ECRONICON OPEN ACCESS

EC DENTAL SCIENCE
Research Article

Effect of Makkah City Local Beverages on Color Changes of Three Types of Denture Bases

Yousef Qasem Al-faifi[1]*, Faisal Fahad Asseri[1], Salim Saeed Alsolami[1] and Tamer Omar Ibrahim[2]

[1]*General Dentist, Umm-AL Qura University, Makkah, Saudi Arabia*

[2]*Professor of Prosthodontics, Umm-AL Qura University, Makkah, Saudi Arabia*

***Corresponding Author:** Yousef Qasem Al-faifi, General Dentist, Umm-AL Qura University, Makkah, Saudi Arabia.

Received: July 08, 2019; **Published:** July 26, 2019

Abstract

Aim: The aim of this study was to evaluate the effect of four local Makkah city beverages on the color changes of three types of denture base materials.

Materials and Methods: Ninety circular shaped samples were divided into the three main groups according to the type of denture base materials. Group 1: Thirty samples of heat cure acrylic resin Group 2: Thirty samples of cold cure acrylic resin and Group 3: Thirty samples of thermoplastic flexible resin. Each group will be immersed in staining solution. Shahee (black tea), Arabic coffee, Hibiscus, Sobya and distilled water.

Digital images of samples were taken after immersed in staining solutions. the color of samples were measured using CIE L*a*b* color system and color changes (ΔE) were calculated. All the data were collected, tabulated and statistically analyzed.

Results: The ΔE values of the staining solutions and its effect on the color changes of heat cure acrylic resin was significant ($P < 0.05$). The ΔE values of the staining solutions and its effect on the color changes of cold cure acrylic resin was non-significant ($P > 0.05$). The ΔE values of the staining solutions and its effect on the color changes of flexible acrylic resin was non-significant ($P > 0.05$). After comparing the ΔE values of heat cure acrylic resin, cold cure acrylic resin and flexible acrylic resin that were immersed in the staining solutions of this study showed statistical significance difference ($P < 0.05$).

Conclusions: Flexible acrylic resin had the highest color changes followed by cold cure acrylic resin, while the heat cure acrylic resin had the least color changes.

Keywords: *Denture Base; Color Changes; Heat Cure; Acrylic Resin; Thermoplastic; Flexible Resin*

Introduction

Heat cured and auto-polymerizing acrylic resins have been common materials of choice for denture bases. Many years, acrylic resin has been successfully used for denture base fabrication. It has many advantages, low cost, ease of manipulation adequate physical and mechanical properties, biocompatibility for patients, and satisfactory appearance [1]. However, these materials exhibit, over time, unsatisfactory characteristics such as hardness, loss of elasticity, abrasion, porosity, and color change [2].

The area has an impact on the people where they live far away from each other, where each region in Saudi Arabia has its culture and traditions for example, popular beverages in Makkah city like "sobyah" and hibiscus cold beverages, Arabian coffee and Shahee hot beverages which are popular drinks [3].

Color stability is an important property of denture base. Color changes indicate aging or damaged dental materials according the color change of a polymeric material may be caused by intrinsic and extrinsic factors. Intrinsic factors involve resin discoloration itself and matrix changes [4], occurring during the aging process of the material due to many physical and chemical conditions. Furthermore, extrinsic factors such as thermal changes, stain accumulation, artificial dyes used in food, drink, cleaning procedures, and handling by the patient can also cause discoloration. It has been mentioned that thermocycling and contact with mouthwashes influence the color change of resin [5]. Thus, oral hygiene, eating and drink habits must be considered in order to preserve most of the acrylic resin properties, such as color stability, hardness, flexibility and durability, among others. For example, hygiene and habits have been correlated to the color stability of acrylic resins [6]. However, little is known regarding the color stability of acrylic resin-based dentures that have been in contact with eating, drink and mouthwashes. However, little information is available on the influence of denture cleaners on the color stability of acrylic resins [7]. The aesthetic appearance of a prosthesis is certainly an important feature required by patients and must satisfy their expectations. Thermoplastic resins have many advantages over the conventional powder-liquid systems [8]. They provide excellent esthetics with tooth or tissue colored materials and are very comfortable for the patient. These are very stable, resist thermal polymer, have high fatigue endurance, high creep resistance, excellent wear characteristics and solvent resistance. They are non-porous so no growth of bacteria, color resistance and even if it is non-porous, it still retains a slight amount of moisture to keep it comfortable against gums. These include thermoplastic Nylon (polyamide), thermoplastic acetal, thermoplastic acrylic and thermoplastic polycarbonate [9].

Materials and Methods

This *in-vitro* study was conducted at Faculty of Dental Medicine, Umm Al-Qura University in the holly city Makkah Al Mokarmh in kingdom of Saudi Arabia.

Grouping

Ninety circular shaped samples were divided into the three main groups according to the type of denture base materials:

- **Group 1:** Thirty samples of heat cure acrylic resin (ECO-CRYL HOT, Protechno company, spain) (Figures 1),

Figure 1: *Heat cure denture base material.*

- **Group 2:** Thirty samples of cold cure acrylic resin (ECO-CRYL COLD, Protechno company, spain) (Figures 2) and

Figure 2: *Cold cure denture base material.*

- **Group 3:** Thirty samples of thermoplastic flexible resin (VERTEX THERMOSENS, Vertex company, Germany) (Figures 3).

Figure 3: *Flexible denture base material.*

Each group will be immersed in staining solution. Shahee solution (black tea) (SH) (Rabee company, Saudi Arabia), Arabic coffee solution (AC) (Alkahir company, Saudi Arabia), Hibiscus solution (HP) (AlNaser company, Saudi Arabia), Sobya solution (SB) (Alkhudary factory, Saudi Arabia) and distilled water (Figure 4).

Figure 4: *Staining components.*

Sample fabrication

Thermoplastic flexible resin sample is made by using Injection Molding Machine (Vertex Thermojector 22, Germany) (Figure 5). By using special flask that's used for injection technique which consist of two parts upper and lower half fixed by 4 screws that should be tightened well in use, in the upper half there is a hole at the top which used to pour the second layer of dental stone. First step preheated the cylinder of machine to 290°C in 8 minutes then Vertex thermosens material cartridge was inserted in the cylinder and put the flask in it's position inside the machine, started the machine injection procedure under pressure of 6.5 bar at 290°C which need 18 minutes, when the program finished the flask removed from the machine (Figure 6).

Figure 5: *Thermojector 22 injection molding machine.*

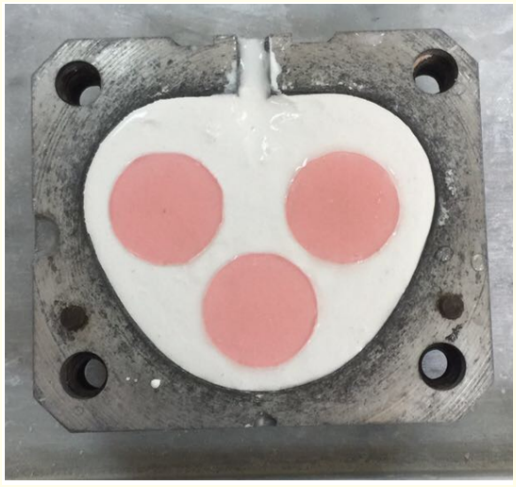

Figure 6: *Flasking of flexible samples.*

Heat and cold acrylic denture base material group were invested in flask with dimensions (20 mm in diameter and 3 mm in thickness) supported by dental stone and fabricated according to the manufacturer's instructions. Specimens were checked visually and removed from analysis if any void was identified.

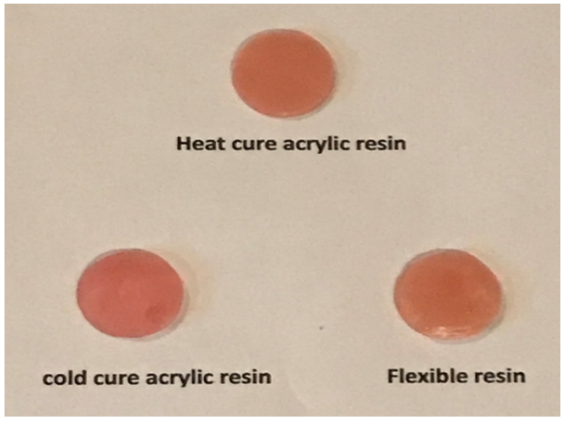

Figure 7: *One sample from each material.*

Preparation of staining solutions

Hot beverages:

1- Shahee solution (SH), one bag (3 grams) of tea was left for two minutes in 800 ml distilled boiling water. The solution was then allowed to cool. Fresh shahee was made for each specimen. The specimen will be immersed in shahee for two hours and then tested dry.

2- Arabic coffee solution (AC), (3 grams) one spoon coffee was left for two minutes in 800 ml distilled boiling water. The solution was then allowed to cool. Fresh coffee was made for each specimen. Coffee immersion time for two hours and then tested dry.

Cold beverages:

1. Hibiscus solution (HP), one bag of Hibiscus (3 grams) was left for two minutes in 800 ml distilled boiling water. The solution was then allowed to cool. Fresh hibiscus was made for each specimen. Hibiscus immersion time for two hours and then tested dry.
2. Sobya solution (SB), which is a mixture of (50 grams barley, 50 grams brown bread, 5 grams cinnamon, 5 grams cardamom,). Fresh sobya was made for each specimen. Sobya immersion time for two hours and then tested dry.
3. Distilled water (as a control) for each specimen. immersion time for two hours and then tested dry (Figure 8).

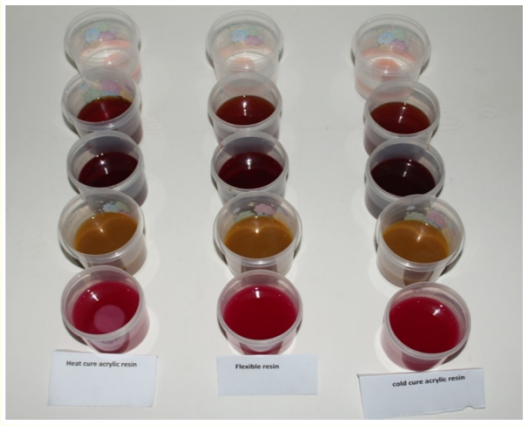

Figure 8: *Immersed samples in staining solutions.*

Digital photography

Photos were taken at a shutter speed of 1/100 s, F:10 and ISO = 12000 Used a digital camera (Canon D70), at distance of 40 cm from each specimen. A camera and tripod was used to stabilize distance between camera and specimens (Figure 9). Photos were saved in TIFF format. In order to standardize the photo conditions. The angle between the lens and the light source was 90°. Standard white photographic paper was placed adjacent to the specimens to calibrate the photos and eliminate the camera and environmental conditions.

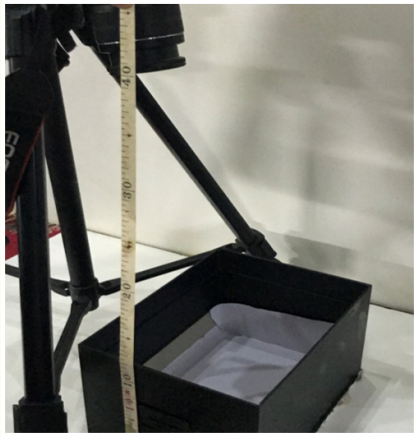

Figure 9: *Placement of camera, tripod and sample in box.*

Color assessment

The CIE L*a*b* color system (Photoshop software, version 11, USA) is a 3-D color space having 3 axes: L, a, and b. The advantages of the CIE L*a*b* system is that color differences can be expressed in units that can be related to visual perception and clinical significance.

The middle one third of each specimen was selected with a freestyle drawing instrument in Photoshop software (CS4) to determine the average a*, b*, and L* (Figure 10).

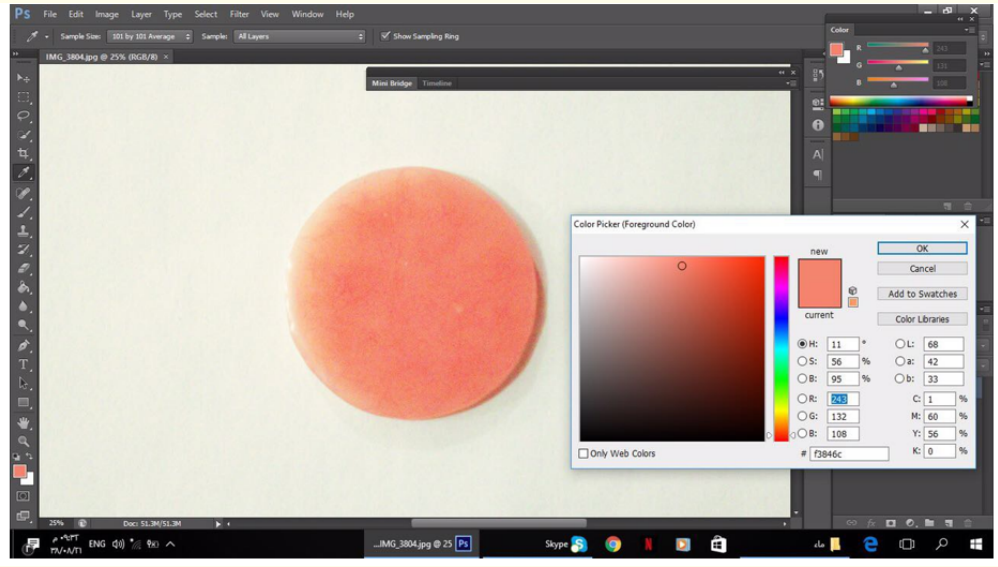

Figure 10: *Photoshop software (CS4) to determine the average a*, b*, and L*.*

The color difference (ΔE), before and after immersion in solution, was calculated for each specimen using the following formula:

$\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}$

Statistical analysis

All the data were collected, tabulated and statistically analyzed. Data were presented as means and standard deviations (SD). One-way ANOVA was used for comparison between the mean values of the tested groups. Independent T-Test was used for pair-wise comparison between the means when ANOVA test was significant. The significance level was set at 0.05. Statistical analysis was performed with IBM SPSS statistics version 23 (Statistical Package for Scientific Studies) for Windows.

Results and Discussion

The ΔE values of the staining solutions and its effect on the color changes of heat cure acrylic resin

The minimum, maximum, mean, standard deviation and P values for heat cure acrylic resin after stored in the staining solutions are shown in table 1.

Material	Solutions	Minimum Values	Maximum values	Mean values	Std. Deviation	P value
Heat cure acrylic resin	SH	2	7	4	5.03736	
	AC	9	12	9.75	3.35203	
	SB	13	16	14.5	8.01864	
	HB	2	6.5	3.8	2.61539	
	Distilled water	0.22	0.42	0.28	0.32222	P = 0.047

Table 1: *The minimum, maximum, mean, standard deviation and P values for heat cure acrylic resin.*

By using One way ANOVA to determine the effect of staining solutions on heat cure acrylic resin. The results indicate that there is a significant difference ($P < 0.05$) between solutions on color change of heat cure acrylic resin.

The influence of solutions on the color changes of heat cure acrylic resin was found that the greatest color change was observed in sobya followed by Arabic coffee, Hibiscus, and the lowest color change was shahee. No influence of distilled water on color change in heat cure acrylic resin as shown in histogram (Figure 11).

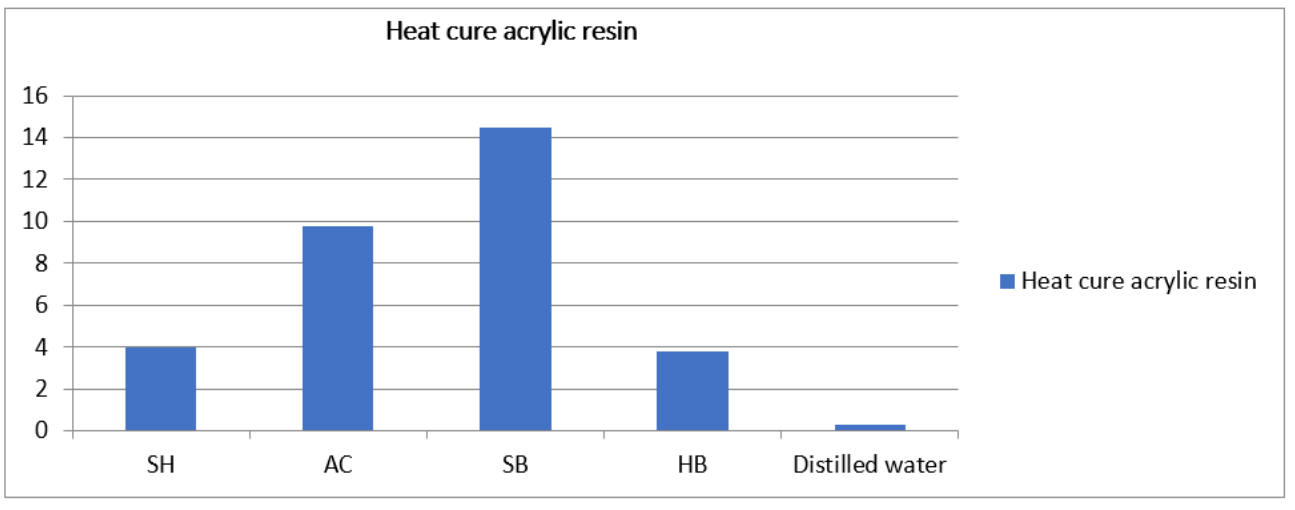

Figure 11: *Histogram show the ΔE values of the staining solutions and its effect on the color changes of heat cure acrylic resin.*

The ΔE values of the staining solutions and its effect on the color changes of cold cure acrylic resin

The minimum, maximum, mean, standard deviation and P values for cold cure acrylic resin after stored in the staining solutions are shown in table 2.

By using One way ANOVA to determine the effect of staining solutions on cold cure acrylic resin. The results indicate that there is no significant difference ($P > 0.05$) between solutions on color change of cold cure acrylic resin.

Material	Solutions	Minimum Values	Maximum values	Mean values	Std. Deviation	P value
Cold cure acrylic resin	SH	10.5	14.5	12.5	7.20830	P = 0.228
	AC	12	19	17.75	5.77144	
	SB	12	18	16	6.01625	
	HB	17	21	13.25	9.04853	
	Distilled water	0.35	0.61	0.43	0.43433	

Table 2: *The minimum, maximum, mean, standard deviation and P values for cold cure acrylic resin.*

The influence of solutions on the color changes of cold cure acrylic resin was found that the greatest color change was observed in arabic coffee followed by sobya, Hibiscus, and the lowest color change was shahee. No influence of distilled water on color change in cold cure acrylic resin as shown in histogram (Figure 12).

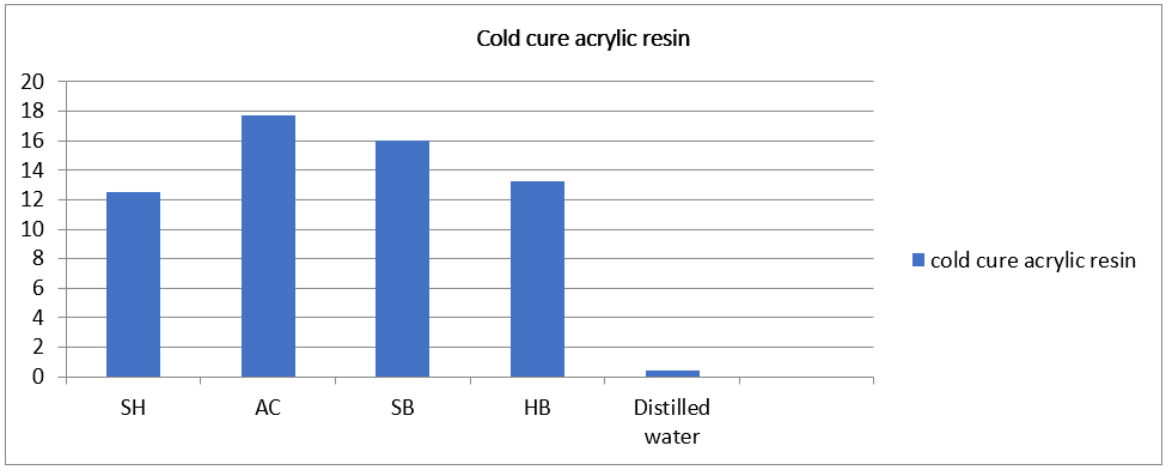

Figure 12: *Histogram show the ΔE values of the staining solutions and its effect on the color changes of cold cure acrylic resin.*

The ΔE values of the staining solutions and its effect on the color changes of flexible acrylic resin

The minimum, maximum, mean, standard deviation and P values for flexible acrylic resin after stored in the staining solutions are shown in table 3.

Material	Solutions	Minimum Values	Maximum values	Mean Values	Std. Deviation	P value
Flexible acrylic resin	SH	9.5	20	13.8	8.40683	P = 0.846
	AC	12	20.5	15.8	5.66144	
	SB	11	22	18.25	4.21523	
	HB	12	21	17	4.04753	
	Distilled water	0.40	0.65	0.52	0.54421	

Table 3: *The minimum, maximum, mean, standard deviation and P values for flexible acrylic resin.*

By using One way ANOVA to determine the effect of staining solutions on flexible acrylic resin. The results indicate that there is no significant difference (P > 0.05) between solutions on color change of flexible acrylic resin.

The influence of solutions on the color changes of flexible acrylic resin was found that the greatest color change was observed in sobya followed by Arabic coffee, Hibiscus, and the lowest color change was shahee. No influence of distilled water on color change in flexible acrylic resin as shown in histogram (Figure 13).

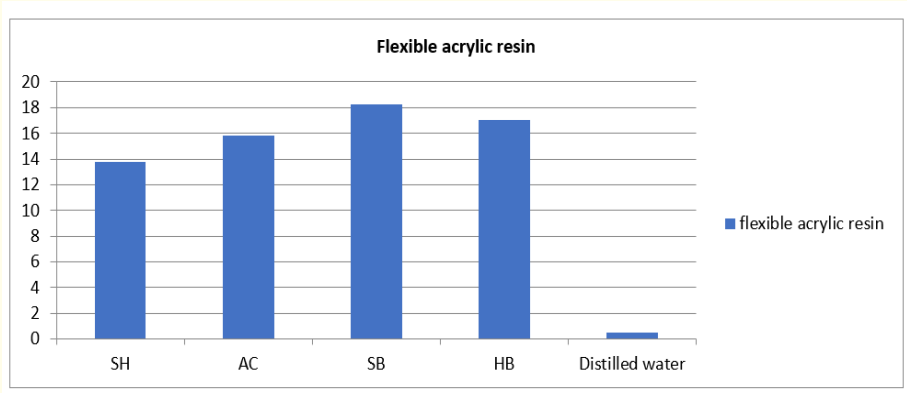

Figure 13: *Histogram show the ΔE values of the staining solutions and its effect on the color changes of flexible acrylic resin.*

Comparing the ΔE values of the staining solutions and its effect on the color changes in the three groups

Comparing the minimum, maximum, mean, standard deviation for the three groups after stored in the staining solutions and the significant difference (P values) shown in table 4.

Materials	Solutions	Minimum Values	Maximum Values	Mean Values	Std. Deviation	P value
Heat cure acrylic resin	SH	2	7	4	5.03736	P = 0.040
	AC	9	12	9.75	3.35203	
	SB	13	16	14.5	8.01864	
	HB	2	6.5	3.8	2.61539	
	Distilled water	0.22	0.42	0.28	0.32222	
Cold cure acrylic resin	SH	10.5	14.5	12.5	7.20830	
	AC	12	17	13.25	5.77144	
	SB	12	18	14.5	6.01625	
	HB	17	21	17.75	9.04853	
	Distilled water	0.35	0.61	0.43	0.43433	
Flexible acrylic resin	SH	9.5	20	13.8	8.40683	
	AC	12	20.5	15.8	5.66144	
	SB	11	22	18.25	4.21523	
	HB	12	21	17	4.04753	
	Distilled water	0.40	0.65	0.52	0.54421	

Table 4: *The minimum, maximum, mean, standard deviation and P values for the three groups.*

After comparing the ΔE values of heat cure acrylic resin, cold cure acrylic resin and flexible acrylic resin that were immersed in the staining solutions of this study were summarized in figure 14.

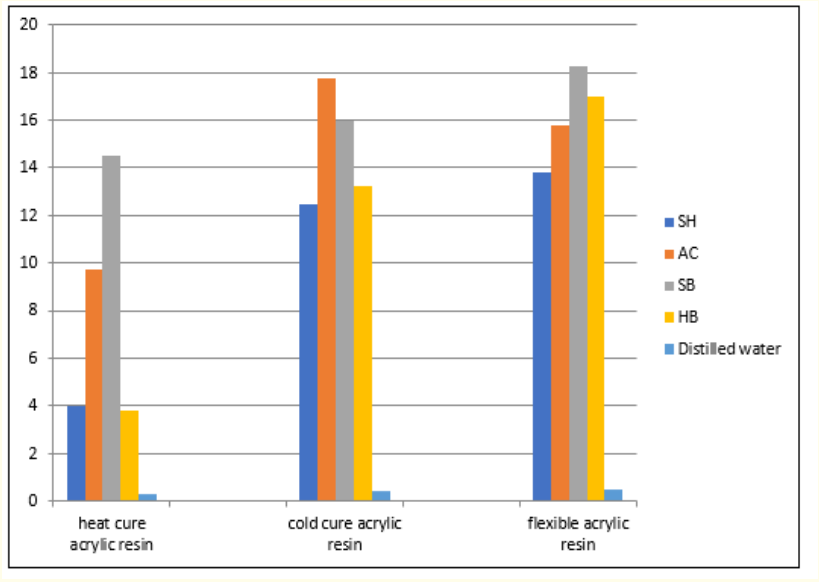

Figure 14: *Histogram shows the significant difference of the ΔE values of the staining solutions and its effect on the three groups.*

By using Tukey honestly significant difference (HSD) multiple comparison tests indicate that ΔE values showed statistical significance difference ($P < 0.05$). Flexible acrylic resin had the highest color changes followed by cold cure acrylic resin, while the heat cure acrylic resin had the least color changes.

Discussion

An increased awareness of esthetics in dentistry has led to the need of removable partial dentures (RPDs) that reveal little or none of the metal supporting structures or retentive elements. The indication of more esthetic materials without metallic support such as flexible resins is limited due to the lack of information provided by manufacturers or literature regarding alterations in chromatic stability and microhardness.

The results showed that all of types of denture materials used in this study had color changes after immersion in staining solution. These are probably because; denture base materials and denture teeth collect deposits 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 sobya, Arabic coffee, shahee and Hibiscus are much difficult to remove. 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.

Porosity or a surface quality conducive to the accumulation of debris and lead to a significant discoloration. This explained the results which showed significant differences between (flexible resin, cold cure acrylic resin) and (heat cure acrylic resin).

Our result agree with Aysan L., *et al*. that evaluated flexible denture base material and polymethylmethacrylate base materials when kept in different solution taken intraorally. It was concluded that flexible denture base material was more stained than the polymethylmethacrylate base materials [10]. also agree with Sagsoz NP., *et al*. that concluded Polyamid (flexible) showed a greater color change compared to polymethylmethacrylate, especially in the coffee solution for 7 days. The color change of polyamide denture base materials was increased with time of storage. Furthermore, color measurements can be affected by surface reflections, inside diffusion and absorption in the specimens and the background [11].

In the present study the influence of solutions on the color changes of denture base materials was found similar. The greatest color change was observed in sobya followed by Arabic coffee, Hibiscus, and the lowest color change was shahee.

Bayındır F., *et al*. found that methyl methacrylate resin provisional materials were more color stable than autocured bis-acryl provisional materials [12].

Our result is in disagreement with many authors who demonstrated that the specimen of heat cured acrylic resin immersed in the coffee solution, produced higher discoloration than those immersed in tea solution due to discoloration of resin-based materials by tea, this was mainly due to surface adsorption of the colorants, while discoloration by coffee was due to adsorption, and absorption of colorants resin materials.

However, flexible resin seems to be more susceptible to discoloration by staining liquids compared to heat and cold acrylic resin. On the other hand, Omata S., *et al*. has been proven that adequate oral hygiene and professional care can substantially reduce the problem of staining [13].

Conclusion

Flexible acrylic resin had the highest color changes followed by cold cure acrylic resin, while the heat cure acrylic resin had the least color changes.

Bibliography

1. Guang H., *et al*. "Influence of denture cleansers on the color stability of three types of denture base acrylic resin". *Journal of Prosthetic Dentistry* 101.3 (2009): 205-213.
2. Goiato M., *et al*. "Color change of soft denture liners after storage in coffee and coke". *Gerodontology* 28.2 (2011): 140-145.
3. Al-Mukhtar R., *et al*. "Sobyah, a traditional Hejazi Ramadan drink". Arab News (2013): 7-17.
4. Robinson J., *et al*. "Denture bases: the effects of various treatments on clarity, strength and structure". *Journal of Dentistry* 15.4 (1987):159-165.
5. Imirzalioglu P., *et al*. "Color stability of denture acrylic resins and a soft lining material against tea, coffee, and nicotine". *Journal of Prosthodontics* 19.2 (2010): 118-124.
6. Oguz S., *et al*. "Color change evaluation of denture soft lining materials in coffee and tea". *Dental Materials Journal* 26.2 (2007): 209-216.
7. Goiato M., *et al*. "Effect of accelerated aging on the microhardness and color stability of flexible resins for dentures". *Brazilian Oral Research* 24.1 (2010): 114-119.

8. Heydecke G., *et al*. "Oral and general health-related quality of life with conventional and implant dentures". *Community Dentistry and Oral Epidemiology* 31.3 (2003): 161-168.

9. Makila E., *et al*. "Clinical study of a heat-cured silicone soft lining material". *Journal of Oral Rehabilitation* 6.2 (1979): 199-204.

10. Aysan I., *et al*. "Comparison of the Color Stability of Three Different Base Materials in the Different Solutions". *The Journal of Dental Faculty of Atatürk University* 21 (2011): 219-225.

11. Sagsoz N., *et al*. "Color Changes of Polyamid and Polymethyl Methacrylate Denture Base Materials". *Open Journal of Stomatology* 4 (2014): 489-496.

12. Bayındır F., *et al*. "The Effect of Staining Solutions on the Color Stability of Provisional Prosthodontic Materials". *Journal of Dentistry* 40.2 (2012): 41-46.

13. Omata S., *et al*. "Staining of hybrid composites with coffee, oolong tea, or red wine". *Dental Materials Journal* 25.1 (2006): 125-131.

Volume 18 Issue 8 August 2019