**RESEARCH ARTICLE**
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# Evaluation of the Color Stability and Surface Roughness of a Novel Single-Shade Composite Resin: A Smart Chromatic Technology

**Cumhur and Cevval Özkoçak. Assessment of Surface Roughness, Color Stability**

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**Abstract**
**BACKGROUND/AIMS:** This study aims to assess the color stability and surface roughness of a newly developed single-shade resin-based composite (RBC) utilizing smart chromatic technology by comparing with nanohybrid and nanoceramic RBCs.
**MATERIALS AND METHODS:** A total of 120 specimens of each RBC discs were prepared on a round metal mold (6x2 mm). Distilled water was used as a control. Three different RBCs; Harmonize (n=40), Omnichroma (OM) (n=40), and Zenit (n=40), were immersed into three staining beverages, namely orange juice, cola, and coffee, respectively, as test groups. Prior to the immersion, the initial roughness and color values were recorded using a profilometer and CIE L*a*b*, respectively. The color change and surface roughness values were determined again after one week. The data were analyzed by means of Kolmogorov-Smirnov and Shapiro-Wilk tests ($p \leq 0.05$).
**RESULTS:** There was no significant difference between the initial surface roughness values (Ra) among the groups. However, a significant increase was observed in the roughness values of the Harmonize's immersed in coffee ($p$=0.024) and OM's immersed in cola (p=0.021). The color stability of RBC was significantly affected by the immersion period, and coffee caused the highest discoloration (p<0,001).
**CONCLUSION:** The new generation monochrome smart composite resin with spherical filler (OM) is clinically recommended as it shows acceptable values in terms of color stability and roughness. Therefore, OM may be preferred as an alternative to multishade composites as it simplifies color selection.
**Keywords:** Discoloration, single-shade composite resin, smart chromatic technology, spherical filler, surface roughness

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## INTRODUCTION

Color stability and surface texture are the most important characteristics of esthetic restorative materials to provide a personalized smile [1]. The maintenance of color throughout the functional lifetime of restorations plays a significant role in the durability of the treatment. This characteristic is not constant among dental materials [2,3]. Various inorganic particles with different components, such as silica, alumina, zirconia, silicate glass, quartz, and ceramics, have been employed in the resin matrix of dental RBCs as reinforcing filler phases. In addition to the composition of fillers, other properties, such as the filler particle content, size, size distribution, shape, morphology, porosity, and surface characteristics, play a critical role in the development of dental RBC**s** for specific applications and purposes [4].

Since composite restorations have different shades and technical sensitivities, success is highly dependent on the skill of the dentist and the choice of shade. This complex process causes the physician to employ the trial and error method and increases the time spent in the dental chair. Therefore, researchers aimed to simplify and reduce the number of shadows based on color interactions. The chameleon or blending effect is the ability of dental materials to adapt to the color of the surrounding dental hard tissue so that color mismatches are compensated to some extent [5]. These materials, which have the properties of imitating natural tooth structures such as enamel and dentine, support the remaining tooth structure as well as a "smart" and can be changed by factors like temperature, humidity, pH, and stress [6]. RBC**s** have undergone many changes over the years to provide positive properties. For this purpose, many composite resin types are offered to the market by making changes in both the monomers forming the organic polymer matrix phase and the inorganic filler particles of the RBCs [4].

Recently, a newly developed monochrome RBC (Omnichroma; OM, Tokuyama Dental, Tokyo, Japan) was introduced to shorten treatment time and reduce the clinician's difficulty in matching colors. The manufacturer claims that the structural color in the OM can mimic the color of the surrounding tooth, regardless of its shade [7]. Homogenized spherical filler particles with a size of 260 nm were used by the "sol-gel method" to obtain uniform filler particles with reflectivity. OM fillers change the light transmitted through the red-yellow area of the color spectrum, allowing it to match the color of the patient's neighboring teeth. OM's wide color matching ability minimizes the waste of unused composite hues by reducing the time spent on color selection and the time spent in the chair by the patient [7,8]. However, today, there is not enough research on the physical properties and color adjustment of composite resins produced with this technology.

This study aims to evaluate the surface roughness and color stability of "OM," a newly developed single-shade composite resin containing spherical particles, by comparing it with nanohybrid and nanoceramic RBCs. The null hypothesis of the present study is that the surface roughness and color change of smart chromatic composite resins stored in different beverages (distilled water, coffee, cola, and orange juice) are not significantly different from multi shade RBCs with various contents.

## MATERIALS AND METHODS

### Preparation of Sample

A total of 120 samples were obtained in this study, with 40 samples for each RBC. A cylindrical metal mold of 6x2 mm was used for composite samples. Mylar strip (Kerr Corp. Orange CA, USA) and cement glass were placed on it to obtain a smooth surface. Based on the manufacturer's instructions, the light emitting diode (LED) light device Monitex Bluex, GT1200, (Monitex Industrial Co., Taiwan) was applied for 20 seconds in full power mode, M1 mode, at 1,200 mW/cm$^2$, with a glass coverslip and light device in contact. Following the polymerization process, the samples were kept in distilled water at 37°C for 24 hours. They were then polished under water spray (new discs were used for every five samples) by applying a unidirectional rotation motion with light pressure from coarse to fine grain with 4-stage OptiDisc (Kerr Corp. Orange CA, USA) containing aluminum oxide abrasive. The composite resin materials used in this study are listed in Table 1.

### Roughness Evaluation

In this study, the initial roughness measurements were made with the Perthometer M2 (Mahr, Gottingen, Germany) profilometer device. Afterward, the samples were kept in four different beverages (distilled water, coffee, cola, and orange juice) in an oven at 37°C for one week, and the beverages were renewed every other day. At the end of the staining process, the final roughness measurements were evaluated. Three measurements were made in the center of the samples with the same device, and Ra values were recorded by calculating the average of these values [9,10]. The calibration process was repeated at every five measurements.

### Evaluation of Color Changes

The Minolta Chromascop colorimeter device (Chroma Me-ter CR 321, Minolta, Osaka, Japan) was used to evaluate color changes. It detects the reflected colors of surfaces using compact tristimulus color analysis. The measurement area was 3 mm and had 45° environmental illumination, and the viewing angle was 0°. Measurements can be given as L * a * b *. During the measurements of the samples, the calibration of the instrument was checked before each color measurement step by using the standard white background. Measurements were repeated three times for each sample, and the average of the values was determined. The amount of color change is expressed as ΔE and calculated as follows;

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

$\Delta L=L2^*-L1^*$

$\Delta a=a2^*-a1^*$

$\Delta b=b2^*-b1^*$

After the initial color measurements were taken and recorded, the samples (n=10) were kept in four different types of beverages (distilled water, coffee, cola, and orange juice) at 37°C for one week. The beverages were renewed daily, the samples were kept in the beverages throughout the day, and final measurements were taken and recorded at the end of one week. For standardization, the same immersion period was applied in all beverages.

### Statistical Analysis

The data obtained from the study were summarized, and descriptive statistics were tabulated as mean ± standard deviation and median and minimum-maximum for continuous variables depending on the distribution. Categorical variables were summarized as numbers and percentages. The normality test of numerical variables was verified by means of the Kolmogorov-Smirnov and Shapiro-Wilk tests. Paired t-test was used to examine whether the roughness value changed before and after the procedure. In comparisons of more than two independent groups, the Kruskall Wallis H test was used when numerical variables did not show normal distribution. Differences among the groups in nonparametric tests were evaluated by the Dwass-Steel-Critchlow-Fligner test. Statistical analyzes were performed using the IBM SPSS Statistics for Windows (Version 20.0) program, and the significance level was considered as 0.05 (*p*-value) in statistical analysis.

## RESULTS

### Roughness

In regard to the staining beverages, when the roughness of each composite filling material was evaluated before staining, there was no significant difference among the Harmonize, OM, and Zenit groups ($p$=0.738, $p$=0.969, and $p$=0.940, respectively) (fig. 1-3). Similarly, no statistically significant difference was observed among the post-treatment roughness of each composite resin ($p$=0.843, $p$=0.229, and $p$=0.745, respectively). A significant increase in roughness was observed in the Harmonize kept in the coffee solution ($p$=0.024) and the OM kept in the cola solution and water ($p$=0.021, $p$=0.038, respectively) (Table 2).

### Color Changes

The overall color change (ΔE*) mean values of the RBCs for all staining beverages are shown in Table 3. When the RBCs were compared with each other in regard to the color change in distilled water, coffee, and cola solution, there was no significant difference between the ΔE* values. The color change of Harmonize and OM composite resins after immersion in distilled water, orange juice, and cola was found to be significantly lower than the ΔE* value obtained after immersion in the coffee ($p$<0,001). When the color stability of the RBCs was compared after immersion in the orange juice beverage, Zenit showed the highest ΔE* value **(**6,47 ± 1,65), and this color change was considered significant when compared to Harmonize and OM (Table 3). Among all RBCs, the ΔE* value of the distilled water was the lowest (1,26), the ΔE* value of the coffee was the highest (7,04), and this difference was determined to be statistically significant ($p$<0,001) (Table 4). The differences among the ΔL, Δa, and Δb color change medians of the composite materials according to the staining beverages used were statistically significant ($p$=0.034, $p$<0.001, and $p$=0.001, respectively), and the differences were examined through multiple comparisons (Tables 5 and 6). When we examined the color change values (ΔE) according to the staining beverages used, the lowest value was found in the distilled water (ΔE=1.26) and the highest degree of color change was found in the coffee group (ΔE=7.04) (Table 4) (Figure 4).

## DISCUSSION

Various factors, such as plaque accumulation, the effect of coloring foods and beverages on the composite resin structure, insufficient polymerization of materials, degree of absorption, smoking, frequency of interaction with chemical agents, and surface roughness of the restoration, cause color change [11]. The roughness and color stability of the composite resin is among the most important factors for a successful esthetic restoration [12]. Choosing the right shade is an important esthetic factor in the direct restoration of teeth using RBCs. For restorations of teeth with different shades, dental material manufacturers have produced a variety of RBCs with different shades and/or translucency. One of the most important problems faced by dentists is the incompatibility of the color between the RBCs used and the natural tooth. To eliminate this issue, many factors, such as symmetry, color, translucency, and the surface feature, should be considered [13].

However, the choice of color increases the time spent on the unit and makes the color selection process subjective. The use of smart technologies in the production of RBC**s** has recently been applied to eliminate all these disadvantages. Manufacturers have developed a resin-based “OM” composite, which has been formulated based on the concept of “Wide Color Matching.” OM creates shades that can cover a large number of natural tooth shades in order to reduce the time required for shade selection and the number of composite shades needed in stock. It is claimed that this new dental composite produced with Smart Chromatic Technology can match the tooth color thanks to its optical structure and that the particles will reflect the color of the surrounding tooth structure [14,15]. So, in the current study, this novel

single shade composite resin with spherical fillers has been compared with the nanohybrid composite Harmonize, which imparts chameleon effect, and the Zenit composite containing fine radiopaque porcelain fillers.
In many studies [16-18], the average critical value has been specified as 0.2 µm for surface roughness. However, there is no accepted threshold value for the assessment of surface roughness yet. In a clinical study conducted by Jones et al, patients could notice when the mean surface roughness was 0.3 µm [19]. In the present study, a significant increase in the mean roughness values of all composite resins was shown after staining (fig. 1-3). We think that this may be related to the acidity of the beverages used and the surface irregularities that occur during the finishing process. With regard to the coloring beverages used, when the roughness of each composite filling material was evaluated before the treatment, no statistically significant difference was found among the Harmonize, OM, and Zenit groups ($p$=0.738, $p$= 0.969, and $p$=0.940, respectively) (Table 2). An increase in roughness was observed after coloring in the Harmonize composite in coffee and the OM composite in cola. This change might cause corrosion on the composite resin surface due to the phosphoric acid and sugars in the structure of the solution [20,21]. Isabel et al. and Gouvea et al. determined that different long-chain organic acids in coffee can dissolve and etch restorative materials, thereby causing surface roughness in composite resins [21,22]. Therefore, the surface roughness of the Harmonize composite in the present study supports these results. Also, these differences are explained by the differences in the polymer matrices, the types of fillers, and the connections between the filler and the polymer matrix [23,24]. It was observed that the roughness values of the OM composite material were significantly different ($p$=0.021) after immersion in cola, but there was no significant difference in Harmonize and Zenit ($p$=0.414 and $p$=0.540, respectively) (Table 2). This difference might be related to the supra nano spherical fillers of the OM composite resin. At the same time, since OM composite resin is a new product, the lack of studies on both its mechanical and esthetic performance limits the interpretation of the success of this material.
In the present study, differences in ΔE values were detected in all samples after they were kept in beverages (Table 3). The composite resins tested in the present study showed a significant color change after immersion in coffee and orange juice but not in distilled water and cola (fig. 4). The highest ΔE value was obtained with coffee (ΔE=7.04), followed by orange juice (ΔE=4.11), cola (ΔE=1.84), and distilled water (ΔE=1.26) (Table 4). Ardu et al. reported that the amount of coloration of RBCs varies according to the brand and content of the composite resin; red wine causes the most color change among the materials used as coloring beverages, followed by coffee, tea, orange juice, and cola [25].
Studies reporting that coffee causes more discoloration than other beverages support this result [26-28]. Bagheri et al. argued that although cola harms the surface integrity of composite materials due to its low pH value, it does not cause coloration as much as coffee and tea due to the absence of yellow dye stuff [29]. Karaarslan et al. reported that there was a decrease in L values in all of the samples after the aging process, and the decrease in L value indicates that the samples darkened [30]. In the present study, the ΔL* values decreased significantly as expected in all composite groups exposed to coffee, cola, and orange juice beverages (Table 4). ΔL* results are consistent with many studies examining the color changes in composite resins exposed to different beverages. In these studies, the effect of discoloration has been observed to result in negative ΔL* values for composite materials [31-33]. In the CIE Lab system, it is stated that the b* coordinate is associated with yellow and blue color. A positive b* value indicates the amount of yellow, and a negative b* value indicates the amount of blue. Tekce et al. found that in all composite resins, there was a shift towards the blue direction (-Δb*) with distilled water exposure, and towards the yellow direction (+Δb*) with black tea exposure (31). Poggio et al. also found a significant increase in the Δb values of composite

resins exposed to coffee, and their findings support our study [32]. In another study it has been reported that yellow colorants in coffee cause coloration by showing low polarity, thus adhering to the surface and penetrating deeply [34]. In the present study, the positive Δb value in all samples kept in coffee and orange beverages is thought to be related to this situation (Table 5), and the highest Δb value belongs to the Zenit composite (Δb=5.81). Although all coloring beverages result in an increase in the Δb value, we believe that Zenit exhibited the highest level of Δb value among the groups, indicating that the effects of the orange solution on Zenit were greater compared to other RBC**s**.

In general, RBCs with low filler content are known to cause more color change [35,36]. In this study**,** when the weight ratios of the particles in their content were examined, Zenit (83%) had the highest value, followed by Harmonize (81%) and OM (79%) (Table 1). However, in regard to the average ΔE values ($p$=0.35), the particle weight was not in line with the results of the study, and the results were not statistically significant (Tables 5 and 6). We examined the monomer structures of the RBCs as we believe that the close similarity in weight percentages of the RBCs used in this study contributed to this result.

One of the most important factors affecting the degree of coloration of RBC is the type of monomers [37]. RBCs with high TEGDMA content are more susceptible to coloration than RBCs containing UDMA because UDMA is a more color-resistant monomer. This is due to the low water absorption of UDMA monomer and the sufficient degree of visible light polymerization [28,38,39]. When the average values in the present study were taken into account, the OM resin material containing UDMA and TEGDMA had the lowest ΔE value (3.33), but no statistically significant difference was observed between the ΔE values of RBC materials (Table 5). The highest ΔE value was obtained in the orange juice solution in Zenit (ΔE=7.02) (Table 3). In parallel with this result, a study by Gregor et al. found that the nanoceramic-based ceram-X Duo was highly affected by acidic fruit juice, and this might be due to a possible acidic attack on the polysiloxane components of the fruit juice [40]. This result supports that the nanoceramic-based Zenit composite containing butanediol di methoxylated and glass particles takes this value.

When the RBC materials were evaluated within themselves, the differences between the ΔE color change were not found to be statistically significant ($p$=0.350) (Table 5). A statistically significant difference was found in the evaluation of color changes of OM composite materials according to different beverages ($p$<0.001) (Table 6). These results are in line with those of Ebaya et al.[5] who concluded that universal shade composites have a satisfactory color and accept surface roughness. In contrast, de Abreu et al. [41] and Iyer et al. [42] reported that the color adjustment of the monochrome composite is lower than that of the multi-shade composite, and this may cause esthetic problems. Based on all these findings, the null hypothesis of the present study was partially rejected.

In vitro studies cannot fully imitate oral conditions. In addition to nutritional habits in clinical conditions, factors, such as temperature, humidity, microorganisms, structure, and the amount of saliva, tongue-cheek function in the oral cavity, cannot be examined, and the coloring beverages in the oral environment can be diluted by saliva and other liquids. Factors that can affect the color changes of dental materials, such as changes in temperature and pH level, can affect the properties of composite restorations. Hence, there is a need for further in vivo and in vitro studies on newly produced RBCs with different contents.

**Study Limitations**

When the literature is examined, there are not enough studies that compare smart monochromatic resins, thus limiting the discussion of color change and roughness values obtained from smart monochromatic resins. Further studies are required to support the results.

**CONCLUSION**

All RBCs are prone to acceptable surface roughness after staining, and the most stable roughness values belong to Zenit composite. Coffee had the highest adverse effect on restoration color and caused unacceptable discoloration in all three RBCs (ΔE>3.3). The universal shade RBC, "OM," shows acceptable values in terms of color stability and roughness and may be clinically recommended with a single color option.

**MAIN POINTS**

- "Monochrome composite" is used to denote composite material produced with smart chromatic technology, thus providing a color match for each tooth color.
- "Omnichroma" is a monochrome composite with 260 nm spherical filler, produced with smart chromatic technology, and adapts to the color of the applied tooth.
- Extensive color matching eliminates the need for color selection and minimizes in-seat time and waste of unused composite hues.
- Since color stability is an important factor in the success of treatment in aesthetic composite restorations, the stability of this novel smart monochromatic RBC material against discoloration is a matter of interest.

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**Table 1. Compositions of the resin based composites in the present study**

| Material | Classification | Organic Content | Inorganic Content | Lot |
|---|---|---|---|---|
| Omnichroma<br><br>Tokuyama Dental, Tokyo, Japan | Supra-nano spherical resin based composite | UDMA, TEGDMA, mequinol, Dibutyl hydroxyl toluene, UV absorber | Spherical silica-zirconia, Average particle size: 0.3 µm<br>Weight: 79%<br>Volume: 68% | 018EY9 |
| Zenit<br><br>President Dental, Germany | Nanoceramic resin based composite | UDMA,<br>BDDMA,<br>BisGMA | Glass filler (0.7 µm)<br>Pyrogenic silica (12 µm)<br>Agglomerated nano-particles (0.6 micron)<br>Weight: 83%<br>Volume:70% | 2019012264 |

| | | | | |
|---|---|---|---|---|
| Harmonize<br><br>Kerr Corp. ,Orange CA, USA | Nanohybride resin based composite | BisGMA, BisEMA, TEGDMA | Spherical silica (30nm)-zirconia (5nm) filler particles, barium glass particles (5-400 μ)<br>Weight: 81%<br>Volume:64% | 7253850 |
| BDDMA: Butanedioldimethacrylate, BisGMA: Bisphenol-A-glycidyl methacrylate, BisEMA: Bisphenol-A- polyethylene glycol diether methacrylate TEGDMA: Triethylene glycol dimethacrylate, UDMA: Urethane Di Methacrylate | | | | |

**Table 2. The values of the surface roughness ($R_a$) of the resin based composites**

| | Beverages | Mean ±SD (Before staining) | Mean±SD (After staining) | *p* * |
|---|---|---|---|---|
| Harmonize | Distilled water | 0,26 ± 0,12 | 0,24±0,08 | 0,798 |
| | Coffee | 0,21 ± 0,07 | 0,29 ± 0,11 | 0,024 |
| | Cola | 0,22 ± 0,11 | 0,26 ± 0,1 | 0,414 |
| | Orange juice | 0,27 ± 0,14 | 0,29 ± 0,15 | 0,683 |
| | ***p***** | ***0,738*** | ***0,843*** | |
| Omnichroma | Distilled water | 0,17 ± 0,09 | 0,23±0,11 | 0,038 |
| | Coffee | 0,19 ± 0,14 | 0,22 ± 0,23 | 0,878 |
| | Cola | 0,15 ± 0,07 | 0,21 ± 0,06 | 0,021 |
| | Orange juice | 0,20 ± 0,14 | 0,25 ± 0,11 | 0,236 |
| | ***p***** | ***0,969*** | ***0,229*** | |
| Zenit | Distilled water | 0,18 ± 0,1 | 0,18 ± 0,08 | 0,906 |
| | Coffee | 0,20 ± 0,12 | 0,23 ± 0,12 | 0,167 |
| | Cola | 0,15 ± 0,06 | 0,16 ± 0,04 | 0,540 |
| | Orange juice | 0,15 ± 0,05 | 0,17 ± 0,07 | 0,341 |
| | *p*** | *0,940* | *0,745* | |

SD: Standard deviation
*: Wilcoxon test, **: Kurskal Wallis test

**Table 3. Comparison of the mean values of color change (ΔE*) of resin based composites after exposed to staining beverages**

| Resin based composites | Beverages | | Mean ± SD | p |
|---|---|---|---|---|
| **Harmonize** | Distilled water | ΔE | 1,41 ± 0,39 | |
| | Coffee | ΔE | 7,77 ± 2,03 | **<0,001** |
| | Cola | ΔE | 2,09 ± 2,31 | |
| | Orange juice | ΔE | 2,87 ± 1,89 | |
| **Omnichroma** | Distilled water | ΔE | 1,42 ± 0,3 | |
| | Coffee | ΔE | 6,37 ± 0,85 | **<0,001** |
| | Cola | ΔE | 2,55 ± 2,09 | |

| | | | | |
|---|---|---|---|---|
| | Orange juice | ΔE | 2,99 ± 0,76 | |
| **Zenit** | Distilled water | ΔE | 0,94 ± 0,41 | |
| | Coffee | ΔE | 6,97 ± 1,59 | **<0,001** |
| | Cola | ΔE | 2,64 ± 1,26 | |
| | Orange juice | ΔE | 6,47 ± 1,65 | |
| Kruskal Wallis test (*p*≤0,05) | | | | |

**Table 4. Comparison of color changes of resin based composites according to staining beverages**

| | Distilled water (n=30) | Coffee (n=30) | Cola (n=30) | Orange juice (n=30) | |
|---|---|---|---|---|---|
| | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | *p* |
| ΔL | 0,46±0,77 | -4,54± 2,01 | -0,14± 1,81 | -0,25±1,13 | <0,001 |
| Δa | 0,08±0,41 | 0,46 ± 0,85 | 0,63 ± 1,6 | -1,32±1,21 | <0,001 |
| Δb | 0,19±0,89 | 4,89 ± 1,69 | 1,13 ± 1,43 | 3,58±2,15 | <0,001 |
| ΔE | 1,26±0,42 | 7,04 ± 1,62 | 2,43 ± 1,89 | 4,11±2,24 | <0,001 |
| Kruskal Wallis test (*p*≤0,05) | | | | | |

**Table 5. Comparison of the mean values of color changes (ΔL,Δa, Δb,ΔE) of resin based composites**

| | Harmonize | Omnichroma | Zenit | |
|---|---|---|---|---|
| | Mean ±SD | Mean ±SD | Mean ±SD | *p* |
| ΔL | -1,58±2,8[a,b] | -0,29± 2,11[b] | -1,49±2,39[a] | 0,034 |
| Δa | 0,39 ± 1,48[b] | 0,13 ± 0,75[b] | -0,64±1,45[a] | <0,001 |
| Δb | 1,4 ± 2,75[a] | 2,71± 1,88[b] | 3,23±2,37[b] | 0,001 |
| ΔE | 3,54 ± 3,08 | 3,33 ± 2,2 | 4,25 ± 2,87 | 0,35 |
| Kruskal Wallis test (*p*≤0,05) | | | | |

**Table 6. Multiple comparisons of color changes of resin based composites according to the staining beverages**

| *Distilled water* | | | ΔL | Δa | Δb | ΔE |
|---|---|---|---|---|---|---|
| Harmonize | - | Omnichroma | 0,087 | 0,002 | <0,001 | 0,981 |
| Harmonize | - | Zenit | 0,753 | 0,007 | <0,001 | 0,060 |
| Omnichroma | - | Zenit | 0,041 | 0,924 | 0,022 | 0,041 |
| *Coffee* | | | | | | |
| Harmonize | - | Omnichroma | <0,001 | 0,121 | 0,636 | 0,121 |
| Harmonize | - | Zenit | 0,234 | 0,141 | 0,636 | 0,540 |
| Omnichroma | - | Zenit | <0,001 | 0,022 | 0,142 | 0,540 |
| *Cola* | | | | | | |
| Harmonize | - | Omnichroma | 0,857 | 0,050 | <0,001 | 0,220 |
| Harmonize | - | Zenit | 0,285 | 0,022 | <0,001 | 0,087 |
| Omnichroma | - | Zenit | 0,073 | 0,103 | 0,191 | 0,285 |
| *Orange juice* | | | | | | |
| Harmonize | - | Omnichroma | 0,857 | 0,540 | 0,448 | 0,797 |
| Harmonize | - | Zenit | 0,962 | 0,003 | 0,006 | 0,006 |
| Omnichroma | - | Zenit | 0,730 | 0,001 | <0,001 | <0,001 |
| Dwass-Steel-Critchlow-Fligner test ($p \leq 0,05$) | | | | | | |

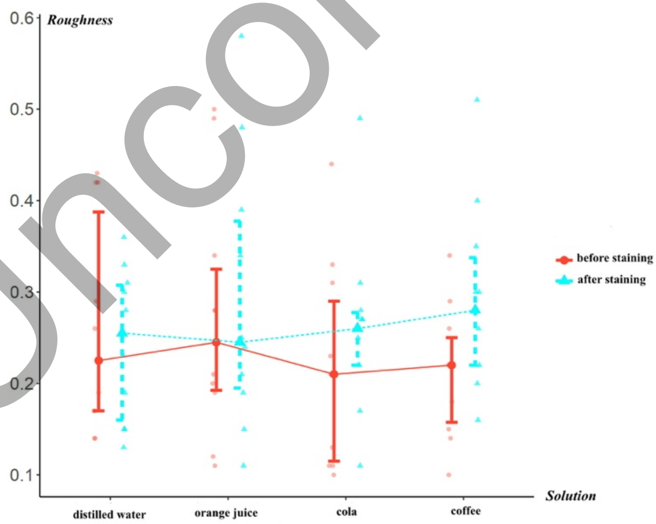


**Figure 1.** Roughness-solution graph of Harmonize resin based composite

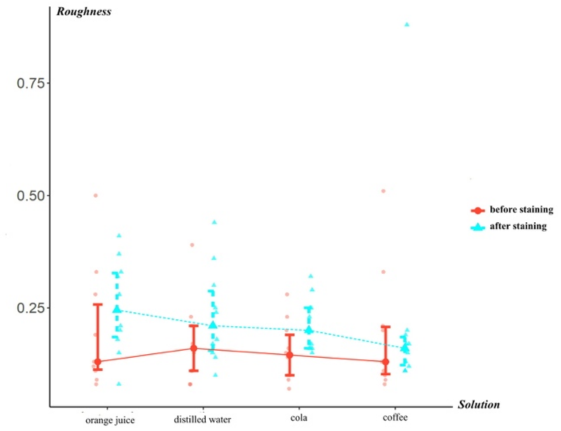


**Figure 2.** Roughness-solution graph of Omnichroma resin based composite

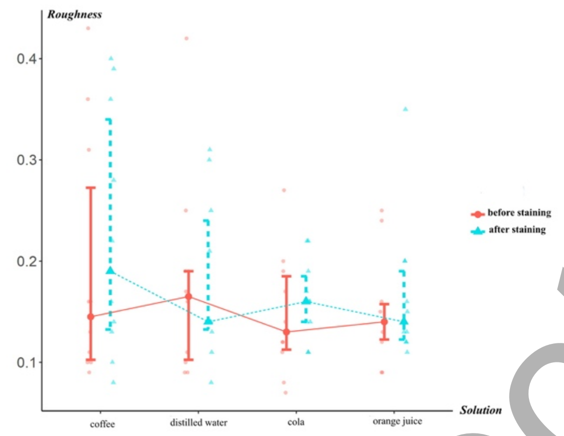


**Figure 3.** Roughness-solution graph of Zenit resin based composite

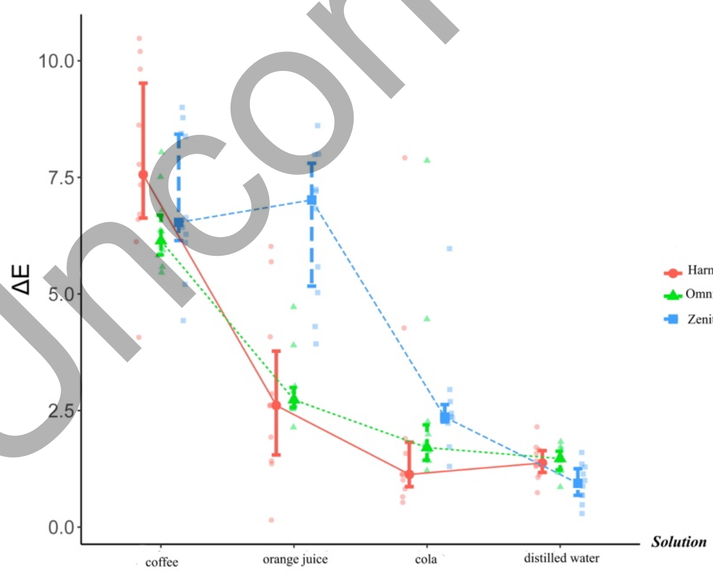


**Figure 4.** ΔE – solution graph of the resin based composites