

The Difference in Effectiveness of Red Grape (*Vitis vinifera* L.) and Green Grape (*Vitis vinifera*) Extracts on Tooth Discoloration During Teeth Whitening

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ABSTRACT

Background: Tooth discoloration is a common aesthetic problem that can affect self-confidence. One solution to address this problem is tooth whitening, using either chemical or natural ingredients. **Objective:** To compare the effectiveness of red grape (*Vitis vinifera* L.) and green grape (*Vitis vinifera*) extracts on tooth discoloration during teeth whitening. **Methods:** This is a laboratory experimental study using a pre-test and post-test control group design. The samples used were 24 permanent first and second premolar teeth, which were soaked in red grape extract and green grape extract for 1, 3, and 5 hours. Tooth color measurements were carried out before and after immersion using a VITA Easyshade V digital spectrophotometer, based on the L (lightness), C (chroma), and H (hue) values. **Results:** The study showed that there was an increase in the L value and a decrease in the C and H values indicating a significant difference in tooth color ($\text{sig} < 0.05$) in all immersion groups, both using red grape extract and green grape extract. The most significant increase in the L value occurred in the 5-hour immersion group with green grape extract juice. **Conclusion:** There is a difference in effectiveness between red grape extract and green grape extract in the tooth whitening process. Green grape extract is more effective as a natural external tooth whitening ingredient, especially with a longer immersion duration, because it is influenced by its active ingredients such as malic acid, vitamin C, flavonoids, and phenols, there is also a difference in pH value in both red grape extract and green grape extract. The pH value of green grape extract is lower than that of red grape extract

INTRODUCTION

Teeth whitening is widely sought after by the public for the purpose of improving dental aesthetics. Appearance becomes increasingly important to everyone, and tooth discoloration can be a factor in reducing self-confidence. Aesthetic treatments aim to achieve a better appearance while maintaining a natural appearance.

Smoking, as well as consuming coffee, tea, and carbonated drinks, are the main causes of tooth decay. Bleaching is a treatment used to lighten teeth, and many individuals do so.

Extrinsic and intrinsic factors contribute to tooth discoloration. Extrinsic discoloration is caused by chromogens from food sources consumed during diet, mouthwash solutions, or plaque on the tooth surface. Intrinsic discoloration is caused by the body's metabolism, genetic factors, and local factors.

Bleaching is an effective dental treatment that can instantly whiten teeth. The cost of in-clinic teeth whitening treatments is relatively more expensive than at-home teeth whitening treatments. Bleaching procedures can be performed either in-office (performed directly in a clinic by a dentist) or at home (performed at home under the supervision of a dentist). They can be performed internally for non-vital teeth or externally for vital teeth. Teeth whitening can be done using chemicals or natural ingredients. Commonly used bleaching agents in dentistry, such as hydrogen peroxide, have several side effects, one of which is tooth sensitivity. Sensitivity to tooth whitening agents and the high cost of dental treatments have led many researchers to seek relatively affordable alternatives that can reduce tooth sensitivity.

The main active ingredients in teeth whitening products vary depending on the manufacturer, but generally include substances such as hydrogen peroxide, carbamide peroxide, or urea peroxide. Additionally, there are non-hydrogen peroxide systems containing components such as sodium chloride, oxygen, and sodium fluoride. Some products even include potassium nitrate and fluoride to reduce tooth sensitivity. Carbamide peroxide itself is a combination of hydrogen peroxide and urea. The concentration of this compound in bleaching products typically ranges from 10% to 22%, with the most common level being 10% and an average acidity level (pH) of between 5.3 and 5.6.^{3,4}

Carbamide peroxide has a distinctive odor and is generally formulated with additional ingredients such as glycerin or propylene glycol, as well as sodium stannate, phosphoric acid, or citric acid. This compound is unstable and can decompose into urea, ammonia, carbon monoxide, and hydrogen. Carbamide peroxide is widely used in extracoronal bleaching procedures and its use must always be under the direct supervision of a medical professional, such as a dentist.

Fruits are known as natural alternatives with the potential to help treat and prevent various diseases. Furthermore, fruit contains a number of important vitamins and minerals that support organ function. Various studies have been conducted to explore the health benefits of fruit consumption, particularly regarding the active compounds that play a role in the prevention and treatment of certain diseases.

According to Filip et al. (2017), the flavonoids and phenols contained in grapes have antibacterial effects, inhibit plaque formation, and help reduce tooth discoloration. Research by Lamuhu et al. (2016) states that the lower the pH of a bleaching agent, the whiter the teeth. Research by Syahland, MR et al. (2013) used grape juice at various concentrations of 50%, 75%, and 100%. The results showed that adding up to 100 ml of distilled water was ineffective as a tooth whitening agent.

In another study, Jayaprakasha, et al. (2001) tested the composition of grape (*Vitis vinifera* L.) extract and its antioxidant effects. They found that grapes contain flavonoids and phenols, which can be used as antioxidants. According to research by Georgia, et al. (2002), grape extract containing phenols can increase the ethanol water content from 10% to 30% and remain constant for water content increases from 30% to 60%. This strongly correlates with the phenol concentration in terms of the color change process.

This study aimed to determine the difference in effectiveness of red grape (*Vitis vinifera* L.) extract and green grape (*Vitis vinifera*) extract on tooth discoloration during the tooth whitening process. It is hoped that the results of this research can contribute to the community in providing alternative natural ingredients that are safe, economical, and able to minimize side effects such as tooth sensitivity in the whitening process.

THEORETICAL REVIEW

Teeth are a body tissue with a higher level of hardness than other tissues. The tooth structure consists of several layers, starting with enamel as the hardest outer layer, followed by dentin (dental bone) beneath it, and pulp, the inner part of the tooth containing blood vessels, nerves, and other supporting tissues that strengthen the tooth structure. Although teeth are considered strong, they are also susceptible to damage.

The natural color of vital teeth is generally bright and normal, while non-vital teeth often show a darker or grayish discoloration caused by the degradation of hemoglobin in dead pulp tissue. Tooth discoloration is a condition that can be aesthetically disturbing and impact a person's self-confidence. White teeth are often associated with a healthy and socially attractive appearance. Tooth discoloration is generally divided into two main types based on its cause: endogenous and exogenous.

Endogenous discoloration originates within the tooth structure and can be caused by local factors such as trauma, errors in treatment procedures, pulp tissue damage, and the use of root canal fillings or restorative materials. Conversely, exogenous discoloration occurs due to external factors originating outside the tooth. This is generally caused by consuming colored foods or drinks such as tea, coffee, and syrups, as well as smoking. Exogenous discoloration usually occurs on the outer surface of the tooth and is relatively easy to treat.

In dentistry, teeth whitening, or dental bleaching, refers to efforts to restore discolored teeth to their natural color, or at least a close match. This process is carried out using chemicals with both oxidizing and reducing properties. The primary goal of this procedure is to restore the aesthetics of the

patient's teeth, resulting in a brighter and more attractive appearance. The goal of bleaching is to restore the normal color of teeth by removing staining agents with strong oxidizing agents known as bleaching agents. The most commonly used bleaching agents are 15-35% hydrogen peroxide, sodium perborate, and 10% carbamide peroxide.

Bleaching is primarily indicated for patients dissatisfied with their current tooth color. The cause of the discoloration affects the success rate and speed of the bleaching treatment. Furthermore, bleaching is also indicated for patients with tooth discoloration issues that cannot be addressed with bleaching agents. These include discoloration caused by aging, consumption of colored foods and drinks, tetracycline medication, and fluorosis. Contraindications for bleaching include allergies to any component of the tooth whitening agent, highly sensitive teeth, temporomandibular joint (TMJ) conditions, pregnancy or breastfeeding, and uncooperative patients.

Tooth whitening occurs through an oxidation reaction triggered by the bleaching agent. Peroxide compounds, as oxidizing agents, contain free radicals that lack a pair of electrons. These free radicals are then released and react with tooth enamel, triggering the oxidation process. Organic molecules in the teeth are oxidized by these electrons, ultimately resulting in a lighter tooth color. Peroxide-based bleaching compounds are able to penetrate the enamel layer and enter the dentinal tubules, where they oxidize the pigments contained in the dentin, making the teeth appear lighter in color.

METHODOLOGY

This study employed a laboratory experimental design with a pre-test, post-test, and control group design. Permanent first and second premolar teeth were immersed in red and green grape extracts, and tooth color was measured before and after treatment using a digital spectrophotometer (VITA Easyshade V) based on the parameters L (lightness), C (chroma), and H (hue). The study samples consisted of intact upper and lower permanent premolar teeth, free from caries, cracks/fractures, or restorations. A total of 24 samples were divided into six treatment groups, each consisting of four samples. The equipment used included: VITA Easyshade V, a blender, a measuring cylinder, a stopwatch, a soaking container, tweezers, and standard laboratory equipment. The materials used included permanent premolar teeth, red grape extract (*Vitis finifera* L.) with a pH of 3.43 before immersion, and green grape extract (*Vitis vinifera*) with a pH of 3.34 before immersion.

The research procedures include examining the ascorbic acid content in both types of juice using spectrophotometry, measuring the initial tooth color using VITA Easyshade V, soaking the teeth in each solution for 1 hour, 3 hours, and 5 hours, and measuring the tooth color after treatment to assess changes in L, C, and H values. Data were analyzed univariately and bivariately. Normality tests were performed using Shapiro-Wilk. If the data were normally distributed and homogeneous, a Paired Sample T-Test was used to compare differences in tooth color before and after treatment.

RESEARCH RESULTS

Data on differences in light (value), chrome, and hue in first and second premolar teeth samples from both the upper and lower jaws were measured before and after being immersed in lemon juice and packaged lemon juice for 1 hour, 3 hours, and 5 hours, based on the research described in Table 1.

Table 1. Sample Measurement Result for 1 hour
Red grape extract in immersion for 1 hour

No	L value before immersion	L value after immersion	C value before immersion	C value after immersion	H value before immersion	H value after immersion
1	9.9	11.1	14.8	10.7	-6.8	-3.3
2	9.6	11.5	14.9	10.6	-7,3	-3.6
3	10.5	10.9	15.5	12.9	-7.6	-3.9
4	10.8	11.2	15.2	12.5	-7.2	-3.7
Mean	10.2	11.76	15.1	11.68	-7.23	-3.61

pH before immersion 3.43

pH after immersion for 1 hour 3.46

Table 2. Sample Measurement Result for 3 hour
Red grape extract in immersion for 3 hour

No	L value before immersion	L value after immersion	C value before immersion	C value after immersion	C value after immersion	C value after immersion
1	11.5	12.8	16.4	12.5	-5.9	-3.9
2	11.2	12.6	16.9	12.1	-5.3	-3.8
3	11.8	12.9	16.5	12.7	-5.6	-4.3
4	11.6	13.2	15.2	12.4	-6.2	-4.7
Mean	11.53	12.88	16.25	12.43	-5.75	-4.18

pH before immersion 3.43

pH after immersion for 3 hour 3.42

Table 3. Sample Measurement Result for 5 hour
Red grape extract in immersion for 5 hour

No	L value before immersion	L value after immersion	C value before immersion	C value after immersion	H value before immersion	H value after immersion
1	13.6	16.1	18.8	13.9	-5.8	-2.3
2	13.5	16.8	18.9	13.6	-5,3	-2.6
3	14.5	16.3	18.1	13.4	-5.6	-2.9
4	14.3	17.2	18.5	13.5	-5.2	-2.7
Mean	13.96	16.6	18.58	13.6	-5.48	-2.63

pH before immersion 3.43

pH after immersion for 5 hour 3.41

Table 4. Sample Measurement Result for 1 hour
Green grape extract in immersion for 1 hour

No	L Value before immersion	L value after immersion	C value before immersion	C value after immersion	H value before immersion	H value after immersion
1	14.8	15.1	16.4	9.9	-4.7	-2.4
2	14.6	15.7	16.9	9.6	-4,3	-2.6
3	14.5	15.9	16.5	9.2	-4.6	-2.9
4	14.3	15.2	16.2	9.5	-4.2	-2.7
Mean	14.56	15.48	16.5	9.55	-4.45	-2.65

pH before immersion 3.34

pH after immersion for 1 hour 3.47

Table 5. Sample Measurement Result for 3 hour
Green grape extract in immersion for 3 hour

No	L value before immersion	L value after immersion	C value before immersion	C value before immersion	H value before immersion	H value after immersion
1	16.9	16.3	18.5	13.7	-4.8	-3.8
2	16.6	16.7	18.9	13.6	-4,3	-3.9
3	16.5	16.0	18,1	13.9	-4.6	-3.5
4	16.8	16.2	18.2	13.5	-4.2	-3.0
Mean	16.7	16.3	18.43	13.68	-4.48	-3.55

pH before immersion 3.34

pH after immersion for 3 hour 3.25

Table 6. Sample Measurement Result for 5 hour
Green grape extract in immersion for 5 hour

No	L value before immersion	L value after immersion	C value before immersion	C value after immersion	H value before immersion	H value after immersion
1	19.9	17.5	16.8	10.5	-5.8	-1.9
2	19.6	17.3	16.9	10.7	-5.3	-1.7
3	19.5	17.9	16.5	10.9	-5.1	-2.2
4	19.8	17.2	16.2	10.3	-5.7	-2.3
Mean	19.7	17.48	16.58	10.6	-5.48	-2.01

pH before immersion 3.34

pH after immersion for 5 hour 3.22

Noted:

L: Light atau Value

C: Chroma

H: Hue

Table 7. paired T test

Time	Catagory	Colour	Mean±SD	<i>p-value</i>
1 hour		L before - L after	- 2.51 ± 1.15	0.072
		C before- C after	5.01 ± 3.32	0.047
		H before - H after	1.55 ± 9.47	0.033
3hour	AM extract	L before - L after	-2.35 ± 9.53	0.038
		C before- C after	2.23 ± 1.35	0.021
		H before- H after	1.11 ± 5.37	0.029
5hour		L before - L after	-3.64 ± 1.42	0.016
		C before - C after	2.63 ± 8.57	0.011
		H before - H after	10.9 ± 2.99	0.009
1 hour		L before - L after	- 1.51 ± 1.35	0.049
		C before - C after	1.51 ± 3.37	0.015
		H before - H after	1.35 ± 9.77	0.047
3hour	AH extract	L before- L after	-3.41 ± 9.03	0.039
		C before - C after	3.63 ± 1.65	0.016
		H before - H after	9.51 ± 5.16	0.032
5hour		L before - L after	-5.61 ± 5.27	0.002
		C before - C after	4.37 ± 8.62	0.017
		H before - H after	9.49 ± 2.90	0.029

Noted:

AM: Red grape

AH: green grape

Based on Table 7, the results of the paired t-test indicate that immersing teeth in red grape extract for 1 hour, 3 hours, and 5 hours resulted in highly significant color changes with a *p-value* <0.05. This is evident from the increase in Light values and changes in Chroma and Hue values in the premolars used as study samples.

Immersing teeth in green grape extract also showed significant color changes with a *p-value* <0.05 at 1 hour, 3 hours, and 5 hours. However, compared to red grape extract, the magnitude of changes in L, C, and H values in green grape extract tended to be lower, indicating slightly different levels of whitening effectiveness between the two types of grape extract.

DISCUSSION

Tooth discoloration is a significant issue in aesthetic dentistry, significantly impacting an individual's quality of life. According to research by Georgia et al. (2002), grape extract containing phenol can increase the ethanol water content from 10% to 30% and remains constant for water content from 30% to 60%, strongly correlating with phenol concentration in terms of color change.

In another study conducted by Jayaprakasha et al. (2001), they tested the composition of grape extract (*Vitis vinifera* L.) and its antioxidant effects. They found flavonoids and phenols that can be used as antioxidants. 9 Research by Syahland et al. (2013) used grape juice with various concentrations of 50%, 75%, and 100%, and the results showed that adding up to 100 ml of distilled water was ineffective as a tooth whitening agent.

Research by Lamuhu et al. (2016) stated that the lower the pH of a bleaching agent, the whiter the teeth. 7 In research by Jayaprakasya (2001), the peroxide enzyme in grapes can be used as a natural ingredient for teeth whitening. This suggests that grapes, despite being natural, possess chemical characteristics that support the tooth whitening process through a reaction pathway comparable to chemical bleaching agents. For comparison, hydrogen peroxide-based bleaching agents are generally used at concentrations of 15%–38%, while carbamide peroxide is used at concentrations between 3%–10%. Both agents act as strong oxidizing agents in teeth whitening, but their use carries the risk of side effects such as tissue irritation and enamel demineralization. Therefore, the use of natural ingredients such as grapes, both red and green, is considered a safer alternative, although their effectiveness still depends on the concentration of the active compound, application time, and the degree of tooth discoloration.

According to research by Jayaprakasha et al. (2001), the presence of flavonoids and vitamin C enhances the ability of red and green grapes as a natural whitener because they act as antioxidants that can help neutralize free radicals and support the breakdown of color pigments. This combination of acidic, oxidative, and antimicrobial properties underpins the use of lemon juice as an alternative natural teeth whitening agent, which is affordable and relatively safe when used correctly.

In theory, grapes contain malic acid, vitamin C, antioxidants, flavonoids, and phenols, which can help remove stains from teeth. Both red and green grapes have slightly different compositions, which also influence their effectiveness as natural whitening agents.

In a study by Syahland, MR et al. (2013), which used red grapes (*Vitis vinifera* L.) as a teeth whitening agent, 20 teeth were stained with tea for six days. The results showed that the teeth changed color, becoming lighter after being immersed in grape juice. This was attributed to the role of malic acid in influencing the discoloration process.

A study by Andriyani, R. (2012), using 15 anterior teeth soaked in 100% red grape juice, carbamide peroxide gel, and distilled water as a control, showed that there was a color change in anterior teeth soaked in 100% red grape juice, although not as effective as the chemical bleaching agent.

According to research by Setyawati A (2013), the malic acid content in various natural ingredients can help remove surface stains on teeth and aid in the natural teeth whitening process. Furthermore, malic acid can neutralize and oxidize the enamel surface of teeth and reduce plaque, making it suitable for use as a natural tooth whitening ingredient.

According to Filip et al. (2017), the flavonoids and phenols contained in grapes have antibacterial effects, inhibiting plaque formation, and helping reduce tooth discoloration.⁶ In addition, polyphenolic compounds such as flavonoids have antioxidant and antimicrobial properties that can aid the natural tooth whitening process. Joiner & Weir (2022), in their theory in the textbook *Contemporary Esthetic Dentistry*, emphasize that bleaching effectiveness is influenced by various factors such as the concentration of the active ingredient, application time, pH of the material, and the condition of the tooth surface. This study strictly controlled these factors to provide objective and valid results.

The mechanism of tooth bleaching is based on an oxidation process involving a chemical reaction between the bleaching agent and molecules that cause tooth discoloration. The most commonly used bleaching agents are hydrogen peroxide (H₂O₂) and its derivatives, which act as powerful oxidizing agents. These compounds produce highly reactive free radicals, which then penetrate the tooth enamel and enter the dentinal tubules. Within the tooth tissue, these free radicals react with large, highly pigmented organic molecules, the primary cause of discoloration. This process converts these molecules into smaller, colorless, and more stable compounds. This chemical process increases the light reflected by the tooth surface, making the teeth visually appear brighter and whiter.

Conversely, the use of natural ingredients such as grapes, both red grapes (*Vitis vinifera* L.) and green grapes (*Vitis vinifera*), tends to be safer and has fewer side effects on the hard tissue structure of teeth. However, the effectiveness of natural ingredients in the bleaching process is relatively lower and requires a longer time to show significant color changes.

This study used extracts of red grapes (*Vitis vinifera* L.) and green grapes (*Vitis vinifera*), known as natural sources rich in biologically active compounds beneficial for health, including in dentistry. The main components contained in these extracts include flavonoids, malic acid, vitamin C, and phenols, with malic acid being the most abundant organic acid in this fruit. These compounds are thought to play a role in the tooth whitening process observed during the study. Flavonoids can help with tooth discoloration, allowing these compounds to help remove surface stains. The cleansing activity of these flavonoids can speed up the process of removing plaque or pigment layers that adhere to enamel.

Meanwhile, flavonoids have high antioxidant and antimicrobial activity. In the context of teeth whitening, flavonoids can help suppress the growth of pigment-producing bacteria or plaque that cause tooth discoloration. Furthermore, the astringent properties of flavonoids can also aid in the remineralization of tooth surfaces, thus supporting the whitening effect. Thus, the flavonoids and phenols in grapes are factors that enhance the effectiveness of

teeth whitening, in addition to malic acid, which is known to lighten tooth color through mild oxidation.

The results of this study also showed significant differences in tooth color after soaking in red grape extract and green grape extract for 1 hour, 3 hours, and 5 hours. The greatest color change occurred in the groups soaked in red grape extract and green grape extract for 5 hours. This indicates that grapes contain bioactive compounds such as malic acid, vitamin C, flavonoids, and phenols, which act as natural whitening agents through oxidation.

The results of this study showed changes in tooth color values, measured using the L (lightness), C (chroma), and H (hue) parameters, across all treatment groups, both for samples soaked in red grape extract and green grape extract. The increase in L values occurred consistently across all groups, indicating that tooth color became lighter after the soaking process. Based on Aschheim's (2015) theory of color in dentistry, the L value represents the level of color brightness, with higher L values indicating lighter teeth, while lower L values indicate darker teeth.

Based on the average results in the L value graph (Figure 5.1), the 5-hour soaking group with green grape extract showed the highest increase in L value compared to the other groups, indicating that longer soaking durations produce more significant color changes, especially in materials that still contain intact natural active compounds. This finding aligns with research by Syahland Mr (2013), Setyawati and Nur (2020), and Filip (2017), which states that natural ingredients such as grape extract or juice can produce progressive color changes, especially when used over several days or weeks.

The results of the paired t-test showed a significant difference ($p < 0.05$) between the L, C, and H values before and after soaking in both the red grape extract and green grape extract groups. This proves that both ingredients have a whitening effect and are quite effective as natural whitening agents. The difference in active compound content, such as flavonoids, vitamin C, and phenols, is theoretically greater in green grapes than in red grapes. Furthermore, this study also found that the pH of red grape extract was 3.43 before immersion, 3.46 after immersion for 1 hour, 3.42 after 3 hours, and 3.41 after 5 hours. The pH of green grape extract was 3.34 before immersion, 3.47 after immersion for 1 hour, 3.25 after 3 hours, and 3.22 after 5 hours. These data also indicate that the low pH of green grape extract plays a significant role in the tooth whitening process because its acidic content helps dissolve stains on the enamel surface. The whitening effect is more effective with green grapes due to their more acidic nature.

From these results, it can be concluded that the choice of bleaching agent must consider effectiveness, long-term safety, and individual conditions. Chemicals are suitable for instant results with professional supervision, while natural ingredients can be a safer alternative for long-term use, although the results are not as rapid.

CONCLUSIONS AND RECOMMENDATIONS

There is a difference in effectiveness between the two ingredients on tooth discoloration. This is due to the higher content of active compounds in green grape extract (*Vitis vinifera*), such as malic acid, vitamin C, flavonoids, and phenols, compared to red grape extract (*Vitis vinifera* L.), making it more effective in breaking down the pigments that cause tooth discoloration. The most significant tooth discoloration was seen in the 5-hour soaking group for both red and green grape extracts. The duration of the soaking period affected the whitening intensity, with the longer soaking time, the greater the effect. Tooth discoloration is influenced by pH, concentration, soaking time, tooth surface cleanliness, shelf life, temperature, enclosed environment, and additives.

ADVANCED RESEARCH

Based on the research conducted, the researchers acknowledge that this study still requires refinement and development. Further research is needed using other natural bleaching ingredients to assess the effects on teeth or as a comparison, in order to evaluate and compare the effectiveness of tooth whitening from various natural sources.

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