*IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*
*e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 23, Issue 8 Ser. 6 (August. 2024), PP 20-23*
*www.iosrjournals.org*

# Comparative Evaluation Of Effect Of Food Stimulating Liquids On Mechanical Properties Of SingleShade Versus MultiShade Resin Composites: An In Vitro Study

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***Abstract***
*Introduction: Single-shade universal resin composites are preferred in clinical practice to reduce the time for shade selection and obtain good aesthetic results. Restorative resins during their prolonged use are exposed to a variety of food and beverages and are subjected to wear and degradation resulting in failing restoration and requiring replacement. This study aimed to evaluate the effect of food-stimulating liquids on the mechanical properties of single-shade versus multi-shade composite resin. Materials and methods: 30 samples (2mmx2mmx18mm) were fabricated from Filtek Z350, Omnichroma, and Charisma Topaz One composite resin composite. The samples were kept in distilled water for 24 hours. Half of the samples were subjected to immediate flexural strength testing while the remainder half were immersed in food-simulating liquid (FSL)-75% ethanol for the next 7 days and then subjected to flexural strength testing. Statistical analysis: Data were analysed using the Post-hoc Tukey`s Test. Results: A statistically significant difference was found between the materials before and after aging in FSL. Conclusion: Charisma topaz showed the highest flexural strength amongst the three groups followed by Filtek Z350 and Omnichroma before and after immersion in FSL.*
***Keywords:*** *Food-simulating liquids, single shade universal composite resin, flexural strength*

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Date of Submission: 11-08-2024 Date of Acceptance: 21-08-2024

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## I. Introduction

Direct resin composite restorations are commonly used in dentistry, due to the improvements in the adhesive dentistry. The "Natural layering concept" was developed to provide esthetically pleasing restoration and mimic natural teeth[1]. Although the technique is commonly used by dental practitioners , it generally requires skills and long chairside time. On the other hand, recently introduced single-shade universal resin composites (SsURC) simplify the restorative procedure and saves time as well[2].

The SsURCs match almost all shades and thereby eliminate the shade selection step. The blending effect of the resin composite helps in the matching restorative material with the color of the surrounding tooth structure through reflections. When light illuminates the restorative material, it diffuses through the surface of the filler particles and scatters in multiple directions. The blending effect is also affected by restoration size and translucency of the restorative material. Chameleon effect and color adjustment potential are the other commonly used terms to state the blending effect[3,4].

The physical and mechanical properties depends on the composition of resin. The polymeric matrix is based on a mixture of dimethacrylate such as bisphenolA glycol dimethacrylate (BisGMA), urethane dimethacrylate (UDMA), bisphenolA dimethacrylate (BisEMA), and triethylene glycol dimethacrylate (TEGDMA)[5]. The filler concentration of resin is generally 70%–80% by weight, comprising radiopaque silicon dioxide, boron silicate, lithium aluminum silicates[6], and heavy metal particles such as barium, strontium, zinc, aluminum, or zirconium[9].

Foods and beverages are amongst many of other extrinsic factors that can degrade and cause aging of composite resins in the oral cavity. Aging of composite resins has been simulated by storage in water and ethanol in previous studies[10,11]. Water storage is considered to have detrimental effects on the composite resin surface according to Sideridou et al[12]. Aqueous ethanol solution also has been the solvent of choice to stimulate and accelerate aging of restorations. In the present study, 75 % ethanol is used as foodsimulating solutions. It is recommended in guidelines from the US Food and Drug Administration to be used as food simulator.

The composite material should show mechanical strength to withstand forces acting on high stress-bearing areas, otherwise, the forces could lead to deformation and fracture of body of the restoration. Flexural strength (F), which is one of the mechanical properties is tested is this study. F can be correlated with clinical wear and this correlation has been proved by the clinical and laboratory outcomes of the study[10]. The aim of the present study was to evaluate the effect of FSL such as 75% aqueous ethanol solution on mechanical properties of single-shade versus multi-shade composite resin.

## II. Materials And Methods

A total of 30 samples of composite resin with the dimensions of 2×2×18 mm were prepared. The content, characteristics, and manufacturer information of the composite resins used in this study are presented in Table 1. A silicone mould was positioned over a glass slide and a mylar strip and filled with composite in a single increment, followed by photopolymerization with an irradiance of 2500 mW/cm$^2$ (Woodpecker ILED Plus Curing Light)[10]. Depending on material used it was divided into 3 groups:

Group 1: 10 blocks of Filtek Z350
Group 2: 10 blocks of Omnichroma
Group 3: 10 blocks of Charizma Topaz One

The samples were kept in distilled water for 24 hours. Half of the samples of each group were subjected to flexural strength testing while the remainder half were immersed in food-simulating liquid (FSL)—75% ethanol stored in a glass at 37°C for the next 7 days to simulate a wet oral environment. After conditioning period the samples were subjected to flexural strength testing, calculated by three-point bending test using a universal testing machine.

***Three-Point Bending Test***:

The flexural strength (FS) was determined using a 3-point bending test according to NIST No.4877, considering a span of 12 mm. The samples prepared and stored as above were loaded in a universal testing machine until fracture at a crosshead speed of 0.5 mm/min, the force during bending was measured.

**Table 1: Chemical composition of the different composite resins**

| Material | Type | Shade | Composition |
|---|---|---|---|
| Omnichroma (Tokuyama Dental, Tokyo, Japan) | Nano filled | Single shade | Matrix: UDMA, TEGDMA. Fillers: 79% by weight uniform supra nano spherical filler ($SiO2$ -$ZrO2$ 260nm). |
| Filtek Z350 3M (ESPE) | Nano composite | A2 shade | Bis GMA, UDMA, TEGDMA, Bis EMA, discrete non agglomerated and non aggregated silica and zirconia fillers of 20 nm and 411 nm in size |
| Charisma Topaz One (Kulzher Germany) | Nanohybrid composite | Single shade | UDMA, TCD-DI-HEA, TEGDMA, Ba−Al−B−F−Si glass, PPF, $SiO_2$, 81wt %, (64vol %) |

Bis-GMA, bisphenol-A-glycidyl dimethacrylate; UDMA, urethane dimethacrylate; TEGDMA, triethylene glycol dimethacrylate; TCD-DI-HEA = 2-propenoic acid; (octahydro-4,7-methano-1*H*-indene-5-diyl) bis(methyleneiminocarbonyloxy-2,1-ethanediyl) ester; PPF = pre-polymerized filler; $SiO_2$ = silicon oxide (silica); $ZrO_2$ = zirconium oxide; $BaO{-}Al_2O_3{-}SiO_2$ = barium aluminosilicate glass; $B_2O_3{-}F{-}Al_2O_3{-}SiO_2$ = boroaluminosilicate

**Statistical Analysis**

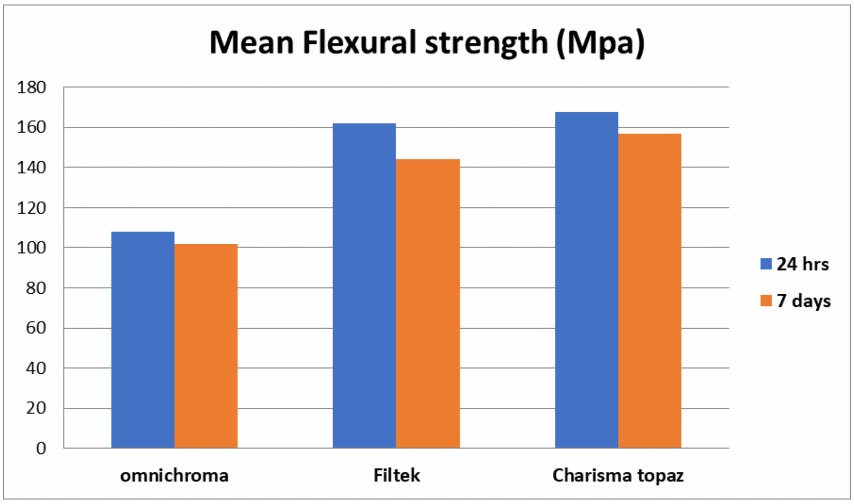
Data were collected by using a structured proforma. Data were entered in MS excel and analyzed by using Statistical Package for the Social Sciences (SPSS) software (version 16). Quantitative data were expressed in terms of Means and Standard deviation. The comparison between the groups were analysed using Post-hoc Tukey`s test. Difference between means of groups was compared using independent t-test. A $p<0.05$ were considered as statistically significant whereas p value $<0.001$ were considered as highly significant.

## III. Results

Statistically significant differences in mean flexural strength were found between the materials after ageing in FSL: mean flexural strengths of Charisma Topaz was highest among three groups followed by Filtek Z350 and Omnichroma ($p< 0.001$). After ageing no statistically significant differences were found between Charisma and Filtek Z350, but these showed statistically significant higher flexural strength than Omnichroma ($p< 0.001$).

**Table 2. Comparison of mean flexural strength after 24 hrs and 7 days.**

| Groups | Days | Mean Mpa (SD) | t- value | P value |
|---|---|---|---|---|
| Omnichroma | 24 hrs | 108(4.18) | **1.544** | **0.16** |
| | 7 days | 102(7.61) | | |
| Filtek Z350 | 24 hrs | 162 (13.5) | **2.58** | **<0.05*** |
| | 7 days | 144 (7.6) | | |
| Charisma Topaz One | 24 hrs | 167.4 (9.8) | **2.3** | **<0.05*** |
| | 7 days | 156.8 (2.9) | | |




## IV. Discussion

SsURCs are preferred in clinical practice to reduce the time for shade selection and improved esthetic properties[13]. Successful resin-based composite restorations require adequate physical, mechanical and biological properties. Despite improvements in materials, the longevity of composite restorations will always be the concern for all clinicians. The degradation of composite resin restoration is a process that involves several factors such as wear, staining, absorption of liquids, inadequate finishing, and polishing. The failures of composites are mainly due to behaviour of different resin matrix and type and percentage of filler incorporated in composite resins[14].

Food Stimulating Liquid, have softening and hydrolyzing effects on resin composites, may cause a decrease in the physio mechanical features of composites due to the deterioration of the polymer matrix. Yap et al.[7] and Wu et al.[8] reported that FSL such as citric acid, lactic acid, heptane, and ethanol softened the composite surface. In this study, ethanol was the solvent of choice to stimulate and age the dental restorations. Composite resin when placed in ethanol which depicts alcohol, released monomer in less time than if it were placed in water[9].

The greatest change in hardness of resin composites after conditioning with FSL has been shown to occur within the first 7 days[15]. In this study, the specimens were conditioned in 75% ethanol for 1 week before the tests. This period may be considered long, since the restoratives come into contact with foods and beverages only during eating and drinking until teeth are cleaned however, these chemical agents can be trapped mostly around the margins and connectors of inadequately fabricated/finished provisional prostheses, and into porosities of poorly manipulated materials[16].

The degrading mechanism of 75% ethanol has been attributed to the softening of the polymer matrix, which results in its partial removal from the surface. The partial removal of the resin matrix may result in the degradation of the filler–matrix interface and this can contribute to the decrease in FS[17,18].

In present study filtek Z350 and Omnichroma showed relatively less flexural strength than charisma topaz one before and after conditioning with 75% ethanol solution. This concentration of ethanol has been shown to cause maximum softening of Bis-GMA-based composite materials. Bis-GMA and TEGDMA provide polar groups in their molecules (─OH─ and ─O─, respectively), which makes the resulting polymer matrix more hydrophilic. Bis-GMA and TEGDMA can be considered relatively hydrophilic monomers that might exacerbate water sorption, leading to long-term degradation.

Charisma Topaz One is based on tricyclodecane-urethane acrylate (TCD-urethane) monomers might have influenced the results. TCD-urethane is a high-molecular weight, low-viscosity monomer prepared through the reaction between hydroxyalkyl (meth)acrylic acid esters and diisocyanates, with a subsequent reaction involving polyols. Due to its low viscosity, TCD-urethane does not require the addition of diluent monomers in the composite, which makes it hydrophobic in nature and decrease absorption of FSL.

Charisma Topaz One was the most mechanically stable among the tested materials, as there was no significant reduction of its flexural strength. This low susceptibility of Charisma Topaz One to FSL induced deleterious effects might also be due to monomer composition, and high filler content of approximately 81 wt%.

## V. Conclusion

Within the limitations of this study, it may be concluded that the Charisma topaz showed highest flexural strength as compared to other groups after ageing in FSL. It may be concluded that these changes are due to the different composition of the resin matrix and different filler particles of the tested composite resins.

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