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# Staining Susceptibility Of Two Commercially Available Universal Composites - An Invitro Study

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## INTRODUCTION

In contemporary restorative dentistry, achieving long-term esthetics is of paramount importance. Among the key factors influencing clinical success, colour stability of composite resins plays a vital role, especially in anterior restorations where esthetic demand is high. Over time, resin composites are prone to discoloration due to intrinsic factors such as resin matrix degradation and extrinsic factors such as dietary stains, smoking, and oral hygiene habits. This colour change may compromise esthetics and patient satisfaction, often necessitating premature restoration replacement[1].

Recent advancements in composite technology have led to the development of universal shade composites, which not only aim to simplify shade selection but also promise enhanced optical and mechanical properties. Two such innovations include Omnichroma (Tokuyama Dental, Japan) and Vittra APS Unique (FGM Dental Group, Brazil), both of which are marketed for their unique shade-matching capabilities and high esthetic potential.[2]

Omnichroma is the first resin composite that utilizes structural colour rather than conventional pigments to achieve shade matching. It is formulated with uniform supranano spherical fillers (~260 nm) that generate a red-to-yellow colour range through *Smart Chromatic Technology*. This mechanism allows the composite to blend with surrounding dentition by reflecting ambient tooth colour via light scattering. As a result, Omnichroma is marketed as a true single-shade solution suitable for all VITA classical shades (A1–D4). In addition to simplifying shade selection, it offers high polishability and gloss retention. However, the absence of pigments and reliance on structural colour raises questions regarding its resistance to staining agents over time.

On the other hand, FGM Vitra APS Unique is a nanohybrid resin composite developed with APS (Advanced Polymerization System), which enhances polymerization depth, conversion rate, and esthetic behaviour even in challenging clinical environments. The material is engineered for a chameleon effect, blending seamlessly into surrounding tooth structures due to the optimized balance of filler translucency and refractive index matching. Vitra APS Unique claims improved colour adaptation and long-term stability owing to reduced residual monomer content and superior matrix-filler interface .[3]

Despite their innovative formulations and manufacturer claims, there is a lack of independent comparative data on their colour stability under standardized conditions. The oral environment frequently exposes restorations to various staining agents such as coffee, tea, and red wine, which can potentially affect the optical properties of

restorative materials. Understanding how these modern composites withstand such exposures is essential for evidence-based material selection and long-term clinical success.[4]
Hence, the current study aims to evaluate and compare the colour stability of Omnichroma and FGM Vitra APS Unique following exposure to commonly encountered staining solutions, using spectrophotometric analysis. This investigation is intended to provide valuable insights into the aesthetic durability of these universal composites and guide clinicians in choosing appropriate materials for long-lasting restoration.

## MATERIALS AND METHODS

This in vitro study was carried out Sri Venkateshwaraa Dental College Hospital and Research Centre, Ariyur, Puducherry, INDIA. The effect of staining solutions (coco cola, tea and distilled water) on the colour stability of Omnichroma and FGM Vittra APS Unique was investigated.

**Specimen Preparation:**

Eighty composite discs were fabricated using two commercially available universal composites. One composite was used to make forty discs, and another composite was used for the remaining forty discs. A plastic mold of 1.5 mm in thickness and 8 mm in diameter was used to create the discs [5]. On a glass slide, the plastic mold was positioned over a Mylar strip. After the tested composites were placed into the mold, a glass slide and another Mylar strip were placed over it [6] [7].To create a smooth and flat surface, a 1 kg weight was put over the glass slide. The specimens were polymerized for 40 seconds using a wide spectrum curing LED unit, and then they were finished and polished. To guarantee full polymerization, all of the specimens were placed in distilled water at 37°C for 24 hours [5]. Forty discs from each composite were randomly assigned to four subgroups.

**Staining Protocol**

A total of forty discs from each composite were randomly divided into four subgroups (n=10) which are before staining, Tea, Coco cola and distilled water. [6]. Tea solution is made by adding one teabag 2.0 g for 10 minutes into 150 ml of boiled distilled water [6]. Samples were immersed in the respective solution for 3 hours followed by rinsing with distilled water. This process was repeated everyday for 40 days. [7] [8].

**Evaluation of Color stability**

Using a spectrophotometer with a visible range of 300 to 800 nm, the amount of color absorption (stain) of the samples was measured. Following their removal from the staining solutions, the samples were properly cleaned under running water, patted dry with absorbent paper, and then put in the viewing port of a spectrophotometer to measure their color. The mean color change for each sample was calculated by comparing the absorbance values at 400–450 nm, which were used as the standard value. Therefore, a criterion of color change in a given sample was chosen to be the percentage of color absorbance.[9]

**Statistical analysis**

Data was analyzed using SPSS (26.0 version, IBM, USA). One-way Analysis of variance (ANOVA) and post hoc Tukeys' test was used for intragroup comparison. Intergroup comparison of mean absorbance values between Omnichroma and Vittara for each staining solution were performed using an independent t-test at significance level of 0.05.

## RESULTS

Tables 1 and 2 represent the intra-group analysis of absorbance values within the Omnichroma and Vittara groups across different staining solutions. In Table 1, one-way ANOVA revealed statistically significant differences in mean absorbance among the four staining subgroups in both Omnichroma ($F = 440.954$, $p < 0.01$) and Vittara ($F = 779.859$, $p < 0.01$), indicating that the type of staining solution had a significant impact on material discoloration. Table 2 details the results of post hoc multiple comparisons (Tukey test), which further confirmed these differences. Within the Omnichroma group, Coca-Cola produced the highest mean absorbance and differed significantly from tea, distilled water, and before staining (all $p < 0.01$). Tea also differed significantly from both before staining and distilled water, while no significant difference was observed between distilled water and before staining ($p = 0.861$), reflecting minimal staining from water. In the Vittara group, Coca-Cola showed significantly higher absorbance than all other subgroups ($p < 0.01$), followed by tea. Even distilled water exhibited a statistically significant increase in absorbance compared to before staining ($p = 0.04$), unlike in the Omnichroma group

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**Table 1. Comparison of mean absorbance among staining solutions within Omnichroma and Vittara groups using One-Way ANOVA, (N = 80).**

| Stain | n | Absorbance Mean (SD) | F- statistics | p-value |
|---|---|---|---|---|
| **Omnichroma** | | | | |
| Before staining | 10 | 0.81(0.04) | 440.954 | <0.01 |
| Tea | 10 | 1.25(0.05) | | |
| Coco cola | 10 | 1.41(0.05) | | |
| Distilled water | 10 | 0.83(0.04) | | |
| **Vittara** | | | | |
| Before staining | 10 | 0.82(0.04) | 779.859 | <0.01 |
| Tea | 10 | 1.0(0.05) | | |
| Coco cola | 10 | 1.68(0.05) | | |
| Distilled water | 10 | 0.88(0.05) | | |

**p-value less than 0.05 is considered statistically significant.*

**Table 2. Pairwise comparisons of mean absorbance between staining subgroups within Omnichroma and Vittara using post Hoc analysis (Tukey Test, N = 80).**

| Group | Reference group | Comparison group | Mean difference (95% CI) | p-value |
|---|---|---|---|---|
| Omnichroma | Coco cola | Before staining | 0.60(0.55, 0.65) | <0.01 |
| | | Tea | 0.16(0.11, 0.22) | <0.01 |
| | | Distilled water | 0.58(0.53, 0.64) | <0.01 |
| | Tea | Before staining | 0.44(0.38, 0.49) | <0.01 |
| | | Distilled water | 0.42(0.37, 0.48) | <0.01 |
| | Distilled water | Before staining | 0.02(-0.04, 0.07) | 0.861 |
| Vittara | Coco cola | Before staining | 0.86(0.80, 0.92) | <0.01 |
| | | Tea | 0.68(0.63, 0.74) | <0.01 |
| | | Distilled water | 0.81(0.75, 0.86) | <0.01 |
| | Tea | Before staining | 0.18(0.13, 0.23) | <0.01 |
| | | Distilled water | 0.12(0.07, 0.18) | <0.01 |
| | Distilled water | Before staining | 0.06(0.003, 0.11) | 0.04 |

**p-value less than 0.05 is considered statistically significant*

**Table 3. Intergroup comparison of mean absorbance between Omnichroma and Vittara across different staining solutions using independent t-Test (N = 80).**

| Stain | Omnichroma absorbance mean (SD) | Vittara absorbance mean (SD) | Mean difference (95% CI) | t- statistics | p- value |
|---|---|---|---|---|---|
| **Before staining** | 0.81(0.04) | 0.82(0.04) | -0.01(-0.04, 0.03) | -0.349 | 0.731 |
| **Coco cola** | 1.41(0.05) | 1.68(0.05) | -0.27(-0.32, -0.22) | -11.646 | <0.01 |
| **Tea** | 1.25(0.05) | 1.0(0.05) | 0.25(0.20, 0.29) | 11.668 | <0.01 |
| **Distilled water** | 0.83(0.04) | 0.88(0.05) | -0.05(-0.09, -0.01) | -2.477 | 0.023 |

**p-value less than 0.05 is considered statistically significant.*

Table 3 presents the intergroup comparison of mean absorbance values between Omnichroma and Vittara for each staining solution using an independent t-test. The absorbance values for before staining did not differ significantly between the two groups ($p = 0.731$), indicating comparable baseline color stability. However, Coca-Cola resulted in significantly higher absorbance in the Vittara group ($1.68 \pm 0.05$) compared to Omnichroma ($1.41 \pm 0.05$), with a mean difference of -0.27 (95% CI: -0.32, -0.22; $p < 0.01$), highlighting greater staining potential in Vittara. Conversely, for tea, Omnichroma showed significantly higher absorbance ($1.25 \pm 0.05$) than Vittara ($1.00 \pm 0.05$), with a mean difference of 0.25 (95% CI: 0.20, 0.29; $p < 0.01$), though the staining intensity

was overall lower than Coca-Cola. In the case of distilled water, a slight but statistically significant difference was observed ($p = 0.023$), with Vittara exhibiting marginally higher absorbance.

## DISCUSSION

The current *in vitro* study intended to evaluate and compare the color stability of two universal shade resin composites—Omnichroma (Tokuyama Dental, Japan) and Vittra APS Unique (FGM Dental, Brazil)—under different staining conditions. Both composites have been marketed as advanced materials with enhanced shade-matching capabilities and simplified esthetic outcomes. However, despite their innovations, the study findings confirm that universal composites remain susceptible to discoloration, with variability depending on the staining solution and material composition.

At baseline, Omnichroma and Vitra APS Unique exhibited comparable absorbance values, indicating similar initial optical properties. This is consistent with previous studies that reported acceptable initial color match and translucency in universal composites due to their optimized filler technology and matrix composition [10,11] . The similarity in baseline performance suggests that differences observed post-staining were attributable primarily to the interaction between the restorative material and the staining solutions.

Coca-Cola caused the highest discoloration in both groups, with significantly greater staining in Vitra APS Unique compared to Omnichroma. This finding aligns with previous literature showing that acidic beverages with low pH can degrade resin matrices, increasing surface roughness and facilitating pigment penetration [12,13]. The phosphoric acid and caramel coloring in Coca-Cola act synergistically to erode the resin matrix, enabling deeper chromogen infiltration[14].

In Vitra APS Unique, the presence of nanohybrid fillers and resin chemistry modified by the APS (Advanced Polymerization System) may contribute to higher susceptibility under acidic conditions. Although APS technology improves polymerization kinetics and reduces residual monomer content, the increased hydrophilicity of the resin matrix may predispose the material to greater water sorption and subsequent staining in acidic environments [15]. This may explain why Vitra APS showed significantly higher absorbance values in Coca-Cola compared to Omnichroma.

Tea, a widely consumed beverage, produced significantly more discoloration in Omnichroma compared to Vitra APS Unique. Tea contains tannins and polyphenolic compounds that can strongly adsorb onto composite surfaces and penetrate the resin matrix[16,17]. While Omnichroma relies on structural color technology—where supra-nano spherical fillers (260 nm) scatter light to generate a red–yellow hue—this mechanism may be particularly vulnerable to surface adsorption of chromogens, which can interfere with light scattering and alter the perceived structural color [18].

By contrast, Vitra APS Unique relies more on pigment-based blending and chameleon effect through refractive index matching of fillers and resin. Pigment-based systems may be less influenced by surface adsorption but remain susceptible to chemical staining [4]. The results suggest that structurally colored composites may not offer superior stain resistance when exposed to tannin-rich solutions such as tea.

Distilled water was used as a control solution, and as expected, both materials exhibited minimal discoloration. Interestingly, Vitra APS Unique showed a statistically significant though minor absorbance increase compared to Omnichroma. This suggests that water sorption and hydrolytic degradation at the resin–filler interface may play a role[19,20] . Water sorption is known to cause swelling of the polymer network, microcrack formation, and hydrolysis of silane coupling agents, all of which may slightly modify optical properties over time [21].

The findings of this study are consistent with earlier reports. Nasim et al.[22] demonstrated that nanohybrid composites showed significant staining in coffee and tea, with discoloration related to resin matrix hydrophilicity. Ertas et al.[16] and Bagheri et al. [13]confirmed that acidic beverages such as Coca-Cola exacerbate staining through surface softening. More recently, Paravina et al. [18] evaluated structural color composites (Omnichroma) and reported that while initial esthetic blending was excellent, the long-term resistance to discoloration required further validation.

## CONCLUSION

The study demonstrated that both Omnichroma and Vitra APS Unique are prone to discoloration when exposed to common dietary staining agents, with Coca-Cola producing the greatest effect overall. Omnichroma exhibited

greater staining with tea, whereas Vitra APS Unique was more affected by Coca-Cola. These findings suggest that material composition, filler technology, and staining solution chemistry collectively determine color stability. Clinicians must balance the convenience of universal composites with their potential vulnerability to staining in order to optimize long-term esthetic outcomes.

## Limitations and Future Directions

The present study was conducted *in vitro* under controlled conditions. Clinical scenarios involve additional factors such as salivary enzymes, fluctuating pH, masticatory forces, and long-term aging, which may alter staining susceptibility. Further studies incorporating long-term water aging, thermocycling, and in vivo evaluation are recommended to validate these results. Additionally, evaluating the effect of polishing techniques and surface coatings on stain resistance may provide valuable insights for improving clinical outcomes.

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