

Teeth re-whitening effect of strawberry juice on coffee stained teeth

Anissya Pramesti*, Tadeus Arufan Jasrin*, Opik Taofik Hidayat**

***Department of Oral Biology Faculty of Dentistry Universitas Padjadjaran**

****Department of Conservative Dentistry Faculty of Dentistry Universitas Padjadjaran**

ABSTRACT

Many people favor coffee. However, regarding health and aesthetic dentistry, coffee gives a negative effect. Tanin in coffee causes a brown stain on the tooth surface. Therefore, in aesthetic dental care, teeth whitening has become popular matter. One of the natural ingredients used for teeth whitening treatment is strawberry. The purpose of this study was to obtain data regarding the effect of strawberry juice on the re-whitening process of the coffee-stained tooth enamel surface. This study was a pure experimental in-vitro using Friedman and Wilcoxon Matched Pairs Tests for statistical analysis. The population of this study was anterior teeth. The samples were maxillary central incisors. The sampling technique using sample size determination based on the testing formulas of the difference of two average data pairs resulted in 11 specimens. The result of the research showed that all coffee-stained teeth sample had an increasing enamel colour index. The samples were then applied with strawberry juice resulted in a significant average difference colour index value indicated by $p < 0.001$. The conclusion of this research indicated that there was an effect of strawberry juice on the coffee-stained teeth re-whitening process.

Keywords: Strawberry juice, coffee stained, teeth whitening.

INTRODUCTION

Coffee is one of the most popular beverages for many people. Coffee has become a very lucrative business. Coffee is a type of beverage derived from the processing and extraction of the coffee beans contains high concentration of caffeine.¹ Caffeine is a compound resulted from the alkaloid secondary group metabolism of the coffee plant.² The role of caffeine inside the body system is to increase the psychomotor function thus makes the body stay awake and provide physiological effects by energy increased,³

reduce the risk of cancer, diabetes, gallstones, and cardiovascular disease.⁴ However, regarding aesthetical aspect in dentistry, coffee gives a negative effect. The tannin deposits present in coffee cause brown staining on the buccal, lingual, labial, and palatal surfaces of teeth.⁵ This condition will affect individual appearances and may decrease confidence.

Nowadays, the general population chooses modern dentistry to improve facial aesthetics, health, and social success.⁶ Techniques and materials available for dentists have also developed rapidly. This fact supports a better and more

conservative restoration. Much attention has been devoted towards aesthetical dentistry aspects and individual attention on physical appearances.⁷

The white tooth color associated with healthiness, young age, and strength. A recent survey of American women showed that 55% of women aged 34-55 years old would undergo the teeth whitening or orthodontic treatment to create a younger appearance.⁸ One development of aesthetic dentistry was the teeth whitening.⁹

Many manufacturers produce teeth whitening products. However, these products containing chemical compounds and often used publicly without any supervision from the dentist. On the other hand, much information regarding non-synthetic materials that have the potential for teeth whitening. One of them is strawberries.¹⁰

Strawberries belong to the herbaceous fruit plants and belong to the family of Rosaceae. Strawberries (*Fragaria* sp.) Is one of many fruits consumed due to its rosy red color, sweet and sour taste, and various benefits. This fact is based on the growing number of people consuming strawberries in both fresh and processed conditions.¹¹ Strawberries have various benefits, including the ability to prevent coronary heart disease and controlling high blood pressure. Strawberry is also useful in assisting the absorption of iron from vegetables consumed. Strawberry contains only a small amount of sugar, so it is appropriate to be consumed by people with diabetes. Also, strawberries can be used to make a more beautiful and healthy skin and improving brain power and vision.¹² Based on these properties, we are interested in researching the effectivity of

strawberry juice as the bleaching agent for the coffee stained tooth enamel surface.

METHODS

This research was a purely experimental in-vitro. The population of this study was anterior teeth. The sample of this study was maxillary central incisors. The inclusion criteria were extracted permanent human teeth without abnormalities and caries-free. Independent variable in this study was the strawberry juice application, and the dependent variable was the tooth color index.

Data obtained from the results of the color change measurements then analyzed statistically using the Friedman and Wilcoxon matched pairs signed-rank test.¹³ The data used was the data score, then the Wilcoxon test was used to determine differences between observation groups.¹³ The Friedman Test was used to compare the average difference in more than two groups of paired data.

RESULTS

The research conducted on the effects of strawberry juice as the bleaching agent of coffee stained tooth enamel surface was performed towards as much as 11 anterior mandibular central incisor specimens. The study was conducted through three stages of the working procedure such as follows: specimen control; coffee staining or discolouring of specimens; and application of strawberry juice towards the specimens. For the

Table 1. Comparison of tooth enamel surface colour index from each treatment

No.	Procedure	Mean	Standard Deviation	Median	Range
1	Original Color	6.36	3.139	6	3 - 10
2	Discoloration by coffee	8.91	3.448	6	6 - 13
3	Strawberry juice application Day 1-1	6.09	3.3	6	3 - 10
4	Strawberry juice application Day 1-2	4.64	1.567	6	3 - 6
5	Strawberry juice application Day 2-1	3.91	1.758	3	1 - 6
6	Strawberry juice application Day 2-2	2.15	0.934	3	1 - 3
7	Strawberry juice application Day 3-1	2.45	0.934	3	1 - 3
8	Strawberry juice application Day 3-2	2.09	1.044	3	1 - 3
9	Strawberry juice application Day 4-1	2.09	1.044	3	1 - 3
10	Strawberry juice application Day 4-2	2.09	1.044	3	1 - 3

Notes : X^2 (Friedman) = 86.377; $p < 0.001$

control specimens, the procedure was performed by immersing the eleven specimens in artificial saliva for 24 hours, then the discolouration procedure was performed by immersing the specimen in the coffee solution for 48 hours. For the treatment specimens, the procedure was performed by applying the strawberry juice towards the specimens for 4 days. Both procedures were performed twice daily. The study was conducted by observing discolouration of the tooth enamel on the labial surface

each day, which assessed using a shade guide.

The results from the comparison test of the tooth enamel surface color index and its original color, after discolouring process and after applied with strawberry juice, were presented in Table 1. From the collected data, the average statistical measure, standard deviation, and the median value were calculated. The Wilcoxon Matched-Pairs Signed Test was used to determine the differences between the observations, and the results were presented in Table 2.

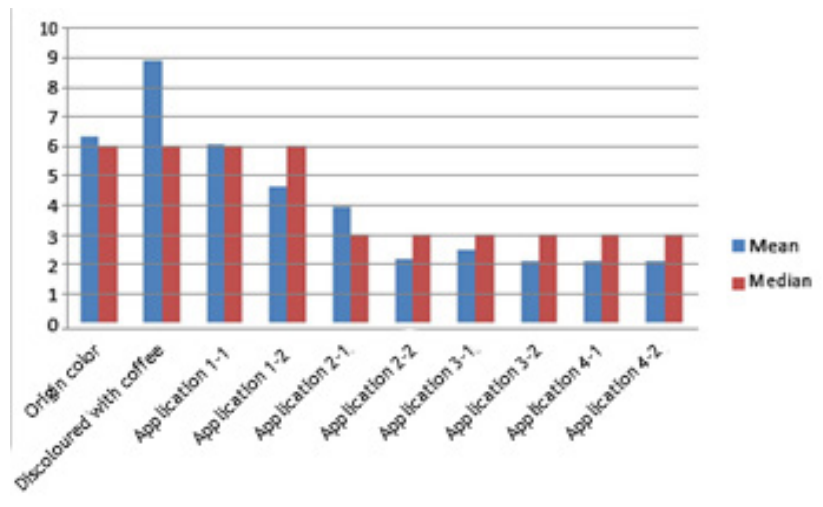


Figure 1. Average of tooth enamel surface colour index decrease in all specimens

Tabel 2. Comparison of the colour index between all specimens after application

No	Inter Group Comparison	Z (Mann-Whitney)	P-value
1	Original colour with Coffee-stained	2.007	0.004
2	Original colour with Strawberry juice application 1-1	0.272	0.785
3	Original colour with Strawberry juice application 1-2	2.121	0.034
4	Coffee-stained with Strawberry juice application 1-1	2.007	0.004
5	Coffee-stained with Strawberry juice application 1-2	2.059	0.004
6	Strawberry juice application 1-1 with Strawberry juice application 1-2	2.00	0.046
7	Strawberry juice application 1-2 with Strawberry juice application 2-1	0.046	0.102
8	Strawberry juice application 1-2 with Strawberry juice application 2-2	1.633	0.006
9	Strawberry juice application 2-1 with Strawberry juice application 2-2	2.762	0.023
10	Strawberry juice application 2-1 with Strawberry juice application 3-1	2.271	0.023
11	Strawberry juice application 2-2 with Strawberry juice application 3-1	2.271	1.0
12	Strawberry juice application 2-2 with Strawberry juice application 3-2	0	0.157
13	Strawberry juice application 2-2 with Strawberry juice application 4-1	1.414	0.157
14	Strawberry juice application 2-2 with Strawberry juice application 4-2	1.414	0.157
15	Strawberry juice application 3-1 with Strawberry juice application 3-2	1.414	0.157
16	Strawberry juice application 3-1 with Strawberry juice application 4-1	1.414	0.157
17	Strawberry juice application 3-2 with Strawberry juice application 4-1	1.414	1.0
18	Strawberry juice application 4-1 with Strawberry juice application 4-2	0	1.0

Notes: significant in $p < 0.05$; very significant in $p < 0.001$



Figure 2. Decrease in colour index score after application

Based on Table 1 and Figure 1 can be seen that from the total of 11 specimens that have been discolored by the coffee solution, there was an increase in the tooth enamel surface color index. For the result in the treatment group, from the total specimen that has been discolored by the coffee solution, there was a decrease in the average of the colour index value after being applied with strawberry juice. However, a decrease in the colour index values was only up to the third day of treatment and did not change significantly on the fourth day of treatment and after.

Furthermore, based on the Friedman's Chi-Square test results obtained the $X^2=71.113$, $p<0.001$. These data indicated that the comparison of the average difference between more than two specimen groups was very significant. Thus seen that the treatment was effectively decreasing the average color index level for all the study samples.

According to Table 2, the comparison between the initial object group and the group being discolored with coffee solution showed a significant difference ($p<0.05$). Comparison between coffee-stained specimen groups with the group already being applied with strawberry juice also showed significant differences on the first day of treatment. Furthermore, a significant difference was also observed in the comparison between the group of strawberry juice application on the first day with the group of second-day strawberry application.

DISCUSSION

From the results of this study can be inferred that strawberry juice was able to act as the bleaching agent for the coffee-stained tooth enamel surfaces. Discolouration of the tooth enamel surfaces is evident of increasing colour

index value after immersed in the coffee solution. By the statement of Kerr⁵ that the tannin deposits presence in coffee causes brown staining on the buccal, lingual, labial, and palatal surfaces of the teeth. Coffee-stained tooth enamel surfaces discolouration is an exogenous color change. This is consistent with the statement of Osborn and Ten Cate¹⁴ which suggested that tooth enamel has an ultramicroscopic slit and has semipermeable properties that can absorb the color from the outside like some food and beverage colouring (coffee, tea, soft drinks, etc.).

The tooth-whitening effect of fruit juice can be characterized by the results of this study which show the average tooth enamel surface color index from all specimens were decreasing significantly after immersed in strawberry juice. This result was consistent with Williams's¹⁵ statement which suggested that example of the natural tooth-whitening procedure was performed by consuming some fruit that has the ability to whiten teeth. Goldstein and Garber¹⁶ suggested that teeth-whitening occurred by the strong oxidizing properties of the bleaching agent. This oxidizing agent has free radicals with unpaired electrons thus make the bleached substance received the electron and oxidized.

Research conducted by Ayub¹⁷ stated that strawberries contain various vitamins and minerals, and also ellagic acid. Strawberries had an acid pH degree, ranged from 3-4. Ellagic acid is built by many OH clusters, according to Gunawan's¹⁸ research stated that the OH cluster formed the ellagic acid structure has the potential of becoming a strong oxidizing agent as well as hydrogen peroxide as the tooth-whitener.

The results of this study were consistent with the research conducted by Carrel¹⁹ suggested that strawberries consumption can help removing

tooth discolouration caused by wine, soda, and coffee. The natural ingredients tooth-whitening effect takes place when consumed in the proper time, concentration, and period.

More research on the use of strawberry juice for teeth whitening is still needed. Consumption of strawberry juice provides a bleaching effect due to its acidic properties, working as a strong oxidizing agent on the enamel surface of the tooth. Thus the side effects caused by the acidic property of the strawberries can be minimized and safer to use in the future.

According to Winston and Bhaskar,²⁰ if an acidic material with the pH value less than equal to the critical value met the enamel surface, it will decrease the enamel surface pH value, then shed the phosphate (PO₄³⁻) and calcium (Ca²⁺) from the enamel surface. The acidity decrease on the enamel surface caused by an acidic material, such as fruit juice, resulted in unsaturation of important ions, PO₄³⁻ and Ca²⁺, which are minerals of the tooth. This condition leads to enamel dissolution.

In this study, when the tooth enamel surface was applied with an acidic material under the critical pH value of the enamel repeatedly, the enamel surface pH value was decreasing into the lower value, thus made the mineral dissolution continue. The same result also found in Larsen's²¹ research suggested that saturated properties of calcium and phosphate at the low pH value prevent remineralization. As the pH value increases again, remineralization will begin. The saturated nature of saliva was expected to stimulate the process of hydroxyapatite remineralization on the tooth enamel surface. Saliva protein compounds also play a role in maintaining this balance.

The use of artificial saliva in in-vitro studies simulates similar chemical conditions in the oral cavity. This treatment was consistent with the study conducted by Leung and Darvell²² suggested that the development of artificial saliva was essential for more valid and controlled experiment as the standardization of the object's concentration for application.

CONCLUSION

The conclusion of this research indicated that there was an effect of strawberry juice on

the coffee-stained teeth re-whitening process.

REFERENCES

1. Merriam-Webster [homepage on internet]. Springfield: Merriam-Webster, Inc.; c1828-2012 [cited 2011 Dec]. Available from: <https://www.merriam-webster.com/dictionary/coffee>
2. Indonesian Nutrition Network [homepage on internet]. Jakarta: Siswono. 2007. Kafein. [cited 2011 Dec]; [about 2 screens]. Available from: <http://gizi.depkes.go.id/arsip/arc10-2007.html>
3. Wildman REC. Handbook of Nutraceuticals and Functional Food. 2nd ed. Boca Raton: CRC Press; 2007. p. 453-62.
4. Ranheim, T and B. Halvorsen. 2005. Coffee consumption and human health. *Mol Nutr Food Research* 49 vol 3: 274-284.
5. Medscape [homepage on internet]. New York: Patel DN, Kerr AR, Butler DF, Eisen D, Elston DM, Belsito D. 2008. Tooth Discoloration. [cited 2012 Jan]; [about 3 screens]. Available from: <https://emedicine.medscape.com/article/1076389-overview>
6. Goldstein RE. Change Your Smile: Discover How a New Smile Can Transform Your Life. 4th ed. Chicago: Quintessence Publishing Co. Inc.; 2009.
7. McLaughlin G, Freedman GA. Color Atlas of Tooth Whitening. St. Louis: Ishiyaku Euroamerica Inc.; 1991.
8. Engelhardt-Nash D. Power bleaching. In: Freedman G. Contemporary Esthetic Dentistry. 1st ed. St. Louis: Mosby-Elsevier; 2012.
9. Abbott FB, Abbott N, Aschheim KW. A Clinical Approach to Technique and Material Esthetic Dentistry. 1st ed. St. Louis: Mosby-Elsevier; 1993.
10. Care2 Healthy Living [homepage on internet]. Redwood City: Johnson C. 2011. Beauty with Strawberries. [cited 2011 Nov]; [about 2 screens]. Available from: <https://www.care2.com/greenliving/strawberries-kitchen-cupboard-beauty.html>
11. Rukmana R. Stroberi Budidaya dan Pasca Panen. Yogyakarta: Kanisius; 1998.
12. Budiman S, Saraswati D. Berkebun Stroberi

- Secara Komersial. Jakarta: Penebar Swadaya; 2008. p. 12-25.
13. Sugiyono. Metode Penelitian Kuantitatif, Kualitatif dan R&D. Bandung: Alfabeta; 2009.
 14. Gaunt WA, Osborn JW, Ten Cate ARL, Mass JW. Advanced Dental Histology, 4th ed. Oxford: Butterworth-Heinemann Ltd.; 1983.
 15. Web MD [homepage on internet]. New York: Williams R. 2009. Dental Health and Tooth Discoloration. [cited 2011 Jan]; [about 10 screens]. Available from: <https://www.webmd.com/oral-health/guide/tooth-discoloration>
 16. Goldstein RE, Garber DA. Complete Dental Bleaching. 1st ed. Chicago: Quintessence Publishing Co. Inc.; 1995.
 17. Ayub M, Ullah J, Muhammad A, Zeb A. Evaluation of strawberry juice preserved with chemical preservatives at refrigeration temperature international. *Int J Nutr Metab.* 2010 Feb;2(2):27-32.
 18. Gunawan LW. Stroberi. Jakarta: Penebar Swadaya; 2003.
 19. Live Strong [homepage on internet]. Santa Monica: Carrel A. 2008. Home Remedies for Getting Visibly Whiter Teeth Overnight. [cited 2011 Aug]; [about 2 screens]. Available from: <https://www.livestrong.com/article/124775-home-remedies-getting-visibly-whiter/>
 20. Winston AE, Bhaskar SN. Caries prevention in the 21st century. *J Am Dent Assoc.* 1998 Nov;129(11):1579-87.
 21. Larsen MJ, Pearce EI. Saturation of human saliva with respect to calcium salts. *Arch Oral Biol.* 2003 Apr;48(4):317-22.
 22. Leung VW, Darvell BW. Artificial salivas for in vitro studies of dental materials. *J Dent.* 1997 Nov;25(6):475-84.