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Comparison of the effect of salt water rinse, sugar-free chewing gum and tooth brushing on the pH of saliva

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ABSTRACT

To compare the effect of salt water rinse, sugar – free chewing gum and tooth brushing on the pH of saliva. 30 participants were included in the study. Baseline pH was measured using a digital pH meter. The participants were asked to swish their mouths with sucrose solution, and pH was measured. They were randomly divided into three groups namely; Group A –salt water rinse, Group B-sugar-free chewing gum and Group C- tooth brushing. After the intervention, the final pH was measured, and the recordings were compared. Repeated measures ANOVA test was used to compare the pH at Baseline, after rinsing and after an intervention. Bonferroni post-hoc test was done to do pair-wise comparison within the groups. There was significant difference pH at baseline and after intervention in all the three groups with Group B showing better results followed by Group C and then Group A. Sugar-free chewing gum significantly increased the pH of the saliva followed by tooth brushing and then salt water rinse.

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INTRODUCTION

The major burden of oral health problems has been attributed to dental caries. (Petersen, 2005) It remains a staggering public health burden in the United States. The main components in the aetiology of the dental caries are cariogenic bacteria (S.mutans), fermentable carbohydrates, tooth, host and time. Mutans streptococci are evidently implicated in the initiation of dental caries. (Emilson, 1977) Bacteria produce acid by fermentation of sugar which eventually leads to dental caries. (Clarke, 1924) Frequent snacking leads to a reduction in pH due to acid production over the time and demineralisation of the tooth. Stephen's curve depicts dental pH change over time in response to carbohydrate load. (Bowen, 2013) The acid produced by the cariogenic bacteria reduces the pH below the critical ph value. At resting pH, an adequate amount of calcium and phosphate are present in the plaque fluid to prevent demineralisation and induce re-mineralisation. Due to the continuous production of acids (intake of sugar for long duration), the pH starts falling, and a point is reached when the concentration of calcium and phosphate becomes inadequate in provoking remineralisation and hence, demineralisation occurs. Gao et al. demonstrated that enamel resisted dissolution at pH 2.5 when a huge amount of calcium and phosphate were added to the de-mineralising solution. (Gao *et al.,* 2000) Children who consume snacks in between meals are more prone to dental caries than who do not consume in between snacks. (Iftikhar *et al.,* 2012) Salivary parameters such as pH, flow rate and buffering capacity play an important role in the degree of mineral loss (Newbrun). There are various methods like

tooth brushing, using mouthwashes, flossing etc., to prevent microbial plaque from accumulating on teeth and gingiva.

Water rinse immediately after having sweetened beverages does not serve the purpose of cleaning the mouth efficiently. It only dilutes the oral fluids with no cleansing effect on plaque. (Mirjalili *et al.,* 2014) Studies show that chewing gum is competent at removing plaque and debris from the bare aspects of tooth surfaces immediately after eating food. (Addy *et al.,* 1982) (Turesky and Bibby, 1944) Xylitol chewing gum removes debris from teeth (Addy *et al.,* 1982), stimulates the salivary flow (Loesche *et al.,* 1984), prevents demineralisation and induces re-mineralisation and eventually reduces caries risk. (Makinen *et al.,* 1995) Xylitol has also shown to lower DMFS scores (Moller). Therefore, chewing of xylitol gums can be implemented in schools after lunch as a substitute for tooth brushing or if there is limited access for any oral hygiene measures.

Tooth brushing induces a transient increment in the secretion of saliva. Tooth brushing with toothpaste is undoubtedly the most common method to maintain oral hygiene. The study aims to evaluate the effect of salt water rinse, toothbrushing and sugar-free chewing gum on pH of saliva.

MATERIALS AND METHODOLOGY

The study protocol and informed consent were approved by the ethical committee board of Saveetha Dental College and Hospital, Chennai. A randomized controlled study was conducted among 30 children in the age group of 4-7 years to evaluate the effect of salt – water rinse, sugar –free chewing gum (Happydent White Xylit Sugarfree Gum, Green Mint Flavour, Perfetti) and tooth brushing (Oral B soft bristle toothbrush and Colgate Total fluoridated toothpaste on pH of saliva. The study protocol and informed consent were approved by the ethical committee board of Saveetha Dental College and Hospital, Chennai. The sample size was calculated using G-Power software version 3.1.

Eligible participants included children in the age group 4-7 years, with no caries and with Frankel's positive behaviour under Frankel's rating scale. Participants have multiple carious lesions, systemic disease, special children and uncooperative children were excluded from the study. Informed consent was obtained from parents of the participants who were suitable for the study. The parents were informed of the nature and description of the study. Initially, un-stimulated saliva was collected from the participants in sterile disposable containers, and the baseline pH was measured using digital p meter (MCP Pocket Digital pH Meter with Autocalibration).

Then the participants were given a 50% sucrose solution and were asked to swish for one minute. (Mirjalili *et al.,* 2014) Saliva was collected after a minute in a sterile container and pH was measured again. The children were randomly divided into three groups using a computer-generated random sequence. Group A-the children were advised to rinse their mouth with the salt water solution provided. They were asked to swish their mouth with salt water for 30 seconds. The children in Group B were given sugar –free chewing gum and were advised to chew it for 5 minutes. (Mirjalili *et al.,* 2014) In Group C-the children were asked to brush their teeth for 2 minutes. All the interventions were done under adult supervision.

After the respective intervention, saliva was collected after 1 minute, and pH was measured again with the digital pH meter and recorded. The baseline pH was compared with the pH after sucrose rinse and after interventions.

RESULTS

The recordings obtained were tabulated and subjected to statistical analysis using the SPSS statistical package ver. 15.0 (SPSS Inc., Chicago, IL, USA). The mean age in Group A was 4.90+_0.738 years, in Group B was 4.91+_0.831 years and in Group C was 5.30+_0.823 years.

The normality tests Kolmogorov-Smirnov and Shapiro-Wilks tests result revealed that variables follow a normal distribution. Therefore, to analyse the data, parametric methods were applied. Comparison of mean salivary pH between groups and at different times was done using one-way ANOVA. To compare proportions between groups Chi-Square test was applied. Significance level was fixed at 5% ($\alpha = 0.05$).

The statistical analysis showed that the mean baseline pH in groups A, B and C were 7.650+_0.3274, 7.545+_0.2876 and 7.600+_0.3300 respectively with a p-value of 0.751 which is not statistically significant.

The mean pH after rinsing with 50% sucrose solution in Group A was found to be 6.800+_0.2749, in Group B was6.855 +_0.2876 and in Group C was 6.960+_0.2319 respectively with a p-value 0.406 which is not statistically significant.

The mean pH after intervention in Group A was found to be 7.960 +_0.4427, in Group B was 8.364 +_0.3695and in Group C was 8.180+_0.2251 with a p-value of 0.051 which is borderline statistically significant.

Table 1: Demographic details of participants

Group	Gender					
	Male		Female		Total	
	N	%	N	%	N	%
Group-A	3	30.0%	7	70.0%	10	100.0%
Group-B	7	63.6%	4	36.4%	11	100.0%
Group-C	6	60.0%	4	40.0%	10	100.0%
Total	16	51.6%	15	48.4%	31	100.0%

Table 2: Mean age of participants between groups

Group	N	Mean Age	Std. Dev	P-Value
Group-A	10	4.90	.738	
Group-B	11	4.91	.831	0.448
Group-C	10	5.30	.823	

Table 3: Mean pH values between three groups at baseline, after rinsing, with sucrose and after intervention with a salt water rinse, sugar-free gum and tooth brushing

Variables	Group	N	Mean pH	Std. Dev	F-Value	P-Value
pH at baseline	Group-A	10	7.650	.3274	0.290	0.751
	Group-B	11	7.545	.2876		
	Group-C	10	7.600	.3300		
pH after rinsing with sucrose	Group-A	10	6.800	.2749	0.932	0.406
	Group-B	11	6.855	.2876		
	Group-C	10	6.960	.2319		
pH after intervention	Group-A	10	7.960	.4427	3.330	0.051
	Group-B	11	8.364	.3695		
	Group-C	10	8.180	.2251		

Table 4: General Linear Model: Repeated measures ANOVA to compare between Baseline, rinsing and after intervention

Group	Time points	N	Mean pH	Std. Dev	F-Value	P-Value
Group-A	pH at baseline	10	7.650	.3274	112.07	<0.001
	pH after rinsing with sucrose	10	6.800	.2749		
	pH after intervention	10	7.960	.4427		
Group-B	pH at baseline	11	7.545	.2876	63.68	<0.001
	pH after rinsing with sucrose	11	6.855	.2876		
	pH after intervention	11	8.364	.3695		
Group-C	pH at baseline	10	7.600	.3300	67.12	<0.001
	pH after rinsing with sucrose	10	6.960	.2319		
	pH after intervention	10	8.180	.2251		

Table 5: Pairwise comparison (Bonferroni post hoc test)

Group	Time points	P-Value
Group-A	Baseline vs. Af0ter rinsing	0.001
	Baseline vs. After intervention	0.002
	After rinsing vs. After intervention	0.001
Group-B	Baseline vs. After rinsing	0.001
	Baseline vs. After intervention	0.001
	After rinsing vs. After intervention	0.001
Group-C	Baseline vs. After rinsing	0.001
	Baseline vs. After intervention	0.002
	After rinsing vs. After intervention	0.001

Repeated measures ANOVA was used to compare the pH at baseline, pH after 50% sucrose solution and ph after intervention within each group. P-value was <0.001. Hence, there was a significant difference in the pH at baseline, pH after 50% sucrose and pH after intervention within each group.

The mean pH value after intervention in Group A was 7.96, in Group B was 8.36, and Group C was 8.18. The results showed that Group B is effective in elevating the pH of the oral cavity followed by Group C and then Group A.

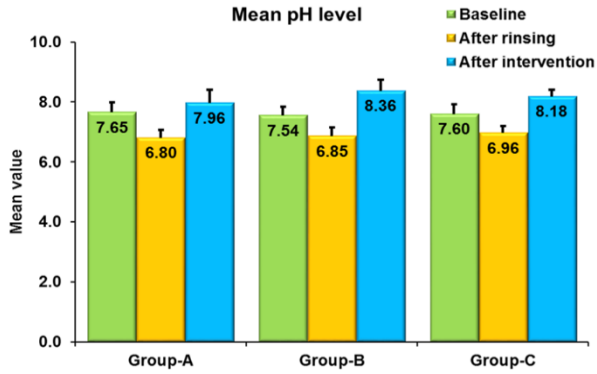

Figure 1: Graph depicting pH changes in saliva at baseline, after rinsing and after intervention (Group A, B and C)

DISCUSSION

Children tend to snack in between the meals, and therefore their oral health status gets compromised due to continuous decrement in pH of the saliva. Association between high consumption of snacks and increased incidence of dental caries was demonstrated by Johansson et al. Hydrolysed starch rapidly lowers the pH of saliva and eventually leads to high chances of dental caries.(Lingstrom *et al.,* 2000).

There are various oral hygiene measures like tooth brushing, mouth rinsing, usage of xylitol-containing chewing gum, mouthwashes etc., which help in reverting back the pH of saliva to a normal level. Toothbrush and toothpaste are not available every time at all places and brushing the teeth after every meal is not feasible.

In this study the mean pH increased from 7.65 to 7.96 in salt water rinse group, 7.545 to 8.364 in the xylitol group and 7.600 to 8.180 in tooth brushing group. A study done by Fomete et al. showed that warm saline mouth wash had no significant effects on bacterial growth. (Fomete *et al.,* 2015) However, Listerine mouth wash showed contradictory results in a study conducted by Okuda et al. (1998) as Listerine is an antimicrobial mouth rinse it eliminates a wide range of bacteria from the oral cavity in 10 to 30 seconds. (Okuda *et al.,* 1998)A clinical trial comparing five different mouth rinses showed that triclosan and essential oil mouth rinses increased the salivary pH immediately after their use. (Tolentino *et al.,* 2011)

After consumption of carbohydrate-rich food, intake of xylitol chewing gums causes the pH to rise due to stimulation of salivary flow and increment in bicarbonate level which eventually increases the pH of the saliva. Thus, dental caries is prevented on a longer period of time. (Scheinin *et al.,* 1975) Honkala et al. in 1999 showed the best results of xylitol in terms of increasing the plaque pH and decreasing dental caries which corresponds to the results of this study. (Honkala *et al.,* 2006) Various authors have stated that xylitol chewing gum increases the salivary flow, pH and buffering capacity and it reduces the S.mutans carriage in the saliva. (Ribelles *et al.,* 2010) A clinical study done by Ribelles et al. showed that the effect of xylitol gum was essential to recover the pH level, thus matching the results in the present study. On a similar note, Mirjalili et al. in 2014 concluded that mint –flavoured xylitol gum could be a preventive adjunct to tooth brushing. (Mirjalili *et al.,* 2014) The highest increase in salivary flow rate was observed in the first minute of chewing xylitol gum in a study done by Karami-Nogourani et al. in 2011. (Karami-Nogourani *et al.,* 2011)The foremost suggested mechanism through which chewing gum improves dental health is the stimulation of the salivary flow during the gum-chewing period. Sugar-free chewing gum containing CPP-ACP was found to support higher levels of remineralisation than a sugar-free gum without CPP-ACP or a no-gum control using an intra-oral remineralisation model. (Cochrane *et al.,* 2012) Chewing a sorbitol gum after intake of snacks appreciably reduced the de-mineralising prospective of the plaque. The chewing of sorbitol gum following the consumption of snacks can be recommended as an accessory caries-preventive dental hygiene measures. (Park *et al.,* 1990)

In a study conducted by Brand et al. stated that there was increased salivary flow rate after tooth brushing due to which there was less retention of bicarbonates in salivary ducts and consequently an increased amount in the saliva. (Ligtenberg *et al.,* 2006) However salivary pH is not affected by the amount of fluoride present in the dentifrice. Calcium carbonate present in toothpaste or dentifrice gets incorporated into plaque and reduces the acidity of the plaque.

The present study shows that there was a mild increase in the pH of the saliva after salt water rinse but less than that by xylitol gum and tooth brushing. Saltwater contains bicarbonates which are essential in increasing the pH of saliva and plaque fluid. Moreover in a study done by Raksha *et al.,* showed that a rise in salivary pH was linked to an increase in salivary bicarbonate concentration. (Ballal *et al.,* 2016) Salt water rinses are a very efficient bactericidal agent that can be safely used in the oral cavity, but it is presumably unacceptable because of its un-favourable taste.

Infection with S.mutans in young children is linked with increased snacking frequency and poor tooth-brushing. A single oral health education session and tooth-brushing instruction to mothers resulted in a reduction of 25% in mutans streptococci Infection in young kids from a reasonably high socioeconomic status.

CONCLUSION

In the present study, it is concluded that xylitol gum significantly increased the pH of the saliva followed by tooth brushing and then salt water rinse.

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