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EFFECT OF AMBON BANANA (*Musa acuminata*) PEEL EXTRACT AS TEETH WHITENING AGAINST KINTAMANI COFFEE STAIN

Putu Ratna Kusumadewi Giri¹⁾, Luh Wayan Ayu Rahaswanti²⁾, Riki Kristanto³⁾, Desak Ayu Dhyana Nitha Dewi⁴⁾

¹⁾Departemen of Endodontics, Dental Education and Dentist Profession Education Study Program, Faculty of Medicine, Udayana University, Denpasar –Indonesia

²⁾Departemen of Pediatric Dentistry, Dental Education and Dentist Profession Education Study Program, Faculty of Medicine, Udayana University, Denpasar –Indonesia

³⁾Departemen of Forensic Dentistry, Dental Education and Dentist Profession Education Study Program, Faculty of Medicine, Udayana University, Denpasar –Indonesia

⁴⁾Departemen of Public Health and Preventive Dentistry, Dental Education and Dentist Profession Education Study Program, Faculty of Medicine, Udayana University, Denpasar –Indonesia

ABSTRACT

Background: Tooth discoloration can impair the aesthetic function of teeth, leading to an increased demand for dental treatments, especially teeth whitening procedures. Teeth whitening with chemicals can cause negative impacts such as gingival irritation and tooth sensitivity. Natural ingredients can be used such as ambon banana (*Musa acuminata*) peel which contains saponins, which are bioactive compounds that can whiten teeth.

Purpose: The purpose of this study was to determine the effect of ambon banana peel extract as a natural tooth whitening agent on external staining using robusta kintamani coffee. **Methods:** This type of research is experimental laboratory study using 36 samples of upper and lower jaw permanent teeth. Each categorized sample was immersed in a coffee solution for 12 days to evaluate the color changes that occur. Treatment group was immersed in ambon banana peel extract, control group was immersed in 10% carbamide peroxide. Each group was observed every 3 hours for 5 days. Tooth discoloration was measured using vitapan classical shade guide. **Results:** The result shows that the highest mean value of tooth color change occurred in the sample group immersed with ambon banana peel extract which reached 7.42, with p value <0.05 that indicated a significant difference. **Conclusion:** It can be concluded that Ambon banana peel extract (*Musa acuminata*) is an effective extract for teeth whitening after immersion with Kintamani robusta coffee.

Keywords: Ambon banana peel extract, Carbamide peroxide 10%, Robusta kintamani coffee, Tooth discoloration.

Correspondence: Putu Ratna Kusumadewi Giri, Departemen of Endodontics, Dental Education and Dentist Profession Education Study Program, Faculty of Medicine, Udayana University, Denpasar, Indonesia, Email address: ratna_kdg@yahoo.com, Phone number: 0811380970.

INTRODUCTION

Oral health is a crucial aspect of physical health that are inseparable from each other because they affect the health of the body as a whole. Tooth discoloration can decrease the function of teeth as one of the aesthetic functions. This promotes an increase in the need for dental care, especially teeth whitening treatments. Studies conducted in several countries show that more than 50% of them are dissatisfied with the color of their teeth.¹

Teeth whitening treatment can be an option to restore the discolored teeth. The treatment can be defined as a procedure to change the color of the teeth to approach natural color desired.² The material used in dental practice is 10% carbamide peroxide.^{3,4} Carbamide peroxide 10% is a combination of hydrogen peroxide and urea therefore also known as urea peroxide. The concentration of 10% carbamide peroxide has been approved by American Dental Association (ADA) for use outside of dental clinics. However, carbamide peroxide is a chemical compound that, when used excessively, can lead to enamel demineralization, gingival irritation, and heightened tooth sensitivity, increasing the risk of structural damage and oral discomfort.⁴⁻⁶ These negative side effects from the usage of Carbamide peroxide, make researchers interested by using natural product as teeth whitening ingredients.

Banana fruits are easily found in environment, the waste is in the form of banana peel. In this study, ambon banana (*Musa acuminata*) peel extract will be used.⁷ Banana peels contain phytochemical components consisting of alkaloids, phenols, flavonoids, tannins, saponins that can bind chromogens thereby whitening teeth. Research using ambon banana peel as a teeth whitening ingredient was previously conducted by Irma (2018), who found that its extract exhibits whitening properties. However, its effectiveness in comparison to existing modalities has not yet been studied.^{1,8-10}

Kintamani is one of the main coffee-producing regions in Bali, with robusta being the most widely consumed coffee variety in Indonesia. Robusta Kintamani was selected as a stainer due to its lower acidity compared to arabica, allowing it to induce tooth staining without significantly increasing the risk of enamel erosion.⁹ Therefore, researchers are interested to investigate the effect of ambon banana (*Musa acuminata*) peel extract as a natural teeth whitening agent on external staining using robusta kintamani coffee.

MATERIALS AND METHODS

Material

Materials used in the study include ambon banana peel, robusta coffee solution, 10% carbamide peroxide, 96% ethanol, and clear nail polish. The instruments used in the research include rotary evaporator, VITAPAN classical shade guide, blender, measuring cup, towel, dental tweezers, handscoon, filter paper, glass jar, digital scale, plastic container, and stationery. Research Ethics Commission of the Faculty of Medicine, Udayana University (ethical clearance number 762/UN14.2.2.VII.14/LT/2021) approved the research protocol.

Methods

This study used an experimental laboratory prepost test with control group design. Research samples consisted of permanent anterior and posterior human teeth obtained from dental clinics in Denpasar, Bali. The inclusion criteria were caries-free teeth, absence of restorations, extraction due to periodontal disease, absence of cracks or fractures, and fully developed roots. The exclusion criteria included primary teeth, perforated roots, teeth with discoloration due to necrosis, teeth diagnosed with irreversible pulpitis, and those affected by fluorosis. These criteria ensured that the selected teeth met standardized conditions for accurate analysis. Base on calculation using Federer equation and accounting for potential sample dropouts, each group consisted of 12 samples, resulting in a total of 24 samples.

This study was conducted at the Pharmacology Laboratory, Faculty of Medicine, Udayana University. All samples were covered with clear nail polish followed by immersion in coffee solution for 12 days before the intervention according to each group. Previous research shows that the new changes appear to be significant after 12 days of immersion.¹

Samples were divided into 2 groups based on the intervention given, treatment group with immersion using ambon banana peel extract and control group with immersion using 10% carbamide peroxide. Observations were conducted in 3 hours for 5 days to see the color changes that occurred. Tooth discoloration was measured using VITAPAN Classical shade guide. Data analysis was performed using SPSS 26.0 (IBM, Armonk, New York) for Windows.

Steps of Procedure

The study started with the process of sample preparation. Collected samples were sorted and numbered 1-24 which made it easier to see changes in tooth color from these samples. The samples then covered with clear nail polish on the cervical part to seal the root so the coffee solution does not penetrate into the dentinal tubules. Making 10 ml of Kintamani coffee solution is carried out by mixing coffee powder and water until well mixed. The sorted samples were then immersed into the coffee solution for 12 days to see the color changes that occurred.¹¹⁻¹³

Measurement of tooth color changes was carried out using a shade guide (VITAPAN Classical). The VITAPAN classical shade guide is a tool used to assess changes in tooth color before and after treatment. It provides a standardized color change scale ranging from the lightest to the darkest shades: B1=1, A1=2, B2=3, D2=4, A2=5, C1=6, C2=7, D4=8, A3=9, D3=10, B3=11, A3.1=12, B4=13, C3=14, A4=15, and C4=16.^{1,13}

Preparation of ambon banana peel extract started with the collection and sorting of 5 kg of ambon banana peel. The banana peels were then washed, dried, pulverized with a blender, and sieved to obtain 250 grams of powder. The powder was then put into a closed jar, then added with 6 liters of 96% ethanol solvent. The solution was stored in a light-tight jar for 2 days and stirred daily with a glass stirrer for 30 minutes and filtered. The extraction results were evaporated using a rotary evaporator at a temperature less than 40°C followed by drying for 2 days until a thick extract of 100% ambon banana peel was obtained.^{1,14,15}

The extract placed into the prepared bowl. Then, the discolored teeth were immersed into the ambon banana peel extract solution and 10% carbamide peroxide solution. Samples with serial numbers 1-12 were immersed in ambon banana peel extract as a treatment group, while samples with serial numbers 13-24 were immersed in 10% carbamide peroxide solution as a positive control group. Each tooth in each group was immersed for 3 hours a day and carried out for 5 days.^{1,11}

Measurements and observations of tooth color were then made using the VITAPAN Classical shade guide. The mean difference between pre- and post-intervention values for each sample in each group was calculated to determine the average color change in the intervention groups treated with banana peel extract and 10% carbamide peroxide. The mean differences in color change for each group were then further analyzed to assess the presence of significant differences between groups.^{16,17} Data normality analysis conducted using the Shapiro-Wilk Test, which showed that the data was not normally distributed. Therefore, the analysis continued with the Wilcoxon Sign Ranks and Kruskal-Wallis Tests, which followed by Mann-Whitney Test.

RESULTS

Descriptive analysis showed the difference in tooth color values before and after immersion in ambon banana peel extract (*Musa acuminata*) and 10% carbamide peroxide in 3 hours observation time for 5 days. The mean value and standard deviation in the ambon banana peel extract group before extract immersion was 9.17 ± 4.152 and after extract immersion 1.75 ± 1.215 . While the mean value and standard deviation in the 10% carbamide peroxide immersion group before immersion was 5.17 ± 2.480 and after immersion 1.25 ± 0.456 (Table 1).

Table 1. Descriptive analysis of tooth color change

Group	Intervention	Mean $\pm$ SD	N
Ambon banana peel extract	Before immersion	$9,17 \pm 4,152$	12
	After immersion	$1,75 \pm 1,215$	12
10% carbamide peroxide	Before immersion	$5,17 \pm 2,480$	12
	After immersion	$1,25 \pm 0,452$	12



Figure 1. After immersion in kintamani coffee solution



Figure 2. After immersion using ambon banana peel extract

Normality test using Saphiro-Wilk showed variation in significance. Some sample groups had $p > 0.05$ (Table 2). The results indicate that the data are not normally distributed, thus requiring further analysis using non-parametric tests.

Table 2. The result of Shapiro-Wilk normality test

Group Intervention	Shapiro-Wilk			Before immersion	Ambon banana peel extract	0,884	12	0,100
	Statistic	df	Sig.					
					10% carbamide peroxide	0,764	12	0,004

After immersion	Ambon banana peel extract	0,687	12	0,001
	10% carbamide peroxide	0,552	12	0,000

Table 3. The result of Wilcoxon Sign Ranks test

Group	Mean tooth color measurement	Tooth color	p-value
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Non-parametric Wilcoxon Sign Ranks test was used to determine the difference in tooth color observation scores before and after treatment based on the sample group. The test results showed differences in tooth color observation scores before and after treatment based on the sample group. The smaller scores represent whiter teeth color. The highest color change was found in the ambon banana peel extract treatment group which reached 7.42 compared to the lowest in the control group which was 3.92. The p value <0.05 in the sample group indicates that there is a significant difference in the tooth color observation score before and after immersion in the extract in the entire group. Therefore, it can be stated that the intervention in each sample group is effective for changing the color of the teeth to be whiter than before (**Table 3**).

Kruskal-Wallis test was used to evaluate the difference in whitening effect between ambon banana peel extract and 10% carbamide peroxide on teeth whitening. The analysis showed significant differences between the treatment groups of banana peel extract and carbamide peroxide 10% with a value of p<0.05 (**Table 4**). Man Whitney test was conducted to determine further differences between groups. The test results showed p<0.05 which indicated a significant difference between the groups being compared (**Table 5**).

Table 4. The result of Kruskal Wallis test

Group Intervention	N	Tooth color change value	
		Mean±SD	p-value
Ambon banana peel extract	12	7,42±4,212	0.002
10% carbamide peroxide	12	3,92±2,234	

	Before immersion	After immersion	change value	
Ambon banana peel extract	9,17	1,75	7,42	0,003
10% carbamide peroxide	5,17	1,25	3,92	0,002

Total	36	5,36±3,765
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Table 5. The result of Man Whitney test

Treatment group	Control group	Mean difference	p-value
Ambon banana peel extract	10% carbamide peroxide	3,500	0,018

DISCUSSION

Tooth discoloration can be caused by extrinsic factors and intrinsic factors.¹⁸ In dental practices to restore tooth color, teeth whitening treatments are usually carried out using hydrogen peroxide or carbamide peroxide.^{5,19} However, the use of teeth whitening agents with high concentrations can cause a burning sensation, inflammatory effects on gingiva, tooth sensitivity, and changes in enamel microhardness.²⁰ Due to the side effects that can be caused, many studies have been conducted using natural ingredients that have abilities as carbamide peroxide.^{20,21} In this study, before the intervention, the tooth samples were immersed in 10 ml coffee solution for 12 days. The 12-day period was chosen because according to research conducted by Suryanti (2015) on the Wilcoxon sign Rank Test showed a significant difference in tooth color after 12 days of immersion in coffee solution with a value of p <0.05.²²

Descriptive analysis in this study showed a higher average value of color change occurred in the treatment group (7.42) compared to the positive control group (3.92). Wilcoxon Sign Ranks test shows the observation value of tooth color before and after immersion of extracts and carbamide peroxide (**Table 3**). The test showed p value <0.05 in both sample groups, Indicating a significant effect of each group on the whitening of tooth color. A smaller tooth color observation score indicates a whiter tooth color.²³ The results of the Kruskal wallis test followed by the Man Whitney test between the treatment group and the control group showed p<0.05. These results show that there is a significant difference between changes in tooth color that occur in the treatment group and the positive control group.

Average color changes in both groups and the results of data analysis show that ambon banana peel extract exhibits a more significant change in tooth color compared to carbamide peroxide. The results of this study are aligned with previous study which showed that ambon banana peel with 100% extract concentration has good effectiveness for teeth whitening.¹ The ability of extract to cause discoloration of the teeth is associated with several mineral components and photochemical components contained in the extract. Mineral components

contained such as potassium, calcium, sodium, manganese, and iron while phytochemical components are flavonoids, alkaloids, phenols, tannins, and saponins.²⁴⁻²⁶

Saponins contained in ambon banana peel are the main bioactive compounds that play a role in teeth whitening. Saponins can bind to chromogens thereby whitening teeth. Saponins are glucosides with foaming characteristics that can act as cleaning agents. Saponins consist of polycyclic aglycones bound to one or more sugar chains.²⁷⁻²⁸ The foaming ability of saponins is due to the combination of polar and non-polar aggregates of the hydrophobic sapogenin and the hydrophilic part of the sugar chain. This indicates that the more exposure of saponin substances to the enamel surface, the more chemical reaction opportunities of the saponin will change the color of teeth.^{27,29}

The high mineral compounds of potassium and magnesium in banana peels play a role in teeth whitening.²⁷ Potassium content of banana peels reaches 78 mg in 100 grams. Magnesium found in banana peels ranges from 40-50 mg in 100 grams.³⁰⁻³²

Potassium has a role in promoting the mineralization process of teeth by maintaining enamel integrity. Healthy enamel can help reflecting the light, giving teeth a brighter appearance.³³ Another study conducted by Safitri et al (2023) showed that potassium has the ability to stabilize nerve impulses in dentin, thereby helping to reduce tooth sensitivity which often becomes a side effect of chemical whitening procedures. With lower sensitivity, whitening procedures can be performed more effectively and comfortably.³⁴ Research conducted by Betur et al (2021) shows that potassium minerals can enhance the effects of teeth whitening ingredients.³⁵

Magnesium has an important role in the formation of hydroxyapatite, the main component of tooth enamel, which helps strengthen teeth and prevent decay.^{36,37} Magnesium also contributes to reducing the presence of plaque and stains. It is associated with magnesium's ability as an antibacterial that can help reduce plaque formation on the tooth surface. The reduced plaque and stains will support the teeth to be whiter.³⁷⁻³⁹ Potassium and magnesium synergistically support dental health through mineralization, reduction of sensitivity, and protection from stain formation.³⁴⁻³⁷

Based on this study, it can be concluded that ambon banana peel extract has high potential as an alternative teeth whitening treatment with minimal side effects. This was demonstrated by the color change analysis results, which showed that the treatment group exceeded the group receiving conventional modality interventions. These findings are important as a reference for future research aimed at maximizing the potential of banana peel as a natural resource to develop products for teeth whitening procedures. However, this study has some limitations, such as the age of the teeth used as samples was not known, which may affect the results of the study associated with a decrease in enamel thickness and an increase in secondary dentin. In addition, this study still uses crude extracts so that the amount of active content that affects teeth whitening cannot be known quantitatively.

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