

The Influence of Saliva, Artificial Saliva and Propolis Extract on the Wettability of Heat-Cured and Visible Light-Cured Denture Base Material

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الخلاصة

أهداف البحث: يهدف البحث إلى تقييم ومقارنة تأثير لعاب الإنسان واللعب الاصطناعي و مستخلص مادة العكبر على قابلية الترطيب لمادة قاعدة الطقم الأكريلية الحرارية والضوئية. المواد الأساسية وطريقة العمل: تم تحضير مجموعة من العينات عددها ثمانين عينة. أربعون منها محضرة من مادة الاكريل الحراري وأربعون عينة أخرى محضرة من الاكريل الضوئي. وقد تم تقسيم هذه المجموعات إلى أربع مجاميع فرعية: مجموعة غير معالجة، ومجموعة معالجة بلعاب الإنسان، ومجموعة معالجة باللعب الاصطناعي، ومجموعة معالجة بمادة العكبر. وقد تم احتساب القياسات بواسطة قياس زاوية القطرة مع السطح باستخدام كاميرا رقمية لتحديد قابلية الترطيب من هذه العينات. إحصائياً تمت مقارنة القيم المتوسطة بواسطة اختبار (انوف) واختبار (دنكن) لتحديد فروقات ذات دلالة إحصائية بين المجموعات التي تم اختبارها. وقد أظهرت النتائج أن هناك اختلافات واضحة بين قيم زاوية القطرة بالسطح للمجاميع التي تم فحصها. وقد لوحظ أن زاوية القطرة انخفضت بشكل ملحوظ في جميع العينات المعالجة. أظهرت هذه الدراسة أن الاكريل الحراري لديه قابلية ترطيب أكثر من الاكريل الضوئي. كما أن لعاب الإنسان واللعب الاصطناعي ومادة العكبر كلها تعمل على زيادة قابلية الترطيب لكل من الاكريل الحراري والضوئي.

ABSTRACT

Aims: To evaluate and compare the effect of human saliva, artificial saliva and propolis extract on the wettability of heat-cured and visible light -cured denture base material. **Materials and Methods:** A total of 80 samples were prepared , 40 samples prepared from heat cured resin and the other 40 samples were prepared from light cured resin. These two groups were divided into four subgroups, control group, human saliva, artificial saliva and propolis. Contact angle measurements by sessile drop method with a micropipette using digital camera to determine the wettability of these samples. Mean values were compared statistically with one way analysis of variance (ANOVA),Duncan's multiple range test and t-test to determine the significant difference among the tested groups. **Results:** There is a significant differences of the mean values of the contact angle among the tested groups. The contact angle significantly decreased in all the treated samples. **Conclusion:** Heat cured resin has more wettability than light cured resin. Human saliva, artificial saliva and propolis increased the wettability of both heat cured and light cured resin.

Key words: wettability ,contact angle ,saliva ,propolis

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INTRODUCTION

Wettability is a measure of the affinity of a liquid for a solid as indicated by spreading of a drop. ⁽¹⁾

The wettability property of dental material exerts its influence on many fronts: contact with oral fluids (predominantly saliva), adsorption of salivary proteins, adhesion of bacteria and / or bio-films ,and frictional forces exerted by affecting the oral tissues or food particles. ⁽²⁾

Wettability refers to the lowering of the energy of a system when a liquid wets a solid surface. Thus, to break such an interface is similar to breaking the adhesion between solids: work needs to be done to

create the break and a strength can be attributed to it as an interface. Conversely, it is true that if there were no wetting, no force would be needed to be applied to separate the denture from saliva and there would be no retention. ⁽³⁾

The contact between the material and the liquid generates an interface solid/liquid which will consume, during its formation, a defined energy called the interface energy (surface free energy) which is an indicator of its wettability. Therefore, the surface free energy is defined as the work necessary to separate two surfaces beyond the range of the forces holding

them together, in most cases the contact angle is used as a relative measure of the surface energy.⁽⁴⁾

Good wetting of heat-polymerized acrylic resin by saliva and saliva substitute is critical for optimum retention of complete dentures.^(5,6)

For good adhesion of the denture to the supporting tissues, the saliva or saliva substitute must flow easily over the entire surface to ensure wetting of the adherent surface. The ability of a denture material to be wetted gives an indication of the degree to which the lubricating effect of saliva will be enhanced, thereby promoting denture retention and patient comfort.⁽⁷⁾

Denture wearing may become difficult because dry mouth can significantly add to the problem of retaining and eating with the dentures, which invariably become loose. The salivary mucins possess rheological properties that include elasticity and adhesiveness, which aid in retention of dentures.^(5,8)

Visible Light Cured resins were introduced into dental practice in 1983 and found applications in fixed and removable prosthodontics, maxillofacial prosthetics, implantology and orthodontics.^(9,10)

Natural products are being increasingly used in oral disease prevention and propolis is considered the most promising one. Propolis is a non-toxic resinous hive product collected by *Apis mellifera* bees from various plant sources, and has been recognized as having several properties that confer health benefits to humans, including prevention of oral diseases. It has shown antimicrobial activity against oral pathogens, such as *Candida albicans*.⁽¹¹⁾ In dentistry, propolis has been used for the treatment of Candidiasis and denture stomatitis.⁽¹²⁾

The contact angle of the saliva substitute on the denture base can be taken as an indicator of the wettability – the smaller the contact angle, the greater the wettability, or the contact angle is a useful inverse measure of wettability.⁽¹³⁾

The aims of this study was to evaluate and compare the effect of human saliva, artificial saliva and propolis extract on the wettability of heat-cured and visible light-cured denture base material.

MATERIALS AND METHODS

Experimental design

Two groups of samples were prepared, the first group consisted of 40 samples prepared from Heat cured denture base material and the second group consisted of 40 samples made from Visible light cured resin. The total is 80 samples. Each group was divided into 4 subgroups. They are:

The control subgroup GI, the human saliva subgroup GII, the artificial saliva subgroup GIII and the last one is propolis extract subgroup GIV.

Preparation of samples:

Rectangular specimens measured (20,15,1.5 mm) were fabricated from heat cured resin and visible light cured resin.⁽¹⁴⁾

The heat cured resin material used in this study was Respal, Heat processed Type I Class I, Italy. Wax samples were invested using dental stone Type III Geastone, Zeus sri Loc. Tamburino GR Italy. In metal dental flasks in accordance with the manufacturer's instructions.

Wax elimination was done then packing of heat curing resin and then curing in water bath according to ADA specifications.

The light curing material used in this study was (Light Cured Material, Megadental / Germany). The rectangular light cured samples were cut using surgical blade to the proper dimensions, then cured using the curing machine for four minutes according to manufacturer's instructions.

No finishing was done for the surface to be tested (tissue surface) to simulate clinical practice. The samples were finished on the other side (polished surface) manually using sand paper on a flat surface.⁽¹⁵⁾

Samples were stored in distilled water for 24 hours.^(15,16)

Surface treatment of samples

Samples stored in distilled water were the control group GI.⁽¹⁵⁾

The second group GII, were immersed in human unstimulated saliva that was collected from a healthy single donor⁽¹⁴⁾, it was clarified by centrifugation at 10,000 g for 10 minutes at 4°C.⁽¹⁷⁾

The samples were placed in human saliva for 30 minutes to form an acquired pellicle.⁽¹⁸⁾

The third group GIII :samples were placed in Fusayama artificial saliva .The composition of this solution was: NaCl, 0.400g;KCl,0.400g;CaCl₂H₂O,0.795g;Na H₂PO₄, 0.69 g; Na₂S.9H₂O,0.005 g; urea 1.0 g; distilled water ,1000 ml.⁽¹⁹⁾

The fourth group GIV :samples were immersed in a plastic tube containing 25 g of propolis alcohol extract(Propolis oil TACT ,Damascus, Syria batch no.621700276272. The solutions were changed daily. The tube supporting racks were covered with aluminum foil for protection against light and were stored at 35±2°C for 14 days.⁽²⁰⁾

Contact Angle Measurement

The measurement of the contact angle was performed by a sessile drop method⁽²¹⁾ .Contact angle measurement was calculated by dropping 15 ul of deionized water applied with micropipette on specimen surface 2 cm above the surface ,the image of three drops for each specimen was captured with a digital camera (DCR–SR45E Sony Japan) situated at a distance of 20 cm from pipette tip .⁽²²⁾

An average of each specimen was calculated. Contact Angle (CA) degree, (Figure1), was measured using Auto-Cad.2008.18.Contact angle measurement was recorded by the angle between the tangent line and the resin surface by the sessile drop method.⁽²³⁾

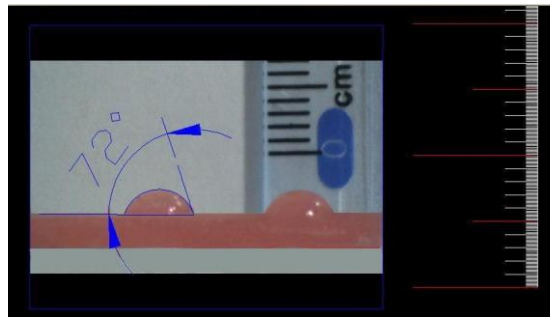


Figure1:Contact angle measurement

Statistically mean values and standard deviation were calculated . Mean values of the tested materials were compared with One way Analysis of VARIANCE (ANOVA) followed by Duncan multiple range test.T–test was carried out to determine the significant difference between heat cured and light–cured resin material.

RESULTS

The contact angle is defined as the angle between solid sample’s surface and the tangent of the droplet’s ovate shape at

the edge of the droplet. A high contact angle indicates a low solid surface energy .This is also referred to as a low degree of wetting.⁽²⁴⁾

ANOVA was carried out to test the significance in difference of contact angle values in the four groups of heat–cured denture base material .The results of ANOVA test revealed in (Table 1) showed that there was a significant difference between the mean values of contact angle of the four groups of heat–cured denture base material.

Table1: ANOVA of contact angle of heat cured resin tested groups

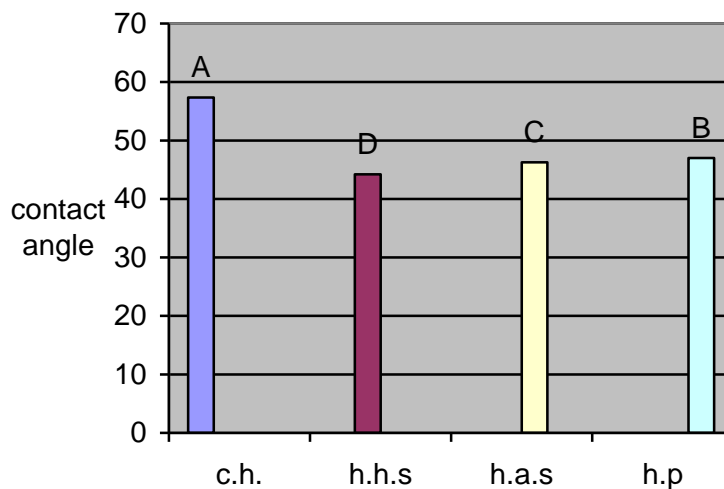
	Sum of Squares	df	Mean Square	F Value	Significant
Between Groups	1036.605	3	345.535	15.476	0.000
Within Groups	803.754	36	22.327		
Total	1840.359	39			

Figure (2) shows the mean values of the four tested groups of heat– cured resin.

The control of heat cured samples showed the highest mean value of contact angle

which was 57.34° while samples treated with human natural saliva showed the lowest mean value of contact angle which

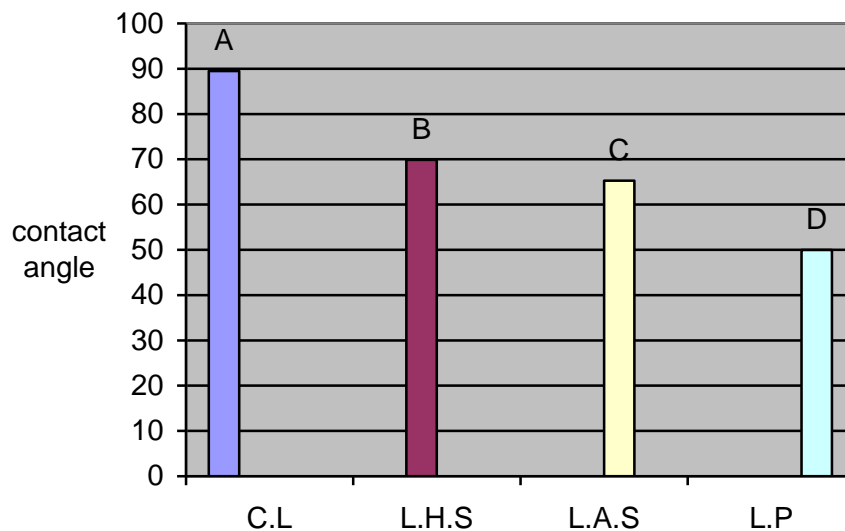
was 44.2 indicating better wettability than the other groups.



c.h: (control heat cured samples); h.h.s: (heat cured samples in human saliva); h.a.s: (heat cured samples in artificial saliva); h.p: (heat cured samples in propolis).
 Figure 2: Duncan Multiple Range Test for heat cured tested groups(contact angle).

In determining the wettability of visible light cured resin .The highest mean value of contact angle was 89.49 for the

control group and the lowest mean value of contact angle was for group of samples treated with propolis.(Figure3)



C.L (control light cured samples), L.H.S (light cured samples in human saliva),L.A.S(light cured samples in artificial saliva)L.P(light cured samples in propolis)

Figure 3: Duncan Multiple Range Test for light cured tested groups(contact angle).

One Way Analysis of Variance (ANOVA) showed in (Table 2) that there

was a significant difference between all the tested groups.

Table 2 : ANOVA of means of contact angle of light cured tested groups

	Sum of Squares	df	Mean Square	F Value	Significant
Between Groups	7964.915	3	2654.972	120.358	0.000
Within Groups	794.125	36	22.059		
Total	8759.040	39			

Student T-test was carried out to compare between hot and light cured resin. In the control untreated samples the heat-cured resin showed low contact angle which was 57.34 compared to high

contact angle of light-cured resin which was 89.49, this means that heat-cured resin have more wettability than light-cured resin(Table3)(Figure4).

Table 3: t-test for the contact angle of control group

Groups	N	Mean	Std.Deviation	t
Con H	10	57.3400	4.56440	-14.611
L	10	89.4900	5.25218	

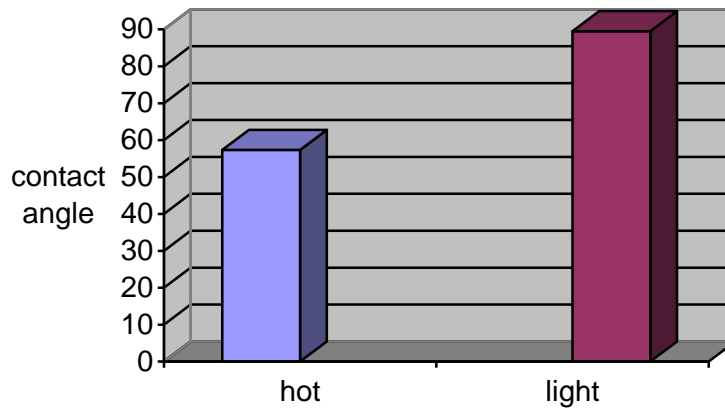


Figure 4: Means of contact angle of control group

For samples treated with human saliva, heat-cured resin showed low contact angle which was 44.2 which means high

wettability when compared to light -cured human saliva treated samples which had contact angle of 69.88 (Table 4)(Figure 5).

Table 4: t-test for the contact angle of human saliva treated sample

Groups	N	Mean	Std.Deviation	t
Hum H	10	44.2000	6.03729	-11.076
L	10	69.8800	4.16007	

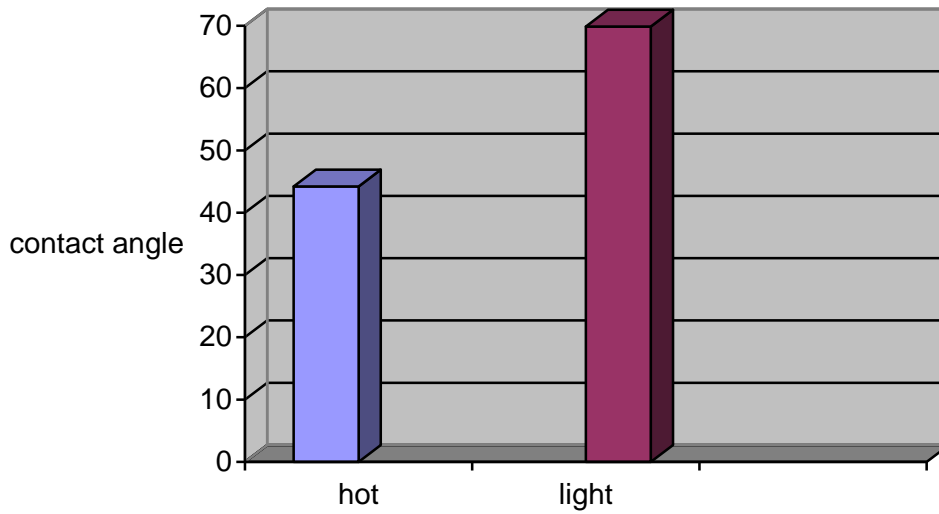


Figure 5: means for contact angle of human saliva treated samples

For samples treated with artificial saliva, heat-cured resin showed low contact angle which was 46.27 compared to high

contact angle of light-cured resin which was 65.28, this is shown in (Table 5)(Figure 6).

Table 5: t-test of contact angle of artificial saliva treated samples

Groups	N	Mean	Std.Deviation	t
Art H	10	46.2700	2078.4	-8.29
L	10	65.2800	67689.5	

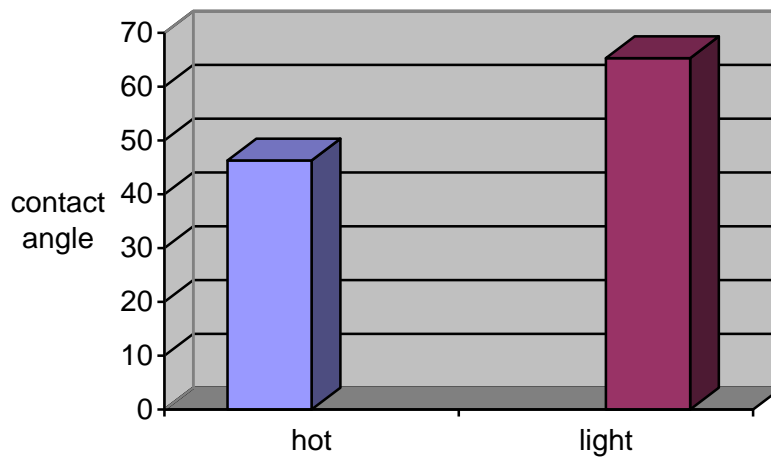


Figure 6: Means of contact angle of artificial saliva treated samples

For samples treated with propolis the mean value of contact angle of heat-cured resin was 47.01 while the contact angle of

light-cured resin samples treated with propolis was 49.96 ,this is shown in (Table6) (Figure 7).

Table 6 : t-test for contact angle for propolis treated samples

Groups	N	Mean	Std.Deviation	t
Pro H	10	47.0100	3.78284	-1.950
L	10	49.9600	2.92810	

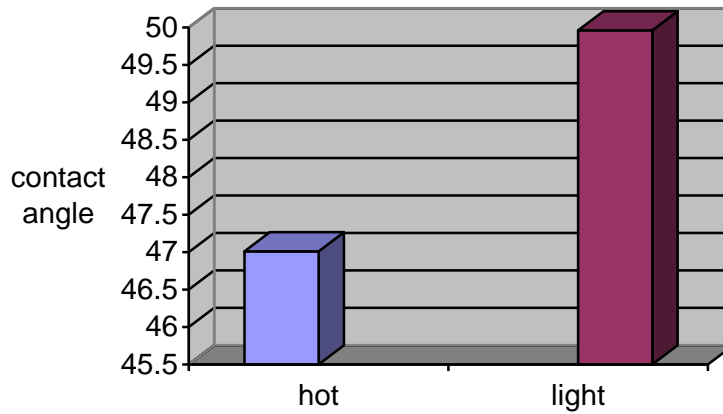


Figure 7: Means of contact angle of propolis treated samples

DISCUSSION

Contact angle measurement was used to examine the surface energy and tension related to wetting the material surfaces. The degree of wetting corresponds to the surface energy of the material, and the drop contact angle varies inversely with its wetting capability.⁽²⁵⁾

Contact angle can reflect the wettability of denture materials and it was influenced by many factors such as surface characters, surface roughness and temperature of the environment.⁽²⁶⁾

The measuring of contact angles at the solid-air-liquid meeting point is a widely known technique used to investigate the wettability of solid surfaces. The values obtained depend on the kind of surface topography, surface tension of the liquid and surface energy of the solid substrate.^(27,28)

The contact angle measurement method is probably the most definitive way to determine the hydrophobicity of material surfaces. Low water contact angle values indicate a hydrophilic surface, whereas high water contact angle are indicative of

a hydrophobic surface. If a contact angle is greater than 90 degrees, poor wetting occurs.^(29,1)

In this study, the wettability of heat-cured resin was better than the wettability of light-cured resin for all the treated groups, this result disagree with Sipahi *et al.*⁽¹⁴⁾

This result could be attributed to the different surface characteristics such as composition, fillers, and topography.⁽³⁰⁾

In this study human saliva and artificial saliva on heat-cured resin and light-cured resin produced better wettability, this result comes in agreement with Sipahi *et al.*⁽¹⁴⁾ and Sharma *et al.*⁽¹⁵⁾

For heat-cured resin the wettability for human saliva was better than the wettability of samples treated with artificial saliva. This result disagree with Aydin *et al.*⁽⁵⁾

For light-cured resin the wettability for samples treated with artificial saliva produced better wettability than samples treated with human saliva.

A factor that would affect the magnitude of contact angle of a fluid on a solid

surface is the roughness of the adherent surface, which differs with respect to the solid.⁽³¹⁾ Immersion of PMMA resins in propolis could alter the wettability due to the entrapment of water droplets in the pores of PMMA resins.⁽³²⁾ In this study, the lower values of contact angle found for groups treated with propolis could be attributed to the propolis accumulation on PMMA resin surfaces, which was visually detected. The results of this study for samples treated with propolis were in agreement with Silva *et al.*⁽²⁰⁾

CONCLUSION

Heat cured denture base material had better wettability than Visible light cure resin. For Heat cured denture base material, samples treated with human saliva had the the best wettability compared to samples treated with artificial saliva and propolis extract. For Visible Light cured resin ,samples treated with propolis extract had the best wettability compared to samples treated with human and artificial saliva.

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