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# To Evaluate Effect of Preheated Composite Resin on Its Colour Stability When Immersed in Three Different Solutions – An in Vitro Study

[1.] Dr. Sadashiv Daokar (Professor & HOD, Department of Conservative Dentistry & Endodontics)
[2.] Dr. Kshama Sarak (Postgraduate student, Department of Conservative Dentistry & Endodontics)
[3.] Dr. Kartik Raman (Reader, Department of Conservative Dentistry & Endodontics)
[4.] Dr. Kalpana Pawar (Professor, Department of Conservative Dentistry & Endodontics)
[5.] Dr. Aishwarya Ranjalkar (Postgraduate student, Department of Conservative Dentistry & Endodontics)
[6.] Dr. Shivani Vyavahare (Postgraduate student, Department of Conservative Dentistry & Endodontics)
[7.] Dr. Shubhangi Gaysmindar (Postgraduate student, Department of Conservative Dentistry & Endodontics)

**Abstract:-**
**Background: Most important concern in using composite resins is, colour tends to change in course of time. Discoloration of these materials compromises the purpose and success of composite restorations over the long period. Aim: The aim of this study is to check the preheating effect of nanohybrid composite resin and its colour stability when immersed in tea and coffee solutions. Materials And Methods: This experimental study included 60 nanohybrid composite disks with a diameter of 5mm and thickness 2mm. 60 samples were divided into 2 groups. Group 1 of 30 samples, composite was placed in refrigerator and placed in plastic moulds when it comes to room temperature. The samples were polymerized for 40 seconds from both the sides. In group 2 of 30 samples, a composite gun containing composite was placed in convection micro-oven and the temperature was adjusted to $68^0$C, the composite was immediately inserted in plastic mould and cured from both the sides. The samples are previously dried with moisture absorbing paper and colour stability was measured (t0). The samples of each group were randomly divided into 3 subgroups (n=10) and were respectively immersed in distilled water, tea and coffee. At the end of 15 days period, all samples were placed against a flat white background and to measure colour stability CIE-L*a*b* system was used. The difference between the measured colours is calculated (ΔE). Results And Conclusion: within the limits of the study, it showed that preheating of the composite resin is effective in the reduction of its colour change and the highest colour change was observed in tea followed by coffee and least in water.**

***Keywords***:- *Composite Resin, Preheating, Colour Stability, Tea and Coffee.*

## I. INTRODUCTION

Esthetics is a very important part of cosmetic dentistry and to give utmost esthetics colour and staining plays a pivotal role in it. Composite resins come in different colour and shades and thus they help in achieving a good esthetics in conservative dentistry. Since composite resins were introduced in the market, many attempts have been made towards increasing their longevity as a restorative material in the oral cavity. Despite the fact thar some progress has been made, optical properties still need to be improved.[1], [2] With rapid improvements in materials science, restorative resin composites have performed a significant role in modern dentistry due to the increasing demand for esthetic restorations [3]. Over the last few years, manufacturers have made improvements in the mechanical properties of composites, which includes reductions in polymerization shrinkage, which have encouraged clinicians to use resin composites in posterior restorations [4].

Unacceptable discoloration/ staining is commonly encountered in tooth-coloured restorations and is a common reason for their regular replacement [5]. So, one of the reasons for long term success of composite restorations is colour stability. Colour stability is one of the important criteria for selection of composite during its service [6–8]. Color stability as a multifactorial phenomenon is an effective factor in the successful clinical performance of direct tooth-colored restorations in dentistry [9,10], which can be affected by debonding of fillers or changes in the resin matrix [11]. The resin matrix discoloration is related to the degree of conversion (DC), physicochemical properties, and hydrophilic nature of the matrix [12,13].

Various studies conducted on the effects of preheating on improving the composite resin properties since its application in dental restorative materials [14-19]. During preheating, the composite syringe is heated in the range of 39-60°C before use [20]. It was stated that chair-side preheating increases the DC and crosslinking in the polymer network by increasing the flow and reactivity of the active groups in the polymerization process and ultimately improves the mechanical properties [17,21]. The increase of polymerization degree can improve the resistance of the material to discoloration by the reduction in water absorption following drinking-colored beverages [22,23].

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Considering the importance of the colour stability of composites in maintaining the aesthetic properties, the role of preheating to ensure the chemical durability of resin matrix [24], and the effect of chemical differences among composite resins on the color stability of composite restorations was the focus of researches [25,26].

In many practices, preheating the resin composite before application has become a popular technique because it improves marginal adaptation and microleakage, potentially improving flowability and material extrusion.[16] Prior to polymerization, increasing the temperature of the resin composite has been shown to increase surface hardness and maximize polymerization. [16,27]

Despite some assumptions there are few studies on the effects of preheating on color stability of composite resins. Some studies reported the positive effects of such a technique [28,29] and one study did not find any effects [22]. Therefore, the aim of this study is to evaluate the effect of preheating of a nano hybrid composite resin on the color stability when immersed in tea and coffee solution. The null hypothesis tested is that the preheating of composite resin had no effect on the colour stability of the material, irrespective of the coloring solutions.

## II. MATERIALS AND METHOD

In this experimental study, a nano hybrid composite resin (Kulzer Charisma Diamond Composite, A2 shade) was selected. The properties of this studied nanohybrid composite resin are described in (Table 1).

**Table 1 The properties of the studied composite resin.**

| Material | Type | Resin | Filler content | Batch Number | Manufacturer |
|---|---|---|---|---|---|
| Kulzer Charisma Diamond Composite | Nano hybrid composite<br><br>Packable | BIS-GMA, UDMA, TCD- Urethaneacrylate | 64% filler by volume, 5 nm- 20 µm, highly discrete nanoparticles, Barium Aluminium Fluoride glass. | 66044511 | Kulzer, Germany. |

60 disk samples with a diameter of 5 mm and thickness of 2 mm were prepared using a plastic mold. Specimens were then divided into 2 main groups according to the temperature of preparation (n=30).

Group 1 was prepared based on following instructions. The composite that was previously placed in refrigerator removed from it and placed at room temperature (25°C) for at least 10 minutes was placed inside a plastic mold. The samples were polymerized from both sides for 40 seconds using an LED light curing unit (Bluephase Style LED) at 1100 mW/cm2.The room temperature was maintained at 25°C using a cooling equipment and regulated by a mercury thermometer.

To prepare group 2, Composite was placed in convection micro-oven at temperature of 53 to $68^0$ C and the composite was immediately inserted in the plastic mold and then it was cured from both sides as that of group 1. To decrease heat distribution, the time between the removing of the composite resin from the oven and placing it in the mold was 10 seconds.

All samples were de moulded and placed at 37° C in distilled water for 24 h until the polymerization was completed. The upper surface of the composites was polished for 20 s using aluminium oxide disks. Each disk was used for one sample. The colour assessment of the samples was performed using a VITA Easy shade spectrophotometer. The samples were previously dried with moisture absorbent paper and were placed against a flat white background and then their colors were measured (t0).

The samples of each group were again randomly subdivided into 3 groups (n=10). Samples of subgroup 1,2 and 3 were respectively immersed in tea, coffee and distilled water.

**Table 2 Division of Samples.**

| Material | Solutions | Room Temperature ($25^0$ C) | Pre Heated ($68^0$ C) |
|---|---|---|---|
| Kulzer Charisma Diamond Composite | Tea | 1A | 2A |
| | Coffee | 1B | 2B |
| | Distilled Water | 1C | 2C |

To prepare the colouring solutions of tea solution, two tea bags are put in 300 mL of boiled water for 5 minutes, for the 3.6 g of coffee powder is dissolved in 300 mL of boiling water and it was boiling for 10 minutes. After that the samples are immersed in the solutions for 15 days.

The colouring solutions were daily changed and samples were washed and brushed for one minute in order to remove any debris. The mean time for drinking of a cup of tea/coffee and the amount of drink have been reported about 15 minutes and 2-3 cups per day respectively [30]. Therefore, an exposure time of 15 days seems to simulate approximately 30 months of tea/coffee consumption. At the end of 15 days period, All samples were placed against a flat white background and their colour was measured (t1).

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Colour evaluation was performed using CIE-L*a*b*system (Commission International De I'Eclairage) [31, 32]. The values of L* (lightness), a* (green-red axis), and b* (yellow-blue axis) were determined in each color reading. The colour change (ΔE) was calculated as follow:

$$\Delta E^* = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}$$

The colour change (ΔE) ≥ 3.3, has been reported scientifically visualized for human eyes and unacceptable [33].

Statistical analysis for this study was performed using version 21.0 of SPSS software, Paired t-test, ANOVA, Tukey's test and Dunnett t-test.

## III. RESULTS

This experimental study was carried out on 60 samples of composite resin to investigate the efficacy of preheating on its colour stability after immersion in tea, coffee and distilled water.

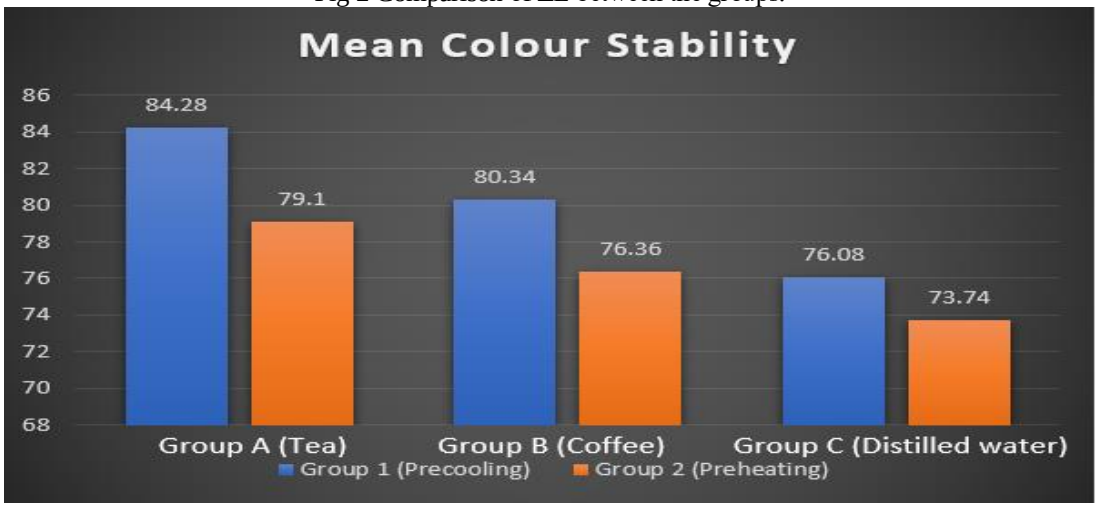
The results of this study showed a statistically significant difference in the mean colour changes between the groups ($p$<0.0001). The highest and lowest color change were obtained for 1A (room temperature materials in Tea solution) and 1C (room temperature materials in distilled water) groups, respectively.

Fig 1 The mean colour change between the groups.

| Colour Change-Precooling | Group 1 (Precooling) Mean (SD) | Group 2 (Preheating) Mean (SD) | Unpaired t test | P value, Significance |
|---|---|---|---|---|
| Group A (Tea) | 84.28 (1.31) | 79.1 (1.32) | t = 8.8 | p<0.001** |
| Group B (Coffee) | 80.34 (1.03) | 76.36 (0.56) | t = 10.6 | p<0.001** |
| Group C (Distilled water) | 76.08(0.61) | 73.74 (1.45) | t = 4.691 | p<0.001** |

Figure 2 indicates the paired comparison of ΔE between the groups. There was no significant difference observed between the 1C and 2C groups. In contrast, the mean ΔE was significantly different between the 1A and 2A groups. Although ΔE was lower in the 1B than 2B group, the difference was not statistically significant.

Fig 2 Comparison of ΔE between the groups.




## IV. DISCUSSION

The null hypothesis tested in this study is partially rejected as the preheated composite resin showed significantly lower discoloration when immersed in coffee but this reduction isn't significant in tea solution.

Discoloration of composite resin material can be external and/or internal by adsorption and/or absorption of the colorant agents. The staining resistance of the resin composite material is related to many factors such as filler particles of the composite material, polymerization type and type of staining agent. Since instrumental measurements remove the subjective interpretation of visual colour comparison, Spectrophotometers, colorimeters have been used to measure colour changes in dental materials [34].

Preheating of the composites reduces absorption and penetration of the colorant solution via increase of polymerization. The preheating of composite resin increases its degree of polymerization and can cause higher resistance to discoloration. In our study, pre heating of composite resin caused higher resistance to discoloration of them in coffee than tea solution. Tea solutions have yellow pigments with different polarity [35].

The colour change of composite resin in the tea solution may be because of adsorption of polar colorants onto the surface of composite resin material, which causes more discoloration than coffee. In this study, we observed colour change of the composite resin in the distilled water (controlled group). However, it was not statistically significant. It seems water sorption itself and departure of soluble material can be the cause of this discoloration. [35]

Coffee was chosen as an experimental solution because it has been shown to have strong staining effect on composite resins as well as on natural tooth structures [36].

Um and Ruyter studied the staining effects of coffee and tea on resin-based veneering materials and they concluded that discoloration by coffee and tea occurred by surface adsorption and absorption of colorants, whereas compatibility of the polymer phase of composite resin with the yellow colorants of coffee served to encourage this adsorption and penetration of colorants.[13]

Micali and Basting studied the effectiveness of composite resin polymerization using different light-curing units and they concluded that residual monomers in the polymeric chain can form colorimetric degradation products. [37]

Non-converted double carbon link in composite resin can leads to microcracks and making composite resin more susceptible to discoloration. Thus, microleakage accelerates penetration of extrinsic staining into the composite restoration.

Thus, this study concludes that preheating composite can lead to better colour stability by increasing marginal adaptation and degree of conversion which decrease residual monomers, microleakage and non-converted double carbon link. But more clinical studies are needed to be done to evaluate colour stability of preheated composite resin due to various intraoral factors.

## V. CONCLUSION

Within the limitations of the study, the findings of the present study showed that preheated composite resin is effective in the reduction of its colour change.

In the preheating group, the highest colour change was observed in tea followed by coffee and least in water. In the pre cooling group, the highest colour change was observed in tea followed by coffee and least in water.

Preheating is more statistical significantly resistant to colour change as compared to pre cooling for all sub groups i.e. tea, coffee and water.

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