Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 5, 2021, Pages. 1028 - 1037
Received 15 April 2021; Accepted 05 May 2021.

The Bleaching Potential of Curcumin and Strawberries (Home Remedies) Versus Carbamide Peroxide (Conventional Home Bleaching Modality) (An In Vitro Study)

Noran Ezzat Abd El-Aziz Mahmoud Mofreh [1], Manal Moustafa EL-Assaly [2], Maha Hassan Bashir [3], Marwa Magdy Saad Abbass [4]

[1] PhD, Oral Biology Department, Faculty of Dentistry, Cairo University, Egypt
Mailing address: dr_noranmofreh@hotmail.com
Telephone number: +201069021521
ORCID ID: 0000-0001-5656-7899
[2]Prof. of Oral Biology Department, Faculty of Dentistry, Cairo University, Egypt
Mailing address: Drmanal.assaly@gmail.com
Telephone number: +201025914000
ORCID ID: 0000-0002-5471-5285
[3]Prof and Head of Oral Biology Department, Faculty of Dentistry, Cairo University, Egypt
Mailing address: Maha.bashir@dentistry.cu.edu.eg
Telephone number: +201005176634
ORCID ID: 0000-0002-7833-695X
[4]Assoc. Prof. of Oral Biology Department, Faculty of Dentistry, Cairo University, Egypt
Mailing address: Marwa.magdy@dentistry.cu.edu.eg
Telephone number: +201119443811
ORCID ID: 0000-0002-6455-7516

Abstract

Objective This study aims to evaluate the bleaching potential of curcumin and strawberries used as home remedies as compared to the conventional carbamide peroxide gel. **Methodology** Twenty-seven extracted sound human third molars stained by Nescafé solution were randomly divided into three equal groups (A, B and C) according to the applied material (20% carbamide peroxide, do-it-yourself (DIY) strawberry paste and curcumin respectively). Scanning electron microscope (SEM), Color change (ΔE), surface roughness (SR), surface micro-hardness (SMH) were used to assess the samples. Measurements were recorded at baseline, after Nescafé immersion and after treatment application. The normality of data was checked with the Shapiro-Wilk test. Comparisons among the three groups were done by using the analysis of variance (ANOVA) test. A p-value less than or equal to 0.05 was deemed statistically significant. **Results** SEM showed evident alterations in group A while group C was the least affected**.** Color changes revealed significant differences among the three treatment groups (P=0.011), with the highest ΔE in group A and the lowest in group C. SR and SMH analyses revealed significant differences among the three treatment groups (P=0.0001) (P=0.027) respectively, with the highest SR in group A and the highest SMH in group C. **Conclusions** Both strawberry and curcumin were shown to have a bleaching effect.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 5, 2021, Pages. 1028 - 1037
Received 15 April 2021; Accepted 05 May 2021.

The bleaching effect of strawberry was stronger than curcumin though weaker than the conventional carbamide peroxide

Keywords: Teeth Bleaching, Peroxides, color change, Home Remedies

Introduction

Recently in the dental field, aesthetics has become a major concern. Changes in the smile have unexpected effects on an individual's self-esteem, especially in a society that puts too much focus on physical appearance. Tooth bleaching is considered one of the most sought-after treatments for patients who want an appealing smile[1].

Multiple products and approaches for dental bleaching already flooded the market; whose main component is hydrogen peroxide or its precursor carbamide peroxide. To achieve the desired results, hydrogen and carbamide peroxides have been used at varying concentrations ranging from 10% to 40%[2]. Although peroxide agents produce outstanding results, the associated clinical adverse effects seem unavoidable. Alterations of surface topography, micro-hardness, the composition of dental hard tissues, gingival irritation, dentin sensitivity and root resorption were recorded after the implementation of peroxide bleaching[3]. Hence, a growing concern aroused toward using home-made natural recipes as safe and natural alternative whiteners[4].

Curcumin is considered a non-toxic, safe and effective alternative for many traditional drugs owing to its distinct medicinal properties. Curcumin as well plays a significant role in dentistry[5]. The suggested use of curcumin as a teeth whitener is based entirely on the personal experiences available online without any objective evidence. Strawberries are herbaceous fruits that are usually consumed due to their numerous health benefits.

Strawberry also contains pectin (natural fiber) which helps self-cleaning of the teeth.[6] Few data on the whitening ability of strawberries have been reported in the literature. According to Kwon et al[7] .these data are based on the malic acid contents of strawberries. Therefore, it is important to provide a scientific database for the effect of these two widely used whitening home remedies; curcumin and strawberries, as compared to the conventional, most used bleaching modality; carbamide peroxide on the enamel surface.

The present study was conducted to evaluate the efficacy of curcumin and strawberries as bleaching agents on the color change, surface roughness, surface topography, micro-hardness and mineral content of human extracted teeth enamel. Furthermore, the resultant effects were compared with that achieved by the conventional carbamide peroxide home bleaching gel.

Materials and Methods

Ethical statement

The experiment was done according to the recommendations and approval of the Ethics Committee of the Faculty of Dentistry, Cairo University for working on extracted human teeth (approval no. 161039). Mandibular third molars were surgically extracted after obtaining patients' written consent.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 5, 2021, Pages. 1028 - 1037
Received 15 April 2021; Accepted 05 May 2021.

Sample selection and preparation

The enamel surface of all teeth was thoroughly rinsed and examined under a stereomicroscope (Leica S8 APO, Leica Microsystems, Switzerland). Specimens that showed defects (caries, cracks and hypoplasia) were excluded.

Samples were disinfected in 5.25% sodium hypochlorite solution for 1 hour and stored in distilled water until usage and during the experiment.

The roots of the 27 teeth were separated from crowns at the cemento-enamel junction using a diamond stone (Komet, Rock Hill, USA, K6974) in low-speed underwater cooling, then they were embedded separately in self-cured acrylic resin (Acrostone Co. Cairo, Egypt, 01CCP50) blocks with the buccal enamel surface exposed.

Twelve out of 27 specimens were randomly selected for micro-hardness assessment. Their enamel surfaces were ground flat with 600 grit diamond paper discs. All specimens were polished with prophy polishing paste[8].

Experimental procedures

Samples were randomly divided into 3 equal groups (n=9); Opalescence® (group A), 20% carbamide peroxide, applied for 6 hours daily for 14 consecutive days/ month for 2 months duration, DIY group (group B). The recipe was applied using a puree of strawberry (7.5 gm) mixed with baking soda (1.25 gm) for 5 minutes followed by brushing with an electric toothbrush (Oral-B Vitality pro-white, USA) for 30 seconds. The procedure was repeated 12 times, five-day intervals for 2 months and curcumin group (group C); Specimens of this group were rubbed with 3 gm of curcumin powder following the same protocol for the application of the DIY recipe.

All enamel samples were initially assessed for color changes, surface roughness, mineral content, changes in surface topography and surface micro-hardness. Samples were then immersed in 200 ml of a newly prepared Nescafé solution (Nescafé – Nestlé, Brazil) with a concentration of 25% (weight per volume), kept at 37ºC for 14 days, the solution was shaken daily and changed after seven days[9]. Samples were then re-assessed after Nescafé staining (pre-treatment assessment) for the same parameters as the baseline. Afterward, enamel samples within each group received their assigned treatment:

Scanning electron microscope (SEM) examination

One specimen from each group was mounted on the SEM plate with electro-conductor glue to examine their surfaces at a magnification of (M) = 4000x. The used SEM model was (JXA-840 Electron Probe Micro-analyzer, JEDL, Japan).

Energy Dispersive X-ray Analysis (EDX)

EDX spot measurement, EDX line scan and element mapping determined the quantitative composition of calcium and phosphorus in the studied samples. The EDX analysis unit works as an integrated feature of the SEM.

Color measurement

Color changes of 4 specimens from each group were measured using a Reflective spectrophotometer (Model RM200QC, X-Rite, Neu-Isenburg, Germany). The aperture size was set to 4 mm and the specimens were exactly aligned with the device. A white background was selected, and measurements were made according to the CIE L*a*b* color space relative to the CIE standard illuminant D65. ΔE of the specimens were evaluated using the following formula:

$\Delta ECIELAB = (\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2})$ ½

Where; L* = lightness (0-100), a* = (change the color of axis red/green) and b* = (color variation of axis yellow/blue)[10].

Surface roughness (SR) analysis

The same 4 specimens used to detect color changes were used to measure SR using a digital microscope equipped with a built-in camera (Scope Capture Digital Microscope, U500X Guangdong, China). The microscope was connected to IBM compatible computer. WSxM software (Version 5 develop 4.1, Nanotech, Electronica, SL) was used to analyze the photos and to create a 3D image of the specimen surface. The average SR was estimated using WSxM software and expressed in µm.

Surface microhardness (SMH) analysis

SMH of four specimens from each group was measured using a digital display microhardness tester with Vickers diamond indenter in the middle third of the buccal surface (Vickers diamond, 200 g, 20s, Model HVS-50, Laizhou Huayin Testing Instrument Co., Ltd. China).

Statistics

IBM SPSS advanced statistics (statistical Package for social sciences, version 21, SPSS Inc., Chicago, IL, USA) processed the data. Data were defined as mean and standard deviation. The normality of data was checked with the Shapiro-Wilk test. Comparisons among 3 groups were done by using analysis of variance (ANOVA) test. A p-value less than or equal 0.05 was deemed statistically significant.

Results

1- SEM examination

Sound enamel has a smooth surface with the aprismatic surface layer. A few rod ends, surface scratches and pores were also noticed (figures 1A, 1B & 1C). After Nescafé immersion, surface etching was seen (figures 2A, 2B & 2C). After treatment application, group A (figure 3A) revealed some surface alterations. Evident perikymata and uniform areas of rod-less enamel were noticed in-between the perikymata. Small concave depressions representing the rod ends along the lines of perikymata were also seen. While group B (figure 3B) showed dissolution. A polished surface with the removal of the aprismatic enamel was evident. Small concave depressions of varying sizes and depths expressing the rod ends were noted. Group C (figure 3C) showed minute changes, nearly the same surface anatomy as compared to after- Nescafé immersion. Aprismatic enamel areas, obliterated rod ends as well as surface scratches and some pores were found.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 5, 2021, Pages. 1028 - 1037
Received 15 April 2021; Accepted 05 May 2021.

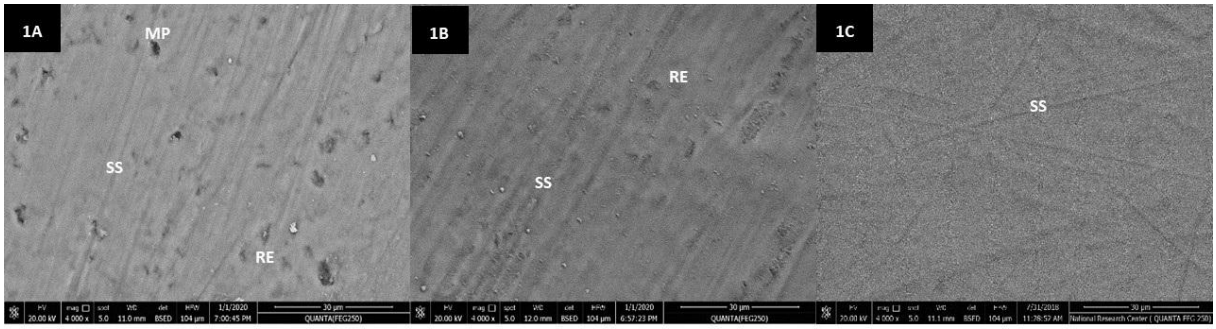

Figure 1: SEM of groups (A, B &C) respectively showing sound enamel surface with few rod ends (RE), surface scratches (SS) and micro porosities (MP) **(Orig. Mag. 4000x).**

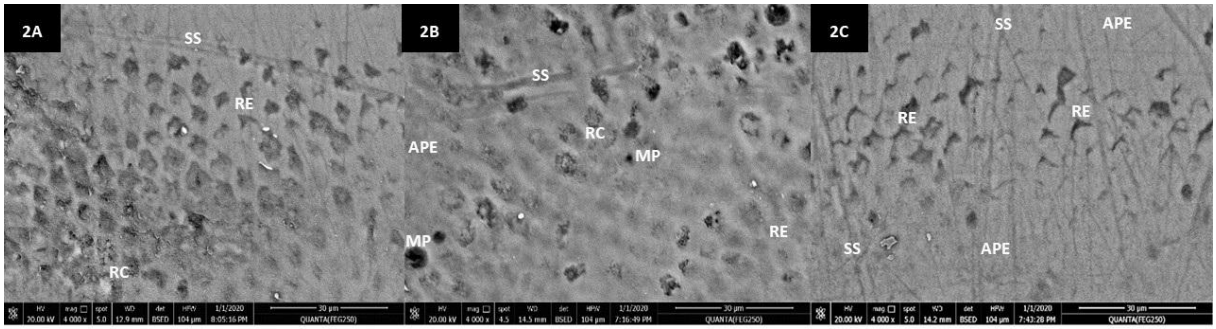

Figure 2: SEM of groups (A, B &C) respectively following staining by Nescafé solution showing surface etching in all groups, fine surface scratches (SS), Micro-porosities (MP), Rod ends (RE) and partial obliteration of the rod core (RC) with aprismatic enamel surface (APE)**(Orig. Mag. 4000x)**

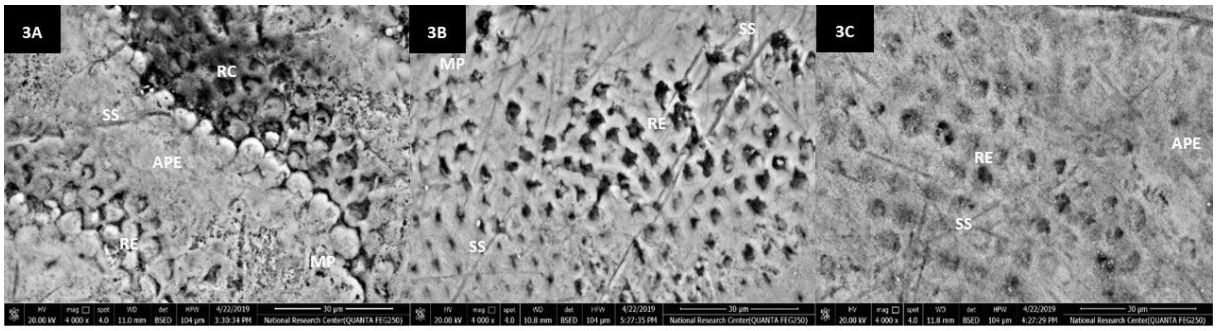

Figure 3: SEM showing surface alterations after the application of Opalescence® bleaching gel (fig 3A), Areas of aprismatic enamel (APE), with defective rod core (RC) and fine surface scratches (SS). DIY group (fig 3B) showing dissolution with polished enamel surface. After curcumin application, Group C (figure 3C) showed minute changes, nearly the same surface anatomy as compared to after- Nescafé immersion. Aprismatic enamel, obliterated rod ends (RE) as well as surface scratches (SS) were noted **(Orig. Mag. 4000x).**

2- EDX measurement

The EDX analysis after treatment application (table 1) revealed a statistically significant difference in the mean of Ca and P wt% among the three groups. The lowest mean value was recorded in group A, while the highest mean value was recorded in group C.

3- Color measurement

The Reflective Spectrophotometer results (table 1) revealed a statistically significant difference among all treatment groups. Group A recorded the highest color changes from Nescafé staining to after treatment application, while group C gave the lowest value.

4- SR analysis

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 5, 2021, Pages. 1028 - 1037
Received 15 April 2021; Accepted 05 May 2021.

The mean SR values of enamel after treatment application are presented in table 1. There was no statistically significant difference between baseline and after-Nescafé immersion within each group ($p \geq 0.05$), while there was a statistically significant increase between after-Nescafé and treatment application within each group ($P<0.05$). Furthermore, there was a statistically significant difference ($P=0.027$) after treatment application among groups A, B & C with the highest SR in group A.

5- SMH analysis

The mean SMH values of enamel after treatment application are presented in table 1. There was no statistically significant difference between baseline and after-Nescafé immersion within each group ($p \geq 0.05$), while there was a statistically significant decrease between after-Nescafé and treatment application within each group ($P<0.05$). Furthermore, there was a statistically significant difference ($P=0.027$) after treatment application among groups A, B & C with the highest SMH in group C.

Table 1: Comparison between the different parameters means after treatment application among the three groups.

P.O.C	Group A	Group B	Group C	P-value
Mean value of Ca wt %	33.04 ± 0.87^{c}	36.89 ± 1.26^{b}	40.71 ± 1.63^{a}	0.0001^{*}
Mean value of P wt %	12.95 ± 0.16^{c}	15.27 ± 0.63^{b}	16.35 ± 1.08^{a}	0.0001^{*}
Mean value of color changes from Nescafé immersion to after-treatment	17.44 ± 2.35^{a}	13.50 ± 4.66^{b}	12.63 ± 4.26^{c}	0.011^{*}
Mean value of surface roughnesses	0.5519 ± 0.0275^{a}	0.5243 ± 0.0278^{b}	0.4621 ± 0.0124^{c}	0.0001^{*}
Mean value of surface micro-hardness	268.48 ± 21.19^{c}	274.95 ± 8.23^{b}	280.29 ± 20.49^{a}	0.027^{*}

a, b, c the mean values with different small superscript letters within the same row indicate significant differences ($P \leq 0.05$). *significant level: $P<0.05$.

Discussion

The purpose of the present study was to evaluate the efficacy of two widely used home remedies (curcumin and strawberries) as bleaching agents. Up to our knowledge, this is the first study to examine the effect of these agents on the color change, surface topography, surface roughness, micro-hardness and mineral contents altogether on human enamel. Furthermore, the resultant effects were compared with that achieved by the conventional carbamide peroxide home bleaching gel.

The previous recorded morphological changes in teeth enamel following dental bleaching using SEM ranged from unchanged morphology[11], slight pitting at localized areas and some porosity of the enamel[12] to serious surface modifications[13] depending on the material used, application frequencies and concentration of the bleaching agent applied.

In the current study, the observed SEM alterations after treatment application in the three groups as compared to the baseline consisted principally of small pores and erosions. The application of the Opalescence® gel resulted in more erosive surface changes as compared to the other treatment groups, where exposure of the enamel prisms after partial removal of the rod-less layer has been observed.

The detected significant decrease in mineral content in the Opalescence® group in our study could be explained according to Ali et al[14] who concluded that dissociation of carbamide peroxide into unstable reactive free radicals could break down the stain molecules in tooth hard substance and this redox reaction may affect the inorganic content of the dental enamel.

Nevertheless, in a study carried out by Mielczarek et al who compared the surface changes –including micro-hardness and surface roughness - associated with exposure to three different bleaching systems: Opalescence® extra Boost, Opalescence® (20% carbamide peroxide) and Crest White strips Supreme®, the authors recorded no changes in the hardness nor the surface roughness of enamel with bleaching[15].

The variability between different studies regarding the effect of carbamide peroxide on the surface micro-hardness and roughness of enamel is likely due to different application methods (time and frequency) rather than the difference in concentration of peroxide. Cvikl et al. who evaluated the differences in enamel micro-hardness and surface roughness between six treatments with different concentrations and different application frequencies further supported this finding. The authors concluded that despite a similar whitening effect, gels with low peroxide concentration and longer contact time negatively affected the enamel surface [16].

Despite following the same approach in the preparation and application of the DIY recipe as Kwon et al.[17] the authors in their study found no effect for the DIY recipe on enamel surface morphology and attributed their results to the neutral pH of the whitening agents employed. Our morphological changes could be explained by the fact that the strawberries might have been inadequately smashed, resulting in a relatively acidic pH of the mix.

In the present study, the DIY group showed a significant decrease in surface micro-hardness after treatment, however, it was significantly less affected as compared to the Opalescence® group. Again, the acidic pH of the strawberry-containing gels could be the mechanism responsible for reducing the Ca and P contents and surface micro-hardness of enamel as well. It has been noticed that strawberry fruit juice has a pH of 3 due to its high content of both ellagic and malic acids. Brambert et al. showed that these acids could bind calcium in tooth enamel and cause porosity that decreases enamel surface hardness, consequently increasing enamel surface roughness, supported this explanation[18].

Our study results were concomitant with Asmawati and Rieuwpassa who carried out an in vitro study comparing enamel surface hardness after application of 10% carbamide peroxide bleach and a strawberry gel. The results showed a decline in enamel hardness following the application of 10% carbamide peroxide relative to the strawberry gel[19].

On the contrary, Kwon et al.[17] evaluated the effect of various tooth whitening modalities including a DIY recipe on micro-hardness, surface roughness and surface morphology of the enamel. They found no significant differences in Knoop hardness changes nor enamel surface roughness after the application of DIY as compared to the baseline values.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 5, 2021, Pages. 1028 - 1037
Received 15 April 2021; Accepted 05 May 2021.

The curcumin group showed minor surface changes with minimal surface loss as compared to the other two groups which were interpreted by mineral contents, micro-hardness and surface roughness results. These results could be attributed to the fact that curcumin is a polyphenolic compound with weak acidic nature, having a hydroxyl group attached to the phenol cycle in its chemical structure.

Assessment of the color changes in our investigation results coincides with Cvikl et al [16], Sulieman et al., Meireles et al. & Meireles et al.[20, 22] either compared bleached to non-bleached enamel or contrasted different peroxide concentrations. They documented the ability of different peroxide compounds to achieve significant whitening results.

Strawberries contain ellagic acid that has potential OH clusters acting as a powerful oxidizer. This was supported by Stephanie et al. who noticed that the more ellagic acid content the more OH clusters produced and the more effective is the bleaching process. The OH and H radicals produced from ellagic acid react with the organic molecules of enamel disrupting the electron conjugation and changing the absorption of energy in enamel with the formation of smaller organic molecules with a lighter color[23].

On the other hand, this finding of our study contradicts the previous work carried out by Pramesti et al. & Puspita et al. [24,25] who observed that the use of strawberry paste had the same whitening potential as chemically manufactured peroxide-containing whitening agents. The minimal duration of the strawberry application to observe a change in teeth coloration varied between studies where Pramesti et al. reported 4 days of application as a sufficient period to achieve a whitening effect while Puspita et al. reported 2 weeks duration for strawberry application. As it is obvious, data collected from different studies revealed that it is difficult to conclude the optimum duration for application of strawberry-containing materials based on these studies, due to different discoloration techniques used as well as different application frequency.

In our study, the curcumin group showed the least whitening effect among the three treatment groups. However, Abidia et al. in a recent study compared the efficacy of different bleaching products including 20% carbamide peroxide, strawberry and curcumin on tooth whitening using a spectrophotometer, the authors stated a significant whitening effect in all groups except for the curcumin group[26].

Conclusions

The overall results of the present research clearly ascertain that strawberry in the DIY recipe induced a whitening effect comparable to the conventional carbamide peroxide home whitening modality. This finding was confirmed by the spectrophotometer results. The SEM revealed that the curcumin group provided a smoother surface as compared to the other treatment groups. Moreover, regarding the mechanical properties of the whitened surfaces, the curcumin group provided an enamel surface with a statistically significant higher micro-hardness and EDX values as compared to the Opalescence® and DIY groups. The current study confirmed that natural homemade remedies for teeth whitening were a successful trend to minimize or better to say to get rid of the traditional side effects associated with chemical bleaching agents.

Acknowledgement

The author has no affiliation with any products mentioned in this article

Conflict of Interest: None

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

1- Cakir FY. Effects of in-office bleaching agent combined with different desensitizing agents on enamel. J Appl Oral Sci. 2019;24(3):1-10.https://doi.org/10.1590/1678-7757-2018-0233.
2- Pillai R, Varghese N, Salim A, Murali N, Lekshmi J, Nair S. Spectrophotometric Analysis of Color Changes in Enamel Following Exposure to Herbal Bleaching Agents: An In Vitro Study. Conserv Dent Endod J. 2018;3(2):62–66. DOI: 10.5005/jp-journals-10048-004.
3- Vekaash C, Reddy T, Venkatesh K. Effect of vital bleaching with solutions containing different concentrations of hydrogen peroxide and pineapple extract as an additive on human enamel using reflectance spectrophotometer: An in vitro study. J Conserv Dent. 2017;20(5):337–340. DOI: 10.4103/JCD.JCD_197_17
4- Lee J, Bae S. A study on the whitening effect of fruit extracts and the changes in the components of the teeth. Indian J Public Heal Res Dev. 2018;9(8):729–735. DOI: 10.5958/0976-5506.2018.00820.3
5- Kuwatada J, Raja M, Sood P. Turmeric: A Boon to Oral Health. IJOCR. 2017;5(4): 338–341. DOI: 10.5005/jp-journals-10051-0128.
6- Rasuna G, Sabila P, Bramantoro T, Setijanto D, Zamzam A**.** Strawberry Utilization Empowerment Program in Low‐ Temperature Environment as a Dental Health Promotion. J Int Oral Heal. 2019;11(2):26–29. DOI: 10.4103/jioh.jioh_225_18
7- Kwon S, Meharry M, Oyoyo U, Li Y. Efficacy of do-it-yourself whitening as compared to conventional tooth whitening modalities: an in vitro study. Oper Dent. 2015;40(1):21-27. DOI: 10.2341/13-333-LR
8- Barnes C, Covey D, Watanabe H, Simetich B, Schulte J, Chen H. An in vitro comparison of the effects of various air polishing powders on enamel and selected esthetic restorative materials. J Clin Dent. 2014;25(4):76–87. https://pubmed.ncbi.nlm.nih.gov/26054183/. Accessed April 27, 2021.
9- Sulieman M, Addy M, MacDonald E, Rees J**.** The effect of hydrogen peroxide concentration on the outcome of tooth whitening: An in vitro study. J Dent. 2004; 32(4):295–299. DOI: 10.1016/j.jdent.2004.01.003
10- Johnston W. Color measurement in dentistry. J Dent. 2009;37(3):2–6. DOI: 10.1016/j.jdent.2009.03.011.
11- Çakır F, Öztaş S, Fırat E, Gürgan S. effect of office bleaching systems on chemical compositions of enamel and dentin: an in vitro study. CDR. 2012;36(3): 35-41. http://www.dishekdergi.hacettepe.edu.tr/htdergi/makaleler/20123.sayi06makale.pdf. Accessed April 27, 2021.
12- Fatima N. (2016). In-vitro comparative study of in-office and home bleaching agents on surface micro-morphology of enamel. J Coll Physicians Surg Pakistan. 2016;26(1):9–12. DOI:01.2016/jcpsp.0912

13- Soares D, Ribeiro A, Sacono N, Loguércio A, Hebling J, Costa C. Mineral loss and morphological changes in dental enamel induced by a 16% carbamide peroxide bleaching gel. Braz Dent J. 2013;24(5):517–521. http://dx.doi.org/10.1590/0103-6440201302225.
14- Ali, S., Nadim, R., & Aslam, K. Consequences Of Tooth Bleaching On Dental Tissues And Composite Restorations : Literature Review. Pakistan oral Dent J. 2015;35(3):493-496. http://podj.com.pk/archive/Sep_2015/PODJ-34.pdf. Accessed April 27, 2021.
15- Mielczarek A, Klukowska M, Ganowicz M, Kwiatkowska A, Kwaśny M. The effect of strip, tray and office peroxide bleaching systems on enamel surfaces in vitro. Dent Mater J. 2008;24(11):1495–1500. DOI: 10.1016/j.dental.2008.03.009
16- Cvikl B, Lussi A, Moritz A, Flury S. Enamel surface changes after exposure to bleaching gels containing carbamide peroxide or hydrogen peroxide. Oper Dent. 2016;41(1):39–47. DOI: 10.2341/15-010-L.
17- Kwon S, Kurti S, Oyoyo U, Li Y. Effect of various tooth whitening modalities on microhardness, surface roughness and surface morphology of the enamel. Odontology. 2014;103(3):274–279. DOI:0.1007/s10266-014-0163-4.
18- Brambert P, Qian F, Kwon S. Erosion Potential of Tooth Whitening Regimens as Evaluated with Polarized Light Microscopy. J Contemp Dent Pract. 2015;16(11):921–925. DOI: 10.5005/jp-journals-10024-1782.
19- Asmawati A Rieuwpassa I. Comparison of enamel hardness after dental bleaching agent application strawberry gel and carbamide peroxide 10%. J Dentomaxillofac Sci. 2018;3(1):17-19. DOI: 10.15562/jdmfs.v3i1.626.
20- Sulieman M, Macdonald E, Rees J, Newcombe R. Whitening Strips: An In Vitro Study. J Esthet Restor Dent**.** 2006;18(2):93–100. DOI: 10.2310/6130.2006.00016
21- Meireles S, Santos I, Bona A, Demarco F. A double-blind randomized clinical trial of two carbamide peroxide tooth bleaching agents: 2-year follow-up. J Dent. 2010;38(12):956–963. DOI: 10.1016/j.jdent.2010.08.003
22- Meireles S, Fontes S, Antônio L, Coimbra A, Bona Á, Demarco D. Effectiveness of different carbamide peroxide concentrations used for tooth bleaching: an in vitro study. J Appl Oral Sci. 2012;20(2):186–191. DOI: 10.1590/s1678-77572012000200011.
23- Stephanie S, Hayati A, Sukartini E. Differences in the tooth whitening effect between strawberry juice and apple juice in-vitro. Padjadjaran J Dent. 2012;24(1):65–70. DOI: 10.24198/pjd.vol24no1.15385
24- Pramesti A, Jasrin TA, Hidayat OT. Teeth re-whitening effect of strawberry juice on coffee-stained teeth. Padjadjaran J Dent. 2013;25(1):15-20. DOI: 10.24198/pjd.vol25no1.15427
25- Puspita S, Tri Rahmawan D, Swara Wijayaningrum K. Comparison of Immersion Time between Strawberry (Fragaria x ananassa) Juice and 35% Carbamide Peroxide on Tooth Discoloration. Mutiara Med J Kedokt dan Kesehat. 2018;18(1):19–24. DOI:10.18196/mm.180110
26- Abidia R, El-Hejazi A, Azam A, Al-Qhatani S, Al-Mugbel K, AlSulami M. Efficacy of Tooth Whitening Using Natural Products in Vitro. Saudi Dent J**.** 2019;31(February), S26. DOI:10.1016/j.sdentj.2019.01.020