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The Effect of Fennel Extract Solution on Surface Roughness and Light Absorption of Flexible Denture Base Material

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Annotation: Background: commercially used chemical dental cleansers adversely affect mechanical properties of denture, therefore there is need for finding alternative which will not change the surface properties of denture base material.

Aim: the aim of this work is to evaluate the effect of fennel's extract solution on Surface roughness and light absorption of flexible denture base material.

Materials and method: 40 specimens were prepared from thermoplastic acrylic resin with dimension of (65×10×2.5mm) and divided into control and experimental groups(n=20) according to the immersion time which done at 15 days and 30 days. Surface roughness test was performed for control group by digital surface roughness tester. Light absorption test was done by visible spectrophotometer.

Results: The highest average value for surface roughness was found in the control group, while the lowest average value of surface roughness was found in the experimental group, but statistically no significant difference. For Visible light absorption, there was significant difference between experimental and control group at day 15 and 30.

Conclusion: Based on our findings, the fennel extract did not adversely affect the surface roughness and light absorption of flexible denture base surface.

INTRODUCTION

There are two categories of materials that can be utilized to make dentures or denture bases: metallic and non-metallic. (11 ,10).

Non-metallic bases like plastic materials may be divided into two groups:

1. Thermo-hardening (vulcanite and phenol-formaldehyde).

2. Thermo-plastic (celluloid. vinyl resin, nylon and acrylic resin). (12).

The thermoplastic nylon (valplast) was first introduced in the field of dentistry in 1950 (1) . The use of thermoplastic nylon has many advantages include good aesthetics, high flexibility, good transparency and so on; such advantages help with creating a colour-matching effect, that is, the denture base colour is identical to the colour of the underlying tissue; another advantage of valplast is that it is biocompatible and has low water solubility. (2)

Thermoplastic materials are characterized by grains with a lower molecular weight (approximately 150,000 gram/mole). These materials have a lower plasticizing temperature and display a high rigidity despite the fact that having a low molecular weight. In fixed and removable prosthodontics. thermoplastic resins are utilized for fixed partial prostheses, orthodontic appliances, implant abutments, occlusal splints, preformed clasps, metal-free removable dentures, temporary crowns. Further chemical improvement of both polymeric and elastomeric materials will broaden the field of clinical uses of thermoplastic materials in dentistry (17).

overview of the use of plants in various fields of dentistry. For example, inperiodontics, aloe vera (medicinal aloe) is used for reducing gingival bleeding and gingival inflammation, Azadirachta indica (neem) is used for reducing plaque index, Pistacia atlantica (mastic tree) is used for its activity against gingival microorganisms14and Salvadorapersica (mustard tree) is used for improving gingival health (23).

Fennel herbs grows wildly in Mediterranean region and in European countries of temperate climate but is now cultivated in most parts of the world for commercial purposes. The fruits commonly referred to as seeds are ridged, oblong or ellipsoid shaped, aromatic and are universally known as fennel and by more than 100 other names throughout the world and have been used medicinally since ancient times as one of the ancient Saxon people's nine sacred herbs, fennel was credited with the power to cure and was valued as a magic herb (7).

A subspecies of fennel, F. vulgare subsp. piperitum, is used for mouth ulcers in the Basilicata region of southern Italy in Portugal, it is highly recommended for treatment of diabetes, bronchitis and chronic coughs, and for kidney stones (29).

Fennel essential oil is also widely used as a flavouring agent in products such as liqueurs, bread, cheese and as an ingredient of cosmetics and pharmaceutical product (30).

Material and methods

Flexible Resin Samples Preparation

40 samples were prepared from valplast thermoplastic resin with dimensions of (65×10×2.5mm) length, width and thickness respectively (31).

Steps by step fabrication of flexible resin samples (32, 33)

1) The dental hard die stone was prepared according to the manufacturer's instructions at a mixing ratio of 25ml of water to 100g of powder and poured into the lower half of the special flask designed for the injection molding technique.

2) Before the stone was hardened, the plastic disc was positioned above the stone surface, where the plastic disc level would be with the level of the stone surface.

3) The sprue formers were attached to make the channels for flowing fluid resin into the mold

when the die stone began to set. Then, the stone surface was lubricated with a separating medium (cold mold seal).

4) The upper half was then located over the lower half of the special flask and another mix was poured into the flask.

5) After the complete set of dental die stones, the flask is open and the plastic disc was removed from the die stone, the wax elimination procedure was done by immersion of the flask in boiling water for 5 min. to soften the wax. The flask was opened and washed to remove all residue wax with clean boiling water.

6) The flask was checked to make sure that both flask halves fit together with intimate metal contact and are allowed to cool. Then, the flask was opened and a thin coat of separating medium was applied to the model and left to dry completely.

Figure (1): electric injection machine

Figure (2): flask and cartridge

7) A cartridge of suitable size was selected and spray (wax surface reducing agent) was applied to the cartridge, the cartridge carrier was then placed in an electric plastic injection machine which is used for softening the flexible material (VALPLAST) at a temperature of 287°C for 20 minutes (according to manufacturer instructions)

8) When the cartridge arrived at the temperature and time specified, the special flask was placed in an electric plastic injection machine

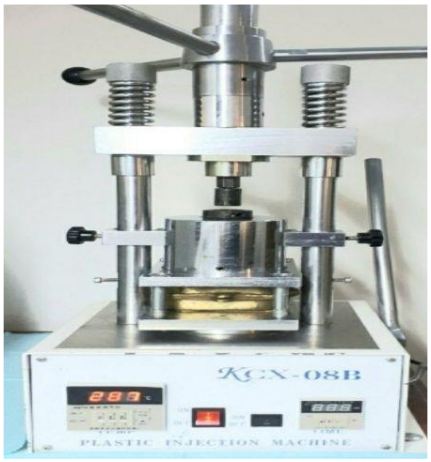


Figure (3): Plastic Injection Machine, Special Flask at temperature 287ºC

8) The levers of the press should be turned rapidly to apply a firm pressure till the press springs were fully compressed. The pressure should be maintained for 3 to 5 minutes.

9) The pressure was then relieved and the flask was allowed to bench cool slowly at room temperature at least from 15 to 20 minutes before opening.

10) The injection pressure should be (100 psi) and the injection time should be 1 minute.

11) Deflasking was done and specimens were then removed from the die stone mold.

Finishing of flexible material (VALPLAST)

The sprue formers are cut with a special type of disk and hand-finished using progressively finer grades of silicon carbide paper (grades 320µm) with continuous draining water for one minute (19). Finishing polyamide resin specimens by using an electronic digital calliper. All specimens stored in distal water for 48 hours.

Preparation of plant extract

Fennel seeds were washed and dried for 3 days away from sunlight, then were ground to powder using commercially blender to prepare a solution, 250 gm of fennel powder was taken and put it in beaker to which sterilized deionized water was added till reach a volume of one liter. Beaker closed tightly and left to boil at 100C for 15 minutes, then left to warm. The liquid was filtered using filter paper No. 1, (35).

Specimen grouping

A total of 40 specimens were prepared from valplast resin and divided in to two group (control and experimental) each group 20 specimens according to the immersion time which done at 15 days and 30 days, all specimens were undergo surface roughness and absorption tests.

Immersion time

20 specimens were tested after 15 days and 20 specimens were tested after 30 days. Throughout these immersion periods, a daily immersion protocol was followed, this involved immersion in the fennel extracts for 8 hrs. followed by 16 hours immersion in artificial saliva for experimental group while immersion in distal water for 8 hrs, followed by 16 hours immersion in artificial saliva in control group (36).

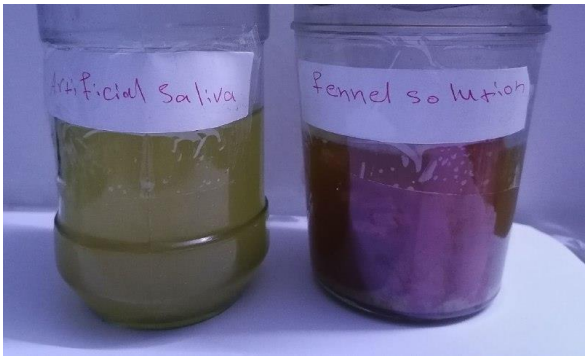


Figure (5): Soaking flexible samples in fennel herb solution

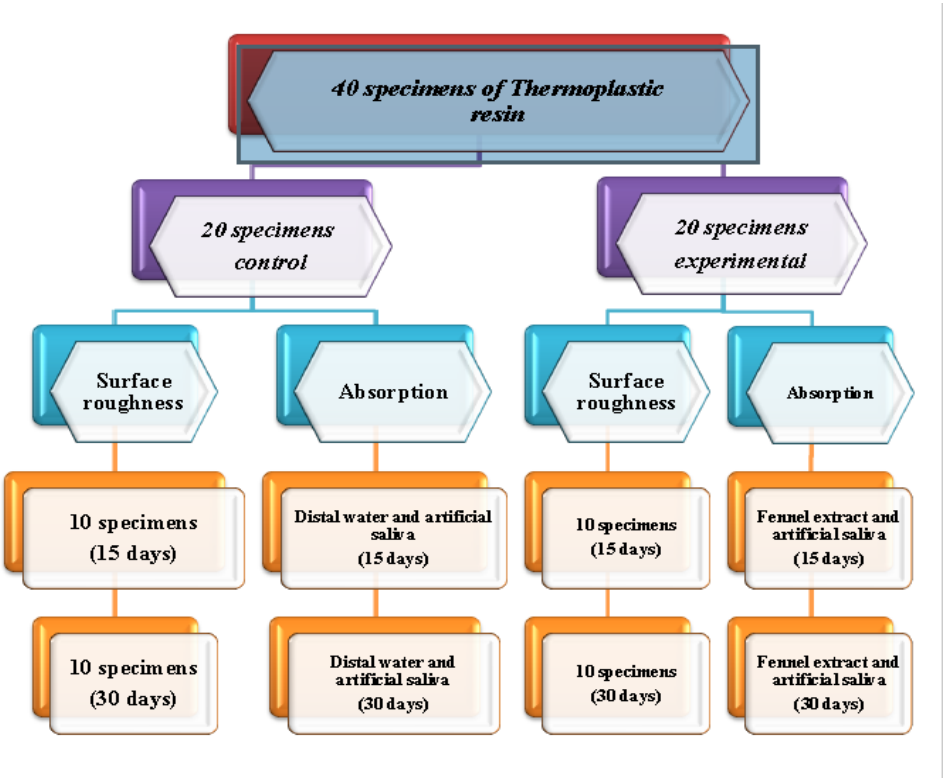


Figure (6) Distribution of samples according to immersion periods.

Surface roughness test

Surface roughness was measured by Digital surface roughness tester. The first ten control samples were measured on day 15 and the second ten on day 30. Each sample had two readings, as well as experimental samples. the Surface roughness (Ra) reading was selected as shown in Figure (7).

Figure (7): Digital surface roughness tester

Visible Light Absorption Test

Immersion liquids were taken directly from the container to measure the amount of acrylic deposited in the solution. The measurement was conducted two times on days 15 and 30.

the testing liquids at day 15 were: Distilled water (control) , Artificial saliva (control) , fennel extract solution (experimental) and Artificial saliva (experimental)

the testing liquids at day 30 were : Distilled water (control) , Artificial saliva (control) , fennel extract solution (experimental) and Artificial saliva (experimental)

The Light Absorption test Procedure

1. fill the special vial (cuvette) with the liquid that would be tested.

2. close the chamber.

3. start the device

4. obtain the reading

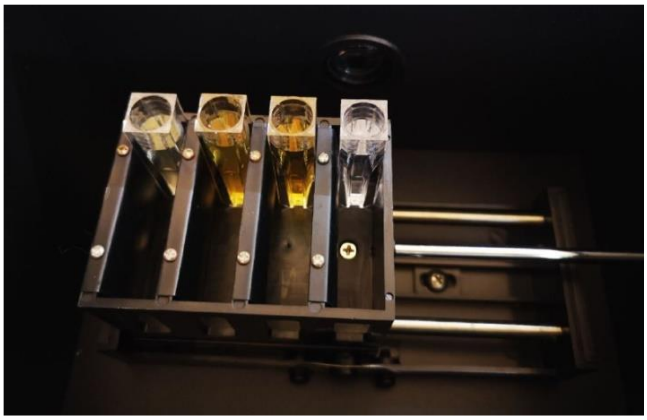
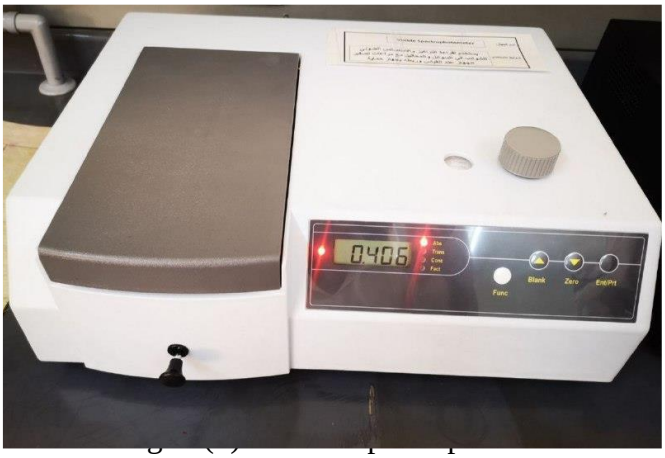


Figure (8) cuvette with the fluid inside the Visible spectrophotometer tester



Results

surface roughness

The descriptive statistic in Table (4. 1) for surface roughness show that in control group the highest mean value is in day 30 (1.3980) and the lowest is in day 15 (1.3263)

In experimental group the highest mean value (1.2692) at day 30 and the lowest value (1.1786) for day 15

Table (1) Descriptive Statistics for surface roughness

Descriptive Statistics

Dependent Variable : Surface Roughness

Groups	Mean	Std. Deviation	N
PMMA (Control):15 day	1.3263	.15734	10
PMMA (Extract):15 day	1.1786	.09811	10
PMMA (Control):30 day	1.3980	.16833	10
PMMA (Extract):30 day	1.2692	.11999	10
Total	1.2930	.15623	40

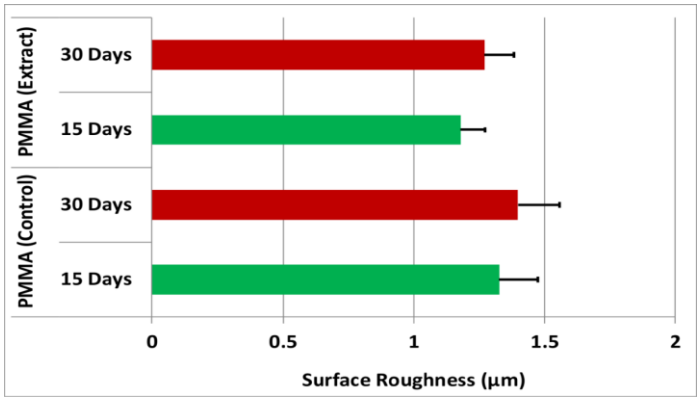


Figure (1) bar chart for surface roughness

Levene's test and Tukey test showed non-significant different between groups

Table (2) Levene's test of Equality of error Variances

Dependent Variable : Surface Roughness

F	df1	df2	Sig.
1.364	3	36	.269

Table (3) Tukey HSD

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	P-Value	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
PMMA (Control):14 day	PMMA (Extract):15 day	.1477	.06209	.100	NS	-.0195	.3149
	PMMA (Control):30 day	-.0717	.06209	.659	NS	-.2389	.0955
	PMMA (Extract):30 day	.0571	.06209	.795	NS	-.1101	.2243
PMMA (Extract):14 day	PMMA (Control):30 day	-.2194*	.06209	.006	S	-.3866	-.0522
	PMMA (Extract):30 day	-.0906	.06209	.472	NS	-.2578	.0766
PMMA (Control):28 day	PMMA (Extract):30 day	.1288	.06209	.181	NS	-.0384	.2960

*. The mean difference is significant at the .05 level.

Light Apsorbtion

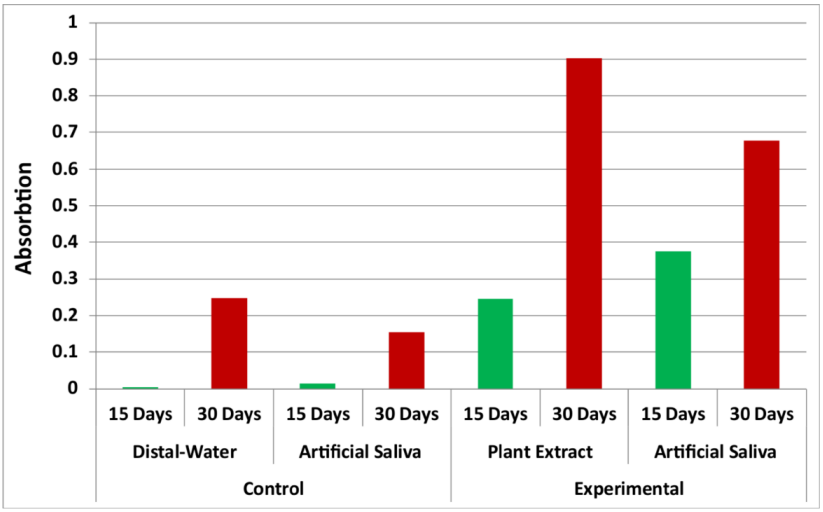
The control group shows the highest mean value for artificial saliva is in day 30 (0.155) and the lowest is in day 15 (0.015).

For experimental group , the highest mean value for fennel extract (0.903) at day 30 and the lowest value (0.246) for day 15 and the highest mean value for artificial saliva (0.678) at day 30 and the lowest value (o.375) for day 15

Table(4) light absorbtion mean values for control and experimental groups

Control				Experimental			
Distal-Water		Artificial Saliva		Plant Extract		Artificial Saliva	
15 Days	30 Days	15 Days	30 Days	15 Days	30 Days	15 Days	30 Days
0.005	0.248	0.015	0.155	0.246	0.903	0.375	0.678

Figure (2) bar chart for light absorbtion



Discussion

Traditional chemical denture cleansers, although being effective antimicrobials, are being replaced with natural plant extracts due to the developing resistance shown by microbes against them. These plant extracts have shown efficient antimicrobial and antifungal properties and are being added as constituents in mouth rinses, toothpastes. (37)

Wetting properties of the surface of denture base material are strongly correlated to bonding affinity of biomolecules to that surface. In the oral cavity, denture is in the contact with oral mucosa and also exposed to the different particles and microorganism from the oral environment. Thus, saliva ingredients can precipitate on the surface, while microorganisms from the oral flora cạn attach and form biofilm on denture.

However, the use of different mechanical and chemical approach in maintaining the denture hygiene could change the surface properties. Therefore, it is important to keep the surface of material unchanged. (38)

The result of this study showed that lowest mean value in experimental group for surface roughness test at 15 and 30 days immersion periods but statistically no different between groups. This due to thermoplastic cured acrylic resin has a property of absorbing water through diffusion, namely the transfere of a substance through a cavity. Absorption of water causes the solvent molcules to accupy the space between the polymer chain. Resulting in the chain being disrupted and spread (39, 40).

Regarding experimental group at 15 days immersion period, the increase Visible light absorbtion showed in artificial saliva (0.375) then followed by fennel extract (0.246) however after at 30 days immersion period the highest Visible light absorbtion was in that of fennel extract (0.903) followed by artificial saliva (0.678), because the components of the plant extract interacted with artificial saliva, and therefore more debris appeared, so the absorption of light increased. Therefore, it is encouraged to use the settled solution on the 14th day.

Conclusion

Based on our findings that fennel extract did not adversely affect the surface roughness and light absorption of the denture base resin surface at day 15, it can be concluded that it does not contain any component that can penetrate and damage the polymer matrix structure, unlike the commonly used chemical cleaner.

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