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**Research Article**

# Evaluation of Coloration Degrees of Light-Cured Temporary Filling Materials Kept at Two Different Temperatures

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**Abstract:** ***Purpose:*** The aim of this study is to evaluate the coloration effects of different drinks on temporary restorative materials kept at different temperatures (4ºC, 25 ºC). ***Materials and Method:*** Eeach group consisting of 15 samples was randomly divided into 3 subgroups (n = 5), namely Tempit and First Fill, light cured temporary resins were used separately at 4°C in the refrigerator and at 25°C at room temperature a total of 60 (15x4) discs kept at two different temperatures (4ºC, 25ºC ). The samples were polymerized for 40 seconds with a LED light device and all samples were placed in distilled water in a 37 ºC incubator for 24 h. The initial color values of the samples were determined and recorded with the Vita EasyShade digital colorimeter device. Then, the samples were divided into subgroups of 5 (n = 5) and kept in the prepared coffee solution (Nescafe Classic), cherry juice and distilled water at 37°C for a week. The samples were measured on the 1st, 3rd and 7th days. Before each measurement, after washing and drying the samples, the color values were determined with a digital colorimeter device and the color differences (ΔE*) were calculated by recording the data according to the CIE 2000 system. Color difference data were evaluated using one-way ANOVA and Tukey test. ***Results:*** Although, the coloration degree was lower in the temporary filling material stored in 25°C, there is no statistically significant difference between the 4°C and 25°C groups. The coloration level of Temp-it was less than First Fill. ($p<0.05$) The highest average ΔE value among all groups was obtained at 4°C in the First Fill group in the coffee solution. ***Conclusion:*** It is concluded that the use of light-cured resin-containing temporary restorative materials in the front areas of anterior teeth where aesthetics are important, the use of light-cured temporary filling materials that are heated at 25°C will result in less coloration.
**Keywords:** Light cure temporary filling material, color stability, beverages.

## INTRODUCTION

A tooth undergoing endodontic treatment must be covered with a temporary restorative material in between endodontic treatment sessions, if the treatment is not completed in one session. This is one of the most important steps for preventing oral fluids, food residues and microorganisms from reaching the canal system from the oral cavity [1, 2]

A temporary material should be easy to apply, able to withstand constant contact with oral fluids, resistant to chewing forces, and non-toxic [3]. Additionally, temporary fillers are not ideal, because they can prevent the application and polymerization of adhesive to the teeth in situations where adhesive resin restoration will be applied [4, 5] Accordingly, light curing temporary fillers have been developed for this purpose. The use of these materials is increasing daily, because light curing temporary fillers are aesthetic, simple to apply, and are easy to clean from cavity walls [6-8].

The temporary restoration should be close to patient's natural tooth color and should maintain its color throughout the period of use [9, 10]. The coloration is evaluated using a spectrophotometer device and color evaluation systems such as CIEDE 2000. With society's high aesthetic expectations, a visible difference in coloration during temporary restoration may disturb patients.

Previous studies have investigated the coloring effects of tea, coffee, cola, wine, and the applied preheating process on resin materials [11]. However, there is no study on the heating and coloring of temporary restorative filling materials.

The aim of this study is to evaluate the coloration effects of different drinks on temporary restorative materials kept at different temperatures (4ºC, 25 ºC).

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## MATERIALS AND METHOD

In this study, two different light-cured temporary resins (Tempit, Spident, Korea, First Fill, Pentron Clinical Technologies, Wallingford, CT, USA) were placed in a 4 mm diameter and 2 mm deep mica mold and cured at two different temperatures (4ºC, 25 ºC). The contents of the Light-cured temporary resin materials used in this study are shown in Table 1. A total of 15x4 = 60 disc samples were prepared. For this study, each group consisting of 15 samples was randomly divided into 3 subgroups (n = 5), namely Tempit and First Fill, light cured temporary resins were used separately at 4°C in the refrigerator and at 25°C at room temperature after standing for 2 hours. (Table 2) A transparent tape was placed on the cement glass, and the temporary light cured resin materials were moved to the slot inside the mold using a mouth spatula. Then, transparent tape and cement glass were placed on the light-cured temporary resins. Light pressure was applied to obtain excess material overflowed, and a smooth surface. The prepared samples were polymerized for 40 s using a LED light device (EliparFreelightII, 3M ESPE, St.PaulMN, USA). The power of the light device was checked with a radiometer before polymerization of each sample to ensure a power higher than 500 mW / cm2. Afterwards, all samples were placed in distilled water in a 37 ºC incubator (Binder 80339, Munich Germany) for 24 h. Then, the initial L0 * a0 * and b0 * color values of the samples were determined using an Easy Shade spectrophotometer (Vita Zahnarzt, Germany) and a standard white background. The measurements were made in D65 standard lighting conditions, and the device was calibrated before each measurement.

Three measurements were made for each sample, and the averages of these measurements were recorded. After this process, cherry water, distilled water and 2 g of coffee (Nescafe Classic, Nestle, Switzerland) were prepared in 200 mL of boiled distilled water and mixed for 10 min. The samples were measured with basic color, they were placed in glass petri dishes, and then, the prepared solutions were added. The prepared tubs were kept in the incubator (Binder 80339, Munich Germany) at 37°C for 7 days, and the solutions were renewed every other day. Color measurements of the samples were recorded on day 1, day 3 and day 7. After washing and drying the extracted samples on the 1st day, the initial L0 * a0 * and b0 * color values and the determined L1 * a1 * and b1 * color values (ΔE) between differensite were calculated again with the digital spectrophotometer device.

CIEDE 2000 (ΔE) FORMULA:

$$\Delta E_{00} = \sqrt{\left(\frac{\Delta L'}{k_L S_L}\right)^2 + \left(\frac{\Delta C'}{k_C S_C}\right)^2 + \left(\frac{\Delta H'}{k_H S_H}\right)^2 + R_T\left(\frac{\Delta C'}{k_C S_C}\right)\left(\frac{\Delta H'}{k_H S_H}\right)}$$

In addition, L3 * a3 * and b3 * and L7 * a7 * and b7 * values were measured on the 3rd and 7th days, and the color differences between the initial L0 * a0 * and b0 * color values were calculated using the formula CIEDE2000 (ΔE).

One-way ANOVA and Duncan multiple comparison tests were used to analyse the differences between and within the groups. Additionally, taking into account repeated measurements for time, the analyzes were completed by using the repeated ANOVA algorithm in all analyzes, taking into account the dependencies between measurements.All tests were performed at a 5% significance level.

## RESULTS

The results regarding the coloration values of the transients kept at different temperatures are shown in Table 3. There were differences in terms of coloration degrees between temporary composite materials kept in distilled water, cherry juice and coffee for 24, 72 hours and 1 week. Distilled water was used as the control group in our study. No clinically noticeable color change occurred in the samples kept in distilled water during the experiments. Although, the coloration degree was lower in the temporary filling material stored in 25°C, there is no statistically significant difference between the 4°C and 25°C groups. The coloration level of Temp-it was less than First Fill. ($p<0.05$) The highest average ΔE value among all groups was obtained at 4°C in the First Fill group in the coffee solution. At the end of the seventh day, it was shown that the light-cured temporary resin samples exceed the clinically acceptable color change threshold in beverages used other than distilled water.

**Table-1: Light-curing temporary filling material's contents.**

| Temporary Filling Materials | Components | Manufacturer |
|---|---|---|
| Temp-it | Urethane dimethacrylate, hydroxyethyl methacrylate, silicon dioxide, BHT, camphorquinone, ethyl 4- (N, N dimethylamino) benzoate | Spident Co. Ltd, South Korea |
| First Fill | Mono and dimethacrylate resin, silica, titanium dioxide and catalysts | Pentron Clinical Technologies, LLC, U.S.A. |

**Table-2: Classification of the groups.**

| Material and preapplication temperature | Test Solutions |
|---|---|
| Temp- it 4ºC<br>First Fill 4ºC | Distilled Water |
| | Cherry Juice |
| | Coffee |
| Temp-it 25 ºC<br>First Fill 25 ºC | Distilled Water |
| | Cherry Juice |
| | Coffee |

**Tablo-3: Evaluation of coloration levels of light-cured temporary filling materials kept at two different temperatures**

| Tested solutions | Stored temperature of the materials (C°) | Temp- it | First Fill | *P- Value* |
|---|---|---|---|---|
| | | $\bar{X} \pm S_{\bar{X}}$ | $\bar{X} \pm S_{\bar{X}}$ | |
| **Distilled Water** | **4** | **2.95±0.36$^{a,A}$** | **3.06±0.43$^{a,A}$** | **>0.05** |
| | **25** | **2.72±0.36$^{a,A}$** | **2.84±0.50$^{a,A}$** | **>0.05** |
| **Cherry Juice** | **4** | **12.66±0.74$^{b,B}$** | **25.49±1.74$^{a,B}$** | **<0.05** |
| | **25** | **11.12±0.62$^{b,B}$** | **22.89±2.08$^{a,B}$** | **<0.05** |
| **Coffee** | **4** | **31.90±2.90$^{b,C}$** | **37.49±2.59$^{a,C}$** | **<0.05** |
| | **25** | **29.81±1.30$^{b,C}$** | **33.64±2.36$^{a, C}$** | **<0.05** |

* Different superscript letters (A,B,C) in each column represent significant differences
** Different superscript letters (a,b,c) in each row represent significant differences

## DISCUSSION

Temporary restorative materials are employed to temporarily close the entrance cavities and to protect the root canal system against to external factors Light-cured resin-based temporary restorative materials may be preferred in anterior teeth between endodontic treatment sessions in which mechanical retention cannot be achieved and aesthetics are important [3].

Preheating processes applied to fill materials increase the average kinetic energy and molecular motion of light-cured resins. As a result of this process, the fillers, which become fluid, adapt more easily to the cavity and can improve polymerization. Thus, the degree of monomer conversion of the material increases and the amount of coloration decreases [12-14]. Micali and Basting reported that sufficient polymerization and a high degree of conversion positively affected color stability [15].

Mundim *et al.* reported that samples kept at 8°C before photo-activation experienced less monomer conversion than the groups at 25°C and 60°C [16]. In studies [12-16], they reported that before polymerization, the preheating composites increased their monomer conversion degrees significantly and applied less light to provide more conversion degrees. Gönülol *et al.* [17] found that samples polymerized at low temperature showed more color change than composite samples polymerized at high temperatures.

Similar results were obtained in our study. Although the samples kept at 25°C generally showed less coloration than those at 4°C, this difference was not statistically significant.

Ladislav Gregor *et al.* [18] found the highest coloration in coffee and red wine with resin-containing fillers and no difference between CIEDE 2000 and CIE L* a* b color evaluation system. In another study [19], it was reported that the CIEDE 2000 color evaluation system was more successful in detecting low color differences. For this reason, CIEDE 2000 color evaluation system was selected for use in this study.

Light-cured temporary restorative materials absorb fluids due to their rheological and viscoelastic properties. Elasticity and viscosity ratio of resin composite materials are affected by the resin matrix ratio within the substance, filler amount and shape, and particle size and distribution [20]. Temporary filling materials have a low particle and filler ratio when compared with composites. This feature allows the material to be easily removed from the cavity after polymerization. In addition to light-cured temporary restorative materials, the amount of staining is high due to the lack of microparticles and the high resin matrix ratio. However different studies should prove this recommendation [3].

Filler particle properties of the composite resins directly affect the surface smoothness and external coloration. According to Patel *et al*. [21], abrasives are used in the finishing and polishing process, and they obtain successful results in micro-particle composites, as another composites contain macro-particles. The final surface remains rough and causes more coloring [22-24]. In the present study, more coloration was observed due to the macro-particle size of the light-cured temporary filling materials and the lack of polish on the materials after polymerization.

Temp-it light-cured temporary filling material showed less coloration than First Fill temporary filling material in the present study. Although First Fill and Temp-it temporary filling materials have similar resin matrix content, the resin matrix / filler ratio and shape, particle size and distribution may account for this difference.

The external coloration of resin materials stem from contact and absorption of various coloring liquids such as coffee, cola, tea, and fruit juice [22]. Resin materials can absorb water as well as other liquids and pigments that result in coloration [24]. According to the results of numerous in vitro studies with commonly consumed foods and beverages such as coffee, tea, fruit juice, cola, mustard and ketchup, the materials have been reported to cause significant discoloration on the composite resin restoration surface [22, 25-28].

In another study, it was found that certain drinks containing dyes, such as coffee, cause severe coloring [29]. As a result of the interaction of polymerized composite particles with yellow particles and long colorimetric chains in coffee, the yellow color increases and the b* coordinate value is affected [30]. In the present study, in parallel to these studies, there was more coloring in temporary composite samples that included coffee.

## CONCLUSION

It is concluded that the use of light-cured resin-containing temporary restorative materials in the front areas of anterior teeth where aesthetics are important, the use of light-cured temporary filling materials that are heated at 25°C will result in less coloration.

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