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Original Article

Measuring the buffering capacity of commercially available soft drinks in India: An *in vitro* study

K. B. Naziya, R. Pradeep Kumar, I. Meignana Arumugham, D. Sri Sakthi

Department of Public Health Dentistry, Saveetha Dental College, Saveetha University, Chennai, Tamil Nadu, India

Correspondence: Dr.R.Pradeep Kumar, Saveetha Dental College and Hospitals, 162, Masilamani Nagar, Seneerkuppam Bypass Road, Poonamallee, Chennai - 600 077, Tamil Nadu. E-mail: drrpradeepkumar@gmail.com

ABSTRACT

Dental erosion has been reported to be a rising health problem among children and adults globally. In contemporary societies, there is an increasing concern on the effect of consumption of acid drinks such as soft drinks, fruit juices, and fruit teas on dental erosion. Intake of soft drink, even for short duration, can diminish enamel microhardness. The aim of this study is to measure the initial pH of various commonly used beverages and to determine their ability to maintain a low pH by measuring their buffering capacities. 100 ml of each drink was titrated with 1 M sodium hydroxide (NaOH) added in 0.2 ml increments until the pH reached 5.5 and 7. This was done using a stirrer until a stable pH reading was obtained after each increment (0.2 ml) of NaOH. This was done to measure the total titratable acidity; titrations were repeated in triplicate for all drinks to check for reproducibility and to give a mean value for that drink. Titratable acidity of a solution is measured by reacting the acids present with a base such as NaOH to a chosen endpoint, close to neutrality. The titratable acidity was kept at 5.5 and 7. The amount of NaOH required to raise the pH to 5.5 and 7 was noted. The data were entered in Microsoft Excel spreadsheet and the data were subjected to statistical analysis using Mann–Whitney test. The buffering capacity was found to be lowest for milk-based drink followed by preserved fruit juices. Carbonated beverages, especially coke has highest pH and buffering capacity followed by Fanta and Sprite.

Keywords: Buffering capacity, dental erosion, soft drinks

Introduction

Over the past few decades, there was a drastic decline in the prevalence of dental caries worldwide which has been accompanied by a remarkable increase in the incidence of noncarious lesions such as dental erosion. It is defined as the irreversible loss of tooth structure due to chemical dissolution by acids not of bacterial origin. Dental erosion is the most common chronic disease.[1]

Dental erosion is defined as an irreversible loss of dental hard tissue by a chemical process without the involvement of microorganisms and is due to either intrinsic or extrinsic factors. Acids of intrinsic and extrinsic origins are the main etiological factors.[2]

Intrinsic causes like recurrent vomiting, which is a part of eating disorders like anorexia or bulimia nervosa result in erosion of teeth. Extrinsic causes include acidic substances, beverages, medication, and environmental exposure to acidic agents.[3] With the change in the dietary patterns, the prevalence of dental erosion seems to have increased presumably due to an increase in the consumption of soft drinks and fruit juices.[4]

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The erosive effects of fruit juices have been recognized way back in 1892, by Darby. Frequent consumption of these easily and widely available carbonated beverages and fruit juices showed erosion of the enamel both *in vitro* and *in vivo*.[5-7]

Soft drinks have been extensively investigated over a long period and are undoubtedly one of the principal factors in the etiology of extrinsic dental erosion. Drinks that are consumed frequently are fruit juices, carbonated drinks, and tea. The drink which causes erosion has low pH intrinsically.[8]

Study conducted by Hughes *et al*.[9] associated increasing dental erosion with decreasing pH and increasing acid concentration. Other studies have also revealed the potential erosive nature of fruit juices because of their high content of titratable acid.

Soft drinks have many potential health problems including caries and enamel erosion. This may result from the frequent exposure to erosive acids. The most frequent source of acid is the soft drinks like cola. The drink which causes erosion has low pH intrinsically.[8] The erosive potential depends on low pH and the buffering capacity of the drinks.

It has been accepted that titratable acidity which is a measurement of the total acid content is a more important indicator than actual pH value in determining erosive potential of beverages.[10]

This study was, therefore, conducted with the aim of measuring the initial pH of various commonly used beverages and their ability to maintain a low pH is determined by measuring their buffering capacities.

Aim

The aim of this study is to measure the initial pH of various commonly used beverages and to determine their ability to maintain a low pH by measuring their buffering capacities.

Objectives

i. To measure the initial pH of various commonly used beverages such as carbonated drinks, preserved fruit juices, milk-based drink, and tea-based drink.
ii. To determine the buffering capacity of various carbonated drinks, preserved fruit juices, milk-based drink, and tea-based drink.

Materials and Methods

For this *in vitro* study, eight commercially available drinks were tested: Three varieties of preserved fruit juices, three varieties of carbonated beverages, a milk-based drink and tea-based drink. Mineral water is taken as the control group.

pH measurement

The initial pH of each drink was measured using a pH meter (pH 107). 100 ml of freshly opened drink at room temperature was placed in a beaker and stirred using a stirrer until stable reading was obtained. Three readings were taken of each drink from each group to given a mean measurement for that drink.

Preparation of 1 M sodium hydroxide (NaOH) solution

44 g of NaOH pellets was weighed and dissolved in 1 L of water to give a 1 M NaOH solution.

Buffering capacity

100 ml of each drink was titrated with 1 M NaOH added in 0.2 ml increments until the pH reached 5.5 and 7. This was done using a stirrer until a stable pH reading was obtained after each increment (0.2 ml) of NaOH. This was done to measure the total titratable acidity; titrations were repeated in triplicate for all drinks to check for reproducibility and to give a mean value for that drink.

Titratable acidity of a solution is measured by reacting the acids present with a base such as NaOH to a chosen endpoint, close to neutrality. The titratable acidity was kept at 5.5 and 7. The amount of NaOH required to raise the pH to 5.5 and 7 was noted. The data were entered in Microsoft Excel spreadsheet and the data were subjected to statistical analysis using Mann–Whitney test.

Results

Table 1 summarizes initial pH and buffering capacity of each drink.

Table 2 depicts the mean initial pH of various drinks. It was lowest for the carbonated drinks and highest for the preserved fruit juices. According to this, it can be stated that carbonated drinks were most acidic among all the beverages.

Table 3 depicts there was significant difference among the carbonated drinks and fruit juices at pH levels of 7. There was significant difference between carbonated drinks and fruit juices in relation to tea.

Discussion

Carbonated drinks, fruit juices, and other beverages are frequently consumed among children and youth. Hence, the current study was intended to evaluate the enamel solubility potential of juices and soft drinks. Although acute consumption of soft drinks will have

Table 1: Initial pH and buffering capacity of each drink

Soft drink	Initial pH	Volume of base needed to increase pH to 5.5	Volume of base needed to increase pH to 7
Water	6.9	0	0
Milk	6.5	0	0
Fanta	2.3	2.7	6.4
Sprite	2.6	3.1	4.1
Coke	1.8	2.6	7.6
Appy fizz	2.5	3	3.5
Frooti	2.7	2.8	3.1
Minute maid	2.8	2.4	3.1
Lipton	2.5	2.1	2.5
Total	3.4	2.1	3.3

Table 2: Mean initial pH of various group of beverages

Group	Code	Mean pH	SD
Water	W	6.9	0.01
Milk-based	M	6.5	0.05
Carbonated drinks	CD	2.28	0.35
Preserved fruit juices	FJ	2.71	0.11
Tea	T	2.50	0.05

SD: Standard deviation

Table 3: *P* values comparing the amount of NaOH in ml to raise pH to 5.5 and 7

pH 5.5	CD	FJ	T
CD	-	NS	≤0.05
FJ	NS	-	≤0.05
T	≤0.05	≤0.05	-
pH 7.5	CD	FJ	T
CD	-	≤0.05	≤0.05
FJ	≤0.05	-	≤0.05
T	≤0.05	≤0.05	-

Mann-Whitney test ($p<0.05$)

negligible effect on teeth enamel, it is well-recognized that recognized that repeated consumption of soft drinks causes acid dissolution of enamel as most of these commercially available drinks have pH below the critical level.[11]

An association between the ingestion of acidic drinks and erosion has been recognized.[12] Soft drinks usually contain citric and phosphoric acids along with carbonic acid for aeration. The pH of these may be as low as 2.6 and they have been shown to cause erosion.[13] When the pH of the solution is less than the critical pH, the solution is unsaturated, and the mineral from tooth enamel will tend to dissolve until the solution becomes saturated,[14] and the critical pH is the pH at which a solution is just saturated with tooth enamel. However, it is not only the pH value but also the calcium, phosphate, and fluoride contents of a drink or foodstuff that are important factors in determining the degree of saturation with respect to tooth minerals, which is the driving force for enamel dissolution.[15] However, measuring the endogenous pH of the acidic drinks can be a useful method to evaluate their potential for enamel dissolution.

The pH of all the test drinks ranged from 1.8 to 2.8 which are far below the critical pH. Although many presume that the readily available fruit juices are healthy, they have been observed to cause tooth erosion due to their higher buffering capacity (because of the added preservatives) like carbonated beverage.[16]

The mean pH of fruit juices was significantly greater than that of carbonated beverages which are in accordance with the previous findings of the study from Nigeria.[17] It is not only the pH but rather the titratable acidity that plays an active role in causing tooth erosion.[18] Although we observed no significant differences for titratable acidity between carbonated drinks and fruit juices, the amount of base required to reach neutral pH was less for fruit juices and carbonated drinks.

Finally, the current study is not free of limitations with the major drawback of the study being it's *in vitro* design that involved evaluation of only few factors that are related to enamel solubility. Therefore, the findings of this study cannot be generalized to real clinical situation.

Conclusion

The buffering capacity was found to be lowest for milk-based drink followed by preserved fruit juices. Carbonated beverages, especially coke has highest pH and buffering capacity followed by Fanta and Sprite.

These results provide further information to the dentist regarding carbonated beverages and commercial fruit juices and their potential role in the development of erosion. Hence, dietary advice and preventive care are mandatory for anyone who frequently consumes commercially available flavored drinks and milk-based drinks can be a safer alternative for consumption.

References

1. von Fraunhofer JA, Rogers MM. Dissolution of dental enamel in soft drinks. Gen Dent 2004;52:308-12.
2. Cheng R, Yang H, Shao MY, Hu T, Zhou XD. Dental erosion and severe tooth decay related to soft drinks: A case report and literature review. J Zhejiang Univ Sci B 2009;10:395-9.
3. May J, Waterhouse PJ. Dental erosion and soft drinks: A qualitative assessment of knowledge, attitude and behaviour using focus groups of schoolchildren. A preliminary study. Int J Paediatr Dent 2003;13:425-33.
4. Shaw L, O'Sullivan E. UK national clinical guidelines in paediatric dentistry. Diagnosis and prevention of dental erosion in children. Int J Paediatr Dent 2000;10:356-65.
5. Larsen MJ, Nyvad B. Enamel erosion by some soft drinks and orange juices relative to their pH, buffering effect and contents of calcium phosphate. Caries Res 1999;33:81-7.
6. West NX, Maxwell A, Hughes JA, Parker DM, Newcombe RG, Addy M. A method to measure clinical erosion: The effect of orange juice consumption on erosion of enamel. J Dent 1998;26:329-35.
7. Meurman JH, Frank RM. Scanning electron microscopic study of the effect of salivary pellicle on enamel erosion. Caries Res 1991;25:1-6.
8. Grobler SR, van der Horst G. Biochemical analysis of various cool drinks with regard to enamel erosion, de-and remineralization. J Dent Assoc S Afr 1982;37:681-4.
9. Hughes JA, West NX, Parker DM, van den Braak MH, Addy M. Effects of pH and concentration of citric, malic and lactic acids on enamel, *in vitro*. J Dent 2000;28:147-52.
10. Edwards M, Creanor SL, Foye RH, Gilmour WH. Buffering capacities of soft drinks: The potential influence on dental erosion. J Oral Rehabil 1999;26:923-7.
11. Jain P, Nihill P. Commercial soft drinks: *In vitro* dissolution of enamel. Gen Dent 2007;17:86-91.
12. Brown CJ, Smith G. The erosive potential of flavored sparkling water drinks. Int J Pediatr Dent 2007;17:86-91.
13. Gray A, Ferguson MM. Wine tasting and dental erosion, case report. Aust Dent J 1998;43:32-4.
14. Dawes C. What is the critical pH and why does a tooth dissolve in acid? J Can Dent Assoc 2003;69:722-4.
15. Lussi A, Jaeggi T. Chemical factors. Monogr Oral Sci 2006;20:77-87.
16. de Fatima L, Freire GM, Tejo M. Cariogenic and erosive potential of industrialized fruit juices available in Brazil. Braz J Oral Sci 2010;9:351-7.
17. Bamise CT, Ogunbodede EO. Erosive potential of soft drinks in Nigeria. World J Med Sci 2007;2:115-9.
18. Shaw L, Smith AJ. Dental erosion-the problem and some practical solutions. Br Dent J 1999;186:115-8.