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Original Article

Comparative clinical efficacy of three toothpastes in the control of supragingival calculus formation

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ABSTRACT

Objectives: The purpose of this double-blind, parallel clinical study was to assess clinical efficacy in supragingival calculus formation reduction using Abhaibhubejhr Herbal Toothpaste compared to Colgate Total and Colgate Cavity Protection toothpastes. **Materials and Methods:** A total of 150 subjects participated in the pretest phase. All subjects were given oral soft/hard tissue evaluation, calculus examination using Volpe-Manhold calculus, and whole mouth oral prophylaxis. They received noncalculus control fluoride toothpaste and a soft-bristled toothbrush to brush for 1 min two times daily for 8 weeks. After which, subjects were given a test phase oral soft/hard tissue evaluation and calculus examination and were randomized into one of the three toothpaste groups. All subjects in the test phase received a whole mouth oral prophylaxis and were given their assigned toothpaste and a soft-bristled toothbrush to brush for 1 min two times a day for 12 weeks. Thereafter, subjects were assessed for their oral soft/hard tissue and calculus formation. **Results:** Mean Volpe-Manhold calculus index scores for the Cavity Protection, Abhaibhubejhr, and Total toothpaste groups were 0.78, 0.62, and 0.48, respectively, at the 12-week test phase evaluation. Abhaibhubejhr and Total toothpaste groups show 20.51% and 38.46% significantly less calculus formation than the Cavity Protection toothpaste group ($P < 0.05$). Total toothpaste group also show 22.58% significantly less calculus formation than the Abhaibhubejhr toothpaste group ($P < 0.05$). **Conclusion:** The use of Colgate Total toothpaste over a 12-week period was clinically more effective than either Abhaibhubejhr or Colgate Cavity Protection toothpastes in controlling supragingival calculus formation.

Key words: Abhaibhubejhr, Colgate Total, supragingival calculus formation, toothpaste

INTRODUCTION

Dental calculus or tartar is calcified deposit occurring on the teeth or other solid structures in the oral cavity such as restorations, prosthetic appliances, and dental implants. Calculus is calcified dental plaque which can be classified as supragingival or subgingival calculus. Dental plaque is the diverse community of microorganisms found on tooth surface as a biofilm. The microorganisms bind tightly to one another and the tooth surface by means of an extracellular matrix of polymers of host and microbial origin.[1,2] Dental plaque biofilms are responsible for many common oral diseases including dental caries, gingivitis, periodontitis, and peri-implantitis.[3]

Calculus is invariably covered with plaque on its surface. Calculus promotes the retention of dental plaque and may increase the rate of plaque formation. Its porosity can serve as a reservoir for periodontal pathogens and can retain noxious bacterial components such as endotoxin.[4,5]

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Recently, there has been a growing interest in natural products. People's interest has been shifted from synthetic toothpaste to herbal toothpaste. Herbal toothpaste does not contain any artificial colors or flavors that many of the regular toothpaste have. Artificial colors and flavors of the toothpaste are also giving birth to many diseases and health-related issues. The demand for herbal toothpaste suppliers has risen due to the great advantages which are associated with this toothpaste type. There are a number of brands of herbal toothpaste on the market. Abhaibhubejhr is a widely known herbal-based toothpaste containing Guava leaves, Betel vine leaves, and Mangosteem peel for which medicinal properties are claimed. However, many of the health claims made for them have not been clinically proven.

The objective of this clinical study was to evaluate the anticalculus efficacy of Abhaibhubejhr Herbal Toothpaste compared to Colgate Total toothpaste (positive control) and Colgate Cavity Protection toothpaste (negative control).

MATERIALS AND METHODS

Screening and selection of subjects

This study was approved by the Faculty of Dentistry, Mahidol University Institutional Review Board (COA.No.MU-DT/PY-IRB 2012/016.1204). Adult subjects from the Faculty of Dentistry, Mahidol University, Thailand, signed an informed consent form and were screened by the examining dentist to identify those subjects who meet the inclusion characteristics and demonstrate a tendency to form calculus. The first 150 subjects who meet the inclusion/exclusion were entered into the pretest phase of this double-blind, randomized, parallel clinical study.

Inclusion characteristics included good general health, male and female subjects, aged 18–70, inclusive, scoreable lower six anterior teeth free of large restorations or dental prosthetic crowns, a Volpe-Manhold calculus index score of at least 10, and available for the 20-week duration of the study.

Exclusion characteristics include the presence of orthodontic appliances or more than one lower anterior tooth with a prosthetic crown or veneer, tumors or significant pathology of the soft or hard tissues of the oral cavity, moderate or advanced periodontal disease, five or more carious lesions requiring immediate care, use of antibiotics or steroids any time during 1 month before entry into the study, participation in any other clinical study or panel test, pregnant or breastfeeding women, history of allergies to dentifrice and personal care ingredients, and allergies to dentifrice products.

Pretest phase: Oral soft/hard tissue and calculus examination, oral prophylaxis and toothpaste use at home

All subjects received an evaluation of their oral soft/hard tissues by the dental examiner. This examination included an evaluation of the soft and hard palate, gingival mucosa, buccal mucosa, mucosa-gingival fold areas, tongue, sublingual and submandibular areas, salivary glands, and the tonsillar and pharyngeal areas. Candidates were examined by the examining dentist to identify those subjects who demonstrate the presence of supragingival calculus. The scoring procedure used to evaluate calculus formation was the Volpe-Manhold calculus index which uses a standardized and calibrated (in millimeters) periodontal probe to measure supragingival calculus formation in three planes (mesial, midline, distal) of the lingual surfaces of the six lower anterior teeth. Adding the 18 measurements of six teeth constitutes, a total Volpe-Manhold score for each subject.[6,7]

All subjects entered into the pretest phase of the study received a complete oral prophylaxis after the pretest phase calculus examination. The prophylaxis procedure was verified for its thoroughness by use of a red plaque disclosing solution. Subjects were provided a fluoride toothpaste (washout product) for the pretest phase of the study and a soft-bristled adult toothbrush for home use. Subjects were instructed to brush their teeth for 1 min twice daily for 8 weeks. Subjects were instructed to use only the toothpaste provide during the 8-week pretest phase period. There were no restrictions regarding diet and smoking habits during the study.

Test phase: Oral soft/hard tissue and calculus examination, randomization of subjects, oral prophylaxis and toothpaste use at home

After using fluoride toothpaste for 8 weeks, all subjects reported back to the clinical facility. Subjects received an evaluation of their oral soft/hard tissues and examined for calculus formation. The same examination, scoring, and recording procedure employed at the start of the pretest phase of the study were repeated. The same examining dentist performed all examinations.

All subjects were randomized into three balanced groups based on their sex and test-phase calculus examination scores. Each group was randomly

assigned to one of the three test toothpastes. All toothpastes were packaged in over wrapped tubes so that neither the subjects nor the examining dentist were aware of the product identities during the study.

All subjects entered into the test phase of the study received a complete oral prophylaxis after the test phase calculus examination. The prophylaxis procedure was verified for its thoroughness by use of a red plaque disclosing solution. Subjects were provided with their assigned toothpaste for the test phase of the study and a soft-bristled adult toothbrush for home use. Subjects were instructed to brush their teeth for 1 min twice daily. Subjects were instructed to use only their assigned toothpaste during the 12-week test phase period. There were no restrictions regarding diet and smoking habits during the study.

Test phase: 12-week oral soft/hard tissue assessment and calculus examination

After using their assigned toothpaste for 12 weeks, all subjects reported back to the clinical facility to receive an evaluation of their oral soft/hard tissues and calculus formation. The same examination, scoring, and recording procedure employed at the start of the test phase were repeated. The same examining dentist performed all examinations.

Statistical analysis

Statistical analysis was calculated using the statistical program SPSS for window version 18.0 (SPSS Inc., Chicago, IL, USA). All statistical tests of hypotheses used two-way analysis of variance (two-way ANOVA) and employed a level of statistical significance of $P < 0.05$.

RESULTS

All 150 subjects who entered the study completed this clinical study. The characteristics and test phase Volpe-Manhold calculus index scores of subjects in the three test toothpastes are given in Table 1. The Cavity Protection group consisted of 50 subjects (19 males and 31 females), aged between 20 and 53 years (mean 35.16 years), and had calculus score of 0.79. The Abhaibhubejhr group comprised 50 subjects (22 males, 28 females), aged between 21 and 54 years (mean 36.06 years), and had calculus score of 0.77 while the Total group had 50 subjects (20 males, 30 females), aged 27–51 years (mean 35.80 years), and calculus score of 0.76. An ANOVA indicated no statistically significant difference among the three toothpaste groups ($P > 0.05$). The three study groups were well-balanced based on the number of subjects, age, gender, and test phase calculus scores.

Table 2 shows the comparison of the Volpe-Manhold calculus index scores of the three test toothpastes after 12 weeks of assigned toothpaste use. The mean 12-week calculus scores for the Cavity Protection, Abhaibhubejhr, and Total toothpaste groups were 0.78, 0.62, and 0.48, respectively. The subjects who used the Abhaibhubejhr and Total toothpastes for 12 weeks showed 20.51% and 38.46% less calculus formation, respectively than subjects who used the Cavity Protection toothpaste, which was statistically significant ($P < 0.05$). In addition, subjects using the total toothpaste had 22.58% statistically significant less calculus formation than subjects using the Abhaibhubejhr toothpaste ($P < 0.05$).

DISCUSSION

Tooth brushing is relatively effective in dental plaque removal, but it is still inadequate for the maintenance of gingival health. Chemotherapeutic agents have been used to supplement the mechanical removal of dental plaque and calculus from teeth. To the best of our knowledge, this study is the first to evaluate the effect of Abhaibhubejhr Herbal Toothpaste in the control of supragingival calculus formation. This study showed significant anticalculus benefits for the Colgate Total and Abhaibhubejhr toothpastes. Results from this study also showed superior calculus inhibition properties for the Colgate Total versus the Abhaibhubejhr toothpaste. These findings are consistent with other reports in literature showing positive anticalculus benefits for Colgate Total toothpaste.[8,9] The active ingredients in Colgate Total toothpaste were 0.3% triclosan and 2.0% PVM/MA copolymer, whose

Table 1: Number, age, gender, and test phase calculus scores of subjects in the three study groups

Toothpaste groups	Number subjects			Age (year)		Calculus score (mean±SD)
	Male	Female	Total	Range	Mean	
Cavity protection	19	31	50	20-53	35.16	0.79±0.259
Abhaibhubejhr	22	28	50	21-54	36.06	0.77±0.225
Total	20	30	50	22-51	35.80	0.76±0.202

SD: Standard deviation

Table 2: The mean 12 weeks calculus scores for the three toothpaste groups and % calculus reduction

Toothpaste groups	Mean calculus scores±SD	Reduction of calculus (%)	
Cavity protection	0.78±0.252		
Abhaibhubejhr	0.62±0.213	20.51	
Total	0.48±0.111	38.46	22.58

SD: Standard deviation

mechanism of action is antimicrobial. Triclosan is a broad-spectrum antimicrobial agent active on both Gram-positive and Gram-negative bacteria. At bacterioctatic concentrations, triclosan prevents essential amino acid uptake, while at bactericidal concentrations, triclosan destroys the integrity of the cytoplasmic membrane and causes leakage of cellular contents.[10]

The principal ingredients in Abhaibhubejhr Herbal Toothpaste were fruit pericarp of *Garcinia mangostana* Linn (mangosteen), leaf of *Piper betle* Linn (betel), and leaf of *Psidium guajava* Linn (guava). Phytochemical studies showed that mangosteen pericarp contained various bioactive substances including xanthones, tannins, triterpenes, anthocyanins, polysaccharides, phenolic compounds, Vitamin B_1, B_2, and C.[11] These xanthones exhibit a variety of biological and pharmacological properties including antibacterial, anti-inflammatory, antiviral, antifungal, antioxidant, antiallergy, analgesic, and anticancer.[12,13] Due to its antimicrobial activity, mangosteen pericarp could probably lead to the reduction of plaque and calculus formation. Some studies suggested that mouthwash containing mangosteen pericarp has benefits as an adjunct to periodontal treatment and for control of oral malodor.[14,15]

Betel leaf contains volatile oil (eugenol, cadinene, carvacrol, caryophyllene, chavitbetol, chavicol, estragole, amino acids, pyridine alkaloids, sitosterols, tannins, stigmasterol, Vitamin C, oxalic acid, malic acid, and inorganic elements like fluoride and iron).[16] Further betel leaf possesses anti-bacterial, anti-cariogenic, anti-inflammatory, antifungal, antiprotozoan, anti-allergic, antidiabetic, hepatoprotective, anti-ulcer, cardioprotective, antihyperlipidemic, anti-platelet, and immunomodulatory properties.[17]

Guava leaf contains essential oils, flavonoids, tannins, eugenol, saponins, triterpenes, malic acid, and phenolic acid.[18] The potential pharmacologic activities of the extract from guava leaf have been reviewed including antimicrobial, antioxidant, anti-allergy, anti-genotoxic, anti, antiplasmodial, antispasmodic, cardioactive, cough suppressant, antidiabetic, anti-inflammatory, antinociceptive, and antiplaque.[19] It has been reported that the extract of guava leaf reduced the adherence of early plaque bacteria to an experimental pellicle.[20] Razak and Rahim,[21] in 2006, also found that treatment of the early plaque settlers with aqueous guava extract reduced the cell-surface hydrophobicity of *Streptococcus sanguinis*, *Streptococcus mitis*, and *Actinomyces* sp. The extract was observed to have the ability to alter and disturb the surface characteristics of the early plaque settlers and make them less adherent leading to its potential as an antiplaque and anticalculus agent.

Recently, there is the study that revealed differences in the antimicrobial activities of commercial natural toothpastes and suggested that the toothpastes with natural compounds have therapeutic potential and need searching in more detail for the clinical applications.[22] In addition, a recent study indicated that a gel preparation containing 10% *Lippia sidoides* essential oil was an efficient herbal antiplaque and antigingivitis agent.[23]

CONCLUSION

This study evaluated the anti-calculus efficacy of Abhaibhubejhr Herbal Toothpastes compared to a positive control toothpaste (Colgate Total) and a negative control toothpaste (Colgate Cavity Protection). The Abhaibhubejhr and Colgate Total toothpastes revealed significant anti-calculus efficacy compared to the control. The Colgate Total had superior anti-calculus efficacy compared to the Abhaibhubejhr toothpaste.

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Conflicts of interest
There are no conflicts of interest.

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