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Research article

Differences in effectiveness between soaking star fruit juice (Averrhoa Bilimbi Linn) with tomato fruit juice (Lycopersicon Esculentum Mill) as a natural tooth whitening agent

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Abstract: Teeth whitening treatment or dental bleaching is a process that can make teeth whiter as close to the original color of the teeth by using chemicals. The bleaching materials used in this study were star fruit juice (Averrhoa Bilimbi Linn) and tomato fruit juice (Lycopersicon Esculentum Mill). This study aims to compare the effectiveness of teeth whitening between star fruit juice (Averrhoa Bilimbi Linn) and tomato fruit juice (Lycopersicon Esculentum Mill). The type of research used is true experimental design and pretest-posttest group design. The total number of samples in this study were 24 samples which were divided into 4 experimental groups; soaked 100% star fruit juice (Averrhoa Bilimbi Linn), 100% tomato fruit juice (Lycopersicon Esculentum Mill), 10% carbamide peroxide gel and sterile distilled water. Samples measurement using a spectrophotometer. The pretest-posttest paired analysis test using the Paired T-Test test showed that the mean differences of the groups before and after were significantly different. Parametric statistical tests with Oneway Anova showed that there were significant differences in each group after treatment. The highest level of effectiveness showed by 10% carbamide peroxide gel seen from the mean difference value of the Post Hoc LSD test. Based on the results of the study, it can be concluded that 100% star fruit juice (Averrhoa Bilimbi Linn) is more effective than 100% tomato fruit juice (Lycopersicon Esculentum Mill) as a tooth whitening agent, but not more effective when compared to 10% carbamide peroxide gel.

Keywords: *Star fruit juice (Averrhoa Bilimbi Linn), tomato fruit juice (Lycopersicon Esculentum Mill) 100%, carbamide peroxide gel 10%, teeth whitening.*

INTRODUCTION

Increased public knowledge about dental care has grown, including the desire to improve appearance. Discolouration of the anterior teeth is an aesthetic

problem that often encourages patients to seek treatment, namely by performing teeth whitening. Teeth whitening is an option because it is relatively simple, inexpensive, conservative and can reduce and eliminate discoloration or staining of vital and non-vital teeth [1]. Teeth discolouration is a problem because it makes many people feel uncomfortable when talking or smiling. They believe that white teeth can make people feel more beautiful and confident [2].

Hilya in 2012 mentioned that bleaching is a teeth whitening procedure that changes the colour until it approaches the original colour of the teeth with a chemical repair process to restore the aesthetics of one's teeth. Bleaching is the re-bleaching of discoloured teeth to bring them back to their original colour. Chemicals that are often used are hydrogen peroxide and carbamide peroxide [3].

The number of people who are sensitive to bleaching materials many researchers are looking for alternative materials that are safer and cheaper. The natural ingredients used for the teeth whitening process are Star fruit (Averrhoa Bilimbi Linn) and tomato fruit (Lycopersicon Esculentum Mill). Star fruit (Averrhoa Bilimbi Linn) contains carboxylic compounds in the form of oxalic acid that can be utilised as a natural dental bleaching agent. In addition, there are also peroxide compounds in Star fruit that are thought to be able to whiten teeth that are discoloured [4].

Tomatoes are certainly not a novel ingrediens and the benefits of tomatoes for everyday life cannot be doubted, most Indonesians use tomatoes as a seasoning enhancer for cooking, drinks, industrial materials, and even commonly used for facial beauty. Previous research results reported that the hydrogen peroxide and peroxidase content in tomatoes can be used as an alternative material for teeth whitening [5]. Based on the above background, the author is interested in examining the difference in effectiveness between immersion of star fruit juice (Averrhoa Bilimbi Linn) and tomato fruit juice (Lucopersicon esculentum Mill) as a natural ingredient.

The purpose of this study was to determine the difference in effectiveness between immersion of star fruit juice (Averrhoa Bilimbi Linn) and tomato fruit juice (Lucopersicon esculentum Mill) as a natural tooth whitening agent.

METHODS

Objectives the purpose of this study was to determine the difference in effectiveness between immersion of star fruit juice (Averrhoa Bilimbi Linn) and tomato fruit juice (Lucopersicon esculentum Mill) as a natural tooth whitening agent. The study used an experimental laboratory design with true experimental design and pretest-posttest group design. In this group design there is a pretest, which is before treatment and a post test, which is when the treatment has been given. The number of samples used in this study were 24 samples with each group using 6 samples.

In this study, tooth colour measurements were made using the Vital Shade Guide instrument which was used to equalise the colour of the teeth at an early stage before immersion, at this stage observing the colour of the teeth with benchmark numbers A1-A3. To measure the value of tooth colour, the Genesys 30 Spectrophotometer brand Thermo Scientific was used. The instruments used in this study are: Spectrophotometer, Shade guide, 24 small bottles with covers, Dental tweezers, 25 ml and 250 ml measuring cups, Thermometer and incubator. Materials: 100% star fruit juice (Averrhoa Bilimbi Linn), 100% tomato fruit juice (Lucopersicon esculentum Mill), sterile distilled water, 10% carbamide peroxide gel, 24 maxillary and mandibular anterior permanent teeth, coffee powder, clear nail polish, mineral water, 48 disposable cuvettes. Research path : Initial observation of tooth colour using Vital Shade Guide, making 100% star fruit juice (Averrhoa Bilimbi Linn), making 100% tomato fruit juice (Lucopersicon esculentum Mill), making coffee solution of robusta type.

Sample discoloration stage by means of: 24 tooth samples were coated with clear nail polish at the root of the tooth to the CEJ so that the coffee solution did not penetrate to the dentinal tubules. Put one tooth sample each into 24 bottles that have been given coffee solution and closed tightly. Samples soaked in coffee solution then place it in to incubator at 37°C for 1 week until discoloration occurs. After one week remove the samples one by one from the bottle, re-soak the tooth samples that have undergone discoloration using distilled water for 8 hours, then measured with a spectrophotometer, then soaking in 100% star fruit juice (Averrhoa

Bilimbi Linn) and 100% tomato fruit juice (Lucopersicon esculentum Mill) for 56 hours followed soaking in distilled water for 8 hours, then measured with a spectrophotometer.

RESULTS

Based on the measurement of samples using a spectrophotometer, there is a difference in the average value of tooth colour observation results from before and after the immersion treatment of 100% Star fruit Juice (Averrhoa Bilimbi Linn), 100% Tomato Juice (Lucopersicon esculentum Mill), Sterile Distilled Water and 10% Carbamide Peroxide Gel for 56 hours of immersion of tooth samples that have been discoloured by coffee solution. The observation results are in the form of a table as follows:

Table 1. The observation results

Group		Mean dE*ab value		
Treatment	**N**	**Before**	**After**	**Difference**
JBW	6	0,946	0,517	0,429
JBT	6	0,972	0,714	0,258
GKP	6	0,960	0,226	0,734
AS	6	0,975	0,849	0,126

In the table above, the average dE*ab value after treatment has decreased in each group. The results before being treated show the same average value of 0.9. After being treated, the results obtained different differences in each group. The highest to lowest difference value occurred in the group are soaked in 10% carbamide peroxide gel, 100% star fruit juice (Averrhoa Bilimbi Linn), 100% tomato fruit juice (Lucopersicon esculentum Mill) and sterile distilled water.

Description :

JBW : 100% Starfruit juice (Averrhoa BilimbiLinn)

JBT : 100% tomato fruit juice (Lucopersicon esculentum Mill)

GKP : 10% carbamide peroxide gel

AS : Sterile distilled water

dE*ab : Total value of tooth colour intensity

N : Number of samples

The results obtained from the four treatment groups were the group soaked with 100% star fruit juice (Averrhoa Bilimbi Linn), 100% tomato fruit juice (Lucopersicon esculentum Mill), 10% carbamide peroxide gel and sterile distilled water. The following results are shown in the tables :

Table 2. Data Normality Test

Group		N	*p-value*
Star fruit juice	Before	6	0,983
	After	6	0,683
Sterile distilled water	Before	6	0,617
	After	6	0,097
Sarbamide peroxide	Before	6	0,149
	After	6	0,454
Tomato fruit juice	Before	6	0,399
	After	6	0,568

Based on the results of the data normality test, the p value in all groups is greater than $\alpha = 0.05$, so it was concluded that the data in all groups are normal distribution. After the normality prerequisite test is fulfilled, the paired sample t-test can then be carried out. This test is conducted to determine the difference in results before and after treatment.

Table 3. The difference in results of before and after treatment

Group	Difference Mean	t-count	*p-value*
Star fruit juice	0,445	63,766	0,000
Sterile distilled water	0,126	34,928	0,000
Carbamide peroxide	0,734	142,992	0,000
Tomato fruit juice	0,257	27,296	0,000

Based on the results of the t-test data in the table above, the p-value price is smaller than 0.05. This means that there is a significant difference in the average results before and after treatment. After all prerequisite tests are fulfilled, then the anova test can be carried out. This test was conducted to determine the difference in posttest averages in each treatment group.

Table 4. The difference in posttest averages in each treatment group

Group	Mean	*p-value*
P_1	0,517	0,000
P_2	0,849	
P_3	0,226	
P_4	0,714	

Description: P1 = star fruit juice group; P2 = sterile aquadest group; P3 = carbamide peroxide group; P4 = tomato fruit juice group

Based on the table above, it was known that the treatment group that has the highest mean was group P2. Meanwhile, the p-value is 0.000, greater than 0.05. This means that H0 is rejected or there is a significant difference in the average posttest in each treatment group. Furthermore, the LSD further test was carried out to determine the differences in each group.

Table 5. The LSD further test

Group	Difference Mean	p-value	Difference
P_1 with P_2	-0,333	0,000	Significant
P_1 with P_3	0,291	0,000	Significant
P_1 with P_4	-0,198	0,000	Significant
P_2 with P_3	0,623	0,000	Significant
P_2 with P_4	0,135	0,000	Significant
P_3 with P_4	-0,488	0,000	Significant

Description: P1 = star fruit juice group; P2 = sterile aquadest group; P3 = carbamide peroxide group; P4 = tomato fruit juice group

Based on the table above, each group has a difference in the average posttest. The mean difference, 100% star fruit juice (Averrhoa Bilimbi Linn) has a lower value than 100% tomato fruit juice (Lucopersicon esculentum Mill) after 10% carbamide peroxide gel which was a positive control. So it can be concluded that the effectiveness of 100% Star Fruit Juice (Averrhoa Bilimbi Linn) was higher than 100% tomato fruit juice (Lucopersicon esculentum Mill) but not higher than 10% Carbamide Peroxide Gel.

The results in this study showed that the dE*ab value on teeth after soaking with 100% star fruit juice (Averrhoa Bilimbi Linn), 100% tomato fruit juice

(Lucopersicon esculentum Mill), 10% carbamide peroxide gel and sterile distilled water tended to be lower than before treatment, This was in accordance with research conducted by Aschheim & Dale (2001), a low tooth color value (dE*ab) indicates that the pigment in the tooth was absorbed more and more so that the tooth specimen will become whiter. The results of the Shapiro Wilk normality test show that all variables were normally distributed because they have a significance value greater than 0.05.

Furthermore, the Paired T- test significance (p-value) obtained is 0.000 which was smaller than 0.05 , which means there were significant differences in all treatment groups consisting of 100% star fruit juice (Averrhoa Bilimbi Linn), 100% tomato fruit juice (Lucopersicon esculentum Mill), 10% carbamide peroxide gel and sterile distilled water. So, it can be said that the four variables have the ability to whiten teeth.

This is in accordance with research conducted by Silvana (2020). 100% star fruit juice (Averrhoa Bilimbi Linn) was proven effective in teeth whitening because it contains citric acid, malic acid, oxalic acid, acetic acid, formic acid, saponin, niacin, tannin, and carboxylic acid. The content of carboxylic acid in this fruit has the ability to whiten teeth by oxidizing the surface of tooth enamel so that it becomes neutral and causes a whitening effect on teeth. Carboxylic compounds are found in the form of oxalic acid, so it was suspected that star fruit can also be utilized as a tooth whitening agent. Carboxylic compounds were believed to have the same properties as peroxide.

This was also supported by research conducted by basis (2020) which says the saponin content in star fruit can function as a tooth cleaner and brightener. Saponins were the highest contained in star fruit, which was as much as 3.582. Saponins are glucosides with foaming characteristics that can act as a cleanser. Saponins consist of polycylic aglycones and are bound to one or more sugar chains, so the saponins contained in star fruit can function as a cleanser and brighten teeth. Calcium and phosphorus in star fruit also play an important role in the process of tooth remineralization. The lactic acid content in star fruit has the ability to bind calcium ions and provide a buffer in an acidic atmosphere so that the remineralization process can occur.

In addition, there are also peroxide compounds in star fruit (Averrhoa Bilimbi Linn), peroxide compounds found in belimbing wuluh in the form of hydrogen peroxide which can whiten teeth that were discolored. This research was also supported by Lumuhu's research (2016) which states that the content of hydrogen peroxide was proven effective in whitening discolored teeth. Hydrogen peroxide was capable of undergoing many reactions including molecular addition, substitution, oxidation and reduction. Various chemical reactions result in changes in the absorption energy of large molecules that change color in enamel and dentin, so this will result in tooth discoloration. His is supported by the statement of Kelleher (2008), which states that large molecules were broken down into smaller molecules which results in the loss of stains on the teeth.

Tomato fruit juice (Lucopersicon esculentum Mill) has hydrogen peroxide content that can whiten teeth and has been proven to have efficacy in whitening teeth. The peroxide content in tomatoes can also increase the speed of hydrogen peroxide in reducing color. So that the content of hydrogen peroxide and peroxidase in tomatoes can be used as an alternative ingredient for teeth whitening. Tomatoes are fruits that have quite complete contents such as β carotene, provitamin A carotenoids, and ascorbic acid. Ascorbic acid (vitamin C) is a substance that effectively contains superoxide, hydrogen peroxide, singlet oxygen and other free radicals.

The content of hydrogen peroxide in tomatoes is an effective compound for whitening teeth by diffusing through the enamel to get to the dentin tubules. Hydrogen peroxide is able to damage dye molecules so that it can provide a whitening effect on teeth 11. The peroxidase content in tomatoes can also increase the speed of hydrogen peroxide in reducing color. So that the content of hydrogen peroxide and peroxidase in tomatoes can be used as an alternative ingredient for teeth whitening. Tomato fruit extract contains hydrogen peroxide which can whiten teeth and has been proven to have teeth whitening properties [12].

Carbamide peroxide is a tooth whitening agent that is usually used in home bleaching procedures. In this study, 10% carbamide peroxide gel was used. According to Januarizqi et al (2017) 10% carbamide peroxide contains 3.6% hydrogen peroxide content and 6.4% urea, the American Dental Association (ADA)

statement says that the composition of this content has been proven safe and effective for use outside the dental clinic. As a teeth whitener, the use of carbamide peroxide gel still ranks the highest in terms of effectiveness. This statement is supported by the dE*ab value in this study which shows that 10% carbamide peroxide has the lowest dE*ab value, indicating that carbamide peroxide gel is the variable that has the most effective role in teeth whitening.

However, there are side effects that can be caused by the use of carbamide peroxide gel, such as irritation of the gingiva and increased tooth sensitivity (Januarizqi et al, 2017). This risk is very small but of course there is no guarantee that everyone will be free from this risk, consideration is needed regarding the dose or concentration in each teeth whitening treatment. Therefore, there is no reason to be concerned about the use of 10% carbamide peroxide gel in the concentration used for home bleaching procedures.

Sterile distilled water is water that has gone through a distillation process that is free from impurities so it is often used as a solvent because of its better quality than all liquids commonly used in medicine. In this study, the sterile distilled water variable was less effective in whitening teeth. According to Khotimah (2018) Sterile distilled water is pure, this is because distilled water has gone through the distillation stage so that it can be used for laboratory and health care purposes. However, researchers found that sterile distilled water was able to make teeth whiter with very little potential compared to other variables.

This is because sterile distilled water has a solubility level caused by the tendency of distilled water molecules to form hydrogen bonds with the hydroxyl groups of sugar and alcohol so that it can dissolve the stains caused by the coffee solution that is still attached to the tooth sample. So that researchers get spectrophotometer results with dE*ab results before and after treatment that are less significant than other variables. Researchers saw directly that sterile distilled water was almost invisible due to its very small potential and neutral nature.

In this study, it was found that 100% star fruit juice (Averrhoa Bilimbi Linn) and 100% tomato fruit juice (Lucopersicon esculentum Mill) can be used as alternative materials to brighten teeth but are not more effective than 10% carbamide peroxide gel. The difference between star fruit juice (Averrhoa Bilimbi

Linn) and tomato fruit juice (Lucopersicon esculentum Mill) as natural ingredients in this study depend in the compounds contained in each fruit, this results caused differences in ability and effectiveness in whitening teeth. The dE*ab value in this study also shows that the dE*ab value of star fruit juice (Averrhoa Bilimbi Linn) has a lower value than tomato fruit juice (Lucopersicon esculentum Mill) so this supports the statement that star fruit juice (Averrhoa Bilimbi Linn) was more effective to brightening teeth compared to tomato fruit juice (Lucopersicon esculentum Mill).

CONCLUSION

The conclusion of this study that 100% star fruit juice (Averrhoa Bilimbi Linn) was more effective than 100% tomato fruit juice (Lucopersicon esculentum Mill) as a teeth whitening agent, but not more effective compared to 10% carbamide peroxide gel.

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