

## Evaluation of Addition of Plant Fixed Oil Extracts (Ginger , Maramia, Eucalyptus) on Some Properties of Heat Cured Denture Base Material

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### الخلاصة

الاهداف: تهدف هذه الدراسة الى تقييم تأثير ثلاثة أنواع من زيوت النبات الطبية الطبيعية على قوة الانثناء وعلى المونومير المتبقي وعلى صلادة مادة البوليميثايل ميثاكريلات. المواد وطرائق العمل: تم تحضير (١٠٥) عينة للدراسة، خمس عشرة عينة منها من مادة قاعدة الاكريل نوع (بروبايكس) تم تحضيرها بدون إضافات (نماذج قياسية) و(٩٠) عينة تم تحضيرها مع إضافة زيت الزنجبيل، زيت الميرامية، وزيت اليوكالبتس بتركيزين هما (١,٥ و ٢,٥) بالمائة لتقييم قوة الانثناء، والصلادة والمونومير المتبقي. النتائج: أظهرت النتائج بان هناك فروقات واختلافات معنوية بين المجموع القياسية والمجموع المضاف إليها الزيوت فحص الصلادة وفحص قوة الانثناء. كذلك فان إضافة الزيوت قللت قوة الانثناء وزادت الصلادة لمادة قاعدة الطقم الاكريلية. كما أظهرت النتائج عدم وجود فروقات معنوية بين المونومير المتبقي للعينات القياسية مقارنة مع العينات المضاف لها الزيوت لكن مجموعة العينات القياسية في اليوم الأول أظهرت زيادة في تحرير المونومير المتبقي. الاستنتاجات: نستنتج من هذه الدراسة ان إضافة زيوت اليوكالبتس والميرامية والزنجبيل للراتنج الاكريلي قلل من قوة الانثناء للمادة. التراكيز العالية من (٢,٥%) أظهرت زيادة في قوة الانثناء لمادة الاكريل مقارنة بالتراكيز القليلة من (١,٥%). إضافة تلك الزيوت لمادة الراتنج الاكريلي زادت صلادة المادة وتركيز (١,٥%) اظهر زيادة في الصلادة مقارنة بتركيز (٢,٥%).

### ABSTRACT

**Aims:** The aim of this study was to evaluate the effect of three types of natural medicinal plants oils on the transverse strength, residual monomer and hardness of polymethylmethacrylate. **Materials and methods:** Total number of samples of (105) have been prepared in this study. Fifteen samples of heat cured ProBase acrylic resin were prepared without additives ( Control), and (90) samples were prepared with additives ( Ginger oil ,Meramia and Eucalyptus oil) in two concentrations (1.5 and 2.5) to evaluate transverse strength, indentation hardness and residual monomer. **Results:** The results showed a significant difference between control and addition groups in the transverse strength and hardness tests. The addition of oils decreased the transverse strength ,and increased the hardness. There was no significant difference between the residual monomer for control and addition groups, but the control group at the first day showed higher residual monomer release. **Conclusion:** The addition of eucalyptus , meramia and ginger oils to acrylic resin decreased the transverse strength , increased its hardness and showed no significant difference in residual monomer.

**Key words:** Ginger oil, Eucalyptus oil, sage oil.

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### INTRODUCTION

The material most commonly used for fabricating removable partial and complete dentures is heat-cured polymethyl methacrylate (PMMA). Its low cost, ease of application and polishing, and reliance on simple processing equipment have made

PMMA a preferred base material.<sup>(1)</sup> In recent years, there has been an increasing interest in the use of natural substances, essential oils are concentrated, hydrophobic liquids extracted from plant. They possess a wide spectrum of pharmacological activities. The antimicrobial effects of es-

essential oils have been documented and used in herbal medicine in many countries. (2) Ginger (*Zingiberofficinale*) is one of the most widely used species of ginger family. Ginger has long history of medicinal use dating back 2500 years in China and India. Recently, medical researchers have verified that ginger contains several bioactive constituents and possesses health promoting properties. (3) Maramia or sage oil (*Salvia officinalis L.*) it is one of the oldest medicinal herbs. It is mentioned in ancient Rome. It is used for healing in various ways. (4) Eucalyptus oil has numerous traditional uses. Eucalyptus oil based products have been used as a solvent/sealer in root canal dentistry. (5) Antifungal activity of ginger extract observed by study done by Zahra et al. (6) showed a significant effect on the oral species of (*Candidal Albicans*). The aims of this study is to evaluate the effect of incorporation of three plant oils (ginger, sage and eucalyptus) in two concentrations on the transverse strength, hardness and residual monomer of denture base acrylic resin.

## MATERIALS AND METHODS

The materials used in this study were ProBase hot cured acrylic resin denture base material (Ivoclar), and three types of commercially available oils (ginger, sage and Eucalyptus) which are used as additive into the powder of the acrylic and subtracted the volume from monomer volume in two concentration (1.5% and 2.5%). The samples were packed directly into prepared mold and then placed to be cured by two steps polymerization of water bath at 70 °C for 30 minutes, then proceed at 100 °C for 30 minutes (according to the manufacturers' instruction), in thermostatically controlled water bath. Then the flask was left aside for slow bench cooling before it was opened. (7,8) These acrylic resin specimens were subjected to the following tests: transverse strength test, Indentation hardness test and Measurement of residual monomer test. The total sample numbers were (105).

### Transverse Strength Test:

Thirty five Samples with dimensions of 65×10×2.5±0.03mm (length, width and thickness) respectively were prepared according to ADA (9). The samples stored in

distilled water at 37 °C for 48 hours, and subdivided into (7) groups as illustrated in diagram (1). The test was measured in air by using a three point bending on an Instron testing machine (Clock house, England). The device was supplied with a central loading plunger and two support, with polished cylindrical surface of 3.2mm in diameter and 50mm between supports. The support should be parallel to each other and perpendicular to the central line, the tests were carried out with cross head speed of 5mm/min. The test samples held at each end of the two support, and the loading plunger placed mid-way between the supports. The samples were deflected until fracture occurred the transverse strength were calculated using the following equation:

$$S = \frac{3PI}{2bd^2}$$

S = transverse strength (N/mm<sup>2</sup>)

b = width of specimen (mm)

d = depth of specimen (mm)

I = distance between supports (mm)

P = maximum force exerted on specimen (N) (10).

### Indentation hardness test:

Thirty five Samples were prepared with dimensions of 30×15×3±0.03 mm. The samples stored in a distilled water at 37 °C for 48 hours before testing, and subdivided into (7) groups. The samples surfaces were tested for hardness at five different locations then the mean is taken for each sample. The test was done by using Rockwell hardness tester (Brooks Inspection Equipment Ltd, Model MAT 24 CRBV, Cholchester-England), equipped with an indenter in the form of round steel ball of 6.350 mm in diameter. The sample was first subjected to fixed minor load of 10kg, then load of 60 kg was applied to the sample and the Rockwell hardness number was recorded after application of this load by 15 sec. (11)

### Measurement of residual monomer

Thirty five specimens were prepared using stone moulds in metal denture flasks, at dimensions of 20 x 20 x 3±0.03mm length, width and thickness respectively). Each specimen of each group was stored in a sealed glass container which contained 10 ml of distilled water at 37°C at time intervals (24, 48 hours, 3rd, 4th, 5th, 6<sup>th</sup> and 7th

days). At end of each leaching period, the supernatants were removed and replaced daily by other 10 ml of fresh distilled water. The time dependence of the monomer concentration was followed by monitoring the amount of monomer present in the supernatant medium using: Ultraviolet– visible spectrophotometer (Labomed,USA), wavelength of ( $\lambda=254 \text{ nm}$ )<sup>(12)</sup>.By SPSS

statistical program we obtained DUNCAN and ANOVA one way analysis.

**RESULTS**

**Evaluation of Transverse Strength:**

The transverse strength of seven different groups of heat cured acrylic denture base (control and additives)was evaluated, meanand standard deviation shown in Figure (1).

MPa

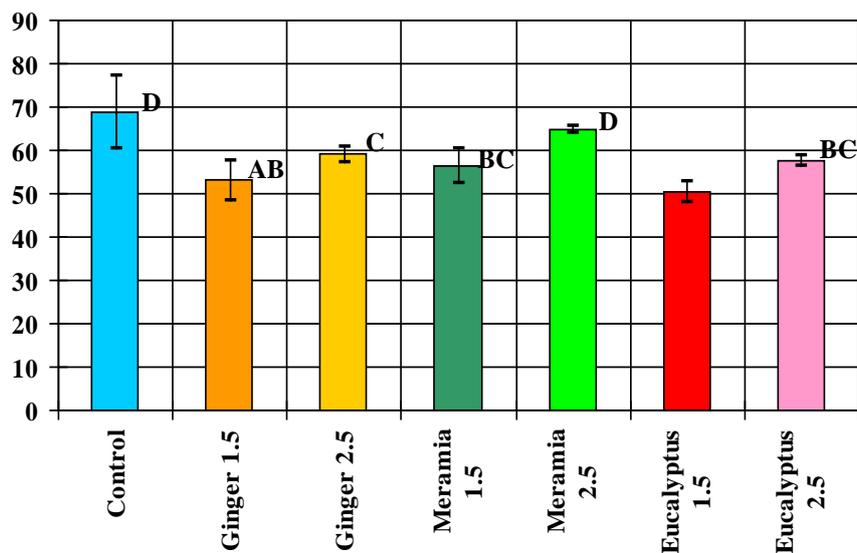


Figure (1): Transverse strength

One way ANOVA of transverse strength showed significant difference

between the tested groups at  $p \leq 0.05$  (Table 1).

Table (1): ANOVA of transverse strength

	Sum of Squares	df	Mean Square	F	p-value
Between Groups	1214.090	6	202.348	12.208	0.000
Within Groups	464.112	28	16.575		
Total	1678.202	34			

Duncan’s multiple range test of transverse strength for the tested groups were shown in (Table2).

Table (2): Duncan's multiple test of transverse strength

Group	No.	Duncan's Grouping			
		A	B	C	D
Eucalyptus 1.5	5	50.400			
Ginger 1.5	5	53.100	53.100		
Meramia 1.5	5		56.400	56.400	
Eucalyptus 2.5	5		57.600	57.600	
Ginger 2.5	5			59.100	
Meramia 2.5	5				64.800
Control	5				68.640

Eucalyptus 1.5% showed the lowest strength ( $50.400 \pm 2.24$ ), Ginger 1.5% ( $53.1 \pm 4.52$ ) with no significant difference between them. Meramia 1.5% show ( $56.4 \pm 3.8$ ) with no significant when compare to Ginger 1.5%. Eucalyptus 2.5% showed transverse strength value ( $57.6 \pm 1.2$ ) then ginger 2.5% showed ( $59.1 \pm 1.77$ ) with no significant difference between them. Meramia 2.5% and control group showed significant difference with value ( $64.8 \pm 0.84$ ,  $68.64 \pm 8.37$ ) respective-

ly. The results showed that the transverse strength is higher in 2.5% oil concentration for the additive groups than 1.5% for the same groups. In spite the control showed highest transverse strength value when compared to all additive groups.

**B-Evaluation of Hardness** The hardness of the control group of the heat cured acrylic denture base and the other six additive groups was tested. Hardness means and standard deviation were shown in (Figure 2).

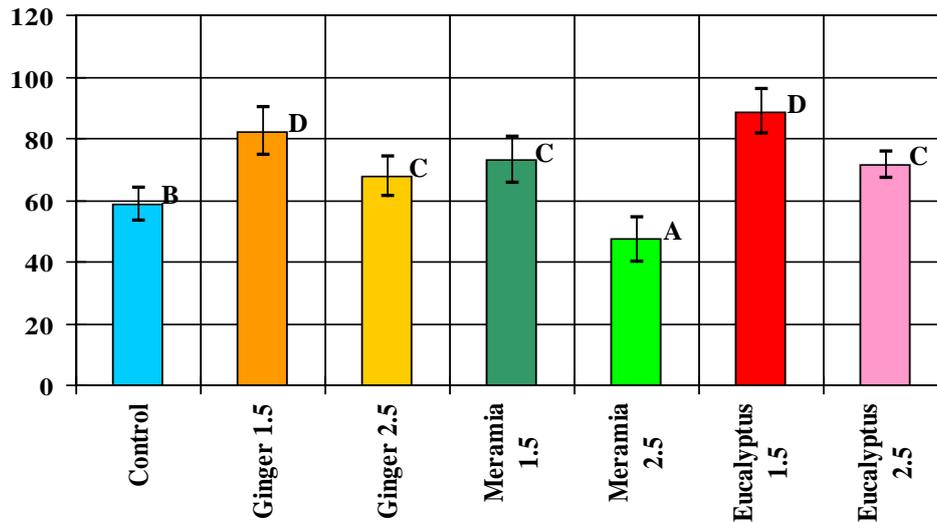


Figure (2): Hardness test

One way ANOVA of hardness showed significant difference between the tested groups at  $p \geq 0.05$  as shown in Table (3).

Duncan's multiple range test of hardness for the tested groups were shown in (Table 4).

Table (3): ANOVA of hardness

	Sum of Squares	df	Mean Square	F	p-value
Between Groups	5781.087	6	963.514	21.983	0.000
Within Groups	1227.212	28	43.829		
Total	7008.299	34			

Table (4): Duncan's multiple test of hardness

Group	No.	Duncan's Grouping			
		A	B	C	D
Meramia 2.5	5	47.400			
Control	5		58.660		
Ginger 2.5	5			67.700	
Eucalyptus 2.5	5			71.300	
Meramia 1.5	5			73.200	
Ginger 1.5	5				82.400
Eucalyptus 1.5	5				88.600

Highest value recorded for eucalyptus 1.5% and ginger 1.5% ( $88.60 \pm 3.2496$ ,  $82.4 \pm 3.4293$ ) respectively, meramia 1.5%, eucalyptus 2.5% and ginger 2.5% have ( $73.2 \pm 7.5$ ,  $71.3 \pm 4.3$  and  $67.7 \pm 6.3$ ) respectively. All above additive groups showed

significant difference to control group which record ( $58.66 \pm 5.20$ ).

**C-Evaluation of Residual Monomer:** The residual monomer everyday release of the heat cured acrylic denture base (control and additive groups) was measured in ( $\mu\text{g}$ ) for seven days is plotted in (Figure 3).

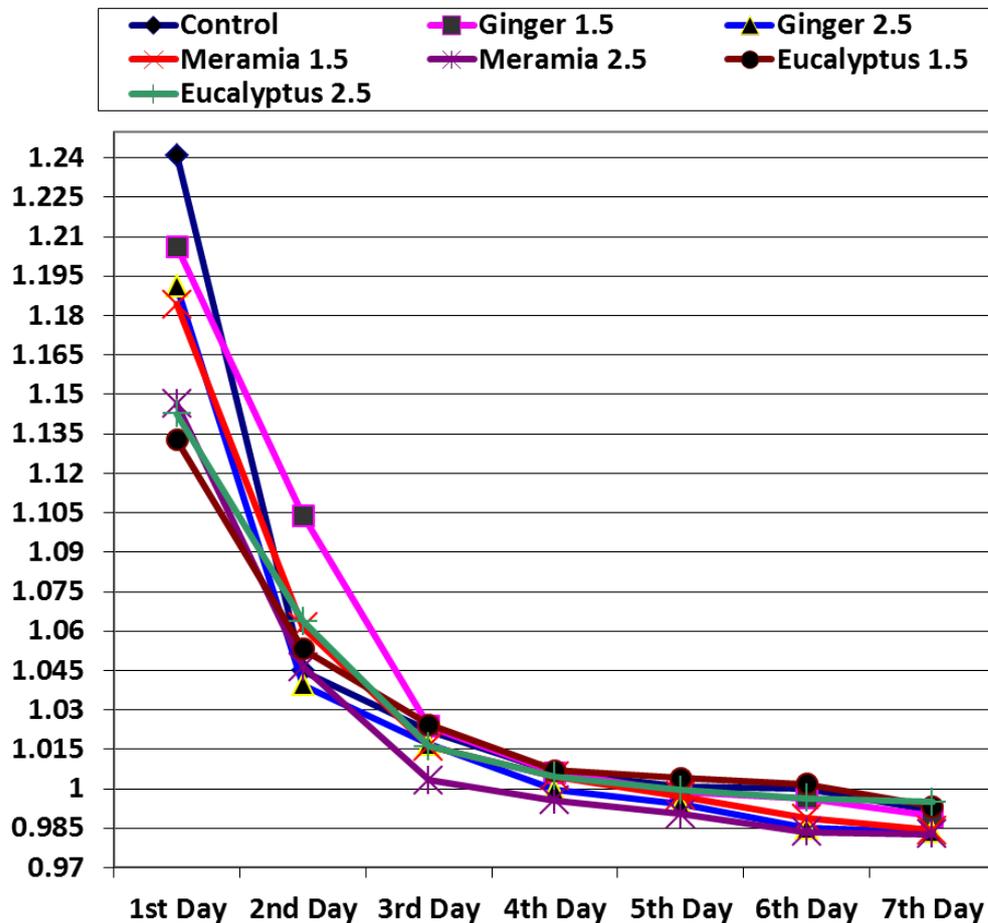


Figure (3): Residual monomer

There are no significant differences between residual monomer for control and additive groups.

### DISCUSSION

The transverse strength test, one of the mechanical strength tests, is especially useful in comparing denture base materials in which a stress of this type is applied to the denture during mastication<sup>(13)</sup>. The transverse (flexural) strength is a combination of compressive, tensile and shear strength, all of which directly reflect the stiffness and

resistance of material to fracture. The present in vitro investigation was designated to compare the transverse strength of heat cured acrylic resin (control) and additive groups (Eucalyptus, Meramia and Ginger) in two concentration (1.5% and 2.5%). The recent study showed that the control group has higher transverse strength than the additive groups for both 1.5% and 2.5%. This may be due to that the oil will coat the polymer particles and this coating will decrease the amount of conversion of monomer to polymer and some unreacted mono-

mer are left in the polymerized material, so this will weaken the mechanical strength of the resin. <sup>(14)</sup> This results disagree with *Hatim et al 2010*<sup>(15)</sup> that may be due to the type of essential oil used in the study or the difference in oil concentration applied.

**The hardness test:** The Rockwell hardness test is based on the ability of the surface of any material to resist the penetration of a specific tip with a given load for a specific time. In our study, there is a significant difference between the control and additive groups, there is a significant difference between the two concentration for all additive groups with higher hardness for 1.5% concentration, this may be due to unreacted monomer with oil coated polymer and this can explained by water sorption phenomenon of methylmethacrylate denture base material <sup>(15,16,17)</sup>. It has been proven that there is a relationship between residual monomer and water sorption, if residual monomer is present, less monomer conversion occur and may result in increasing sorption, as water sorption increase the hardness increase agree with *Hatim et al 2010*<sup>(15)</sup> and these two properties related to surface properties <sup>(18)</sup>.

**Residual monomer** According to the results at the 1<sup>st</sup> day show higher residual monomer release this can explained by the uncoated particles with oil cause faster monomer release. At the 2<sup>nd</sup> day the elution from additive groups increase with significant difference to control ( the day we test the hardness and transverse strength) due to unreacted monomer coated with oil<sup>(15)</sup>, then continue by gradual longer lasting elution of monomer <sup>(19)</sup> with no significant difference between tested groups.

### CONCLUSIONS

- 1- The addition of eucalyptus , meramia and ginger oils to acrylic resin decreased the transverse strength, the high concentration of 2.5% showed the higher transverse strength than the concentration of 1.5%.
- 2- The addition of these oils to acrylic resin increased its hardness and the 1.5% concentration showed increase in hard-

ness compared to the concentration of 2.5%.

3-There are no significant differences between residual monomer for control and additive groups.

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