Impact of different oils with single and double layers as separating medium on surface hardness and roughness of tissue surface of acrylic denture base material

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Abstract

It is essential to apply a separating medium to prevent the acrylic denture base material from penetrating and adhering to the relatively hard and rough surface of the gypsum mold. The main purpose of this study was to assess and evaluate the influence of four types of oil on the surface hardness and roughness of the base material for acrylic prostheses, to be then compared with one and two layers of cold-mold seal separating media. Sixty-four specimens in total have been collected. Based on the types of separating media utilized in this research, the specimens were divided up into eight groups: cold mold seal one layer (group A), jojoba oil one layer (group B), lemongrass essential oil one layer (group C), linum usitatissimum oil one layer (group D), cold mold seal with two layer (group A1), jojoba oil with two layer (group B1), lemongrass essential oil with two layer (group C1) and linum usitatissimum oil with two layers (group D1). Each group includes eight samples whose surface roughness and hardness have been studied following the processing of the acrylic denture base material. A one-way ANOVA test and an LSD test have been used to analyze the data statistically. Nevertheless, the one- and two-layer cold mold seals do not differ statistically in terms of the surface roughness of the acrylic denture base material. Using a single layer of jojoba oil, followed by one layer of cold mold seal and two layers of cold mold, respectively, produced the best surface hardness of the acrylic denture base material.

Keywords: Acrylic denture base, Surface roughness, Separating medium, Hardness surface, Cold mold seal.

Introduction

A denture is among the earliest devices for replacing missing natural teeth. Denture bases have been created using a variety of substances; acrylic has become more and more common considering its excellent features. Yet, the perfect denture base material has not been created yet [(1)], Other oral health care processes for PMMA are represented by the manufacturing of artificial acrylic teeth, printed or milled casts, treatment planning dies, denture relining, and repair, special trays, temporary crowns, occlusal splints, and obturators for cleft palates [(2)]. The term "separating medium" refers to a substance that is usually applied to an impression aimed at helping in the removal of the cast or a coating that is applied to a surface to avoid a second surface from being stuck to the first one [(3)]. In order for other materials to be separate when being placed on the top of them later, certain materials usually referred to as "separating media" are poured against a porous surface. The acrylic resin, thus, needs to be fully protected from the gypsum surface in the mould gaps throughout the manufacturing process [(4)]. Due to its impact on the rate of polymerization and the optical and physical attributes of the ultimate denture base

materials, it is considered as one of the most essential elements in the growth of dental prostheses. To provide the protection required, separating media can be either sheets including cellophane, tin foil, and rubber dam which were placed over the mold's surface, or liquids such as alginates that were painted on an empty mold to cover the pores of investment and, at the same time, create a thin film on the surface applied. A layer of gypsum products impregnated with polymer will be found adhered to the surface of the denture base and, as a result, will be extremely hard to remove if the mold's surface is not coated with separating materials [5, 6] . Tin foil was the first material; it is most effective as a separating medium with time are developed to include material such as water glass, this material used only on dental plaster surface it undergoes chemical reaction with dental plaster but it simply dries to form a shiny surface. Cold mould seal is another material used as a "separating agent" it is suitable for all processes, making tough elastic film which is unbreakable under pressure [7]. The common carrier oils that are now used for aromatherapy massages are jojoba oil, grape seed oil, macadamia nut oil, and sweet almond oil. Among these, jojoba oil is one of the most widely used carrier oils worldwide. Jojoba oil is a fatty acid-containing wax ester and is different from common vegetable oils, rich in triglycerides [8]. Lemongrass is a medicinal plant that produces essential oil with a variety of therapeutic properties. Although lemongrass essential oil is promising in clinical applications, the existing knowledge on the efficacy and safety of LGEO remains limited [9]. Linum usitatissimum has analgesic activity partially like "morphine". Concerning the safety and possessing antioxidant and various effects of plants with anti-oxidant activities, Linum usitatissimum might be used as analgesic and anti-inflammatory agent, as well as treatment of for other diseases [10]. One of the key factors that promotes bacterial colonization is the surface roughness of the denture base; microorganisms need to be stuck to a surface so that they can be colonized [11, 12]. Being effective in forming biofilms, surface roughness plays a clinical role making it hard to remove [12]. In prosthetic and dental restorative materials, there is a need for a clinically suitable threshold level of surface roughness (Ra) of 0.2 μm, beyond which no additional decrease in plaque accumulation is anticipated [13, 14]. In the oral cavity, complex masticatory loads can cause damage to denture base substances. As a result, the functional performance of denture base materials (bio-functionality) is determined by their mechanical qualities [2] . Additionally, the resilience of a material is of great importance in dentistry because it indicates how easily a structure can be done and how resistant it is to service scratches. Considering its crucial mechanical characteristic, hardness has to be determined for dental materials in order to guarantee the durability of oral restorations. In technical terms, it is assessed by creating surface indentations and determining the resistance that the material provides [15] .The current research aims at measuring and comparing the outcomes of various oil types (linum usitatissimum oil, lemongrass essential oil, as well as jojoba oil) with either one or two layers on the surface roughness of the acrylic denture base. The result will then be compared to those examined with cold-mold seal separating media. Also, for measuring and comparing the effect of different types of oil (lemongrass essential oil, jojoba oil and linum usitatissimum oil) with one and two layer on surface hardness of acrylic denture base and compared to those processed with cold-mold seal separating media.

Materials and Methodologies

General Preparation of the Acrylic Denture Base Samples

Sixty-four specimens in total have been used during this study. Based on the types of the separating medium and the number of additions used in this study during packing, the samples were divided into eight groups. Group (A and A1) for cold mold seal, group (B and B1) for jojoba oil, group (C and C1) for lemongrass

essential oil, and group (D and D1) for linum usitatissimum oil. Sixty-four specimens of acrylic for the surface roughness and shore D test were subdivided into eight groups as following:

Group A: 8 samples with one layer of cold mold seal

Group B: 8 samples with one layer of jojoba oil.

Group C: 8 samples with one layer of lemongrass essential oil.

Group D: 8 samples with one layer of linum usitatissimum oil

Group A1:8 samples with two layers of cold mold seal.

Group B1: 8 samples with two layers of jojoba oil.

Group C1: 8 samples with two layers of lemongrass essential oil.

Group D1: 8 samples with two layers of linum usitatissimum oil.

Acrylic Samples Preparation

To save time and effort, four wax patterns have been designed using base plate wax (China) with proper measurements. As observed in Figure 1, the size and shape of each sample were developed in compliance with the tests required. The samples were measured by Vernier to be (30 cm) length, (2 cm) wide, and (2 cm) thick. The circular specimens were then cut out using a wax knife and ruler.

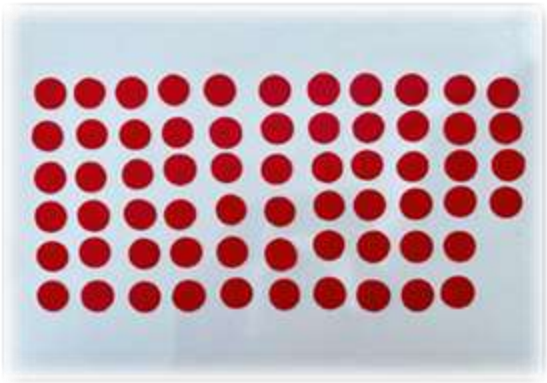

Figure 1: wax pattern.

Mold Preparation

Following specimen preparation, the wax samples were placed within the lower portion of the dental flask after using a separating medium within the flask. As directed by the manufacturer, slurry stone (Zhermack) was to be made with (W/P ratio: 25 ml/100 g) to be afterwards poured into the lower half of the dental flask until its level would be just below that of the wax samples. It was then given some time to set, as illustrated in Figure 2. After having been solidified, the dental stone and the base plate's surface wax were coated with a separating medium. Upon completion, the dental stone was poured into the flask and the upper half was settled on the lower half. In order for the wax to be soft, the flasks were immersed in boiling water for (3- 5) minutes right after the second layer of stone became solid. After that, as illustrated in Figure 3, the flasks were opened and flushed with clean boiling water to remove wax left (wax elimination), if any. The edges of the flask were eventually evaluated to make sure that both halves fit together properly.

Appling Separating Agent

Upon giving the model, a thin layer of separating agent, let it dry thoroughly. Using a disposable syringe (5 ml), a coat of separating media (cold mold seal, jojoba oil, linum usitatissimum oil, and lemongrass essential oil) was measured by disposable syringe and the material is evenly distributed over the surface and in one direction only when applied with disposables brush onto the stone surface in each flask half. The time to leave the separating medium for each flask is a one minute then the mould was ready for packing the acrylic material inside the mould.

Figure 2: Wax specimens inside the flask.

Figure 3: Mould after wax elimination.

Packing Procedure

Afterwards, it is necessary to set up the packaging by combining the acrylic (liquid and powder) in accordance with the manufacturer's guidelines (Veracril). The acrylic dough must be placed in the flask once the acrylic reaches the dough stage to get ready for pressure inside the mould. After an hour and a half, the flask must be placed inside a bath of water set at 74°C. Then, the temperature is raised to 100°C and should be left for half an hour. Finally, the flask must be taken out of the water bath. The flask is opened and the acrylic resin design was taken out of the stone mold after being bench cooled for at least 15 to 20 minutes [16]. Instead of distorting the prosthesis, the flasks should not be opened at that point; this is only required when applying a single layer of the separating medium. By using two layers of separating medium, we follow the same previous steps when applying a single layer of separating media from de-waxing (wax elimination) and packing it, following similar periods of time and conditions (temperature, pressure and mixing) ...etc. However, the difference is the application of two layers of the separating media (cold mold seal, Jojoba oil, Linum usitatissimum oil, lemongrass essential oil) in case of applying the first layer of separating media with a disposable brush, to be then left to dry for about 1minute. Later, the second layer of the separating media is applied with a disposable brush, and left to dry for 1 minute in maximum. After that, the previous steps would be complete as it is from dewaxing (wax elimination) and packing. The separating media mentioned in Table 1 are used in this study. The samples were finished only border according to the manufacturer's recommendation and the measure of the surface roughness changes if we make a finishing. It should be mentioned that there was no polishing for all of the samples used after de-flasking (as tissue fitting surface of denture base).

Table 1: Separating media used in this study.

ISOACRYL	Cold-Mold Seal	India	Alginate, excipients
Jojoba oil	**Huila de jojoba**	**Pakistan**	**-10% moisture -22.9% crud protein -1.20% crude oil -15.40% crude fiber -1.4% Ash -53.80% nitrogen free extract -0.43%Simmondsin**
Linum usitatissimum	**Linseed**	**Pakistan**	**-41% fat - 20% protein -28% total -dietary fiber -7.7% moisture -3.4% ash**
Lemongrass essential oil	**Lemon oil**	**India**	**-31.5% neral -26.1% citral - 2.27% geranyl acetate**

Surface Roughness Test

With the use of the profilometer machine (TR220 Portable, Roughness Tester User's manual, China), sixty-four samples have been used in the test to study the micro geometry of the test surface (the results of two samples from each group were discarded due to error in the result and the final surface roughness measurement was only 48 samples). In order for the surface roughness of the specimens to be measured, the profilometer device (usually known as surface roughness tester) is used as seen in Figure 4. After being flasked, each specimen was set on a solid and fixed platform, and the device was then modified in order that the stylus only contacted the specimen's surface. The result of this procedure was then displayed on a digital scale as seen in Figure 4[17]. Reflecting the traversal of the stylus along the surface of the sample to the right direction with a 5 mm length and a 0.25 cut-off. Each sample experienced two surface roughness measurements, applying mean average (Ra) values for the statistical analysis. It is worth mentioning that micrometers are used to express the findings [18, 19] .

Figure 4: Profilometer device for surface roughness test.

Surface Hardness Test

In this research, the indentation or hardness of the samples was verified using a Shore hardness tester (China) in Figure 5. Having a flat sample supported by a smooth, solid platform, the Shore D hardness device was mounted vertically [20]. After three seconds of steady contact over the sample, the indenter was strongly and rapidly driven down so that the highest reading can be recorded. The reading scale was used as the source of the reading. To avoid measurement inaccuracy, the shore hardness tester's contact surface needs to be parallel to the test stand's specimen support. There were only 5-12 millimeters separating the specimen surface from the hardness tester's indenter. During the test, the sample and the indenter were subjected to a load of approximately 5 N and contact time of 6 seconds. The hardness value was determined using the average of the three readings obtained by marking three points on every sample, separated about 6 mm apart (with approximately six mm distance between each other). The reading was calculated after collecting the data from the scale [4, 18] .

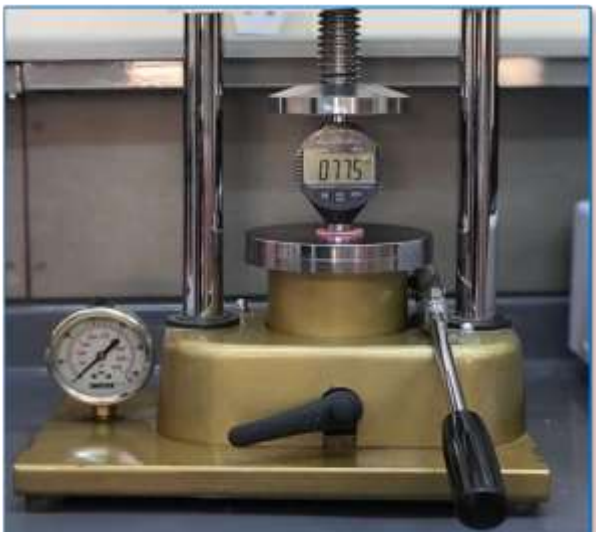

Figure 5: Shore D device for surface hardness test.

Statistical Analyses

Statistically, the most appropriate methods used for analyzing and assessing the results were as follows:

1. Descriptive statistics:

Summary statistics regarding the distribution of reading, including mean, standard deviation (SD), standard range (SR), minimum, and maximum. Graphical presentation using bar charts.

2. Inferential statistics have been used to approve or reject statistical hypotheses, including the one-

way analysis of variance (ANOVA) test with multiple comparisons, as well as the least significant differences (LSD) test. There is a significant mean difference at the ((0.05)) level.

Results and Discussion

Surface Hardness Test

Table 2 and Figure 6 demonstrate the mean values as well as standard Deviation (SD) respectively for the surface hardness test for eight distinct categories using several separation media.

Table 2: Descriptive Statistics of the surface hardness measurement.

Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
					Lower Bound	Upper Bound		
cold mold seal (A)	8	79.0830	4.48122	1.58435	75.3366	82.8294	72.67	85.50
Jojoba oil(B)	8	81.4790	2.98991	1.05709	78.9794	83.9786	74.50	84.33
Lemongrass essential oil (C)	8	64.5831	4.46504	1.57863	60.8503	68.3160	57.33	69.33
Linum usitatissimum oil(D)	8	64.9787	3.33155	1.17788	62.1935	67.7640	58.17	68.83
cold mold seal (A1)	8	77.0622	4.14006	1.46373	73.6011	80.5234	73.00	84.67
Jojoba oil(B1)	8	62.7081	6.92393	2.44798	56.9196	68.4967	54.00	74.33
Lemongrass essential oil (C1)	8	52.8831	2.62988	.92980	50.6845	55.0818	49.90	56.00
Linum usitatissimum oil(D1)	8	50.9788	4.60633	1.62858	47.1278	54.8297	44.83	57.33
Total	64							

Figure 6 shows the average surface hardness of the eight groups (three types of oils and cold mold seal).

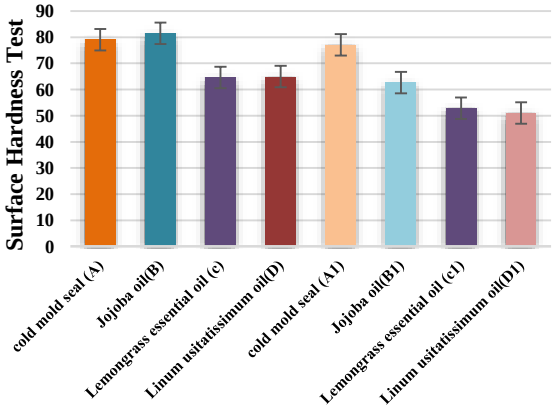

Figure 6: Mean distribution of surface hardness test for all groups.

One-way ANOVA showed a significant difference when comparing all studied groups when used different separating media with one and double layer, illustrated in Table 3.

Table 3: One – way ANOVA to compare surface hardness measurement.

ANOVA	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	7524.587	7	1074.941	56.106	.000
Within Groups	1072.904	56	19.159		
Total	8597.491	63			

As seen in Table 4, an additional analysis has been conducted using the LSD test between every two sub-groups of the eight main groups in order for the source of variance to be determined among them.

Table 4: Multiple comparisons between groups by LSD test.

(I) surface hardness	(J) surface hardness	Mean Difference (I-J)	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
Cold mold seal (A)	Jojoba oil(B)	-2.39600-	.278	-6.7802-	1.9882
	Lemongrass essential oil (c)	14.49988*	.000	10.1157	18.8841
	Linum usitatissimum oil(D)	14.10425*	.000	9.7201	18.4884
	Cold mold seal (A1)	2.02075	.360	-2.3634-	6.4049
	Jojoba oil(B1)	16.37488*	.000	11.9907	20.7591
	Lemongrass essential oil (c1)	26.19988*	.000	21.8157	30.5841
	Linum usitatissimum oil(D1)	28.10425*	.000	23.7201	32.4884
Jojoba oil (B)	Lemongrass essential oil (c)	16.89588*	.000	12.5117	21.2801
	Linum usitatissimum oil(D)	16.50025*	.000	12.1161	20.8844
	Cold mold seal (A1)	4.41675*	.048	.0326	8.8009
	Jojoba oil(B1)	18.77088*	.000	14.3867	23.1551
	Lemongrass essential oil (c1)	28.59588*	.000	24.2117	32.9801
	Linum usitatissimum oil(D1)	30.50025*	.000	26.1161	34.8844
Lemongrass essential oil (C)	Linum usitatissimum oil(D)	-.39562-	.857	-4.7798-	3.9886
	Cold mold seal (A1)	-12.47912-*	.000	-16.8633-	-8.0949-
	Jojoba oil(B1)	1.87500	.395	-2.5092-	6.2592
	Lemongrass essential oil (c1)	11.70000*	.000	7.3158	16.0842
	Linum usitatissimum oil(D1)	13.60437*	.000	9.2202	17.9886
Linum usitatissimum oil (D)	Cold mold seal (A1)	-12.08350-*	.000	-16.4677-	-7.6993-
	Jojoba oil(B1)	2.27062	.304	-2.1136-	6.6548
	Lemongrass essential oil (c1)	12.09562*	.000	7.7114	16.4798
	Linum usitatissimum oil(D1)	14.00000*	.000	9.6158	18.3842
Cold mold seal (A1)	Jojoba oil(B1)	14.35412*	.000	9.9699	18.7383
	Lemongrass essential oil (c1)	24.17912*	.000	19.7949	28.5633
	Linum usitatissimum oil(D1)	26.08350*	.000	21.6993	30.4677
Jojoba oil (B1)	Lemongrass essential oil (c1)	9.82500*	.000	5.4408	14.2092
	Linum usitatissimum oil(D1)	11.72937*	.000	7.3452	16.1136
Lemongrass essential oil (C1)	Linum usitatissimum oil(D1)	1.90437	.388	-2.4798-	6.2886

*There is a significant mean difference at the (0.05) level

Surface Roughness Test

Table 5 and Figure 7 reveal the mean values and standard deviation (SD) for the surface roughness test for eight groups using different separating media.

Table 5: Descriptive statistics of the surface roughness measurement.

Groups	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
					Lower Bound	Upper Bound		
Cold mold seal (A)	6	1.1808	.15510	.06332	1.0180	1.3435	1.02	1.39
Jojoba oil (B)	6	2.0228	.49371	.20155	1.5046	2.5409	1.11	2.47
Lemongrass essential oil (C)	6	3.0824	.41211	.16824	2.6499	3.5149	2.64	3.69
Linum usitatissimum oil (D)	6	2.5732	.44883	.18323	2.1021	3.0442	1.68	2.90
Cold mold seal (A1)	6	1.8646	.50544	.20635	1.3342	2.3950	1.27	2.59
Jojoba oil (B1)	6	1.8577	.37638	.15366	1.4627	2.2527	1.17	2.23
Lemongrass essential oil (C1)	6	3.2096	.48810	.19926	2.6974	3.7218	2.31	3.71
Linum usitatissimum oil (D1)	6	2.0684	.44174	.18034	1.6048	2.5320	1.63	2.60
Total	48							

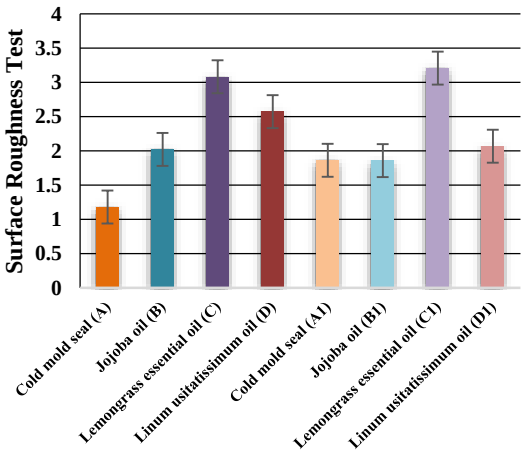

Figure 7: Mean distribution of surface roughness test for all groups.

One-way ANOVA showed a significant difference when comparing all studied groups when used different separating media with one and double layer, shown in Table 6.

Table 6: One – way ANOVA compared to Surface Roughness measurement

ANOVA	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	19.476	7	2.782	15.146	.000
Within Groups	7.348	40	.184		
Total	26.824	47			

According to the least significant difference analysis in Table 7, statistically no significant difference was found between the Ra of the cold mold seal 2 layer and cold mold seal 1 layer, the roughness data revealed that the Ra mean value is affected by the acrylic substrate and techniques. Statistically, there was no significant difference between groups if (p-value of 0.05). Further analysis was done by using the LSD test between every two subgroups of the eight main

groups, determine the source of variance among them, as shown in Table 7.

Table 7: Multiple comparisons between groups by LSD test.

(I) surface roughness	(J) surface roughness	Mean Difference (I-J)	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
cold mold seal (A)	Jojoba oil (B)	-.84200-*	.002	-1.3421-	-.3419-
	Lemongrass essential oil (c)	-1.90167-*	.000	-2.4018-	-1.4015-
	Linum usitatissimum oil(D)	-1.39242-*	.000	-1.8925-	-.8923-
	Cold mold seal (A1)	-.68383-*	.009	-1.1840-	-.1837-
	Jojoba oil(B1)	-.67692-*	.009	-1.1770-	-.1768-
	Lemongrass essential oil (c1)	-2.02883-*	.000	-2.5290-	-1.5287-
	Linum usitatissimum oil(D1)	-.88767-*	.001	-1.3878-	-.3875-
Jojoba oil (B)	Lemongrass essential oil (c)	-1.05967-*	.000	-1.5598-	-.5595-
	Linum usitatissimum oil(D)	-.55042-*	.032	-1.0505-	-.0503-
	Cold mold seal (A1)	.15817	.526	-.3420-	.6583
	Jojoba oil(B1)	.16508	.509	-.3350-	.6652
	Lemongrass essential oil (c1)	-1.18683-*	.000	-1.6870-	-.6867-
	Linum usitatissimum oil(D1)	-.04567-	.855	-.5458-	.4545
Lemongrass essential oil (C)	Linum usitatissimum oil(D)	.50925*	.046	.0091	1.0094
	Cold mold seal (A1)	1.21783*	.000	.7177	1.7180
	Jojoba oil(B1)	1.22475*	.000	.7246	1.7249
	Lemongrass essential oil (c1)	-.12717-	.610	-.6273-	.3730
	Linum usitatissimum oil(D1)	1.01400*	.000	.5139	1.5141
Linum usitatissimum oil (D)	Cold mold seal (A1)	.70858*	.007	.2085	1.2087
	Jojoba oil(B1)	.71550*	.006	.2154	1.2156
	Lemongrass essential oil (c1)	-.63642-*	.014	-1.1365-	-.1363-
	Linum usitatissimum oil(D1)	.50475*	.048	.0046	1.0049
cold mold seal (A1)	Jojoba oil(B1)	.00692	.978	-.4932-	.5070
	Lemongrass essential oil (c1)	-1.34500-*	.000	-1.8451-	-.8449-
	Linum usitatissimum oil(D1)	-.20383-	.415	-.7040-	.2963
Jojoba oil (B1)	Lemongrass essential oil (c1)	-1.35192-*	.000	-1.8520-	-.8518-
	Linum usitatissimum oil(D1)	-.21075-	.399	-.7109-	.2894
Lemongrass essential oil (C1)	Linum usitatissimum oil(D1)	1.14117*	.000	.6410	1.6413

There was a significant difference in surface roughness between group A (cold mold seal) compared to the other groups, considering the inferential statistic that employed a one-way ANOVA and LSD test for making a comparison among the groups. The difference was also significant between group B (jojoba oil) and groups C, D, and C1, but non-significant with A1, B1, and D1, whereas it is significant between group C (lemongrass essential oil) and groups (D, A1, B1 and D1) and non-significant with group (C1) and significant between group D (linum usitatissimum oil) and groups (A1, B1, C1and D1). While it is significant between group A1 (cold mold seal) and group C1, it is non-significant with groups B1 and D1. It is significant between groups B1 and C1 and non-significant with group D1. However, it is significant between group C1 and group D1.

Discussion

Separating medium is regarded as a kind of coating put on a surface to keep another one from being stuck to the first one. The oil distributed in water forms the separating media, and the high interfacial tension of the medium separating the

two various matrices determines its ability to separate the materials [5].

Surface Roughness Test

In general, polishing a dental material aims at creating a sufficiently shiny and smooth surface, preventing, as a result, the growth of bacterial plaque by gently eliminating rough layers from the surface [19]. Bacterial colonization can be promoted by the denture base's surface roughness; microorganisms will not colonize a surface unless they stick to it [11, 12]. In accordance with the descriptive statistic for the mean of each group, lemongrass essential oil was ineffective as a proper separating medium with reference to the surface roughness of the fitted tissue acrylic denture base; yet, cold mold seal, jojoba oil, and linum usitatissimum oil could be applied as separating media during the manufacturing process of the acrylic denture base. That would be more than 0.2 µm representing the maximum clinically feasible roughness level without the need for additional smoothness. The best smooth surface (lowest surface roughness) of acrylic would be seen in group A (cold mold seal), [17] stated that using jojoba oil, lemongrass essential oil, and linum usitatissimum oil as a separating medium, the roughness of resin would be much lower. There might be several reasons behind that. The first one is their oil viscosity, which helps inhibit any voids or porosity detected since the penetration coefficient of this material is very high, allowing the material to pass through and close any porosity seen. The surface tension of the separating medium is considered as another possible reason, as there is an adhesion force between its molecules. Additionally, there are other causes represented by the high surface tension of the separating medium, and the higher the sealing and separation between investment material and polymer denture base materials. There are at least three potential causes for those findings. The initial reason is represented by the viscosity of the separating medium in such a way that a substance with a low viscosity may fill any voids or porosity visible owing to its considerable coefficient of penetration, causing the substance to go inside and secure any porosity. Based on the contact angle of the separating medium molecule on the stone surface, another reason might be attributed to the strong wettability of the material, enabling the separating medium to flow smoothly over the surface of the gypsum product. Since there is an adhesion force detected between its molecules, the high surface tension of the separating medium as well as the high sealing and separation of the dental stone and the acrylic denture base might possibly be the third reason [5, 14] .

Surface Hardness Test

Hardness, as opposed to resistance to wear or scratching, is a commonly used term for describing the resistance of shore hardness [4] . Based on the findings of the current study, the linum usitatissimum oil group formed the lowest mean value, whereas the greatest mean value, went for the jojoba oil group (B) followed by the cold mold seal group (A) and then lemongrass essential oil group as shown in Table 4. Additionally, the results revealed a considerable difference between groups C, D, B1, C1, and D1 and cold mold seal (group A), meanwhile, there is non-significant difference between cold mold seal (group A) and group (B and A1). But the difference between jojoba oil group(B) and groups (C,D,A1,B1,C1 and D1) is significant, and also significant between lemongrass essential oil group (C) and groups (A1, C1and D1) whereas it is non-significant with groups (D and B1), and significant between linum usitatissimum oil group (D) and groups(A1,C1,D1) and non-significant with group (B1), and significant between cold mold seal group (A1) and groups (B1,C1 and D1) ,and significant between group (B1) and group (C1and D1) and revealed that there were no significant differences between lemongrass essential oil group (C1) and linum usitatissimum oil group (D1) on hardness of acrylic denture base. The water sorption phenomena of the

denture base material, methyl methacrylate, might serve to justify this. Consequently, the cold mold seal film does not completely eliminate water, which, by turn, prevent acrylic from being completely polymerized [21, 22].

Conclusion

Within the limitations from the study it can be concluded that:

1) Taking into consideration the surface roughness (less surface roughness) of the final processed with acrylic denture base in this study, cold mold seal and jojoba oil are better separating medium as compared to lemongrass essential oil and linum usitatissimum oil.
2) The poorest surface roughness shown was that of the acrylic samples produced with linum usitatissimum oil as separating medium. In terms of statistics, there are, however, no differences between jojoba oil and the surface roughness of the acrylic denture base material processed with cold mold seal, or between lemongrass essential oil and linum usitatissimum oil.
3) In case of using cold mold, jojoba oil, lemongrass essential oil and linum usitatissimum oil respectively, the acrylic denture base material would have the highest surface hardness.
4) When compared among each other, there is a significant difference between cold mold seal and lemongrass essential oil, as well as between jojoba oil and linum usitatissimum oil. However, there is no statistically significant distinction between the surface hardness of the acrylic denture base material processed using cold mold seal and jojoba oil, or between lemongrass essential oil and linum usitatissimum oil.

Conflict of interest

The author declares that there was no conflict of interest.

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