss than studies performed in Australia [13]. In Brazil, it was demonstrated that the decrease in hardness of enamel was similar between cola drinks and a soy based orange juice [33], while in Denmark, erosion of teeth was ten times higher in cola drinks compared to that of orange juice. The proteins present in saliva drastically reduce this [30].

Red bull showed 21% reduction in weight of the immersed tooth specimens. This was in accordance with studies done across various sports drinks [15,34], which had higher erosive potential than carbonated drinks and fruit juices. Pepsi showed 14% mean percent weight loss. The studies done on carbonated cola drinks in various parts of the world is in agreement that; these beverages have an effect on reduction of tooth structure, hardness and cause erosion of the tooth structure [12,14,19].

The effect of carbonated drinks depends on the pH and acidity of the drink to determine the extent of the potential tooth damage possible [35]. Lemon juice caused significant reduction of the tooth structure at irregular levels and increased drastically as the incubation time varied [36]. In the present study the loss of structure for teeth immersed in fresh lemon juice was seen to increase significantly from 1 week to a period of 30 days.

Green tea and coffee showed least mean percent weight loss, which suggests them to be better beverages than most of the soft drinks or fruits juices. Green tea has been suggested to supplement the carbonated soft drinks in order to reduce the erosive potential of these drinks [26]. Apple juice also showed considerable effect on loss of tooth material as compared to a study done in India on different types of drinks with apple juice [37]. A previous review suggests that the effect of beverages on teeth is affected by the pH, acidity of the beverage, the method of sipping the beverage, the time the beverage is held in the mouth and the time the beverage is swished in the mouth [19]. Incorporation of fluoride in an attempt to reduce the erosive effects of beverages did not bring any significant difference in the rate of erosion of the teeth.

The present study did not consider the factors of saliva, which play a major role in the protection against erosion. Also immediate effect of the beverages on the tooth structure was not assessed. These factors need to be considered in further researches so that a better understanding of the physiological processes and its effects from diet can be displayed and methods or the appropriate action measures can be assumed to reduce these effects if potentially harmful.

## Conclusion

Considering the limitations of the present study, orange juice and Red Bull showed the highest mean percent weight loss. There was also significant weight loss with Pepsi and lemon juice. Green tea and coffee were perceived to be the least erosive of the beverages tested. All the beverages showed dissolution at different rates with time.

## References

1. Imfeld T. Dental erosion. Definitions, classification and links. *Euro J Oral Sci* 1996; 104(2):151-5. doi: 10.1111/j.1600-0722.1996.tb00063.x.
2. Gandara BK, Truelove EL. Diagnosis and management of dental erosion. *J Contemp Dent Pract* 1999; (1):16-23.
3. Mandel L. Dental erosion due to wine consumption. *J Am Dent Assoc* 2005; 136(1):71-5. doi: 10.14219/jada.archive.2005.0029.
4. Jaeggi T, Lussi A. Prevalence, incidence and distribution of erosion. *Monogr Oral Sci* 2006; 20:44-65. doi: 10.1159/000093350.
5. Gregg T, Mace S, West NX, Addy M. A study in vitro of abrasive effect of the tongue on enamel and dentine softened by acid erosion. *Caries Res* 2009; 38(6):557-60. doi: 10.1159/000080586.
6. Ng SW, Zaghoul S, Ali H, Harrison G, Yeatts K, El Sadig M, Popkin BM. Nutrition transition in the United Arab Emirates (UAE). *Eur J Clin Nutr* 2011; 65(12):1328-37. doi: 10.1038/ejcn.2011.135.
7. Jacob S, Tambawel J, Trooshi FM, Alkhoury Y. Consumption pattern of nutritional health drinks and energy drinks among university students in Ajman, UAE. *Gulf Med J* 2013; 2(1):22-6.
8. Owens BM, Mallette JD, Phebus JG. Effects of carbonated cola beverages, sports and energy drinks and orange juice on primary and permanent enamel dissolution. *Austin J Dent* 2014; 1(1):1004.

9. Gambon DL, Brand HS, Veerman EC. Dental erosion in the 21st century: What is happening to nutritional habits and lifestyle in our society?. *Br Dent J* 2012; 213(2):55-7. doi: 10.1038/sj.bdj.2012.613.
10. Tao DY, Hao G, Lu HX, Tian Y, Feng XP. Dental erosion among children aged 3-6 years and its associated indicators. *J Public Health Dent* 2015; 75(4):291-7. doi: 10.1111/jphd.12098.
11. Johansson AK, Johansson A, Birkhed D, Omar R, Baghdadi S, Khan N, Carlsson GE. Dental erosion associated with soft-drink consumption in young Saudi men. *Acta Odontol Scand* 1997; 55(6):390-7.
12. Bardsley PF, Taylor S, Milosevic A. Epidemiological studies of tooth wear and dental erosion in 14-year-old children in North West England. Part 1: The relationship with water fluoridation and social deprivation. *Br Dent J* 2004; 197(7):413-6. doi: 10.1038/sj.bdj.4811722.
13. Cochrane NJ, Cai F, Yuan Y, Reynolds EC. Erosive potential of beverages sold in Australian schools. *Aust Dent J* 2009; 54(3):238-44. doi: 10.1111/j.1834-7819.2009.01126.x.
14. Sener Y, Botsali MS, Kucukyilmaz E, Tosun G, Altunsoy M. Influence of soft drinks on dental enamel: An in vitro study. *J Pediatr Dent* 2013; 1:42-5. doi: 10.4103/WKMP-0028.117445.
15. Cochrane NJ, Yuan Y, Walker GD, Shen P, Chang CH, Reynolds C, Reynolds EC. Erosive potential of sports beverages *Aust Dent J* 2012; 57(3):359-64. doi: 10.1111/j.1834-7819.2012.01708.x.
16. S Scaramucci T, Hara AT, Zero DT, Ferreira SS, Aoki IV, Sobral MA. Development of an orange juice surrogate for the study of dental erosion. *Braz Dent J* 2011; 22(6):473-8. doi: 10.1590/S0103-64402011000600006.
17. Rees J, Loyn T, Hunter L, Sadaghiani L, Gilmour A. The erosive potential of some flavoured waters. *Eur J Dent* 2007; 1(1):5-9.
18. Sirimaharaj V, Brearley Messer L, Morgan MV. Acidic diet and dental erosion among athletes. *Aust Dent J* 2002; 47(3):228-36. doi: 10.1111/j.1834-7819.2002.tb00334.x.
19. Bamise CT, Kolawol KA, Oloyede EO. The determinants and control of soft drinks-incited dental erosion. *Rev Clin Pesq Odontol* 2009; 5(2):141-54.
20. Khamverdi Z, Vahedi M, Abdollahzadeh S, Ghambari MH. Effect of a common diet and regular beverage on enamel erosion in various temperatures: An in-vitro study. *J Dent* 2013; 10(5):411-6.
21. Benjakul P, Prommontri P, Chuenarrom C, Leggat U. Effects of sour curry temperature with fermented shrimp paste on surface hardness of tooth enamel. *Songklanakarin J Sci Technol* 2011; 33(4):419-23.
22. Ehlen LA, Marshall TA, Qian F, Wefel JS, Warren JJ. Acidic beverages increase the risk of in vitro tooth erosion. *Nutr Res* 2008; 28(5):299-303. doi: 10.1016/j.nutres.2008.03.001.
23. Pinto SCS, Batitucci RG, Pinheiro MC, Zandim DL, Spin-Neto R, Sampaio JEC. Effect of an acid diet allied to sonic tooth brushing on root dentin permeability: An in vitro study. *Braz Dent J* 2010; 21(5):390-5. doi: 10.1590/S0103-64402010000500002.
24. Pashely DH. Smear layer: Physiological considerations. *Oper Dent* 1984; 3:13-29.
25. Buzalaf MAR, Hannas AR And Kato MT. Saliva and dental erosion. *J Appl Oral Sci* 2012; 20(5):493-502. doi: 10.1590/S1678-77572012000500001.
26. Barbosa CS, Kato MT, Buzalaf MA. Effect of supplementation of soft drinks with green tea extract on their erosive potential against dentine. *Aust Dent J* 2011; 56(3):317-21. doi: 10.1111/j.1834-7819.2011.01338.x.
27. Davis RE, Marshall TA, Qian F, Warren JJ, Wefel JS. In vitro protection against dental erosion afforded by commercially available, calcium-fortified 100 percent juices. *J Am Dent Assoc* 2007; 138(12):1593-8. doi: 10.14219/jada.archive.2007.0109.
28. Goyal P, Singh MG, Bansal R. Comparative evaluation of erosive potential of different beverages on enamel and tooth colored restorative materials: An in vitro study. *J Pediatr Dent* 2013; 1(3):58-62. doi: 10.4103/WKMP-0028.121203.
29. Yusuf F, Srirekha A, Hegde J, Karale R, Bashetty K, Adiga S. Effect of alcoholic and non-alcoholic beverages on the wear and fracture toughness of teeth and resin composite materials: In vitro study. *J Res Dent* 2013; 1(1):11-7. doi: 10.4103/2321-4619.111227.
30. Jensdottir T, Holbrook P, Nauntofte B, Buchwald C, Bardow A. Immediate erosive potential of cola drinks and orange juices. *J Dent Res* 2006; 85(3):226-30. doi: 10.1177/154405910608500304.
31. Tadakamadla J, Kumar S, Ageeli A, Vani NV, Babu MT. Enamel solubility potential of commercially available soft drinks and fruit juices in Saudi Arabia. *Saudi J Dent Res* 2015; 6(2):106-9. doi: 10.1016/j.sjdr.2014.11.003.
32. Larsen MJ. Prevention by means of fluoride of enamel erosion as caused by soft drinks and orange juice. *Caries Res* 2001; 35(3):229-34. doi: 10.1159/000047461.

33. Torres CP, Chinelatti MA, Gomes-Silva JM, Rizóli FA, Oliveira MAHM, Palma-Dibb RG, Borsatto MC. Surface and subsurface erosion of primary enamel by acid beverages over time. *Braz Dent J* 2010; 21(4):337-45. doi: 10.1590/S0103-64402010000400009.
34. Pinto SCS, Bandeca MC, Silva CN, Cavassim R, Borges AH, Sampaio JEC. Erosive potential of energy drinks on the dentine surface. *BMC Res Notes* 2013; 6:67. doi: 10.1186/1756-0500-6-67.
35. Borjian A, Ferrari CCF, Anouf A, Touyz LZG. Pop-cola acids and tooth erosion: An in vitro, in vivo, electron-microscopic, and clinical report. *Int J Dent* 2010; Article ID 957842: 12 pages. doi: 10.1155/2010/957842.
36. Grandó LJ, Tames DR, Cardoso AC, Gabilan NH. In vitro study of enamel erosion caused by soft drinks and lemon juice in deciduous teeth analysed by stereomicroscopy and scanning electron microscopy. *Caries Res* 1996; 30(5):373-8.
37. Sudeep CB, Jain V, Maliyil M, Sequeira PS, Jain J. Effects on pH value of saliva following intake of three beverages containing apple juice - A double blind cross-over study. *Nat J Med Dent Res* 2013; 1(4):18-23.