

Efficacy of natural teeth whitening remedies: Pineapple and banana

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ABSTRACT: Purpose: To determine how effective plant-based natural teeth whiteners are in comparison to the gold standard of at-home teeth whiteners. **Methods:** Human molars (N= 64) were embedded and placed in artificial saliva. Experimental groups consisted of NC: Negative control consisting of immersion in water for 5 minutes; PA: Rubbing teeth with pineapple core for 5 minutes; BA: Rubbing teeth with a banana peel for 5 minutes; HW: 10% carbamide peroxide in custom-fitted tray for 8 hours. All groups were treated for 10 days and consisted of 16 specimens each. The Kruskal-Wallis test was used to assess the difference in overall color change among groups at $\alpha = 0.05$. **Results:** Lightness and chroma measured at 1 day and 1 week post whitening showed a statistically significant difference among the groups ($P < 0.001$). Only HW and PA showed an increase in lightness and a decrease in chroma. Overall color change was highest for HW followed by PA, BA, and NC. (*Am J Dent* 2025;38 Sp Is A:16A-19A).

CLINICAL SIGNIFICANCE: The use of at-home whitening with 10% carbamide peroxide showed greater efficacy compared to natural whitening options. Yet, the utilization of pineapple as a potential whitening remedy demonstrated encouraging prospects, warranting further exploration.

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Introduction

The pursuit of a brighter and more radiant smile has resulted in a multitude of options in the ever-evolving landscape of teeth whitening. According to the American Dental Association Scientific Council, the gold standard for safety and effectiveness remains dentist-supervised at-home whitening, utilizing customized trays and 10% carbamide peroxide.¹ Yet, the current market is flooded with a plethora of do-it-yourself (DIY) solutions, ranging from fruit-based concoctions to over-the-counter products.² As oral health care professionals, it is crucial to navigate through these choices with caution, prioritizing the oral health of consumers above all else.

Natural DIY whitening options that utilize limonene, ascorbic acid, citric acid, caproic acid, coconut oil, bromelain, papain, banana peel, and strawberry have been popular due to the concept of naturalness. Generally, natural ingredients are regarded positively and perceived to be better, safer, healthier, and more environmentally friendly.³⁻⁵ Recent studies showed that the use of strawberry, coconut oil, and activated charcoal does not increase the lightness nor reduce the chroma of teeth.⁶⁻⁸ However, the search for a natural ingredient that may have whitening efficacy is ongoing and the use of “bromelain” which is commonly found in pineapples has gained attention.⁹ Bromelain has a protein-digesting enzyme that can catalyze the hydrolysis of the peptide bonds of stains breaking them into tiny particles, enhancing light reflection, and creating the illusion of a brighter smile.⁹⁻¹¹ The use of banana peels has been strongly promoted as potassium, magnesium, and manganese in banana peels absorb into teeth helping to remineralize and create an illusion of whiter teeth.⁵ It is important to note that whitening refers to a color change due to extrinsic stain removal while bleaching is the change of tooth color towards a lighter and whiter shade by chemical means.¹²

Therefore, this study determined how effective plant-based natural teeth whiteners are in comparison to the gold standard

of at-home teeth whiteners.¹³⁻¹⁵ The hypothesis was that natural products such as banana peel and pineapple, when compared to at-home whitening utilizing 10% carbamide peroxide had no significant difference in tooth color change when applied for 10 days.

Materials and Methods

Sample selection and preparation - Extracted sound human third molars (N= 64) were collected and stored in 0.2% sodium azide solution at 4°C. The use of extracted teeth without identifiers was determined to be non-human subject research by the Institutional Review Board of Loma Linda University. All teeth were observed for the absence of developmental anomalies, caries, existing restorations, deep crack lines, or severe attrition. Teeth were then embedded in a plastic dish with acrylic resin to expose the anatomic crown of the teeth. The mounted specimens were then placed in artificial saliva for 24 hours at room temperature before initiating the experiment. Artificial saliva¹⁶ was prepared and replaced weekly throughout the study.

Experimental groups - The step-by-step process of the experiment is illustrated in Fig. 1. The mounted specimens were distributed to four groups: Group NC: Negative control group consisting of immersion in water for 5 minutes for 10 days, Group PA: Rubbing of teeth with pineapple core for 5 minutes for 10 days; Group BA: Rubbing of teeth with banana peel for 5 minutes for 10 days; Group HW: Application of 10% carbamide peroxide (Opalescence PF^a) in custom-fitted tray for 8 hours for 10 days. For all groups, teeth were cleaned with a soft bristle toothbrush (Oral-B Indicator Contour Clean Soft Bristle Manual Toothbrush^b) after the experimental procedure and stored in artificial saliva at room temperature.

Tooth color assessment - Instrumental color measurements were performed on the middle third of the buccal surface using a contact-type intraoral spectrophotometer (VITA Easyshade

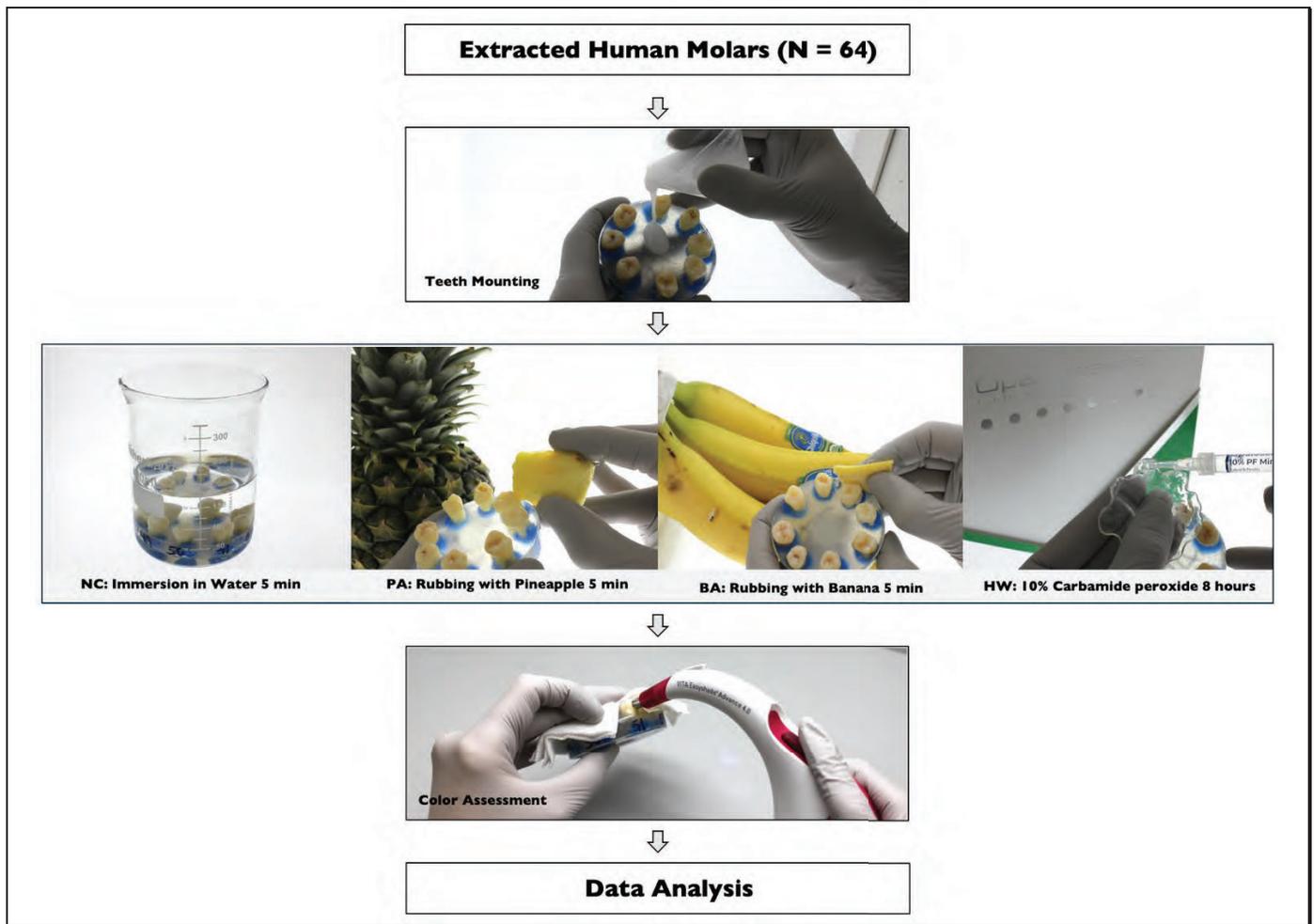


Fig. 1. Step-by-step experimental protocol.

Table. Lightness and Chroma values over time by group.

Time	Parameters	NC	PA	BA	HW	P-value*
Baseline	L++	80.9 ± 5.2	82.2 ± 4.6	81.7 ± 4.8	82.4 ± 4.1	0.819
	a1	-0.5 ± 1.2	-1.2 ± 1.8	-0.6 ± 2.5	-0.9 ± 2.1	0.599
	b1	34.2 ± 3.8	33.9 ± 3.9	35.6 ± 4.9	35.3 ± 5.3	0.646
1-day post whitening	L2	80.0 ± 4.9a	83.9 ± 3.6a	80.4 ± 4.5a	90.7 ± 4.3b	< 0.001
	a2	-0.4 ± 1.2a	-1.4 ± 1.6a	-0.0 ± 2.6a	-3.1 ± 2.0b	< 0.001
	b2	32.7 ± 3.9a	31.4 ± 4.1ab	35.7 ± 4.6ac	25.6 ± 4.0d	< 0.001
1-week post whitening	L3	81.2 ± 4.3a	84.0 ± 3.3ab	78.8 ± 5.2ac	91.5 ± 2.8d	< 0.001
	a3	-0.4 ± 1.3a	-1.2 ± 1.7a	0.3 ± 2.6a	-3.7 ± 1.2b	< 0.001
	b3	33.3 ± 3.3a	31.0 ± 4.3ab	36.5 ± 5.2ac	23.7 ± 4.2d	< 0.001

*Kruskal-Wallis test. The same lower-case letters within the same row indicate no statistically significant difference after multiple pairwise comparisons.

Advance 4.0°). A custom-fabricated jig was used for repeated measurements on the same area. Measurements were performed under a color-controlled light box (MM 4e GTI Mini Matcher^d) at CIE D65, a color temperature of 6,500 K and a light intensity of ≈1,200 lux. Results were expressed by recording L*, a*, and b* values at baseline (T1), 1 day post-whitening (T2), and 1 week post-whitening (T3). The overall color change as measured with the spectrophotometer was expressed as ΔEab* from the Commission Internationale de l’Eclairage.¹⁷ The following equation was used and calculated relative to baseline color parameters:

$$\Delta E_{ab}^* = [(L^*2 - L^*1)^2 + (a^*2 - a^*1)^2 + (b^*2 - b^*1)^2]^{1/2}$$

Data analysis - G*Power 3.1.9.4e was used to determine the sample size based on a previous study using the following parameters: 80% power and 20% difference and four experimental groups. A minimum sample size of 15 specimens per group was assessed to be appropriate. Means and standard deviations of L*, a*, and b* and color change between the baseline and 1-day and 1-week post-whitening measurements were calculated. The Kruskal-Wallis procedure was performed to compare the differences by groups. Post-hoc comparisons were conducted with Bonferroni corrections where appropriate. All tests of significance were two-sided and conducted at an alpha level of 0.05 with Jamovi^f software.¹⁸

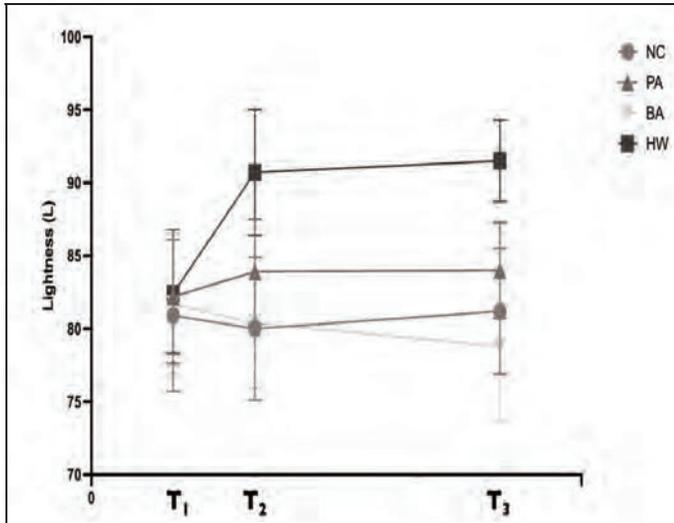


Fig. 2. Line plots of Lightness over time by group.

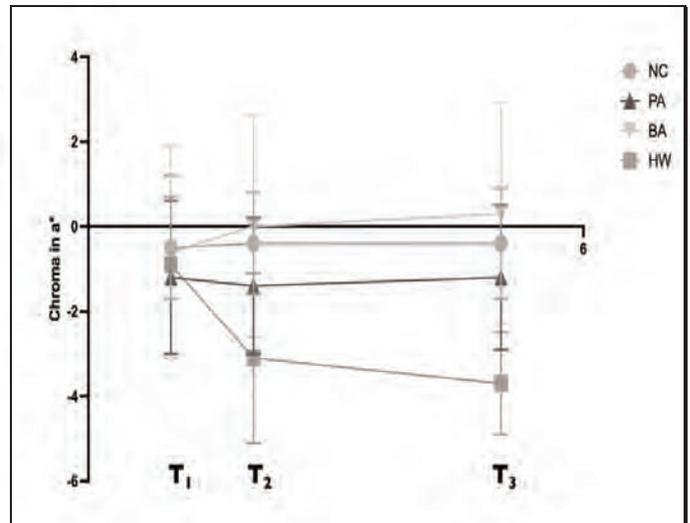


Fig. 3. Line plots of Chroma a* over time by group.

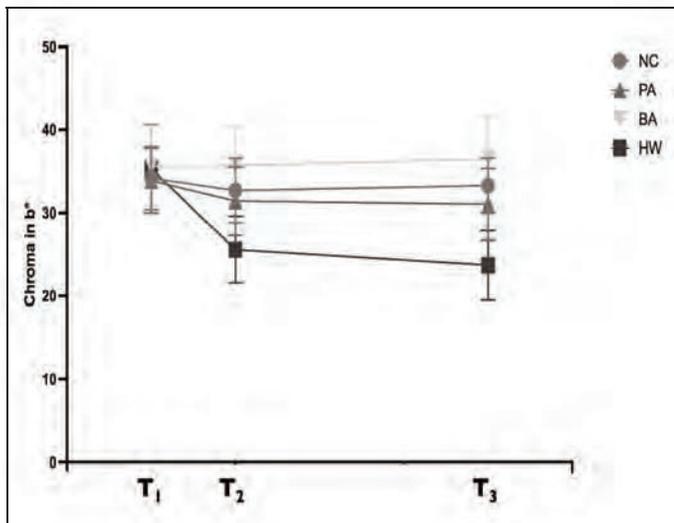


Fig. 4. Line plots of Chroma b* over time by group.

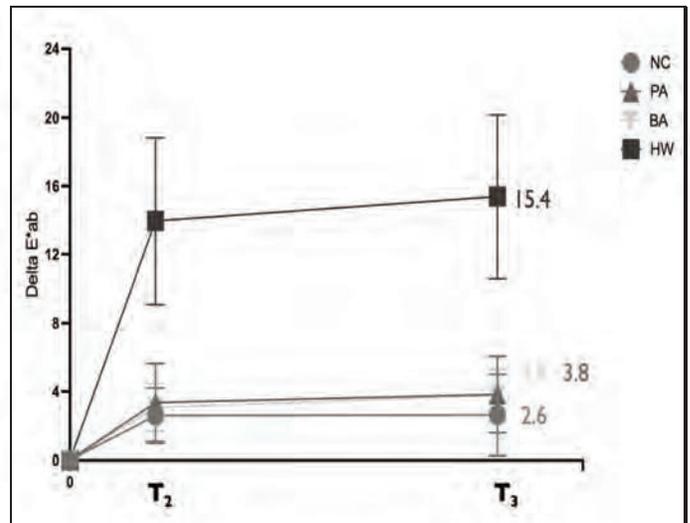


Fig. 5. Line plots of overall color change over time by group.

Results

Lightness and chroma values over time are summarized in the Table. The baseline lightness ranged from 80.9 to 82.4 and there was no statistically significant difference among the groups ($P=0.819$). Baseline chroma ranged from -1.2 to -0.5 and 33.9 to 35.6 for a^* and b^* respectively. There was no statistically significant difference for chroma among the groups ($P=0.599$ and $P=0.646$).

At 1 week post-whitening, lightness was highest for HW (91.5) and lowest for BA (78.8), chroma was least for HW (23.7) and greatest for BA (36.5). The change over time in lightness, chromas a^* and b^* are illustrated as line plots in Figs. 2-4.

The overall color change ΔE_{ab}^* and standard deviation at 1 week post-whitening were 2.6/2.4, 3.8/2.2, 3.8/1.5, and 15.4/4.8 for NC, PA, BA, and HW, respectively. There was a statistically significant difference in overall color change among the groups ($P < 0.001$) with the least change in NC and the highest change in HW. The overall color change over time is illustrated in line plots in Fig. 5.

Discussion

Tooth whitening with natural ingredients presents a promising alternative for individuals seeking to brighten their smiles without relying on traditional chemical-based products. However, based on the results, we rejected our hypothesis as at-home whitening with the use of 10% carbamide peroxide yielded the greatest overall tooth color change. The results agree with another laboratory study⁶ that showed that the use of 10% carbamide peroxide for 2 weeks yielded a ΔE_{ab}^* of 13.8 which was comparable to 15.5 in the present study.

The ISO/TR 28642 outlines the understanding of color compatibility findings under controlled conditions and methodologies. According to the report, when comparing dental materials with human tissues, a color difference equal to or less than $\Delta E_{ab}^* = 1.2$ indicates a highly favorable match, whereas a mismatch exceeding $\Delta E_{ab}^* = 2.7$ is deemed unacceptable.¹⁹ Consequently, clear acceptability thresholds (AT) are established for assessing color compatibility between dental materials and human tissues.²⁰⁻²² In a systematic review²³ addressing the interpretation of tooth whitening effectiveness,

it was suggested that a threshold of $\Delta E_{ab}^* = 3.790$ could serve as a potential cut-off value for recognizing whitening efficacy. It is noteworthy that the negative control of immersion in water yielded a $\Delta E_{ab}^* = 2.6$, which is less than the acceptability threshold and as expected did not create a significant change in tooth color. However, the use of pineapple resulted in an increase in lightness and a decrease in chroma with a $\Delta E_{ab}^* = 3.8$ that exceeds the acceptability threshold and is also exceeding the potential cut-off value of 3.790 for recognizing whitening efficacy. In contrast, the use of banana peel resulted in the same $\Delta E_{ab}^* = 3.8$ but was a result of a decrease in lightness and an increase in chroma.

The potential of pineapple as a natural whitening remedy shows promise in changing tooth color. However, the existing study failed to assess the impact of rubbing pineapple on tooth surface properties such as gloss, roughness, or microhardness. Furthermore, it remains uncertain whether the observed color change resulted from the erosive properties of pineapple or the hydrolysis of the peptide bonds' effect of bromelain. Another study⁶ assessing the immersion of teeth in a 1.0 citric acid solution with a pH of 3.9 for 60 minutes revealed a notable $\Delta E_{ab}^* = 5.1$, attributed to the sole erosive nature of the acid.

The findings of the study support the conclusion that at-home whitening with 10% carbamide peroxide exhibited greater efficacy compared to natural whitening options. Yet, the utilization of pineapple as a potential whitening remedy demonstrates encouraging prospects, warranting further exploration. Future investigations on the safety and how pineapple-derived substances work and how effective they are in whitening teeth could lead to more natural and sustainable whitening methods.

- a. Ultradent, Provo, UT, USA.
- b. Procter & Gamble, Cincinnati, OH, USA.
- c. Vita Zahnfabrik, Bad Säckingen, Germany.
- d. GTI Graphic Technology, Newburgh, NY, USA.
- e. Heinrich-Heine Dusseldorf University, Germany.
- f. Jamovi, Sydney, Australia.

Disclosure statement: The authors declared no conflict of interest. The study was supported by the Loma Linda University School of Dentistry Student Research Program.

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