

THE EFFECTIVENESS OF BAKING SODA (*Sodium Bicarbonate*) 20%, 40%, AND 60% ON TEETH THAT HAVE COFFEE STAIN
(EFEKTIVITAS BAKING SODA (*Sodium Bicarbonate*) 20%, 40%, DAN 60 % TERHADAP GIGI YANG MENGALAMI PEWARNAAN KOPI)

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ABSTRACT

Coffee consumption can cause extrinsic discoloration. A treatment that can be done to improve tooth discoloration is bleaching. Bleaching procedures can be carried out using alternative materials that do not cause side effects on dental and oral health, such as baking soda (sodium bicarbonate). This study aims to determine the effectiveness of baking soda 20%, 40%, and 60% on teeth that were discolored by coffee. The study used experimental research with a pretest-posttest group design with a total of 27 premolars study samples divided into three treatment groups: soaking the teeth in a solution of baking soda 20%, 40%, and 60%. Measurement of tooth discoloration using the VITAPAN® Classical Shade guide. Data analysis using the One-Way Anova test followed by post-hoc Tukey analysis. The results showed a significant change in tooth color between the three immersion groups, namely the group with the concentration of baking soda 20%, 40%, and 60% with $p=0.012$ ($p<0.05$). A 60% baking soda solution was more effective in

whitening teeth with coffee discoloration than 20% and 40%, respectively.

Keywords: coffee; discoloration; sodium bicarbonate; teeth whitening

ABSTRAK

Konsumsi kopi dapat menyebabkan diskolorasi ekstrinsik. Perawatan yang dapat dilakukan untuk memperbaiki perubahan warna gigi adalah bleaching. Prosedur bleaching dapat dilakukan dengan menggunakan bahan alternatif yang tidak menimbulkan efek samping bagi kesehatan gigi dan mulut, seperti baking soda (sodium bicarbonate). Penelitian ini bertujuan untuk mengetahui efektivitas baking soda 20%, 40% dan 60% pada gigi yang mengalami perubahan warna akibat kopi. Penelitian ini merupakan penelitian eksperimen dengan desain pretest-posttest group design dengan total 27 sampel penelitian gigi premolar yang dibagi menjadi 3 kelompok perlakuan yaitu merendam gigi dalam larutan baking 20%, 40%, dan 60%. Pengukuran perubahan warna gigi menggunakan panduan VITAPAN® Classical Shade. Analisis data menggunakan uji One Way Anova dilanjutkan dengan analisis Tukey post hoc. Hasil penelitian menunjukkan bahwa terdapat perubahan warna gigi yang signifikan antara ketiga kelompok perendaman yaitu kelompok dengan konsentrasi baking soda 20%, 40% dan 60% dengan nilai $p=0,012$ ($p<0,05$). Dapat disimpulkan bahwa larutan soda kue 60% lebih efektif dalam memutihkan gigi dengan perubahan warna kopi dibandingkan dengan larutan soda kue 20% dan 40%.

Kata kunci: diskolorasi; kopi; pemutihan gigi; sodium bicarbonate

INTRODUCTION

Healthy and white teeth will increase one's self-confidence. However, if there is a change in the color of the teeth to yellow or even brown, it can cause aesthetic problems, making people feel less

confident.^{1,2}

Intrinsic and extrinsic factors can cause tooth discoloration (discoloration). Extrinsic discoloration occurs outside the enamel, which can be caused by external factors such as the consumption of tea,

coffee, carbonated drinks, cigarettes, and drugs that can leave stains on the surface of the enamel or tooth pellicle.^{3,4}

Coffee is one of the drinks that the community often consumes every day. For Indonesian, coffee has become a lifestyle because coffee is able to reduce stress and depression. The habit of drinking coffee can cause discoloration of the teeth. The compounds contained in coffee that play a role in tooth discoloration are tannins. Tannins as chromogen agents can bind and give color to the surface of tooth enamel. In addition, coffee also contains chlorogenic acid, which can affect the solubility of enamel so that it can cause dye deposition on the surface of tooth enamel.³⁻⁵

One of the treatments that can be done to correct discoloration of the teeth is bleaching. In general, bleaching materials use chemical compounds such as hydrogen peroxide, carbamide peroxide, sodium perborate, and sodium peroxyborate monohydrate. However, using teeth whitening agents containing these chemical compounds can affect dental and oral health in the form of sensitive teeth and irritation of the mucosa. The bleaching procedure can be carried out using natural ingredients or alternative materials that do not cause side effects for dental and oral health, for example, baking soda (sodium bicarbonate).⁶⁻⁹

Baking soda is a chemical compound that can be used as an alternative to whitening teeth. The bleaching process using baking soda is the same as home bleaching, where the bleaching process using baking soda occurs due to an oxidation reaction by sodium bicarbonate and oxygen. Another advantage of baking soda is that it has low abrasive properties alkaline properties, is easy to obtain, inexpensive, and easy to use.⁹⁻¹²

Sari et al. 2019, examined the effect of using 5 ml of baking soda solution with a smearing time of 3 minutes on the reduction of tobacco stains in smokers. Paramita 2015, concluded that baking soda mixed with salt and added water to resemble toothpaste by rubbing it for 3 minutes is useful for cleaning stains on teeth. Fatmasari et al. 2014, concluded 50% baking soda (sodium bicarbonate) solution is more effective for alternative dental concentrations than 30% concentration with soaking time for 20 minutes every day for 5, 10, and 15 days. Rahayu et al. 2018, concluded that the combined concentration of lemon and sodium bicarbonate 10% with immersion times of 48 hours and 72 hours was more effective than soaking 8 hours and 24 hours.^{9,10,13,14}

The purpose of this study was to determine the effectiveness of baking soda 20%, 40%, and 60% on teeth with coffee

discoloration. This research is expected to add references and can be a comparison with previous research.

METHOD

The study used experimental research with a pretest-posttest group design. The sample of this study was 27 extracted permanent premolars, caries-free, without restoration, crown intact, and rooted. The samples were divided into three treatment groups with ten repeaters: soaking the teeth in a solution of baking soda 20%, 40%, and 60%. Tooth discoloration was measured using the VITAPAN® Classical Shade guide. The research was conducted at the Biochemistry Laboratory of the Faculty of Medicine and the Skill Laboratory of the Faculty of Dentistry, Universitas Jenderal Achmad Yani, in October-November 2021.

The research procedure consisted of a sample preparation stage where all samples were to be used cleaned using a micromotor and a bur brush that had been given prophylactic paste. Then after that, the teeth are smeared with clear white nail polish on the cervical part to the root of the tooth. For coffee staining preparation, 65 grams of robusta coffee powder were mixed with 450 ml of water at a temperature of 58-60°. The pH of the coffee was counted using a pH meter, and the pH level was 5.1. For

teeth staining, 15 ml of coffee solution was poured into each plastic container containing a tooth sample and soaked at room temperature for 14 days. Then, after 14 days, the teeth were removed, rinsed with distilled water, and dried using a tissue to dry. After immersion in coffee solution, tooth color was measured using a VITAPAN® Classical shade guide. Vitapan Classic's shade guide was arranged by value with a score of B1=1, A1=2, B2=3, D2=4, A2=5, C1=6, C2=7, D4=8, A3=9, D3=10, B3 =11, A3,5=12, B4=13, C3=14, A4=15, C4=16. Baking soda solution was prepared to 20%, 40%, and 60% in distilled water. The research sample was divided into three groups, group A containing 20% baking soda solution, group B containing 40% baking soda solution, and group C containing 60% baking soda solution, with each group having nine samples and soaking time for 48 hours. After soaking using a 20%, 40%, and 60% baking soda solution, the tooth color was measured using a VITAPAN® Classical shade guide. Vitapan Classic's shade guide was arranged by value with a score of B1=1, A1=2, B2=3, D2=4, A2=5, C1=6, C2=7, D4=8, A3=9, D3=10, B3 =11, A3,5=12, B4=13, C3=14, A4=15, C4=16. Data were analyzed using the One-Way Anova statistical test followed by post-hoc Tukey analysis.

RESULT

The graph of differences in tooth discoloration before and after immersion in 20%, 40%, and 60% baking soda solutions can be seen in Figure 1.

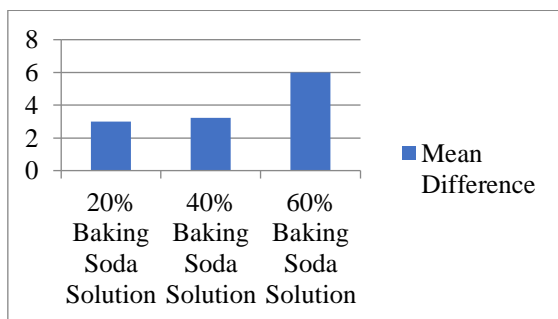


Figure 1. Graph of differences in tooth discoloration before and after immersion in 20%, 40%, and 60% baking soda solution.

Figure 1 shows a change in tooth color after immersion in a 20%, 40%, and 60% baking soda solution, which was indicated by an increase in the average score at each concentration. Changes in tooth color before and after immersion in baking soda solution can be seen in Figure 2.



Figure 2. Tooth discoloration before immersion in a baking soda solution (A4) and after immersion in a baking soda solution (A3). Personal documentation.

Based on Figure 2 shows that there is a change in the color of the teeth before and after soaking in the baking soda solution.

The t-paired test was carried out to find out whether there was a change in tooth color before and after immersion in a 20%, 40% and 60% baking soda solution. The results of the paired t-test in each concentration group can be seen in Table 1.

Table 1. Tooth discoloration before and after immersion in 20%, 40%, and 60% baking soda solution

No	Baking Soda Solution	Mean \pm SD		Mean Difference \pm SD	p-value	Interpretation
		Before	After			
1	20%	7,67 \pm 2,65	4,67 \pm 2,45	3,0 \pm 0,19	0,008	Difference
2	40%	6,78 \pm 2,05	3,56 \pm 2,35	3,22 \pm 0,30	0,019	Difference
3	60%	9,78 \pm 3,73	3,78 \pm 2,39	6,0 \pm 1,35	0,000	Difference

Based on Table 1, there were differences in tooth discoloration between before and after immersion in baking soda solution in all groups.

The One-Way Anova test was done to compare the changes in tooth color between the three immersion groups, namely the group with a concentration of baking soda solution of 20%, 40% and 60%, and presented in Table 2.

Table 2. Tooth color before and after immersion in a 20%, 40% and 60% baking soda solution

No	Baking Soda Solution	Mean \pm SD	p-value
1	20%	3,00 \pm 1,581	

2	40%	3,220 ± 1,563	0,012
3	60%	6,000 ± 3,041	

Based on Table 2, there was a significant change in tooth color between the three soaking groups, namely the group with the baking soda solution concentration of 20%, 40%, and 60% with $p=0.012$ ($p<0.05$).

The Post Hoc Tukey test was carried out to compare the three immersion groups (baking soda solution 20%, 40%, and 60%). The results of the Post Hoc Tukey test can be seen in Table 3.

Table 3. Comparison of tooth discoloration before and after immersion in 20%, 40%, and 60% baking soda solution

No	Baking Soda Solution	P-value	Interpretation
1	20% to 40%	0,974	No Difference
2	20% to 60%	0,02	Difference
3	40% to 60%	0,032	Difference

Table 3 shows that the 20% baking soda solution and 40% baking soda solution did not have a significant difference with $p=0.974$ ($p>0.05$). In comparison, the 20% baking soda solution and 60% solution had a significant difference with $p=0.02$ ($p<0.05$), and the 40% solution with 60% baking soda solution had a significant difference with $p=0.032$ ($p<0.05$).

DISCUSSION

Sample in a coffee solution so that the tooth was discolored. Coffee contains many bioactive substances, such as nicotinic acid, trigonelline, quinolinic acid, tannic acid, pyrogallol, and caffeine. Tannins act as carriers and color binders, which can cause brownish discoloration of the teeth. The content of chlorogenic acid in coffee can cause the pH of soft coffee drinks to reach a pH below 5.5. This acidic condition can cause calcium hydroxyapatite to dissolve, causing a demineralization process that can cause pores or porosity to form on the enamel surface, making it easier for chromogenic agents to be deposited into the tooth enamel surface, which can cause discoloration of the teeth.^{3,6,15}

The results of this study were seen visually using a VITAPAN® Classical shade guide on the buccal part of the premolars. The measurement of tooth color showed various changes in tooth color after immersion in coffee solution for 14 days and after immersion in 20%, 40%, and 60% baking soda solution for 48 hours. The variation in tooth discoloration in each group was thought to be related to the thickness of the enamel layer and the age of the patient. The teeth used in this study came from different patients, so the thickness of the enamel of the teeth also varied. The thicker the layer of tooth enamel, the less the coffee's ability to cause

discoloration. The thickness of the enamel also affects the ability of the bleaching material to carry out the teeth whitening process.¹⁶

One of the treatments that can be done to improve the teeth' discoloration is bleaching. In general, bleaching materials use chemical compounds such as hydrogen peroxide, carbamide peroxide, sodium perborate, and sodium peroxyborate monohydrate. However, using teeth whitening agents containing these chemical compounds can cause side effects on dental and oral health in the form of sensitive teeth and irritation of the mucosa. To reduce these side effects, bleaching procedures can be carried out using natural ingredients or alternative materials that do not cause side effects for dental and oral health, for example, baking soda (sodium bicarbonate).⁶⁻⁹

The study showed that the results of measuring changes in tooth color showed a significant difference between before and after immersion in a 20%, 40% and 60% baking soda solution (Table 2). Changes in tooth color before and after immersion in a 20%, 40% and 60% baking soda solution can be seen in Figure 3.

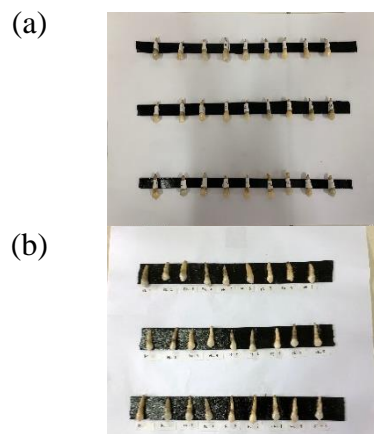


Figure 3. Teeth color before immersion in 20%, 40% and 60% baking soda solution (a) after immersion in 20%, 40% and 60% baking soda solution (b).

Based on Figure 3 shows that there is a change in tooth color after immersion in a 20%, 40%, and 60% baking soda solution. It happened because the content of baking soda can remove stains on teeth. An oxidation reaction by sodium bicarbonate and oxygen causes teeth whitening that occurs. Sodium bicarbonate diffuses through the enamel and dentin. During the bleaching process, the carbon ring compounds were opened and converted to the chain bonds of the lighter elements. Existing double-bonded carbon compounds were converted into hydroxyl groups.^{9,10,17}

Baking soda has many beneficial properties, including being water soluble, neutralizing acids, compatible with fluoride, eliminating bad breath, having an antibacterial ability, and being abrasive to

clean teeth from plaque and stains on the tooth surface. If the abrasive power is too high, it can damage the enamel structure and cause abrasion to the teeth. However, baking soda has low abrasive properties coupled with high solubility with a low RDA (Relative Dentin Abrasivity) value of baking soda, which is 7. So that the use of baking soda is more effective in removing stains and whitening teeth without causing side effects compared to toothpaste that does not contains baking soda with a higher level of abrasiveness, so baking soda is safer to use and reduces the potential for tooth enamel damage. However, external bleaching cannot correct intrinsic discoloration because cases of intrinsic discoloration can only be performed by internal bleaching procedures, also known as walking bleaching techniques.^{11,12,18-23}

The limitation of this study is that it is not known what specific chemical substances and their amounts or levels can actively play a role in the antibacterial effect of rambutan honey so that it is better than other honey. In addition, limited information regarding the interaction between rambutan honey and the composition of the toothpaste base that could reduce the inhibition of the 60% rambutan honey toothpaste group or cause negative effects is also a limitation of this study.

This research is in line with the study conducted by Fatmasari et al. 2014 states that a 50% concentration of sodium bicarbonate solution is more effectively used for alternative ingredients to whiten teeth than a concentration of 30%, where the more significant the concentration, the faster the whitening reaction takes place so that in this study 60% sodium bicarbonate solution was more effective at concentrations of 20% and 40 %. In addition, research by Rahaju et al. 2018 states that the concentration of a combination of lemon and sodium bicarbonate 10% solution with a soaking time of 48 hours and 72 hours is more effective in whitening teeth than soaking for 8 hours and 24 hours.

Baking soda (sodium bicarbonate) could be an effective solution for whitening teeth in an in vitro study. Baking soda has low abrasive properties, so it is safer to use and reduces the potential for tooth enamel damage. Baking soda can also neutralize acids in the oral cavity so that the tooth enamel matrix will avoid demineralization.

CONCLUSION

Based on the research that has been done, it can be concluded that 60% baking soda (sodium bicarbonate) solution is more effective in whitening teeth that have coffee

discoloration than the concentrations of 20% and 40%, respectively.

CONFLICT OF INTEREST

We declare no conflict of interest in the scientific articles we write.

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