Effects of Simulated Salivary Hexametaphosphate on De-/Remineralization *in vitro*

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ABSTRACT

Objective: An *in vitro* pH-cycling model was utilized to evaluate the impact of a new chewing gum additive (hexametaphosphate, polyphosphate) on fluoride activity in conjunction with a series of dose response dentifrice formulations containing NaF. **Methods:** Enamel crowns were used to study lesion initiation and progression. A series of fluoride dose response dentifrice formulations and a tartar control dentifrice, both with and without the gum additive, were compared. The pH cycling was carried out for 14 days, consisting of twice daily dentifrice treatments before and after a demineralization period, and simulated saliva soaking (with and without the additive). The regimen was modified for some treatment groups to permit simulation of chewing gum, with and without the additive. Crowns were assessed by cross-sectional microhardness; mineral loss (ΔZ, vol% mineral x μm) was calculated. **Results:** The model demonstrated a good fluoride dose response for the dentifrice formulations (1100ppm = 1677 ± 554, 250ppm = 2690 ± 989, and < 1ppm = 3606 ± 812, differences were significant at $p = 0.05$). The treatment groups modified to simulate additive-free chewing gum also demonstrated a good fluoride dose response (1100ppm = 1042 ± 231, 250ppm = 1227 ± 316, and < 1ppm = 1932 ± 665, differences were significant at $p = 0.05$). The treatment groups containing the additive exhibited less lesion severity at each fluoride level. These Delta Z values were nearly identical (1100ppm = 535 ± 571, 250ppm = 513 ± 281, and <1ppm = 656 ± 445, no significant differences, $p > 0.05$). **Conclusion:** Based on these results, we conclude that the new chewing gum additive (hexametaphosphate, polyphosphate) does not negatively impact fluoride's anticaries potential and shows no apparent detrimental effects.

PURPOSE

The purpose of this study was to observe the influence of a new chewing gum additive (hexametaphosphate) in conjunction with a dose response series of fluoride containing dentifrices on the inhibition of demineralization and/or the enhancement of remineralization using an *in vitro* pH cycling model.

INTRODUCTION

Research has demonstrated that the addition of hexametaphosphate salts to chewing gum produces a salivary solubilization of polyphosphate with a time release profile. Levels may be as high as 10,000ppm during the first minute of chewing and quickly diminish 15-20 minutes after chewing commences. Chewing gums that contain hexametaphosphate has been shown to provide anti-stain protection, protection against plaque mineralization (calculus formation) and a clean mouth feel. Studying the effects of hexametaphosphate on hard tissues is an important aspect in the development and improvement of chewing gums for commercialization.

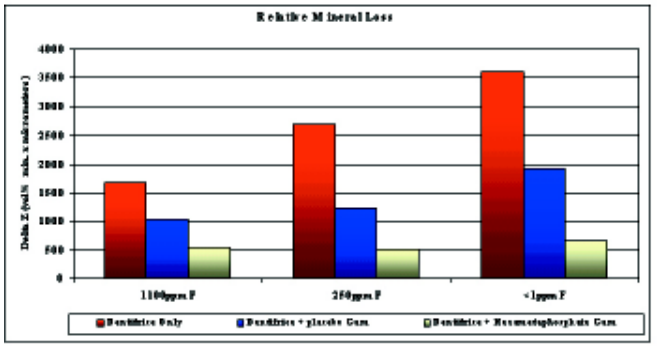
MATERIALS AND METHODS

Caries free enamel crowns were prepared according to standard procedures (Featherstone et al., 1983). Crowns were cleaned, polished and covered with acid resistant nail varnish leaving an exposed window (approximately 3.0 x 2.0 mm) on the enamel surface. Windows of enamel were exposed to the following treatment schedule (see below). Following 14 days of treatments crowns were assessed by cross-sectional microhardness and mineral loss (ΔZ) was calculated (White and Featherstone, 1987).

Modified pH Cycling	Modified pH Cycling without gum additive	Modified pH Cycling with gum additive
• Rinse in DD-water • One minute immersion in 12:1 water/dentifrice slurry • Rinse in DD-water	• Rinse in DD-water • One minute immersion in 12:1 water/dentifrice slurry • Rinse in DD-water	• Rinse in DD-water • One minute immersion in 12:1 water/dentifrice slurry • Rinse in DD-water
• 6 hours of demineralization	• 4 hours of demineralization • Rinse in DD-water	• 4 hours of demineralization • Rinse in DD-water
• Rinse in DD-water	• 120 minutes in artificial saliva • Rinse in DD-water	• 120 minutes in artificial saliva/gum (7500ppm anion) mix • Rinse in DD-water
• One minute immersion in 12:1 water/dentifrice slurry • Rinse in DD-water	• One minute immersion in 12:1 water/dentifrice slurry • Rinse in DD-water	• One minute immersion in 12:1 water/dentifrice slurry • Rinse in DD-water
• 16 hours in mineralizing solution	• 16 hours in mineralizing solution	• 16 hours in mineralizing solution
• 14 days of pH cycling • Plus two weekends in mineralizing solution	• 14 days of pH cycling • Plus two weekends in mineralizing solution	• 14 days of pH cycling • Plus two weekends in mineralizing solution

A dose response was studied using each cycling regimen. The results are shown in corresponding colors.

RESULTS



Model validity was confirmed by a clear separation of the dentifrice fluoride doses (red columns). A dose response was also shown when simulated gum treatments were added (blue columns) demonstrating that the model can be adapted to include simulated gum chewing. The treatment groups containing the additive exhibited less lesion severity at each fluoride level (white columns).

CONCLUSION

Based on these results, we conclude that the new chewing gum additive (hexametaphosphate, polyphosphate) does not negatively impact fluoride's anticaries potential and shows no apparent detrimental effects.

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White DJ, Featherstone JDB. A longitudinal microhardness analysis of fluoride dentifrice effects on lesion progression *in vitro*. Caries Res 1987; 21:502-512.