Evaluation of the color stability of two different composite resins with two different cavosurface margins at different storage times (In vivo study).

Magdy Abd Elhameed Elshora* Ahmed Gamal Eldin Abd Elhameed Abdullah Ahmed AbdElhady*****

** Department of Operative Dentistry Faculty of Dental Medicine, Boys, Cairo, Al Azhar University*

*** Professor of Operative Dentistry Department, Faculty of Dental Medicine, Boys, Cairo, Al Azhar University*

****Lecturer of Operative Dentistry Department, Faculty of Dental Medicine, Boys, Cairo, Al Azhar University*

ABSTRACT

Objectives: This study was performed to evaluate and compare the color stability of two different composite resins with two different cavosurface margins at different storage times (In vivo study). **Subjects and methods:** A total number of thirty six anterior teeth were used in this study with two dissimilar types of resin composite restorative materials in class V restorations of anterior teeth with or without cavity beveling over three different test periods (one day, six months, and one year). The restoration in this study were divided regarding the used material type as follows; Group A, Omnichroma single shade composite, Group B, multi-shade nanofilled composite, Filtek Z350XT (3MESPE), (n = 18) each main group was divided based on cavity beveling into cavity with beveling or cavity without beveling, each sub group was further subdivided into three divisions according to storage time (one day, six month and one year) Both materials were tested with regard color stability in vivo by vita easy shade device. **Results:** The results of this study demonstrated that nano filled composite (Filtek Z350XT) showed a statistically significant higher color stability than Omnichroma after 6 months, and one year of follow-up periods. However, there was no statistically significant difference at the baseline. Moreover, the results of this present study revealed that there was a statistically significant difference regarding to color stability between the different follow-up periods for each tested material either with cavity beveling or without cavity beveling. **Conclusions:** Omnichroma single-shade composite showed better color matching immediately after restoration but it affected negatively by time .

Keywords: Class V restoration, Maxillary anterior teeth, Omnichroma single shade composite, Restorative materials, vita easy shade.

DOI: 10.48047/ecb/2022.11.12.34

Introduction:

Composite resins are frequently used in dentistry for restorative procedures, cosmetic procedures, and altering the color and shape of teeth. [1, 2] The resin composites have undergone gradual improvement and alterations since their inception over 50 years ago to improve their qualities as an aesthetic restorative material. [3] New resin composite materials with streamlined application procedures, increased strength, and lifespan, improved aesthetic qualities, decreased polymerization shrinkage, improved enamel, and dentin adhesive systems, and modified composite resin filler types with better wear resistance have been developed. [4]

According to many features, including size, content, filler type, and the physical and mechanical qualities of the components, various classes of composite resins have been proposed. [5] The physical, mechanical, and optical properties of the resin composite have improved in some ways despite excellent recent advancements in composition, color availability, transparency levels, and effects; however, due to the material itself, the resin composite still has lower biomimetic potential because they lack a crystalline structure and because of the reduction in translucency, opacity, effects, and absorption. These features alone make it very challenging to match the color of the resin composite with the tooth structure. [6]

Over time, significant efforts were made to improve the aesthetic qualities of dental restorative materials. Restorative material must closely resemble natural teeth in terms of color, translucency, and surface texture in order to provide the best aesthetics, and it must exhibit long-lasting color stability. [7] Dental materials that color shift toward the color of the surrounding hard dental tissues may have a clinical advantage since this can enhance the restoration's aesthetic appeal, make shade matching simpler, use fewer shade guide tabs, and be partially correct for color mismatches. [8]

Self-blending resin composites are one applicable filler technology. This is a single-color mixing composite that mimics the physical properties of light rather than using pigments or dyes, generating structural colors rather than adding color to the material to match the tooth color. [9] Resin composites that have a blending effect, also referred to as the "*Chameleon effect*," where the color of the surrounding tooth structure is reflected by the resin composite, increasing aesthetics. Using nano-fillers that simulate light transmission, diffusion, and reflection, the chameleon effect enables color to shift to match the environment. [10]

The most common clinical scenarios for direct restorative procedures call for the use of Omnichroma composite, a single shade structurally colored universal composite. Due to its wide color-matching capability, physicians can save chair time, waste unwanted composite shades, and reliance on shade-matching procedures by doing away with the requirement for a shade-taking technique and decreasing composite inventory. [11, 12]

Color stability is the ability of materials to retain their original color. [13] Despite recent advancements in aesthetic restorative materials, discoloration still poses a serious challenge for direct tooth-colored restorations. [2]

This study aimed to evaluate the color stability of two different composite resins with two different cavosurface margins at different storage times.

Materials and Methods

The materials used in this study were two different restorative resin composite materials of different compositions and two universal bonding agent materials of self-etch strategy as follows:

1- Dental composites:

- Omnichroma composite (single-shade composite) (Tokuyama Dental, Japan).
- Nanofill composite Filtek Z350XT (multi-shade composite) (3M ESPE).

2- Bonding agents

- -Tokuyama Universal Bond (Tokuyama Dental, Japan) .
- Scotch Bond. Single Bond Universal Adhesive (3M ESPE).

Ethical considerations:

Approval for this research was obtained from Research Ethics Committee, Faculty of Dentistry, Al-Azhar University (EC Ref No.:622 / 296). The purpose of the present study was explained to the patients and informed consents were obtained according to the guidelines on human research adopted by the Research Ethics Committee, Faculty of Dentistry, al-azhar University.

Eligibility criteria of the study:

Inclusion criteria of selected patients for in_ vivo study include anterior permanent teeth, good oral hygiene and patient's age- range is 20 - 40 years free from periodontal problems and free from any formative and developmental defects.

Exclusion criteria of patients include badly broken and restored teeth, cracked tooth, patients enrolled on other treatment plane and mobility.

Sample size calculation: For vivo study: -According to Color Stability of previous clinical study [(1)], sample size calculation was undertaken via G power version 3.1 statistical software based on the following pre-established parameters: an alpha-type error of 0.05, a power test of 0.95.

Intervention:

A total of 36 anterior teeth were used in this study and were divided into 2 equal main groups (n=18) concerning the restorative material as follows:

Group I: Teeth restored with single-shade (Omnichroma) resin composite (n=18).

Group II: Teeth restored with Filtek Z350 XT nanofilled composite (n=18).

Each main group was further divided into 2 equal subgroups (n=9) according to the status of cavity beveling (with and without-bevel).Each sub group was further subdivided into three divisions according to storage time (one day, six month and one year).

Caries removal procedure:

All procedures were performed by single operator to trying to standardize the clinical procedures. After local anesthetic injection and rubber dam application, the carious lesions were removed following the guidelines published by the International Caries Consensus Collaboration; the teeth were prepared using conventional instruments and adhesive conservative techniques. Cavity preparation was with dimensions of 3 mm occluso-gingival, 3 mm mesio-distal, and 2 mm depth; all materials were used according to the respective manufacturers' directions figure (1).

Composite restoration:

The composite resin was adapted with a flat faced or elliptical condenser. Placement of resin composites followed the vertical incremental technique (2 mm-thick layers).

Light curing: curing three-sided technique was used for 20 seconds using Bluephase N (Bluephase N, Ivoclar) at zero distance. Wavelength range and providing a light intensity of 1,200 mW/cm2. The restorations were finished under water-cooling with fine and super fine diamond points (KG Finishing Kit, Karensen Ltd, Brasil) and rubber polishing kits (Eveflex Polisher, EVE Ernst Vetter GmbH, Germany) figure (1).

Figure (1): before, cavity preparation, and restoration.

Evaluation of color stability:

The color measuring tool VITA Easyshade® (v) was used to determine the CIELAB values. (Fig. 2)This device emits light from a halogen lamp and employs a manual clamping probe with a 5 mm measuring area. The measurement mode for a single tooth was chosen. Each tooth was measured by holding the probe tip (5 mm) away from the cavity at 90 degrees from the surface in the middle. Calibration was conducted by inserting the probe tip into the calibration port incorporated into the machine (a standard for calibration) before each measurement. As soon as the restorations were put in place, the shade of each one was noted using a VITA Easyshade®. Then, measurement was done at the baseline one day, six and twelve months after starting the treatment. The shade difference between each restoration and the tooth (Δ E) was then computed using the formula:

$$\Delta E = ((\Delta L*)2 + (\Delta a*)2 + (\Delta b*)2)1/2$$

Where L* denotes the color's lightness, a* denotes the color's redness-greenness, and b* denotes the color's yellowness-blueness.

Fig. (2): A photograph showing VITA Easyshade®.

Statistical analysis:

Data were collected, tabulated, and statistically analyzed using SPSS ® statistics Version 20. The Kolmogorov-Smirnov test was used to verify the normality of distribution. Numerical data were described as mean and standard deviation-test (ANOVA) was used for normally distributed quantitative variables, to compare between more than two groups. The qualitative data were. The level of significance was set at P<0.05. • All tests were two-tailed. The mean of a quantitative variable changes of two categorical variables were performed by a two-way ANOVA

Results:

The Easy shade results in color stability concerning the type of the cavity bevelling and the different follow-up periods. ***With cavity beveling*** The results of independent t-test of the Omnichroma and Nano fill composite color change (ΔE) in Class V with beveling at the day one of follow-up intervals showed that the difference between the sample average of subgroups is not statistically significant (p-value = 0.652 and t = 0.67). The results of independent t-test of the Omnichroma and Nano fill composite color change (ΔE) in Class V with beveling at 6 months of follow-up intervals showed that the difference between the sample average of subgroups is a statistically significant (p-value = 0.00003 and t = 1).

The results of independent t-test of the Omnichroma and Nano fill composite color change (ΔE) in Class V with beveling at one year of follow-up intervals showed that the difference between the sample average of subgroups is a statistically significant (p-value <0.001and t = 1).

Table (19): Comparison of Omnichroma and Nano fill composite color change in Class V with beveling at different time intervals:

Variable	Omnichroma	Nano fill composite	t-value	p-value
	Mean± SD	Mean± SD		
1 day	0.011±0.00	0.011±0.00	0.67	0.652 ns
6 months	1.23±0.06	1.01±0.09	1	0.00003*
1 year	2.27±0.05	1.72±0.08	1	<0.001*

*; significant at p≤0.05, ns; non-significant.

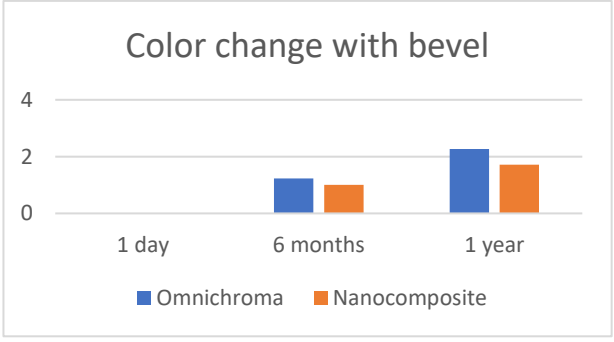

Fig. (3): Comparison of Omnichroma and Nanocomposite color change in Class V with beveling at different time intervals.

Class V cavity without beveling The results of independent t-test of the Omnichroma and Nano fill composite color change (ΔE) in Class V without beveling at the day one of follow-up intervals showed that the difference between the sample average of subgroups is not statistically significant (p-value = 0.660 and t = 0.66).

The results of independent t-test of the Omnichroma and Nano fill composite color change (ΔE) in Class V without beveling at 6 months of follow-up intervals showed that the difference between the sample average of subgroups is a statistically significant (p-value = 0.0000 and t = 1).

The results of independent t-test of the Omnichroma and Nano fill composite color change (ΔE) in Class V without beveling at one year of follow-up intervals showed that the difference between the sample average of subgroups is a statistically significant (p-value <0.001and t = 1).

Table (20): Comparison of Omnichroma and Nano fill composite color change in Class V without beveling at different time intervals:

Variable	Omnichroma	Nano fill composite	t-value	p-value
	Mean± SD	Mean± SD		
1 day	0.012±0.00	0.011±0.00	0.66	0.660 ns
6 months	1.27±0.05	1.04±0.09	1	0.000*
1 year	2.32±0.06	1.79±0.14	1	<0.001*

*; significant at p≤0.05. Ns; non-significant.

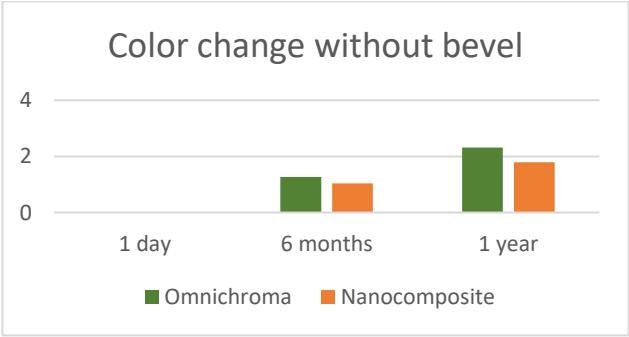

Fig. (4): Comparison of Omnichroma and Nanocomposite color change in Class V without beveling at different time intervals.

Discussion:

These modern variations, known as "nano-filled composites," combine the greatest qualities of numerous other composites. These brand-new restorative materials are composed of nanoparticles with sizes ranging from 1 to 100 nanometers, which have a variety of physical and mechanical characteristics necessary for withstanding the stresses of mastication in the oral cavity while yet keeping tooth-like looks. (14)

Dental materials that display color shifting in the direction of the hard dental tissues around them may have a clinical advantage since they can enhance the aesthetics of the restoration, make shade matching easier, use fewer shade guide tabs, and partially correct for color mismatches. (8) Omnichroma composite was selected as a test restorative material in this present study because it is a single shade structurally colored universal composite designed for use with most direct restorative clinical cases. Its wide color-matching ability eliminates the need for a shade-taking procedure and reduces composite inventory, allowing clinicians to minimize chair time and the wastage of unused composite shades, and reduce reliance on shade-matching procedures. (11, 12)

The Filtek Z350 XT universal nanofill composite served as the study's control group. Even though it has many filler and matrix systems, it is still regarded as one of the most researched composite materials, particularly with regard to its color stability and gloss qualities. (15) Moreover, The A2 shade was chosen in this present study because A2 is thought to be the clinically most commonly utilized shade. (16)

Therefore, single-shade (Omnichroma) resin composites served as the study's test group because it offers shade matching in place of multi-shade composite, for all tooth hues utilizing just one shade with a chameleon effect. (15)

Class V cavities were chosen for study because it is simpler to standardize the preparations, Class V restoration margins are located in both enamel and dentin, Class V lesions are minimal and relatively simple to prepare and restore, somewhat reducing practitioner variability, and Class V cavities have unfavorable C-factors, resulting in high-contraction scores within an adhesively fixed resin material. Furthermore, it can be difficult to achieve proper marginal sealing because these cavities typically have gingival edges in the dentin. (17)

Class V carious lesions continue to be a serious oral health concern for high-risk and elderly patients. (18) Another issue with Class V cavities is that if the restorative material is

not bonded to the dentin or cementum, microleakages occur that allow bacteria to enter the cavity through the gap between the cavity wall and resin composite. This can result in hypersensitivity, secondary caries, pulpal pathosis, and eventually restoration failure. [19] Therefore, Class V cavities with or without beveling were selected to be examined in vivo and in vitro in this current investigation.

The theory behind beveling enamel margins in Class V cavities is that it reduces marginal leakage, boosts adhesion, and enhances aesthetics. On the other hand, it has been argued that bonding to beveled margins just enhances aesthetics rather than producing a superior marginal seal than the unshaved margins. [17]

Color Stability:

Over time, significant efforts were made to improve the aesthetic qualities of dental restorative materials. Restorative material must mimic natural teeth in color, translucency, and surface texture to achieve the best aesthetics and have long-term color stability. [7] Therefore, long-term color stability was selected as a test property in this present study.

It is difficult to draw a direct connection between adhesive restorative systems in vitro and in vivo performance. This is because a prepared tooth's three-dimensional structure naturally differs from the flat surfaces used to evaluate adhesive compounds in vitro. In an in vivo model, the bonded contact is additionally exposed to various strains and more difficult circumstances. [2] Therefore, the in vivo color stability of the materials chosen for this study has only been examined in a few studies.

According to **Dozic et al. (2007)** [20], found VITA EasyShade to be the most precise among five other commercially available devices, both in vitro (VITA shade tabs) and in vivo, the use of the VITA EasyShade V spectrophotometer to evaluate color change was in accordance with their findings. They also reported that the device provided dependability and accuracy.

The CIE L*a*b* method was used to assess color change (ΔE) in this present study because according to **El Wakeel et al. (2017)** [21]. It is appropriate for identifying tiny color changes and possesses qualities like repeatability, sensitivity, and impartiality.

The results of this study showed that the Filtek Z350 XT's multi-shade featured much fewer color variations than its single shade (Omnichroma). This might be explained by the structure of their resin matrix. The Filtek Z350 XT was composed of larger molecular weight monomers like Bisphenol-ethyl-methacrylate (BisEMA), which exhibits low water sorption due to its hydrophobicity and a high degree of conversion, as well as Bis-GMA, which

heightens the crosslinking density of the polymer. [22-24] Omnichroma matrix, however, is made up of monomers with reduced molecular weight (UDMA) and (TEGDMA). Which exhibits (hydrophilic monomer) studies, water sorption increased, and impairing color stability? [22] .

The results of this study agreed with **Ahmed et al. (2022)** [9]who stated that the composite's resin component is a key factor in stain susceptibility. Generally, TEGDMA is a more hydrophilic monomer that exhibits water absorption, according to **Hamadamin and Saeed (2021)** [25]. Our findings are in accordance with **Ahmed et al. (2022)** [9] who reported that due to its low water solubility and absorption, studies have demonstrated that UDMA is more stain-resistant than bis-GMA. Moreover, the three primary parts of Filtek Z350 are bis-GMA, UDMA, and Bis-EMA. [22-24].

In this present study, Filtek Z350 XT had color stability levels that were substantially greater than Omnichroma at all follow-up periods. This may also be explained by differences in filler sizes; for example, Filtek Z350 XT's smaller nanofillers (20 nm silica and 4-11 nm zirconia) may result in superior surface quality and gloss retention than Omnichroma's bigger submicron fillers (260 nm spherical SiO_2-ZrO_2). [15, 26] These results agreed with **El-Rashidy et al. (2022)** [15] who concluded that multi-shade (Filtek Z350XT) displayed better color stability with time than Omnichroma single-shad composite. Also, these results agreed with the results of **Aydn et al. (2021)** [27] who reported that in all time periods, composite resin with a single-shade system (Omnichroma) showed statistically significantly greater color change than composite resin with a multi-shade system (Filtek Z350XT). However, in disagreement with the results of this present study **Sensi et al. (2021)** [28] discovered that Omnichroma displayed superior color stability and the lowest overall color change when compared with other multi-shade resin composites.

In agreement with the results of this present study **El-Rashidy et al. (2022)** [15] concluded that multi-shade (Filtek Z350XT) and single-shade composite (Omnichroma) displayed unacceptable color change with time after aging in different immersion solutions. These results also agreed with the results by **Islam et al. (2022)** [29] who concluded that all multi-shade and single-shade resin composites showed color alteration after the staining challenge. Additionally, **Alshehri et al. (2022)** [30] stated that Filtek Z350XT and Omnichroma displayed noticeable color changes with time after aging in different immersion solutions

The change in color in nanofill composite with time in this present study could be attributed to the infiltration of colorants and water at the interface between the imperfectly silanized nano-aggregated particles and resin matrix as described by **Ardu et al. (2017)** [31] However, the change in color in the Omnichroma composite with time could be attributed to the Omnichroma matrix, These results also agreed with **Abdelhamed et al. in 2022** [10] who reported that Omnichroma recorded the highest significant color change and sorption values, but also the least solubility value after 3 and 6 months of aging.

Conclusions:

Within the limitations of this study, the results demonstrated that

1. Omnichroma single-shade composite showed lower color stability than multi-shade nanofill composite.
2. The color stability of the restorative material affected significantly by time.
3. Omnichroma single-shade composite showed good color matching immediately after restoration.
4. Enamel beveling increase the clinical effectiveness and durability of resin restorations in terms of adhesion and color stability.

Recommendations

1- It is advised to conduct more research on how aging in various beverages affects the translucency and sealing ability of Omnichroma single-shade restorative material.

2- Using a minimally invasive dentistry technique, the cavosurface angle beveling did not need to be prepared.

References:

1. **Attin T, Wegehaupt FJ**. Impact of erosive conditions on tooth-colored restorative materials. Dent Mater. 2014; 30(1):43-9.
2. **Ceci M, Viola M, Rattalino D, Beltrami R, Colombo M, Poggio C**. Discoloration of different esthetic restorative materials: A spectrophotometric evaluation. Eur J Dent. 2017; 11(2):149-56.
3. **Sanad M, Fahmy OI, Abo Elezz AF**. Evaluation of Color Matching Ability of a Single Shaded Resin Composite versus a Single Translucency Resin Composite with Different Teeth Shades. Dental Science Updates. 2022; 3(2):165-72.
4. **Fugolin APP, Pfeifer CS**. New Resins for Dental Composites. J Dent Res. 2017; 96(10):1085-91.

5. **Senawongse P, Pongprueksa P**. Surface roughness of nanofill and nanohybrid resin composites after polishing and brushing. J Esthet Restor Dent. 2007; 19(5):265-73; discussion 74-5.
6. **Kim BJ, Lee YK.** Influence of the shade designation on the color difference between the same shade-designated resin composites by the brand. Dent Mater. 2009; 25(9):1148-54.
7. **Tekçe N, Tuncer S, Demirci M, Serim ME, Baydemir C.** The effect of different drinks on the color stability of different restorative materials after one month. Restor Dent Endod. 2015; 40(4):255-61.
8. **Pereira Sanchez N, Powers JM, Paravina RD.** Instrumental and visual evaluation of the color adjustment potential of resin composites. J Esthet Restor Dent. 2019; 31(5):465-70.
9. **Ahmed MA, Jouhar R, Khurshid Z.** Smart Monochromatic Composite: A Literature Review. International Journal of Dentistry. 2022; 2022:2445394.
10. **Abdelhamed B, Metwally AA-H, Shalaby HA.** Rational durability of optical properties of chameleon effect of Omnichroma and Essentia composite thermocycled in black dark drinks (in vitro study). Bulletin of the National Research Centre. 2022; 46(1):184.
11. **Kim BJ, Lee YK.** Influence of the shade designation on the color difference between the same shade-designated resin composites by the brand. Dent Mater. 2009; 25(9):1148-54.
12. **Morsy a, Gamal W, Riad M.** Color Matching of a Single Shade Structurally Colored Universal Resin Composite with the Surrounding Hard Dental Tissues. Egyptian Dental Journal. 2020; 66:2721-7.
13. **Vinay C, Uloopi K, RojaRamya K, Penmatsa C, Ramesh M**. Clinical performance of one shade universal composite resin and nanohybrid composite resin as full coronal esthetic restorations in primary maxillary incisors: A randomized controlled trial. Journal of Indian Society of Pedodontics and Preventive Dentistry. 2022; 40(2):159-64.
14. **Alshehri A, Alhalabi F, Mustafa M, Awad MM, Alqhtani M, Almutairi M, et al.** Effects of Accelerated Aging on Color Stability and Surface Roughness of a Biomimetic Composite: An In Vitro Study. Biomimetics (Basel). 2022; 7(4).

15. **El-Rashidy AA, Abdelraouf RM, Habib NA.** Effect of two artificial aging protocols on color and gloss of single-shade versus multi-shade resin composites. BMC Oral Health. 2022; 22(1):321.
16. **Rodrigues S, Shetty SR, Prithviraj DR.** An evaluation of shade differences between natural anterior teeth in different age groups and gender using commercially available shade guides. J Indian Prosthodont Soc. 2012; 12(4):222-30.
17. **Nagy I, El-Sayed H, Shalaby M.** Evaluation of marginal seal of different composite restored class V cavity preparations with different cavosurface margins. Tanta Dental Journal. 2018; 15(3):140-7.
18. **Mehesen R, Jazar H, Sheta N, Montaser M.** Scan Electron Microscope Evaluation of Marginal Adaptation of Alkasite, Bulk-fil Resin Composite, Resin Modified Glass Ionomer, and High Viscosity Glass Ionomer Restorative Materials. Egyptian Dental Journal. 2022; 68(2):1859-66.
19. **Jawaed NU, Abidi SY, Qazi FU, Ahmed S.** An in-vitro evaluation of microleakage at the Cervical Margin between two different class II restorative techniques using dye penetration method. J Coll Physicians Surg Pak. 2016; 26(9):748-52.
20. **Dozić A, Kleverlaan CJ, El-Zohairy A, Feilzer AJ, Khashayar G.** Performance of five commercially available tooth color-measuring devices. J Prosthodont. 2007; 16(2):93-100.
21. **El Wakeel A.** THE EFFECT OF TEA AND COFFEE ON THE COLOR STABILITY OF BULK AND INCREMENTAL FILL RESIN COMPOSITE. Egyptian Dental Journal. 2017; 63(Issue 4 - October (Fixed Prosthodontics, Dental Materials, Conservative Dentistry & Endodontics)):3651-65.
22. **Gajewski VE, Pfeifer CS, Fróes-Salgado NR, Boaro LC, Braga RR.** Monomers used in resin composites: degree of conversion, mechanical properties and water sorption/solubility. Braz Dent J. 2012; 23(5):508-14.
23. **Elliott JE, Lovell LG, Bowman CN.** Primary cyclization in the polymerization of bis-GMA and TEGDMA: a modeling approach to understanding the cure of dental resins. Dent Mater. 2001; 17(3):221-9.
24. **Hamdy T.** Polymerization shrinkage in contemporary resin-based dental composites: A Review Article. Egyptian Journal of Chemistry. 2021; 64.

25. **Hamadamin DI, Saeed D.H.** The Impact of Energy Drinks on Surface Roughness, Hardness, and Color Stability of Three Types of Composite Restorations. J Hunan Univ Nat Sci. 2021; 7:44–8.
26. **Elbishari H, Silikas N, Satterthwaite JD.** Is Deterioration of Surface Properties of Resin Composites Affected by Filler Size? Int J Dent. 2020; 2020:2875262.
27. **Aydın N KllS, Oktay E A, Ersöz B.** InvestigationofSingleShadeCompositeResinSurfaceRoughnessandColor Stability. Atatürk Üniversitesi Dis ̧ Hekim. 2021; 31:207-14.
28. **Sensi L, Winkler C, Geraldeli S.** Accelerated Aging Effects on Color Stability of Potentially Color Adjusting Resin-based Composites. Oper Dent. 2021; 46(2):188-96.
29. **Islam MS, Huda N, Mahendran S, Aryal Ac S, Nassar M, Rahman MM.** The Blending Effect of Single-Shade Composite with Different Shades of Conventional Resin Composites-An In Vitro Study. Eur J Dent. 2022.
30. **Alshehri A, Alhalabi F, Mustafa M, Awad MM, Alqhtani M, Almutairi M, et al.** Effects of Accelerated Aging on Color Stability and Surface Roughness of a Biomimetic Composite: An In Vitro Study. Biomimetics (Basel). 2022; 7(4).
31. **Ardu S, Duc O, Di Bella E, Krejci I.** Color stability of recent composite resins. Odontology. 2017; 105(1):29-35.