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Comparison Between Bio-star Sheets and Heat Cured Acrylic Resin in terms of Surface Hardness and Surface Roughness

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Abstract

Introduction: Duran foil is a type of bio-star foils which utilized in splint therapy as a supernumerary material to acrylic resins. Prosthodontists frequently wish to fabricate and deliver a splint shortly instead of having them made up in a dental lab when treating patients with tempromandibular joint disorders.

Aims: compare the hardness and roughness of bio-star sheets and acrylic resins after immersion in tea, coffee, and Pepsi for 15 days. Materials and methods

80 samples were fabricated in total. 40 acrylic samples constructed using plastic patterns (65mm length X 10 width X 2.5mm thickness). The other 40 were made from Duran sheets using a bio-star device. Then samples were immersed in coffee, tea and Pepsi for 15 days. Surface hardness and roughness tests were conducted using a shore D hardness tester and TR220 portable roughness tester. Data were analyzed using SPSS *v* 24 and comparisons were made using ANOVA and Tukey tests.

Results: there was an increase in the roughness of acrylic groups compared to bio-star groups. The ANOVA test revealed significant differences (P <0.05) among groups. Regarding hardness, there was an increase in the hardness of acrylic in comparison to bio-star groups. Furthermore, ANOVA test showed significant differences (P <0.05) among groups.

Conclusion: Acrylic samples had a higher hardness than bio-star samples. Acrylic samples had a rougher surface than bi-ostar. Acrylic resins are considered the preferred material for removable orthodontic retainers because of their outstanding mechanical properties. It is recommended to assess other mechanical properties such as tensile strength.

Introduction:

Poly methyl methacrylate is a great organic biocompatible polymeric material to create denture bases. It was originally used to produce dentures in 1937 because of its superior mechanical and physical properties, and it has since become the preferred material [1,2]. PMMA has several advantages, including color similarity to real gum, excellent chemical retention with prosthetic teeth, ease of manipulation, and repairable [3]. PMMA lacks enough mechanical strength and surface hardness when used alone. Furthermore, a significant impact event or a patient biting down with a lot of force might easily fracture it [4,5]. Because of several issues with its mechanical assets, involving the hardness, flexural strength, and impact strength [6-7], there are still many issues with this content. To enhance the attempts to produce (PMMA) material stronger and more useable, several additive techniques were employed, such as fibers of various kinds, such as polyester, glass fibers, and polypropylene fibers in varied lengths and concentrations [8,9]. Other efforts concentrated on the use of nanoparticles such as titanium oxide, aluminum oxide and silica in different quantities [10-13].

In place of heat-curable acrylic, another hard-elastic, abrasion-resistant, and unbreakable substance known as Duran® is used for all purposes in splint therapy. A bite splint is typically composed of composite or acrylic, that covers the incisal and occlusal surfaces of the teeth in the upper or lower jaw. While soft acrylic and light-cured composite are other alternatives, heat-cured acrylic is used to make most current splints [14-15].

As an occlusal splint, Duran®, a kind of Bio-star foil occlusal splint, is utilized. Generally speaking, occlusal splints can be formed from a number of materials and can completely or partially cover the mandible or maxilla. Acrylic resins are reasonably robust materials that may be used as night guards since they are versatile and long-lasting. Another choice are vacuum-formed vinyl splints, although they have serious disadvantages [16]. Research revealed that various staining agents had an impact on the physical and mechanical characteristics of various retainer substances such as light transmittance, flexural modulus, and surface roughness [17-19]. This research assessed to compare the Bio-star sheets and heat acrylic resin in terms of hardness and roughness after staining in tea, coffee, and Pepsi for 15 days.

Materials and methods

Sampling

In this study,80 samples (length=65mm, width=10 mm, and thickness=2.5mm) were prepared and divided into 2 groups. 40 samples were made from heat cure acrylic resin(AARC DENTAL , India) and the other 40 were constructed from bio-star sheets(Scheu, Germany).

Heat-cure Specimen Preparation

Heat-cure samples were constructed using plastic strips(65mm length X 10 width X 2.5mm Thickness) for surface hardness and roughness [20]. The lower portion of the dental flask was coated with Vaseline, and then filled with dental stone according to the manufactured instructions (i.e., 30ml/100mg), After the stone had set, the stone surface was coated with a separating medium (Figure 1). Next, the upper part of the flask was placed on the lower part and then filled with the stone. Then the flask was left for one hour to set . The upper and lower parts were separated , and plastic strips were removed from the mold carefully.

Mixing, packing, and curing of heat polymerized resin

The acrylic powder and liquid were mixed according to the manufacturer's instructions (24g: 10 ml). When the mixture reached the dough stage, it was packed inside the mold, and the 2 parts of the flask were put in contact and placed beneath the hydraulic press and then in a flask clamp. The flask was cured in a water bath machine according to manufacturer instructions. The flask was removed from the water bath following curing and left to cool. The acrylic specimens were removed from the flask, and finished by using a prosthetic engine with stone and acrylic burs and constant water cooling to avoid deformation and overheating. The specimens were polished

until they were glossy using a rouge in a dental lathe system running at 1500 rpm and continuously cooling with water (Figure 2). Then, acrylic samples were immersed in coffee, tea and Pepsi for 15 days.

Bio-star (Duran®) specimen preparation

Samples for hardness and roughness tests were prepared with dimensions (65 mm length X 10mm width X 2.5mm thickness). Duran sheets (Scheu, Germany) were made using a bio-star device(Germany). The border was finished using acrylic bur and diamond bur, and then bio-star samples were immersed in coffee, tea and Pepsi for 15 days(Figures 3,4 and ,5).

Mechanical tests

Shore D Surface Hardness Test:

The Shore D surface hardness tester (Shore D, China) was used for testing with a 4 N load for 15 seconds. Three readings were taken (left, middle and right), and the average was recorded.

TR220 portable roughness tester:

The TR220 portable roughness tester (China) is a device used for measuring surface roughness. Three measurements were taken and the average was obtained.

Result:

Surface roughness

Descriptive statistics for the roughness for the studied groups are shown in Table 1 which includes minimum, maximum value, mean and standard deviation. The result indicated a rise in the surface roughness of acrylic groups when compared to Bio-star groups(Figure 6). The Multiple Tukey test was utilized to see if any significant differences between the 2 groups. The results are indicated in Table 2. The ANOVA test showed significant differences (P <0.05) among all groups as illustrated in Table 3.

Surface hardness

Descriptive statistics for surface hardness for all groups are shown in Table 4 which includes minimum, maximum value, mean and standard deviation. The result showed an improvement in the surface hardness of acrylic groups when compared to Bio-star groups(Figure 7).The Tukey test showed significant differences between the 2 groups with the exception no significant differences between the control and group stained in Pepsi; acrylic groups which stained in coffee and tea.. The results are indicated in Table 5. Furthermore, the one-way ANOVA test indicated there were significant differences (P <0.05) among the groups as illustrated in Table 6.

Discussion:

Duran, a particular kind of Bio-star foil, is used as an occlusal splint following manufacturing. A variety of materials may be used to make occlusal splints, which can be used for full or partial occlusal covering, maxillary or mandibular, occlusal relocation, or stability. For occlusal splints, laboratory-processed acrylic resin is the preferred material; it is a practically hard substances that is adaptable and robust enough to act as a night guard. The Vacuum formed Vinyl Splints have excellent physical qualities, such as minimal moisture susceptibility, superior shape, and volume stability. Despite their shortcomings, they are nonetheless helpful[21]. Furthermore, these materials save time and are easy to utilize. These materials can be used in the dental office by the dental assistant to create splints that patients are comfortable wearing immediately [22]. The results of the investigation show that Duran has lower hardness than heat-cure acrylic resins, which may be because the major ingredient in Duran, poly (ethylene terephthalate), has been treated with glycol to enhance its mechanical properties [23].

Another argument is that the Duran was a thermoplastic substance with small particles that could be utilized immediately after being remolded under high temperatures and pressures, in contrast to the other two types of resins. The present study agrees with Callister [24] who stated that it is possible that the cross-linking agent will increase surface hardness. More cross-linking results in stronger and more solvent-resistant polymers than less. Homopolymers are cross-linked using a single cross-linking substance to create a polymer cross-linking tie, which ultimately develops into

a three-dimensional structure with robust connections between the chains [23,24]. The findings of this investigation presented that the highest roughness values are found in heat-cure acrylic resins. The surface of the heat-cured acrylic resin is rougher than that of the thermoplastic Bio-star when when diethyl glycol di methacrylate 1-2% is added as a cross-linking agent [22]. These results were in agreement with Hameed [25] who found the acrylic specimens had a rougher surface than biostar samples.

Conclusions

According to the present investigation's findings, acrylic samples had a higher hardness than Bio-star samples. The acrylic samples had a rougher surface than Bio-star specimens. Acrylic resins are considered the preferred material for removable orthodontic retainers because of their outstanding mechanical properties.

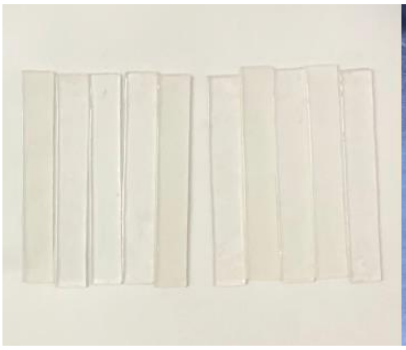

Figure (1): Heat cure acrylic samples preparation

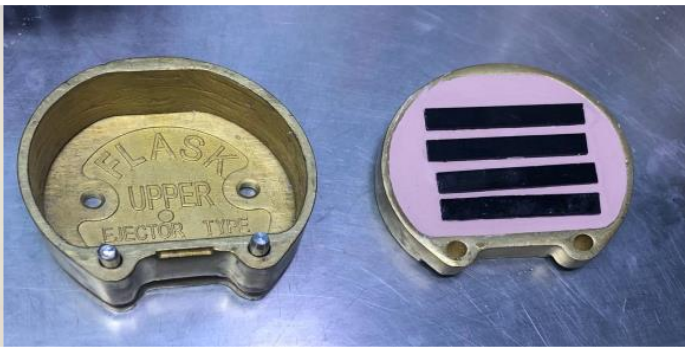

Figure (2): Heat cure specimens

Figure (3): Biostar sheets

Figure (4):Biostar specimens' preparation

Figure(5): Biostar specimens preparation

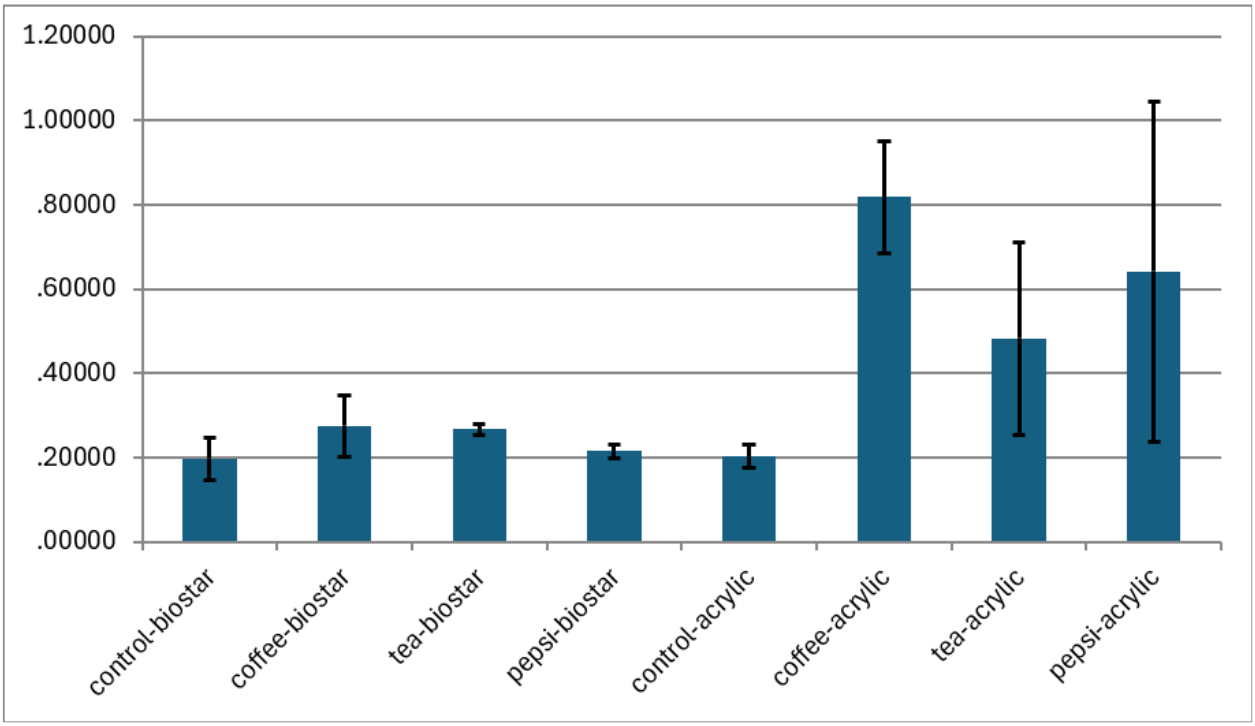

Figure (6): Bar chart for surface roughness test for all groups

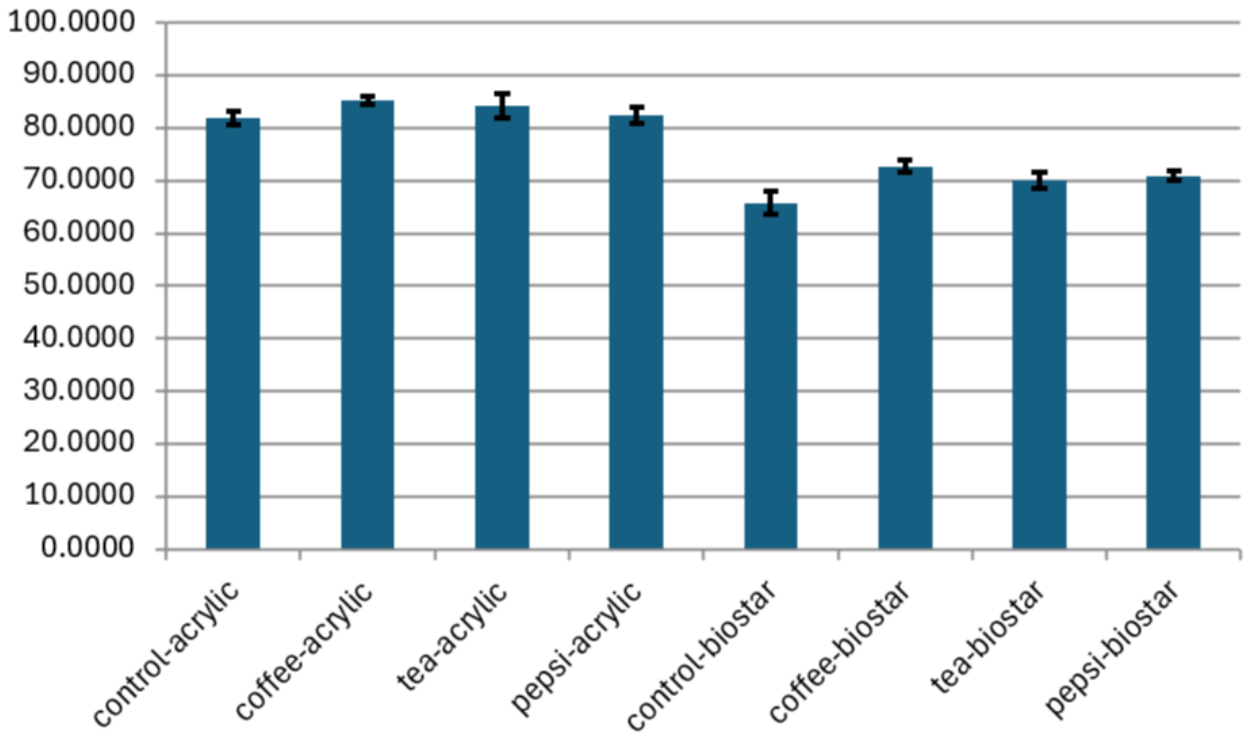

Figure (7): Bar chart for surface hardness test for all groups

Table (1): Descriptive Statistics of surface roughness test for all groups

Groups	N	Mean	Std deviation	Minimum	Maximum
Control biostar	10	.197	.051	.133	.258
Coffee biostar	10	.275	.073	.178	.381
Tea biostar	10	.267	.013	.250	.285
Pepsi biostar	10	.216	.016	.189	.232
Control acrylic	10	.202	.027	.157	.226
Coffee acrylic	10	.818	.133	.632	.967
Tea acrylic	10	.482	.228	.266	.857
Pepsi acrylic	10	.642	.403	.196	1.068

Table (2):Multiple Comparisons between two groups for surface roughness

Groups	Groups	P value	sig
Control biostar	Coffee biostar	.484	N.S
	tea biostar	.535	N.S
	pepsi biostar	.867	N.S
	Control acrylic	.965	N.S
	Coffee acrylic	.000	S
	tea acrylic	.014	S
	pepsi acrylic	.000	S
coffee biostar	Tea biostar	.937	N.S
	pepsi biostar	.593	N.S
	Control acrylic	.511	N.S
	Coffee acrylic	.000	S
	tea acrylic	.069	N.S
	pepsi acrylic	.002	S
tea biostar	pepsi biostar	.648	N.S

	Control acrylic	.536	N.S
	Coffee acrylic	.000	S
	tea acrylic	.059	N.S
	pepsi acrylic	.002	S
pepsi biostar	Control acrylic	.902	N.S
	Coffee acrylic	.000	S
	tea acrylic	.021	S
	pepsi acrylic	.000	S
Control acrylic	Coffee acrylic	.000	S
	tea acrylic	.016	S
	pepsi acrylic	.000	S
Coffee acrylic	tea acrylic	.004	S
	pepsi acrylic	.118	N.S
tea acrylic	pepsi acrylic	.156	N.S

Table (3): One Way Anova for Surface Roughness.

	Sum of squares	df	Mean square	f	sig
Between groups	1.932	7	0.276	9.135	.000
Within groups	.967	32	0.30		
total	2.898	39			

Table (4): Descriptive Statistics of hardness test for all groups

	N	Mean	Std deviation	minimum	maximum
Control acrylic	10	81.800	1.304	80.000	83.000
Coffee acrylic	10	85.200	.837	84.000	80006
tea acrylic	10	84.200	2.280	81.000	87.000
pepsi acrylic	10	82.400	1.517	80.000	84.000
Control biostar	10	65.800	2.180	63.000	69/000
Coffee biostar	10	72.700	1.095	71.000	74.000
tea biostar	10	70.000	1.581	68.000	72.000
pepsi biostar	10	70.400	.894	70.000	72.000

Table (5): Multiple Comparisons for surface hardness

Groups	Groups	P value	sig
Control biostar	Coffee biostar	.000	H.S
	tea biostar	.000	H.S
	pepsi biostar	.000	H.S
	Control acrylic	.000	H.S
	Coffee acrylic	.000	H.S
	tea acrylic	.000	H.S
	pepsi acrylic	.000	H.S
coffee biostar	Tea biostar	.010	H.S
	pepsi biostar	.078	N.S
	Control acrylic	.000	H.S
	Coffee acrylic	.000	H.S
	tea acrylic	.000	H.S

	pepsi acrylic	.000	H.S
tea biostar	pepsi biostar	.000	H.S
	Control acrylic	.000	H.S
	Coffee acrylic	.000	H.S
	tea acrylic	.000	H.S
	pepsi acrylic	.000	H.S
pepsi biostar	Control acrylic	.000	H.S
	Coffee acrylic	.000	H.S
	tea acrylic	.000	H.S
	pepsi acrylic	.000	H.S
Control acrylic	Coffee acrylic	.002	S
	tea acrylic	.021	S
	pepsi acrylic	.549	N.S
Coffee acrylic	tea acrylic	.320	N.S
	pepsi acrylic	.008	S
tea acrylic	pepsi acrylic	.078	N.S

Table (6) :ANOVA test for Surface hardness.

	Sum of squares	df	Mean square	f	sig
Between groups	2001.475	7	285.925	116.704	.000
Within groups	78.400	32	2.450		
total	2079.875	39			

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