https://doi.org/10.25130/tjds.2015.1.1

Tikrit Journal for Dental Sciences 1(2015)

Evaluation of Color Stability for Two Types of Denture Base Materials: Heat Cured Acrylic and Flexible Resin.

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Key words
Color stability, staining of denture, heat cure acrylic, Valplast thermoplastic resin.

Abstract

Commonly consumed beverages used by human being daily (Tea & Cola) caused external staining. This study is done to evaluate the color stability for two different types of denture base materials against this external staining caused by (Tea & Cola).

Sixty (60) samples were prepared, divided into two groups, 30 samples of heat cure acrylic material & 30 samples of flexible resin material (Valplast). Each group divided into three subgroups 10 samples in each, according to the type of staining solution that immersed in it, (synthetic saliva & tea), (synthetic saliva & Cola), and (synthetic saliva alone as a control). Tea & Cola were mixed with synthetic saliva in order to create intraoral environment to certain extent. Color measurement was made at Baghdad University, Collage of Engineering, using reflected spectrophotometer before immersion (at baseline) & after immersion, at intervals of (24 hours) & (1 week) respectively.

The result was a highly significant difference between, heat cure acrylic & flexible resin at baseline & the (flexible samples) were the higher value in discoloration than (heat cure acrylic samples) regardless the type of staining solution. Maximum discoloration was seen in (synthetic saliva & tea) solution for both denture base materials. Followed by (synthetic saliva & Cola) & (synthetic saliva alone) respectively.

Both denture base materials had a color changes after immersion in staining solution (tea, Cola & synthetic saliva). The color changes, for two materials, were increased with the increase of immersion time.

Introduction

Since the mid 1940s, most denture bases have been fabricated using poly methyl-methacrylate (PMMA) resins (1). It becomes an increasingly popular choice, due to its properties and ease of handling; though color stability is still controversial (2) (3), While the thermoplastic material for dental prosthesis were first introduced to dentistry in the end of 1959, rapid injection systems currently known as the flexible company introduced the first flexible thermoplastic which was a flour polymer (A Teflon type of plastic) (4) .The term thermoplastic implies that a polymer softens on heating and then hardens into the final shape upon cooling; this is a desirable property for an oral appliance because the final shape can be individualized for each case by using a study model (5).

Oral hygiene remains important even when some or all teeth have been replaced with

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removable dentures (6). It is generally recognized that dirty dentures may have undesirable effects on the patient oral health and ability to successfully wear dentures (7). Denture cleanser is essential to prevent malodor, poor aesthetics and the accumulation of stains, plague and calculus with its deleterious effects on the mucosa (8). Denture base materials and denture teeth collect deposits and stain in the same manner, as do natural teeth (9). Soft debris that clings to a denture can be removed easily by light brushing followed by rinsing. Hard deposits and stains such as those that occur from tea, coffee, cola and tobacco tars are much difficult to remove (10).

Crispin & Caputo in 1979 (11), studied the color stability of different types of materials. They found that methyl methacrylate material exhibited the least darkening, followed by ethyl methacrylate and another types of thermoplastic acrylic materials. In-spite of various studies being carried out to study the color changes of different provisional materials using different staining solutions, still the literature on color stability of these materials is limited (12). Thus, this study was directed to determine color stability for two different types of denture base materials (Heat cure acrylic & thermoplastic-flexible resins), after immersion in most commonly used staining solution (Tea, Cola & Synthetic saliva as control), to find out the most color stable between them.

Materials and Methods

Sixty (60) samples were prepared. They divided into two main groups according to the type of denture base material: 1st group: 30 samples of heat cure acrylic resin. Figure (1)-A

2nd group: 30 samples of thermoplastic (flexible) resin. Figure (1)-B

Each group was divided into three subgroups according to the type of staining solution that immersed in it, each subgroup consist of 10 samples: 10 samples immersion in synthetic saliva & tea, 10 samples immersion in synthetic saliva & cola, & 10 samples immersion in synthetic saliva only as control.

Mould Preparation: Metal mould made from a brass in the form of a rectangular. Figure (2)

The dimensions are (40 mm length, 20 mm width & 0.8 mm thickness); these dimensions are according to the spectrophotometer device, "Macbeth Color Eye 7000A" (Macbeth, USA)

Preparation of samples:

A- Preparation of the heat cured acrylic samples:

The conventional flasking technique for complete denture was followed in mould preparation. All material were mixed and manipulated according to manufactures instructions in each procedure, packing, curing till to the finishing, polishing & conditioning.

The 2 halves of the mould were coated with separating medium (cold mold seal) and allowed to dry biform investing them in the lower half of the flask which contain stone mix according to the manufacture instruction and allow setting. The patterns were inserted to one half of its depth. The set lower half was coated with separating medium and allowed dry and then the upper half of the flask was assembled and filled with stone mixture. After removal of the metal patterns the two halves of the mold were coated with a separating medium to be ready for packing with acrylic dough. Figure (3)

The mixed procedure was carried out in glass jar with clean metal spatula; mixture was then covered and left to second until it reached a consistency suitable for packing (dough stage).(13)

Packing for heat cure acrylic:-

The acrylic resin was packed in the late dough stage indicated by clean separation of resin from the walls of glass mixing jar. Acrylic resin dough was placed and the 2 halves were assembled and placed under the press with gradual application of pressure to allow even flow of the dough throughout the mould space, then the pressure was relieved. The flask was then opened and the over flowed material surrounding the mould space was removed with sharp knife. A second trial closure was preformed that the 2 halves of the flask were finally closed under pressure until metal to metal contact had

been established and left under press (20 bar) for 5 mints before clamping was done .(13)

Curing cycle of heat cure acrylic:-

Curing cycles were followed used water path, by use the rapid- cure method at 165f°for one hour and then boiled for half one hour. After completion and curing, the acrylic specimens were removed carefully from stone mold. (13)

Finishing, Polishing & conditioning:

All of the samples were carefully de-flask and cleaned flashes of hot cure acrylic were removed with acrylic bur. To get a smooth surface, all samples were finished by stone bur to remove all excessive materials for two minute with low speed 1500 rpm and low pressure then Tungsten carbide bur for two minute with low speed 1500 rpm and low pressure after that sand paper (120) grain size, for one minute with low speed 1500 rpm and low pressure with continuous water cooling. Figure (4) , finally the samples were polished for two minute with low speed 1500 rpm and low pressure . Polishing was accomplished by using bristle brush, (60 mm) diameter (Milano, Italy), and rag wheel with pumice, fine grade (QD, England), in lathe polishing machine. A gloss surface was obtained by using dental lathe using low speed (1500 rpm] with regard to continuous cooling with water to avoid overheating. (14)

B- Preparation and injection of flexible resin:

The conventional flasking technique for complete denture was followed in the mold preparation in the first part of flask then a major sprue with (2.5 mm) in diameter & (3cm) in length was attach to the middle of specimen. Or two minor sprues, (l.5 mm) in diameter, were attached to each other from one end and other end attached to the specimen **Figure (5).** Then the point that attach to the specimen must be removed & coated with a separated medium.

The upper half of the flask was placed in position and filled with stone mixtures and allowed to be hardened for(60) minutes the flask was put in boiling water for 5 minutes for wax elimination after that we put a separating medium (15). Then the flask was placed inside the special clamp in plastic injection machine. Care should be taken that the opening of the major sprue should meet the opening of the clamp. The machine of plastic injection is operated. The flask should stay hot in temperature (70-100) 0C on a special heater to avoid cooling of injection material during injection. When the temperature of machine is reach to (287) C° place the capsule of flexible acrylic inside the heater of machine for (12-15) minutes and began the procedure of injection of material with rapid pressure applied about (4.5) Bar by hydraulic press. (15)

All samples were finished by using: Stone bur to remove all excessive materials, Tungsten carbide bur, and Sand paper for two minute with low speed 1500 rpm and low pressure with continuous water cooling manually.

Polishing was accomplished by using bristle brush (60 mm) diameter (Milano, Italy), fine grade (QD, England), in lathe polishing machine with wet rag wheel. A gloss surface was obtained by using dental lathe using low speed (1500 rpm for two minutes. (14)

Preparation of Staining Solutions:

(Tea & Cola) solutions were mixed with synthetic saliva in order to create intraoral environment to certain extent. 250 ml test solution of tea & synthetic saliva was prepared in the ratio of 2:1. Tea solution was prepared using 150 ml of boiling distilled water, with tea bag, teaspoon of sugar, and teaspoon of powdered milk, immersed for 5 minute and then filtered through a filter paper (Tea caused the discoloration , milk &sugar are written here as details of materials &methods). **Figure (6)**

Similarly, test solution of Cola beverage & synthetic saliva, Figure (7) was prepared in the ratio of 2:1. And finally a sample of 250 ml of synthetic saliva was taken as control (16), Figure (8).

The synthetic saliva of Fusayama -Meyer type was the electrolyte solution chosen for testing in this study (17) (18). The composition of synthetic saliva in gm/l:

0.4 NaCl; 0.4 KCl; 0.795 NaCl2.2H20; 0.69 NaH2Po4; 1.0 Urea; 1000 ml distilled water.

The color measurement was made using reflectance spectrophotometer at baseline (before immersion), at intervals of 24 hours,

and 1 week, respectively. Immersion in staining solutions of synthetic saliva & tea for three times per day for ten minutes each, in synthetic saliva & Cola beverage for one time per day for ten minutes each, and synthetic saliva (control) for whole day(16). The sample was rinsed with the distilled water and then evaluated the color change. The same procedure was followed subsequently for next immersion period (1 week). Solution was changed on every dipping in order to use fresh solution each time (16). Descriptive Statistics was applied; mean and standard deviation were calculated for each variable, for each group. ANOVA test was applied to see significant difference among groups & T-test was applied to see the trend of different beverages within the group.

Results

The resultsindicated that the relationship among denture base materials, immersion solutions and immersion time which cannot be summarized through a series of simple additive relationships, and it is necessary to consider the particular combination of these three factors to obtain an assessment of color change. **Table (1) & Figure (10),** showed the first readings of (heat cure acrylic & flexible resin) samples, by using spectrophotometer (before immersion in any staining solutions). From the first sight to these numbers, the readings of flexible resin samples are more than those of heat cure acrylic samples, LSD showed highly significant between them.

The results in **table (2)** showed the readings of (heat cure acrylic samples) by spectrophotometer after immersion in staining solution (tea, Cola and synthetic saliva as a "control") at intervals 24 hours. The LSD appears that there are highly significant differences between tea & synthetic saliva, and significant differences between Cola & synthetic saliva and between tea & Cola. While the results associated with (Flexible resins samples) at the same intervals, appeared that there are significant differences between tea & synthetic saliva, and between tea & Cola. There were non-significant differences between Cola & synthetic saliva as shown in **table (3).**

The results in **table (4) & (5)** showed the readings of (heat cure acrylic) and (flexible resin) samples respectively after immersion in staining solutions for 1week. Highly significant differences appeared between synthetic saliva & both tea & Cola, & significant differences between Tea & Cola.

The results in **table (6), (7)** showed a compares between the two types of denture materials used in this study, after immersion in tea at two intervals (24 hours & 1week) respectively, While the results in **table (8), (9)** showed a compares between these materials after immersion in **Cola** at the same intervals**.**

Tables (10, 11, 12, and 13) showed the effect of immersion time on the samples.

Table (10 & 11) showed the results of flexible samples, while **table (12, 13**) showed the results of heat cure acrylic samples. In all tables there are highly significant differences between the two intervals.

Discussion:

According to the types of denture materials:

The results showed that both types of denture materials used in this study had color changes after immersion in staining solution. These are because; denture base materials and denture teeth collect deposits and stain in the same manner, as doing natural teeth. Soft debris that clings to a denture can be removed easily by light brushing followed by rinsing. Hard deposits and stains such as those that occur from tea, coffee, cola and tobacco tars are much difficult to remove. So stains are pigmented deposits result from the pigmentation of the colorless salivary pellicle and may be removed by polishing. The surface of the material possess a certain degree of porosity and surface roughness, and an organic mucin and inorganic salt matrix must be developed to increase the tenacity of the stain, which should be indicative of these found in the oral environment [(19)].

Porosity or a surface quality conducive to the accumulation of debris & lead to a significant discoloration [(11)] .This explained the results which showed highly significant differences between heat cure acrylic &

flexible resin. Staining of acrylic resins related to the chemico-physical properties of the resin & also to the patient habits. Fluid pigments from food, beverage, drugs and nicotine are deposited in the prosthetic appliances and restorations, especially on the acrylic resins, which are more porous than light activated resin, reinforced resins and hybrid resins [20].

The surface roughness of the flexible resin is more than that of heat cure acrylic resin. This is due to the finishing & polishing procedures that are important steps in the fabrication of heat cured acrylic resin dentures [21]. The role of finishing & polishing is crucial in reducing pigmentations [20]. It would seem that any efficient polishing treatment should produce a smooth surface, certainly on smooth surfaces absorption of proteins is likely to be reduced and cleaning would be facilitated [22].

According to the types of staining solutions:

A- Tea solution: Maximum discoloration was seen in (synthetic saliva & tea) solution for both two materials. That according to the results in **table (2, 3, 4, 5),** the tea solution was the solution that cause the most color changes for both heat cure acrylic & flexible resin. This is duo to the chief constituents of tea: - Inorganic constituents (K^+, Ca^{+2}, P^{+3}, Fe^{+2}, Mg^{+2}, S^{-2}, Al^{+3}, Na^+, Si^{+2}, Zn^{+2}, Cu^{+2} and F), Nitrogen compounds (a stimulant and diuretic caffeine), and Polyphenols which are the most important constitutions of tealeaf that occurring in tea as derivatives of gallic acid and cathechin. The best-known gallic acid derivatives are the tannins [23].

The stain is more likely composed of a combination of iron and components of the denatured salivary pellicle. So it appeared necessary to denature the salivary pellicle by tannic acid, organic acids or detergents to produce stains with iron [24]. This would explain why consumption of tannic acid would cause discoloration. Scotti et al. in 1997 [20], made an in vitro comparative evaluation of the color variation of acrylic resins for provisional prostheses. Auto-polymerized resin-specimens were immersed in synthetic saliva alone, synthetic saliva with tea and synthetic saliva with coffee, for periods of 20 and 30 days.

The resulting color changes were evaluated using a spectrophotometer and compared to the baseline, they concluded that all the solutions darkened all the specimens, darkening was found to be less in saliva and saliva with tea solutions produced the greatest darkening. Finally, Hanna & Al-Ameer in 1999 [25], confirm the previous results and concluded that tea caused more stain of acrylic resin specimens when compared to other solutions like saliva & distilled water.

B- Cola Solution: The results in **table (2, 3, 4, 5),** showed that Cola solution is also caused color changes for both hot cure acrylic & flexible resin but it is less than color changes caused by tea solution .This is because the color or pigments is one of the contents of Cola which are: Carbonated water, high fructose corn syrup, caramel, **color**, phosphoric acid, natural flavors, and caffeine content [26].

Later on, Yuodelis et al. in 1980 [27], immersed acrylic resins materials in Cola & other types of solution for up 1month. They reported that all materials showed perceptible color changes after immersion.

C- Synthetic saliva: The synthetic saliva of Fusayama-Meyer type was the electrolyte solution chosen for testing [17] [18], this is to resemble the composition of the normal saliva which is a mixture of water, proteins, electrolytes and mineral elements that constitute the saliva's pH and organic elements (mucin, Ig A) that constitute its biological properties [28]. The total solids of saliva may vary from 0.3 % up to 1.4 %. Saliva of 0.6 % total solids would contain about 0.4 % organic and 0.2 % inorganic material.

The chief organic constituent is a glycoprotein, mucin and the important constituent is salivary amylase. The other organic constituents include small amounts of albumin and globulin, urea and uric acid, and traces of thiocyanic acid. The inorganic constituents are K^+, Na^+, Ca^{+2}, Mg^{+2}, HCO3-, Cl-, $HPO4^{-2}$ [29]. Extrinsic discoloration may be caused by retention of colored substances in the

salivary pellicle or by chemical alterations of this organic integument [30].

In vitro spectrophotometric method, the modifying effect of saliva upon the staining of acrylic specimens by tea was determined and showed that there was a significant increase in the staining of specimens by tea pretreated with saliva when compared to specimens exposed to tea only and it was concluded that pellicle derived from salivary glycoprotein would to encourage stain formation [31]. These results were confirmed by Addy & Robert [32].

Hanna & Al-Ameer in 1999[25], found that acrylic specimens soaked in saliva for one hour twice daily then kept in tea solution for the rest of time showed highly significant differences from that soaked in distilled water. This mean that saliva caused increase in the staining of specimens when compared to distilled water.

According to the immersion time:

Color changes of both materials were increased with the increase of immersion time. In this study, two intervals of immersion were employed, 24 hours & 1 week. The immersion for 24 hours is equivalent in time to 1 year of 4 minute daily use as described by El-Badrawy et al. [33]. And the color changes normally increase at intervals (1 week) with increasing of dipping time because of increasing of exposure of the materials to the staining solutions. Both the concentration of the staining agents and the period of exposure may affect the degree of pigmentation [34] [20].

Extrinsic discoloration may be caused by retention of colored substances in the salivary pellicle or by chemical alterations of this organic integument [35]. It was indicated that the salivary pellicle is a - thin, structure less, organic layer formed by a selective adsorption of glycoprotein from saliva. The amount of these discolorations was increase with the increase of exposure of salivary pellicle to the colored agent. [36]

Conclusions:

1- There was a highly significant difference between heat cure acrylic & flexible resin at baseline. Both of them, had color changes after immersed in staining solution and the (flexible resins samples) were the higher value in discoloration than (heat cure acrylic resin samples) regardless the type of staining solution.

2- Maximum discoloration was seen in (synthetic saliva & tea) solution for both two materials. Followed by (synthetic saliva & Cola) & (synthetic saliva alone) respectively.

3- The color changes of both materials were increased with the increase of immersion time.

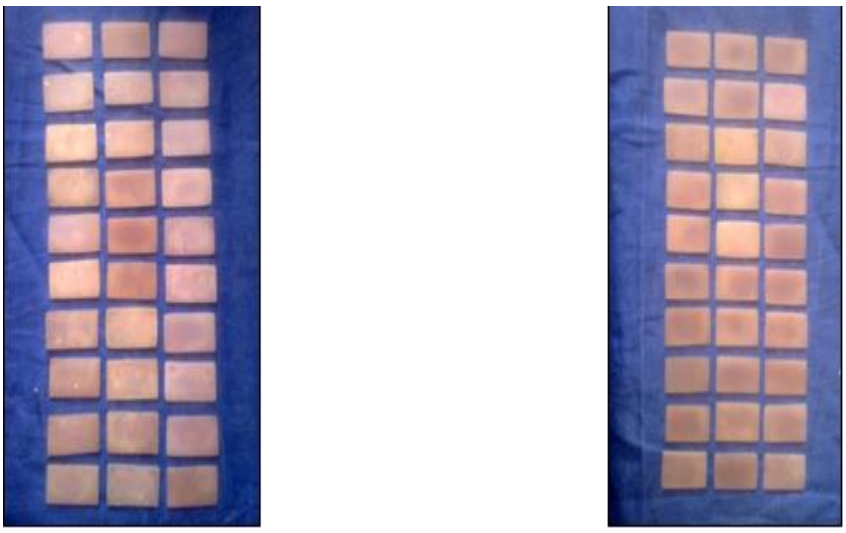

Figure (1): Samples used in this study.
A- 30 samples of heat cure acrylic resin.
B -30 samples of flexible resin.

Figure (2): Mold used in this study

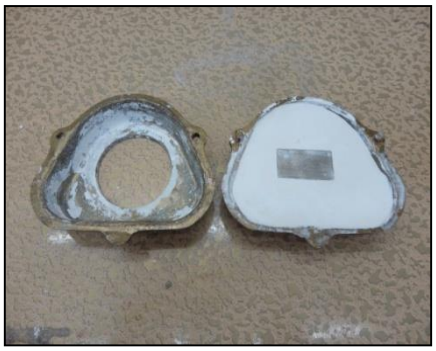

Figure (3): The patterns were inserted to one half of its depth.

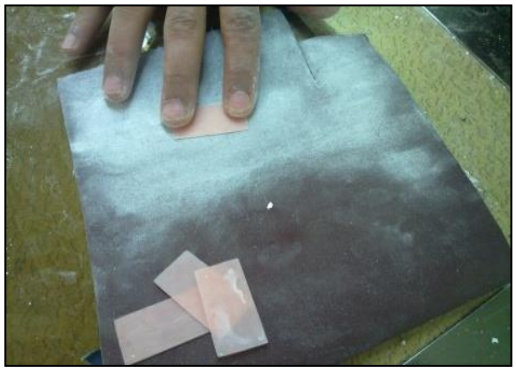

Figure (4): Finishing of the samples.

A **B**

Figure (5): A- A major sprue attach to the middle of specimen.
B- Two minor sprues attached to each other from one end and other end attached to the specimen

Figure (6): Test solution of tea & synthetic saliva.

Figure (7): Test solution of Cola & synthetic saliva.

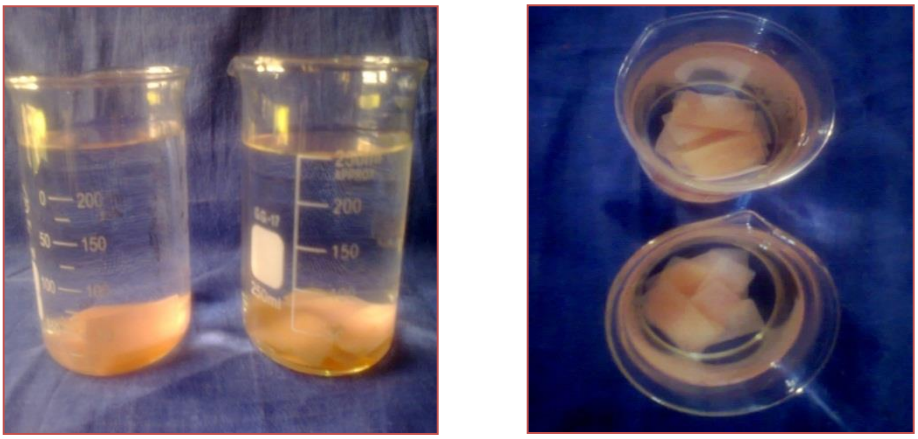

Figure (8): 10 Samples of heat cured acrylic & 10 samples of flexible resin are immersed in synthetic saliva alone as a control.

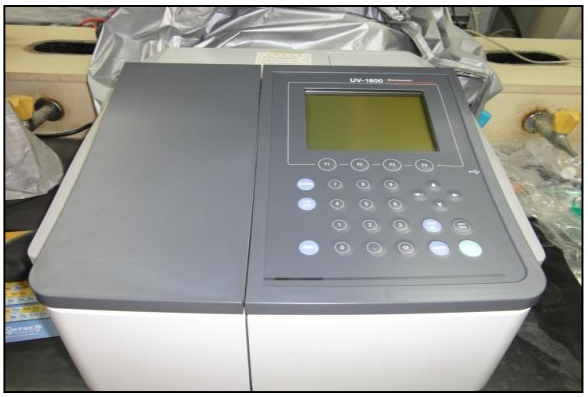

Figure (9): Spectrophotometer Devise

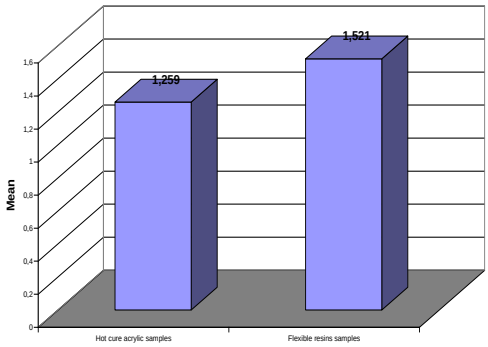

Figure (10): Histogram shows the mean of the optical density of (heat cure acrylic & flexible resin), by using spectrophotometer (before

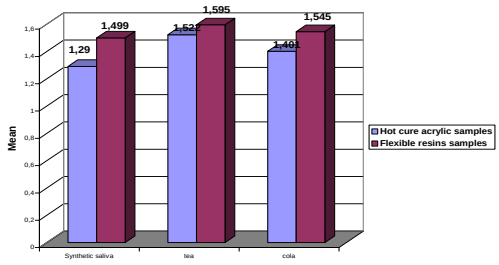

Figure (11): Histogram shows the mean of the optical density of (heat cure acrylic samples &flexible resin samples) by spectrophotometer after immersion in staining solution (tea, Cola and synthetic saliva) at intervals 24 hours.

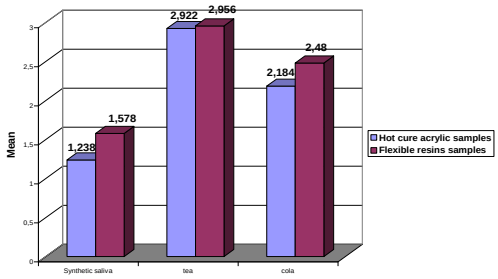

Figure (12): Histogram for the mean of the optical density of the samples after immersion at intervals 1week.

Table (1): Original data represent the first readings of (heat cure acrylic & flexible resin) samples, by spectrophotometer before immersion.

Heat cure acrylic sample						Flexible resins samples					
N	Read-ing	N	Read-ing	N	Read-ing	N	Read-ing	N	Read-ing	N	Read-ing
1	1.381	11	1.336	21	1.255	1	1.498	11	1.503	21	1.466
2	1.046	12	1.219	22	1.310	2	1.597	12	1.579	22	1.406
3	1.284	13	1.262	23	1.443	3	1.486	13	1.540	23	1.519
4	1.218	14	1.202	24	1.321	4	1.523	14	1.601	24	1.563
5	1.310	15	1.382	25	1.122	5	1.477	15	1.546	25	1.563
6	1.201	16	1.114	26	1.388	6	1.445	16	1.479	26	1.579
7	1.255	17	1.228	27	1.037	7	1.597	17	1.547	27	1.406
8	1.157	18	1.113	28	1.305	8	1.515	18	1.516	28	1.574
9	1.336	19	1.293	29	1.287	9	1.543	19	1.416	29	1.562
10	1.264	20	1.443	30	1.284	10	1.433	20	1.576	30	1.539

T-test=12.48
P<0.01 highly significant

Table (2): Readings of (heat cure acrylic samples) by spectrophotometer after immersion in staining solutions (tea, Cola and synthetic saliva) at intervals 24 hours

Heat cure acrylic samples					
N	Synthetic saliva	N	tea	N	Cola
1	1.275	1	1.541	1	1.313
2	1.127	2	1.574	2	1.417
3	1.290	3	1.432	3	1.387
4	1.398	4	1.490	4	1.382
5	1.196	5	1.521	5	1.473
6	1.251	6	1.581	6	1.434
7	1.364	7	1.489	7	1.389
8	1.388	8	1.490	8	1.440
9	1.389	9	1.511	9	1.461
10	1.219	10	1.598	10	1.322

ANOVA TEST / F-test =23.388 / P<0.01 highly significant

LSD/ Solutions	P-value	Sig.
Synthetic Saliva & Tea	P< 0.01	HS
Synthetic Saliva & Cola	0.008	S
Tea & Cola	0.01	S

Table (3): Readings of (Flexible resins samples) by spectrophotometer after immersion in staining solutions (tea, Cola and synthetic saliva) at intervals 24 hours.

Flexible resins samples					
N	Synthetic saliva	N	tea	N	Cola
1	1.469	1	1.609	1	1.518
2	1.407	2	1.605	2	1.569
3	1.470	3	1.624	3	1.611
4	1.596	4	1.624	4	1.563
5	1.432	5	1.639	5	1.552
6	1.481	6	1.567	6	1.591
7	1.515	7	1.629	7	1.490
8	1.482	8	1.591	8	1.501
9	1.576	9	1.520	9	1.482
10	1.564	10	1.547	10	1.582

ANOVA TEST/ F-test=7.794/ P-value=0.036
P<0.05 Significant

LSD/ Solutions	P-value	Sig.
Synthetic Saliva & Tea	0.007	S
Synthetic Saliva & Cola	0.115	NS
Tea & Cola	0.019	S

Table (4): Readings of (heat cure acrylic samples) by spectrophotometer after immersion in staining solution (tea, Cola and synthetic saliva) at intervals 1week

Heat cure acrylic samples					
N	Synthetic saliva	N	Tea	N	Cola
1	1.120	1	2.978	1	1.707
2	1.199	2	2.691	2	2.695
3	1.290	3	2.998	3	2.115
4	1.215	4	3.000	4	1.672
5	1.345	5	2.934	5	1.693
6	1.242	6	2.794	6	2.491
7	1.351	7	2.991	7	2.649
8	1.228	8	2.912	8	2.390
9	1.127	9	3.000	9	2.107
10	1.251	10	2.930	10	2.313

ANOVA TEST/ F-test=11.513/ P<0.01
Highly significant

LSD/ Solutions	P-value	Sig.
Synthetic Saliva & Tea	P<0.01	HS
Synthetic Saliva & Cola	P<0.01	HS
Tea & Cola	0.01	S

Table (5): Readings of (Flexible resin samples) by spectrophotometer after immersion in staining solution (tea, Cola and synthetic saliva) at intervals 1week

Flexible resins samples					
N	Synthetic saliva	N	tea	N	Cola
1	1.455	1	2.995	1	2.266
2	1.410	2	2.813	2	2.581
3	1.507	3	3.000	3	2.682
4	1.581	4	3.000	4	2.530
5	1.722	5	3.000	5	2.482
6	1.701	6	2.959	6	2.670
7	1.805	7	3.000	7	2.394
8	1.508	8	2.835	8	2.412
9	1.513	9	3.000	9	2.306
10	1.541	10	2.936	10	2.220

ANOVA TEST/ F-test=32.122 / P<0.01
Highly significant

LSD/ Solutions	P-value	Sig.
Synthetic Saliva &Tea	P<0.01	HS
Synthetic Saliva & Cola	P<0.01	HS
Tea & Cola	0.021	S

Table (6): Comparison between samples of (heat cure acrylic (HCA) & flexible resin (F)) after immersion in tea for 24 hours (h)

N	1	2	3	4	5	6	7	8	9	10
HCA in tae/24 h	1.541	1.574	1.432	1.490	1.521	1.581	1.489	1.490	1.511	1.598
F in tea/24 h	1.609	1.605	1.624	1.624	1.639	1.567	1.629	1.591	1.520	1.547

T-test=2.972 / P-value=0.016 / P<0.05 / Significant

Table (7): Comparison between samples of (heat cure acrylic & flexible resin (F)) after immersion in tea for 1 week (W)

N	1	2	3	4	5	6	7	8	9	10
HCA in tae/1 W	2.978	2.691	2.998	3.000	2.934	2.794	2.991	2.912	3.000	2.930
F in tea/1W	2.995	2.813	3.000	3.000	3.000	2.959	3.000	2.815	3.000	2.936

T-test=1.415 / P-value=0.191 / P>0.05 Non significance

Table (8): Comparison between samples of (heat cure acrylic (HCA) & flexible resin (F)) after immersion in Cola for 24 hours

N	1	2	3	4	5	6	7	8	9	10
HCA in Cola/24h	1.313	1.417	1.387	1.382	1.473	1.434	1.389	1.440	1.461	1.322
F in Cola/24h	1.518	1.569	1.611	1.563	1.552	1.591	1.490	1.501	1.482	1.582

T-test=5.923 / p<0.01 / highly significant

Table (9): Comparison between samples of (heat cure acrylic (HCA) & flexible resin (F)) after immersion in Cola for 1week (W) .

N	1	2	3	4	5	6	7	8	9	10
HCA in Cola/1W	1.707	2.695	2.115	1.672	1.693	2.491	2.649	2.390	2.107	2.313
F in Cola/1W	2.266	2.581	2.682	2.530	2.482	2.670	2.394	2.412	2.306	2.220

T-test=2.161/ P=0.049/ Significant

Table (10): Comparison between samples of flexible resin (F), after immersion in tea for 24 hours & for 1week

N	1	2	3	4	5	6	7	8	9	10
F in tea/24h	1.609	1.605	1.624	1.624	1.639	1.567	1.629	1.591	1.520	1.547
F in tea/1W	2.995	2.813	3.000	3.000	3.000	2.959	3.000	2.835	3.000	2.936

T-test=55.39 / P<0.01 / highly significant

Table (11): Comparison between samples of (flexible resin) after immersion in Cola for 24 hours and for 1 week

N	1	2	3	4	5	6	7	8	9	10
F in Cola/24h	1.518	1.569	1.611	1.563	1.552	1.591	1.490	1.501	1.482	1.582
F in Cola/1W	2.266	2.581	2.682	2.530	2.482	2.670	2.394	2.412	2.306	2.220

T-test=20.53 / P<0.01 / highly significant

Table (12): Comparison between samples of (heat cure acrylic) after immersion in tea for 24 hours and for 1 week

N	1	2	3	4	5	6	7	8	9	10
HCA in tea/24h	**1.541**	**1.574**	**1.432**	**1.490**	**1.521**	**1.581**	**1.489**	**1.490**	**1.511**	**1.598**
HCA in tea/1W	**2.978**	**2.691**	**2.998**	**3.000**	**2.934**	**2.794**	**2.991**	**2.912**	**3.000**	**2.930**

T-test=31.3 / P<0.01 / highly significant

Table (13): Comparison between samples of (heat cure acrylic) after immersion in Cola for 24 hours and for 1week

N	1	2	3	4	5	6	7	8	9	10
HCA in Cola/24h	**1.313**	**1.417**	**1.387**	**1.382**	**1.473**	**1.434**	**1.389**	**1.440**	**1.461**	**1.322**
HCA in Cola/1W	**1.707**	**2.695**	**2.115**	**1.672**	**1.693**	**2.491**	**2.649**	**2.390**	**2.107**	**2.313**

T-test=6.376 / P<0.01 / highly significant

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