A Comparative Evaluation Of Enamel Surface Abrasion Of Three Different Herbal Dentifrices Using A Customized Brushing Model: An In Vitro Profilometric Study

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Abstract: Background: Abrasives are the insoluble components added to dentifrices to aid the physical removal of stains, plaque and food debris. However, replete of abrasivity cause enamel abrasion, dentin hypersensitivity, damaging the smile as well as masticatory apparatus. The aim of this study is to evaluate the enamel surface abrasivity using three different herbal dentifrices and a customised brushing machine under profilometer. Materials And Method: A total of 30 enamel blocks are prepared from buccal surface of maxillary central incisor which are randomly divided into three groups. Group-1 Specimens brushed with Colgate Vedshakti, Group-2 Specimens brushed with Patanjali Dant Kanti, Group-3 Specimens brushed with Dabur Red. All specimens were brushed using a customised brushing model with Oral-B powered brush for 30 minutes. Surface roughness of all three groups specimens were analysed using a surface roughness tester-profilometer. Statistical analysis used in this study was one-way analysis of variance (ANOVA) followed by post hoc turkey's test. Results: Statistically significant difference was observed in value of enamel abrasion amongst Group1, 2 and 3. ($p<0.05$) Conclusion: Toothpaste with higher relative enamel abrasivity has the potential to abrade the enamel and cause hypersensitivity. The least enamel abrasion was observed in Colgate Vedshakti when compared with Patanjali Dant Kanti and Dabur Red toothpaste.
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Introduction: Care of oral hygiene dates as old as 3000 BC. The Charaka Samhita describes using a Neem stick in the form of a brush which should be either astringent or pungent or bitter on its ends and should be changed every day and to be used twice a day without injuring the gums. But it was in the early 16th century that the mechanical teeth cleaning and mouth rinsing were established as a daily practice.[1]

Although toothbrush is the most important tool for removing plaque, adjuncts like dentifrices (toothpastes or toothpowder) are used for additional effects and also for the delivery of various therapeutic agents which helps in cleaning and maintenance of oral hygiene.[2]

Mechanical plaque removal with brushing and flossing are challenging for every individual, very time consuming and also results in gingival recession and tooth abrasion. This results in discolouration and sensitivity. Abrasion is defined as the surface loss of tooth structure resulting from direct friction forces between the teeth and external objects, or from frictional forces between contacting teeth components in the presence of an abrasive agents. To maintain the good oral hygiene and increase the effectiveness of toothpaste, abrasive agents are most important components. Its effectiveness reduces if abrasive-free formulas are used which might result in poor cleaning capacity of the toothbrush alone in removing of pellicle which results in rapid regrowth of biofilm and staining of teeth.[3]

International Organization for Standardization (ISO) states that Relatively Enamel Abrasivity (REA) of 40 and Relative Dentin Abrasivity (RDA) of 250 for adults' toothpaste for daily use is safe. Different techniques are used for evaluating the enamel abrasivity. The quantitative techniques are Radioactive Dentin Abrasion- RDA method, volume and weight loss techniques whereas qualitative techniques are measuring the roughness of the abraded material with profilometer, light reflection technique, microscopy etc.[4]

Various factors like brushing technique, frequency, duration and also forces along with toothbrush types and dentifrice's concentrations are important factors for enamel abrasion.

Amongst these, the abrasive particles are potentially more impactful on abrasion of enamel surface. Although, the exact mechanism of abrasivity of enamel surface is not clear, to measure the changes in surface roughness, profilometer is used. It measures roughness average (Ra) values of surface.[4]

Recently, there has been a dramatic upsurge in consumption of plant-based toothpastes. People are favoring it against conventional toothpastes for better tastes, smell and viscosity and also help against gingival inflammation and halitosis.

Considerable research has been done on herbal toothpastes like Dabur Red and Patanjali Dant Kanti but non with the Colgate Vedshakti.[5]

Aggarwal et al (2017) had comparing abrasivity of herbal and non-herbal toothpastes and they concluding that Himalaya Hiora and Patanjali Dant Kanti toothpaste resulted less abrasive on tooth surface compared to Colgate and Dabur Red. [6]

The aim of this study was to evaluate the enamel surface abrasion using Colgate Vedshakti, Patanjali Dant Kanti and Dabur red herbal toothpastes using a customized brushing model under a profilometer.

Materials and Methods: As per the norms of ethical rule, no approval was required in this in-vitro study. Forty-Five freshly extracted maxillary central incisors were taken for present study.

Teeth which were extracted for periodontal cause and were free from cracks, caries, discolorations, or enamel defects were selected.

The teeth were stored in normal saline and cleaned using an ultrasonic scaler. All samples decoronated with the help of diamond disc and the crown portion was again stored in saline solution until use.

Enamel blocks of 9 mm × 9 mm × 2 mm were prepared from the labial surface of all samples. The enamel blocks were embedded in self-curing acrylic resin cylindrical blocks (DPI-RR Cold Cure Powder and Liquid) with dimensions of 2 cm length and 1 cm radius. The samples were then randomly divided into three groups (n=15). (Figure 1).

Figure 1: Specimen Embedded In Acrylic Blocks

Group1: Colgate Vedshakti Toothpaste (Colgate Palmolive Company, India); Group2: Patanjali Dant Kanti Toothpaste (Patanjali Ayurved Limited, India); Group3: Dabur Red Toothpaste (Dabur India Limited, India)

Table 1: Toothpastes And Their Ingredients

Toothpaste	Ingredient List
Colgate Vedshakti	Calcium Carbonate, Sorbitol, Sodium Lauryl Sulfate, Silica, Zinc Oxide, Sodium Silicate, Carrageenam, Sodium Monofluorophosphate, Flavour, Zinc Citrate Trihydrate, Sodium Bicarbo - nate, Benzyl Alcohol, Potassium Nitrate, Sodium Saccharin, Lemon, Clove, Neem, Eucalyptus, Indian Gooseberry, Basil, Camphor, Honey, Mint, Fennel, Cinnamon, Aloe Vera And Thymol
Patanjali Dantkanti	Akarkara, Babul, Tomar, Neem, Pudina, Laung, Long Pepper, Vajradanti, Bakul, Vaividang, Haldi, Meswak/ Pilu, Majuphal, Calcium Carbonate,Sodium Benzoate And Fluoride
Dabur Red	Calcium Carbonate, Sorbitol, Aqua, Hydrated Silica, Sodium Lauryl Sulfate, Herbal Extract [Piper Nigrum, Piper Longum, Zanthozylum Alatum, Zingber Officinate], Red Ochre, Flavour Containing Clove, Mint , Xanthan Gum, Sodium Silicate, Sodium Benzoate,Sodium Saccharin, Propylparaben, Methylpara-ben, Formalin, Clove Oil, Pudina Satva, Karpura

	(Camphor), Pippali, Garic, Tomar Beej, Sunthi, Babul Extract, Meswak Extract

A customized brushing wooden model was constructed. It had two wooden segments, first where a commercially available powered toothbrush- Oral-B Cross Action (P&G) was attached. Attachment of the toothbrush was such that the bristle part was facing down. The tooth sample was placed on second wooden segment just below the toothbrush such that the bristle of the tooth brush just touches the labial part of tooth surface (Figure 2).

Figure 2: (A) A Powered Tooth Brush. (B) A Customized Brushing Wooden Model And A Powered Brush Attached To It. (C) Slurry Applied Over Specimen (D) Toothbrush Over Mounted Specimen.

The powered toothbrush was chosen considering the following conditions: Load of the toothbrush was standardized at 250 g, verified with the internal pressure control of the brush, brushing time: 30 min, toothbrush head with soft end-rounded bristles, rotation sense changing every 30 sec.

According to EN ISO 11609:2010 standard (Dentistry-Toothpastes: Requirements, test methods and marking) dentifrice slurry was prepared. Water and toothpastes were mixed in a ratio of 1:3 by weight and spread over the mounted enamel specimens before toothbrushing. While brushing, the same amount of slurry was prepared, applied over the enamel surface and gently spread with a tip of manual toothbrush bristle.

The samples were brushed with the dentifrice they are grouped under. A new toothbrush head was used for each group. The toothbrush head was in direct contact with the enamel block and the dentifrice. The average time taken to brush by a person daily is 120 s. Based on this estimation, the maximum contact time for one tooth surface per day is 5 s.[7] Thus, in this study, the total brushing time was calculated to be 30 min, which is equivalent to 6 months.

After brushing, specimens were rinsed with distilled water for 30 secs and gently dried with absorbent paper.

All the specimens were subjected to Profilometer-roughness testing machine (Mitutoyo Surftest SJ-201 Series) and Ra value (µm) readings were recorded.

The procedure was performed in three different places of the specimen which resulted in an average final Ra value (Figure 3).

Figure 3: Samples Tested By Profilometer

Statistical Analysis was performed with the help of One-way analysis of variance (ANOVA) was done to compare the mean values across the three groups (Table 2).

Table 2: Mean Values Of Ra Of All Three Groups

	Group A Colgate Vedshakti	Group B Patanjali Dantkanti	Group C Dabur Red
Mean	0.637143	3.511429	1.261429

Standard Deviation	0.1686925	0.3596493	0.4032133
Standard Error	0.0637598	0.1359347	0.1524003

The mean difference was found to be significant at 0.05 level. This was followed by the Post-hoc Tukey's test which was performed to know the significant mean surface roughness difference among all groups (Table 3).

Table 3: Intergroup Comparison Of Mean Ra Values

Treatment Pair	Tukey's Mean Difference	Standard Error	Significance Value
A versus B	-2.8742857	0.1746795	0.000*
A versus C	-0.6242857	0.1746795	0.008*
B versus C	2.2500000	0.1746795	0.000*
***P < 0.05 is significant**			

Results: There was a statistically significant difference in enamel roughness among all the groups. In intergroup comparison, Group 1 Colgate Vedshakti (0.63) showed the least mean Ra value. Whereas Group 2 Patanjali Dant Kanti (3.51) showed maximum mean Ra value.

Discussion: There is always a dilemma for general public how to choose a toothpaste for their oral health care. Besides, there is a growing preference for products that are said to have `natural' ingredients and India's preference to brush with an herbal toothpaste is growing fast.[8]

90% of regular (non-herbal) toothpaste mainly contains abrasives (calcium carbonate, silica), surfactants and fluoride. Flavouring/sweetening agents and other ingredients, which helps differentiate a product from another, creating a brand's own unique selling point (USP), forms 10% of the total constituent.

Herbal extracts and various other Ayurvedic elements are added in this 10% which then results in a 'Herbal toothpaste' which proves as effective as the conventionally formulated dentifrice in the control of plaque and gingivitis.[9]

For better cleaning and good oral hygiene, toothbrush and toothpastes are always recommended. But its long-term usage may damage the tooth surface and surrounding soft tissues if the abrasivity of the toothpaste is damaging.

The toothpaste abrasivity is related to its abrasive particles' concentration, size and surface structure and also other ingredients of the products.[10] Typically, the required particle size and shape of abrasive agents should be in a desirable range (i.e., 1–20 µm or 5–15 µm) and should not be sharp or angular.[11]

The highest mean enamel abrasivity was showed in Patanjali Dant Kanti (3.5) followed by Dabur Red (1.26) and least with Colgate Vedshakti (0.63). This observation is co-related with

Athawale et al (2017) that Colgate Total caused highest maximum and Pepsodent Whitening caused least maximum enamel abrasion in

permanent teeth amongst the groups. Whereas in Primary teeth, Dabur Red caused highest maximum and Colgate Total caused least maximum enamel abrasion.[12]

Calcium carbonate is a base component in Patanjali which may give a more abrasivity on enamel surface comparing to other toothpastes. Although Dabur Red consists of Calcium carbonate, ingredients like hydrated silica, sodium lauryl sulfate, herbals are also added which reduces plaque and toothache and are also less abrasive on enamel surface.

One component of Colgate Vedshakti is Thymol which helps whiten the teeth, protects against cavities and strengthens the tooth and also helps against gingivitis and halitosis.

In the present study, with the use Powered Toothbrush attached to a fixed wooden model, it was ensured that brushing technique, brushing force, frequency and duration were kept constant.

Manual toothbrushes might result in vigorous and faulty brushing technique.[7] To avoid this and to just evaluate abrasivity of the herbal dentifrice, powered toothbrush was chosen.

RDA values for regular toothpaste are: 0-70 which is considered low abrasive, 70-100 is considered medium abrasive, 100-150 is

considered highly abrasive and 150-250 is considered harmful limit.

There is no information regarding REA values. Therefore, the present study was evaluating the enamel abrasivity with three herbal toothpastes.[12] It was in 1972, by Ashmore et al that described the first use of Profilometer to test abrasivity of any dentifrices.[13,14] Although RDA method of abrasivity is most followed, Profilometry method is also advantageous over other methods as it is more accurate and does not damage the surface during the measurements.[4]

The tip of profilometer is placed at the center of each specimen for recording the Ra value. Ra is defined as the arithmetic average deviation of the absolute values of the roughness profile from the mean line or the center line.[15]

Nainan et al. (2014) compared the effects of different herbal and non-herbal whitening toothpastes (Colgate Total- Advanced whitening, Salt and lemon- Dabur and Hiora Shine-Himalaya) on the micro-hardness of a nano hybrid composite resin and evaluated that herbal whitening toothpastes causes lesser reduction in microhardness compared to non-herbal whitening toothpaste.[16]

Hence, the present study was undertaken to compare all herbal toothpastes and came to the conclusion that all the toothpastes, irrespective of being herbal or non-herbal, causes some amount of enamel abrasivity albeit within recommended limits.

So, it can be safely inferred that herbal toothpastes is as efficacious as the conventional formulated toothpastes and could be used as an alternative for people interested in natural products.

Conclusion: Within the limitations of this study, it can concluded that the highest abrasive potential was seen in Patanjali Dant Kanti followed by Dabur red and least with Colgate Vedshakti.

References:

1. Avinash J, Singh A, Singh DK, Powered Toothbrush vs Manual Toothbrush: Generation X of Mechanical Plaque Control. Int J Prev Clin Dent Res 2017;4(2):122-132.
2. Hoover JN, Singer DL, Pahwa P, Komiyama K. Clinical evaluation of a light energy conversion toothbrush. J Clin Periodontol 1992;19:434-6.
3. Cury JA, Tenuta LM. Evidence-based recommendation on toothpaste use. Braz Oral Res 2014;28:1-7.
4. Rath SK, Sharma V, Pratap CB, Chaturvedi TP. Abrasivity of dentrifices: An update. SRM J Res Dent Sci 2016;7:96-100.
5. Hosadurga, R., Boloor, V. A., Rao, S. N., & MeghRani, N. (2018). Effectiveness of two different herbal toothpaste formulations in the reduction of plaque and gingival inflammation in patients with established gingivitis – A randomized controlled trial. Journal of Traditional and Complementary Medicine, 8(1), 113–119.
6. Aggarwal, A., Krishan, S., Midha, V., Kaur, S., Bala, D., Singh, P., Bhagat, A., Mann, N. Abrasive Action of Herbal vs Non-Herbal Toothpaste: A Profilometric Analysis. Journal of Pharmaceutical and Biomedical Sciences, [S.l], v. 7, n. 5, may. 2017. ISSN 2230-7885.
7. Boyd RL, McLey L, Zahradnik R. Clinical and laboratory evaluation of powered electric toothbrushes:In vivo determination of average force for use of manual and powered toothbrushes. J Clin Dent 1997;8:72-5.
8. Sagar Malviya. Herbal toothpastes make up more than a fifth of India's oral care market: Nielson. brandequity.com. Economic Times. February 23 2017
9. George J, Hegde S, Rajesh KS, Kumar A. The efficacy of a herbal-based toothpaste in the control of plaque and gingivitis: a clinic-biochemical study. Indian J Dent Res. 2009;20:480e482.
10. Aggarwal, A., Krishan, S., Midha, V., Kaur, S., Bala, D., Singh, P., Bhagat, A., Mann, N. Abrasive Action of Herbal vs Non-Herbal Toothpaste: A Profilometric Analysis. Journal of Pharmaceutical and Biomedical Sciences, [S.l], v. 7, n. 5, may. 2017. ISSN 2230-7885.
11. Knowlton JL, Pearce SE. Handbook of Cosmetic Science and Technology. 1st ed. Oxford, UK: Elsevier Publications; 1993. p. 251.
12. Athawale R, Srinath SK, Chowdary C. Comparative evaluation of enamel abrasivity of different commercially available dentifrices – An in vitro study. J Indian Assoc Public Health Dent 2018;16:78-82.
13. Ashmore H, Van Abbé NJ, Wilson SJ. The measurement in vitro of dentine abrasion by toothpaste. Br Dent J 1972;133:60-6.

14. Boyd RL, McLey L, Zahradnik R. Clinical and laboratory evaluation of powered electric toothbrushes:In vivo determination of average force for use of manual and powered toothbrushes. J Clin Dent 1997;8:72-5.
15. Robert Shelton. Toothpaste Abrasivity. https://www.sheltondentistry.com/patient-information/toothpaste-abrasivity/,2020 (accessed 25th March 2020).
16. Nainan MT, Balan AK, Sharma R, Thomas SS, Deveerappa SB. The comparison of the effects of different whitening toothpastes on the micro hardness of a nano hybrid composite resin. J Conserv Dent 2014;17:550-4

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