The effect of Beverages on Color Stability of Highly Impact Acrylic Resin

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الخلاصة

المقدمــة: تهــدف هــذه الدراســة الى تقييــم تأثــير المشــروبات (المــاء المقطــر ، البرتقــال الصناعــي ، مــاء زمــزم ، البرتقــال الطبيعــي ، الكــولا ، القهــوة ، الشــاي) علــى ثنائيــة اللــون للاكريــل المقــاوم للكســر . **المــواد والطــرق** : العــدد الكلــي للنمــاذج كان ٤٨ عينــة حضــرت ٣٠×٢٠×١٫٥ ملــم «طــول ، عــرض ، سمــك» و ٦ عينــة غمــرت لــكل نــوع مــن انــواع المشــروبات . العينــات الســتة المتبقيــة كانــت بــدون غمــر لاي نــوع «بعــد فتــح» البودقــة المعدنيــة واكمــال العينــات . تغــير اللــون بــين مجموعــة القياســية وبــين مجاميــع التعــرض للمشــروبات الاخــرى بعــد مــرور ٣ ســاعة ، ٩ ســاعة ، ١٨ ســاعة ، ٣٦٫٥ ســاعة و ٧٣ ســاعة وكانــت نتائــج البحــث تحليلهــا بواســطة جــدول تحليــل التبايــن والدنكــن. **النتائــج**: اظهــرت النتائــج انــه لا يوجــد اختــلاف احصائــي بــين المشــروبات للاوقــات «٣ ســاعة ، ٩ ســاعة ، ١٨ ســاعة ، ٧٣ ســاعة» ، ماعــدا لـــ ٣٦٫٥ ســاعة ، حيــث يوجــد اختــلاف معنــوي وكذلــك اظهــرت النتائــج انــه لايوجــد اختــلاف معنــوي بــين الاوقــات لــكل انــواع المشــروبات. **الاســتنتاجات** : بــين انــواع المشــروبات اظهــرت القهــوة والشــاي قيــم غــير مقبولــة لتغــير اللــون لــكل انــواع الغمــر مــا عــدا بعــد ٩ ســاعة مــن الغمــر ، بينمــا اظهــرت الكــولا قيــم مقبولــة لتغــير اللــون مــا عــدا بعــد ٣ ســاعة مــن الغمــر حيــث كان تغــير اللــون غــير مقبــول.

ABSTRACT

Aim: To evaluate the effect of beverages (Distilled water ,Artificial orange, Zamzam water, Natural orange, Cola, coffee, and Tea) on the color stability of the highly impact resin. **Materials and methods**: Total samples of this research were (48) samples of highly impact resin were prepared 30 * 20 * 1.5 mm (length, width and thickness). Six samples were immersed in each type of beverage. The last six sample (control) without any type of beverage (after control group and other beverage groups were evaluated after (3 hours, 9 hrs, 18 hrs, 36.5 hrs, and 73 hrs) immersion time intervals by using (CIE L* a* b*) system. the results of this research were analyzed statistically by ANOVA and Duncan's multiple range test. **Results** : There was no significant difference among beverages at immersion time intervals (3 hrs, 9 hrs, 18 hrs, and 73 hrs) except at (36.5 hrs) there was a significant difference, also the results showed that there was no significant difference among immersion time intervals for different types of bever-ages. **Conclusions**: among beverages coffee and tea showed unaccepted value of ΔE at all immersion time intervals except at (9 hrs) while cola showed an accepted values of ΔE except at (3 hrs) of immer-sion where ΔE value was unaccepted.

Key words: Color stability, Beverage, Highly impact resin.

INTRODUCTION

Acrylic resin has been introduced in 1937 for construction complete and partial dentures, and had been widely used due to their acceptable esthetic, low permeability in oral fluid and color stability[1,2,3].

Color was an important property for esthetic evaluation of acrylic resin denture base after exposure to beverages and food[4].

One type of highly impact acrylic resin was prepared by adding the elastomer, to polymethyle methacrylate which act as a plastifying agent, the addition of elastomers to the material increase the ability of absorb energy and over come the possibility of resin fracture[5,6]

Color change of prosthodontic materials might result in patient dissatisfaction and increase the possibility of prosthesis replacement[7].

Studies demonstrated that coffee, cola, and juice deposite stains on dental materials and resulted in a gloss changes[8,9]. Increased experimental time period showed a decrease in the gloss of denture acrylic resin[10] .

Imirzalioglu et al[11] found that the color shifts of heat polymerized acrylic, injec-tion molded acrylic, and autopolymerized acrylic were clinically acceptable (ΔE < 3.7) after 30 days of soaking in tea, coffee and nicotine.

Navarro et al [12] showed that the staining effect of coffee of two heat cured denture base acrylic (Lucitone 550, Vipicril), and one nylon denture base resin (Transflex) to

be at a clinically acceptable levels after 30 days of immersion.

The present research was designed to evaluate the effect of beverages (Distilled water ,Artificial orange, Zamzam water, Natural orange , Cola, Coffee, and tea) on color stability of highly impact acrylic resin. Also, to evaluate the effect of immersion time on color stability of highly impact acrylic resin.

MATERIALS AND METHODS

In this research, the used beverages were Distilled water, Artificial juice (Rani orange. Aujan Industries co.,Kindom of Saudi Arabia), zamam water, natural orange juice, cola, coffee, and tea. 30 gm of tea (Alghazaleen) and 30 gm of coffee powder (Brazilian coffee) were added into one liter of boiling distilled water, then simmered for 5 minute and filtered through filter paper[13, 14].

Highly impact acrylic (VertexTM-Netherland) was polymerized in water bath at 70°C for 90 minute and raised to 100°Cfor 30 minute according to manufacturers instruction. After deflasking, the samples were abraded on both sides with (600) grit sand paper. A slurry of water and pumice were applied for polishing[12].

The pH values of beverages were measured by using pH meter device. After cleaning the electrode and calibrating the device, then the pH values of beverages were measured as shown in Table (1).

Table (1) : pH Values of Beverages

Beverage	pH
Artificial orange	2.66
Distilled water	70
Zamzam	7.92
Natural orange	2.64
Cola	1.84
Coffee	5.24
Tea	5.71

Forty eight samples of acrylic were prepared with dimensions of 30*20*1.5 mm (length, width, and thickness)[14,15]. six samples were immersed for each type of beverages, the remain six sample being evaluated as a control (after deflasking, finishing, and polishing) with out immersion in beverage.

The samples were converted to digital images by using digital scanner (HP scanner, HP desk jet F 2280). The images were digitized with an input resolution of 1200 pixels per inch[16]. These digital images were prepared with dimension 85 pixels X85 pixels for each sample by soft were program Adob photoshop 9.0, then these images were saved. Special program were used, operating with in MATLAB to reach direct values of (CIE L*a*b*) for (7225) pixels that were presented in these surface area of image[17] . Each (CIE L*a * b *) for all pixels will be given values, and the result present directly on excel program. The total color change ΔE of each sample was calculated using the following formula[18,19]

$$\Delta E = [(\Delta L^*)2 + (\Delta a^*)2 + (\Delta L^*)2]1/2$$
$$\Delta E = [(L2^* - L1^*)2 + (a2^* - a1^*)2 + (L2^* - L1^*)2]1/2$$

When no color difference will be detected after its exposure to the testing environment (ΔE = O). ΔE value of 3.7 or less was considered to be clinically acceptable in vitro study[19]

The protocol of immersion time was as a continues immersion[20] and was estimated in this research as follows : 3 caps of liquid per day time, 2 minute of each cup through 365 days (3×2×365) equal to 2190 min (36.5 hours per year) so, the immersion time intervals were 3, 9, 18, 36.5 and 73 hours represent 1, 3, 6, 12, and 24 months respectively.

The following statistical methods were used to analyze and assess the results with SPSS V 11.5 for windows, descriptive statistics include mean ± standard deviation values, ANOVA and Duncan multiple range test were used. The statistical results were considered significant at P≤0.05.

RESULTS

In this research, the scanner image was used because it could be used to digitally evaluate color change of dental materials with (CIE L* a * b *) system[15, 16].

Color change (ΔE) measurements of

highly impact resin in comparison among beverages (Figures 1-5) demonstrated the mean ± standard deviation values and Duncan's multiple range test of color change ΔE.
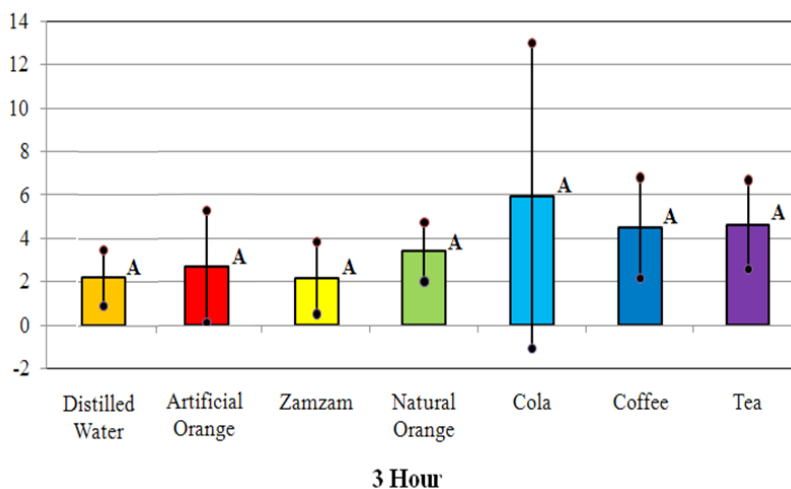

Figure (1) : Mean ± SD and Duncan's multiple range test of color change ΔE for comparison among beverages at 3hrs of immersion
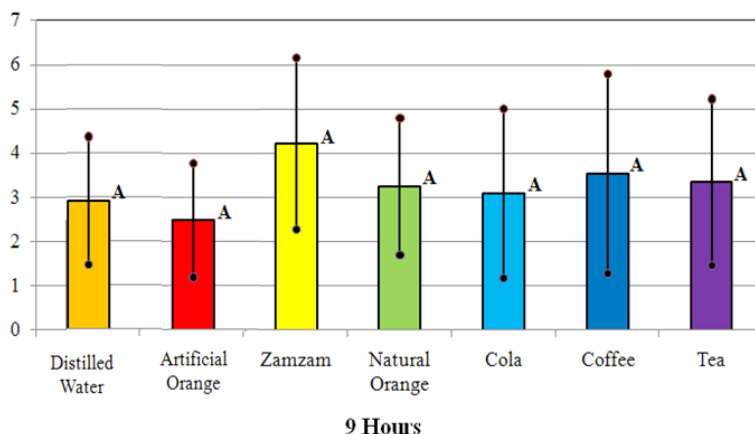

Figure (2) : Mean ± SD and Duncan's multiple range test of color change ΔE for comparison among beverages at 9hrs of immersion
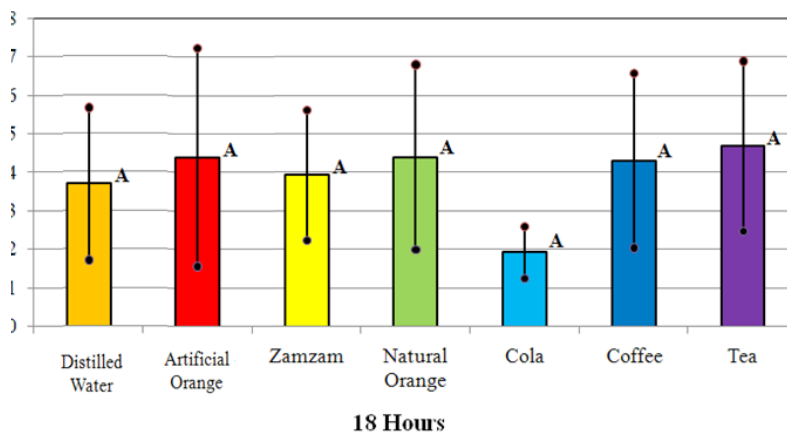

Figure (3) : Mean ± SD and Duncan's multiple range test of color change ΔE for comparison among beverages at 18 hrs of immersion
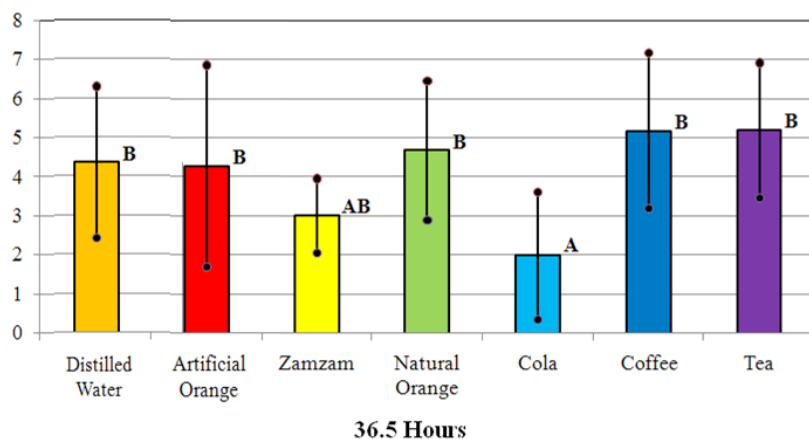
Figure (4) : Mean ± SD and Duncan's multiple range test of color change ΔE for comparison among bever-ages at 36.5 hrs of immersion
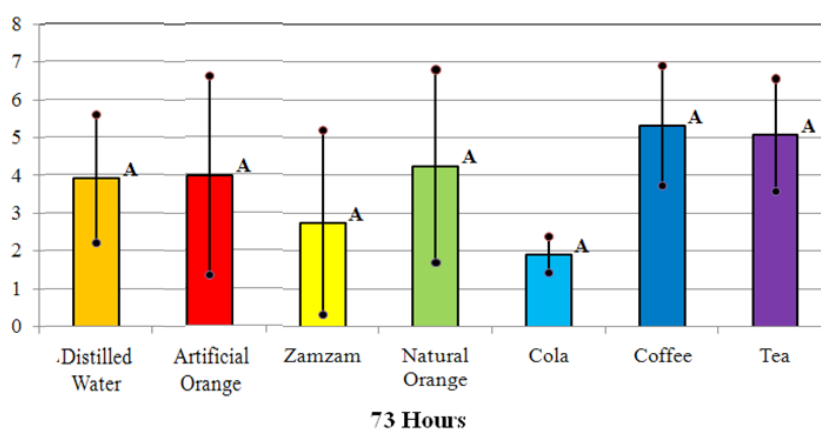

Figure (5) : Mean ± SD and Duncan's multiple range test of color change ΔE for comparison among bever-ages at 73 hrs of immersion

The one way analysis of variance (ANOVA) as shown in (Table 2) demonstrated that there was no significant differences among beverages at immersion time intervals (3 hrs, 9 hrs, 18 hrs, and 73 hrs) except at (36.5 hrs) there was a significant difference among beverages where the lowest color change, showed with cola that significantly not differ from Zamzam water (Figure 4).

Table (2) : Analysis of variance (ANOVA) for comparison of color change ΔE among different types of beverage

Time	SOV	SS	df	MS	F–value	p–value
3 Hr	Between Groups	73.589	6	12.265	1.193	0.333
	Within Groups	359.961	35	10.285		
	Total	433.550	41			
9 Hrs	Between Groups	10.469	6	1.745	0.551	0.766
	Within Groups	110.891	35	3.168		
	Total	121.360	41			
18 Hrs	Between Groups	31.336	6	5.223	1.174	0.342
	Within Groups	155.718	35	4.449		
	Total	187.054	41			
36.5 Hrs	Between Groups	50.309	6	8.385	2.451	0.044*
	Within Groups	119.758	35	3.422		
	Total	170.067	41			
73 Hrs	Between Groups	52.821	6	8.804	2.266	0.059
	Within Groups	135.979	35	3.885		
		188.800	41			

SOV: Source of variance; SS: Sum of squares; MS: Mean square; df: Degree of freedom.
* indicated significant difference at $p < 0.05$.

The explanation of this results might due to low pH of cola (pH – 1.84) that cause solubility of the resin and later, absorption might take place with increasing immersion time. The very high acidity of the solution leads to an increase in water sorption[21]. The equilibrium between solubility and absorption processes resulting in decreasing the color change[13]. Zamzam water was alkaline (pH = 7.92) and characterized by the presence of metals, cations and anions[22], resulting in a difference in color change from that of distilled water (pH = 7.0).

Color change (ΔE) measurements of highly impact resin in comparison among immersion time intervals (Figures 6-12) demonstrated the mean ± standard deviation values and Duncan's multiple range test of color change (ΔE).
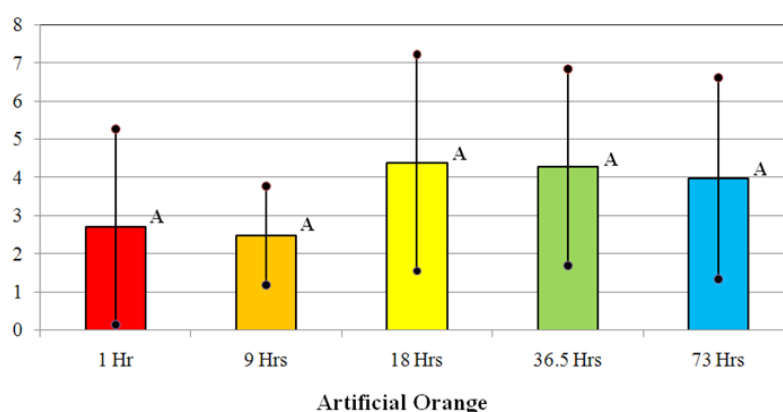

Figure (6) : Mean ± SD and Duncan's multiple range test of color change ΔE for comparison among immer-sion time intervals for artificial orange
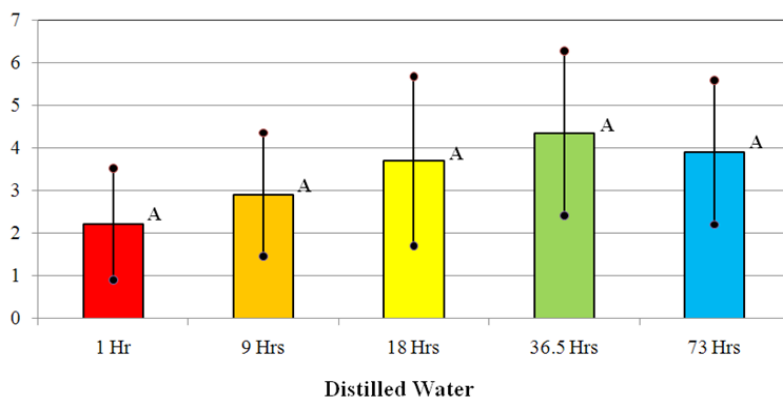
Figure (7) : Mean ± SD and Duncan's multiple range test of color change ΔE for comparison among immer-sion time intervals for distilled water
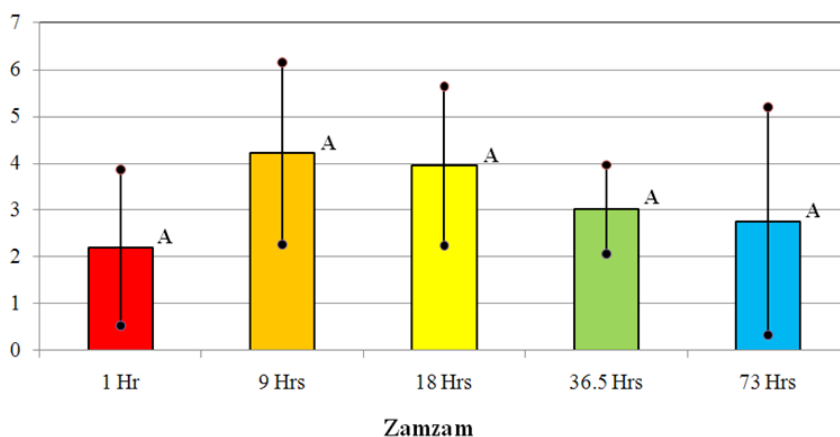

Figure (8) : Mean ± SD and Duncan's multiple range test of color change ΔE for comparison among immer-sion time intervals for zamzam water
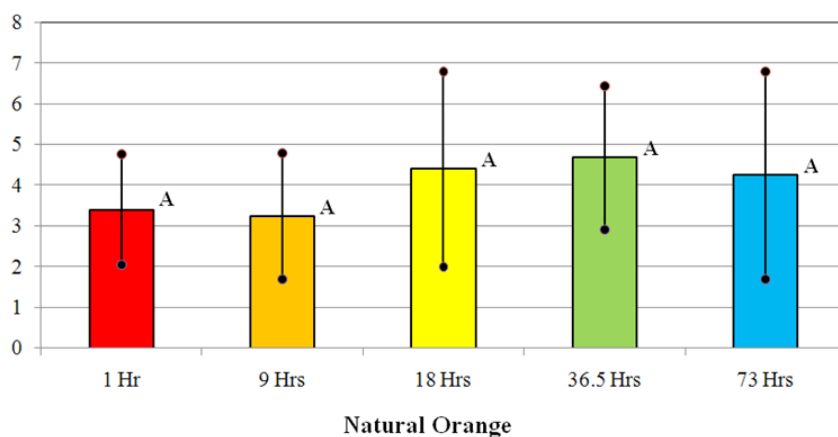

Figure (9) : Mean ± SD and Duncan's multiple range test of color change ΔE for comparison among immer-sion time intervals for natural orange
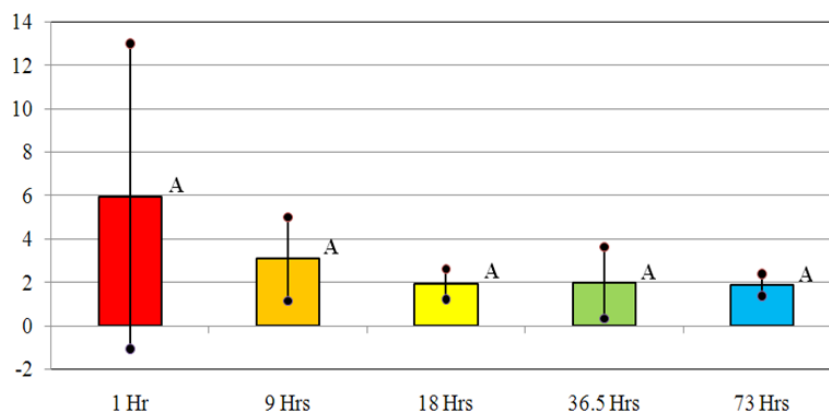
Figure (10) : Mean ± SD and Duncan's multiple range test of color change ΔE for comparison among immer-sion time intervals for cola

Figure (11) : Mean ± SD and Duncan's multiple range test of color change ΔE for comparison among immer-sion time intervals for coffee

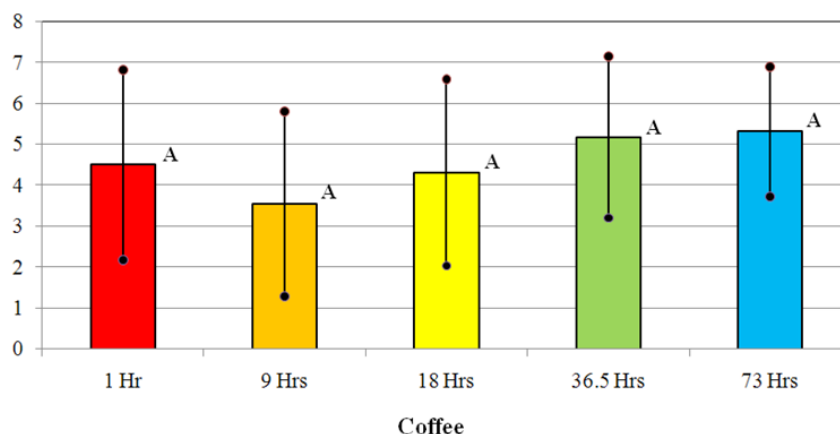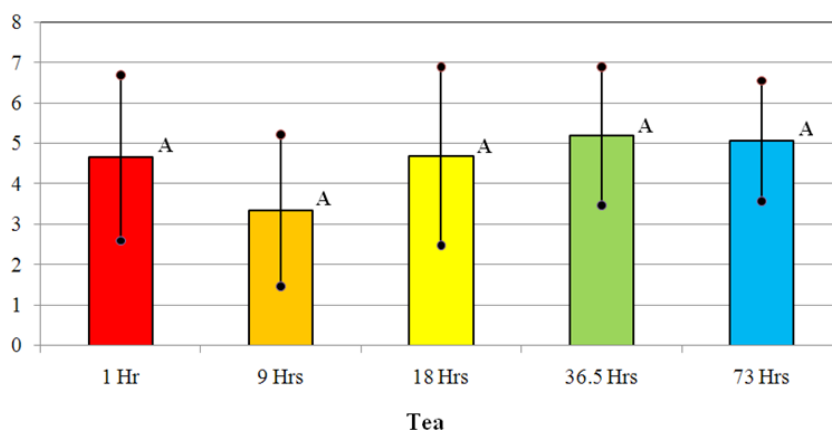Figure (12) : Mean ± SD and Duncan's multiple range test of color change ΔE for comparison among immer-sion time intervals for tea

The one way analysis of variance (ANOVA) as shown in (Table 3) demonstrated that there was no significant difference among immersion time intervals for different types of beverages (Artificial orange, Distilled water, Zamzam water, Natural orange, Cola, Coffee, and Tea).

Table (3) : Analysis of variance (ANOVA) for comparison of color change ΔE among different types of beverage

Time	SOV	SS	df	MS	F–value	p–value
Artificial Orange	Between Groups	19.596	4	4.899	0.818	0.526
	Within Groups	149.653	25	5.986		
	Total	169.249	29			
Distilled Water	Between Groups	17.346	4	4.337	1.513	0.229
	Within Groups	71.634	25	2.865		
	Total	88.980	29			
Zamzam	Between Groups	16.832	4	4.208	1.296	0.298
	Within Groups	81.167	25	3.247		
	Total	97.999	29			
Natural Orange	Between Groups	9.639	4	2.410	.613	0.657
	Within Groups	98.318	25	3.933		
	Total	107.957	29			
Cola	Between Groups	73.344	4	18.336	1.622	0.200
	Within Groups	282.618	25	11.305		
	Total	355.962	29			
Coffee	Between Groups	12.345	4	3.086	0.701	0.599
	Within Groups	110.121	25	4.405		
	Total	122.466	29			
Tea	Between Groups	12.864	4	3.216	0.905	0.476
	Within Groups	88.797	25	3.552		
	Total	101.661	29			

SOV: Source of variance; SS: Sum of squares; MS: Mean square; df: Degree of freedom.

To measure color changes of highly impact resin, color change (ΔE) comparison between control group (without immersion) and other groups was shown in (Table 4).

Table (4) : Color change ∆E between control group and other beverage groups

Time	SOV	SS	df
	Artificial orange	2.71150214	Accepted
	Distilled water	2.21500900	Accepted
	Zamzam	2.19777261	Accepted
3 Hrs	Natural orange	3.40813775	Accepted
	Cola	5.97688046	Unaccepted
	Coffee	4.50446044	Unaccepted
	Tea	4.65746991	Unaccepted
	Artificial orange	2.48562833	Accepted
	Distilled water	2.91202986	Accepted
	Zamzam	4.21416931	Unaccepted
9 Hrs	Natural orange	3.25185107	Accepted
	Cola	3.09894761	Accepted
	Coffee	3.54181787	Accepted
	Tea	3.35132736	Accepted
	Artificial orange	4.39822064	Unaccepted
	Distilled water	3.79544411	Unaccepted
	Zamzam	3.94215295	Unaccepted
18 Hrs	Natural orange	4.40538591	Unaccepted
	Cola	1.93118071	Accepted
	Coffee	4.31372002	Unaccepted
	Tea	4.69303309	Unaccepted
	Artificial orange	4.27528225	Unaccepted
	Distilled water	4.35366683	Unaccepted
	Zamzam	3.02090021	Accepted
36.5 Hrs	Natural orange	4.68261597	Unaccepted
	Cola	1.99500953	Accepted
	Coffee	5.18020098	Unaccepted
	Tea	5.18997560	Unaccepted
	Artificial orange	3.98207094	Unaccepted
	Distilled water	3.90318768	Unaccepted
	Zamzam	2.76049099	Accepted
73 Hrs	Natural orange	4.25718138	Unaccepted
	Cola	1.90373758	Accepted
	Coffee	5.31700963	Unaccepted
	Tea	5.07440180	Unaccepted

* ∆E ≤ 3.7 color change accepted in vitro

Artificial orange, Distilled water, and Natural orange groups showed an accepted (∆E) values in vitro after (3 hrs, and 9 hrs) of immersion and then converted to unaccepted (∆E) values with increasing immersion time intervals (18 hrs, 36.5 hrs, and 73 hrs). The unaccepted (∆E) values associated with increasing immersion time might due to increase water sorption which affect the degree of color change[16] because water sorption develop some change in visual appearance[20]. The erosive activity of citric acid that present in Artificial orange juice (pH = 2.66) and natural orange juice (pH = 2.64) might play a role in increasing color change (∆E) with increasing immersion time intervals[23, 24].

Color change (ΔE) after immersion in coffee and tea showed unaccepted values at all immersion time intervals except at (9 hrs) of immersion were the values of ΔE (3,54 and 3, 35) for coffee and tea respectively. Generally, the unaccepted value of ΔE after immersion in coffee and tea might due to the discoloration effect of coffee and tea beverages and accumulated layers of stain from coffee and tea[25]. The unaccepted values of color change (ΔE) associated with coffee was agreement with Rejab study[16]. The unaccepted values of color change (ΔE) associated with tea was agreement with AlTahho study[14]. The unaccepted values of ΔE associated with coffee and tea were disagreement with the findings of imirzalioglu et al.,[11] who found that the color change (ΔE) of heat polymerized acrylic was accepts up to 30th days of storage in coffee and tea. The difference of findings of present research from Imirzalioglu et al., was due to the different strategy of test work between the two researches. In the present research the control group (without immersion) after deflasking, finishing and polishing while the control group in imirzalioylu et al., research was immersed in saliva. In addition to the difference in immersion time between the two researches. The immersion time in the present research up to 24 months while in Imizalioglu et al., research only up to one month.

The values of color change (ΔE) after immersion in Cola were accepted for all immersion time intervals except at (3 hrs) of immersion where ΔE was unaccepted, which might due to high acidity of Cola (pH = 1.84) that cause solubility of resin resulting in unaccepted color change and with increasing the immersion time, absorption might take place. The equilibrium between two processes of solubility and absorption might decrease the color change (ΔE) within accepted values(13).

The values of color change (ΔE) after immersion in Zamzam water was accepted (ΔE) after (3 hrs) of immersion and became unaccepted after (9 hrs, and 18 hrs) of immersion and with increasing immersion time intervals to (36.5 hrs, and 73 hrs) would return to accepted values. This behavior of color change associated with Zamzam water (pH = 7.92) differ from that color change (ΔE) associated with

distilled water (pH = 7.0) might due to the presence of metals, cations and anions in composition of Zamzam water[22].

CONCLUSIONS

Among beverages coffee and tea showed unaccepted value of ΔE at all immersion time intervals except at (9 hrs) while cola showed an accepted values of ΔE except at (3 hrs) of immersion where ΔE value was unaccepted.

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