Comparative Prevention of Dental Stain Acquisition by Dentifrices *In Vitro*

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ABSTRACT

The prevention and removal of extrinsic stains from tooth surfaces can be accomplished by either mechanical process (i.e. abrasives) or chemical action (i.e., chelation or oxidation). Previously, we reported a test method for studying the tooth stain based upon dentifrice treatment of saliva pellicle coated hydroxyapatite discs (HAPD). The method involves multiple cycles of saliva, dentifrice, chlorhexidine and tea exposure to HAPD followed by measurements of color parameters. **Objectives:** The purpose of this study was to compare the stain prevention/removal efficacy of various dentifrices by use of this cyclic stain method. **Method:** HAPD were treated (6/grp.) to a sequence including saliva soaks (S) - 1 hr initial and 30 min. between treatments, 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: (SDSCxSTSCxSTSCxSTSD). 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 5 days) - the color of the HAP chips was read with a SpectraScan® PR650 Chromameter using the L*a*b* color scale to calculate and compare change in total color (ΔE) values. Toothpastes compared to a water (W) treated control included Crest® Dual Action Whitening (CDAW), Colgate® Total® Plus Whitening (CTW), Aquafresh® Multi-Action Whitening (AMAW), Arm & Hammer® Advanced White™ (A&H) and Rembrandt® Plus™ (RP). **Results:** Following staining/treatment periods efficacy was observed as follows: ΔE: CDAW: 5.7a; AMAW: 8.8c; A&H: 7.0b; RP: 9.4c; CTW: 9.4c; and W: 10.7c; (a≠b @ p<0.05 students paired t). **Conclusions: The results of this study demonstrate that sodium hexametaphosphate containing dentifrice is significantly superior to all tested dentifrices in chemically preventing extrinsic stains.**

INTRODUCTION

Extrinsic stains on tooth surfaces caused by dietary substances such as tea and coffee can be removed through mechanical (abrasives) and chemical processes (chelation, oxidation). These processes are also used to prevent the build up of stain following more extensive cleaning/whitening regimes provided by dental offices and products such as Crest Whitestrips™. Chemical removal of stains allow for control beyond the reaches of brushing (i.e. gumline, between teeth). Commercially, several chemical whitening technologies are available in dentifrice form including Crest Dual Action Whitening containing sodium hexametaphosphate. Sodium hexametaphosphate, a chemical chelator, removes stains by desorption of pellicle and prevents the acquisition of stains by adhering to tooth surfaces. It also provides the additional benefit of tartar control.

PURPOSE

This study compared the tooth whitening technologies of several commercially available dentifrices to that of Crest Dual Action Whitening with sodium hexametaphosphate utilizing a 5 day in vitro cyclic stain method. This method evaluates the chemical action of whiteners in preventing extrinsic stain acquisition on synthetic hydroxyapatite discs (HADP) using chlorhexidine (stain enhancer) and tea in the presence of a salivary pellicle. Interceding saliva soaks serve to eliminate any direct precipitation reactions and to ensure reactivity within the pellicle surface boundary.

MATERIALS AND METHODS

Roughened HAPD (6 discs/treatment) were placed in fresh saliva for 4 hours on a rotary mixer to apply a pellicle. HADP were air-dried and baseline color of both sides (n = 12) was measured with a SpectraScan® PR650 chromameter (Kyokko Trading Co., Ltd., Japan) using Hyperterminal® software (version 595160, Hilgraeve, Inc., Monroe, MI) for measuring L*a*b* color space.

The stain cycle was repeated for five days as follows:

1. Dentifrice treatments were prepared at a 25 % wt/wt slurry. Crest Dual Action Whitening (Sodium Hexametaphosphate)
    - Colgate Total plus Whitening PVM/MA Copolymer (Gantrez)
    - Aquafresh Multi-Action Whitening (Triclene®)
    - Arm & Hammer Advance White (Baking Soda,
    - Peroxide+Pyrophosphate),
    - Rembrandt Plus (Citroxain®)
2. HAPD were hydrated for 1 hour in fresh pooled saliva.
3. HAPD were treated in dentifrice slurry for 5 minutes, rinsed.
4. HAPD were rotated through the following process 3 times:
    - Saliva 30 minutes.
    - Chlorhexidine 1 minute, rinsed.
    - Saliva 30 minutes.
    - Tea (1 bag/50 ml water) 15 minutes, rinsed.
5. HAPD were rotated in saliva 30 minutes.
6. HAPD were treated in dentifrice slurry for 5 minutes, rinsed, and air dried.
7. Stain level of each disc side was measured.

RESULTS

Amount of stain (ΔE) measured after each treatment day (1 day = 3 stain cycles). Values are an average of 12 color measurements per treatment. ΔE = 0 indicates less stain, ΔE = 12 indicates more stain. (“s” denotes statistical significance at p<0.05 paired students t-test. “ds” denotes directional significance).

Research presented at the 80th General Session of the IADR, March 6-9, 2002

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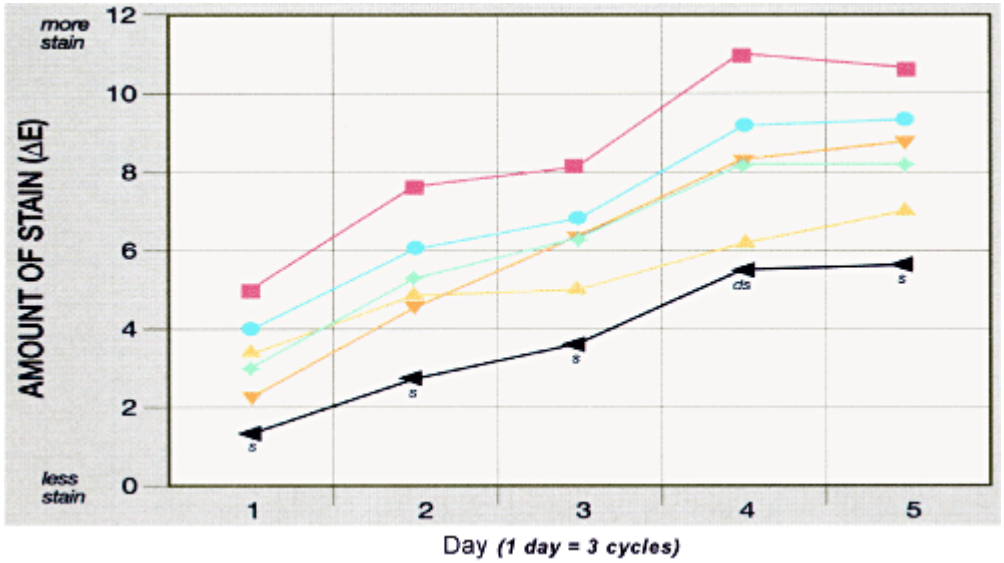
	Sodium Hexameta-phosphate ◀	Triclene ▼	Baking Soda, Peroxide Plus Pyrophosphate ▲	Citroxain ◆	PVM/MA Copolymer (Gantrez) ●	Water ■
DAY 1 3 cycles	1.4	-s- 2.3	-s- 3.4	-s- 3.0	-s- 4.0	-s- 5.0
DAY 2 6 cycles	2.8	-s- 4.6	-s- 4.9	-s- 5.3	-s- 6.0	-s- 7.6
DAY 3 9 cycles	3.7	-s- 6.3	-s- 5.0	-s- 6.3	-s- 6.9	-s- 8.1
DAY 4 12 cycles	5.5	-s- 8.3	-ds- 6.2	-s- 8.2	-s- 9.1	-s- 11.0
DAY 5 15 cycles	5.7	-s- 8.8	-s- 7.0	-s- 8.2	-s- 9.4	-s- 10.7

AMOUNT OF STAIN (ΔE)



$\Delta E = \sqrt{((\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2)}$
$\Delta a^* = (a^* \text{ baseline} - a^* \text{ day}_n)$; $\Delta b^* = (b^* \text{ baseline} - b^* \text{ day}_n)$;
$\Delta L^* = (L^* \text{ baseline} - L^* \text{ day}_n)$

CONCLUSION

The results of this study demonstrate that Crest Dual Action Whitening containing sodium hexametaphosphate is significantly superior to all tested dentifrices in chemically preventing extrinsic stains.

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