The Effect of Different Beverages on Salivary pH in 12-Year-Old School Children in Chennai

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ABSTRACT

Aim: This analytical study aims to evaluate the effect of different beverages on salivary pH in 12-year-old school children.

Materials and methods: The course of different beverages on the salivary pH was evaluated among two groups. Group A subjects (n = 16) constituted children who had DMFT = 0 and group B subjects (n = 16) constituted children who had DMFT≥ 5. Five group of test beverages were chosen for the study (fresh fruit group, acidic group, milk group, drink fortified with calcium and phosphorous group and basal group). Baseline saliva and beverage parameters were evaluated. The pH change from 1 to 60 minutes was recorded and compared using t test.

Results: It was shown in this study, that group B subjects had a more pronounced salivary pH fall than the group A subject and this was found to be statistically significant. Also the group B subjects' salivary pH returned to the baseline values much later than the group A subjects.

Conclusion: It could be concluded from this study that salivary pH fall is attenuated in the presence of dental caries posing a greater risk for quicker progression of dental caries.

Keywords: Saliva, Dental caries, Salivary pH, Beverages.

INTRODUCTION

Dental caries is a chronic ubiquitous disease. It is defined as 'a microbial disease of the calcified tissue of the teeth, characterized by demineralization of the inorganic portion and destruction of the organic substance of the tooth'.[1]

The problem of dental caries is old age. With modernization and the impact of Western world the problem of dental erosion seems to be on the advancing front.

In India, 23% of the 12-year-old suffer from this condition.[2] 80 to 85% of children suffer from this disease and the average number of decayed, missing and filled teeth per child at the age of 16 years is about 4 in rural areas and 5 in urban areas of India with almost no dental restorative help available particularly in the rural and deprived areas.[3]

Dental erosion is defined as 'a loss of tooth substance by a chemical process that does not involve known bacterial origin'.[4] The etiology of dental caries as well as dental erosion share a common background that is the nature of the saliva. The reaction of saliva has been the object of study by numerous investigators, either for direct reasons or because of a suspected causal relationship with dental caries. The properties and functions of saliva, as well as the role of saliva in oral health, have been discussed extensively in articles, textbooks and various reviews.[5]

Beverages are known to produce a tremendous drop in the salivary pH as they contain organic acids and sugars. In dental literature this is reported as critical pH in saliva, the value of which is 5.5 (Stephan, Englander et al and Schmidt-Neilson,1946).[6] A further fall in the pH disturbs the calcium and phosphate regulation leading to dental caries.[6-9] A step further has been taken in studying the effect of temperature of the beverages on salivary pH by Banan et al (2005)[8] found an inverse relationship with respect to temperature and fall in the pH. The salivary flow rate also markedly influences the pH. Low salivary secretion rate accentuates the fall in the pH.[10] The presence of dental caries makes the oral cavity more vulnerable to the effects of acidogenicity than its absence.[7-9]

As a result of westernization and cultural changes in the dietary pattern, the beverage industry has grown by 60% in the last two decades. All these can have detrimental effects on oral health that necessitates the need for further exploration in this field. As 12 years is the index age group for global monitoring as per the World Health Organization and children are in their learning years, health education regarding their dietary patterns could be easily learnt and amended at this age. Hence, targeting the 12-year-old school children seems to be a sensible choice.

Fall in the salivary pH after any dietary intake is a crucial parameter for oral health. With this in mind the following study is proposed to be conducted to determine the difference in pH of whole saliva, following the intake of different groups of beverages.

AIM

To evaluate the effect of different beverages on salivary pH in 12-year-old school children.

OBJECTIVES

To evaluate the beverage that is potentially more acidogenic in the oral cavity and to evaluate the association between change in salivary pH and dental caries

MATERIALS AND METHODS

The consent was obtained from the Ethical Committee, Saveetha University. A pilot study was carried out in 12 years old children at St Antonys High School, Chennai. Four children with DMFT score = 0 (group A) and four children with a DMFT ≥ 5 (group B) were selected. The beverages that were served were orange juice (pH = 5.4), Cocacola (pH = 3.8) and water (pH = 7.2). The mean difference in the salivary pH drop from the baseline to 5 minutes was greater in group B subjects when compared to group A subjects. This difference was found to be statistically significant when subjected to t test (df = 5). Based on these results the sample size was estimated to be 32 subjects (16 in each group).

Assumption Higher Secondary School was randomly selected from a list of 277 schools. The subjects were divided into two groups. Group A consisted of children who are caries free, with a DMFT score of 0 and group B consisted of children who have dental caries, with a DMFT score of ≥ 5. The test beverages served were orange juice, lemonade, Cocacola, Sprite, Rasna, Tang, milk, buttermilk and water served as the control. The saliva is collected in a sterile glass tube for nine times (1, 5, 10, 15, 20, 30, 40, 50 and 60 minutes) for each individual for each beverage.

The subjects were examined by a single examiner using a mouth mirror and Explorer (No. 5) in the school premises. The intraexaminer variability was computed using the Kappa statistic which yielded a value of 0.8 (good agreement). The carious teeth, missing teeth, and filled teeth were recorded based on the Henry Klein, Carrolle E. Palmer and Knutson JW (1938) criteria for DMFT index.

For every session the children were instructed to brush their teeth under supervision, but not assisted, by a trained assistant. The subjects were also instructed not to drink or eat anything for half an hour prior to commencement of beverage intake. Baseline data pertaining to salivary flow rate (stimulated and unstimulated flow rate), the buffering capacity of the saliva and the pH of the saliva of study subjects were collected. The buffering capacity and pH of the test beverage was also measured. The buffering capacity of the saliva was measure using Dentobuff® Strip system and the salivary pH was measured using a calibrated portable pH meter (Checker®, Hannah Instruments, Germany). The data gathered was entered in the proforma and analyzed using t-test.

RESULTS

Table 1 shows the baseline salivary pH among study subjects according to gender and DMFT status. The mean baseline pH in group A and group B subjects were 7.09 and 5.87 respectively. The difference in the mean baseline pH among group A and group B subjects were statistically not significant (t = 2.925, df = 7, p > 0.05). The mean baseline pH among groups A and B males were 7.21 and 6.49 respectively. The difference among males of both the groups were statistically not significant (t = 0.000256, df = 7, p > 0.05). The mean baseline pH among group A and group B females were 6.97 and 6.71 respectively. The difference among the females of both the groups were statistically not significant (t = 0.040806, df = 7, p > 0.05).

Table 1: Baseline salivary pH among study subjects according to gender and DMFT status				
S.no.	Group A		Group B	
	Males	*Females*	*Males*	*Females*
1	7.04	6.78	6.45	6.68
2	7.16	6.95	6.11	6.57
3	7.34	6.66	6.25	6.47
4	7.12	7.34	6.72	7.11
5	7.69	7.08	6.52	6.56
6	6.98	6.99	6.23	6.78
7	7.45	6.75	6.57	6.98
8	6.88	7.21	7.09	6.49
Mean	7.21*	6.97†	6.49*	6.71†
SD	0.27	0.24	0.31	0.24
Group mean	7.09§		5.874§	
Group SD	3.23		2.90	

*t = 2.925†; t = 0.000256 §; t = 0.040806; Independent t test: df = 7 NS

Graph 1 show the mean pH changes in saliva after the consumption of different test beverages from baseline through 60 minutes in group A subjects. Maximum pH drop were noted at 1 minute for Rasna and Tang [6.01 and 6.03 respectively]. At 5 minutes the pH drop were observed for Cocacola, orange juice, buttermilk, Sprite, milk and water (5.29, 5.72, 5.95, 6.08, 6.75 and 6.93). At 10 minutes the pH drop was observed for Lemonade (5.21). After the pH drop
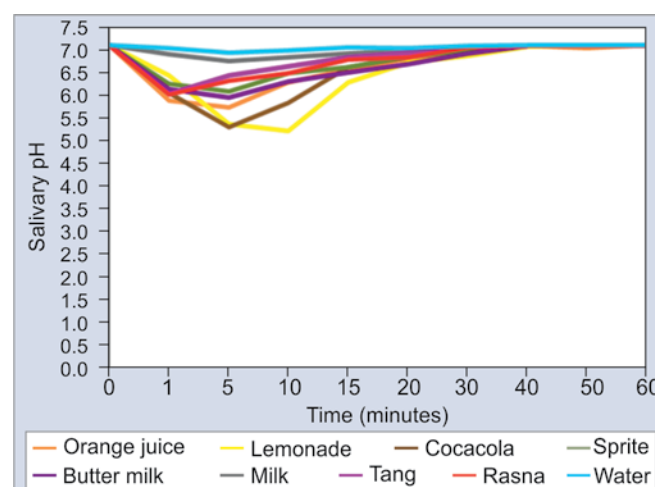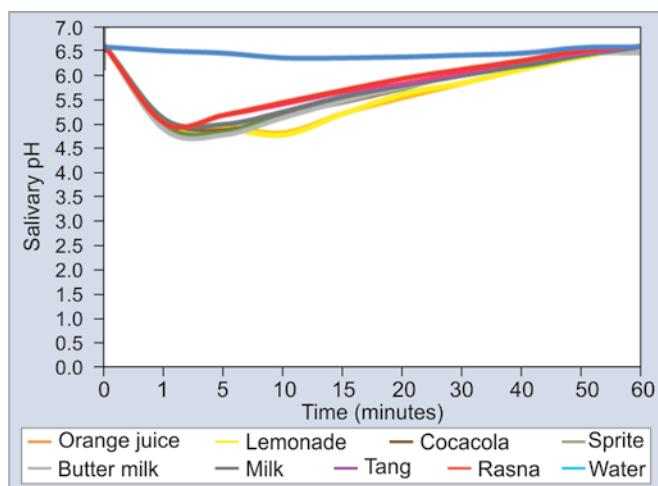

Graph 1: Mean salivary pH changes in saliva after the consumption of different test beverages from baseline through 60 minutes in group A subjects

the beverages showed a slow increase nearing the baseline value of 7.09. Recovery of the salivary pH to the baseline value were observed at 40 minutes for water and milk, at 50 minutes for Lemonade, Cocacola, Sprite, butter milk, Tang and Rasna, and at 60 minutes for orange juice.

Graph 2 shows the Mean pH changes in saliva after the consumption of different test beverages from baseline through 60 minutes in group B subjects. Maximum pH drop were noted at 1 minute for Tang and Rasna international (5.01 and 5.02 respectively). At 5 minutes the pH drop were observed for butter milk, Sprite, Cocacola and milk (4.78, 4.83, 4.90 and 5.00 respectively). At 10 minutes the pH drop were observed for lemonade and orange juice (4.78 and 4.83 respectively). At 15 minutes the pH drop was observed for water (6.37). Recovery of the salivary pH, back to the baseline value to 6.6 was observed in all the beverages with the exception of butter milk for which the pH value at 60 minutes was 6.4.

Table 2 shows comparison of mean difference in salivary pH drop between group A and group B subjects. The difference in the mean salivary pH drop from the baseline is statistically very highly significant ($p < 0.001$) with respect to orange juice and milk. The difference is statistically highly significant ($p < 0.01$) with respect to Lemonade, butter milk and Tang. The difference is statistically significant ($p < 0.05$) with respect to Cocacola and Sprite while Tang and water showed no significant differences in both the groups ($p > 0.05$).

DISCUSSION

The acidogenic potential of various dietary constituents is dependant upon several contributing factors. One of the important contributing factors is the presence of organic acids in various fruit and beverages, which can potentially damage the dentition.[11] The consumption of these beverages leads to a fall in the salivary pH;[6] which further leads to decalcification.[12] The result of the acidogenic challenge makes the tooth surface more prone to dental caries attack. Hence, this study was done to evaluate the acidogenic nature of different beverages on the cariogenic process.

The mean baseline pH and salivary flow rates in the study subjects were similar to other studies reported in Indian children.[11] Matching was done to discard the potential difference from age and gender. The mean baseline pH and the salivary flow rates, in the present study showed no significant differences with respect to gender and DMFT status in both the groups.

To combat the deleterious effects of various organic acids, the saliva resist change in the pH by altering the ionic product (buffering capacity) due to the presence of phosphate and bicarbonate ions.[13] In the present study the buffering capacity in dental group B subjects was significantly lower than in group A subjects, making it a inherent factor in the development of dental caries.[14,15] On analyzing the buffering capacities of the test beverages, it was elicited that all the test beverages had low buffering capacity with the exception of water. This is in agreement with other studies done by M Edwards et al. The order of the acidogenicity could be

Graph 2: Mean salivary pH changes in saliva after the consumption of different test beverages from baseline through 60 minutes in group B subjects

S. no	Beverage	Mean pH Group A	Mean pH Group B	t-value	p-value
		Table 2: Comparison of mean difference in salivary pH drop between groups A and B subjects			
1.	Orange juice	0.82 (0.23)*	1.78 (0.29)*	4.8916	<0.001
2.	Lemonade	1.88 (0.22)†	1.82 (0.27)†	3.5300	<0.01
3.	Cocacola	1.80 (0.29)§	1.69 (0.35)§	2.3523	<0.05
4.	Sprite	1.01 (0.24)§	1.77 (0.27)§	2.3077	<0.05
5.	Butter milk	1.14 (0.25)†	1.81 (0.37)†	2.9920	<0.01
6.	Milk	0.34 (0.09)*	1.52 (0.42)*	4.8775	<0.001
7.	Tang	1.06 (0.24)	1.59 (0.19)	1.6111	>0.05
8.	Rasna	1.08 (0.16)†	1.58 (0.29)†	3.2499	<0.01
9.	Water	0.16 (0.09)	0.23 (0.25)	0.3486	>0.05

*Very highly significant; †highly significant; §significant

ranked as follows: fresh fruit group > acidic beverage > fortified beverages > milk group > basal group.

A prolonged decrease in salivary pH was observed at 10 minutes for Lemonade in both the groups, the pH drop to 5.21 (0.23) in group A subjects, while in group B subjects it dropped to 4.78 (0.12). This is also elicited in studies done by Banan et al.[8]

In agreement with studies done by Azrak et al[9] this study also brings to light the fact that the recovery back to the baseline pH was quicker in group A subjects (at 40 minutes) than in group B subjects (at 60 minutes). There were significant differences in the pH drop across both the groups with respect to all the beverages with the exception of Tang and water. Orange juice and milk showed a significant effect on dental caries in the present study.

This study highlights the fact that though similar pattern of pH drop at similar time intervals in both groups; but recovery back to the baseline pH was prolonged in group B subjects proving the fact that the neutralization of organic acids is a prolonged process in high caries risk individuals. This concurs with previous studies done by Azrak et al,[9] Anisimova et al[14] and Rodriquez.[16]

In the present study the acidogenic and subsequently cariogenic nature of beverages in the various beverage groups were as follows:

- In the fresh fruit group Lemonade was found be more acidogenic when compared with orange juice
- Both the beverages in the acidic beverage groups were equally acidogenic
- In the milk group butter milk was more acidogenic
- In the fortified beverage group Rasna international was found to be more acidogenic
- Tang and water were the least acidogenic and did not show any significant effect on dental caries and hence can be recommended.

CONCLUSION

It could be concluded from this study that salivary pH fall is attenuated in the presence of dental caries posing a greater risk for quicker progression of dental caries.

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