



## The effect of denture cleansers on the color stability, water sorption and water solubility of stained light cured acrylic denture base material

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### Abstract

The dirty denture may have undesirable effect on patient's health and ability to successful wear of the denture, if a patient's denture becomes unsanitary, the consequences may be bad breath, poor esthetic, denture stomatitis and angular cheilitis and the using of the denture cleanser is the solution for this problem but the prolong use of such cleansers may affect the properties of the denture. The aim of the study is to observe the effect of denture cleansers on color stability, water sorption and water solubility of the light cured acrylic resin after their immersion in tea solution.

Light curing acrylic resin was prepared and immersed in four types of denture cleansers after there staining with tea then color stability, water sorption and water solubility of acrylic resin was measured.

There were no changes in the stained acrylic properties when the samples were immersed in prepared denture cleansers and in the alkaline peroxide cleanser compared to that immersed in the distilled water in respect to color stability, sorption and solubility of the testing groups.

The water sorption, water solubility and color stability of the light cured acrylic resin where immersed in the prepared denture cleanser solutions are in accordance with the American dental association no.12. The denture cleanser are good and satisfactory cleanser materials for the acrylic resin denture base and it's recommended for cleansing the prostheses which are cured by light curing method.

**Key words: light cure acrylic, denture cleanser, water sorption, water solubility, color stability.**

### Introduction

Light activated polymers in dentistry are not new. Over many years ultraviolet light activated fissure sealants and composites tooth filling materials were introduced. Within the past few years, tooth filling materials activated by visible light have been developed, and "Triad" is similar system recommended for use in

prosthodontics, orthodontics and crown and bridgework <sup>(1)</sup>. Some of the advantages ascribed to visible light cured resins (VLC) are accuracy, superior strength, complete polymerization without residual compounds, absence of free methylmethacrylate, low exothermic heat, color stability, ease of fabrication and ease of manipulation. <sup>(2,3)</sup>

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Prostheses have been identified as a source of cross contamination between patient and dental personal (4-7). Numerous yeast has been commonly found in greater abundance on palatal surface of the denture than on palate itself which indicated that acrylic denture acts as a reservoir for infection (8-11). Accordingly, it was suggested that treatment would be better directed towards the denture and not towards the mucosa (12) and it can be recommended to use denture cleansers to removed, killed the microorganism and to suppress reinfection denture surfaces (13,14). Denture cleansers are popular methods used by denture wearers for cleaning (15). The efficient cleansing of the fitting surface of the denture is a key factor in the maintenance of healthy oral mucosa and important for the long term success of removable prosthodontics treatment (16, 17).

Restoring the Color and appearance of natural dentition is an important physical property of materials used in dentistry (18). The aesthetic considerations in restorative and prosthetic dentistry have assumed a high priority within the past several decades (19, 20). There are two methods used to measure the color stability of the material: The subjective and objective methods. The subjective methods are pursued by visual grading of stain according to a non parametric ranking of the area and/or the intensity of discoloration, while objective methods follow an instrumental approach for color measurement such as spectrophotometer, colorimeter and computer image analysis; usually the stain formed on clear acrylic resin blocks was measured by using a spectrophotometer, while computer assisted image analysis has been recently applied as a quantitative tool in the study of stain (21-23). Sheen and Harrison showed that the analysis of

digital images gave similar results as the visual scoring method (24).

Sorption of the material represents the amount of water absorption on the surface and into the body of the material. The sorption of poly methyl methacrylate (PMMA) is facilitated by its polarity and the mechanism primary responsible for ingress of water is diffusion (20). PMMA absorbs water slowly over a period of time the imbibitions is due primarily to the polar properties of the resin molecules. High equilibrium uptake of water can soften a denture because the absorbed water can act as a plasticizer of (PMMA) and reduce the strength of the material (25). Where as solubility represents the mass of the soluble materials from polymer. The only soluble materials present in the denture base resins are initiator, plasticizers and free monomer (15, 26, 27); High solubility is not a favorable characteristic for denture materials. The denture base resins are completely insoluble in water and in most fluids that come in contact with the resin in the oral cavity. Any observed loss of weight of the resin is a measure of the specimen solubility (26). The rate at which the materials absorbed water or lost soluble components varied considerably with the type of material, the amount of the plasticizer or filler content and the solution in which they were immersed (28).

This study evaluated the effects of prepared denture cleanser solution (4% Oxalic acid, 4% tartaric acid and 4% citric acid) in addition to alkaline peroxide solution on water sorption, water solubility and color stability{by using two methods of color measurement, vision and by using spectrophotometer} of stained acrylic resin material that cured by light curing method.

## Materials and methods

A disc of (50±1 mm in diameter and 0.5±0.1mm in thickness) constructed from a sheet of the visible light activated acrylic (palatray, <sup>R</sup>XL) was used to measure the color stability, water sorption and water solubility (the preparation of the acrylic samples were conducted according to the ADA specification). A sheet of the visible light activated acrylic was adapted on the mold and then put in the light curing unit for curing for 4 min to have the final shape of the samples which used to measure the color stability, water sorption and water solubility [For each test, 25 Specimens were prepared (5 samples for each group)].

### Sample grouping

The specimen grouping was classified as follows (5 samples for each group):

**Group 1:** Specimens immersed in 4% citric acid denture cleanser solution.

**Group 2:** Specimens immersed in 4% tartaric acid denture cleanser solution.

**Group 3:** Specimens immersed in 4% oxalic acid denture cleanser solution.

**Group 4:** Specimens immersed in alkaline peroxide denture cleanser solution.

**Group 5:** Specimen immersed in distilled water (control group).

### Preparation of the solutions

1. **Tea solution:** Four grams of dry tea boiled in 500 ml of distilled water for 4 minutes, and allowed to cool at room temperature, and then the solution was decanted from tea leaves <sup>(29)</sup>.

2. **Alkaline peroxide solution:** It's prepared according to the manufacturers instructions {1 tablet of alkaline peroxide added to 150 ml of warm distilled water (50°C)}.

3. **The experimental denture cleanser solutions:** A fresh denture

cleanser solutions was prepared by dissolving each of the oxalic acid, tartaric acid and citric acid in the isopropyl alcohol (the isopropyl alcohol was chosen as solvent to the acid powder due to its antiseptic effect) <sup>(30,31)</sup> as followed:

4 gm of acid powder + 100 ml. of isopropyl alcohol → 4% W/V of acid denture cleanser solution

Then, prior to the use each prepared denture cleanser solutions were diluted with an equivalent volume of distilled water as follow:-

50 ml. of distilled water + 50 ml. of prepared denture cleanser solutions → 100 ml. of fresh diluted denture cleanser solution

### Color stability test:

The color stability test was measured by two methods

a. Objective method (Spectroscopic study).

b. Subjective method (visual examination).

A Spectrophotometer device was used to measure the light absorption of each specimen at two wavelengths at 400λ and 500λ. For all groups the light absorption for each disc was measured before immersion of the discs in the solutions. Then the discs of groups 1, 2, 3, 4 were immersed first in the fresh tea solution then they were immersed in the denture cleansing solution while for the control group (group 5) the discs were immersed just in the distilled water. After the completion of immersion of the discs of all the groups the light absorption of the discs were measured as done before the immersion procedure by using a spectrophotometer at the same two wave length and the difference between the two readings were calculated.

The visual examination of staining removal was assessed by 10

independent observers (dentist) each observer read the samples after their removal from the solutions. The samples were evaluated visually for stain removal by comparing the tested samples with the control group by placing the specimens on a white background and they were graded for the amount of staining on a scale of (No, slight, mild, moderate, sever).

### Water sorption and water solubility test:

The specimen preparation and testing procedure were done according to the ADA specification No.12 for denture base resin<sup>(9)</sup>.

The specimens were dried in a desiccator containing freshly dried silica gel. The desiccator was stored in an incubator at a  $37^{\circ}\text{C} \pm 2^{\circ}\text{C}$  for 24 hours. After 24 h. The specimens were removed to a similar desiccator at room temperature for one hour then weighed with a digital balance on a precision of 0.1mg. This cycle was repeated until a constant mass "conditioned mass" was reached (The weight loss at each disc was not more than 0.5mg in 24 hours period).

Then the discs of group (1, 2, 3, 4) were immersed in fresh tea solution for 24 hours then they were immersed in the denture cleansing solution for another 24 hours, while the discs of group 5 were immersed in distilled water at  $37^{\circ}\text{C} \pm 2^{\circ}\text{C}$  for 48 hours.

For all groups after which time the discs were removed from the solutions with tweezers wiped by a clean dry hand towel until free from moisture, waved in the air for 15 seconds and weighed one minute after removal from the solutions this mass was consider as mass after immersion. After that to obtain the value of solubility test, the discs were reconditioned to a constant mass in the desiccator at  $37^{\circ}\text{C} \pm 2^{\circ}\text{C}$  as done

previously for sorption test and considered as the reconditioned mass.

The values for sorption were calculated for each disc from the following equation and the final value should be rounded to the nearest 0.1  $\text{mg}/\text{cm}^2$ :

$$\text{Sorption } (\text{mg}/\text{cm}^2) = \frac{\text{mass after immersion (mg)} - \text{condition mass (mg)}}{\text{Surface area } (\text{cm}^2)}$$

The soluble matter lost during immersion was determined to the nearest 0.01  $\text{mg}/\text{cm}^2$  for each disk as follows:

$$\text{Solubility } (\text{mg}/\text{cm}^2) = \frac{\text{condition mass (mg)} - \text{reconditioned mass (mg)}}{\text{Surface area } (\text{cm}^2)}$$

In the analysis we used arithmetic mean, standard deviation and one way analysis of variance test.

## Results

By the use of the spectrophotometer device, the mean and standard deviation of the amount of absorption difference before and after immersion of the samples in the denture cleanser solution as well as in distilled water are presented in Table (1). The one way analysis of variance test revealed a no significant difference between the groups at 500nm as well as at 400nm ( $P > 0.05$ ).

The result of visual examination of staining removal of all groups shows no difference in the color when compared with the control group as shown in Table (2).

The mean and the standard deviation of sorption test for the experimental and the control groups are listed in Table (3).The sorption value for all the groups are nearly similar they were all within the ADA specification limit. No.12 for denture base polymers (the uptake should not be more than  $0.8\text{mg}/\text{cm}^2$ ).One way analysis of variance test demonstrated

a statistically no significant difference ( $P > 0.05$ ) in the sorption between the 5 groups.

Similar methods of statistical analysis used for sorption test were applied to the results of solubility test. The mean and standard deviation of solubility test are presented in Table (4). The solubility value was complied with the ADA specification limit (The loss in weight should not be more than  $0.04 \text{ mg/cm}^2$ ). The One way analysis of variance test of solubility demonstrated no significant difference between the investigating material.

## Discussion

There was no color change observed visually after immersion of the acrylic samples in the denture cleanser solutions and in the distilled water, this may be due to that the human eyes are not sensitive enough like the spectrophotometer device. These results are comparable with those of Al-khafaji<sup>(31)</sup> when the same prepared denture cleanser solution was used but the type of acrylic was cured by the water bath curing method and by microwave energy it was found that there was non-significant difference among the tested samples that were immersed in the denture cleansers compared to that immersed in the distilled water.

The results obtained from the spectrophotometer showed that for all tested groups there was no significant difference among the tested groups. Several researchers showed similar results finding that acrylic resin whether cured by microwave or by water bath methods showed adequate color stability when acrylic resin processed according to the manufacturers instructions<sup>(15, 30-34)</sup>. The spectrophotometer study showed no statistically significant difference among the tested groups ( $P > 0.05$ ), the

color difference was often clinically insignificant because many researchers demonstrated that when the value of color difference was less than one it means that the color difference was clinically insignificant<sup>(35-38)</sup>.

The visible light acrylic resin was least affected by conditions of accelerated aging<sup>(33)</sup>; Similar finding were reported by Wazniak et al.<sup>(39)</sup> and Wang et al.<sup>(40)</sup> as they found that the cold cured resin stained more than heat cured resin. While May et al.<sup>(41)</sup> found that the color change occurred in both acrylic resin (the heat cured denture base resin and "Acron" microwave acrylic resin) when the acrylic was exposed to the accelerate aging.

In the present study the sorption and solubility were measured according to ADA specification no.12<sup>(6)</sup>, The result of immersion of acrylic resin in the denture cleanser as well as in the distilled water complied with ADA requirement; similar conclusion were reported by others authors<sup>(34, 36-38)</sup> using other denture cleanser solution and other types of acrylic resin (water bath and microwave acrylic resin). Also these results agree with the results of Al-khafaji<sup>(31)</sup> who used the same prepared denture cleanser solution but water bath and microwave acrylic resin was used instead of light cured acrylic. She found that there was a non-significant difference among the tested samples that immersed in the denture cleansers compared to that immersed in the distilled water. The denture cleanser solution cause no effect on the sorption and solubility of the acrylic this may be due to that the prepared cleanser solutions were used in low concentration although those concentrations were found to be effective as cleansing solution. Also we noticed that the sorption and solubility of the light cured acrylic that was immersed in the denture cleansers was nearly close to that immersed in

the distilled water, this may be attributed to the fact that the acid powders of the prepared denture cleansers were weak acid so it does not cause any differences in the sorption and solubility of the acrylic<sup>(42, 43)</sup>

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Table (1)-mean value and standard deviation of color stability test

Denture cleanser	N	400 nm		500 nm	
		Mean	S.D.	Mean	S.D.
Citric acid	5	0.020	0.004	0.022	0.002
Tartaric acid	5	0.000	0.011	0.035	0.009
Oxalic acid	5	0.052	0.012	0.007	0.006
Alkaline peroxide	5	0.051	0.004	0.032	0.002
Distilled water	5	0.102	0.009	0.075	0.001

Table (2) - Visual examination of acrylic resin specimens

Materials	Degree of staining
Citric acid	0.34 (NO)
tartaric acid	0.42 (NO)
Oxalic acid	0.40 (NO)
alkaline peroxide	0.10 (NO)

Scale of staining {NO → Slight → Mild → Moderate → Severe}

NO=0; Slight=1; Mild=2; Moderate=3; Severe=4

Table (3)- mean value and standard deviation of water sorption test

Denture cleanser	N	Mean	S.D.
Citric acid	5	0.366	0.001
Tartaric acid	5	0.422	0.010
Oxalic acid	5	0.311	0.005
Alkaline peroxide	5	0.309	0.001
Distilled water	5	0.414	0.008

Table (4)- mean value and standard deviation of water solubility test

Denture cleanser	N	Mean	S.D.
Citric acid	5	0.016	0.001
Tartaric acid	5	0.027	0.003
Oxalic acid	5	0.039	0.003
Alkaline peroxide	5	0.040	0.001
Distilled water	5	0.018	0.001