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# Color match analysis of single-shade and multi-shade composite resins using spectrophotometric and visual methods after bleaching

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The aim of this study is to evaluate the color match of the materials after the staining and bleaching procedures applied to the teeth restored with single-shade and multi-shade composite resins. Cavities prepared on the facial surface of human incisors were restored with two different composite resins. After 24 h, the color matching parameters between the initial filling-tooth of the samples were recorded. Then, the color measurements of the samples subjected to the coloring process were repeated. Each composite resin group was randomly divided into 2 subgroups and home and office bleaching methods were applied to the samples. After bleaching, color measurements were repeated. In terms of periods, a statistically significant difference was found in $\Delta E$ values 1 day and 28 days after bleaching ($p<0.05$). In addition, it was found that the color match between filling-tooth was generally weaker in Omnichroma material and after home bleaching.

*Keywords*: Bleaching, Chameleon effect, Color match, Composite resin, Esthetic composite resin

## INTRODUCTION

Tooth-colored dental composite materials have been meeting the functional and esthetic expectations of patients and physicians, especially in the anterior region, for a long time[1]. Although dental composites, which are intended to maintain this harmony by fully adapting to the patient's tooth color, have very different color scales, it still remains a challenge for the dentist to achieve a full harmony between the restoration and the color of the surrounding tooth tissue[2,3]. Providing esthetic results with the use of resin composite filling materials is closely related not only to the choice of color but also to the color properties of these materials[4]. Despite all this, the color incompatibility between tooth-filling material may cause additional costs and dissatisfaction for the patient. This situation may negatively affect the reputation of the physician[5].

Although the color harmony between tooth-filling is defined in more scientific terms as 'assimilation/blending/shifting' in terminology, it is referred to as a 'chameleon effect' in today's dental jargon[6]. The purpose of using single-shade (universal color) resin composite is to provide color harmony by replacing different colors with chameleon (chameleon) or blending effect[7]. These composites not only prevent loss of time in color selection, but also aim to eliminate the necessity of composites including different colors in the clinic.

When the studies on single-shade composite are examined in terms of color matching, there is a difference between the results obtained. In some of the studies, it has been concluded that single-shade composite is positive in terms of color matching and is more practical in clinical use[8,9]. However, contrary to these findings, some studies have reported that especially multi-shade composites are more successful in terms of color matching and are more effective in reducing esthetic errors in clinical use[10,11]. Therefore, further studies are required to obtain more conclusive results.

The expectation of the dentist from anterior restorations is not only to ensure compliance with the tooth, but also to maintain it. In the mouth, especially anterior region restorations are exposed to many effects. Colored foods and beverages with coloring properties or pigments in cigarettes cause discoloration of anterior restorations[12]. Tooth color can be improved with treatments such as whitening toothpastes and polishing, or in-office or home bleaching treatment can be recommended[13,14]. The bleaching process can remove the discoloration on the composites and return them to their original color, but the whitening may not be as in the natural tooth structure. In fact, care should be taken as bleaching process carries the risk of increasing the surface roughness of the restoration and making the filling more prone to discoloration[15,16].

Renewing the old solid composite, which seems incompatible after the coloring and whitening process, will lead to the loss of unwanted material in the tooth, and this is an avoidable situation for both the physician and the patient. New developments in dental materials aim to support the natural tooth structure and to preserve the esthetic appearance of the tooth for a long time despite all conditions. There are a limited number of studies examining the color match between natural teeth and composite restorations created by bleaching after coloring in restored teeth.

Therefore, in this study, it was aimed to compare the color match of the single-shade composite and the multi-shade composite resin after the staining and bleaching processes using spectrophotometric and a visual method.

The null hypotheses tested were that (1) the color

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match between tooth-filling would not depend on the type of restorative material and (2) the bleaching process would not affect the color match between tooth-filling.

## MATERIALS AND METHODS

*Sample preparation*

This study was carried out with the ethical approval of Atatürk University Faculty of Dentistry Ethics Committee (12.29.2022/12) and conducted in accordance with the Declaration of Helsinki. Teeth were extracted for periodontal reasons, and patients' consent was obtained prior to the study.

A total of 80 extracted human incisors were freshly collected. The teeth were scaled and polished using a rubber cup and pumice. A total of 80 extracted human incisors were freshly collected. These teeth were visually analyzed with the VITA Classical color guide (VITA Zahnfabrik, Bad Säckingen, Germany) and those with A3 color were included in the study, while teeth with discoloration, caries and enamel defects were excluded. Cavities of 3×5 mm width and 2 mm depth were prepared on the facial surfaces of the selected teeth. A silicone guide-mold was prepared in these dimensions to ensure standardization in cavity dimensions and bevel was not applied in the preparation. Single Bond Universal (3M Oral Care, St. Paul, MN, USA) adhesive was applied to the cavities to be restored according to the manufacturer's instructions with a microbrush, air-sprayed for 5 s to evaporate the solvent, and then polymerized for 20 s using a Curing Pen (light intensity:1,200 mW/cm$^2$, Eighteeth, Changzhou, China,). The light intensity of the light-curing unit used for the polymerization process was checked using a radiometer (Hilux UltraPlus Curing Units, Benlioglu Dental, Istanbul, Turkey). Then, the teeth were divided into 2 groups according to the type of composite to be placed. Information on the composite materials used in this study is given in Table 1. One group was restored using Clearfil Majesty Esthetic material (Kuraray, Tokyo, Japan) and the other group using Omnichroma (Tokuyama Dental, Tokyo, Japan) material. A sequence of diamond discs (Sof-Lex, 3M ESPE, St. Paul, MN, USA) was used for finishing and polishing. Coarse, medium and fine discs were used sequentially for 15 s each. The speed of the rotary tool was set to the lowest mode while polishing. Finishing and polishing processes were always applied in the same dental unit and by the same physician.

*Color matching evaluation*

1. Visual analysis

Two blinded clinicians evaluated the samples' shade at each time point. Under illumination of a D65 light source and using a 0°/45° viewing geometry, the observers performed blind visual evaluations of all specimens in a random order. Restored teeth were placed on neutral gray paper, under appropriate clinical lighting, and at an angle of 90° to the specimen surface. In this way, it was aimed to simulate clinical conditions. The observers were allowed 25 s to rank the each tooth as either: (a) best match, (b) intermediate match, and (c) poorest match, one in each category. Observers were asked to look at a neutral blue background after each shade was evaluated to avoid eye strain[17].

2. Spectrophotometric analysis

Baseline color measurements were made using a spectrophotometer (Spectro ShadeTM Micro, MHT Optic Research, Milan, Italy) of the samples, which were kept in distilled water for 24 h after polymerization.

For spectrophotometric measurement, the samples were gently air dried and fixed with white adhesive on a white surface. The measurement was made by placing the measuring tip perpendicular to the facial restoration and the device was calibrated between measurements. *L*a*b** values and color of 4 different regions on the buccal/labial surface of the teeth were recorded. In order to determine the color of the tooth surrounding the

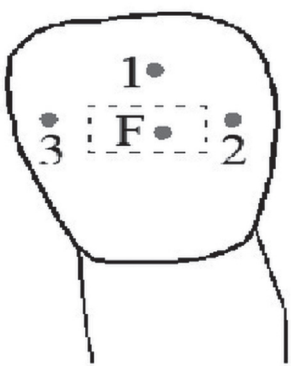


Fig. 1 Schematic representation of color measurement. Restoration was shown with the F symbol. Three readings were made on the tooth using spectrophotometer and the fourth was taken over the restoration.

Table 1 Information on the restorative materials used in the study

| Material | Matrix | Filler | Filler content | Lot no |
|---|---|---|---|---|
| Omnichroma (Tokuyama Dental, Tokyo, Japan) | TEGDMA UDMA | Supra-nano spherical filler, Composite filler (260 nm spherical $SiO_2$-ZrO2) | 79/68 | O41M1 |
| Clearfil Majesty Esthetic A3 (Kuraray Noritake, Tokyo, Japan) | Bis-GMA | Barium glass filler, micro glass filler (1.5 Bis-GMA μm), nano glass filler (20 nm), pre-polymerized organic filler | 78/66 | 7B0160 |

filling, measurements were made from 3 different parts of the tooth and the average was recorded. The fourth area was taken directly over the filling (Fig. 1).

Color measurements of the samples were repeated at baseline (T1), after the staining process (T2), 1 day after bleaching process (T3), 7 days after bleaching process (T4), 14 days after bleaching process (T5) and 28 days after bleaching process (T6).

The color differences between filling-tooth of the samples for each period were calculated with the formula CIEDE2000 ($\Delta E_{00}$)[18].

$$\Delta E_{00}=[(\Delta L'/K_L S_L)^2+(\Delta C'/K_C S_C)^2+(\Delta H'/K_H S_H)^2 +R_T(\Delta C'/K_C S_C)(\Delta H'/K_H S_H)]^{1/2}$$

where $\Delta L'$, $\Delta C'$, and $\Delta H'$ were considered lightness, chroma, and hue differences between color measurements. $K_L$, KC, and $K_H$ were symbols that indicate the influence of viewing and lighting conditions and were set to[19]. $R_T$ shows the interaction of hue and chroma differences in the blue area and shows the weighting for color difference adjustment in case of position change of $S_L$, $S_C$ and $S_H$, $L^*$, $a^*$ and $b^*$ coordinates[19,20].

In this study, the CIEDE2000 color difference formula is based on the evaluation of color differences. The 50%:50% perceptibility and 50%:50% the clinical acceptability thresholds for the CIEDE2000 are set to $\Delta E_{00}>0.8$ units and $\Delta E_{00}\leq 1.8$ units, respectively[21,22].

*Staining process*

After the baseline color measurement, samples were colored with coffee (Nescafe 3-in-1, 3 g of coffee powder dissolved in 150 mL of boiling water according to the manufacturer's recommendation) for 5 days at room temperature and the coffee solution was changed daily. It was reported that the average coffee consumption per day is 3.2 cups, and the time to consume a cup of coffee is 15 min[23]. Therefore, this 5-day coloring simulates approximately 5 months of coffee consumption.

*Bleaching process*

After staining, each composite group was divided into 2 subgroups, and samples were subjected to office bleaching (Opalescence Boost 40%) and home bleaching (Opalescence PF 16%) ($n$=20). Bleaching materials and their application procedures were shown in Table 2. The bleaching process was implemented by applying it on the teeth in the specified cycles, and it was removed with

Table 2 Information on the bleaching materials used in the study

| Bleaching agents | Contents | Application procedure | Lot no |
|---|---|---|---|
| Opalescence Boost 40% in-office bleaching agent (Ultradent® Products, South Jordan, UT, USA) | 40% hydrogen peroxide ($H_2O_2$) | 2 cycles of 20 min, once a week for 2 weeks | BHC2Y |
| Opalescence PF 16% home bleaching agent (Ultradent® Products) | 16% carbamide peroxide ($CH_4K_2O$-$H_2O_2$) | 4 h/day for 14 days | BGGL7 |

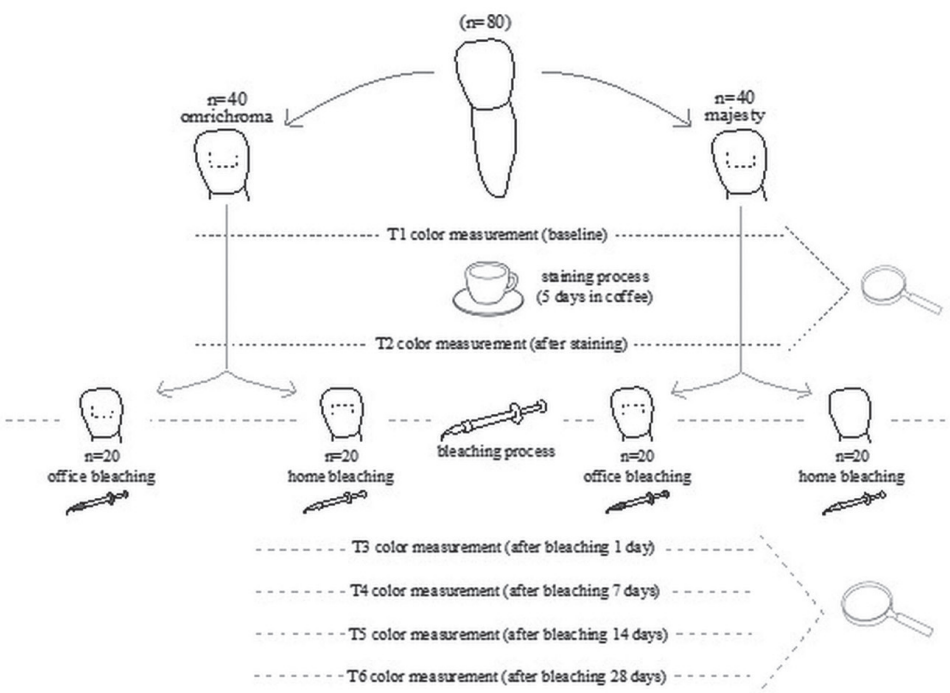


Fig. 2 Flow chart of the study.

a clean cotton pellet at the end of the application period. Between cycles, the samples were washed and returned to distilled water. All samples were stored in distilled water when bleaching was not applied.

Color measurements of all samples with spectrophotometer and visual evaluations were performed again at 1,7,14 and 28 days after bleaching procedures. The flow chart of the study is given in Fig. 2.

*Statistical anaysis*

For the statistical analysis of the data obtained, the SPSS 20 (IBM, Chicago, IL, USA) statistical package program was used and the distribution of the data and the homogeneity of the variance were analyzed using Kolmogorov-Smirnov and Levene tests, respectively. Repeated Measures ANOVA and LSD *post-hoc* tests were used to compare the $\Delta E$ values obtained from the measurement periods for each group. One-way ANOVA and Tukey *post-hoc* tests were used to compare the material and bleaching groups in each measurement period. For all analyses, the level of significance was set to $\alpha$=0.05.

## RESULTS

In this study, $\Delta E$>0.80 values were taken as the perceptible color change, and $\Delta E$>1.8 values as clinically unacceptable color change limits[20,21]. In the study, statistically significant differences were found between the groups in the application periods ($p$<0.05) (Table 3). In the baseline spectrophotometer measurements, $\Delta E$ values of Clearfil Majesty Esthetic composite samples were lower than those of Omnichroma samples, but this difference was not statistically significant ($p$>0.05). Although there was an increase in $\Delta E$ values of both materials after staining, the greatest increase was observed 1 day after bleaching ($p$<0.05). However, these values decreased after the 7-day period. In the evaluation performed 1 day after bleaching, the highest $\Delta E$ value was found in the Omnichroma group in which office bleaching was applied (14.49±8.28), while the lowest $\Delta E$ value was observed in the Omnichroma group in which home bleaching was applied (4.20±2.33). In the 28-day period, the Clearfil Majesty Esthetic group, in which home bleaching was applied, showed a higher $\Delta E$ value compared to the other groups ($p$<0.05) (Table 4). However, all measured $\Delta E$ values were above the clinically accepted limit ($\Delta E$>1.8). The sample numbers

Table 3 Results of repeated measures ANOVA

| Source | SS | df | MS | F | $p$ |
|---|---|---|---|---|---|
| Period | 1,778.740 | 1.613 | 1,102.643 | 54.470 | 0.000* |
| Period*Composites | 99.238 | 1.613 | 61.518 | 3.039 | 0.062 |
| Period*Bleaching | 1,016.660 | 1.613 | 630.229 | 31.133 | 0.000* |
| Period*Composites *Bleaching | 146.049 | 1.613 | 5.692 | 90.536 | 0.020* |
| Error | 2,481.803 | 122.600 | 20.243 | — | — |

SS: Sum of squares, MS: mean of squares, *$p$<0.05 significant

Table 4 $\Delta E_{00}$ (mean±standard deviation) values of the groups and statistical comparison results

| Composites | Bleaching Groups | Baseline | After staining | 1 day after bleaching | 7 days after bleaching | 14 days after bleaching | 28 days after bleaching |
|---|---|---|---|---|---|---|---|
| Omnichroma | OB | 2.24 (0.65) Aa | 3.72 (1.57) Ab | 14.49 (8.28) Cc | 3.45 (1.77) Abd | 3.89 (1.84) Abd | 3.17 (1.61) Ad |
| | HB | 2.42 (1.10) Aa | 2.88 (1.66) Aab | 4.20 (2.33) Ac | 3.88 (1.63) Ac | 3.62 (1.69) Abc | 4.27 (2.17) Ac |
| CME | OB | 1.97 (0.89) Aa | 2.77 (1.64) Aab | 8.88 (6.91) Bc | 2.88 (1.50) Ab | 2.82 (1.50) Ab | 3.03 (1.31) Ab |
| | HB | 1.79 (1.09) Aa | 2.81 (1.14) Ab | 5.05 (2.04) ABce | 4.01 (1.35) Acd | 3.51 (1.63) Abd | 5.76 (1.55) Be |
| $p$ | | 0.161 | 0.157 | 0.000* | 0.105 | 0.223 | 0.000* |

CME: Clearfil Majesty Esthetic, OB: office bleaching, HB: home bleaching, $p$<0.05 significant. Upper case letters in the same column show the comparison results of groups for each period (One-way ANOVA). Lower case letters in the same row show the comparison results of periods for each material (Repeated Measures ANOVA). Different letters indicate statistical significance.

Table 5 Sample numbers within the clinically acceptable limit ($\Delta E$<1.8) for each group

| Composites | Bleaching groups | Baseline | After staining | 1 day after bleaching | 7 days after bleaching | 14 days after bleaching | 28 days after bleaching |
|---|---|---|---|---|---|---|---|
| Omnichroma | OB | 9 | 6 | 0 | 5 | 7 | 4 |
| | HB | 13 | 4 | 0 | 0 | 2 | 0 |
| CME | OB | 4 | 1 | 0 | 2 | 1 | 3 |
| | HB | 3 | 7 | 1 | 2 | 2 | 0 |

CME: Clearfil Majesty Esthetic, OB: office bleaching, HB: home bleaching

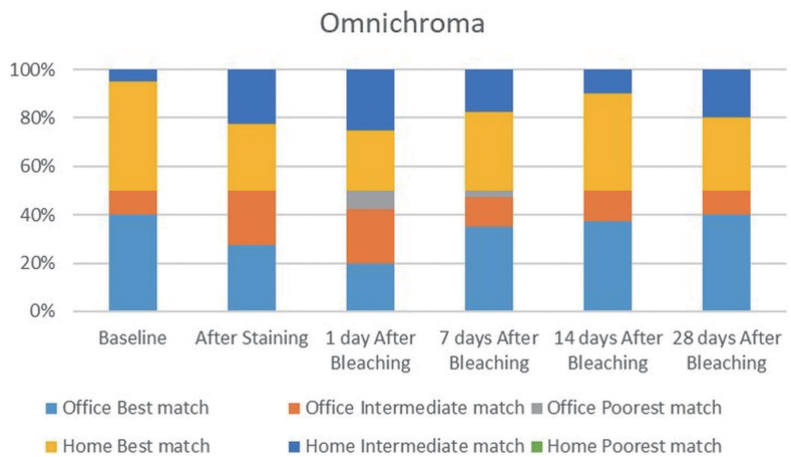


Fig. 3 Color match scores of Omnichroma material.

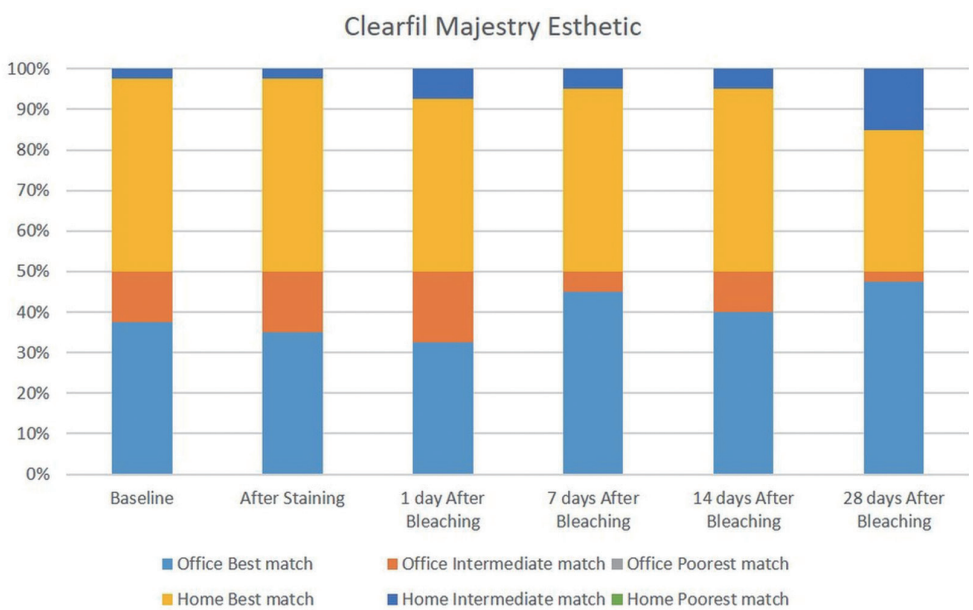


Fig. 4 Color match scores of Clearfil Majesty Esthetic material.

within the clinically acceptable limit for each group were given in Table 5. In terms of bleaching methods, it was found that there were more samples in the acceptable limit in the office groups after bleaching. In terms of composite resins, more samples were found within the clinically acceptable limit in groups containing Omnichroma material (Table 5).

When the $\Delta E$ values in the baseline, after staining and bleaching periods were examined for each group, $\Delta E$ values increased in both materials 1 day after office

bleaching, but decreased in the other periods. From the period of 7 days after bleaching, higher $\Delta E$ values were obtained in samples with home-type bleaching in both materials (Table 4). When the findings were evaluated in terms of materials, it was found that the color match between filling-tooth was generally weaker in Omnichroma material.

On visual assessment, none of the samples showed poor match at baseline assessments. After staining, the Clearfil Majesty Esthetic samples received a total of 22 'best match' scores, while the Omnichroma samples received 33 'best match' scores (Figs. 3 and 4). In the measurement performed 1 day after office bleaching, 3 samples of Omnichroma samples had "poor match" scores (Fig. 3). In the 28-day measurements after bleaching, the Clearfil Majesty Esthetic groups had higher 'best match' scores than the Omnichroma groups (Figs. 3 and 4).

## DISCUSSION

While the anterior teeth are exposed to staining and bleaching processes, it is a matter of curiosity how well the restorations on them can adapt to this match. It is of great importance in material selection to predict how the material in which the tooth is restored responds to the staining and teeth bleaching procedures, and whether it can maintain the match achieved with the tooth color.

In the present study, color match between the tooth-filling after the staining and bleaching processes applied to single-shade and multi-shade composite resins was compared. Considering the results of the study, the highest $\Delta E$ values were observed in the period 1 day after office bleaching, while home bleaching caused a greater difference in other periods. In terms of materials, it was found that the match between the tooth- filling was higher in the Clearfil Majesty Esthetic material. Therefore, both null hypotheses were rejected.

Compatibility of the composite restoration with the surrounding tooth structure depends on many factors such as surface texture, contours of the restoration, preparation design, size of the carious structure[24]. For this reason, the cavity design and size was kept constant in this study. Since the data is measured with a spectrophotometer, it contains scores of both "objective" and visual assessment with high adaptability to daily life. CIE $L^*a^*b^*$ color coordinates are used to calculate the color difference between two samples. Later, the formula was updated to CIEDE2000 with improved reliability in 2001. With the new system, it is aimed to reduce the variation between the calculated and perceived color differences. CIEDE2000 color difference calculation formula was used in the present study because it gives more accurate results and is up-to-date[18,25,26].

Recently, composite resins have shown developments that will save the clinician time and meet high aesthetic expectations[27]. One of these developments is the monochrome composite Omnichroma. Omnichroma, containing 260 nm spherical uniform filler, can adapt to various colors of teeth by developing a structural color phenomenon and a wide reflection spectrum, showing a chameleon effect[28]. This gives the clinician the freedom to use a single material that matches the color of many different teeth[29]. When the literature was examined, although there are studies evaluating the compatibility of Omnichroma with the surrounding dental tissue in the cavity where it is placed, there are differences in terms of results. Iyer *et al.*[17] found that Omnichroma showed lower visual and instrumental color matching ability, compared to 2 other multi-shade composites. In the same study, it was stated that multi-shade composite system may be better to achieve the best esthetic result. In another study[10], it was reported that Omnichroma showed higher $\Delta E$ scores in photographic analysis, compared to 3 other multi-shade composites. Although the study showed that Omnichroma had the potential to mix similarly with different tones, it was noted that there was a major concern with the translucency parameter to better match the resin. It was mentioned that this problem can be solved by compensating for the dark background of the oral cavity by using the 'blocker' produced by the Omnichroma manufacturer. Riad *et al.*[30], reported that Omnichroma monochrome resin composite matches the enamel color for class V restorations, and the blending effect of the resin composite is promising. Considering the baseline evaluation in the present study, it was found that although the Omnichroma material showed higher $\Delta E$ values than the Clearfil Majesty Esthetic composite, this difference was not significant ($p>0.05$). Considering the number of clinically acceptable samples, although Omnichroma contains more samples, when the mean $\Delta E$ values of all samples are taken, all of mean $\Delta E$ values in both materials were found below the clinically acceptable limit. In the visual evaluation, the two composite groups had similar match scores.

Not only the match of anterior region composite resin restorations, but also the color stability is important. Coloring of composite resin restorations is considered as an esthetic failure and, the problem is unfortunately solved by renewing the restoration. This means extra cost and time loss for both patient and physician[31]. Coffee, in particular, causes color change by showing strong affinity for the polymers in the structure of the composite with its yellow pigment[32]. Coffee has been used in many studies to change the color of the samples because it has intense coloration and is widely consumed in the world[33-35]. In the present study, coffee was preferred as the coloring solution. It has been reported that the average coffee consumption per day is 3.2 cups, and the time to consume a cup of coffee is 15 min[36]. In the present study, samples were colored with 3 g of coffee powder dissolved in 150 mL of boiling water for 5 days. This 5-day coloring, in which the solution is changed daily, simulates approximately 5 months of coffee consumption[23]. The Clearfil Majesty Esthetic composite used in the present study was chosen because it was shown to be resistant to coloration in many studies. Cangül *et al.*[37] in their study investigating the color changes of 4 different aesthetic composite resins (Estelite Sigma Quick, G-Aenial, Clearfil Majesty Esthetic, Ceram X One), they found that the color

stability of the Clearfil Majesty Esthetic material was better. Öztürk *et al*.[38] evaluated the coloration resistance of 4 different nanofil composites and found that the Clearfil Majesty Esthetic material was the composite material that showed the least color change against cola and lemonade solutions. When the color susceptibility of the materials was examined, it was seen that the filler type played an important role. Inorganic fillers separate from the resin matrix and form voids, resulting in an increase in surface roughness. In nanohybrid composites, the part separated from the material is smaller, so it is more resistant to coloration. Beltrami *et al*.[39] stated that when the coloration of esthetic restorative materials was examined after they were kept in coffee solution, the least color change was observed in nanofill composites, followed by nanohybrid and microhybrid composites. In addition, it was stated that as the particle size of the composite resin decreases, discoloration decreases due to the decrease in surface roughness[40]. Another factor is the amount of resin in the composite. Increasing this amount causes the material to absorb more water and consequently hydrolytic degradation[41]. It was reported that the resulting hydrolytic decomposition increased the coloration[42]. Another factor affecting coloration is the monomer content. It was reported that TEGDMA based composites showed more coloration than Bis-GMA based composites because Bis-GMA provided rigid network formation. In addition, UDMA and Bis-EMA based composites were more resistant to coloration[43]. Aydın *et al*.[11] in their study comparing the color change of nanofil, nanohybrid composites and Omnichroma, found that Omnichroma showed statistically significantly more color change in all time periods. Although there was no statistically significant difference between the groups after the staining procedure in the present study, the Omnichroma group showed higher $\Delta E_{00}$ values, compared to the Clearfil Majesty Esthetic group. In visual evaluation, a total of 33 samples in the Clearfil Majesty Esthetic group received the 'best match score', while this score was 22 in the Omnichroma group. The presence of TEGDMA monomer in the structure of Omnichroma may have caused this situation.

In the literature, the effects of bleaching procedures on the resin composite surface was evaluated in many studies[44-47], but it was observed that the studies on the effects of bleaching materials on the match between tooth-filling were limited[48,49]. It was shown that hydrogen peroxide in the bleaching agent produced free radicals and disrupted the polymer network by creating diffusion and penetration on the composite material. Gül *et al*.[50] reported that different bleaching systems caused an increase in the surface roughness of two composites, one of which was Clearfil Majesty Esthetic, and this could be due to deterioration of the resin matrix. Evans[51] evaluated colorimetric and visual color match between tooth-filling in teeth restored with Omnichroma. As a result, they found a significant decrease in the $\Delta E$ values of the tooth, compared to the composite with repeated bleaching treatments. They also found that the color match between the composite and the tooth improved as the bleaching was done. Similarly, Dunn[9]. restored extracted teeth in A1-D4 colors with Omnichroma and evaluated the color match after bleaching. As a result, they found that Omnichroma matched the enamel colors for class V restorations and when bleached, the color match between the tooth-filling was so successful that it could not be detected clinically. Al Samraie *et al*.[52] compared the color match of a conventional multicolor composite and an Omnichroma composite before and after bleaching. They found that the bleaching process affected the color matching of both composites and Omnichroma showed statistically significantly less color difference with the tooth after bleaching, compared to the multicolor composite. Asdagh *et al*.[53] exposed the teeth restored with nanohybrid composite first to the staining procedure and then to home bleaching and found that bleaching increased the color match between the tooth-filling, but this difference was not statistically significant. In the same study, it was concluded that bleaching may be an appropriate treatment to increase the color match between natural teeth and composite restorations in the clinic. In this study, the Omnichroma group, which was applied in-office bleaching, showed significantly higher $\Delta E$ values in the 1-day measurement after bleaching. However, the difference in $\Delta E$ values from the 7th day after bleaching was found to be similar to other periods. It was observed that office bleaching with higher concentrations whitened faster, but after the 7-day period after bleaching, a decrease in $\Delta E$ value was observed with the regression of natural tooth color. When the results were evaluated in general, all samples that applied office or home bleaching showed similar $\Delta E$ values at the end of 28 days, except for the Clearfil Majesty Esthetic home-type group. When the values are examined, it can be said that a weaker color match is obtained with home bleaching than office bleaching.

The limitations of the present study were that only coffee solution was used for coloring restorative materials and since the study was conducted *in vitro*, it could not directly simulate oral conditions.

## CONCLUSIONS

Within the limitations of this current study, it was concluded that:

1. Clearfil Majesty Esthetic material was more successful in terms of color matching between the tooth-filling.
2. The in-office bleaching application had less effect on color matching between the tooth-filling.

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## CONFLICT OF INTEREST

The authors declare no competing interests.

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