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Research Report

Color changes of nanofiller composite resin after glycerin application immersed in turmeric extract

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ABSTRACT

Background: *Nanofiller composite resin has good mechanical strength also used for restoration that require aesthetics. However, resin composites can experience discoloration resulting in extrinsic or intrinsic factors. To produce perfect polymerization, glycerin can be used as an air-inhibition coating to prevent the formation of Oxygen-Inhibited Layer resulting in a more stable over discoloration.* ***Purpose:*** *To knowing the color change due to the application of glycerin on nanofiller composite resin immersed in turmeric extract solution.* ***Methods:*** *It is a laboratory experimental study with a Pre-Test-Post-Test Control Group Design using 28 samples of 3M ESPE Filtek 350XT nanofiller composite resin divided into 4 groups, namely the group with glycerin application and without glycerin application which were soaked in turmeric extract with and saline for 4 days. The color changes were measured using a CHNSpec CS-10 colorimeter before and after immersion.* ***Results:*** *Nanofiller composite resin with turmeric extract immersion without glycerin application had an average discoloration of 90.97 + 23.26 while with glycerin application it had a lower average of 84.37 + 9.24. On the results of the independent sample t-test with a significant level of 5%, it has a value of p = 0.506 > 0.05.* ***Conclusion:*** *Composite resin with glycerin application experienced less color change than composite resin without glycerin application in turmeric extract immersion, but statistically not significant.*

Keywords: *color change; glycerine; nanofiller composite resin; oxygen-inhibited layer; turmeric extract*

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INTRODUCTION

Dental caries or tooth decay still has a high prevalence rate in Indonesia. Based on the Riskesdas 2018 report the prevalence of caries in Indonesia reached 88.8%.[1] Tooth decay can be treated with a restorative approach. The use of composite resin as a general filling material was chosen because of its good aesthetics and mechanical properties. In addition, composite resins are also available in a variety of consistencies for easy manipulation and good capability as a direct-filling material.[2-4] Development of nanotechnology to improve the mechanical properties, chemical properties, and optical properties of composite resins[5] produces a new type of composite resin, one of which is nanofiller composite resin which has good mechanical strength and supports restorations that require good aesthetics.[4]

In addition to its advantages, composite resin also has disadvantages, namely it can experience discoloration which is certainly a problem for patients because it requires more time and costs to replace restorations.[6] The color change can be caused by intrinsic factors or extrinsic factors. Intrinsic factors are factors that come from the composite resin itself such as the composition of the composite resin.[7] Composite resin has a matrix that is hydrophilic which causes an increase in the amount of water that diffuses and the presence of air bubbles.[8] Oxygen in contact with free radicals formed in the initiation process will inhibit the polymerization reaction of the composite resin and produce an Oxygen-Inhibited Layer (OIL). This layer has polymer bonds that are prone to discoloration and surface roughness in the composite resin[9] which can be caused by microcracks. The empty space formed due to microcracks between the matrix bonds which increases in number will make it easier for water and dissolved dyes to diffuse so that accumulation occurs which causes the composite resin to appear to change color.[10-12] Extrinsic factors are factors that can come from dye to exposure to food and drink ingredients that contain color, temperature, the stages in making restorations, as well as the condition of the patient's oral cavity which can cause discoloration of the composite resin.[7]

Indonesian people have a habit and culture of self-medication by utilizing medicinal plants such as consuming

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fresh herbs as evidenced by a study conducted in the city of Yogyakarta involving 640 respondents.[13] Based on the 2018 Riskesdas, 48% of Indonesian people still use traditional health services by consuming ready-made ingredients and another 31.8% consume homemade ingredients.[1] Jamu kuning tamarind is a variation of herbal medicine made from turmeric (*Curcuma domestica* Val.) or turmeric in Indonesian and the fruit/leaves of the tamarind plant (*Tamarindus indica* L.) which has a sweet and sour taste.[14] Curcumin is the dominant compound of the curcuminoids contained in Curcuma longa which can give a yellow color.[7] Studies conducted by Singh (2013) and Sachdeva, et al. (2022) proved in vitro that if there was a color change of the 3M FILTEK ESPE Z350 nanocomposite in a turmeric solution.[15,16]

Glycerin ($C_3H_8O_3$) is the result of purification from the reaction of oil and fat with water which produces a clear, colorless, thick consistency, odorless and has a sweet taste and is stable to oxygen. This compound can be used as an air-inhibition coating aimed at preventing the reaction of free radicals with oxygen during the composite resin polymerization process so that no OIL is formed.[17,18]. No OIL formation will result in a restoration that is more stable against discoloration and roughness. From the description above, this study aims to determine the differences in the application of glycerin to discoloration of nanofiller composite resins with glycerin applied and nanofiller composite resins without glycerin applied in turmeric extract solution immersion.

MATERIALS AND METHODS

The type of research used was laboratory experimental conducted at the Research Center Laboratory, Faculty of Dentistry, Airlangga University, with the research design is *Pretest-Posttest Group design.* The sample used was nanofiller composite resin (Filtek Z350XT, 3M ESPE, USA) in the form of a disc with a diameter of 10 mm and a thickness of 3 mm. This study consisted of 28 samples divided into 4 groups consisting of Group 1 which was the sample group without glycerin application immersed in saline, Group 2 which was the sample group with glycerin application immersed in saline, Group 3 was the sample group without application glycerin immersed in turmeric extract, and Group 4 is the sample group with the application of glycerin immersed in turmeric extract.

Sample preparation was carried out by inserting the nanofiller composite into an acrylic plate mold that had been coated with Vaseline using a plastic filling instrument, after that it was flattened using a glass lab and given a load and tidied up, the glycerin was taken using a micropipette (50 µl) and leveled using a micro brush in one layer on the composite group coated with glycerin. The wavelength of light cure light is measured with a light-meter 400-600 nm, after that, light curing was carried out for 20 seconds on both sample surfaces. The sample is released in the opposite direction so that the wings are cut by the edge of the acrylic plate. The surface of the sample is cleaned once using a cotton swab soaked in 70% alcohol on the surface of the composite. The surface of the sample that will not be treated is coated with clear colored polish so it does not absorb liquid. Place the sample in an acrylic container that has been coded on the lid.

Preparation of turmeric extract solution by mixing 4 grams of Herbana Relief Sari turmeric extract powder with 200 mL of water at 100°C. The solution was allowed to stand at 37°C. Before soaking the composite samples, color measurements were carried out using the CHNSpec CS-10 colorimeter. Samples were immersed in the immersion medium according to each sample group and placed in an incubator at 37°C for 4 days with the soaking medium replaced every 24 hours to reduce the absorption saturation of the composite. After soaking, the color was measured. The results of color measurements before and after calculations are carried out using the formula[19,20]:

$$\Delta E_{lab^*} = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

Notes:

ΔE_{lab} = color change of nanofiller composite resin.

ΔL = value of color lightness.

Δa = substraction of red with green (red-green).

Δb = substraction of yellow with blue (yellow-blue).

The data obtained was then processed by statistical tests, namely the normality test using the Shapiro Wilk Test statistic, the homogeneity test with the Levene test, and the Independent T-test.

RESULTS

In this study there were 4 treatment groups, each group having 7 samples. From the research conducted, the results were obtained as shown below (Figure 1). Based on Table 1 it can be seen that group 1 has an average discoloration (ΔEab) of 2.20 + 0.19, group 2 has an average discoloration (ΔEab) of 2.09 + 0.52, Group 3 has an average discoloration (ΔEab) 90.97 + 23.26, and group 4 had an average color change (ΔEab) of 84.37 + 9.24. The results of the normality test using the Shapiro Wilk Test statistic result if the data for all sample groups are normally distributed with a p-value> 0.05 with a significance level of 5% so that they meet the requirements for using the Independent T-test. The results of the homogeneity test in this study were obtained if the sample group 1 had a homogeneous data variant ($p>0.05$), while the other three groups were not homogeneous ($p<0.05$).

Based on Table 2, The results of the independent T-test for differences in the color change of nanofiller composite resin based on the application of glycerin had a value of $p = 0.599 > 0.05$ in both the groups soaked in saline and turmeric extract so that it can be concluded that there was no significant difference between the average color change of the immersion nanofiller composite resin. saline without glycerin or with glycerin. While the results of the independent T-test the difference in color change of nanofiller composite resin based on soaking had a p value

<0.05 both in the group without glycerin application and with glycerin application which showed that immersion with turmeric extract had a significant impact on increasing the color change score of nanofiller composite resin. compared to saline immersion either with glycerin application or without glycerin application.

DISCUSSION

This study aims to determine the color change that occurs due to the application of glycerin on nanofiller composite resin soaked in turmeric extract solution. From the results of descriptive analysis in this study, it was found that

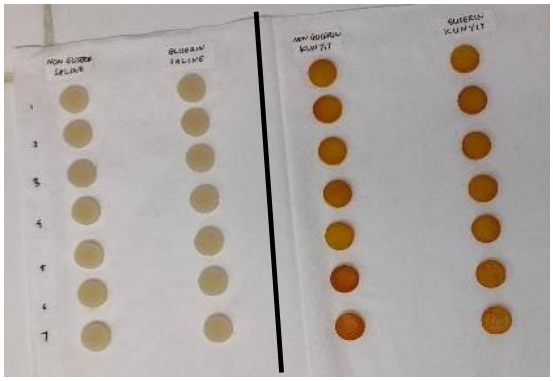

Figure 1. Samples after immersion in saline (left side of the line) and turmeric extract (right side of the line).

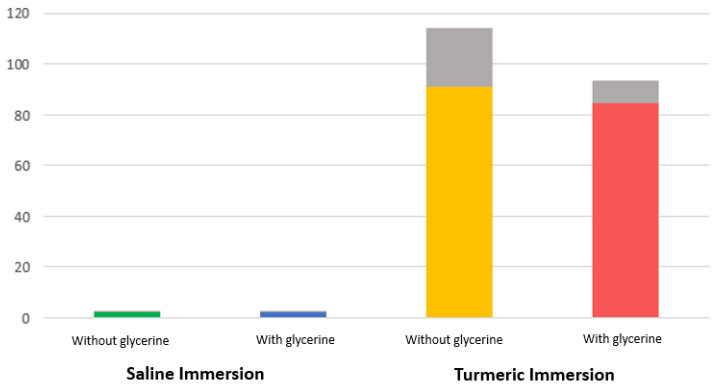

Figure 2. Graph of average color change of nanofiller composite resin ((ΔEab).

Table 1. Characteristics of nanofiller composite resin discoloration data

Group		n	Mean + SD	Normality (p)	Homogeneity (p)
Saline	Without Glycerin	7	2.20± 0.19	0.061*	0.184**
	With Glycerin	7	2.09± 0.52	0.784*	0.016
Turmeric Extract	Without Glycerin	7	90.97±23.26	0.130*	0.000
	With Glycerin	7	84.37± 9.24	0.583*	0.004

Description: n = number of samples. Mean = Average color change of nanofiller composite resin (ΔEab). SD = Standard Deviation. * = Shapiro Wilk test with a significant level of 5%: normal data (p > 0.05) ** = Levene's test with a significant level of 5%: homogeneous data ($p > 0.05$).

Table 2. Independent T-test comparative test results

Immersion	Based on glycerin application Mean ± SD		p
	Without Glycerin	With Glycerin	
Saline	2.20 ± 0.19	2.09 ± 0.52	0.599
Turmeric Extract	90.97 ± 23.26	84.37 ± 9.24	0.506
Glycerin application	**Based on Immersion Mean ± SD**		**p**
	Saline	Turmeric Extract	
Without Glycerin	2.20 ± 0.19	90.97 ± 23.26	0.000*
With Glycerin	2.09 ± 0.52	84.37 ± 9.24	0.000*

* = $p<0.05$ (Significantly different with a significant level of 5%)

the color change of nanofiller composite resin soaked in turmeric extract for 4 days without glycerin application had an average color change (90.97 + 23.26 ΔEab) higher than the average color change of nanofiller composite resin. with glycerin application (84.37 + 9.24 ΔEab). Likewise, in saline immersion, the average color change in the sample group without glycerin application (2.20 + 0.19) was higher than the average color change in nanofiller composite resin with glycerin application (2.09 + 0.52). However, statistical testing using the Independent T-test, found no significant difference ($p > 0.05$) between the average color change of nanofiller composite resin without glycerin application and with glycerin application, both in turmeric extract immersion and saline immersion. Meanwhile, based on the type of immersion solution, the descriptive analysis results show that the average color change of nanofiller composite resin by immersion of turmeric extract is higher than the average color change of nanofiller composite resin soaked in saline solution, both in the treatment group without glycerin application. Statistical testing using the Independent T-test also showed that there was a significant difference between the average color change of nanofiller composite resin based on soaking, both in the treatment group without glycerin application ($p=0.000$, $p<0.05$) and in the treatment group with glycerin application ($p=0.000$, $p<0.05$). This can also be interpreted if immersion with turmeric extract has a significant impact on increasing the color change score of nanofiller composite resin compared to saline immersion with either glycerin application or without glycerin application.

The color changes that occur in the composite resin can be observed visually or using instruments. However, the use of instruments, namely a spectrophotometer and colorimeter, is preferred over a visual inspection to detect and evaluate changes in color because it is considered more objective and reduces the probability of error due to subjective interpretation.[15,6] The instrument uses the CIE Lab system developed in 1978 by the Commission Internationale de l'Eclairage. Measurements using this system are based on human perception[6]. Referring to the CIE Lab system, the color change or (ΔE) is measured using a 3-dimensional variation of the color space with the CIE Lab scale coordinate system, namely L*, a*, and b*.[19,20] L* (*lightness)* has a scale of 0 to indicate black to 100 to indicate white. a* is chroma which interprets reddish color for positive values and green for negative values. b* is chroma which interprets yellowish for positive values and bluish for negative values.[6,21]

The results in this study are inconsistent with the theory which should indicate a significant color difference between samples with glycerin application and without glycerin application in turmeric extract immersion. In theory, glycerin can be used as an air-inhibition coating aimed at preventing the reaction of free radicals with oxygen during the composite resin polymerization process so that no OIL is formed.[17,18] *Oxygen-Inhibited Layer* (OIL) is a layer containing residual monomers resulting from the involvement of oxygen which binds to free radicals during the polymerization reaction thereby converting highly reactive radicals into stable hydroperoxides. Free radicals that have reacted with oxygen will not bind to the monomer and produce peroxide radicals which reduce the degree of conversion and also produce bonds that are prone to discoloration and form a rough restoration surface which can cause discoloration.[9,17,18,19]

However, research conducted by Borges, et al. (2021) showed the same results as this study, namely that there was no significant difference in the use of glycerin on the surface discoloration of composite resin samples that were treated by immersion in a drink containing color.[9] This may occur due to several limitations such as the experimental design that should be adjusted in order to be able to represent the condition in the oral cavity and the activity of consuming materials containing food coloring so as to produce more relevant data. The same limitation also occurs in this study, namely the research design which does not represent the condition in the oral cavity and the activity of consuming turmeric extract so that the results of the research are not in accordance with the theory. In addition, this study used turmeric extract with a high curcumin content of 11.86% in a 4-day soaking time which allowed a bias in the results of the color change score of the nanofiller composite resin considering other studies using turmeric solution as a soaking medium as was done Yew, H.Z. (2012), Thaliyadeth, et al, (2019), and Bhat, et al (2019)[22,23,24] only using turmeric solution without extraction so that the curcumin content in the media used was much less than that used in this study. The content of curcuminoids in turmeric is as much as 3-15% with the most curcumin component being 71.5%. The concentration of curcumin compounds also remains dominant in the form of turmeric powder, which is 7.798%.[25] The amount of glycerin applied is also an aspect that needs further analysis as a limitation in this study. The study was conducted using glycerin in an amount of 50 microliters which was applied to the surface of a composite resin sample with a diameter of 10 mm so that the glycerin used in that amount resulted in inadequate surface coating ability during irradiation. These limitations can affect the results of the study.

The results of this study also show that soaking turmeric extract has a significant effect on increasing the color change score of the nanofiller composite resin which is in accordance with previous studies in assessing the color change of composite resin in immersion of turmeric solution.[23,24] In several previous studies that aimed to determine the color change in composite resin in different immersion media, immersion in turmeric solution had the highest color change score (ΔE) compared to other immersion media. These results can occur because turmeric has small molecular particles[7] so that it is easy to enter with water considering that the 3M ESPE Filtek Z350 nanofiller composite resin contains TEGDMA which has a heterogeneous polymer form resulting in microporous formations.[26] The level of discoloration in nanohybrid and nanofiller composite resins due to exposure to turmeric is influenced by the concentration and duration of exposure

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to the composite resin with turmeric solution. Research conducted by Monika, et al, (2018) proved that samples soaked in turmeric solution for 48 hours had a higher color change score (ΔE) than samples soaked in turmeric solution for 24 hours. The study also showed that there was a significant difference between the color changes that occurred in samples soaked in turmeric solution with the smallest concentration of 0.015% and samples soaked in turmeric solution with higher concentrations of 0.15%, 1.15%, and 15%. %.[21]

From this study it was concluded that the composite resin with glycerin application experienced less discoloration (ΔEab = 84.37 + 9.24) than the composite resin without glycerin application (ΔEab = 90.97 + 23.26) in turmeric extract immersion, but statistically not significant.

REFERENCES

1. Kementerian Kesehatan Republik Indonesia. Riset Kesehatan Dasar 2018.
2. Zhou X, Huang X, Li M, et al. Development and status of resin composite as dental restorative materials. Journal of Applied Polymer Science; 136. Epub ahead of print 20 November 2019.
3. Anusavice KJ, Chiayi S, Rawls HR. Phillips' Science of Dental Materials (Anusavice Phillip's Science of Dental Materials), 12E (2012).
4. Sakaguchi RL, Ferracane JL, Powers JM. Craig's restorative dental materials. 2012.
5. Alzraikat H, Burrow MF, Maghaireh GA, et al. Nanofilled resin composite properties and clinical performance: A review. Oper Dent 2018; 43: E173–E190.
6. Khosravi M, Esmaeili B, Nikzad F, et al. Color Stability of Nanofilled and Microhybrid Resin-Based Composites Following Exposure to Chlorhexidine Mouthrinses: An In Vitro Study, www.jdt.tums.ac.ir (2016).
7. Safira Virgiani Y, Soetojo A, Zubaidah N. Literature Review Discoloration of Nanohybrid and Nanofiller Resin Composites after Exposure to Turmeric, https://e-journal.unair.ac.id/CDJ (2021).
8. Ultrani Tangkudung M, Chandra Trilaksana A, Pendidikan Dokter Gigi Spesialis Konservasi Gigi P. Glycerin for resin composite restoration: Literature Review Penggunaan gliserin pada restorasi resin komposit: kajian pustaka. 2019.
9. Borges MG, Silva GR, Neves FT, et al. Oxygen inhibition of surface composites and its correlation with degree of conversion and colorstability. Braz Dent J 2021; 31: 91–97.
10. Istibsyaroh, Lestari S, Nugroho R. Perubahan Warna Resin Komposit Nanofiller Setelah Perendaman Dalam Minuman Susu Fermentasi (Penelitian In Vitro). 2018; 10: 2087–5053.
11. Aulia NR, Puspitasari D, Nahzi MYI. Perbedaan perubahan warna resin komposit nanofiller pada perendaman air rebusan daun sirih merah (Piper crocatum) dan obat kumur non-alkohol. Dentino: Jurnal Kedokteran Gigi 2017; 2: 50–55.
12. Fernandes RA, Strazzi-Sahyon HB, Suzuki TYU, et al. Effect of dental bleaching on the microhardness and surface roughness of sealed composite resins. Restor Dent Endod; 45. Epub ahead of print 2020.
13. Widayati A, Candrasari DS, Mariana LJ, et al. Perceptions of Traditional Medicines For Self-Medication Among People in Dieng Plateau Central Java Province, Indonesia. Jurnal Riset Kesehatan 2021; 10: 132–138.
14. Harmayani E, Anal AK, Wichienchot S, et al. Healthy food traditions of Asia: Exploratory case studies from Indonesia, Thailand, Malaysia, and Nepal. Journal of Ethnic Foods; 6. Epub ahead of print 2019.
15. Singh SV, Nikhil V. An In-Vitro Evaluation of Tea and Turmeric Solution on the Color Stability of Nanocomposite and Microhybrid Composites. Dental Journal of Advance Studies; 1.
16. Sachdeva S, Das S, Midday AR, et al. Staining Susceptibility of Dental Composite Resins with Various Nano-Filler Technologies. Cumhuriyet Dental Journal 2022; 25: 29–35.
17. Zakiyah D, Effendy R, Arif EP, et al. The effect of glycerin on the surface hardness and roughness of nanofill composite. Conservative Dentistry Journal 2019; 8: 104–111.
18. Tri Mardianti F, Sampoerna G. Literature Review Benefit of Glycerine on Surface Hardness of Hybrid & Nanofill Resin Composite. CDJ Conservative Dentistry Journal 2021; 11: 28–31.
19. Marigo L, Nocca G, Fiorenzano G, et al. Influences of Different Air-Inhibition Coatings on Monomer Release, Microhardness, and Color Stability of Two Composite Materials. Biomed Res Int; 2019. Epub ahead of print 2019.
20. Nasution MF, Maria F, Suprastiwi E, et al. Comparison and correlation of nanofiller and nanohybrid color stabilities with barium leaching. Journal of Stomatology 2020; 73: 295–301.
21. Monika A, Irawan B, Indriani DJ. Effects of turmeric (Curcuma domestica) on color changes of nanohybrid composite resins. In: Journal of Physics: Conference Series. Institute of Physics Publishing, 2018. Epub ahead of print 7 September 2018.
22. Zenn Yew H. A report submitted to the University of Adelaide in partial fulfilment of the requirements for the degree of Doctor of Clinical Dentistry Colour Changes in Nano-Filled And Micro-Hybrid Composite Resins on Exposure to Spices. 2012.
23. Thaliyadeth LB, Chakravarthy D, Neelamurthy PS, et al. Comparative evaluation of color stability of nanohybrid direct and indirect resin-based composites to Indian spices: An in vitro study. Journal of Contemporary Dental Practice 2019; 20: 1071–1076.
24. Bhat MM, Mir A, Farooq R, et al. Color Stability of Composite Resin after Immersion in Local Kashmiri Staining Solutions and Beverages. International Journal of Contemporary Medical Research [IJCMR]; 6. Epub ahead of print March 2019.
25. Suprihatin T, Rahayu S, Rifa M, et al. Senyawa pada Serbuk Rimpang Kunyit (Curcuma longa L.) yang Berpotensi sebagai Antioksidan Compounds in Turmeric Rhizome Powder (Curcuma longa L.) which have Potential as Antioxidants. Buletin Anatomi dan Fisiologi ; 5.
26. Gabrillah Saetikho S, Lestari S, Nugroho R. Effect of Glycerin Application on Discoloration of Nanofiller Composite in Instant Coffee. Indonesian Dental Association Journal of Indonesian Dental Association. Epub ahead of print 2022.