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Durability of Chameleon Effect of Giomer Restorative Material versus Nano-Filled Resin Composite: An In Vitro Study

Running title: Chameleon Effect of Giomer Restorative Material versus Nano-Filled Resin Composite

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Abstract

Aim: The aim was to assess the durability of the chameleon effect of S-PRG restorative material versus nano-filled resin composite after immersion in three different solutions for 3 months.

Subjects and methods: 48 Class I cavities were prepared in extracted molar teeth with the following dimensions: 4 mm depth, 7 mm mesio-distally, and 1.5 buccolingually. The teeth were classified into two groups: group 1 (S-PRG restorative material: Beautifil II LS, Shoufu inc) and group 2 (nanohybrid resin composite: Filtek Z250 XT, 3M ESPE). The restorations were immersed in 3 solutions: distilled water, Roselle, and tea. Each tooth was evaluated immediately, after 1 week, 1 month, and 3 months. Color measurements were evaluated by using a spectrophotometer (VITA Easyshade® V).

Results: S-PRG (Giomer) group showed the highest significant ΔE values than the nano-hybrid resin composite group, where the p-value was (≤ 0.001). Roselle subgroup showed the highest statistically significant ΔE values than tea and distilled water, where the p-value was

(≤ 0.000). The highest statistically significant value of color change was recorded at 3 months (T4)>1 month (T3)>1 week (T2).
Conclusion: 1. Giomer (S-PRG: surface pre-reacted glass) fillers negatively affect the durability of the chameleon effect and the clinical esthetic performance of the restorations.2. Colored beverages have a noticeable effect and may affect the color stability of resin-based restorations.3. Regardless of the chemical formulation, time can adversely affect the color stability of tooth-colored restorations.
Keyword: chameleon effect - Giomer - Nanohybrid resin composite - spectrophotometer

Introduction

Tooth-colored restorations are often used in cosmetic treatments and are becoming more popular among patients. Tooth-colored restorative materials have undergone several modifications to increase their strength longevity. These include improving resin composite filler types and reducing polymerization shrinkage, **(1)**.
In 1970 Wilson and Kent introduced Glass ionomer cement (GICs) which are widely used for many clinical situations, due to their fluoride-release anti-cariogenic activity, biocompatibility, adhesion to the dental structure, and linear expansion coefficient which is similar to that of the tooth **(2)**. In order to improve conventional glass ionomer to the level of resin composite the mechanical properties and durability of conventional glass ionomers various ion-releasing materials based on the fluoro-aluminosilicate glass as a filler component have been introduced: cermets, fibre-reinforced glass-ionomer, resin-modified glass-ionomers, compomers, and Giomers to improve the mechanical properties and durability of conventional glass ionomers. Giomers feature a resin-based matrix and unique pre-reacted glass ionomer (S-PRG) fillers, which have a conventional glass core with a surface glass ionomer layer pretreated with polyalkenoate acid and a completed acid–base reaction. S-PRG fillers were silanated to ensure copolymerization of the resin **(3).**
For tooth-colored restorative materials to function, they need to maintain shade matching with the adjacent tooth structure. Staining or discoloration of restorative materials is one of the reasons for replacing tooth-colored restorations, which occurs due to the aging process of the oral environment due to several extrinsic or intrinsic factors **(4).**
The chameleon effect refers to the perception that an existing color difference between the restorative material and the remaining tooth structure is perceived as smaller when the two colors are physically adjacent to each other at the restoration site than when they are shown separately at some distance from each other also it is called color blending **(5).**
Beautifil II LS, (SHOFU Inc, and Tokyo, Japan) A Giomer restorative material provide minimal shrinkage and maximum esthetics. Beautifil II LS has excellent polishing properties that match natural tooth shades. It shows a natural light reflection leads to a well-balanced chameleon effect in both dentin and enamel. Therefore, it was of primary importance to assess the durability of the chameleon effect of Beautifil II LS.

Materials and Methods

The protocol and ethical issues of this study were approved by the Council of Conservative Dentistry Department and the Research Ethics Committee – Faculty of Dentistry – October 6 University on January 5th, 2022 (Approval No RECO6U/1-2022).

A total calculated sample size of 48 teeth was sufficient to detect an effect size of 0.55 with 80% power (1-β=0.80) at a significance probability level of $p<0.05$ with a partial eta squared of 0.21. According to sample size calculations, each subgroup of restorative material, immersion solution, and evaluation time would be characterized by a minimum of 8 teeth with a total sample size of 48 teeth. The sample size was calculated using G*Power software version 3.1.9.3 (University of Düsseldorf, Düsseldorf, Germany).

Standardized class I The occlusal cavity is prepared with the following dimensions: buccolingual = 1.5 mm, Mesiodistal = 7 mm, and depth = 4 mm) (Fig. 6) Spinning in a high-speed handpiece (NSK PanaAir FX PAF-SU M4, NSK, Japan) using a Coplen slit and inverted tapered bur (Mainland China), using a large amount of air-water coolant. The cavity dimensions were assessed using a graduated periodontal probe.

The teeth were divided into two equal groups (n=24) according to the type of restorative materials (M): Giomer dental restorative material (M1) or nano-hybrid universal resin composite (M2). The materials used as well as their specifications, principal components and manufacturers, and lot numbers were listed in Table (1). Each group was further subdivided into three equal subgroups (n=8) according to the type of immersion solution (S): distilled water (S1), Roselle (S2), and Tea (S3). Each subgroup was assessed at four-time intervals (T): at baseline (before restoration) (T0), Immediate (T1), 1 week (T2), 1 month (T3), and 3 months (T4) Table (1).

The immersion protocol was the following: the first subgroup was immersed in distilled water, and the second subgroup was immersed in Roselle (Hibiscus Label, Lipton, Egypt) of (2g) into 300 ml of boiling distilled water for 15 min 3 times daily and the third subgroup was immersed in Tea (Yellow Label Tea, Lipton, Egypt) of (2g) into 300 ml of boiling distilled water for 15 min 3 times daily **(6).** Roselle and tea solutions were prepared by immersing two manufactured instant preparation tea bags (2gm × 2) into 300 mL of boiling water for 3 minutes. After 3 minutes, the bags were discarded, and the Roselle and tea solution was allowed to cool down for 5 minutes. Prepare the solution fresh daily for 90 days. The fabricated specimens were immersed in the corresponding solutions every day for 15 minutes. After the immersion regimen, specimens were stored in distilled water. This regimen was followed for 90 days **(7).**

The color evaluation was done on the 7th, 30th day and 90th day. The shade matching was done as previously described before cavity preparation. The color changes (ΔE*) were calculated as follows: $\Delta E^*=[(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{½}$ **(8)**

Data management and statistical analysis were performed using the Statistical Package for Social Sciences (SPSS) version 20. Numerical data were summarized using mean, standard deviation, median, and range. Data were explored for normality by checking the data distribution and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Comparisons between groups with respect to the normally distributed numeric variable (color change) were performed using independent t-test. One way analysis of variance (ANOVA) test, followed by the Bonferroni post hoc test for pairwise comparison were used to compare different immersion solutions. Evaluation times were compared using repeated measures ANOVA. Multiple ways ANOVA test was used to study the effect of different variables and their interaction. All p-values are two-sided. P-values ≤0.05 were considered significant.

Results

Effect of restorative material:

The mean and standard deviation of ΔE of both groups after immersion in distilled water, roselle, and tea were presented in **Table** (2) and **Figures** (1, 2, 3).

Distilled Water: For the immediately assessed restoration (T1), the value of the S-PRG (surface pre-reacted glass) group (5.26 ± 1.06) was statistically significantly higher than that of the nanohybrid resin composite group (4.04 ± 1.01), where the P value (≤0.03). After 7 days (T2): The value of the S-PRG group (5.64 ± 1.25) showed a statistically non-significantly higher value than the nano-hybrid resin composite group (4.80 ± 0.90), with a P-value (≤ 0.14). After 1 month (T3): The value of the S-PRG group (7.06 ± 1.08) showed a statistically non-significantly higher value than the nano-hybrid resin composite group (6.46 ± 1.30), with a P value of (≤ 0.33) . After 3 months (T4): The value of the S-PRG group (9.67 ± 0.70) was significantly higher than that of the nano-hybrid resin composite group (8.03 ± 1.01), with a P value (≤ 0.002).

Roselle: For immediately assessed restorations (T1): the values in the S-PRG group (9.91 ± 1.71) were statistically significantly higher than those in the nanohybrid resin composite group (7.75 ± 1.33), with a P-value (≤ 0.01). While after 7 days (T2): the value of the S-PRG group (10.91 ± 1.30) was statistically significantly higher than that of the nanohybrid resin composite group (7.94 ± 1.40), with a P value (≤ 0.0006). After 1 month (T3): The value of the S-PRG group (11.55 ± 1.79) was lower than that of the nanohybrid resin composite group (12.70 ± 1.55), with a P value (≤ 0.19), which was statistically significant. After 3 months (T4): The S-PRG group showed a statistically non-significant higher value (15.8 ± 1.69) than the nano-hybrid resin composite group (13.77 ± 4), with a P-value (≤ 0.21).

Tea: For immediately assessed restorations (T1): the S-PRG group showed a statistically non-significantly higher value (5.29 ± 0.97) than the nanohybrid resin composite group (3.96 ± 1.59), where the P value (≤0.06). After 7 days (T2): The value of the S-PRG group (7.26 ± 1.53) was significantly higher than that of the nano-hybrid resin composite group (5.12 ± 0.97), with a P value (≤0.004). Then, after 1 month (T3): the S-PRG group showed a higher statistical non-significant value (7.40 ± 1.04) than the nano-hybrid resin composite group (6.97 ± 1.10), with a P-value (≤0.43). After 3 months (T4): The S-PRG group showed a statistically higher value (11.65 ± 0.93) than the nano-hybrid resin composite group (9.09 ± 0.93), with a P-value (≤0.0001). Table (2),

Means with different superscript letters in the same raw were significantly different as P<0.05
Means with the same superscript letters in the same raw were insignificantly different as P>0.05. Figure (1, 2, 3)

2-Effect of immersion solution on the color change on restorative materials: The mean and standard deviation of ΔE of each group after immersion in all solutions at all intervals were presented in Table (3).

2.1 Effect of immersion solutions on S-PRG (Intervention) group: For restorations evaluated immediately (T1), the Roselle subgroup showed the highest statistically significant value (9.91 ± 1.71), while there was a non-significant difference between distilled water (5.26 ± 1.06) and tea (5.29 ± 0.97), where p-value (<0.0001). After 7 days (T2), the Roselle subgroup showed the highest statistically significant value (10.91 ± 1.30), while there was a non-significant difference between distilled water (5.64 ± 1.25) and tea (7.26 ± 1.53), where p-value (<0.0001). After 1 month (T3), the Roselle subgroup showed the highest statistically significant value (11.55 ± 1.71), while there was a non-significant difference between distilled water (7.06 ± 1.08) and tea (7.40 ± 1.04), where p-value (<0.0001). After 3 months (T4), the Roselle subgroup showed the highest statistically significant value (15.80 ± 1.69), followed by tea (11.65 ± 0.93), while distilled water was the lowest significant value (9.67 ± 0.70), where p-value (<0.0001). Figure (4)

2.2. Effect of immersion solution on nanohybrid resin composite (Control) group: For restoration evaluated immediately (T1), the Roselle subgroup showed the highest statistically significant value (7.775 ± 1.33), while there was a non-significant difference between distilled water (4.04 ± 1.01) and tea (3.96 ± 1.59), where p-value (<0.0001). After 7 days (T2), the Roselle subgroup showed the highest statistically significant value (7.94 ± 1.40), while there was a non-significant difference between distilled water (4.80 ± 0.90) and tea (5.12 ± 0.97), where p-value (<0.0001). After 1 month (T3), the Roselle subgroup showed the highest statistically significant (12.77 ± 4), while there was a non-significant difference between distilled water (6.46 ± 1.30) and tea (6.97 ± 1.10), where p-value (<0.0001). After 3 months (T4), the Roselle subgroup showed the highest statistically significant value (13.70 ± 1.55), followed by tea (8.03 ± 1.01), while distilled water showed the lowest statistically significant value (9.09 ± 0.93), where p-value (<0.0003). Figure (5)

Discussion

All patients seek a tooth-colored restoration that blends with the tooth as much as possible to maintain the natural appearance of the tooth and the effectiveness of its functions: chewing, clear speech and normal facial shape **(9)**

Tooth-colored restorations can be subjected to a variety of sources of staining during their lifespan. One of the common sources is dietary consumption of colored beverages. In addition, inherent properties of the material, such as color shift and the ability to achieve a smooth glossy surface after polishing are important for maintaining aesthetics. So, the goal of this research had been to compare the durability of the chameleon effect of Giomer restorative materials with nano-filled resin composites after immersion in three different solutions and evaluated at four different time intervals.

Sound human molars were used to better simulate the clinical situation. Only sound teeth with normal anatomy, no cracks, dysplasia, staining and without any restorations or fractures were used to provide standardization and avoid any confounding factors **(10).**

The selection of tooth-colored restorative materials is an essential stage of the restorative treatment protocol. Color stability has been carried out by 2 different methods, visually or instrumentally. The visual method has been the most used technique for color determination;

nevertheless, it is a subjective procedure that holds numerous disadvantages such as inconsistency and lack of standardization. Instrumental color determination, which uses color-matching tools like spectrophotometers & colorimeters, is employed in dentistry research investigations to get around these restrictions. These tools have been unbiased, & outcomes have been quantifiable. To further understand color perception, Commission Internationale de L'Eclairage (CIE) developed the CIELAB color system. The most popular system for measuring color in dentistry is this one. This research used spectrophotometry & CIE L*a*b* coordinates system. CIE L*a*b* technique had been chosen to assess color change (ΔE) as it can be used to detect small color changes & has qualities like repeatability, sensitivity, and impartiality. VITA Easyshade ® V was used because it is a reliable and accurate device with 90% accuracy **Gamal et al. (1), Ferreira et al. (11), Şişmanoğlu et al. (8), Korać et al. (12), Abdelhamed et al. (13).**

Roselle is widely consumed as a traditional drink in some countries, especially in Egypt. These drinks are believed to improve health and treat many diseases. Roselle has been shown to control blood pressure and blood sugar levels. Therefore, medical advisors recommend the intake of such herbal beverages for the natural management of many common medical problems, **Abdelaziz and El-Malky, (14).**

Tea is a type of beverage that is often consumed by the public. It is estimated that an average person consumes about 120ml of tea or the equivalent of a cup of tea per day. Tea is favored by many people because of its distinctive taste it also has quite a lot of benefits. Research has shown that tea is very helpful in the prevention and therapy of many diseases and benefits the body **Pramudiyanti et al. (15).**

The immersion cycle consists of immersion in the indicated liquid for 15 minutes 3 times/ day. The immersion lags had been broken up by intervals of storage in distilled water to simulate real-life intake & entire cycle had been performed every day for 3 months. The staining time was kept for 15 minutes. 3 times a day, as the average person drinks for about 10-15 minutes a day, thus simulating possible stain sensitivity of the restoration **Meshki et al. (16)**

Giomers have surface PRG-ionomer (S-PRG) particles that were found to be fluoride reservoirs that release and replenish fluoride ions, but it may not enhance their initial or late color stability**.** Third-generation Giomer materials are available in many forms of resin-based materials involving both conventional and flowable. Traditional form Beautifil II LS (Shofu Inc.) combines the properties of resin composites and glass ionomers **Ozer et al. (17)** acid-reactive fluorosilicate glass has been reacted with poly acids in presence of water before being freeze-dried, milled, silanized, powdered, & used as fillers. Water molecules can have impacts on the material's internal structure, such as creating microvoids in resin matrix or plasticizing or debonding filler, as a result of continuous water dissolution. This degradation or softening of Giomer can affect some if its physical & optical properties **Al-Saud et al. (18).** Hydrophilic nature of matrix speed of diffusion and the water sorption degree. Water sorption negatively obstructed the optical properties because it may lead to over-inflation of the material that, in turn, leads to internal pressures in the restoration and color change **Rusnac et al. (19**).

Transparency is an optical property between opacity and transparency. Transparency is a material's ability to transmit light without being scattered through its physical qualities. Materials with a homogeneous refractive index will exhibit this characteristic. Overall, the translucency of materials is inversely correlated with the number & size of fillers **Vattanaseangsiri et al. (9).** The translucency parameter is also significantly influenced by the number of fillers, the higher the filler content, the lower the translucency parameter **Rusnac et al. (20**).

The incorporation of surface pre-reacted glass (S-PRG) filler in the composition of Giomer restorative material tends to affect water exposure more than other filler types incorporated in nanohybrid resin composite restorative material. The degradation of Giomers also get accelerated by water sorption and causes harm to optical properties such as color matching**.** **Al-Shekhli et al. (21).**

Based on their hydrophobicity, molecular weight, flexibility of the polymer & residual monomers had been diffused out of the polymeric matrix. TEGDMA had been released from the matrix in greater amounts because it is lighter and more mobile than stiffer Bis-GMA molecule. TEGDMA serves as a hydrophilic monomer in (Giomers). Change in matrix composition between materials may account for variances in the water resorption of materials **Kim et al. (22**). Based on the storage solution, hydrophilic structures have been drawn to a wet environment while hydrophobic particles have been attracted to organic media. Diffusion of the storage liquid into the resin matrix's micropores may cause those pores to gradually enlarge & the polymeric matrix to swell **Rusnac et al. (19).**

It was found in current study that the Roselle group showed the highest color change followed by tea and distilled water. Roselle (Hibiscus) contains anthocyanins pigments (blue, purple, pink, red, and black Spectrum) with the ability to stain objects in contact. These pigments usually diffuse into and are not dissolved in water giving the tea its characteristic bluish-red color. These facts certainly support the findings of the current study showing that specimens immersed in roselle were stained **Abdelaziz and El-Malky (14).**

Black tea contains higher levels of theaflavins, thearubigins and thea naphthoquinones. Theaflavin gives a yellowish-red color, while thearubigin and theanaptoquinone give a brownish-red and yellow. Black tea is produced through a total fermentation process in which catechins are oxidized to theaflavins, thearubigins, and theanaphthoquinones by polyphenol oxidase **Pramudiyanti et al. (15), Patil et al. (7).**

Time has an impact on the discoloration of resin composite. Over time, resin composite becomes discolored due to exposure to light, heat, and other environmental factors. Discoloration may be caused by the breakdown of the resin matrix, the presence of staining agents, and the accumulation of debris. Additionally, the presence of water can cause discoloration due to the leaching of pigments from the resin composite. Over time, discoloration progressively increased reaching the highest values after 3 months, as demonstrated before**.** As a result of colorant surface adsorption or water absorption with pigments in resin matrix as a result of superficial degradation, discoloration has been thought to be more superficial. When the polymer network has been fully saturated, absorption of colors reaches its peak in 1 to 2 months. In the aquatic environment, unreacted monomers from resin composites are rapidly excreted. Unreacted matrix monomers as well as ions from fillers & activators appear & water molecules enter the resin composite. **Korać et al. (12)**

Conclusions

Based on the results of the present in vitro study, the following conclusions could be drawn: Giomer (S-PRG: surface pre-reacted glass) fillers negatively affect the durability of the chameleon effect and the clinical esthetic performance of the restorations. Colored beverages have a noticeable effect and may affect the color stability of resin-based restorations. Regardless of the chemical formulation, time can adversely affect the color stability of tooth-colored restorations.

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Table (1)

Materials	Specification	Composition	Manufacturer	Lot number
Meta Biomed	Etching gel	37% Phosphoric Acid	Meta Biomed, Chungcheongbuk-do, Republic of Korea www.meta-biomed.com	MET2111251
BeautiBond	Self-etching	Ceramics (alumina,	SHOFU INC, Tokyo, Japan	062142

Universal	adhesive/Dual cure	zirconia) or metal surface to enhance bonding.	www.shofu.com	
BEAUTIFIL II LS	Giomer dental restorative material	Glass powder, Urethane diacrylate, Bis-MPEPP [(1)], Bis-GMA[(2)], TEGDMA[(3)], Polymerization initiator, Pigments and other	SHOFU INC, Tokyo, Japan www.shofu.com	O52147
3m ESPE Filtek Z250 XT	Nano Hybrid Universal Resin Composite	The inorganic filler loading is 81.8% by weight, (67.8% by volume) with a particle size of 20 nm for the silica and approximately 0.1 - 10 microns for the zirconia/silica Resins: BiS-GMA[(2)] , UDMA[(4)], TEGDMA[(3)] BIS-EMA[(5)], PEGDMA[(6)] and resins.	3M Deutschland GmbH, Seefeld, Germany www.3MESPE.com	NE04331

(1) Bis-MPEP: bisphenol-A-ethoxylate(2) dimethacrylate
(2) Bis-GMA: Bisphenol A diglycidylmthacrylate.
(3) TEGDMA: Triethyleneglycoldimethacrylate
(4) UDMA: Urethane dimethacrylate.
(5) Bis-EMA: Bisphenol A polyethylene glycol dietherdimethacrylate.
(6) PEGDMA: Polyethyleneglycoldimethacrylate.

Table (2): Comparison between intervention and control groups regards different immersion solutions at all intervals

	Distilled water	Intervention group S-PRG		Control group Nanohybrid resin composite		P value
		M	SD	M	SD	
Distilled water	T1 (Immediate)	5.26	1.06	4.04	1.01	0.03*
	T2 (7 days)	5.64	1.25	4.80	.90	0.14

	T3 (1month)	7.06	1.08	6.46	1.30	0.33
	T4 (3 months)	9.67	0.70	8.03	`1.01	0.002*
Roselle	T1 (Immediate)	9.91	1.71	7.75	1.33	0.01*
	T2 (7 days)	10.91	1.30	7.94	1.40	0.0006*
	T3 (1month)	11.55	1.79	12.70	1.55	0.19
	T4 (3 months	15.80	1.69	13.77	4.00	0.21
Tea	T1 (Immediate)	5.29	0.97	3.96	1.59	0.06
	T2 (7 days)	7.26	1.53	5.12	0.97	0.004*
	T3 (1month)	7.40	1.04	6.97	1.10	0.43
	T4 (3 months	11.65	0.93	9.09	0.93	<0.0001*

M: mean SD: standard deviation
P: probability level which is significant at $P \leq 0.05$

Table (3): Comparison between different immersion solutions in all groups at different intervals

Group	Time interval	Distilled water		Roselle		Tea		P value
		M	SD	M	SD	M	SD	
Intervention	T1 (Immediate)	5.26 ^{a}	1.06	9.91 ^{b}	1.71	5.29 ^{a}	0.97	<0.0001*
	T2 (7 days)	5.64 ^{a}	1.25	10.91 ^{b}	1.30	7.26 ^{a}	1.53	<0.0001*
	T3 (1month)	7.06 ^{a}	1.08	11.55 ^{b}	1.79	7.40 ^{a}	1.04	<0.0001*
	T4 (3 months	9.67 ^{a}	0.70	15.80 ^{b}	1.69	11.65 ^{c}	0.93	<0.0001*
Control	T1 (Immediate)	4.04 ^{a}	1.01	7.75 ^{b}	1.33	3.96 ^{a}	1.59	<0.0001*
	T2 (7 days)	4.80 ^{a}	0.90	7.94 ^{b}	1.40	5.12 ^{a}	0.97	<0.0001*
	T3 (1month)	6.46 ^{a}	1.30	12.70 ^{b}	1.55	6.97 ^{a}	1.10	<0.0001*
	T4 (3 months	8.03 ^{a}	1.01	13.77 ^{b}	4.00	9.09 ^{a}	0.93	0.0003*

M: mean SD: standard deviation
P: probability level which is significant at $P \leq 0.05$

Means with different superscript letters in the same raw were significantly different as P<0.05
Means with the same superscript letters in the same raw were insignificantly different as P>0.05

Figures

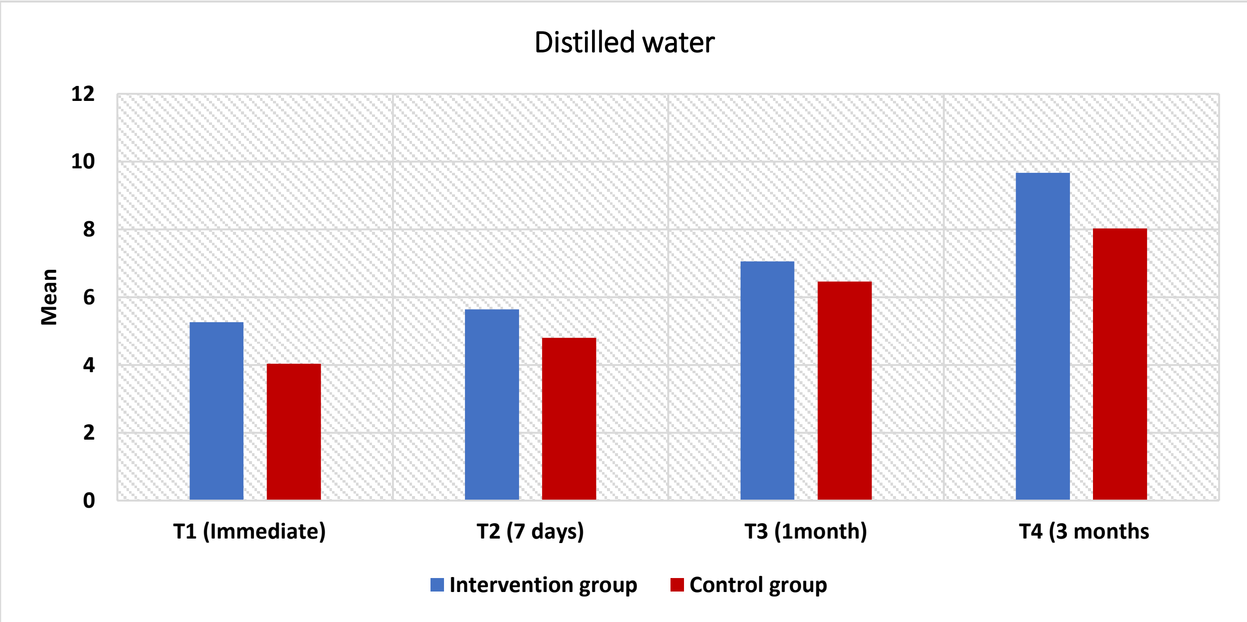

Figure (1): Bar chart showing ΔE of both groups for restorations immersed in distilled water

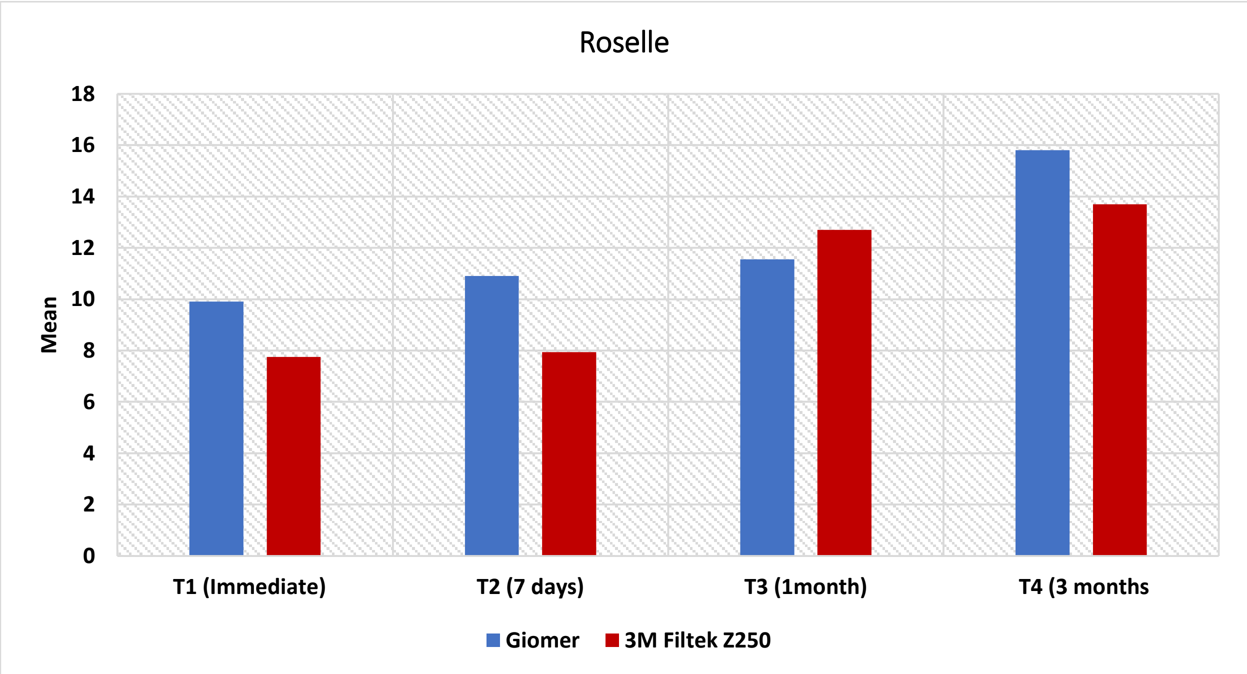

Figure (2): Bar chart showing ΔE of both groups for restorations immersed in Roselle

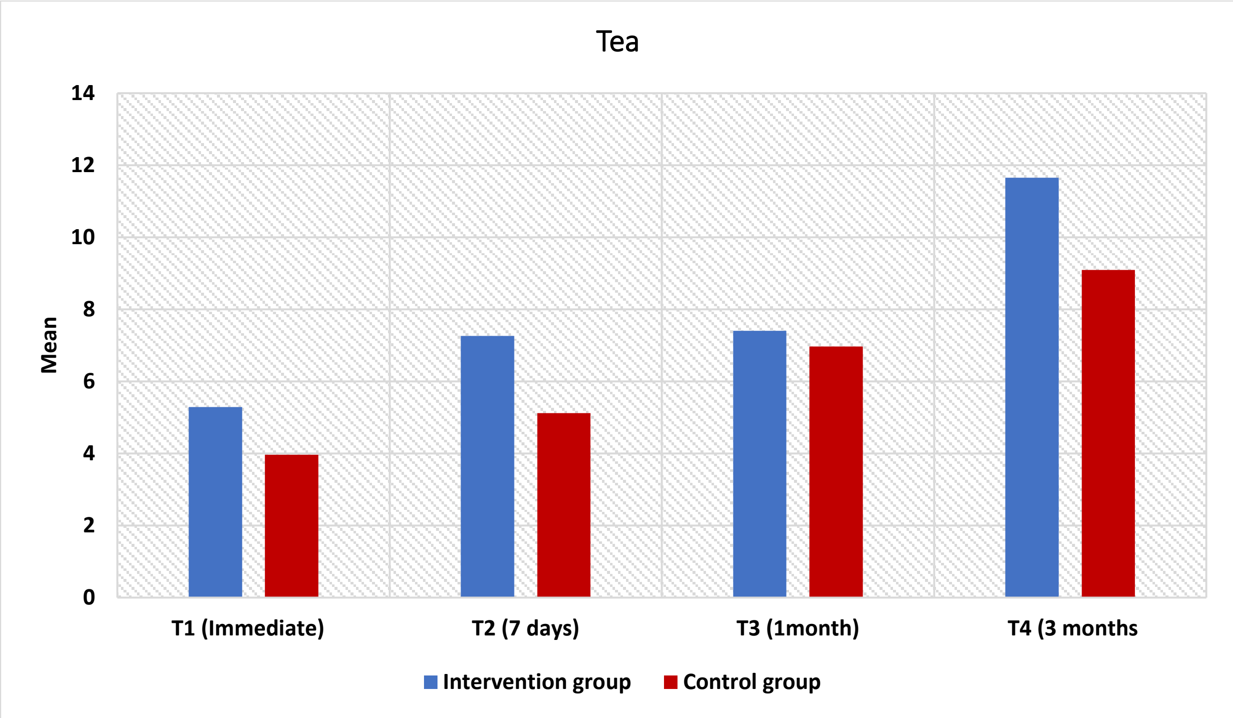

Figure (3): Bar chart showing ΔE of both groups for restorations immersed in Tea

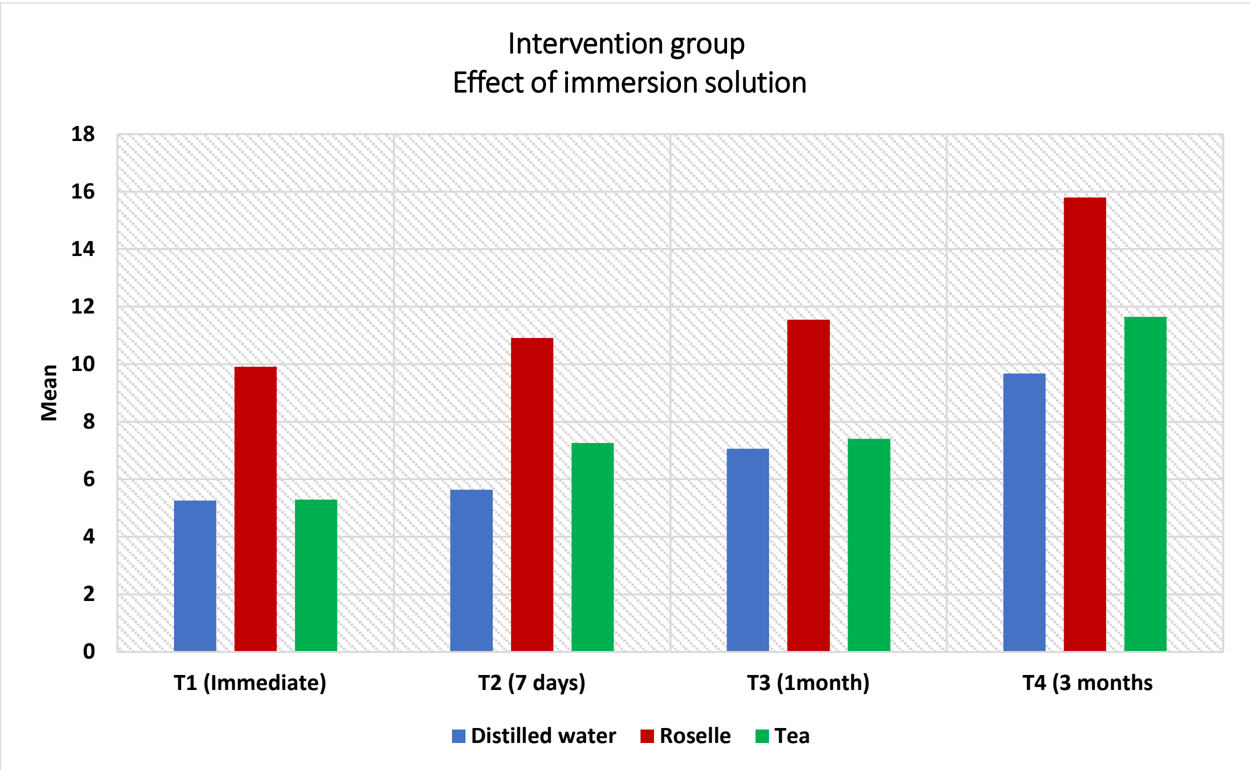

Figure (4): Bar chart showing ΔE of the intervention group in different immersion solutions at all intervals.

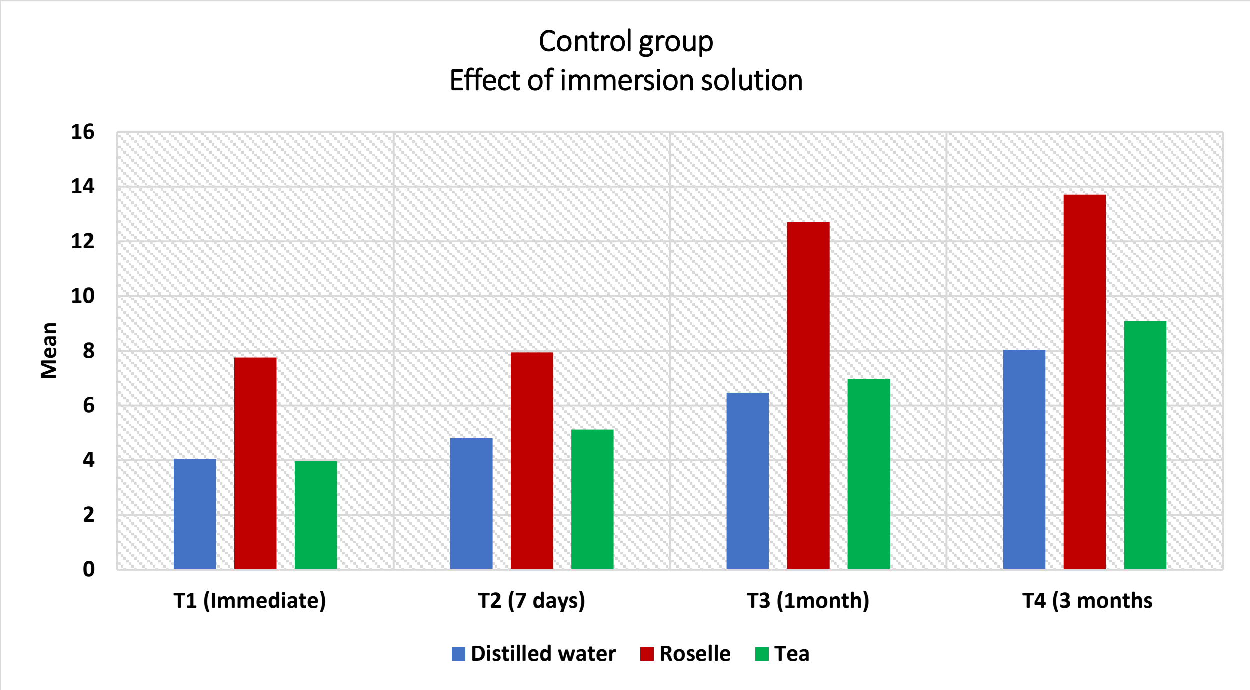

Figure (5): Bar chart showing ΔE of the control group in different immersion solutions at all intervals

Figure legends:
Figure (1): Bar chart showing ΔE of both groups for restorations immersed in distilled water
Figure (2): Bar chart showing ΔE of both groups for restorations immersed in Roselle
Figure (3): Bar chart showing ΔE of both groups for restorations immersed in Tea
Figure (4): Bar chart showing ΔE of the intervention group in different immersion solutions at all intervals.
Figure (5): Bar chart showing ΔE of the control group in different immersion solutions at all intervals