

Laboratory Model for Evaluating Dentifrice Effects Toward Chemical Stain Prevention

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ABSTRACT

Hydroxyapatite (HAP) powders serve as useful synthetic analogs for studying the adsorption and desorption chemistries involved in chromogen attachment, retention and curing during stain formation. By using HAP powders as substrate, a new method has been developed in our laboratory to screen chemical agents and formulations for their whitening chemistries. **Objectives:** The purpose of the present study was to evaluate the chemical stain prevention efficacy of various marketed dentifrices using the newly developed in vitro HAP powder model. **Methods:** Two hundred mg of HAP powder (BIO-RAD Laboratories, Hercules, CA, U.S.A.) was exposed to 20 ml of dentifrice supernatant (25% w/w slurry), vortexed for one minute and centrifuged. After twice washing with deionized water, the powder was exposed to 20 ml of filtered tea solution (1 Lipton tea bag/50 ml water), vortexed for one minute and centrifuged. Finally, the powder was twice washed with deionized water, filtered and air-dried. The powders were photographed for visual evaluation as well as examined quantitatively by measuring the L, a, and b scores using SpectraScan PR650. The dentifrices compared with the water control were Crest® Dual Action Whitening (CDAW), Colgate® Total® Plus Whitening (CTW), Aquafresh® Multi-Action Whitening (AMAW), Arm & Hammer® Advanced Whitening (A&H) and Rembrandt® Plus™ (RP). **Results:** Pre-treatment of HAP with various dentifrices produced significant differences in the levels of stain acquired by HAP powder as observed visually and measured quantitatively as follows ΔE : CDAW: 2.0a; AMAW: 4.5a; A&H: 16.8b; RP: 20.5b,c; CTW: 23.3c,d; and Water control: 27.1d; (a≠b @ p<0.05 students paired t). **Conclusions:** The surface active agents having strong affinity for HAP were found to be very effective in inhibiting the adsorption of stain components. The active in CDAW, sodium hexametaphosphate, showed directionally better than AMAW dentifrice and significantly superior to all other tested dentifrices towards stain prevention efficacy.

INTRODUCTION

Bleaches, abrasives and chelants are the main ingredients added to dentifrice to provide stain control and whitening benefits. Bleaches are ineffective at stain control when delivered from dentifrice because of the lower concentrations at which they are present due to safety and stability issues. Abrasives provide a significant whitening benefit, particularly on smooth surfaces, but are of limited use for areas along the gumline and interproximally. Chemical chelants such as condensed phosphates can remove stains through desorption and subsequent binding at tooth surfaces. Sodium hexametaphosphate, a polymeric analogue of pyrophosphate, has shown superior surface binding and activity in in vitro and in vivo studies.

A new whitening dentifrice formulation has been developed that contains sodium hexametaphosphate as a chelant for stain removal and prevention. This study was aimed at evaluating the stain prevention activity of various whitening technologies through chemical action by use of a newly developed HAP powder stain model.

PURPOSE

The purpose of the present study was to evaluate the chemical stain prevention efficacy of various marketed dentifrices using the newly developed in vitro HAP powder stain model.

MATERIALS AND METHODS

	Combine Hydroxyapatite (HAP) powder (BIO-RAD Laboratories) with toothpaste treatment (supernatant of 25% slurry). Vortex for 1 minute.
	Centrifuge to separate the powder from the toothpaste. Wash powder 2x with water to remove residual toothpaste.
	Add filtered tea solution (1 Lipton teabag/50 ml) to powder. Vortex for 1 minute.
	Centrifuge to separate the powder from the tea solution. Wash powder 2x to remove residual tea.

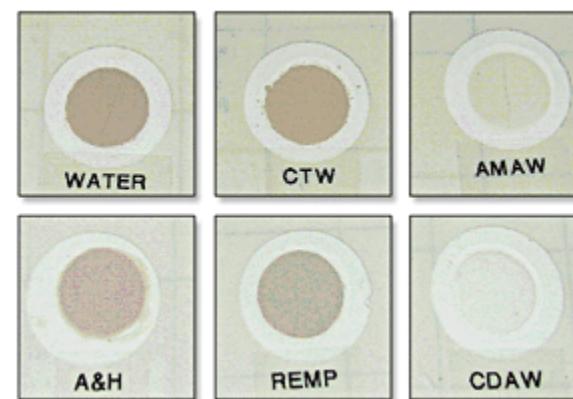
RESULTS

Chromameter Color Readings and Average Change in HAP Color Post-Tea Staining:

Products	ΔL^*	$\Delta L(\%)^{**}$	ΔE^*	$\Delta E(\%)^{**}$
Crest Dual Action Whitening (CDAW)	1.2 a	94.1	2.0 a	92.5
Aquafresh Multi-Action Whitening (AMAW)	1.4 a	93.1	4.5 a	83.6
Arm & Hammer Advanced Whitening (A&H)	11.3 b	45.1	16.8 b	37.6
Rembrandt Plus (REMP)	14.5 b	29.8	20.5 b,c	24.2
Colgate Total Plus Whitening (CTW)	16.2 b,c	21.5	23.3 c,d	13.9
Water Control	20.7 c	0.0	27.1 d	0.0

n = 6, a ≠ b ≠ c ≠ d, students paired t
* vs. untreated HAP ** % reduction vs. water control

Images of tea stained HAP powders pre-treated with various commercially available dentifrices:



CONCLUSION

The HAP powder stain model produced excellent differentiation in chemical stain prevention between various whitening technologies.

The surface active agents having strong affinity for HAP were found to be very effective in inhibiting the adsorption of stain components.

The active in CDAW, sodium hexametaphosphate, produced superior stain prevention activity relative to other whitening technologies.