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ORIGINAL ARTICLE

Estimating the pH of Commercially Available Dentifrices and Evaluating its Effect on Salivary pH After Brushing

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ABSTRACT

Objectives: The purpose of the study was to estimate the pH of commercially available dentifrices and evaluating its effect on salivary pH after brushing

Material and Methods: 60 study subjects were selected and were divided into 12 groups (each group comprises of 5 subjects). The salivary pH was directly estimated using the digital pH meter calibrated using buffers of pH 4, 7 and 9. Paired t test was used to compare the changes in the mean salivary pH after brushing in each group. One way ANOVA and Tukey's test was used to compare the changes in mean salivary pH after brushing between different groups.

Results: pH of different types of commercially available dentifrices which were used in the study was found to be 8.4, 7.9, 7.9, 6.7, 7.2, 8.3, 8.4, 7.1, 6.5, 5.6, 8.2 and 6.5 respectively. Difference in mean salivary pH after brushing was found to be statistically significant for Colgate, Neem active group, Vicco, Triguard, Colgate active salt, Dabur meswak, Dabur babool, Close-up active gel, RA Thermoseal, Dabur lal dant manjan, Colgate powder groups. Mean salivary pH (before and after brushing) between study groups showed a statistically significant difference.

Conclusion: The pH of saliva increases after brushing in each commercially available dentifrice group.

Keywords: pH, Saliva, Dentifrice, Tooth brushing

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INTRODUCTION

Saliva is a complex fluid consisting of 99% of the water and remaining 1% of organic and inorganic molecules. It plays a major role in the demineralization and remineralization processes of the teeth. The diverse functions of the oral tissues such as the mastication, deglutition, taste sensation, speech and initial digestion of the carbohydrates would be impossible without the salivary secretions. The interface between the saliva and oral tissue is the site of many dynamic reactions which affect both the soft tissue and hard tissues of the mouth. Saliva provides this physiologic environment where the complex interactions between the agent, host and the environment factor occurs, to bring about the demineralization of the tooth and subsequent development of the caries (1).

By the chemical laws of mass action, calcium and phosphate ions influence the driving force for the precipitation of calcium hydroxyapatite, the principal inorganic component of dental hard tissues. If, as occurs when the pH in the oral cavity decreases, the thermodynamic conditions become unfavorable, there is a driving force for hydroxyapatite dissolution or demineralization. When normal oral pH returns, the thermodynamic conditions become favorable and there is a driving force for hydroxyapatite precipitation or remineralization. The pH at which any particular saliva ceases to be saturated is referred to as 'critical pH' and below this

value; the inorganic material of teeth may dissolve in it (2). There is no pH value above which teeth will not dissolve if calcium and phosphate ions are absent. The salivary parameters which affect the enamel stability in the oral environment are pH of saliva, salivary flow rate, oral clearance, concentrations of calcium, phosphate and fluoride ions and salivary levels of the oral microorganisms (1).

Dentifrices are the major products for routinely administering effective cosmetic and therapeutic agents in the mouth. Because of their widespread and regular use they serve as the most effective tool for oral disease prevention and control (3). Dentifrices are considered agents with antibacterial potential which could have a beneficial effect on plaque control and disease prevention (4). Usually the actual or alleged therapeutic effect is to reduce caries incidence, gingivitis, or tooth sensitivity. Dentifrices are marketed as toothpowders, toothpastes, and gels. All are sold as either cosmetic or therapeutic products. The attributes of the dentifrices which may affect their cosmetic or therapeutic effect are their physical form, chemical composition, their pH, their solubility.

The dentifrices which are marketed for public use are customarily neutral or mildly alkaline; that is, when the dentifrices are slurried with water in a ratio of about 1 part of dentifrice to about 3 parts of water (a combination which approximately corresponds to the composition formed when a dentifrice is applied to the teeth), the pH value obtained by the use of conventional pH measuring instruments will be 7.0 or higher. The pH of dentifrices may be changed by adding small amounts of alkaline or acid materials. This alkaline pH of the dentifrice may have some desirable and undesirable effects. To the disadvantage when a neutral or alkaline dentifrice is used in brushing the teeth mucoproteins present in the mouth tend to adhere to the surface of the teeth in the form of a slimy film and are difficult to remove. When a dentifrice is used which has a pH of 6.0 or less the mucoproteins lose this adhesive quality, thus aiding in their removal from the surface of the teeth by brushing or rinsing (5). On the other hand the alkaline pH of toothpaste helps neutralize the plaque and salivary acids which cause tooth decay but there is very little documentary evidence supporting this fact.

Keeping the above mentioned points in view, a clinical trial was undertaken with the objectives to estimate the pH of different commercially available dentifrices and to evaluate the effect of these dentifrices on salivary pH after brushing.

MATERIAL AND METHODS

Estimation of pH of 12 commercially available dentifrices

The pH values were estimated for each of these 12 different type of dentifrices (in suspension form) using the digital pH meter. Measure 2 grams of dentifrice by using digital weighing machine and add it to the labeled beaker. Then add 80 ml of distilled water to this beaker and stir the dentifrice/water mixture with a stirring rod until a suspension is formed. To measure the pH of dentifrice, pH sensitive electrode was dipped into the beaker. The digital reading was allowed to stabilize for a few seconds and the pH reading was recorded. In between the readings, the electrode was cleaned with a stream of distilled water and placed in a standard solution of pH 7. This ensured stable readings and provided a constant check on any drift. Same procedure was repeated for all 12 types of dentifrices to find out their pH.

Sampling Procedure

The sample of 60 undergraduate students who were residing in the hostel of the K.D Dental College and Hospital, Mathura were selected on the basis of inclusion and exclusion criterion. Subjects who were caries free i.e. DMFT score =0 and were willing to participate were included in the study. Subjects who were using tobacco or alcohol in any of the forms, those who were suffering from any systemic illness or using any medication at the time of study or in period of last 15 days prior to the study were excluded from the study. All the study subjects were standardized in terms of their dietary habits, oral hygiene practices and other lifestyle factors which could have significant effect on the study results.

Before carrying out the present study the ethical clearance was obtained from the institutional ethical clearance committee. The purpose and methodology of the study was explained to each of the subject and informed consent was obtained.

Study Design

60 study subjects were selected and were divided into 12 groups (each group comprises of 5 subjects). Each of the study group was given different type of dentifrice for the test period of 1 month before the study.

Collection of Salivary Samples

The unstimulated salivary samples were collected from the subjects in morning around 7am before brushing. Then the subjects were asked to brush with dentifrice which they were given for last 1 month and salivary samples were collected immediately after brushing. Same procedure was carried out for each group. Saliva was collected in the sterile test tubes. For the laboratory analysis the salivary samples were transported for the laboratory analysis on the same day immediately after the brushing and salivary pH was estimated within 30 minutes after the collection of the samples.

Laboratory Analysis

The laboratory analysis was carried out in the Pharmaceutics department of Rajeev academy of Pharmacy which is located in the college campus only. The salivary pH was directly estimated using the digital pH meter calibrated using buffers of pH 4, 7 and 9. The accuracy of pH meter was checked at regular intervals to ensure that readings were correct.

Statistical analysis

The collected data was entered in the Microsoft Excel Sheet and analyzed using the SPSS Version 11.5 statistical package. The mean and the standard deviation calculated for the salivary pH and dentifrice pH using descriptive statistics. Paired t test was used to compare the changes in the

Table 1: pH of different types of commercially available dentifrices

Name of dentifrice	pH
Colgate	8.4
Neem Active	7.96
Vicco	7.94
Triguard	6.7
Colgate Active Salt	7.23
Dabur Meswak	8.32
Dabur Babool	8.4
Close-up Active gel	7.16
RA Thermoseal	6.57
Dabur lal dant manjan	5.6
Colgate Powder	8.21
MDH dant manjan 6.5	

Table 2: Mean salivary pH of study groups before and after brushing

Study groups	N	Mean salivary pH ± SD (before brushing)	Mean salivary pH ± SD (after brushing)
Colgate	5	6.85 ± 0.09	7.48 ± 0.08
Neem active	5	6.84 ± 0.09	7.10 ± 0.10
Vicco	5	6.81 ± 0.12	7.06 ± 0.15
Triguard	5	6.81 ± 0.09	7.65 ± 0.11
Colgate active salt	5	6.86 ± 0.11	7.04 ± 0.12
Dabur meswak	5	6.79 ± 0.11	7.11 ± 0.13
Dabur babool	5	6.90 ± 0.07	7.37 ± 0.06
Close-up active gel	5	6.92 ± 0.10	7.23 ± 0.08
RA Thermoseal	5	6.79 ± 0.08	7.56 ± 0.18
Dabur lal dant manjan	5	6.86 ± 0.07	7.43 ± 0.14
Colgate powder	5	6.89 ± 0.09	7.61 ± 0.17
MDH dant manjan	5	6.93 ± 0.14	6.95 ± 0.05

mean salivary pH after brushing in each group. One way ANOVA and Tukey's test was used to compare the changes in mean salivary pH after brushing between different groups. The p value equal to or less than 0.05 was fixed to be statistically significant at confidence interval of 95%.

RESULTS

pH of Dentifrices Colgate, Neem active, Vicco, Triguard, Colgate active salt, Dabur meswak, Dabur babool, close-up active gel, RA thermoseal, Dabur lal dant manjan, Colgate powder and MDH dant manjan was found to be 8.4, 7.9, 7.9, 6.7, 7.2, 8.3, 8.4, 7.1, 6.5, 5.6, 8.2 and 6.5 respectively (Table 1).

Table 2 shows the mean salivary pH of 12 groups before and after brushing. Mean salivary pH was found to be 6.85 (SD=0.09) for Colgate group before brushing. Similarly mean salivary pH of Neem active group, Vicco, Triguard, Colgate active salt, Dabur meswak, Dabur babool, Close-up active gel, RA Thermoseal, Dabur lal dant manjan, Colgate powder and MDH dant manjan groups was found to be 6.84 (SD=0.09), 6.81 (SD=0.12), 6.81 (SD=0.09), 6.86 (SD=0.11), 6.79 (SD=0.11), 6.90 (SD=0.07), 6.92 (0.10), 6.79 (0.08), 6.86 (SD=0.07), 6.89 (SD=0.09) and 6.93 (SD=0.14) respectively.

Mean salivary pH was found to be 7.48 (SD=0.08) for Colgate group after brushing. Similarly mean salivary pH of Neem active group, Vicco, Triguard, Colgate active salt, Dabur meswak, Dabur babool, Close-up active gel, RA Thermoseal, Dabur lal dant manjan, Colgate powder and MDH lal dant manjan groups was found to be 7.10 (SD=0.10), 7.06 (SD=0.15), 7.65 (SD=0.11), 7.04 (SD=0.12), 7.11 (SD=0.13), 7.37 (SD=0.06), 7.23 (SD=0.08), 7.56 (SD=0.18), 7.43 (SD=0.14), 7.61 (SD=0.17) and 6.95 (SD=0.05) respectively.

Paired t test was employed to find out the intragroup comparison of mean salivary pH within study groups before and after brushing. Difference in mean salivary pH after brushing was found to be statistically significant for Colgate, Neem active group, Vicco, Triguard, Colgate active salt, Dabur meswak, Dabur babool, Close-up active gel, RA Thermoseal, Dabur lal dant manjan, Colgate powder groups. However no statistically significant difference was found between the mean salivary pH be-

Table 3: Intragroup comparison of mean salivary pH within study groups-before and after brushing (paired t test)

Dentifrice	N	Mean pH of saliva before brushing	Mean pH of saliva after brushing	Mean difference in pH	t value	p value
Colgate	5	6.85	7.48	0.62	26	0.000
Neem active	5	6.84	7.10	0.26	4.87	0.008
Vicco	5	6.81	7.06	0.24	5.34	0.006
Triguard	5	6.81	7.65	0.83	31.3	0.000
Colgate active salt	5	6.86	7.04	0.19	6.34	0.003
Dabur meswak	5	6.79	7.11	0.32	27.8	0.000
Dabur babool	5	6.90	7.37	0.47	13.8	0.000
Close-up active gel	5	6.92	7.23	0.30	4.22	0.013
RA Thermoseal	5	6.79	7.56	0.76	9.54	0.001
Dabur lal dant manjan	5	6.86	7.43	0.57	9.12	0.001
Colgate powder	5	6.89	7.61	0.71	14.4	0.000
MDH dant manjan	5	6.93	6.95	0.02	0.37	0.730

Table 4: Inter group comparison of change in mean salivary pH (before and after brushing) between study groups (oneway anova test)

Dentifrice	N	Mean difference	F value	p value
Colgate	5	0.62	24.4	0.00
Neem active	5	0.26		
Vicco	5	0.24		
Triguard	5	0.83		
Colgate active salt	5	0.19		
Dabur meswak	5	0.32		
Dabur babool	5	0.47		
Close-up active gel	5	0.30		
RA Thermoseal	5	0.76		
Dabur lal dant manjan	5	0.57		
Colgate powder	5	0.71		
MDH dant manjan	5	0.02		

fore brushing and after brushing in MDH dant manjan (Table 3).

Oneway ANOVA was applied to compare the change in mean salivary pH (before and after brushing) between study groups and it showed a statistically significant difference between the changes in mean salivary pH of different dentifrices. (Table 4)

When post hoc Tukey's test was employed it was seen that a significant difference was found between change in mean salivary pH of Colgate group and change in mean salivary pH of Neem active, Vicco, Colgate active salt, Dabur meswak, close-up active gel, and MDH dant manjan groups. However, no significant difference was found between change in mean salivary pH of Colgate group and change in mean salivary pH of Triguard, Dabur babool, RA thermoseal, Dabur lal dant manjan, and Colgate powder groups (Table 5).

DISCUSSION

The present study was conducted to estimate the pH of different commercially available dentifrices and to evaluate the effect of these dentifrices on salivary pH after brushing. The salivary pH is an important biomarker for dental caries. The dentifrices varying in their chemical composition, pH range might influence the salivary pH.

The present study found that the pH of different available dentifrices used in the study were in the range of 5.6 – 8.4, highest pH being reported for Colgate and lowest being reported for Dabur lal dant manjan respectively. Similar results were obtained in study by Bardal PA et al. (6), who reported the pH of dentifrices to be in the range of 6.8 – 9.9. However World Intellectual Property Organization in the year 1996 (7) reported the preferred pH of dentifrice to be in the range of 6.5 – 9.0, as we know that the application of acidified toothpastes may result in erosion of the enamel surface. Erosion occurs at much lower pH levels where the solutions are undersaturated with respect to hydroxyapatite and also fluorapatite and therefore, remineralization would not be possible with respect to thermodynamics.

The present study also attempted to find the effect of pH of these dentifrices on the salivary pH of the study subjects after brushing. Our study found a statistically

Table 5: Inter group comparison of change in mean salivary pH (before and after brushing) between study groups (post hoc tukey test)

	Colgate	Neem active	Vicco	Triguard	Colgate active salt	Dabur meswak	Dabur babool	Close-up active gel	RA Therm-oseal	Dabur lal dant manjan	Colgate powder	MDH dant manjan
Colgate	–	0.00	0.00	0.18	0.00	0.007	0.625	0.004	0.731	1.00	0.97	0.00
Neem active	–	–	1.00	0.00	0.99	0.99	0.18	1.00	0.00	0.005	0.00	0.09
Vicco	–	–	–	0.00	1.00	0.99	0.12	1.00	0.00	0.003	0.00	0.14
Triguard	–	–	–	–	0.00	0.00	0.00	0.00	0.99	0.03	0.90	0.00
Colgate active salt	–	–	–	–	–	0.83	0.02	0.92	0.00	0.00	0.00	0.51
Dabur meswak	–	–	–	–	–	–	0.67	1.00	0.00	0.05	0.00	0.01
Dabur babool	–	–	–	–	–	–	–	0.53	0.00	0.96	0.05	0.00
Close-up active gel	–	–	–	–	–	–	–	–	0.00	0.03	0.00	0.01
RA Thermoseal	–	–	–	–	–	–	–	–	–	0.27	1.00	0.00
Dabur lal dant manjan	–	–	–	–	–	–	–	–	–	–	0.67	0.00
Colgate powder	–	–	–	–	–	–	–	–	–	–	–	0.00
MDH dant manjan	–	–	–	–	–	–	–	–	–	–	–	–

significant affect of pH of these dentifrices on the salivary pH as it was found that there was significant increase in mean salivary pH of study subjects after brushing with various dentifrices ($P<0.05$) except for one dentifrice ($P>0.05$). The results are in accordance with the study conducted by H.J. Florestano et al. (8) and Surdacka A et al. (9).

Salivary pH is the important salivary parameter affecting the carious process. Demineralization and remineralization processes of the teeth, occurring in the oral cavity are dependent on the pH of the saliva. The saliva is rich in the calcium and phosphates and is nearly always supersaturated with respect to enamel minerals and other biological appatites. The pH of the saliva depends on bicarbonate content. As the flow rate of saliva increase, pH also increases. The alkaline pH of the saliva neutralizes the acid produced by the plaque bacteria Further the more basic is the pH of the saliva more is the remineralization of tooth surface by the precipitation of bicarbonate ions (10,11).

LIMITATIONS AND RECOMMENDATIONS

- Small sample size of the study—might have influenced the study results.
- As the study population was a captive population restricted to hostel inmates of the dental institute, the results obtained were specific.
- Hence, the results cannot be generalized to the whole population for which further studies are recommended taking larger samples with wider geographical representation.

CONCLUSION

It was found from the study that the pH of saliva increases after brushing in each commercially available dentifrice group.

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