Original Research

Effect of Application of Turmeric Extract Powder Solution on the Color Changes of Non-vital Teeth: An *In-vitro* Study

Haidy N. Salem[1], Nada O. Kamel[1], Shahinaz N. Hassan[1], Sherif M. Elhefnawy[2]

[1]Department of Restorative and Dental Materials, National Research Center, Cairo, [2]Department of Operative Dentistry, Faculty of Dentistry, October University for Modern Sciences and Arts, Cairo, Egypt

Abstract

Aim: The aim of this study was to assess the effect of using turmeric powder extract on changes of tooth color with extra-coronal and intra-coronal bleaching methods. **Materials and Methods:** Turmeric powder extract was weighted and mixed with two different hydrogen peroxide concentrations (3% and 6%) to be used as a bleaching agent. Thirty teeth were allocated into three groups (n = 10): Group A: bleaching agent (6%) was applied on the labial surface, Group B: bleaching agent (3%) was applied inside the pulp chamber, and Group C: extra- and intra-coronal bleaching techniques were used (6% and 3%, respectively). A standardized access cavity was opened in the palatal surface of each tooth in both Groups B and C. Color parameters were measured using a spectrophotometer. **Results:** A statistically significant difference in color difference values (ΔE^*) and enamel brightness (ΔL^*) was found between Group C and each of Groups A and B. There was no statistically significant difference in (ΔE^*) and (ΔL^*) between Group A and Group B. The highest mean value of (ΔE^*) and (ΔL^*) was found in Group C, whereas the least mean value was found in Group B. **Conclusion:** Bleaching the external and internal tooth structure with low concentrations of hydrogen peroxide solution mixed with turmeric extract has a promising effect in color enhancement.

Keywords: Bleaching, Hydrogen Peroxide, Spectrophotometer, Turmeric

Received: 20-06-2022, **Revised:** 05-10-2022, **Accepted:** 07-10-2022, **Published:** 30-12-2022.

Introduction

Dental bleaching is a conservative approach for gaining cosmetic as well as esthetic effects rather than any other treatment method such as crowns and veneer that necessitates special preparations.[1]

In spite of the tooth bleaching esthetic advantages, studies reported some drawbacks following its procedure including transient tooth sensitivity during and after the procedure, changes in surface morphology, decreased tooth microhardness, increased surface roughness, and surface alterations within the tooth structure.[2] Moreover, the internal bleaching of endodontically treated teeth has some disadvantages, such as the tendency of the teeth to be broken due to necrosis from the penetration of the used chemicals through the dentinal tubules causing inflammation resulting in decreased tooth microhardness and cervical root resorption.[3] It has been reported that bleaching using 30% hydrogen peroxide caused external cervical root resorption associated with other factors such as trauma and orthodontics.

The natural herbal product curcumin, which is the active ingredient of turmeric, is a molecule that has shown a variety of therapeutic actions including anti-inflammatory, antioxidant, and analgesic. Moreover, it has efficacy in eliminating dental pain, periodontitis, and oral cancer diseases.[4]

Regarding all aforementioned facts and claims, the current study was carried out using a creamy form of turmeric

Access this article online

Quick Response Code:

Website: www.jioh.org

DOI: 10.4103/jioh.jioh_134_22

Address for correspondence: Dr. Haidy N. Salem, National Research Center, 33 El Buhouth St. (Former El Tahrir St.) Dokki, Giza, Egypt.
E-mail: haidy_salem@hotmail.com

How to cite this article: Salem HN, Kamel NO, Hassan SN, Elhefnawy SM. Effect of application of turmeric extract powder solution on the color changes of non-vital teeth: An *in-vitro* study. J Int Oral Health 2022;14:612-7.

extract powder solution to assess the effect of using turmeric powder extract on the changes of tooth color with extra-coronal and intra-coronal bleaching methods.

Materials and Methods

Materials, ingredients, descriptions, and manufacturers are listed in Table 1.

Study design

Thirty sound human incisors were chosen and haphazardly allocated into three groups (n = 10) as follows: Group A: external bleaching (extra-coronal) where the bleaching agent was applied to the labial surface; Group B: internal bleaching (intra-coronal) where the bleaching agent was applied intra-coronal (inside the pulp chamber); and Group C: extra- and intra-coronal bleaching techniques were used.

Tooth selection and preparation

Thirty human incisors were chosen and extracted to be used in the current study. All selected teeth were cleaned and scaled ultrasonically to remove any debris, washed under running tap water, and then examined under a stereomicroscope to exclude those with surface defects. Then, they were immersed in a 0.01% thymol solution for 1 week. Afterward, teeth were stored in a tightly sealed container containing standard saline solution at room temperature till the time of use.

Preparation of bleaching material

One gram of turmeric powder extract was weighted by a sensitive digital balance (AE ADAM PW124 Lab Balance, UK) and added to 1.5 mL of 3% and 6% hydrogen peroxide solutions (Luna Cosmetic Product, EGYPT) to obtain intra-coronal bleaching and extra-coronal bleaching mixture, respectively. This amount of turmeric powder extract was determined on the basis of a pilot study conducted before the test to obtain a creamy mix to be easily applied on the tooth surface and easily injected inside the pulp chamber.

Table 1: Investigated materials, ingredients, and manufacturers

Material name	Composition	Manufacturer
Turmeric Curcumin EXTRACT capsules 1000 MG Herbal Supplement	(*Curcuma longa*) (root) 900 mg, (*Curcuma longa*) (root) 100 mg standardized to contain 95% curcumineids, BioPerine Btack Pepper Extract (*Piper nigrum*) 5 mg, gelatin, vegetable stearic acid	Puritan's Pride, Inc., Ronkonkoma, NY, USA
Hydrogen peroxide bleaching solution (H_2O_2)	3% concentration	Luna Cosmetic Product, Egypt
Hydrogen peroxide bleaching solution (H_2O_2)	6% concentration	Luna Cosmetic Product, Egypt

Cavity preparation

A standardized access cavity was opened in the palatal surface of each tooth in both Groups B and C using a tapered stone with round ends fixed in a handpiece with high speed. The remnants of pulpal tissues were taken out with a sharp broach (Dentsply Maillefer, Ballaigues, Switzerland). The pulp chambers and roots were washed with sodium hypochlorite (NaOCl) followed by saline solution. Root canals were then dried using paper point size 60 (Dentsply Maillefer, Ballaigues, Switzerland).

A 3 mm layer of resin-modified glass ionomer (Ionolux, Voco Inc., Germany) was applied as a barrier 2 mm below the cementoenamel junction and beyond the level of the canal orifices, to prevent the bleaching agent to flow inside the root canals.[5] The light-curing was done for 20 s.

Bleaching procedure

Group A (extra-coronal bleaching)

The prepared mixture for extra-coronal bleaching was loaded in a monojet-curved tip irrigation syringe 12 mL for the ease of application of the mixture. The mixture was placed on the labial surface of the experimental teeth for 15 min, then washed with saline, and dried. That process was repeated three times to result in a total application of 45 min of the prepared mixture. After completion of the procedure, the treated teeth were kept in a labeled vial containing distilled water until the time of color measurement.

Group B (intra-coronal bleaching)

The cavity walls of the access cavity were cleansed from any remnants using a small carbide bur and then a whole rinsing with 2 mL of 2.5% sodium hypochloride (NaOCl). The prepared mixture for intra-coronal bleaching was injected intraconal with the help of a monojet-curved tip irrigation syringe inserted in the pulp chamber. The coronal access was filled with a temporary filling material (Cavit, 3M ESPE, St Paul, USA). Each tooth was stabilized in a 5 mL plastic vial containing distilled water and stored at 37°C with 100% humidity; the tooth was kept in an incubator for 28 days during bleaching procedures. The bleaching agents were exchanged weekly for 4weeks. Every time, the previous bleaching mix was washed with saline solution and activated with an ultrasonic tip to ensure complete removal of the material. Fresh bleaching mix was prepared and placed, and the teeth were then returned in plastic-labeled vials containing fresh distilled water and stored in an incubator at 37°C for 1 week.

Group C (intra- and extra-coronal bleaching)

The same bleaching methods used in Group A and Group B were repeated in the same manner for Group C.

Color measurement

CIELAB color parameters (Commission Internationale de la'Eclairage, 1986) have been largely used to compare color variation among materials. The CIE $L^*a^*b^*$ apparatus is a nearly equivalent color space with lightness coordinates, namely, white-black (L^*), redness-green (a^*), and yellowness-blueness (b^*). The (L^*, a^*, b^*) color values of each sample were evaluated before exposure to a Reflecting light spectrophotometer (X-Rite, RM200QC, Neu-Isenburg, Germany). The size of the aperture was set to 4 mm and the samples were precisely aligned with the device. A background with white color was selected. Evaluations were done in accordance to the CIE $L^*a^*b^*$ color space relative to the CIE standard illuminant D65.[6] The samples were located in the measuring head center of the spectrophotometer using a white Teflon holder. This attachment set up was used to ensure repeated measurements for each sample from the same area.

Moreover, any external light source was prevented from entering the system by this attachment setup. The readings were taken three times for each sample, and then the L^*, a^*, b^* mean values were calculated. Following the baseline measurements for each group, the bleaching procedures were carried out for the three tested groups: Group A intra-coronally, Group B extra-coronally, and Group C intra- and extra-coronally, as previously mentioned in the bleaching procedure section. At this stage, same spectrophotometer was used to record color measurements, under the similar conditions described for the baseline measurements by two operators. The color variation ΔE^* calculations between two color positions (baseline and after bleaching) in 3-dimensional $L^*a^*b^*$ color space is as follows:

$$\Delta ECIELAB = (\Delta L^*2 + \Delta a^*2 + \Delta b^*2)1/2,$$

where L^* is the lightness (0–100), $a^*$is the color change of the axis (red/green), and b^* color variation axis (yellow/blue).

Statistical analysis

The standard deviation and mean values were recorded for each tested group, using Kolmogorov–Smirnov and Shapiro–Wilk tests; results were explored for normality. The data showed a normal distribution. One-way analysis of variance (ANOVA) followed by Tukey's *post hoc* test for ΔE [Table 2] and for ΔL [Table 3] was applied to compare non-related samples between more than two groups. $P \leq 0.05$ was set as the significance level. IBM® SPSS® Statistics Version 20,Windows was used for statistical analysis.

Results

The color difference between the different bleaching methods was evaluated by a spectrophotometer by determining the values of ΔE [Table 4]. There was a statistically significant difference in the mean of the color difference values (ΔE^*) between the three tested groups ($P<0.001$). Group C had statistically significant difference in color change values (ΔE^*) when compared with Groups A and B ($P<0.001$). There was no statistically significant difference ($P=0.804$) in color changes between Groups A and B. Regarding the intra- and extra-coronal bleaching, Group C recorded the highest mean value of color change, whereas the least mean value was observed in Group B while performing intra-coronal bleaching.

A statistical significant difference in enamel lightness parameter (ΔL*) from baseline between the three tested groups ($P < 0.001$) was recorded, as given in Table 4. There was no statistical difference in (ΔL^*) ($P=0.512$) between

Table 2: The two-way ANOVA and Tukey's *post hoc* test for ΔE values with three bleaching methods

One-way ANOVA						
ΔE						
	Sum of squares	df	Mean square	*F*	Sig.	
Between groups	48.041	2	24.021	13.545	0.000	
Within groups	90.446	51	1.773			
Total	138.487	53				
Multiple comparisons						
Dependent variable: ΔE						
Tukey HSD						
(I) Groups	(J) Groups	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
Group A	Group B	0.28000	0.44390	0.804	-0.7916	1.3516
	Group C	-1.84611*	0.44390	0.000	-2.9177	-0.7745
Group B	Group A	-0.28000	0.44390	0.804	-1.3516	0.7916
	Group C	-2.12611*	0.44390	0.000	-3.1977	-1.0545
Group C	Group A	1.84611*	0.44390	0.000	0.7745	2.9177
	Group B	2.12611*	0.44390	0.000	1.0545	3.1977

*The mean difference is significant at the 0.05 level

Table 3: The two-way ANOVA and Tukey's *post hoc* test for ΔL values with three bleaching methods

One-way ANOVA					
ΔL					
	Sum of squares	df	Mean square	*F*	Sig.
Between groups	43.810	2	21.905	55.073	0.000
Within groups	20.285	51	0.398		
Total	64.095	53			

Multiple comparisons						
Dependent variable:						
Tukey HSD						
(I) Groups	(J) Groups	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
Group A	Group B	0.23333	0.21022	0.512	-0.2741	0.7408
	Group C	-1.78333*	0.21022	0.000	-2.2908	-1.2759
Group B	Group A	-0.23333	0.21022	0.512	-0.7408	0.2741
	Group C	-2.01667*	0.21022	0.000	-2.5241	-1.5092
Group C	Group A	1.78333*	0.21022	0.000	1.2759	2.2908
	Group B	2.01667*	0.21022	0.000	1.5092	2.5241

*The mean difference is significant at the 0.05 level

Table 4: Mean and standard deviation (SD) values of color change with three bleaching methods

Variables	Color change			
	ΔE		ΔL	
	Mean	SD	Mean	SD
Group A	5.38[b]	0.85	1.93[b]	0.60
Group B	5.10[b]	0.87	1.70[b]	0.47
Group C	7.23[a]	1.96	3.72[a]	0.78
P-value	<0.001*		<0.001*	

Means with different letters in the same column indicate significant difference

*Significant ($P < 0.05$)

Groups A and B. Group C showed a marked increase in ΔL^* value with statistical difference, whereas Group B recorded the least mean value.

The interclass correlation coefficient values were 0.943 and 0.919 for ΔL and ΔE, respectively, with no statistically significant difference ($P = 0.49$). This states a strong reliability and agreement between the two readings.

Discussion

Discolored teeth became no longer tolerated by patients who wished to have a perfect smile. Hence, tooth bleaching has been evolved due to its safety, simplicity, as well as its efficiency.[7]

Vilhena *et al.*[8] reported in their study changes in the surface roughness and microhardness within the tooth structure following bleaching protocols. These changes might be assigned to the action of urea and oxygen by-products on the organic matrix, causing fragile tooth structure and enhancing its higher degradation compromising the tooth structure.

Using different light-activated systems causing a rise in the temperature accompanied by production of heat; due to the absorption of energy by the bleaching gel. That temperature rise causes pulpal damage as well as tooth hypersensitivity.[9] Moreover, Júnior *et al.*[10] concluded in their study that using less peroxide concentrations by NaF/HMP addition to in-office bleaching agent was not interfering with the enamel microhardness.

Application of a cervical barrier is preferred before internal bleaching as it has been theorized that during internal bleaching, the bleaching gel undergoes diffusion via the dentinal tubules resulting in cervical root resorption.[11]

In the present study, the turmeric extract powder was mixed with low concentration of hydrogen peroxide bleaching solution to minimize the side effects that could arise from using higher bleaching concentrations and at the same time to obtain a creamy mix of an acceptable consistency to be easily applied over the tooth surface as well as inside the pulp chamber. This was in agreement with a previous study that stated that using lower concentrations of hydrogen peroxide agents may result in the same color changes effect with the benefit of low tooth sensitivity.[12]

The concentration of peroxide solution mixed with turmeric extract powder for the extra-coronal bleaching (6%) was higher than that used in the mixing used for the intra-coronal bleaching (3%). This difference in the concentrations of hydrogen peroxide was attributed to the fact that in the case of intra-coronal bleaching, the applied bleaching material is left for a longer period (4 weeks) and was changed every 7 days to avoid its seepage which causes external root resorption. While in the

extra-coronal bleaching, the procedure was performed three times each for a 15 min period ending in a total of 45 min after application.

The efficacy of tooth bleaching methods, represented by the color difference, was evaluated by the spectrophotometer. This method provides detailed color definition as well as spectral data analysis.[13]

The results of the current study demonstrated that all groups produced a highly significant increase in color difference ΔE as well as enamel brightness ΔL from baseline to post-bleaching [Table 4]. This finding was expected, as hydrogen peroxide was effective in promoting teeth bleaching.[14]

Moreover, *turmeric* and its curcumin constituent have remarkable antioxidant activity, equivalent to hydrogen peroxide, in soluble extracts. Hence, its use with hydrogen peroxide might optimize its bleaching effect.[15]

The highest mean values of color difference ΔE as well as the enamel brightness ΔL were found in intra- and extra-coronal bleaching groups (Group C). The reason could be the flow of the bleaching agent inside the dentinal tubules in the intra-coronal method. This is in agreement with Mounika *et al.,*[16] who observed in their study a very fast penetration of hydrogen peroxide bleaching agent via the dentinal tubules after 15 min of its application. Hence, there is arrival of a larger amount of reactive species to the pulp chamber.

Moreover, it has been stated in some studies that tooth bleaching is much easier in young patients with discolored teeth than it can be in older patients with tooth discoloration. This might be due to the widely opened dentinal tubules in younger patients that permit better penetration of the bleaching agent.[17] However, not all studies are in collaboration with the bleaching success related to age-related patients.

There was no statistically significant color difference between ΔE and the enamel brightness values ΔL, between the extra-coronal bleaching group (Group A) and the intra-coronal bleaching group (Group B). This result was in disagreement with a previous study which reported that enamel is of much lower permeability for diffusion of bleaching agents compared with dentine.[18] That explanation might be referred to the bleaching peroxide concentration mixed with turmeric extract powder for Group A (extra-coronal group 6% concentration) that was higher than that concentration used in mixing for Group B (intra-coronal group 3% concentration). This finding was in agreement with Pallarés-Serrano *et al*.[19] These authors observed in their study that the strength of the reaction is associated with the bleaching agent concentration.

In spite of being recognized that turmeric does not cause any side effects on the short term, there are still large-scale trials that could test its drawbacks in the long term. As for now, turmeric is neither considered as a substitution for esthetic tooth whitening protocols nor a renewal for general oral health care. Eventually, more future researches should be carried out with suggested outlets in improving turmeric bioavailability, bio-efficacy, and proper use in the field of dentistry because using herbs and plants for dental curing became widespread native system in our life.

Conclusions

Based on the observations of the present study, it can be concluded that:

1. Turmeric extract powder can be effectively used as an adjunct to low concentration hydrogen peroxide bleaching solution in obtaining tooth whitening.
2. Bleaching the external and internal tooth structure with low concentrations of hydrogen peroxide solution mixed with turmeric extract has a promising effect in color enhancement.

Acknowledgement

Not applicable.

Financial support and sponsorship

This study was self-funded by the authors.

Conflicts of interest

There are no conflicts of interest.

Authors' contributions

All authors had contributed equally and given approval for publication of the article.

Ethical policy and Institutional Review Board statement

Not applicable.

Patient declaration of consent

Not applicable.

Data availability statement

Data are available on reasonable request.

References

1. Freitas MR, Carvalho MM, Liporoni PCS, Fort ACB, Morais RM, Zanatta RF. Effectiveness and adverse effects of over-the-counter whitening products on dental tissues. Front Dent Med 2021;2:1-9.
2. Majeed A, Farooq I, Grobler SR, Rossouw RJ. Tooth-bleaching: A review of the efficacy and adverse effects of various tooth whitening products. J Coll Physicians Surg Pak 2015;25:891-6.
3. El Sayed DM, EL-Sawa AA, Karam SS. Effect of fluoride incorporation in bleaching agents on enamel. ADJ 2020;45:21-6. doi: 10.21608/adjalexu.2020.79876
4. de Arruda AM, dos Santos PH, Sundfeld RH, Berger SB, Briso AL. Effect of hydrogen peroxide at 35% on the morphology of enamel

and interference in the de-remineralization process: An *in situ* study. Oper Dent 2012;37:518-25.
5. Kalay TS. Effects of intracoronal bleaching agents on the surface properties of mineral trioxide aggregate. Odontology 2019;107:465-72. DOI: 10.1007/s10266-019-00418-6
6. Alaghehmand H, Rohaninasab M, Bijani A. The effect of office bleaching on the color and bond strength of resin restorations. Dent Res J (Isfahan) 2019;16:47-52.
7. Borges AB, Guimaraes CA, Bresciani E, Ramos CJ, Borges ALS, Torres CRG. Effect of incorporation of remineralizing agents into bleaching gels on the micro hardness of bovine enamel *in situ*. J Contemp Dent Pract 2014;15:195-201. DOI: 10.5005/jp-journals-10024-1514
8. Vilhena KFB, Nogueira BCL, Fagundes NCF, Loretto SC, Angelica RS, Lima RR, *et al*. Dental enamel bleached for a prolonged and excessive time: Morphological changes. PLoS One 2019;14:e0214948.
9. Gomes MN, Francci C, Medeiros IS, De Godoy Froes Salgado NR, Riehl H, Marasca JM, *et al*. Effect of light irradiation on tooth whitening: Enamel microhardness and color change. J Esthet Restor Dent 2009;21:387-94.
10. Júnior NAN, Nunes GP, Gruba AS, Danelon M, da Silva LMAV, de Farias Batista G, *et al*. Evaluation of bleaching efficacy, microhardness, and trans-amelodentinal diffusion of a novel bleaching agent for an in-office technique containing hexametaphosphate and fluoride. Clin Oral Investig 2022;26:5071-8.
11. Khedmat S, Ahmadi E, Meraji N, Fallah ZF. Colorimetric comparison of internal bleaching with and without removing mineral trioxide aggregate (MTA) on induced coronal tooth discoloration by MTA. Int J Dent 2021;2021:8319986.
12. Maran BM, Matos TP, de Castro ADS, Vochikovski L, Amadori AL, Loguercio AD, *et al*. In-office bleaching with low/medium vs. high concentrate hydrogen peroxide: A systematic review and meta-analysis. J Dent 2020;103:103499.
13. Salem W, Moussa TA, Abouraya NL. Chemical characterization of bleached turmeric hydro-alcoholic extract and its effect on dentin microhardness versus sodium hypochlorite as an endodontic irrigant: *In vitro* study. Egy Dent J 2021;67:1453-62.
14. Pereira R, Silveira J, Dias S, Cardoso A, Mata A, Marques D. Bleaching efficacy and quality of life of different bleaching techniques - randomized controlled trial. Clin Oral Investig 2022:1-11. doi: 10.1007/s00784-022-04678-5.
15. Fuloria S, Mehta J, Chandel A, Sekar M, Rani NNIM, Begum MY, *et al*. A comprehensive review on the therapeutic potential of *Curcuma longa* Linn. in relation to its major active constituent curcumin. Front Pharmacol 2022;13:820806.
16. Mounika A, Mandava J, Roopesh B, Karri G. Clinical evaluation of color change and tooth sensitivity with in-office and home bleaching treatments. Indian J Dent Res 2018;29:423-7.
17. Srivilai J, Phimnuan P, Jaisabai J, Luangtoomma N, Waranuch N, Khorana N, *et al*. Essential oil slows hair-growth and lightens skin in axillae; a randomized, double blinded trial. Sci Direct 2017;25:29-38. DOI: 10.1016/j.phymed.2016.12.007
18. Nathan KB, Nadig RR, Job TV, Nithin PV, Karthik R, Choudary S. Radicular peroxide penetration from different concentrations of carbamide peroxide gel during intracoronal bleaching—An *in vitro* study. J Contemp Dent Pract 2019;20:587-92.
19. Pallarés-Serrano A, Pallarés-Serrano S, Pallarés-Serrano A, Pallarés-Sabater A. Assessment of oxygen expansion during internal bleaching with enamel and dentin: A comparative *in vitro* study. Dent J (Basel) 2021;9:98. PMID: 34562972.