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Evaluation of colour stability, water sorption and solubility of no-cap flowable bulk fill resin composites

Merve Kütük Ömeroğlu^{1*} and Hüseyin Can Hekimoğlu²

Abstract

Background The aim of this study is to investigate the colour stability, water absorption, and solubility values of low viscosity bulk fill resin composites that do not require an additional layer in comparison with high viscosity and low viscosity bulk fill resin composites used as a base.

Methods In the present study, four different bulk fill resin composites were used: Charisma Bulk Flow One (Kulzer), Estelite Bulk Fill Flowable (Tokuyama), X-tra Base (VOCO), Filtek One Bulk Fill (3M ESPE). The resin composites were prepared as disc-shaped samples with a diameter of 5 mm and a thickness of 4 mm, then polymerized using a LED light device (Elipar DeepCureS, 3M ESPE). The samples were kept in artificial saliva and coffee solution for 28 days to determine water absorption, solubility levels and Δ E values, with measurements taken on days 7, 14, 21 and 28. Water absorption and solubility levels were calculated based on ISO4049:2009 specification, and mean colour change values were calculated based on CIEDE2000 formula. Repeated Measures ANOVA, along with post hoc Bonferroni, Tamhane, and Adjusted Bonferroni tests, were used for the statistical evaluation of the data (p < 0.05).

Results Among all composite groups at all time intervals, Charisma Bulk Flow One composite showed the highest water absorption, solubility, and discolouration values.

Conclusion The water absorption, solubility and discolouration values of the resin composites used in this study were affected by the amount of filler in the resin structure. The clinical applicability of low-viscosity bulk-fill resin composites that do not require an additional capping layer should be carefully reassessed.

Keywords Discolouration, Low viscosity bulk fill composite, Solubility, Water absorption

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Introduction

In recent years, 'bulk fill' composites, which can be placed in the cavity in 4–5 mm layers at a time, have been developed to eliminate the disadvantages of the layering technique and to facilitate treatment procedures, especially in the restoration of large posterior cavities [1]. Bulk fill resin composites are produced in two different viscosities: low viscosity (flowable) and high viscosity. Flowable bulk fill resin composites are generally used as a base, especially in areas with high occlusal stress, and need to be covered with a high viscosity bulk fill or conventional composite resin [2, 3]. Applying an additional composite layer is believed to enhance the wear resistance and overall mechanical performance of restorations. Another reason for covering it with a high viscosity composite layer is insufficient colour stability [4].

Recent advancements in restorative dentistry have led to the development of no-cap flowable bulk-fill resin composites, eliminating the need for an additional capping layer. These resins can be applied to the cavity as a single layer, enhancing the adaptation of the restorative material to irregular cavities due to their low viscosity [5]. It is believed that utilizing low viscosity bulk fill composites that can be applied as a single layer will facilitate clinical procedures. Evaluating these resin composites' water absorption, solubility, colour stability, and surface properties, and comparing the results with those of higher viscosity resins that have demonstrated superior physical and mechanical stability, is crucial to ensure their safe application.

The clinical success of composite restorations is affected by their physical and mechanical properties. Water absorption, solubility, and colour stability are important parameters used in determining the clinical life of restorations. When resin composites are evaluated in terms of water absorption, they are expected to remain stable, but the polymer network structure of the resin can absorb the moisture in the environment and affect the weight of the material [6]. Water absorption can lead to hydrolysis of chemical bonds at the resin matrix-filler interface, deterioration in colour stability, poor mechanical properties and reduced wear resistance. It can also increase the solubility of resin composites by causing the movement of residual monomers that have not undergone polymerization, which can adversely affect their biocompatibility and cause volume reduction [6–9]. Low viscosity resin composites have been reported to discolour more and have lower colour stability than high viscosity resin composites due to their low filler/resin matrix ratios [5].

This study assessed the water absorption, solubility, and colour stability of newly developed and marketed no-cap low viscosity bulk fill resin composites that do not require the occlusal surface to be covered with an additional high viscosity composite. The hypotheses of the study are: (1) there will be no significant difference in water absorption, solubility, and colour stability between high viscosity and low viscosity bulk fill resin composites that do not require an additional layer, (2) low viscosity no-cap bulk fill resin composites will demonstrate superior properties compared to traditional low viscosity bulk fill resin composites used as a base.

Materials and methods

Preparation of study samples

In the present study, four different resin composites were used: two low viscosity, no-cap bulk fill composites, Estelite Bulk Fill Flow (EBF) (Tokuyama Dental Corporation, Tokyo, Japan), Charisma Bulk Flow One (CBF) (Heraeus Kulzer, Hanau, Germany), one high viscosity Filtek One Bulk Fill (FBF) (3 M ESPE, St. Paul MN, USA), and a low viscosity X-tra base (XB) (Voco, Cuxhaven, Germany). The composite resins used in the study, their properties, contents, and polymerization times are shown in Table 1. For each restorative material, thirty disk-shaped specimens (5 mm diameter, 4 mm thickness) were prepared using a Teflon mold [10]. The resin composites were applied in a single layer inside the teflon mold and then covered with a mylar strip. A glass slide was used to compress the top of the material after each mold was filled with material and covered with a matrix strip (Hawe Stopstrip, Kerr). To standardize the curing distance, the upper surface of the specimens was cured with light, and the tip of the light was brought into contact with the glass slide. The Elipar Deep Cure S curing device (3 M ESPE, St. Paul MN, USA) was used for polymerization. Samples were polymerized according to the manufacturers' recommended curing times.

Water absorption-solubility protocol

After preparing samples, 10 samples were randomly selected from each resin composite group for water absorption and solubility tests. The absorption and solubility tests were conducted in accordance with the International Organization for Standardization (ISO) 4049:2009 standards. The selected samples were numbered, placed in a desiccator, and then transferred to an oven (EN025, Nüve, Turkey), where they were maintained at 37 ± 1 °C for 22 h, followed by 23 ± 1 °C for an additional 2 h. Subsequently, the specimens were weighed using an analytical balance (Precisa XB 220 A, Zurich, Switzerland) with an accuracy of 0.0001 g. This cycle was repeated until the loss of mass of each sample was less than 0.1 mg within a period of 24 h. The initial constant mass (m₁) of the samples was determined using a precision scale. Then, the samples were kept in artificial saliva (K₂HPO₄, KSCN, Na₂HPO₄, NaHCO₃, NaCl, Urea, HCl) at 37±1 °C at neutral pH for 7 days. Afterward,

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Table 1	Resin com	posites	used in	the study	v and their	properties
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Resin Composite	Viscosity	Manufacturer firm /LOT numbers	Monomer Content	Filler type	Filler rate (wt%/vol%)	Polym- eriza- tion time (s)
Filtek One Bulk Fill (FBF)	High viscosity	3 M ESPE, St. Paul MN, USA/10,018,902	AUDMA, AFM, Diüretan-DMA, 1,12-dodekan-DMA	Non-clustered Silica, Non-clustered Zirconia, Clustered silica and zirconia, YbF ₃	76.5/58.5	20
X-tra base (XB)	Low viscosity	Voco, Cuxhaven, Germany/2,333,691	BisEMA, TCDDMA	Ba-Al-B silicate glass, YbF ₃ , smoked silica	75/-	10
Charisma Bulk Flow One (CBF)	Low viscosity	Heraeus Kulzer, Hanau, Germany/ N010026	UDMA, EBADMA	Ba-Al-F silicate glass, YbF ₃ , SiO ₂	65/41	20
Estelite Bulk Fill Flow (FBF)	Low viscosity	Tokuyama Dental Corporation, Tokyo, Japan/163E83	Bis-GMA, Bis- MPFPP, TEGDMA	Spherical Silica-zirconia	70/56	10

Abbreviations: AUDMA: Aromatic urethane dimethacrylate, AFM: Addition- fragmentation monomer, DMA: decanediol dimethacrylate, BisEMA: bisphenol A ethoxylated dimethacrylate, TCDDMA: 4,8-dimethacryloxy methylene triclodecane, UDMA: urethane dimethacrylate, EBADMA: Ethoxylated bisphenol A dimetacrylate, Bis-GMA: bisphenol A glycol dimethacrylate, Bis-MPEPP: Bisphenol A polyethoxy dimethacrylate, TEGDMA: triethylene glycol dimethacrylate, YbF₃: Ytterbium Fluoride, Ba-Al-B: Barium-aluminium-boron, Ba, Al, F: Barium-aluminium-fluoro, SiO₂: silicium dioxide

they were washed with distilled water, dried with absorbent paper at room temperature for 15 min, and then the constant mass (m_2) was measured by the same method. On the 14th, 21st and 28th days, the same procedure was performed, and the mass of m_2 was obtained for each time interval. The samples were dried in a desiccator to calculate the solubility values on the 28th day, after the measurements of m_2 were completed, and the constant mass m_3 was calculated using the same protocol as for m_1 . The diameter and thickness of the samples were determined and the volume (V) in mm³ was calculated. The water absorption (SS) and solubility (SL) levels of the samples were calculated in mg/mm³ according to the following formula:

 $SS = (m_2 - m_3)/V.$ $SL = (m_1 - m_3)/V.$

Colour measurements

After using the samples for water sorption and solubility testing, the remaining 20 samples were used for colour measurements. Initial colour measurements were recorded after 24 h. Subsequently, the samples were randomly divided into two groups (n = 10). One group was immersed in artificial saliva (control group), and the other group was immersed in a coffee solution. The coffee solution was prepared by dissolving the contents of a 2 g sachet of Nescafé Gold (Single Bags; Nestlé, Switzerland) in 200 ml of boiled water. In order to avoid bacteria or yeast contamination, the solutions were renewed daily at room temperature [8]. The colour of the samples kept in the solutions was measured by spectrophotometer (VITA Easyshade, Vita Zahnfabrik, Bad Säckingen, Germany) on days 7, 14, 21 and 28. The measurements were repeated three times and L, C, H values were determined according to the CIEDE2000 system and the colour change was calculated according to the following formula.

$$\begin{split} \Delta E_{00} &= \sqrt{[(\Delta L'/k_L S_L)^2 + (\Delta C'/k_C S_C)^2 + (\Delta H'/k_H S_H)^2 + R_T (\Delta C'/k_C S_C)(\Delta H'/k_H S_H)]} \end{split}$$

Statistical analysis

The assumption of normal distribution was checked using the Shapiro Wilk test, homogeneity of variance was checked using Levene's test, and the sphericity assumption was checked using Mauchly's W test. An ANOVA test was used to examine the difference between the averages of three or more independent groups where the assumption of normality was met, and Kruskal Wallis test was applied when the assumption was not met. Repeated Measures ANOVA was used to examine the difference between the averages of three or more dependent groups when the normality assumption was met, while the Friedman test was used when the assumption was not met. Post Hoc Bonferroni, Tamhane and Adjusted Bonferroni tests were used to reveal the group or groups that created the difference. ANOVA and Kruskal Wallis tests were applied to compare the discolouration values according to composites for measurement times. Repeated Measures ANOVA and Friedman tests were applied to compare the discolouration values according to measurement time for composites. Analyses were performed in IBM SPSS (v25.0, Chicago, IL, USA) software.

Results

Significant differences in water absorption values among composites were observed across all time intervals (p < 0.05). On day 7, the CBF group had significantly higher water absorption than FBF, XB, and EBF (p < 0.05). On day 14, CBF and XB showed higher values than FBF and EBF (p < 0.05). On day 21, CBF had significantly higher absorption than FBF (p < 0.05). On day 28, CBF and EBF had higher absorption than XB (p < 0.05), while no difference was found between XB and FBF. Water

 Table 2
 Distribution and comparison of water absorption values according to composites and measurement times

Time	Day 7	Day 14	Day 21	Day 28
Group	Mean ± SD	$Mean \pm SD$	Mean±SD	Mean±S.D.
FBF	$1.30 \pm 1.86^{A, a}$	$2.96 \pm 1.29^{A, b}$	$1.30 \pm 1.25^{A, a}$	$1.85 \pm 1.38^{\text{A},\text{B},\text{a},\text{b}}$
CBF	$5.40 \pm 2.29^{B, a, b}$	$7.10 \pm 1.57^{\text{B, a}}$	$3.09 \pm 0.76^{B, b}$	$3.50 \pm 1.84^{A, b}$
XB	$1.65 \pm 1.14^{A, a}$	$6.48 \pm 1.57^{B, b}$	$1.80 \pm 1.20^{A, B, a}$	$0.69 \pm 1.65^{B, a}$
EBF	$1.20 \pm 0.76^{A, a}$	$3.43 \pm 1.24^{A,b}$	$2.41 \pm 1.46^{A,B,a,b}$	$3.15 \pm 1.25^{A, b}$

A, B: Different letters in the same column indicate significant differences between composites, separately for each time periods (p < 0.05)

a, b: Different letters in the same row indicate significant differences between time periods, separately for each group ($p\,{<}\,0.05)$

absorption values according to composites and measurement times are shown in Table 2; Fig. 1.

All resin composites valuated in this study exhibited negative solubility values. Significant differences in solubility values among composite groups were observed (p < 0.05), with Bonferroni tests revealing a significant difference between FBF and EBF groups (p < 0.05). CBF had higher solubility than FBF and EBF, while FBF and XB had higher solubility than CBF.

Comparison of solubility values according to composites is shown in Table 3; Fig. 2.

Significant differences in discolouration values among composites were observed across all time intervals

according to composites	
Group	Mean ± SD
FBF	-11.2 ± 1.19^{A}
CBF	-5.14 ± 3.09^{B}
XB	-2.06 ± 1.22^{B}
EBF	-11.76±1.95 ^A

 Table 3
 Distribution and comparison of solubility values

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A, B: Different letters in the same column indicate significant differences between composites (p < 0.05)

(p < 0.05). For samples immersed in coffee, the highest ΔE values were recorded in the CBF group at all time intervals, whereas the EBF group exhibited the lowest values.

No significant differences were found between FBF and XB groups on days 7, 21, and 28, but on day 14, FBF (14.32±4.55) had a significantly higher ΔE than XB (11.69±1.6). Discolouration increased with longer immersion in coffee.

For samples in distilled water, no statistical differences were found on day 7. The FBF group had the lowest ΔE values at all times. In the CBF group, ΔE values increased significantly between days 7, 14, 21, and 28 (p < 0.001). In the EBF group, the ΔE values on day 28 were higher than those on days 7 and 14. No significant time-dependent differences were found between FBF and EBF groups



Fig. 1 Water absorption values according to composites and measurement times



Fig. 2 Solubility values according to composites

Table 4 ΔE values according to time and composites

Time	ΔE Day 7	ΔE Day 14	ΔE Day 21	ΔE Day 28
Group	Mean ± SD	Mean ± SD	Mean ± SD	Mean±SD
FBF (Coffee)	9.74±0.96 ^{A, a}	$14.32 \pm 4.55^{A, a, b}$	14±1.27 ^{A, b}	15.21±1.49 ^{A, b}
FBF (Distilled Water)	$1.05 \pm 0.33^{B, a}$	$09.6 \pm 0.31^{B, a}$	$1.03 \pm 0.33^{B, a}$	1.14 ± 0.39 ^{B, a}
CBF (Coffee)	13.24±0.91 ^{C, a}	15.57±0.69 ^{A, b}	17.47 ± 1.22 ^{C, c}	18.24±0.9 ^{C, c}
CBF (Distilled Water)	$1.28 \pm 0.12^{B, a}$	1.92±0.19 ^{B, C,D, b}	2.24±0.23 ^{A, B,b, c}	2.43±0.22 ^{A, B,c}
EBF (Coffee)	$5.52 \pm 0.58^{D, a}$	$6.35 \pm 1.29^{C, a, b}$	6.77±0.74 ^{A, D, b}	$7.46 \pm 0.82^{A, D, c}$
EBF (Distilled Water)	1.36±0.60 ^{B, E,a}	1.58±1.26 ^{B, C,a}	$1.33 \pm 1.21^{B, D, a}$	1.66±1.39 ^{B, D,a}
XB (Coffee)	$9.30 \pm 0.93^{A,a}$	11.69±1.6 ^{D, b}	$13 \pm 1.4^{A, c}$	$14.15 \pm 1.62^{A, d}$
XB (Distilled Water)	1.37±0.47 ^{B, F,a}	1.57±0.45 ^{B, C,a}	$1.58 \pm 0.46^{B, D, a, b}$	$1.9 \pm 0.33^{B, D, b}$

A, B: Different letters in the same column indicate significant differences between composites, separately for each time periods (p < 0.05)

a, b: Different letters in the same row indicate significant differences between time periods, separately for each group (p < 0.05)

(p > 0.05). ΔE Values according to time and composites are shown in Table 2; Fig. 1.

Discussion

The first hypothesis of the present study, which stated that there would be no difference between the water absorption, solubility, and colour stability between high viscosity and low viscosity bulk fill resin composites that do not require additional layers, was partially rejected. This is because the colour change, water absorption, and solubility at certain time intervals were significantly different when comparing Charisma Bulk Flow One resin composite with other resins at all time intervals.

There are a number of in vitro studies using a variety of beverage colourants to evaluate the discolouration of resin composites [11-13]. Beverages such as instant



Fig. 3 Discolouration values according to composites and measurement times

coffee, black tea, red wine, cola and fruit juice are frequently used as colourants in the literature [14, 15]. Many previous studies have shown that coffee is one of the most staining beverages and is consumed on a daily routine basis [16–18]. Therefore, this study used coffee as the staining solution and artificial saliva as the control group to simulate the oral environment.

In line with the findings of the present study, a statistical difference was found between the colour stability, water absorption, and solubility values when the low viscosity CBF and EBF resin composites, which do not require an additional layer, were compared with the XB composite resin used as a base. CBF showed more discolouration and had higher water absorption than EBF and XB composite. When EBF was compared with XB, it exhibited significantly less discolouration on days 7 and 14, while no statistical difference was found at other time intervals. When the water absorption and solubility of these two composites were evaluated, it was observed that EBF composite showed less water absorption on day 14, while their solubility differed. According to these findings, second null hypothesis of the present study that low viscosity bulk fill resin composites that do not require an additional layer will show better properties than conventional low viscosity bulk fill resin composites used as a base is partially accepted.

Resin composites have become an indispensable part of aesthetic restorative dental treatment in modern dentistry. Despite their widespread use, they cause water absorption and discolouration of the resin composite matrix, which is constantly interacting with the discolourant agents in the structure of food and beverages in the dynamic oral medium [14]. The matrix structure, filler content, amount, and dimensions of the resin composite also affect the severity of discolouration [19]. A recent scoping review compared the colour stability of bulkfill and conventional resin composites, highlighting that bulk-fill composites may exhibit different discolouration patterns due to their unique composition and polymerization characteristics [20]. Water absorption may compromise the bond between the resin matrix and filler particles, potentially leading to microcracks and void formation. Discolourant agents can then pass through these surfaces, increasing the potential for restoration discolouration [21]. Water absorption, solubility, and colour stability are important properties that affect the clinical life of dental restorative materials [22]. Therefore, the water absorption, solubility, and colour stability of newly developed bulk fill resin composites that do not require an additional layer were evaluated in this study.

According to ISO 4049 standards, the water absorption and solubility values should be less than 40 μ g/mm³

and 7,5 μ g/mm³, respectively [23]. All of the resin composites tested in this study showed water absorption and solubility in accordance. The CBF composite (7.10±1.57) showed the highest water absorption on Day 14, while XB composite (0.69±1.65) showed the lowest water absorption on Day 28.

Water absorption is inversely proportional to the amount of inorganic filler in the structure of resin composite [9, 24]. CBF, which had the lowest filler amount, showed the highest water absorption at all time intervals, while gradually decreasing water absorption was observed in the XB, EBF and FBF groups, respectively. This can be explained by the decrease in water absorption associated with the polymeric matrix due to the decrease in the polymeric matrix as the weight ratio of the filler amount in the structure of the resin composite increases [25].

Alzahrani et al. compared the water absorption and solubility of bulk fill composites, and the lowest water absorption and solubility values were obtained for Filtek One Bulk Fill resin composite, which is consistent with the findings of the present study [26]. The lower water absorption in the FBF composite group can be explained by the high filler amount and the hydrophobicity of the cross-linked resin matrix, compared to the other groups. There is less free volume for solvents to penetrate into the resin composite, which has a highly cross-linked network structure, increasing the resistance of the material to the effect of solvents [27].

Water absorption is also affected by the organic matrix content of the resin composite. In previous studies, it has been reported that there may be differences in the water absorption of resin composite depending on the monomer type and the water absorption has been reported as TEGDMA > Bis-GMA > UDMA > Bis-EMA, respectively [28]. In the present study, resin composites with and without these monomers showed similar water absorption values. This similar behavior can be explained by the coexistence of different monomers in the structure of the resin composite and the changes in the rates.

Water absorption levels of resin composites also vary depending on time. Different results were found in studies investigating the time-dependent changes of water absorption [29]. In their study, Örtengren et al. measured water absorption on days 1, 7, 60 and 180. The water absorption reached the highest level on day 7. On days 60 and 180, lower water absorption was observed compared to day 7. In another study investigating the long-term water absorption and solubility of bulk fill and conventional resin composites in water and artificial saliva, it was reported that all resin composites, except for one material, reached constant weight within three to four months, and that there was a weight increase during this period [9]. In the present study, water absorption reached the highest level on day 14 and a decrease in water absorption was observed after this period. This result can be attributed to the dynamic process of water absorption and solubility, along with the time required to reach a constant weight.

Water absorption of resin composites leads to the removal of residual monomers from the matrix, resulting in chemical degradation and dissolution [30]. According to the findings of this study, negative solubility values were obtained in all resin composite groups. Although these findings do not indicate the absence of solubility, they may indicate low solubility of the resin composite. There are a large number of studies in which the solubility values of resin composites are negative [9, 26, 30–32]. According to the results of these studies, while negative solubility values are associated with possible hydrolytic reactions of glass fillers and metal oxides with water [9], in another study, it was stated that resin composite is sensitive to water absorption and this may cause weight increase that may mask the actual solubility [33]. Composite resins exhibit negative solubility due to their structure, which allows for moisture absorption that can lead to the leaching of unreacted monomers and ions, ultimately degrading the material's properties and increasing solubility without necessarily indicating poor performance [34]. This does not indicate that there is no solubility, but rather that water absorption is greater than solubility [33]. Wei et al. examined the water absorption and solubility of five different resin composites in a study and obtained negative solubility values in composites soaked in distilled water for 150 days [32]. They reported that the negative solubility values of these composites do not mean that no eluate is removed from their structures and that the final mass (m3) may return to the initial mass (m1) or less if the desorption process takes long enough. Another possible reason for the negative solubility values is that the absorbed partial water becomes bound water in the resin matrix and cannot be removed irreversibly.

Similarly, in the present study, the negative solubility values of the composites may be attributed to the fact that water absorption is high and the final mass cannot be reached as a result of incomplete dehydration of the materials, or the absorbed water becomes bound water in the resin matrix structure and cannot be removed. Additionally, the hydrolytic degradation of inorganic fillers and the prolonged exposure to moisture may contribute to this effect. These factors suggest that while resin composites exhibit negative solubility, it does not necessarily indicate a lack of solubility but rather a complex interaction between water absorption, retention, and material degradation.

It is known that extrinsic factors causing discolouration of resin composite restorations include plaque deposition and absorption of dyes and pigments, while intrinsic factors causing discolouration are related to the content, size and filler rates of filler particles [35, 36]. The susceptibility of resin composites to discolouration may be affected by their hydrophilicity and degree of water absorption. If a resin composite can absorb water, it can also absorb other liquids and cause discolouration [37]. Nevertheless, it is important to acknowledge that dental treatments, such as bleaching, affect the colour stability of dental restorations, making it a critical consideration as it may influence the longevity and aesthetic outcomes of restorative treatments [38, 39].

Colour is one of the most important aesthetic parameters in dentistry and visual assessment is the most commonly used method. There are two basic thresholds for assessing colour differences: perceptibility threshold (PT) and acceptability threshold (AT). According to CIEDE2000 (Δ E00), these values are (PT) 0.8 and (AT) 1.8, respectively [40]. According to the findings of the present study, all resin composites soaked in coffee showed discolouration above the threshold value at all time intervals. The discolouration procedure was applied for 28 days, during which time a gradual increase in Δ E00 values was observed.

The type of organic matrix of resin composites is known to have an effect on colour change. It has been reported that UDMA monomers show less water absorption and are more resistant to discolouration compared to Bis-GMA [41].

According to the findings of the present study, the highest colour change was observed in CBF resin composite immersed in coffee with low filler content. The composites of the CBF composite group kept in distilled water showed discolouration above the acceptable threshold value starting from day 14. The higher discolouration of CBF resin composite, which contains a discolourationresistant UDMA monomer in its structure, compared to other composites can be attributed not only to the monomer structure but also to the low filler rate and the different sizes of fillers (20 nm -5μ m), which have an increasing effect on discolouration. When comparing the low viscosity CBF composite group, which does not require an additional covering layer, to the EBF composite group in terms of average Δ E00, it was observed that the EBF group was less discoloured. The difference between these two composite groups despite their low viscosity should be attributed to the high filler content of the EBF group.

In a study comparing the physicomechanical properties of low viscosity bulk fill resin composites with high viscosity bulk fill resin composites, Palfique Bulk flow, SDR flow and One Bulk Fill resin composites were used [5]. According to the findings of this study, One Bulk Fill and SDR flow composites showed better properties than Palfique Bulk flow composite in terms of colour stability. This was explained by the high filler ratio of One Bulk Fill and SDR flow composites. In the present study, it was concluded that the colour stability of FBF group composites kept in distilled water was better due to the high filler rate.

Conclusion

This study evaluated the colour stability, water absorption, and solubility of no-cap low viscosity bulk fill resin composites in comparison with other bulk fill composites. The findings indicate that the composition and filler amount of resin composites significantly influence these properties. Among all tested materials, Charisma Bulk Flow One exhibited the highest water absorption, solubility, and discolouration values across all time intervals.

The clinical performance of no-cap flowable bulk fill resin composites should be carefully considered, as their higher water absorption and discolouration may compromise long-term aesthetic and mechanical stability. Although they offer the advantage of simplified application without the need for an additional covering layer, their potential drawbacks in colour stability and solubility raise concerns about their suitability for clinical use.

Further in vitro and in vivo studies are needed to assess the long-term behavior of these materials under dynamic oral conditions. The selection of bulk fill resin composites should be made cautiously, considering factors such as filler amount, resin matrix composition, and the specific clinical requirements of each case to ensure durable and aesthetically stable restorations.

Abbreviations

AFM	Addition-fragmentation monomer
AUDMA	Aromatic urethane dimethacrylate
Ba,Al,F	Barium-aluminium-fluoro
Ba-Al-B	Barium-aluminium-boron
BisEMA	Bisphenol A ethoxylated dimethacrylate
Bis-GMA	Bisphenol A glycol dimethacrylate
Bis-MPEPP	Bisphenol A polyethoxy dimethacrylate
DMA	Decanediol dimethacrylate
EBADMA	Ethoxylated bisphenol A dimethacrylate
ISO	International Organization for Standardization
SiO2	Silicium dioxide
TCDDMA	4,8-Dimethacryloxy methylene triclodecane
TEGDMA	Triethylene glycol dimethacrylate
UDMA	Urethane dimethacrylate
YbF3	Ytterbium fluoride

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Author contributions

MKO: Conceptualization, Methodology, Investigation, Validation, Writingoriginal draft, Writing-Review&Editing. HCH: Conceptualization, Methodology, Validation, Writing-original draft.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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