Journal of Medicinal and Chemical Sciences 6 (2023) 1614-1620

Journal of Medicinal and Chemical Sciences

Journal homepage: http://www.jmchemsci.com/

Original Article

The Effect of Addition Radish Oil on Some Mechanical Properties

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ARTICLE INFO

Article history

Receive: 2022-09-23
Received in revised: 2022-10-09
Accepted: 2022-10-21
Manuscript ID: JMCS-2210-1826
Checked for Plagiarism: **Yes**
Language Editor:
Dr. Fatimah Ramezani
Editor who approved publication:
Dr. Ali Delpisheh

DOI:10.26655/JMCHEMSCI.2023.7.12

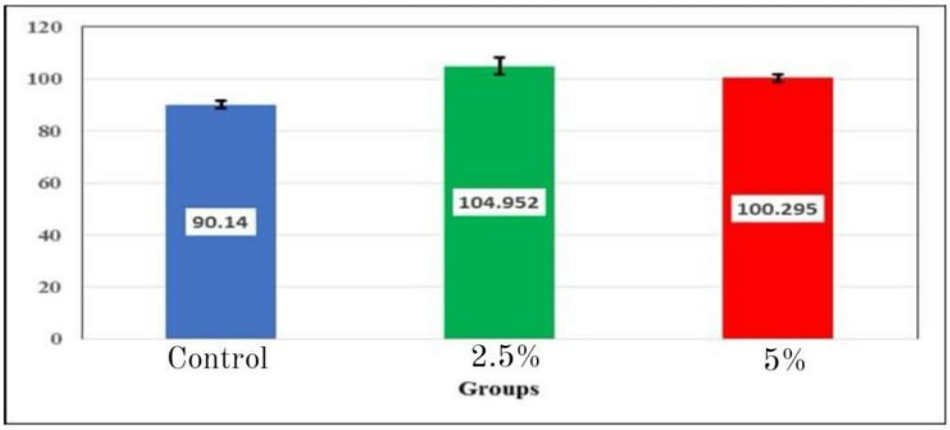
KEYWORDS

Essential oils
Radish oil
Polymethyl methacrylate material

ABSTRACT

The objective of this study is to investigate the effects of radish oil on the transverse strength and surface roughness of polymethyl methacrylate. In this study, a total of sixty (60) samples have been made. 20 specimens of heat-cured acrylic resin were created with no additives (control), and 40 samples were created with additives in different concentrations (2.5% wt and 5% wt) to test the surface roughness and the transverse strength. In the surface roughness test, a non-significant difference was found between the control and addition groups, but a high significant difference was observed in the transverse strength. When oils were added, the surface roughness decreased and the transverse strength increased. When radish oils were added to acrylic resin, the surface roughness decreased and the transverse strength increased.

GRAPHICAL ABSTRACT



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Introduction

The material most commonly used for the fabrication of dentures complete or partial is heat-cured poly (methyl methacrylate) (PMMA). This material is not ideal in every respect and it is the combination of virtues rather than one single desirable property accounts for its popularity and usage. However, it is still far from ideal with fulfilling the mechanical requirements of prosthesis [1]. One of the most common complications of denture base prosthesis is cracking of denture due to its rigidity either from the long-term fatigue failure caused by repeated masticatory force or from extra-oral high impact force resulting from accidental dropping of the prosthesis [2]. Bacterial resistance to the antibiotics became a considerable clinical problem as bacteria is able to develop resistance to antimicrobial agents, which is inconstant in different geographic regions and it has been connected with general population consumption of antibiotics. Moreover, the antibiotics resistance serious threat to the global public health, which decreases the efficacy of these remedies and compromises patient. Medicinal plants and herbs have been considered as one of the important type of medicines from the start of human development. Moreover, the number of medicinal plants used in the indigenous medicine has been tested as the alternative medicines because of their bactericidal properties. Hence, many research focused on the potential application of natural antimicrobial compounds in food, cosmetic, and pharmaceutical manufacturing which is of high significance [3]. The essential oils are concentrated, water-repellent liquids that come from plants. They can do a lot of different things in the field of pharmacology.

They have been shown to kill bacteria and are used in herbal medicine in several countries. After testing the plant extracts and oils for antimicrobial activity, it was found that Brassicaceae plants could be a source of chemicals that kill bacteria [4]. Research in dentistry has shown that incorporating radish oil to heat-cure acrylic makes it less likely that yeast will grow on the acrylic. This could be a new way to treat denture stomatitis [5]. Radish oil works well as an antifungal when added to polymers, but we do not know what happens to the surface of the denture base material after the oil is added.

Materials and methods

Specimens preparation

Surface roughness

Thirteen samples that are (65 mm long, 10 mm wide, and 2.5 mm thick). Before the test, all of the samples had keep in filtered water at 37 °C for 48 hours (ADA specification No.12, 1999) [6]. Profilometer was used to study the microgeometry of test samples (Figure 1). This tool is made up of a surface analyzer, which is a sharp diamond stylus used to trace the profile of surface imperfections. The stylus can move up to 11 mm, and it records all of the peaks and valleys on the test specimen surface. Three areas, one in middle, and two at each end were chosen, and the average of the three readings was calculated.

Transverse strength test

According to ADA [6], thirteen samples were made with the following sizes: 65102.50.03 mm (length, width, and thickness). The specimens were kept in filtered water at 37 °C for 48 hours, and then they were split into three groups. The test was done in the air with an Instron testing machine and a three-point bend (Clock House, England). The device emerged with a central plunger for loading and two supports. The polished cylinder surface of the supports was 3.2 mm in diameter, but there was 50 mm between them. The supports should be the same distance from the center line and parallel to each other. The tests have been done with the cross head moving at a speed of 5mm/min. The test specimens had been kept between the two supports and the loading plunger was placed between the two supports. The samples were bent until they broke, and then the transverse strength was determined by using the formula:

$$S=3PI/2bd2$$

S=Transverse strength (N/mm^2)

b = Sample width (mm)

d = Sample depth (mm)
I = The space between supports (mm)
P = The most force that was put on the specimen (N) [6]

Mold preparation

To make the stone mold, separating medium was put on the plastic patterns made for the roughness test and the transverse strength test. The dental stone was put in the bottom of the metal flask. The plastic patterns were put into the flask until they reached about half of flask depth. The top half of the flask was then filled with stone, which was shaken, and the lid was put on. After the stone was set, the two halves were separated and the plastic patterns were taken off to make a mold cavity for the acrylic specimen. Separating medium was then added and left to dry, and the flask was then ready for packing the acrylic specimen.

Specimens fabrication

Twenty samples for the control group were made from heat-cure acrylic resin (Czech, super acryl) using the manufacturer's recommended powder-to-liquid ratio of 44gm±0.2/20 mL, while the experimental groups (40 samples) had been created within the same acrylic resin, but with varying quantities of 100% radish oil (Hemani, Pakistan) (2.5 wt%, 5 wt%). The needed quantity of radish essential oil was measured with a micropipette and calculated by subtracting from the amount of monomer. The oil and monomer were then mixed for 1 minute with a mini electric hand mixer in a clean and dry glass beaker. Thereafter, this mixture was incorporated to acrylic powder and mixed. Curing was done according to the instructions from the manufacturer.

Mechanical and physical tests

Before each test, all of the specimens were kept at 37 °C for 48 hours in filtered water [6].

Transverse strength test

The test was carried with the Instron universal test machine CZL203. Each specimen was put horizontally on the bending fixture that has two parallel supports that are 50 mm apart. A load applied with a cross head speed of 1 mm/min by a rod in the middle of the supports, causing the sample to bend until it broke. Using the following equation, the transverse bend strength was found.

Transverse strength = 3PL/2bd2
p: Load peak.
L: Length of the span (50 mm).
b: Width of sample.
d: Thickness of sample.

Test of surface roughness

Profilometer used to study the test pieces' microgeometry. This device is made up of a surface analyzer, which is a sharp diamond stylus used to trace the profile of surface imperfections. The stylus can move up to 11 mm, and it archives all the peaks and valleys on the test specimen surface. Three areas, one in the middle and two at each end, were chosen, and the average of the three readings was found.

Results and Discussion

After 48 hours of incubation in filtered water, the surface roughness result shows that both experimental groups (2.5 wt% and 5 wt% radish oil) had the lower mean values than the control group. The participants with (5 %radish oil) had the least mean value of (1.72005 m), as displayed in Figure 1.

After 48 hours of incubation in filtered water, the surface roughness result shows that both experimental groups (2.5 wt% and 5 wt% radish oil) had the lower mean values than the control group. The participants with (5 %radish oil) had the least mean value of (1.72005 m), as displayed in Figure 1.

One-way ANOVA for roughness test showed that there was no significant difference in the mean values between any of the groups ($p > 0.05$) (Table 1). One-way ANOVA of roughness test.

In distilled water, the transverse strength test showed that both experimental groups After 48 hours of incubation (2.5 wt% and 5 wt% radish oil) had a higher mean value than the control group and the experimental group with 2.5%

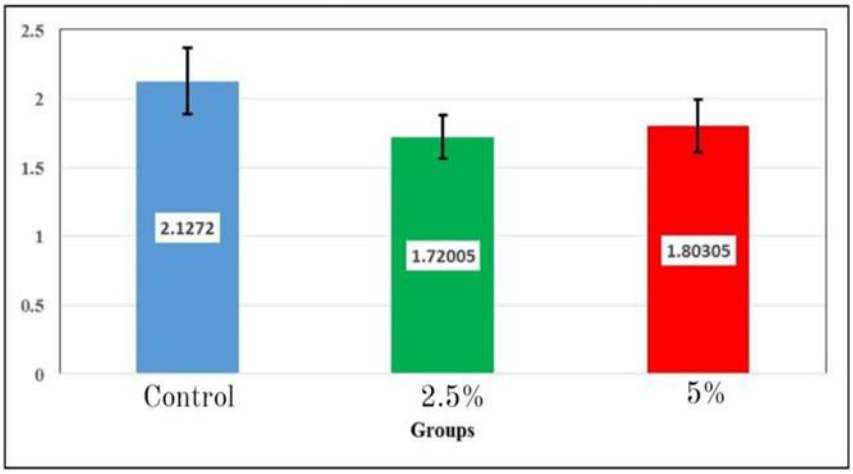

Figure 1: The Roughness test bar chart shows the average values and standard deviations from the mean for all groups in micrometers

Table 1: One-way ANOVA of Roughness test

ANOVA					
VAR00001					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.311	2	0.156	0.896	NS
Within Groups	4.691	27	0.174		
Total	5.003	29	Mean Square		

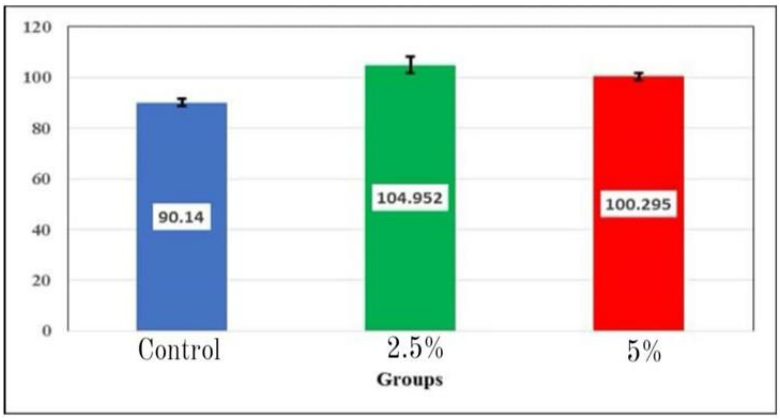

Figure 2: The mean values and standard deviations from the mean for each study group are shown on a bar chart for the transverse strength test (N/mm²)

radish oil had the highest mean value (104.952 N/mm²) (Figure 2).

The transverse strength test's one-way ANOVA revealed a highly significant difference in the mean values of all groups ($p< 0.01$) (Tables 3). To choose the kind of multiple comparison post hoc test and assess the homogeneity of variances, Levene's test was used (Table 3). Levene's test for the transverse strength test is shown in Table 3.

The Post-hoc Tucky's (Honest Significant Difference) test was performed to compare the mean values across all research groups. The experimental groups (2.5 wt% and 5 wt%) showed a highly significant difference from the control group ($P<0.01$), and there was also a highly significant difference between the experimental groups (2.5 wt% and 5 wt%) at ($P< 0.01$) levels (Table 4).

Table 2: The transverse strength test using one-way ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1147.357	2	573.678	126.812	0.000 HS
Within Groups	122.144	27	4.524		
Total	1269.501	29			

Table 3: Levenś test for transverse strength test

	Levene Statistic	df1	df2	P value	Sig.
Based on Mean	3.155	2	27	059	NS

Table 4: Post-hoc Tuckyś test for transverse strength test

Tukey HSD						
(I) VAR00002	(J) VAR00002	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Control	2.5%	-14.81200*	0.95119	0.000	-17.1704	-12.4536
	5%	-10.15500*	0.95119	0.000	-12.5134	-7.7966
2.5%	5%	4.65700*	0.95119	0.000	2.2986	7.0154

* The mean difference is significant at level of 0.05.

The roughness of a material's surface is an important property that plays a big part in how it interacts with its surroundings [7]. One of the main goals of resin restoration is to get a smooth surface without or with very fine surface scratches. An increase in the surface roughness makes dentures look bad, while a smooth and shiny surface makes it harder for stains, debris, and plaque to build up [8]. Therefore, it impacts the health of the tissue right next to the denture. Likewise, most microorganisms in the mouth, especially those that cause denture stomatitis, cavities, and periodontal disease can only live in the mouth if they stick to a surface that doesn't shed and start to form colonies [9]. Knowingly, the roughness of the surface of dental acrylic resins is mostly caused by how the material is made, how it is polished, and how skilled the operator is [10]. In this study, adding 2.5 and 5% radish oil made the surface roughness values go down compared with the control group (0 % radish oil), and this drop was statistically high significant for both experimental groups. This could be because the physical bonds between oil molecules and resin particles make it easier for polymer chains to stick together. This makes it less likely that particles will break off the surface during de-flasking and grinding, which could make the surface less rough.

This explanation fits with a study from 2013 by Srivatstava *et al.*, who added oregano oil to tissue conditioner and found that the surface roughness was lessened. It is important to remember that different experimental methods, different types of PMMA used, and different ways of measuring surface roughness make it hard to compare roughness values from different studies [11].

Transverse strength is a mechanical property that is most often measured in research because its loading characteristics represent the clinical situation that the denture base goes through intra-orally [12]. This property directly reflects the material's resistance to fracture because it is a combination of compressive, tensile, and shear strengths [13]. Therefore, the more transverse strength a material has, the less likely it is to break under masticatory load.

In this study, adding 2.5% or 5% radish oil increased the transverse strength values compared with the control group (0% radish oil), and this increase was statistically high significant for both experimental groups. These results could be caused by radish oil, which may act as an elastomer with PMMA, or by the fact that the maximum saturation of the matrix between PMMA and radish oil happened at these concentrations. This is in agree with [14] results, which showed that adding tea tree oil to heat-

cured acrylic resin makes it stronger in all directions.

Another reason for these results could be that the PMMA denture base material absorbs water [15]. This is in agreement with a study of [16], revealing that adding Thyme and Nigella oils to acrylic resin makes the material stronger across its width. These results are different from those of [17], who found in their study that adding eucalyptus, meramia, and ginger oils to acrylic resin made it weaker in the transverse direction. This could be because of differences in the type of oil and its chemical makeup, or because different amounts of oils were added to the material.

Conclusion

Within the limits of this research, it could be mentioned that when radish oil was added to heat-cured acrylic resin at both concentrations (2.5% wt and 5% wt), the roughness test had a Non-significant decrease, but the transverse strength test had a high Significant increase was seen in all concentration.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

Conflict of Interest

The author declared that they have no conflict of interest.

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HOW TO CITE THIS ARTICLE
Sadeq Aadi Rahi, Wasmaa Sadik Mahmood. The Effect of Addition Radish Oil on Some Mechanical Properties. *J. Med. Chem. Sci*., 2023, 6(7) 1614-1620
https://doi.org/10.26655/JMCHEMSCI.2023.7.12
URL: http://www.jmchemsci.com/article_161704.html