

## ABSTRACT

While multibenefit (MB) dentifrices offer therapeutic opportunities beyond simple caries prevention, tooth whitening/cleaning remains a priority for many U.S. patients.

**Objectives:** We compared the pellicle stain removal activity of several commercial MB dentifrices with conventional (non-whitening) controls (CTR) in the Pellicle Cleaning Ratio Test (PCR) (Stokey et al., J Dent Research, 61: 1236-1239, 1982). **Methods:** Bovine enamel blocks were prepared and color values (CIELAB) were evaluated by chromameter. Specimens were stained in a mixture of TSB staining broth containing mucin, ferric chloride, instant coffee and tea, along with inoculums of *Sarcina Lutea*. Specimens with 25 < L\* < 40 color values were stratified 16/tmt.grp. and brushed for 800 strokes in a V8 brushing machine at 150 gm. load using 25/40 wt.% toothpaste/water slurries. Final color values were used to calculate a PCR scores{L\*<sub>f</sub>-L\*<sub>i</sub>/ΔL\*<sub>(avg. i-f)ADA Std</sub>}X100. PCR's were averaged for each test group and compared via Students t. **Results:** Cleaning scores ± SD for tested dentifrices measured: Colgate® Total® (MB) 64.2 ± 29.5 a; Crest® Gum Care (MB) 89.0 ± 26.6 b; Colgate® Total® Plus Whitening (MB) 90.2 ± 26.6 b; ADA Standard Calcium Pyrophosphate 100.0 ± 28.2 bc; Crest® Cavity Protection (CTR) 104.6 ± 26.3 bc; Crest® Tartar Protection (CTR) 115.9 ± 23.8 c: where a#b at p < 0.05. **Conclusions:** A MB dentifrice surprisingly produced laboratory whitening significantly lower than all other tested dentifrices. A 'whitening' version of this dentifrice produced improved stain removal but whitening efficacy was still directionally decreased vs. standard dentifrices.

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## INTRODUCTION

Today, the improved health, oral health and living standards of our patients has helped to encourage their interest in cosmetic dentistry and oral products which provide more 'aesthetic' benefits of refreshment, breath control and most particularly tooth whitening. Over the counter products available for tooth whitening include dentifrices, which primarily act to control surface stains, and bleaching systems, which act to whiten both exterior and intrinsic sources of tooth discoloration.

Patient interest in whitening products has promoted a complex array of marketplace introductions with virtually every 'therapeutic' focused formulation offering both standard and 'whitening' versions. For the most part, these whitening variants appear to include modified cleaning abrasives. The PCR, pellicle cleaning ratio test, is a laboratory method accepted as useful in the characterization of stain cleaning (whitening) actions of abrasive dentifrices, showing good correlations with clinical efficacy for stain reductions. This study compared the stain cleaning capabilities of several marketed antimicrobial dentifrices with comparisons to conventional 'cavity only' and 'tartar control' variants respectively.

## MATERIALS AND METHODS

The relative stain cleaning power of dentifrices and abrasives was compared in a Pellicle Cleaning Ratio protocol developed at Indiana University. 8 mm square bovine enamel blocks were mounted in methacrylate blocks sized to fit into a V-8 brushing machine. Specimens were wet polished with 600 grit SiC paper followed by flour of pumice and sonicated to remove debris. Ground specimens were etched in 1 % HCl (60 sec.) followed by saturated NaCO<sub>3</sub> solution. A final immersion in 1 % phytic acid solution cleaned off remaining debris. Specimens were mounted in humidified and heated staining wheels as also described by Stokey and subjected to a stain procedure including immersion of specimens in 5.4 % TSB staining broth comprising 2.5 % mucin, 50 ppm ferric chloride, 0.338 % instant coffee (Folgers, Procter and Gamble Inc.), 0.338 % instant tea (Liptons - non sweetened, Liptons, Inc.) and 4 inoculums of *Sarcina Lutea* bacterial culture. The staining solution was applied for a period ranging from 4-8 days, with specimens withdrawn based upon Chromameter assessment of color. Stained specimens were evaluated for tooth color utilizing a Chromameter. Tooth specimens qualified with 25 < L < 40 (L indicates the light/dark assessment in conventional CIELAB color space) as assessed on the chromameter. A special sample jig was prepared to allow pre and post brushing color evaluations. Initial color assessments allowed teeth to be sorted and rank ordered for treatment distribution normalized to tooth color.

Specimens were stratified to treatment groups based upon initial L values for each treatment group. In these tests, 16 specimens are used within each treatment group. Toothbrushing was carried out in a V8 brushing machine using Oral B® 40 toothbrushes (Oral B 40 Regular Toothbrush, Oral B Inc., Belmont, California) pre-conditioned at 20,000 strokes at a 150 gram normalized load. One treatment always included a control reference standard prepared by adding 10 grams calcium pyrophosphate (ADA reference standard calcium pyrophosphate, Monsanto Inc., St. Louis, Missouri) to 50 grams of 5.2 % CMC (carboxymethylcellulose) solution. Dentifrices were applied in 25/40 dentifrice/water slurries prepared with a biohomogenizer wand. Treatments were rotated so that enamel specimens from each treatment group were brushed in each position on the V8 brushing machine. Specimens were brushed in test slurries for 800 strokes at a normalized pressure of 150 grams. Following brushing, specimens were air dried and re-examined for color L values on the Chromameter. Treatment effects were assessed according relative efficacy as compared against the reference calcium pyrophosphate abrasive as follows:

$$\frac{L_{Tf} - L_{Ti}}{L_{Cf} - L_{Ci}} \times 100 = \text{PCR}$$

Where L<sub>Ti</sub> and L<sub>Tf</sub> are L chromameter values for test dentifrice treated specimens initial and post brushing and L<sub>Ci</sub> and L<sub>Cf</sub> are values for calcium pyrophosphate abrasive control respectively. For statistical analysis, the raw cleaning score for each tooth, L<sub>Tf</sub> - L<sub>Ti</sub> within each treatment group is calculated. These individual scores are converted to cleaning ratio scores (PCR scores) by division of these individual scores by the average raw cleaning score obtained for calcium pyrophosphate ADA abrasive control and multiplication by 100. These PCR scores are averaged and comparisons are carried out using Students paired t tests for each of the individual groups.

Obviously, the conversion of the individual scores to PCR scores renders the calcium pyrophosphate abrasive slurry average score as 100 (by definition) although this group will have a standard deviation around this value owing to variance of  $L_{Cf}$  and  $L_{Ci}$  scores. In net, all individual scores are thus multiplied by a constant which is identical for all treatments, but permits cleaning to be assessed on a scale normalized to a single cleaning material - in this case calcium pyrophosphate. While statistics are carried out on PCR scores, the relative improvement for various treatments is calculated as the ratio of average PCR scores x 100 to create a percentage difference.

Toothpastes included in testing were accessed through commercial outlets and were all tested within expiration date. Treatments included: Crest Cavity Protection (NaF/silica; Procter & Gamble Co.); Crest Tartar Protection (NaF/silica/pyrophosphate; Procter & Gamble Co.); Colgate Total (NaF/silica/Gantrez/triclosan; Colgate Palmolive Co.); Colgate Total + Whitening (NaF/silica/Gantrez/triclosan; Colgate Palmolive Co.); Crest Gum Care (SnF2/silica; Procter & Gamble Co.).

## RESULTS – PCR COMPARISONS

Treatment	Pellicle Cleaning Ratio $\pm$ SD
Colgate Total Dentifrice	64.2 $\pm$ 29.5 a
Crest Gum Care Dentifrice	89.0 $\pm$ 26.6 b
Colgate Total Plus Whitening Dentifrice	90.2 $\pm$ 26.6 b
ADA Standard Calcium Pyrophosphate	100.0 $\pm$ 28.2 bc
Crest Cavity Protection Dentifrice	104.6 $\pm$ 26.3 bc
Crest Tartar Protection Dentifrice	115.9 $\pm$ 23.8 c
Students paired t comparisons $p < 0.05$ a $\neq$ b $\neq$ c	

## CONCLUSION

Available antimicrobial dentifrices were generally less effective in stain cleaning than conventional dentifrices.

Colgate Total Plus Whitening formula was significantly improved vs. Colgate Total Regular, but essentially comparable in cleaning ability to Crest Gum Care and directionally less effective than Crest Cavity Protection.

Standard Crest Tartar Protection was a superior stain cleaning dentifrice to antimicrobial dentifrices.



Pre - Stained Bovine Enamel Chip



V - 8 Brushing Machine



Post - Brushed Stained Bovine Enamel Chip