

# Investigation of the Effect of Whitening Mouthwashes on the Translucency of Resin Composites at Different Times



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One of the main goals of aesthetic dentistry is to form restoration that complements the optical properties of natural teeth. Optical properties such as translucency and color have the highest impact on natural tooth appearance, as they are the most easily observed.

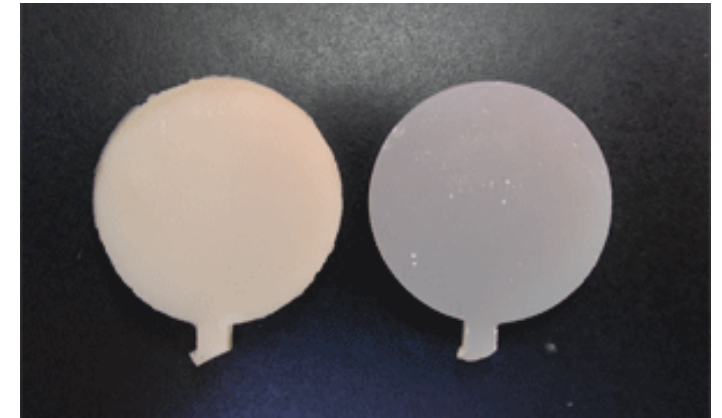
Translucency is defined as the middle of opacity and transparency. Translucent materials allow light to pass through but scatter light in contrast to transparent materials, preventing objects behind them from being seen clearly [1].

The translucency parameter (TP) was used to evaluate the translucency of dental materials. The TP can be measured for materials of a given thickness on an ideal black and white background. In most dental studies on translucency, it is stated to measured using the CIELAB color formula [2].

In the literature, use of the CIEDE2000 color formula, which aims to correct and improve the perceived and calculated color differences of the CIELAB formula, has been suggested [3][4].

2. Salas, M., Lucena, C., Herrera, L. J., Yebra, A., Della Bona, A., Pérez, M. M. Translucency thresholds for dental materials. *Dent. Mater.* **2018**, *34*, 1168–1174. <https://doi.org/10.1016/j.dental.2018.05.001>.
3. Ghinea, R., Pérez, M. M., Herrera, L. J., Rivas, M. J., Yebra, A., Paravina, R. D. Color difference thresholds in dental ceramics. *J. Dent.* **2010**, *38*, e57–e64. <https://doi.org/10.1016/j.jdent.2010.07.008>
4. Pecho, O. E., Ghinea, R., Perez, M. M., Della Bona, A. Influence of Gender on Visual Shade Matching in Dentistry. *J. Esthet. Restor. Dent.* **2017**, *29*, E15–E23. <https://doi.org/10.1111/jerd.12292>

The TP determination depends on the color, thickness, matrix composition of different composite resins, fillers particle size and contents, and type and amount of opacifiers used [2].



Nowadays, it is noteworthy that patients apply to dental clinics with increasing aesthetic expectations and demand for whiter teeth [5].

Stained restorations are a costly treatment option to correct aesthetic problems. Repolishing and the use of whitening products can be considered less costly alternative treatments. Whitening can be accomplished with a variety of methods or systems, often categorized as office bleaching, home bleaching, or over-the-counter (OTC) bleaching [6].

5. Öngül, D., Mim, A., Sahin, H. Değer, S. The effect of mouthrinses on color stability of the restorative material. *J. Istanbul Univ. Fac. Dent.* **2012**, 46, 13-20.
6. Gul, P., Harorlı, O. T., Ocal, I. B., Ergin, Z., & Barutçigil, C. Color recovery effect of different bleaching systems on a discolored composite resin. *Niger. J. Clin. Pract.* **2017**, 20, 1226–1232. [https://doi.org/10.4103/njcp.njcp\\_385\\_16](https://doi.org/10.4103/njcp.njcp_385_16)

Mouthwashes have become a very popular OTC bleaching product due to their ease of application, low cost, and widespread availability in supermarkets and pharmacies [7].

Although sales of whitening mouthrinses have increased in recent years, there is little information about their effectiveness.

Therefore, the aim of the current study was to investigate the effect of whitening mouthrinses on the translucency change of resin composites at different times after coloring with coffee.

**The null hypothesis** of this study is that whitening mouthrinses do not have a significant effect on translucency change.





# **Materials and Methods**



Omnichroma

Estelite  $\Sigma$   
Quick Ant

G-Aenial  
Anterior



# Listerine Advanced White



# Crest 3D White



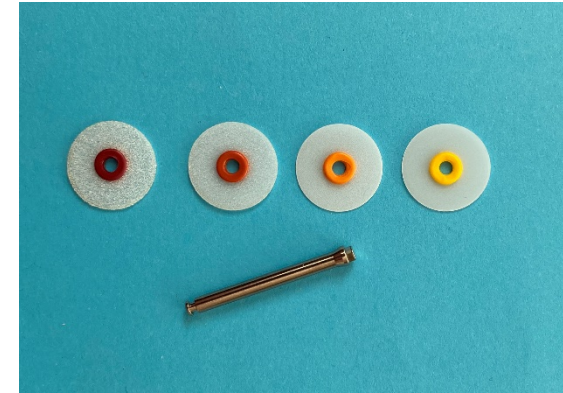
Composite Material/Manufacturer	Type	Component	Filler concentration: weight %– volume %	Lot
G-Aenial Anterior (A2), (GC Corp, Tokyo, Japan)	Microhybrid	UDMA, dimethacrilat co-monomers, prepolymerized organic filler, silica, stronsiyum, lanthanoid florid, fumed silica (0,1–17µm)	76/63	190603B
Estelite Σ Quick (A2), (Tokuyama Dental, Tokyo, Japan)	Submicron composite filler	Spherical submicron filler (0,1- 0,3 µm) Bis-GMA, TEGDMA, silica-zirconia	82/71	271E79
Omnichroma (Tokuyama Dental, Tokyo, Japan)	Supra-nano composite filler	UDMA, TEGDMA, Uniform size supra-nano spherical filler (260nm spherical SiO <sub>2</sub> -ZrO <sub>2</sub> ), composite filler (260nm spherical SiO <sub>2</sub> -ZrO <sub>2</sub> )	79/68	021E10
Bis-GMA: bisphenol A glycol dimethacrylate; TEGDMA: triethylene glycol dimethacrylate, UDMA: urethane dimethacrylate				
Mouthrinses / Manufacturer	Ingredients			
Listerine Advanced White (Johnson & Johnson Consumer Services EAME Limited, Maidenhead, UK)	Aqua, alcohol, sorbitol, tetrapotassium Pyrophosphate, Pentasodium Triphosphate, Citric Acid, poloxamer 407, sodium benzoate, eucalyptol, thymol, menthol, sodium saccharin, sodium fluoride, tetrasodium pyrophosphate, propylene glycol, sucralose, aroma, disodium phosphate,			
Crest 3D White (Procter & Gamble, Cincinnati, OH, USA)	Water, glycerin, hydrogen peroxide, propylene glycol, sodium hexametaphosphate, poloxamer 407, sodium citrate, flavor, sodium saccharin, citric acid (alcohol free)			

(3M Elipar™ Deep Cure- S LED, Saint Paul, MN, USA)-40 sn



Resin samples were prepared using disc-shaped Teflon molds with a diameter of 8 mm and a depth of 2 mm. Resin materials were placed in the mold with the help of a hand instrument. A Mylar strip was placed at the top, and slightly pressured with cement glass was applied.

A total of 90 disc-shaped samples were prepared from the resin composite groups, with 10 samples selected randomly in each group.



	Manufacturer	Composition	Lot No
OptiDisc	KerrHawe, Bioggio, Switzerland	Impregnated with aluminium oxide particles 4-grits system for contouring, finishing, polishing and high gloss polishing	6778506

A polishing system (OptiDisc, KerrHawe, Bioggio, Switzerland) was applied to a single surface of the samples in each group (n=10).

As stated in the previous study [8], 3.6 g of coffee (Nescafé Classic, Nestle Turkey, Bursa, Turkey) was dissolved in 300 mL of hot water. The immersion solution was stirred and freshed every  $12 \pm 1$  hours [8].

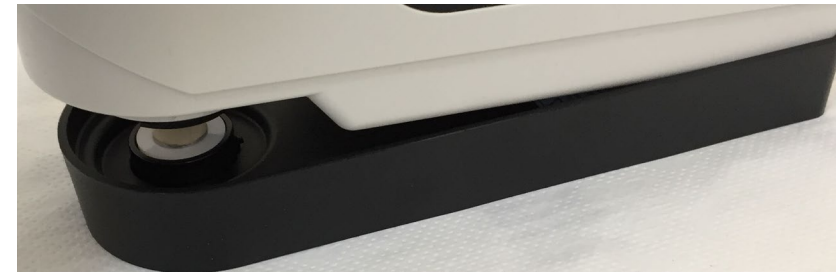
The studies reported that the immersion time of the samples in coffee should be 12 day, to one year of drinking coffee [8][9]



8. Guler, A. U., Yilmaz, F., Kulunk, T., Guler, E., Kurt, S. Effects of different drinks on stainability of resin composite provisional 44 restorative materials. *J. Prosthet. Dent.* **2005**, 94, 118–124. 45
9. Tinastepe, N., Malkondu, O., Iscan, I., Kazazoglu, E. Effect of home and over the contour bleaching on stainability of CAD/CAM 46 esthetic restorative materials. *J. Esthet. Restor. Dent.* **2021**, 33, 303–313. <https://doi.org/10.1111/jerd.12604>



After being colored in coffee, the  $L^*a^*b^*$  values of the samples were measured with a spectrophotometer (Lovibond RT Series, Tintometer Group, UK). Three measurements were made from each sample, and the average of these measurements was recorded as a single value. Measurements were made on black and white backgrounds for the TP under lighting conditions in D65 standards.



The TP values (TP00) of the samples were calculated using the CIEDE2000 color formula [2].

$$TP_{00} = \left[ \left( \frac{L'_B - L'_W}{K_L S_L} \right)^2 + \left( \frac{C'_B - C'_W}{K_C S_C} \right)^2 + \left( \frac{H'_B - H'_W}{K_H S_H} \right)^2 + R_T \left( \frac{C'_B - C'_W}{K_C S_C} \right) \left( \frac{H'_B - H'_W}{K_H S_H} \right) \right]^{1/2}$$

where the subscripts “B” and “W” refer to lightness ( $L'$ ), chroma ( $C'$ ) and hue ( $H'$ ) of the specimens over the black and the white backgrounds, respectively.  $R_T$  is the rotation function that accounts for the interaction between chroma and hue differences in the blue region. Weighting functions,  $S_L$ ,  $S_C$ ,  $S_H$  adjust the total color difference for variation in the location of the color difference specimen over the B and W backgrounds in  $L'$ ,  $a'$ ,  $b'$  coordinates and the parametric factors,  $K_L$ ,  $K_C$ ,  $K_H$ , are correction terms for experimental conditions. In the present study, the parametric factors of the CIEDE2000 color difference formula were set to 1.

Ten samples from each group were determined to be kept in distilled water as the control group.

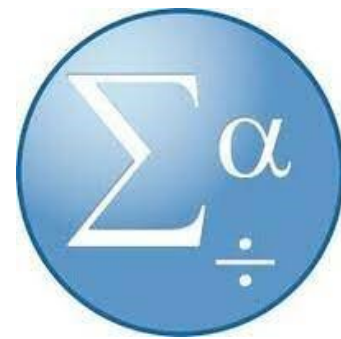
Other groups were formed to be kept in two different whitening mouthwashes (Listerine Advanced White, Johnson & Johnson, Maidenhead, UK, and Crest 3D White, Procter & Gamble, Cincinnati, OH, USA).

The TP values of all groups were recorded after 24 hours (T1) and 72 hours (T2)

# Statistical analysis

SPSS Statistics for Windows, Version 22.0 (IBM Corp, Armonk, NY, USA), was used for data analysis. The data were checked for normal distribution (Kolmogorov-Smirnov test/skewness kurtosis). The  $\Delta TP$  data were analyzed using two-way analysis of variance. The Tukey test was used for multiple comparisons.

Partial eta squared ( $\eta^2$ ) values were evaluated to understand how much effect the independent variables had on the dependent variables. The statistical significance level was accepted as  $p < 0.05$ .





# **Results and Discussion**

Two-way ANOVA results for translucency change main effects and interactions between composite and mouthwash (f1:composite f2:mouthwash). Partial eta squared ( $\eta^2$ ) values were examined to understand how much effect the independent variables had on the dependent variable.

**translucency change  $T_1-T_0$**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
f1	5.275	2	2.638	59.515	0.014	0.100
f2	8.131	2	4.065	151.345	0.002	0.146
f1 * f2	0.828	4	0.352	7.92	0.842	0.017

$R^2 = .230$  (Adj.  $R^2 = .154$ )

**translucency change  $T_2-T_0$**

f1	12.250	2	6.125	9.787	<0.001	0.195
f2	13.270	2	6.635	10.602	<0.001	0.207
f1 * f2	3.097	4	0.774	1.237	0.302	0.058

$R^2 = .361$  (Adj.  $R^2 = .298$ )

**translucency change  $T_2-T_1$**

f1	1.478	2	0.739	1.305	0.277	0.031
f2	0.626	2	0.313	0.553	0.577	0.013
f1 * f2	1.778	4	0.267	0.471	0.757	0.023

$R^2 = .065$  (Adj.  $R^2 = -.028$ )

For the  $\Delta TP$ , the main effects and interaction between the factors are shown in Table 2. The two-way analysis of variance showed no significant interaction between the factors (mouthrinse\*composite) at different time intervals in this study.



Means and standard deviations at different times for translucency change  
( $\Delta TP$ )

<i>Composites</i>				
<i>Mouthwashes*t1-t0</i>	<b>G-Aenial</b>	<b>Estelite</b>	<b>Omnichroma</b>	<b>Total</b>
<b>Control</b>	0.17 ± 0.54	0.01 ± 0.65	-0.31 ± 0.72	-0.04 ± 0.65 <sup>a</sup>
<b>Listerine Advanced White</b>	0.60 ± 0.76	0.25 ± 0.87	0.17 ± 1.01	0.34 ± 0.88 <sup>ab</sup>
<b>Crest 3D White</b>	1.18 ± 0.70	0.52 ± 0.83	0.35 ± 0.66	0.69 ± 0.79 <sup>b</sup>
<b>Total</b>	0.65 ± 0.77 <sup>A</sup>	0.26 ± 0.79 <sup>AB</sup>	0.07 ± 0.84 <sup>B</sup>	0.33 ± 0.83
<i>Mouthwashes*t2-t0</i>	<b>G-Aenial</b>	<b>Estelite</b>	<b>Omnichroma</b>	<b>Total</b>
<b>Control</b>	0.45 ± 0.87	0.04 ± 0.75	-0.39 ± 0.69	0.03 ± 0.83 <sup>a</sup>
<b>Listerine Advanced White</b>	0.77 ± 1.00	0.49 ± 0.53	0.31 ± 0.89	0.52 ± 0.83 <sup>b</sup>
<b>Crest 3D White</b>	1.81 ± 0.81	0.60 ± 0.93	0.49 ± 0.39	0.97 ± 0.94 <sup>b</sup>
<b>Total</b>	1.01 ± 1.05 <sup>A</sup>	0.38 ± 0.77 <sup>B</sup>	0.13 ± 0.77 <sup>B</sup>	0.51 ± 0.94
<i>Mouthwashes*t2-t1</i>	<b>G-Aenial</b>	<b>Estelite</b>	<b>Omnichroma</b>	<b>Total</b>
<b>Control</b>	0.28 ± 0.43	0.03 ± 0.63	-0.08 ± 0.75	0.07 ± 0.61
<b>Listerine Advanced White</b>	0.17 ± 0.90	0.23 ± 0.94	0.13 ± 0.88	0.18 ± 0.87
<b>Crest 3D White</b>	0.62 ± 0.72	0.07 ± 0.74	0.14 ± 0.60	0.28 ± 0.71
<b>Total</b>	0.35 ± 0.71	0.11 ± 0.76	0.06 ± 0.73	0.17 ± 0.74

The lowest  $\Delta TP$  value was exhibited in the control group at T0–T1 and T0–T2 ( $p = 0.001$ ).

The highest  $\Delta TP$  value was exhibited in Crest 3D White mouthwash at T0–T2 ( $p = 0.001$ ). However, there was no difference with Listerine Advanced White.

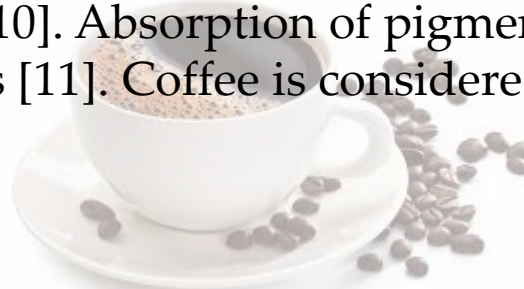
Among the composites, the highest  $\Delta TP$  value was found in G-aenial Anterior at T0–T2, and the lowest  $\Delta TP$  value was found in Omnicroma at T0–T1 (Table 3).

In this study, resin composite materials immersed in whitening mouthwashes for different immersion times (24 and 72 hours) were investigated. It was stated that the daily use of mouthwash for 2 minutes was equivalent to 2 and 6 years of 24 and 72 hours immersion times evaluated in the study [15].

In our study, two whitening mouthwash products with different formulas were evaluated. The Omnichroma resin composite, which has been introduced with a monochromatic structure in recent years, and resin materials with two different contents used in the anterior region were selected. Because of the increasing popularity of these materials, they were preferred for this study.



External factors as a result of accumulation and absorption of surface colorants on the surface of the material are effective in color change [10]. Absorption of pigments in a coloring liquid such as coffee causes coloring of the resin composites [11]. Coffee is considered a coloring agent that can penetrate the organic phase in composite resins [12].



It has been stated that the translucency values of some materials increase and some decrease after aging in different resin composites [13]. It is assumed that whitening mouthwashes, mainly agents such as hydrogen peroxide, offer a whitening effect on teeth [14].

10. Bagheri, R., Burrow, M. F., Tyas, M. Influence of food-simulating solutions and surface finish on susceptibility to staining of aesthetic restorative materials. *J. Dent.* 2005, 33, 389–398. <https://doi.org/10.1016/j.jdent.2004.10.018>
11. Spina, D. R., Grossi, J. R., Cunali, R. S., Baratto Filho, F., da Cunha, L. F., Gonzaga, C. C., Correr, G. M. Evaluation of discoloration removal by polishing resin composites submitted to staining in different drink solutions. *Int. Sch. Res. Not.* **2015**, 853975. <https://doi.org/10.1155/2015/853975>
12. Yazdi, H. K., Nasoohi, N., Benvidi, M. In vitro efficacy of listerine whitening mouthwash for color recovery of two discolored composite resins. *Front. Dent.* **2019**, 16, 181–186. <https://doi.org/10.18502/fid.v16i3.1589>
13. Johnston, W. M., Reisbick, M. H. (1997). Color and translucency changes during and after curing of esthetic restorative materials. *Dent. Mater.* **1997**, 3, 89–97. [https://doi.org/10.1016/s0109-5641\(97\)80017-6](https://doi.org/10.1016/s0109-5641(97)80017-6)
14. Kepler, L. C., Rodrigues, A. P. M., Dall Agnol, M. A., Rodrigues-Junior, S. A. Effect of whitening mouth rinses on the chemical and physical properties of a nanofilled composite. *Braz. J. Oral Sci.* **2021**, 20, e219320. <https://doi.org/10.20396/bjos.v20i00.8659320>

In our study, the initial measured translucency values were observed less in G-aenial Anterior (microhybrid) and Estelite  $\Sigma$  Quick (submicron) composite resins; higher translucency values were observed in the Omnicroma (supranano filler) composite resin. Differences between composite resins can be attributed to the chemical structure of the materials, the intensity particles, or the particle size.

Higher  $\Delta TP$  values were found in the G-aenial Anterior resin material kept in Crest 3D White mouthwash in the T0-T2 interval. It is thought that  $H_2O_2$  in Crest 3D White provides more effective penetration into the resin matrix and, therefore, a higher translucency change occurs.

The translucency changes of whitening mouthwashes at 24 and 72 hours were significantly higher than in the control groups. The Crest 3D White formula used in this study includes hydrogen peroxide as a bleach/stain remover.

The Listerine Advanced White formula, tetrapotassium pyrophosphate and tetrasodium pyrophosphate are used as bleach/stain removing components. Sodium hexametaphosphate, known as polypyrophosphate, chemically removes external stains [16].



In another study, it was reported that Bis-GMA has higher translucency than UDMA and TEGDMA [18]. The reason was that the refractive index of Bis-GMA and the refractive index of silica filler were close. However, the higher translucency values of Omnicroma, which has a one-shade material and does not contain Bis-GMA, may affect these values due to the monomers and fillers in its content.

Omnicroma is pigment-free, and its color characteristics are based on structural colors and chromatic technology to control the optical properties. This approach responds to light waves of a specific frequency by reflecting a specific wavelength within the tooth color area. [19]. The absence of color pigments may be one of the factors in the lower translucency change values of Omnicroma.

18. Azzopardi, N., Moharamzadeh, K., Wood, D. J., Martin, N., Van Noort, R. Effect of resin matrix composition on the translucency of experimental dental composite resins. *Dent. Mater.* **2009**, 25, 1564–1568. <https://doi.org/10.1016/j.dental.2009.07.011>
19. Pereira Sanchez, N., Powers, J. M., Paravina, R. D. Instrumental and visual evaluation of the color adjustment potential of resin composites. *J. Esthet. Restor. Dent.* **2019**, 31, 465–470. <https://doi.org/10.1111/jerd.12488>

In this study, it was concluded that whitening mouthwash had a higher effect on the change of translucency than the composite resin because when the partial eta squared was evaluated, it was determined that the mouthwash had a greater effect on the T0–T1 and T0–T2 intervals in the change of translucency.

In this context, it shows that the short- and long-term use of whitening mouthwashes may have an effect on the translucency changes of the materials. Therefore, the hypotheses tested within the scope of the findings of our study were rejected.

In addition, the alcohol in the content may affect some differences in the analyzed parameters, and this is an important limitation of this study. Tooth brushing, saliva, beverages, and pH levels in the oral environment can also affect the optical property of resin materials.



# Conclusion

Whitening mouthwashes caused an increase in the translucency values of resin materials over time.

Material contents caused differences in translucency values. The effect of mouthwashes in daily use should be evaluated clinically the influence on the optical property of resin composite restorations over time.

It should be noted that long-term use of whitening mouthwashes may affect the translucency values of resin composites.

