

ABSTRACT

This study was aimed at developing a test method for studying tooth stain based upon dentifrice treatment of saliva pellicle coated hydroxyapatite discs (HAP). HAP were treated (4/grp.) to a sequence including saliva soaks (S) - 1 hr init./20 min. between, dentifrice slurry (D) - 5 min. 25 % wt/wt dent./water slurry, chlorhexidine rinses (Cx) - 1 min. 0.12 %, and conc. tea soaks (T) - 15 min. as follows: (SDSCxSTSCxSTSCxSTSDS). The interceding saliva treatments eliminated any direct precipitation reactions and ensured reactivity within the pellicle surface boundary. Prior to and following the treatment series (repeated through 6 cycles) - the color of the HAP chips was read in a PR650 Spectrophotometer with L and E values compared. Toothpastes compared to a water (W) treated control included Regular Crest® - Cr; Crest Tartar Control (5 % pyrophosphate) - CTC; Colgate® Total - CT (2 % Gantrez Acid); Mentadent® Sanogyl - SG (0.7 % ZnSO₄); and Blend-a-Med® Synergy - BAMS (5 % polyphosphate e.g. "poly"pyrophosphate). Following staining/treatment periods efficacy was observed as follows: DE: SG: 13.6 a; W:11.7b; CT: 10.2c; Cr: 9.4c; CTC: 7.2d; BAMS 5.9e°DL: SG: 7.4a; W: 5.8b; Cr: 5.7b; CT: 4.9c; CTC: 3.6d; BAMS: 1.9e (ab @ p<0.05 students paired t). **HAP - surface active anionic ingredients were found to be effective in inhibiting the adsorption of stain components (Cx/T) through chemical actions at the pellicle level with polyphosphate demonstrating markedly superior efficacy. Model relevance is supported by proven clinical efficacy of CTC for stain prevention (Grossman et al., J Clin Dent 6: 185, 1995).**

INTRODUCTION

The removal and prevention of extrinsic tooth stains can be accomplished through abrasion, chemical dispersion and oxidation (bleaching). Historically, dentifrice formulations have helped control tooth stains primarily through the action of selected abrasives. More recently, dentifrices have been developed with enamel surface active chemical ingredients (crystal growth inhibitors) for tartar control purposes. Clinical studies have shown some of these ingredients, notably soluble pyrophosphates, to have efficacy in the removal

and prevention of tooth stains. Polymeric condensed phosphates show enhanced surface mineral activity on apatite surfaces which may contribute to stain removal and stain prevention. The development of dentifrices containing polymeric condensed phosphates has been facilitated by the application of unique dual phase technology (U.S. Patent # 5,939,052).

OBJECTIVES

Establish a cycling chlorhexidine-saliva-tea protocol on apatite substrates for the examination of stain prevention potential of dentifrices.

Examine the stain prevention activity of a dentifrice containing polymeric condensed phosphate (polypyrophosphate) to commercial dentifrices containing other surface active ingredients, including pyrophosphate, carboxylic acid (Gantrez) polymer and baking soda & peroxide.

MATERIALS AND METHODS**Substrate Preparation**

Synamel (synthetic hydroxyapatite) disks were roughened with 300 grit paper on both sides, rinsed with ultra pure water and air dried. Initial L*a*b* color readings from each side of each chip were recorded (see below). Specimens were pre-treated in room temperature pooled human saliva. (Saliva was collected daily from n>8 volunteers, at least 5 hours post brushing, and was kept chilled prior to use). Chips were pretreated for 4 hours (4 chips/10 ml) and air dried overnight - to establish a strongly adherent initial pellicle.

Cycling and Treatments

Four chips were used in each treatment group. The treatment regimen for days 2-6 followed a protocol as shown below:

Cycle Protocol	
Saliva	60 min
Paste Slurry	5 min
Slurry Saliva	20 min
Chlorhexidine	1 min
Saliva	20 min
Tea	15 min
Saliva	20 min
Chlorhexidine	1 min
Saliva	20-60 min
Tea	15 min
Saliva	20 min
Chlorhexidine	1 min
Saliva	20 min
Tea	15 min
Saliva	20 min
Paste Slurry	5 min
Dry overnight	

Treatments

Chlorhexidine treatments were applied as a one minute vortex with 4 chips in a 20 ml vial - with water washing in between treatments. Tea was brewed commercial Lipton® (2 gm bag) tea, 4 bags per 100 ml boiling water, hand pressed following cooling for treatment. Tea treatments were also applied 10 ml/4 chips for 15 minutes on a rotary mixer. Dentifrice treatments were prepared as 25 % w/w dentifrice water slurries. Treatments were carried out as 10 ml/4 chips for 5 minutes on a rotary mixer. Chips were rinsed thoroughly with water following treatments. Note that saliva treatments interceded all other treatments.

Chromameter Color Readings

Color readings were taken using a SpectraScan PR650 camera with imaging software, using a stabilized sample holder for reproducibility. Statistical analyses of DL and DE were carried out with JMP V3.2.2 software at the 95 % confidence level with a one tailed Students t test applied to each pair.

Dentifrices (principal ingredients)

- Blend-a-Med Synergy (polypyrophosphate, sodium fluoride)
- Crest Tartar Control (pyrophosphate, sodium fluoride)
- Colgate Total (Gantrez Acid polymer, sodium fluoride)
- Mentadent Sanogyl (zinc sulfate, triclosan, sodium monofluorophosphate)
- Crest Regular (sodium fluoride)

CONCLUSION

- The cycling protocol produced excellent differentiation in stain prevention with clinically proven control (Crest Tartar Control);
- Polypyrophosphate dentifrice produced superior stain prevention activity to other dentifrices tested;
- Model represents a useful modification of Addy *et al.* (*J. Biomed. Mat. Res.* 18 : 631-641, 1984) with pellicle formation occurring on synamel substrates - more closely simulating dental enamel reactivity *in vivo*.

RESULTS

HAP Chip Staining				
Treatment	DL*	DL%**	DE*	DE%**
BAM Synergy	-1.9 e	64.2%	5.9 e	49.6%
Crest TC	-3.6 d	30.2%	7.2 d	38.5%
Colgate Total	-4.9 c	7.6%	10.2 c	12.8%
Crest Regular	-5.7 b	-7.6%	9.4 c	19.7%
Water	-5.8 b	0.0%	11.7 b	0.0%
Ment. Sanogyl	-7.4 a	-39.6%	13.6 a	-16.2%

*vs. baseline
 **% reduction vs. Water control
 a*b students paired t