

## The Effect of some Natural Products as a Denture Cleansers on some Physical Properties of Acrylic Denture Base Material

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### Key words

denture cleanser,  
surface roughness  
and hardness,  
acrylic resin.

### Abstract

The study aims to evaluate the effect of some commercially available natural products (soda+ vinegar, soda +thymol , saturated salt solution) in relation to the commercial denture cleansers (Protifex) ,on surface roughness and hardness dimensional accuracy of acrylic denture base materials. one hundred samples were prepared from heat activated acrylic resin denture base material, they are (1cm\*1cm\*2mm length, width and thickness respectively). After that, half of the samples for each group were immersed for ½ hr per day in the denture cleanser, the other half of the samples immersed for 8 hr per day in the denture cleanser through one month. The denture cleansers used are three solutions prepared freshly everyday for immersion of the samples. The surface roughness of the samples were tested by using Stylus profilometer(Talysurf 10, England), while the hardness of the samples were tested by using Rockwell hardness tester (Wolpert, Germany), the mean is taken for each group and evaluated by using one way analysis of variance test, Dunnet T-test to compare the groups. The results demonstrated that there were no significant differences in the surface roughness and hardness, but with significant difference between treats of length of acrylic resin denture base material and duration of immersion at (P=0.05). All the prepared natural solutions would be accepted in relation to effect on surface roughness , dimensional accuracy, and hardness of acrylic denture base material.

### Introduction

Acrylic resin is the most employed material in the construction of removable complete denture. This material has been used since 1930<sup>(1,2)</sup>. Chemical cleansing approach is recommended for plaque control <sup>(3-7)</sup> as an alternative to the mechanical approach in patients with lack of motor coordination<sup>(8)</sup>. Chemical denture cleaning solution includes; oxidizing type, disinfectant solutions, and diluted acids<sup>(9,10)</sup>. Knowledge of constituents of

denture cleanser, their efficiency, adverse effects and safety are important needs for dental staff <sup>(11,12)</sup>. The surface roughness (Ra) is a measure of the irregularity of the finished surface<sup>(10)</sup>. The surface roughness of the denture base materials is an important factor in controlling its rate of staining <sup>(13-17)</sup>. Any dental restoration or appliance placed permanently in the oral cavity should be highly polished <sup>(18-20)</sup>. Hatim *et al*<sup>(21)</sup> prepared a new denture cleanser composed of oxalic and tartaric acids which had nearly the same effect on the surface roughness in relation to

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stearadent tablets by immersion technique. This study is to evaluate the effect of some commercially available new denture cleansers on the surface roughness, dimensional accuracy, and hardness of acrylic denture base material.

## Materials and Methods

One hundred and fifty samples were prepared from heat activated acrylic resin denture base material (Major heat activated acrylic resin). Specimens for the three physical tests (surface roughness, hardness, dimensional accuracy) were prepared in dimensions of (1cm\*1cm\*2mm length, width and thickness respectively) according to Webb *et al.*<sup>(22)</sup>. For each test samples were divided into two groups: 25 specimens immersed for about 1/2 hr and 25 specimens immersed for about 8hr, where each 5 specimens immersed in one of the five solutions throughout one month. Flasking was done by mixing in ratio of 28 ml of water: 100 gm of stone, the procedure was done in the conventional method<sup>(1)</sup>. Packing and Curing were carried out by placing the clamped flask in a thermostatically controlled water bath for (1 hr at 74°C then 1/2 hr at 100°C), according to the manufacture instructions, after the completion of curing, flasks were allowed to bench cool for 30minuts. The acrylic specimens were removed from their stone moulds. Any flashes of excess resin material were removed from the specimens. Then specimens numbered on the polished side, and a small hole was prepared in the midline of the upper part for each specimen to allow dispersion by a nylon dental floss in solution without contacting each other so the specimen is surrounded by the solution only. The specimens were stored in distilled water at 37°C in the incubator for 7 days for conditioning.

### Solutions Preparation

This study deals with three experimentally prepared solutions of (soda+ vinegar, soda +thymol, saturated salt solution) diluted in 100 ml of distilled water

(Table 1)<sup>(23)</sup>, and one commercial denture cleanser tablets (Protifex) for comparison and distilled water as a control solution.

#### A- Surface Roughness Test:

Surface roughness is measured by using stylus profilometer. (Talysurf 10) with diameter of the stylus about (5µm), three readings (Ra) that represent average roughness for each specimen is measured.

#### B- Dimensional Accuracy Test:

Dimensional accuracy is measured by using electronic digital caliper with accuracy of 0.001mm.

#### C-Surface Hardness Test:

Hardness was measured by using Rockwell hardness tester (Wolpert) by using HRR style for the elastic materials, with 60 pound load, and the head of the tester(indenter) is a ball of 2,5 mm in diameter.

## Results

**A-Surface Roughness of Acrylic Denture Base Material:** Descriptive statistic of surface roughness of acrylic denture base material between 1/2 hour versus 8hours immersion in the prepared solutions for one month in the prepared solutions (Table 2, and Figure 1). The one way analysis of variance (Table3) showed that at P=0.05 there were no significant differences between different treatments, and no significant differences between different treatments and times, and there were no significant differences between the two times (immersion for 1/2 hour and 8hours daily for one month in the prepared solutions).Duncan's multiple range test (Table 5) showed that at P = 0.05, there were slight increase in surface roughness for all different treatments except for soda + thymol where decrease in surface roughness occur. The best prepared solutions were soda + vinegar and saturated salt solutions while the worst one was Protefix.

**B-Dimensional Accuracy (length, width, and thickness) of acrylic denture base:** Descriptive statistic of dimensional accuracy of length, width, and thickness of acrylic denture base material between 1/2 hour versus 8hours immersion in the

prepared solutions for one month were shown in Table (2). Table (3) showed that at  $P = 0.05$  there were significant differences of length and width between different treatments, but no significant differences between the two times (immersion for 1/2 hour and 8 hours daily for one month in the prepared solutions). Duncan's multiple range test for dimensional accuracy of length, and thickness (Table 5) showed that at  $P = 0.05$ , the best prepared solution was saturated salt solutions.

**C- Surface Hardness of Acrylic Denture Base Material:** The mean, standard error and the 95% confidence interval for the hardness of acrylic denture base material between 1/2 hour versus 8 hours immersion in the prepared solutions for one month were shown in Table (3) and Figure (2). Table (4) showed that at  $P=0.05$ , there were no significant differences of surface hardness between all treatments, no significant differences between the two times of immersion in solutions. Duncan's multiple range test (Table 5) showed that, the best prepared solutions were soda +vinegar and saturated salt solutions.

## Discussion

### A- Surface Roughness of Acrylic Denture Base Material:

The result of surface roughness of this study agreed with authors<sup>(21,23,24)</sup>, they showed that no damaging effect of the disinfectant on the surface of acrylic denture base material, the slight increases in surface roughness by action of tested solutions in relation to D.W may be explained by<sup>(25)</sup>, the higher ionic concentration of denture cleanser compared to water, led to higher release of soluble components. All the prepared natural solution would be accepted in relation to effect on surface roughness of acrylic denture base material. The best prepared natural solutions were soda +vinegar and saturated salt solutions, while the worst one was Protefix that cause the greatest surface roughness. Thymol is the only one that cause decrease in surface roughness of acrylic denture

base material, this may be due to the solvent action of thymol<sup>(26)</sup>. The average range of surface roughness (Ra) of acrylic denture base material treated with the four tested solutions was (0.86-1.2 $\mu$ m), that is accepted by<sup>(27)</sup> were they give a range of surface roughness (Ra) of acrylic denture base material of (0.02 to 3.99-5.3  $\mu$ m).

### B-Dimensional Accuracy of Acrylic Denture Base Material:

The results showed that the four tested solutions had less effect on dimension of acrylic denture base than water. This may be due to the small size of water molecules that more easily penetrate the material and act as plasticizer<sup>(28)</sup>.

### C- Hardness of Acrylic Denture Base Material:

The results showed that according to the mean value of hardness of acrylic denture base material in immersion for 8 hours and 1/2 hour daily for one month in the prepared solutions, there was an increase in hardness in 8 hours in relation to 1/2 hour immersion with Protefix and saturated salt solutions, this agreed with there is a gradual increase in surface hardness of some denture base resins after water immersion<sup>(29,30)</sup>, this improvement in the hardness property has been attributed in part to leaching of the residual monomer from the resin<sup>(29)</sup>, or may be due to saturation effect of these solutions on acrylic denture base material, and this disagreed with<sup>(31)</sup> who stated that there is decrease in hardness of different denture resins by immersion in disinfectants, regardless the material of denture resins or the type of disinfectant solutions used, while soda + thymol solution cause decrease in hardness in 8 hours in relation to 1/2 hour immersion. This could be attributed for the slow absorption of disinfecting solution in relation to water, that cause increase in elasticity and decrease in hardness of acrylic denture base material<sup>(32,33)</sup>, that is agreed with<sup>(34,35)</sup>. There were no significant differences between immersion for 1/2 hr and 8 hrs daily for one month in the prepared solutions, and there were no significant differences between all prepared solution and the control, where the best prepared natural solutions were soda +vinegar and saturated salt

solutions. The hardness range for acrylic denture base material immersed in all the tested solutions for one month were (115-123.75) that is accepted and fall in ranges given by authors<sup>(31, 36,37)</sup>.

### Conclusions

All the prepared natural denture cleansers were accepted in relation to the surface

roughness, dimensional accuracy and hardness of acrylic denture base material. Although Protefix is a commercial denture cleanser, but it produces the roughest surface of the acrylic denture base material in relation to the natural denture cleansers (but in a manner still within the acceptable rang in relation to the control).

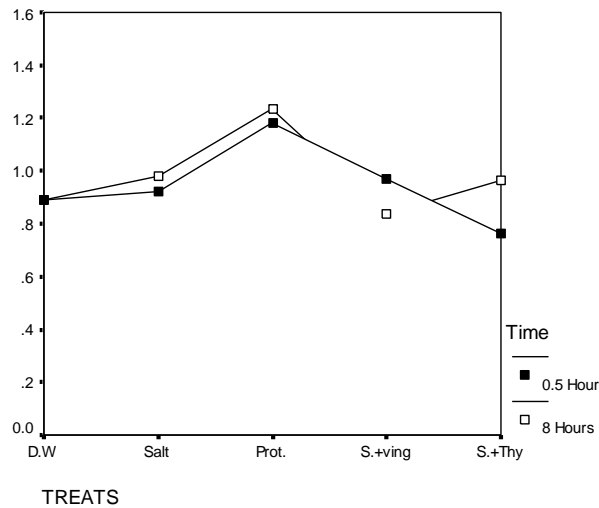


Fig.(1):-The mean for the surface roughness of acrylic denture base material between 1/2 hour versus 8hours immersion in the prepared solutions for one month.

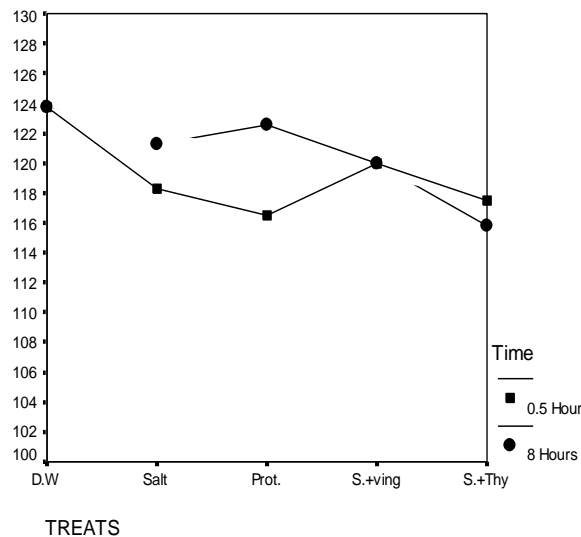


Fig.(2):- The mean for the hardness of acrylic denture base material between 1/2 hour versus 8hours immersion in the prepared solutions for one month.

Table (1):- Solutions Preparation (Khalil)<sup>(26)</sup>.

Solution no.	Material 1	Weight or volume	Material 2	Weight or volume
1	Soda	7 g	Clear vinegar	5 ml
2	Soda	2 g	Thyme oil	3.57 g
3	Saturated salt	40 g		
4	Distilled water	100 ml		
5	Protefix	1 tab= 2.85		

Table (2):- Descriptive statistics for surface roughness, length, width, thickness of acrylic denture base.

TREATS	Time of immersion	Mean , Roughness ( $\mu\text{m}$ ) $\pm$ S D	Mean L.(mm) $\pm$ S D	Mean W.(mm) $\pm$ S D	Mean T.(mm) $\pm$ S D	N
D.W	0.5 Hour	.888333 $\pm$ .1130339	10.0480 $\pm$ .14516	10.0480 $\pm$ .14516	2.0420 $\pm$ .04324	5
	8 Hours	.888333 $\pm$ .1130339	9.8880 $\pm$ .20523	10.2180 $\pm$ .40960	2.0940 $\pm$ .08620	5
Salt	0.5 Hour	.921667 $\pm$ .4901190	9.8680 $\pm$ .22242	10.0680 $\pm$ .22242	2.0960 $\pm$ .12720	5
	8 Hours	.981667 $\pm$ .2015358	9.9580 $\pm$ .28199	10.0880 $\pm$ .02950	2.0900 $\pm$ .09083	5
Protefix	0.5 Hour	1.183333 $\pm$ .4082483	10.1000 $\pm$ .16186	10.1000 $\pm$ .16186	2.1040 $\pm$ .11589	5
	8 Hours	1.235000 $\pm$ .3293478	10.1200 $\pm$ .08396	10.0980 $\pm$ .04604	2.1240 $\pm$ .05320	5
S.+ving	0.5 Hour	.971667 $\pm$ .2592618	9.9700 $\pm$ .15297	9.9700 $\pm$ .15297	2.1320 $\pm$ .06458	5
	8 Hours	.835000 $\pm$ .3888830	10.1380 $\pm$ .04266	10.1200 $\pm$ .06519	2.1620 $\pm$ .06496	5
S.+Thy	0.5 Hour	.763333 $\pm$ .1768238	10.0860 $\pm$ .04669	10.0860 $\pm$ .04669	2.1220 $\pm$ .04604	5
	8 Hours	.961667 $\pm$ .4069111	10.1260 $\pm$ .09099	10.1260 $\pm$ .09099	2.1620 $\pm$ .03564	5
Total	0.5 Hour	.945667 $\pm$ .3299079	10.0144 $\pm$ .16761	10.0144 $\pm$ .16761	2.0992 $\pm$ .08553	25
	8 Hours	.980333 $\pm$ .3195955	10.0460 $\pm$ .18489	10.1200 $\pm$ .18455	2.1264 $\pm$ .07088	25

S.D: standard deviation , N: number of samples, L: length, W.: Width , T.: Thickness

Table (3):- Analysis of variance for surface roughness, dimensional accuracy of length, width, and thickness of acrylic denture base.

Source	Sum of Squares	df	Mean Square	F	Sig.
<b>Surface roughness</b>					
TREATS	.960	4	.240	2.407	.062
Time of immersion	.018	1	.018	.181	.672
TREATS * Time of immersion	.175	4	.044	.438	.780
Error	4.984	50	.100		
Total	6.136	59			
<b>Length</b>					
TREATS	.303	4	.076	2.900	.034
Time of immersion	.012	1	.012	.478	.493
TREATS * Time of immersion	.147	4	.037	1.411	.248
Error	1.044	40	.026		
Total	1.507	49			
<b>Width</b>					
TREATS	.204	4	.051	1.667	.177
Time of immersion	.139	1	.139	4.561	.059
TREATS * Time of immersion	.065	4	.016	.535	.711
Error	1.222	40	.031		
Total	1.631	49			
<b>Thickness</b>					
TREATS	.044	4	.011	1.790	.150
Time of immersion	.009	1	.009	1.497	.228
TREATS * Time of immersion	.005	4	.001	.196	.939
Error	.247	40	.006		
Total	.305	49			
<b>Hardness</b>					
TREATS	205.900	4	51.475	1.828	.149
Time of immersion	21.025	1	21.025	.747	.394
TREATS * Time of immersion	75.100	4	18.775	.667	.620
Error	844.750	30	28.158		
Total	1146.775	39			

a R Squared = .307 , df :degree of freedom

Table (4):- Descriptive statistics for hardness of acrylic denture base.

TREAT S	Time of immersion	Mean	S. E	95% Confidence Interval	
				Lower Bound	Upper Bound
D.W	0.5 Hour	123.750	2.653	118.331	129.169
	8 Hours	123.750	2.653	118.331	129.169
Salt	0.5 Hour	118.250	2.653	112.831	123.669
	8 Hours	121.250	2.653	115.831	126.669
Protefix	0.5 Hour	116.500	2.653	111.081	121.919
	8 Hours	122.500	2.653	117.081	127.919
S.+ving	0.5 Hour	120.000	2.653	114.581	125.419
	8 Hours	120.000	2.653	114.581	125.419
S.+Thy	0.5 Hour	117.500	2.653	112.081	122.919
	8 Hours	115.750	2.653	110.331	121.169

S.E: standard error

Table (5):- Duncan's multiple range test for dimensional accuracy of length, width, surface roughness, and hardness of acrylic denture base.

TREAT.	Subset Length		TREAT.	Subset Thickness		TREAT.	Subset Roughness		TREAT.	Subset Hardness	
	1	2		1	2		1	2		1	2
Salt	9.913		D.W	2.0680		S.+Thy	.862500		S.+Thy	116.63	
D.W	9.968	9.9680	Salt	2.0930	2.0930	D.W	.888333		Protefix	119.50	119.50
S.+ving	10.054	10.0540	Protefix	2.1140	2.1140	S.+ving	.903333		Salt	119.75	119.75
S.+Thy		10.1060	S.+Thy	2.1420	2.1420	Salt	.951667	.951667	S.+ving	120.00	120.00
Protefix		10.1100	S.+ving		2.1470	Protefix		1.209167	D.W		123.75
Sig.	.071	.079	Sig.	.060	.169	Sig.	.535	.051	Sig.	255	.153

TREAT: Treatments with solutions

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