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Original Article

An In Vitro Investigation into the Influence of Banana Peels on Dental Bleaching

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ABSTRACT

Dental bleaching is among the most sought-after procedures for patients with significant aesthetic concerns. This study evaluated the efficacy of banana peels as a bleaching agent in comparison to conventional gels containing 35% hydrogen peroxide (HP). 15 permanent incisors were randomly divided into 3 groups: GI (placebo), GII (35% HP), and GIII (banana peels). Each underwent three 45-minute bleaching sessions. Color changes (ΔE, ΔL, Δa, and Δb) were assessed using a visible ultraviolet light spectrophotometer 7 days after each session. Statistical analysis was performed using analysis of variance and Tukey tests, with a significance level set at 5%. The 35% HP-treated group showed higher ΔE and ΔL values and lower Δb values compared to both the banana peel and control groups. The bleaching effect of banana peels was minimal and not statistically significant ($P < 0.61$), indicating that they have little or no whitening potential.

Keywords: Banana peels, Dental bleaching, Hydrogen peroxide, Natural teeth whitening, Teeth whitening.

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Introduction

Teeth whitening has become one of the most popular dental treatments for individuals with significant aesthetic concerns [1-3]. Discoloration of teeth can result from extrinsic or intrinsic factors [4], which must be thoroughly evaluated to achieve the best treatment outcomes.

A large portion of the population faces issues related to tooth discoloration. Various treatment methods are available to address this concern, including veneers, dental bleaching, and crowns [5]. Among these, dental bleaching is considered a more conservative option [6-8].

Peroxide-based compounds such as carbamide peroxide and hydrogen peroxide are widely recognized for their effectiveness in whitening stained teeth [9].

Many individuals seek natural, affordable, and simple methods for teeth whitening. As a result, the use of fruits for this purpose has gained popularity due to their accessibility, low cost, and ease of application. Several studies have explored the whitening effects of various fruits [7, 10-13].

Recently, banana peels have emerged as a widely used natural alternative for dental bleaching. Many individuals have experimented with this method to achieve whiter teeth at minimal expense. However, there is a lack of sufficient scientific research on the effectiveness of banana peels for teeth whitening.

Modern patients have increasingly high expectations regarding dental aesthetics. A brighter smile is often associated with greater social acceptance and improved self-confidence. However, changes in tooth color over time are a natural occurrence. The primary objective of oral hygiene is to maintain dental aesthetics by

removing extrinsic stains caused by the pigmented pellicle, which develops due to factors such as age, dietary habits, and oral hygiene practices. These factors, either individually or in combination, influence tooth color and surface alterations [2-4].

With the rise of unattainable beauty standards and social media influence, new videos and online profiles constantly emerge promoting homemade teeth whitening methods. These products are often advertised as fast and cost-effective solutions for dental bleaching. However, there is no scientific evidence supporting their safety or effectiveness for oral health [7, 8]. Among the most commonly promoted natural remedies are banana peels, turmeric, and activated charcoal.

Although banana peels are typically regarded as waste, they contain various bioactive compounds with antioxidant and anti-inflammatory properties, including saponins, alkaloids, quinones, flavonoids, and tannins [13, 14]. Additionally, extracts from banana peels exhibit antibacterial effects against bacteria linked to oral diseases. Due to the limited research on the whitening potential of banana peels and other fruits, experimental studies are necessary to assess their impact on dental bleaching. This study aims to evaluate the effectiveness of banana peels in dental bleaching.

Materials and Methods

This in vitro study followed an experimental design incorporating three bleaching agents: banana peel, 35% hydrogen peroxide (35% HP), and a placebo (control). Evaluations were conducted at four-time points: T0 (before bleaching), T1 (7 days after the initial bleaching session), T2 (7 days following the second session), and T3 (7 days post the third session).

45 permanent incisors will be randomly assigned into three groups, with each group consisting of 15 specimens (n = 15) as outlined in **Table 1**.

Table 1. Splitting the test groups based on the chosen bleaching treatment

Groups	Sample (n)	Bleaching product
G I	15	Placebo
G II	15	HP 35%
G III	15	Banana peels

Specimen preparation

All teeth will undergo cleaning with periodontal curettes, followed by prophylaxis using a pumice and water mixture. After cleaning, the teeth will be stored in physiological saline containing 0.1% thymol and kept refrigerated at approximately 4 °C to prevent microbial growth until the experiment starts.

Selection and pigmentation of samples

The selection and pigmentation of samples will start with an initial L* value measurement using a visible ultraviolet reflection spectrophotometer after the storage period. The average L* value for all samples will be calculated. The specimens will then be placed in Eppendorf tubes containing 1 mL of black tea infusion, with the solution being replaced daily for six days. A second color measurement will be conducted after the pigmentation process, as previously described. Subsequently, 45 pigmented teeth will be selected for analysis based on their ΔE values. Following exposure to black tea, the specimens will be rinsed with distilled water for 6 days to eliminate residual pigment and then subjected to prophylaxis with pumice and water to remove any remaining surface stains. The selection process ensures that the specimens have a standardized initial shade and pigmentation level, allowing for consistent assessment of their bleaching potential.

Treatment for bleaching

The 45 stained teeth will be randomly assigned to three groups, each consisting of 15 specimens: GI (control–saline), GII (35% HP), and GIII (banana peels). At the end of each designated time point, the samples will be evaluated using the previously described analytical examination.

Measurements of color shift

Color measurements will be carried out using a visible ultraviolet light spectrophotometer. The color data will be recorded at three specific intervals: T0, before the bleaching procedure; T1, one week after the initial bleaching session; and T2, one week following the second bleaching treatment. The color difference between two points in the CIE L*, a*, b* system will be calculated using the following formula:

$$\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2} \quad (1)$$

Statistical analysis

Statistical analysis was conducted using SigmaPlot version 15.0 (Systat, San Jose, CA, USA). A power analysis determined that a sample size of n = 15 per group provided a power of at least 0.826 at a significance level of 0.05. The data met the normality assumption for all cases. ANOVA with three-way repeated measures was applied, followed by Tukey's post hoc test, to compare the groups across different time points.

Results and Discussion

Table 2 shows that at all assessment time points (T1, T2, and T3), the group treated with whitening gels (GII) exhibited steady and continuous changes in color. In contrast, specimens in the GI and GIII groups did not show any noticeable color changes throughout the study (Table 2). A comparison of the groups at each time point revealed that at T1, those treated with 35% HP had significantly greater color changes compared to the other groups. The placebo group (GI) exhibited the lowest ΔE values at T1, while the banana peel group (GIII) had intermediate values. The results at T2 were similar to those at T1. At T3, the 35% HP-treated group (GII) displayed the most pronounced chromatic changes, with significant differences in ΔE between the GI and GIII groups, as observed at T2.

Table 2. Mean values (SD) of ΔE under various settings for experiments and assessment intervals

Groups	T1	T2	T3
G I	01.20 (0.45) C a	01.50 (0.41) D a	01.20 (0.55) D a
G II	9.30 (3.68) A b	14.69 (4.69) A a	15.10 (4.21) A a
G III	2.25 (0.77) C a	2.40 (0.86) C a	2.75 (1.01) B a

Statistical analysis revealed that means with different letters indicate important differences ($P < 0.05$). Uppercase letters signify statistical variations between rows within a column, while lowercase letters highlight statistical differences between columns within the same row. The analysis was conducted using the Tukey test and a three-way repeated-measures ANOVA.

Throughout the study, the luminosity (ΔL) of the GI and GIII specimens remained consistent, as shown in **Table 3**. Under the second experimental condition, ΔL values progressively increased over time. At T1, the ΔL value for GIII was similar to that of the placebo group (GI), while the bleaching gel-treated groups exhibited comparable results. At T2, the highest ΔL values were observed in the groups treated with the more concentrated bleaching gels (GII), while the lowest values were found in the GI and GIII groups treated with banana peels and placebo gel. By T3, all the whitening gel treatments (GII) showed values that were not only comparable but also significantly different from those of the banana peel (GI) and placebo gel (GIII) treatments.

Table 3. Mean values (SD) of ΔL under various experimental setups and assessment intervals

Groups	T1	T2	T3
G I	0.29 (0.73) B a	0.40 (0.81) C a	00.16 (0.97) B a
G II	9.30 (3.68) A b	14.69 (4.69) A a	15.10 (4.21) A a
G III	2.43 (3.62) B b	3.40 (0.86) B a	3.75 (1.01) B a

Statistical analysis revealed that means with different letters indicate important differences ($P < 0.05$). Uppercase letters signify statistical variations between rows within a column, while lowercase letters highlight statistical differences between columns within the same row. The analysis was conducted using the Tukey test and a three-way repeated-measures ANOVA.

Table 4 shows that by T3, Δ values decreased across all groups. A comparison of the groups' effectiveness at each time point revealed similar outcomes, with the banana peel-treated group achieving the highest results, while the 35% HP gel group recorded the lowest values.

Table 4. Mean values (SD) of Δ the different experimental conditions and evaluation times

Groups	T1	T2	T3
G I	0.66 (0.41) A a	0.75 (0.57) A a	0.47 (0.42) A b
G II	− 1.65 (0.88) B a	−0.67 (1.03) B a	−1.79 (1.20) B b
G III	1.31 (1.52) A b	1.48 (1.66) A b	1.75 (1.80) B b

The statistical analysis indicates that means followed by distinct letters represent significant differences ($P < 0.05$); lowercase letters denote statistical variations across columns within the same row, while uppercase letters highlight differences between rows in a column; the analysis was conducted using a three-way repeated-measures ANOVA in conjunction with the Tukey test.

Table 5 shows that throughout the treatment, Δb values decreased for all groups, except for the GI and GIII groups, where no significant change was observed. At T1, the lowest Δb levels were recorded after bleaching gel treatment. At T2, the group treated with the bleaching gel (GII) had the most consistent and lowest Δb values. The same group (GII) continued to show similar results at T3.

Table 5. Mean values (SD) of Δb in the different experimental conditions and evaluation times

Groups	T1	T2	T3
G I	0.61 (0.57) A a	0.28 (0.80) A a	0.06 (0.60) A a

G II	−2.15 (2.59) B a	−4.76 (2.32) BC a	−5.88 (3.21) C b
G III	1.2 (1.03) A a	0.95 (1.21) A b	−1.05 (1.45) B b

Statistical analysis indicates that means with differing letters signify significant differences ($P < 0.05$); uppercase letters represent statistical differences between groups within the same column, while lowercase letters highlight differences between groups in the same row; the Tukey test and three-way repeated-measures ANOVA were utilized for the analysis.

Extended studies have indicated that while professional bleaching treatments can provide rapid color changes, they may also lead to significant adverse effects [14, 15]. On the other hand, although home bleaching methods are effective, they come with some limitations, such as the necessity for daily tray usage, slower color changes, and potential damage to dental enamel, which could hinder the bonding of restorative materials due to the residual oxygen from the bleaching agent breaking down and being absorbed by the tooth tissue [16]. Octarina and Aprilianti [17] found that lemon juice, containing 5% citric acid, glutaric acid, ascorbic acid (vitamin C), and polyphenols, has teeth-whitening properties. Puspasari *et al.* [18] reported similar findings when applying apple juice to teeth, restoring the enamel's natural shade. Sugianti [19] suggested that rosella juice (*Hibiscus sabdariffa*), rich in saponins and vitamin C, could serve as an alternative natural whitening agent. Diansari *et al.* [20] studied green pear juice and concluded that it was less effective in altering tooth color. Research findings suggest that banana peel extract (*Musa paradisiaca* var. *raja*) may assist in whitening teeth [21]. A study conducted by Maesaroh in 2018 explored the effectiveness of banana peels as a natural teeth-whitening remedy for stained teeth [22]. The results revealed that after immersing molars in banana peel extract for fourteen days, there was a noticeable change in their color compared to the shade guide. The ability of banana peels to cause tooth discoloration is attributed to the various components they contain, such as both mineral and phytochemical elements [22]. Phytochemicals found in banana peels include alkaloids, phenols, flavonoids, tannins, and saponins, while minerals such as potassium, phosphorus, calcium, salt, magnesium, and iron are also present. Additionally, banana peels have a pH of 6.7. Among their bioactive substances, saponins are particularly noted for their ability to bind to chromogens and contribute to tooth whitening. The elevated levels of potassium and manganese in banana peels are other mineral components that contribute to their teeth-whitening effects [22]. Yudhit and Prasetia [21] support this by highlighting that banana peels contain a range of components, including both mineral and phytochemical elements. In addition to saponins, banana peels are cationic bio-sorbents that have the potential to brighten the color of teeth. Saponins are glucosides known for their foaming ability, which creates foam with cleansing properties [21]. The researchers note that various natural teeth-whitening agents can stain teeth, as revealed in multiple studies. This staining may result from several factors related to natural substances, such as their concentration, exposure time, and pH level. Since enamel resistance varies between individuals, some natural substances that cause staining in some cases may not affect tooth color in others. Therefore, these factors must be carefully considered when evaluating natural whitening agents.

Conclusion

Our study demonstrated that the use of 35% HP produced the most significant bleaching effect. In comparison, the whitening effects of banana peels were relatively mild. Banana peels contain a variety of natural ingredients, including saponins, potassium, malic acid, calcium, sodium, phosphorus, magnesium, and iron, while their phytochemical composition includes alkaloids, flavonoids, phenols, and tannins, which contribute to their teeth-whitening properties. However, these natural ingredients are less effective due to the varying thickness of tooth enamel. Natural substances tend to have a reduced impact on posterior teeth, as premolars and molars have thicker enamel compared to the anterior teeth.

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