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Comparative Evaluation Of Colour Stability Of Newer Monochromatic Composite Resin When Continuously Exposed To Various Beverages: An In Vitro Study.

Jaydip Tingare, Prajakta Malode

Abstract
Aim: *Comparative evaluation of colour stability of newer composite resins designed for aesthetic restorations when continuously exposed to various beverages: an in vitro study.*
Material and methods*: A total of 40 disk-shaped specimens made out of two composite materials (Omnichroma, and GC Solare X) were used. A total of 20 specimens measuring 10mm in diameter and 1 mm in thickness were made from each composite resin. After dry storage at 37°C for 24 hours in an incubator, the initial color was assessed by a calibrated spectrophotometer. Test specimens will be immersed in three staining solutions that is tea, coffee and turmeric, and the control group were stored in distilled water. All specimens will be kept in an incubator at 37°C for 28 days. After 7,15 and 28 days, spectrophotometric measurements were again performed to determine the color changes and samples were statistically analysed.*
Results*: For Omnichroma the highest color change caused by turmeric in all time periods and least color change caused by distilled water. For GC-Solar X the highest color change caused by turmeric in all time periods and least color change caused by distilled water.*
Conclusion- *Turmeric leads to the highest discoloration in both the composites followed by tea, coffee and distilled water. Omnichroma is less colour stable compare to GC-Solar X.*
Keywords: *Color stability, Composite resins, GC Solare X Omnichroma, Spectrophotometer, Staining.*

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I. Introduction

The field of restorative and cosmetic dentistry is evolving quickly in terms of new and improved materials to meet the growing need and desire for a more natural-like appearance of dentition.[1] Composite resin is considered one of the best direct restorative materials because it mimics the aesthetics of natural tooth tissue.[2]It is widely used to restore the broken down teeth that are either carious or fractured, the build-up of congenitally malformed teeth, veneering of discoloured natural teeth and cementation of the orthodontic appliances on the teeth.[2] The clinical success of dental composites depends upon their physical, chemical, and mechanical properties, which are greatly influenced by the characteristics of the oral environment and properties of the resin materials.[2] Nowadays, despite improvement in the dental composites, discoloration remains to be a major long term clinical problem (Menon et al., 2019).[1]According to Asmussem et al and Dietschi D et al. there are two types of composite resin discolorations 1) Extrinsic discoloration: This is caused by the accumulation of plaque and superficial pigments 2) Intrinsic discoloration: This is caused by the aging of material itself.

The trend of using the smart monochromatic shade of composite is booming.[2] Dentists are more inclined towards using smart chromatic technology owing to the fact that it reduces the need for a variety of composite shades in inventory, minimizes the wastage of unused composite shades, minimizes chairside time, eliminates the need for shade selection, and reduces reliance on shade-matching procedures.[2] Omnichroma (OM) is one of the smart chromatic materials and is believed to attain the shade of the surrounding tooth structure in which it is placed.[6] Like other universal single shade restorative materials introduced in market GC SOLAR X is one of them. Restorations placed using SOLARE X achieve unmatchable aesthetic invisibility through a remarkable chameleon effect.[3] 90% of restorations can be completed using a single shade only.[3] The intelligent use of diverse filler technologies within SOLARE X means exceptional aesthetic outcomes can be achieved through a simplified shade system, with minimal need to undertake layering techniques.[3]

Numerous studies have been done on the effect of coffee, tea and turmeric over different types of composite materials and differently processed composite restorations.[4] The Indian cuisine is abundant with flavours and colours, where natural and artificial colorants as well as spices are added. Relatively lesser studies are available in the literature assessing the effect of these colorants and spices on the resin composites. Among these studies, more focus had been on turmeric powder.[4] The results show that turmeric has a greater tendency to stain the resin composites.[3] Turmeric is fondly called in Indian cuisine as "kitchen queen," and because of its taste

and color, it is called as "Indian Saffron" in Europe.[3] Coffee is a popular beverage consumed globally for its unique flavour and stimulating effects.[5] In addition to its popularity as a beverage, coffee has also been the subject of numerous studies exploring its potential health benefits.[5] Chlorogenic acids (CGAs) are a group of phenolic compounds found in coffee that contribute to its bitter taste and are also among the culprits in coffee that cause teeth discoloration.[5] The staining of composites by tea has been widely studied and reported.[1] They are important non-alcoholic beverages that act as the main drink in various social gatherings/rituals the discoloration in tea was mainly due to surface adsorption of polar colorants at the surface.[1] However, knowledge regarding the colour stability of these two materials are insufficient in scientific literature. Therefore, it is worthwhile to investigate the colour stability of Omnichroma and GC SOLAR X in comparison to each other.

Hence, the present study is aimed at investigating colour stability of modern composite resin designed for aesthetic restorations when continuously exposed to various beverages. The null hypotheses for the current study is beverages have effect on the color of the composites.

II. Material And Method

This in vitro study was directed in the department of conservative dentistry and endodontics, The study included a total size of 80 samples and four groups, with 10 samples in each group.

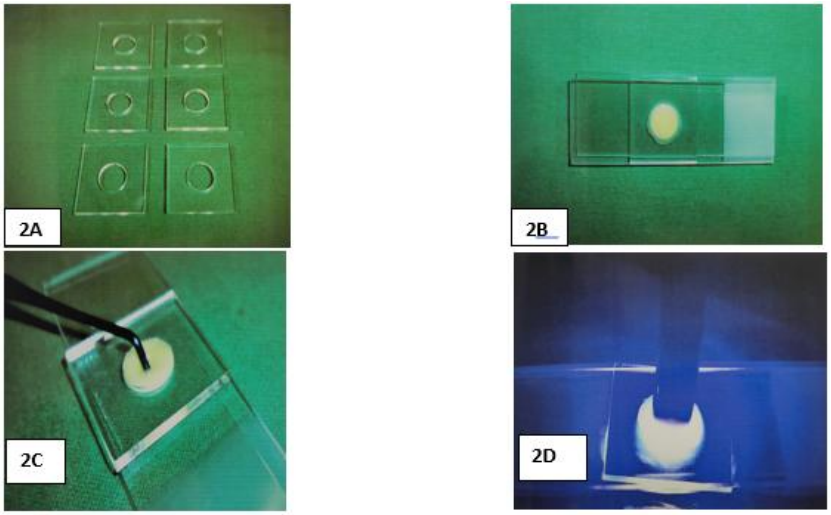
Specimen preparation- A total of 80-disc shaped specimens calibrating 10 mm in diameter and 1 mm in thickness were prepared from two different composite materials (n=40 each). The specimens were grouped as follows;

- Group I: Omnichroma (Tokuyama, Dental Corp, Tokyo, Japan) (Fig. 1A)
- Group II: GC Solar X (GC Corp, Tokyo, Japan) (Fig.1.B)

Fig. 1. A and B: Composite materials used; (A) Omnichroma; (B) GC Solar

COMPOSITE RESIN	TECHNICAL SPECIFICATIONS	SHADE	RESIN MATRIX	FILLER LOADING	FILLER PARTICLE (%)
Nanohybrid	Omnichroma Tokuyama, Dental Corp, Tokyo, Japan	UNIVERSAL	UDMA TEGDMA	UNIFORM SIZE SUPRA-NANO SPHERICAL FILLER (260 nm spherical SiO_2. ZrO_2) and composite filler.	79% BY WEIGHT
Nanohybrid	GC Solar X (GC Corp, Tokyo, Japan	A2-X	Bis – GMA UDMA	PRE-POLYMERIZED FILLERS AND GLASS FILLERS	77 % by weight

The composites were placed into preformed wells, and a glass slab was lodged on top to discard surplus material in order to attain a plane/smooth surface. Following this the composites were light cured at a distance of 1 mm for 20 seconds employing a light emitting diode curing equipment (Eighteeth Orikam curing pen-E Ligh Cure Unit).The LED light source with a wavelength 430-450nm for 20 sec on each side. The tip of the curing unit was placed directly over the glass plate that was 1 mm thick glass slide thus, the distance between the light source and samples was standardized. Fig.2(A-D)



Figs. 2A to D: A. Preformed wells B. Placement of sample in preformed wells C. Glass slab lodged on top to remove surplus amount. D. Curing of composite.

The original color of individual specimens was assessed using a spectrophotometer (VITA Easyshade V, VITA Zahnfabrik) and the analysis of individual specimens was recorded against white background.Fig.3 After recording the preliminary color values of the samples; specimens were stocked in an incubator for 24 hours at 37°C

Fig.3. VITA EasyShade V Spectrophotometer.

Preparation of beverages-

Tea Solution - About 2.8 g of tea was added to 150ml of boiling distilled water.
Coffee solution – About 2.8 g of coffee was added to 150ml of boiling distilled water.
Turmeric solution – About 0.5 g of turmeric was added to 150ml of boiling distilled water. Fig. 4

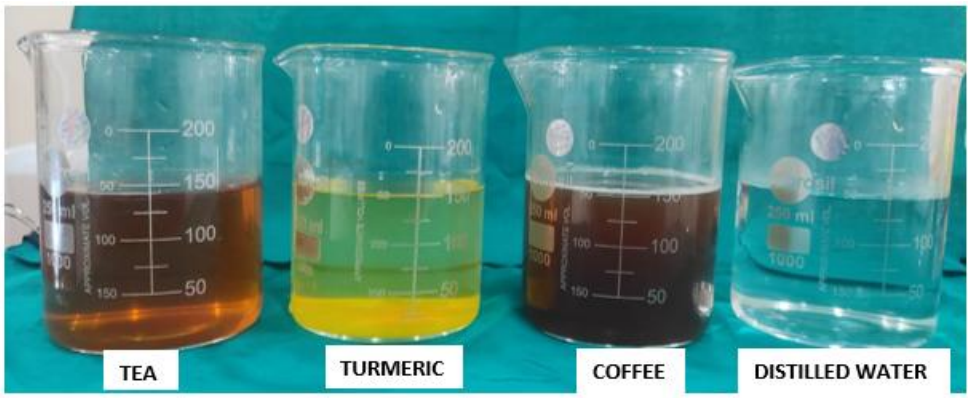


Fig no. 4 – Immersion of specimen in various beverage

Immersion of specimen in brevrages -

To examine the color variations in various beverages, the specimens of each composite resin were individually immersed (n = 10 each) in tea, coffee, turmeric and distilled water. Fig 5. All specimens were stocked in an incubator at 37°C for 7, 14 and 28 days, following which the staining agents were replaced every week to avoid bacteria or yeast contamination. After 7, 14 and 28 days of storage, samples were taken off from staining agents, blot-dried with tissue paper and subjected to color estimation. Fig 6.

Fig. 5. Specimens immersed in their respective mediums (group I) – Ominichroma; Group II – GC Solar X

Fig 6. L*a*b* value on VITA Easyshade spectrophotometer.

Color evaluation

The color of the restoration was measured using a spectrophotometer with a CIE L*a*b system. Individual samples were placed on the measuring head of the spectrophotometer and capped with a black cover. Prior to each measurement session, the spectrophotometer was calibrated according to the manufacturer's recommendations adopting the supplied white calibration standard. The spectrophotometer is programmed to compute the mean color measurement of 20 specimens of each material. Color values were expressed in the CIEL*a*b* color system, L* for lightness from white (L*= 100) to black (L*= 0), a* for green (−a*) and red (+a*), and b* for blue (−b*) and yellow (+b*) color components. Color variations ΔE between baseline and after storage measurements were computed employing the following formulae[2]:

$$\Delta E = \sqrt{\left\{ \begin{array}{l} (L^* \text{ final-} L^* initial)^2 + (a^* \text{ final-a*initial})^2 + \\ (b^* \text{ final} - b^* initial)^2 \end{array} \right\}}$$

Statistical analysis

Data was analyzed using R and python software. P value less than or equal to 0.05 was considered statistically significant. Level of significance was kept at 95%. Data on before and after immersion was analyzed using one way ANOVA TEST. Repeated measures ANOVA were applied for each group separately and if it was significant, the Paired t-test was also applied.

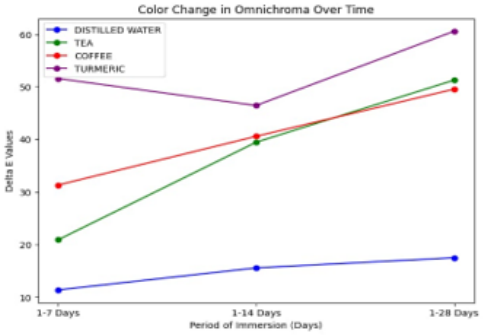
III. Results

The amount of Δ*E* in all groups was greater than 3.3 which indicates that the storage of specimens in different color media and at different time periods causes a clinically diagnosable color change. The Comparison between average colour changes Δ*E* in each group for different time duration for Omnichroma is presented in Table 1. There was a substantial difference in color variations of Ominichroma with tea (p = 0.001), coffee (p = 0.03) and turmeric (p= 0.00002) and distilled water showed insignificant value (p = 0.5).For Omnichroma the

highest color change caused by turmeric (60.97± 1.23) in all time periods and least color change caused by distilled water. Followed by the turmeric color change initially caused by coffee but at the end of study most color change was caused by tea, coffee and distilled water. Graph 1.

Table 1 - The Comparison between average colour changes ΔE in each group for different time duration for Omnichroma. ($\Delta E1$- Colour change value after 7 days, $\Delta E2$ – Colour change after 14 days, $\Delta E3$ – Colour change after 28 days)

Group	Number	$\Delta E1$ Mean ± Standard Deviation	$\Delta E2$ Mean ± Standard Deviation	$\Delta E3$ Mean ± Standard Deviation	P value
Distilled water	10	11.77± 6.95	15.15± 10.61	17.87± 6.56	0.561
Tea	10	21.46± 3.32	40.25± 10.11	52.86± 13.93	0.00136
Coffee	10	32.10± 5.90	40.16± 4.15	49.54± 10.31	0.03537
Turmeric	10	51.56± 4.15	46.43± 3.29	60.97± 1.23	0.00002

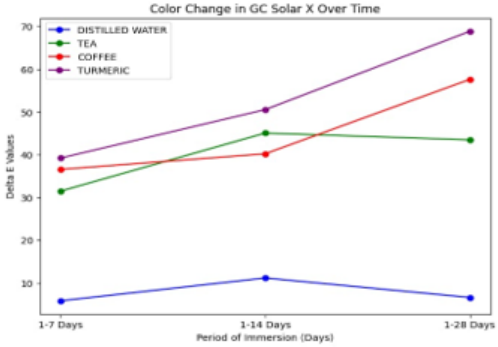


Graph 1 - Color change in Ominichroma over time

The Comparison between average colour changes ΔE in each group for different time duration for GC Solar X in Table 2. There was a substantial difference in color variations of GC Solar X with tea (p = 0.012), coffee (p = 0.02) and turmeric (p= 0.008) and distilled water showed insignificant value (p = 0.10). For GC-Solar X the highest color change caused by turmeric (68.37±0.84) in all time periods and least color change caused by distilled water. Followed by the turmeric color change initially caused by coffee and at the end of study most color change was caused by coffee, tea and distilled water. Graph 2.

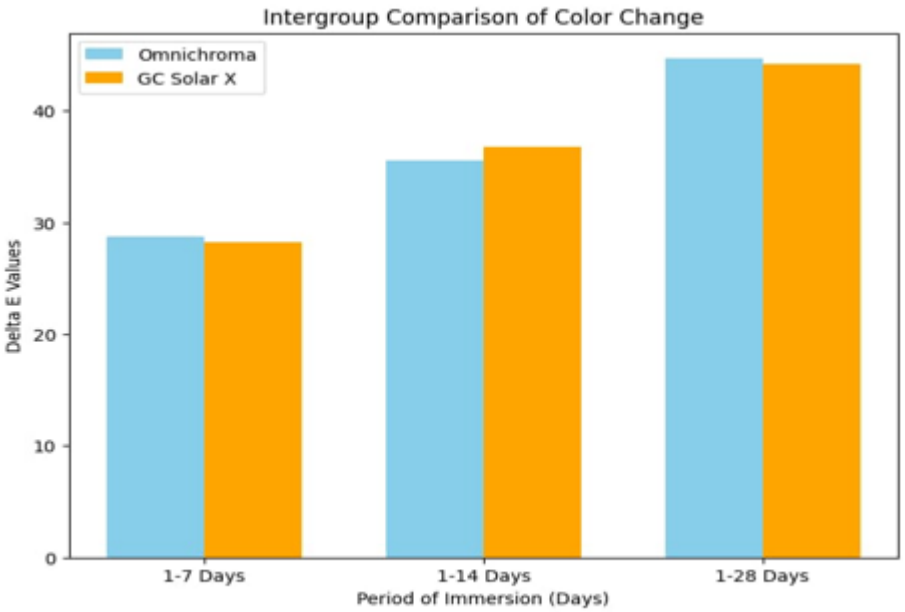
Table 2 - The Comparison between average colour changes ΔE in each group for different time duration for GC Solar X. ($\Delta E1$- Colour change value after 7 days, $\Delta E2$ – Colour change after 14 days, $\Delta E3$ – Colour change after 28 days)

Group	Number	$\Delta E1$ Mean ± Standard Deviation	$\Delta E2$ Mean ± Standard Deviation	$\Delta E3$ Mean ± Standard Deviation	P value
Distilled water	10	5.29± 3.83	11.13± 4.10	6.57± 3.89	0.10
Tea	10	31.46± 11.11	45.54± 6.83	43.96± 15.07	0.012
Coffee	10	36.04± 10.30	39.66± 12.96	55.83± 6.29	0.0216
Turmeric	10	39.23± 4.92	50.77± 1.31	68.37± 0.84	0.00801



Graph 2 - Color change in GC Solar X over time.

By comparing the colour change values of these two composites it can be seen that the color change values for Omnichroma is more than that of GC Solar X over the period of 7, 14 and 28 days so, it can be said that GC Solar X is more color stable in intergroup comparison. Graph 3.



Graph 3 – Intergroup comparison of color change

IV. Discussion

The primary reason for the replacement of dental cosmetic restorations in the aesthetic zone is discoloration or colour instability.[7] According to Satou et al. the most likely sites for the stain to penetrate are the microcracks and micro voids at the filler matrix interphase.[7] The degree of discoloration from external agents differs according to oral hygiene, eating and/or drinking pattern, and habits like smoking.[7] In this study it was determined not to polish the specimens but rather mimic the most extreme clinical scenario in which the composites are polymerized against a mylar strip imbibing a plush resin matrix, as it can happen particularly in the proximal aspects of the teeth.[7] Discoloration in composite resin restoration is multifactorial which involves surface roughness, micro- porosity, incomplete polymerization, Presence of microcracks into the resin matrix as a result of swelling and plasticizing effects along with interfacial gaps created between filler and resin matrix allow stain penetration and discoloration of the restoration.[8] If the resin matrix is capable of absorbing water, it is also capable of absorbing any other fluid, which ultimately leads to discoloration.[9] Water sorption is mostly due to direct absorption in the resin matrix.[9] Glass filler particles cannot absorb water, yet they can contribute to water adsorption at the surface of the material.[9] The level of water sorption is a function of the resin content of the material and the strength of the resin-filler interface.[9] Extreme water sorption causes the expansion and plasticizing of the resin, which leads to reduced longevity of the composite resin and hydrolysis of saline, which in turn creates microcracks.[9] As a result, the microcracks or the interfacial gaps at the interface, between the filler and matrix, allow stain penetration and discoloration.[9] Due to the rough and porous surface of composite resin it allows colorant molecules to penetrate and bind to the resin matrix. Over the period of time after immersion water absorption by composite occurs which can cause microstructural changes increasing surface roughness and porosity which facilitates further deeper penetration colorant into the resin. After this polymer matrix degradation and plasticization of resin matrix begins due to prolonged exposure to moisture making it more susceptible to discoloration. Due to acidic nature of colorants can causes mild hydrolysis of ester bond in both GC solar x and Omnichroma composites. This degradation increases surface roughness and facilitates more pigment adsorption leading to darker discoloration in both the composites. Discoloration can be assessed using instrumental or visual methods.[10] Spectrophotometry, colorimetry, and digital image analysis are instrumental methods for measuring color.[4] spectrophotometry is proclaimed to be a decisive method for evaluating dental materials.[10] Because it can measures the intensity of light across as wide range of wavelength, it has high precision due to spectral data at multiple wavelengths providing detailed colour information, it is more sensitive to subtle colour differences including translucency and surface gloss changes, it is ideal for complex colour matching tasks and monitoring small changes over time. Because of these advantages of spectrophotometer, VITA Easyshade V was selected for color assessment. Visual colour assessment could be ambiguity, as colour perception is a psychophysical

phenomenon with variations between individuals and within an individual at different times, results vary depending on lighting observers experience and fatigue more chance of low repeatability due to variability in human vision and environmental factors, Limited sensitivity as human eyes may not be able to perceive small changes Instrumental measurement has the advantage of preventing the subjective errors of colour assessment.[10]

Tea, coffee, turmeric was utilized as staining solutions in this study based on the various types of beverages consumed by all age groups. As these elements are frequently found in diet.[2] The control group used in this investigation was distilled water. The specific objective of this study was to investigate the cumulative effect of the colorant solutions on the dental composites. Omnichroma and GC Solar x composites were chosen since manufacturers of these composites claim that these are universal single shade composites, because of that it has high alethic value for this purpose, the composite resins were used for 7,14 and 28 days of immersion treatments, because the composites remained in the oral cavity for a long time, with various staining substances, at different times and periods. It has been seen that different beverages have cumulative effect on composite resin colour stability over the period of time. In this soaking time have a great importance. Ertas et al. assessment that 28 days is equivalent to approximately 2 years and 6 months of clinical ageing, 2 weeks of immersion in current study would correspond to an in vivo immersion of 14 months.[2]

In case of discoloration due to coffee could be due to both the adsorption and absorption of colorants on the surface of the composite. Coffee is composed of acidic agents such as chlorogenic acid(354.31 g/mol) and protocatechuic acid (154.12 g/mol) which are able to degrade the composite matrix and since coffee contains yellow stains such as gallic acid(170.12g/mol) and caffeine, they will be absorbed and lead to colour changes in the composite.[1] This is further explained by the fact that the organic phase of the composite material allows for the penetration and absorption of colorants due to the polymer phase of the composite's affinity for the yellow colorants in the coffee.[6] Furthermore, Bagheri et al. also support the finding that coffee causes serious discoloration.[2] Showing depth of penetration around 40-60 microns.

The discoloration in tea is mainly due to adsorption of polar colorants on the surface of resins.[11]

Tannic acid (1701.19g/mol), Catechins (290-450g/mol), The aflavins (500800g/mol), Proanthocyanidins (500300g/mol), Thearubigins(1000-4000g/mol) Flavonoids-Quercetin Kaempferol which are present in tea responsible for composite resin stain.[14] out of these agents Tannic acid is the main culprit responsible for discoloration. Further fine tea particles get deposited in the interfacial gaps. In this way after repeated exposure overall depth of penetration of colouring agents in tea varies from 30-40 microns.

Turmeric has the strongest staining ability of all the composite resins evaluated in this investigation. This is as a result of turmeric's well-known strong colorant nature and inherent staining potential the staining of composite resin restorations by turmeric is primarily attributed to its natural compounds, mainly curcumin and its derivatives. Curcumin(368.38g/mol), desmethoxycurcumin(354.35g/mol), bisdemethoxycurcumin(340g/mol) collectively known as curcuminoids are major polyphenolic compounds in turmeric.[12] The curcuminoids give a yellow-orange coloration to turmeric powder due to the wide electronic delocalization inside the molecules that exhibit strong absorption between 420 to 430 nm in an organic solvent.[13] whenever the turmeric comes in contact with composite resin curcumin molecules get adsorbed onto the surface of composite as it in non polar, hydrophobic and lipophilic compound.[13] Usually turmeric consumed with oil-rich foods as the curcumin in lipophilic, oil acts as carrier it allows the curcumin to penetrate deeper into the micro pore and micro-cracks of the resin material results in deeper discoloration.[13] Curcumin can interact with the organic matrix of composite (TEGDMA and UDMA) by forming a hydrogen bond with them.[13] This interaction increases the stability of composite of stain on the surface. Also curcumin is photo sensitive molecule under the light it get degrade into other yellowish products which makes the stain over the surface more persistent.[13] During the study discoloration of GC Solar X has decreased over days than 14 days in tea the reason for this may be some surface-stained layers might get worn due to erosion or hydrolysis, exposing relatively unstained subsurface layers. Some stains may also leach out over time especially in aqueous solution like tea. Tea is acidic prolonged exposure may lead to sling softening and surface breakdown of the resin matrix. Also, as GC Solar X contain Bis-GMA, it has higher crosslinking, which can limit stain retention over longer duration.

In this study, all the solutions, even distilled water, has caused discoloration in the composite resin, with ΔE higher than 3.7. The rise in the ΔE value of the control sample (distilled water), after being soaked for one day has probably been caused by the increased water absorption by the composite and departure of soluble materials from the structure.[11] Colorant especially coffee, tea, and turmeric showed visible discoloration in composite. This is in line with the findings obtained in other investigations.

In the end more discoloration at end of 28 days in Omnichroma can be seen reason could be lies in the composition of resin matrix and fillers since majority portion of omnichroma is made up of UDMA and TEGDMA which is known for water absorption which causes slight swelling of material. This increases the surface porosity allowing chromogenic molecules from the tea, coffee and turmeric solution to penetrate the surface and bind to the resin. Also, unlike traditional composites OMNICHROMAS does not contain pigments or dyes that can help to mask the discoloration since its shade matching relies solely on light scattering through the fillers any absorbed

pigment such as turmeric becomes more visible. Curcumin has a strong affinity for hydrophobic regions in the resin matrix which could explain the highest level of discoloration seen in turmeric solution. Since UDMA and TEGDMA have hydrophobic segments, they attract and retain curcumin molecules more readily. Where as in case of GC solar x consist of bis-GMA and UDMA in resin matrix tend to be less prone to turmeric induced discoloration because bis GMA has higher rigidity which limits water sorption and pigment penetration along with it contain dyes which can could be easily mask the discoloration. Overall Omnichroma's reliance on optical fillers rather than pigments makes any discoloration more noticeable as the absorbed pigments interfere with its light scattering properties

V. Conclusion

Within the limitations of the study, it can be concluded that both GC SOLAR X and Omnichroma composites displayed colour changes after immersion in different beverages. At 7 days the discoloration was superficial but as time progresses to 14 and 28 days, deeper penetration occurs due to water sorption and polymer swelling. This results in progressively intense and irreversible stain.GC SOLAR X exhibited better colour stability in comparison to Omnichroma. The circumstantial evidence gathered from the present study provides clinicians with information pertaining to individuals' dietary habits and the staining susceptibility of restorative materials. The longevity of maintaining the colour of aesthetic restorations within the oral cavity may be enhanced either by incorporating dietary restrictions or by carefully choosing a compatible restorative material that correlates with one's dietary lifestyle.

References

[1] Racha Joseph Hajj, Lara Nasr (2023) In Vitro Assessment Of The Color Stability Of Two Resin Composites Current Research In Dentistry 2023, Volume 14: 30.40

[2] Ahmed, M.A.; Jouhar, R.; Vohra, (2022) F. Effect Of Different Ph Beverages On The Color Stability Of Smart Monochromatic Composite. Appl. Sci. 2022, 12, 4163

[3] GC BROCHURE

[4] Usha C, Rao SR, George GM. (2018) A Comparative Evaluation Of The Staining Capacity Of Microhybrid And Nanohybrid Resin-Based Composite To Indian Spices And Food Colorants: An In Vitro Study. Indian J Dent Res 2018; 29:201-5.

[5] Soyeon Kima, Shin Hye Chungb, Ryan Jin Young Kimc (2023) Investigating The Role Of Chlorogenic Acids And Coffee Type In Coffee-Induced Teeth Discoloration. ACTA ODONTOLOGICA SCANDINAVICA. 82, NO. 1, 1–8.

[6] Mashalkar Shailendra, Sarita Bhandari, Sangeeta Kulkarni, (2018) Color Depth Penetration Of Direct And Indirect Composite After One Month Interaction With Different Colored Drinks. International Journal Of Applied Dental Sciences 2018; 4(3): 05-08

[7] Kalander S, Kudva AR, S PM, Et Al. Evaluation Of Color Stability Of Omnichroma, Beautifil-Bulk Restorative, And G-Aenial Composites When Exposed To Various Beverages: An In Vitro Study. Int J Prosthodont Restor Dent 2023;13(2):88–93.

[8] Mushtaq Mohammad Bhat, Ajmal Mir, Riyaz Farooq, Aamir Rashid Purra, Fayaz Ahmed Ahanger. (2019) Color Stability Of Composite Resin After Immersion In Local Kashmiri Staining Solutions And Beverages. International Journal Of Contemporary Medical Research 2019;6(3):C1-C4

[9] Mohammad Reza Malekipour, Ala Sharafi1, Shantia Kazemi,(2012) Comparison Of Color Stability Of A Composite Resin In Different Color Media, Dental Research Journal,July, Vol 9 / Issue.

[10] Omnia Mahmoud Abdelkader Nour, Wedad Saleh Ibrahim Alburaidi,(2023) Assessment Of Color Stability Of Shade Less Composite Resin: An In-Vitro Study International Journal Of Medicine In Developing Countries, ;7(12):1871–1875

[11] Mohammad Reza Malekipour, Ala Sharafi1, Shantia Kazemi,(2012) Comparison Of Color Stability Of A Composite Resin In Different Color Media, Dental Research Journal,July, Vol 9 / Issue

[12] A Monika Et Al (2018) Effects Of Turmeric (Curcuma Domestica) On Color Changes Of Nanohybrid Composite Resins, Journal Of Physics: Conf. Series 1073 ,032024

[13] Augustine Amalraj, Anitha Pius, Sreerag Gopi, Sreeraj Gopi, (2017) Biological Activities Of Curcuminoids, Other Biomolecules From Turmeric And Their Derivatives E A Review, Journal Of Traditional And Complementary Medicine, 7(2017) 205 – 233

[14] Bayne SC, Taylor OF. Dental Materials The Art And Science Of Operative Dentistry. Sturdevant CM (Ed.) 3rd. Ed. St. Louis: Mosby 1995;206-287

[15] Aiah A. El-Rashidy, Rasha M. Abdelraouf And Nour A. Habib (2022). Effect Of Two Artificial Aging Protocols On Color And Gloss Of Single-Shade Versus Multi-Shade Resin Composites, BMC Oral Health,22:321

[16] Alshehri, A.; Alhalabi, F.; Mustafa, M.; Awad, M.M.; Alqhtani, M.; Almutairi, M.; Alhijab, F.; Jurado, C.A.; Fischer, N.G.; Nurrohman, H.; Et Al. Effects Of Accelerated Aging On Color Stability And Surface Roughness Of A Biomimetic Composite: An In Vitro Study. Biomimetics 2022, 7, 158.

[17] Coutinho CA, Hegde D, Sanjeevan V, Coutinho IF, Priya A. Comparative Evaluation Of Color Stability Of Three Commercially Available Provisional Restorative Materials: An In Vitro Study. J Indian Prosthodont Soc 2021;21:161-6

[18] S. Vijay Singh, Vineeta Nikh, Sampann Chowdhry, Anil Chandra, An In-Vitro Evaluation Of Tea And Turmeric Solution On The Color Stability Of Nanocomposite And Microhybrid Composites

[19] A Monika Et Al (2018) Effects Of Turmeric (Curcuma Domestica) On Color Changes Of Nanohybrid Composite Resins, Journal Of Physics: Conf. Series 1073 ,032024

[20] Ahamed, S.A.S.; Raheel, S.A.; Ajmal, M.B.; Kaur, M.; Alqahtani, N.M.; Tasleem, R.; Bahamdan, G.K.; Hegde, M.; Bhavikatti, S.K. Evaluation Of Color Stability Of Composite Resin Used To Characterize Acrylic Teeth—An In Vitro Study. Appl. Sci. 2023, 13, 1498.

[21] Reddy PS, Tejaswi KLS, Shetty S, Annapoorna BM, Pujari SC, Thippeswamy HM. Effects Of Commonly Consumed Beverages On Surface Roughness And Color Stability Of The Nano, Microhybrid And Hybrid Composite Resins: An In Vitro Study. J Contemp Dent Pract 2013;14(4): 718-723.

[22] Arash Shishehian , Farnaz Firouz , Sara Khazaee , Hossein Rajabi , Maryam Farhadian , Fatemeh Niaghiha Color Stability Of 3D-Printed Resins Eur J Transl Myol 33 (3) 11493, 2023 Doi: 10.4081/Ejtm.2023.11493

[23] OMINICHROMA BROCHURE

[24] Saud, S.; Salamatullah, A.M. Relationship Between The Chemical Composition And The Biological Functions Of Coffee. Molecules 2021, 26, 7634.
[25] Heber Isac Arbildo-Vega , Barbara Lapinska , Saurav Panda César Lamas-Lare , Abdul Samad Khan And Monika Lukomska-Szymanska Clinical Effectiveness Of Bulk-Fill And Conventional Resin Composite Restorations: Systematic Review And Meta-Analysis Polymers 2020, 12, 1786; Doi:10.3390/Polym12081786
[26] Nada A Abdelaleem, Afnan A Nassar, Aseel K Alhindi, Rahaf K Jarwan, Raghad M Iskandar, Shahad O Bashihab, Dental Staining Associated With Various Types Of Coffee, J Res Med Dent Sci, 2022, 10 (9):254-259.
[27] Mohamedm.Abdul-Monem, Mohameda.Hussein,Monag.Abdelrehim(2024) Effect Of Repolishing On Color Stability, Translucency, And Surface Roughness Of Aged Monochromatic Dental Composites, Eur Jgendent2024;13:240–246.
[28] . Douglas WH, Craig RG. Resistance To Extrinsic Stains By Hydrophobic Composite Resin Systems. Journal Of Dental Research 1982;61:41-43.
[29] Arima T, Hamada T, Mccabe JF. The Effects Of Crosslinking Agents On Some Properties Of HEMA-Based Resins. Journal Of Dental Research 1995;74: 1597-1601.
[30] Oysaed H, Ruyter IE. Water Sorption And Filler Characteristic Of Composites For Use In Posterior Teeth. Journal Of Dental Research 1986;65: 1315-1318. 35. Lnokoshi S, Burrow MF, Kataumi M, Yamada T, Takatsu T. Opacity And Colour Changes Of Tooth Coloured Restorative Materials. Operative Dentistry 1996;21 :73-80.