

Effect of Denture Cleansers on Sorption and Solubility of Soft Denture Lining Materials Immersed in Different Time Interval

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Abstract

Chemical denture cleansers have been considered to be an efficacious method to prevent denture plaque formation. However, daily use of those cleansers in clinical practice can damage soft denture lining materials.

The purpose of this study is to evaluate the effect of two types of denture cleansers on sorption, solubility of soft denture lining materials at different time intervals.

Twenty one specimens of the soft liners (silicon based) were prepared (50mm±1mm in diameter and 0.5mm ± 0.05mm in thickness) in dimension was distributed into three groups according to the immersion solution each group consist of seven specimens immersed daily as the following:

Group 1: Samples immersed in distilled water for 24 hours (control group).

Group 2: Samples immersed in alkaline peroxide (corega) for 15 min. denture cleanser solution.

Group 3: Samples immersed in 4% citric acid denture cleanser solution for 10 minutes.

The specimen were tested at different time intervals, specimens of sorption were tested after 1 and 3 weeks; while those for solubility were tested after 3 weeks only.

The results of sorption of Ufi Gel soft lining in this study using (ANOVA) test showed that, there were high significant changes with the immersion time interval and the different immersion solutions used. Also the results of solubility using (ANOVA) test showed that a high significant difference among tested group after 3 weeks only.

Generally; it is concluded that deterioration of soft liners in the denture cleansers appeared to be more significant with time.

الخلاصة

المنظفات الكيميائية لأطقم الاسنان تعتبر الطريقة الفعالة لمنع تكوين البلاك (plaque) على الطقم، الاستعمال اليومي للمنظفات يمكن ان يؤدي الى تلف مادة تبطين الطقم. الهدف من هذه الدراسة هو تقييم نوعين من منظفات طقم الاسنان على القدرة على الامتصاص والقابلية الذوبانية لمادة التبطين اللدنة للطقم بعد غمرها في مادة التنظيف لفترات زمنية مختلفة.

حضرت احدى وعشرون عينة من مادة التبطين اللدنة ذات التركيب السيليكوني بأبعاد (٥٠ ملم ± ١ ملم قطر و ٥،٥ ملم

± ٠،٥ ملم سمك) وزعت الى ثلاث مجاميع حسب محاليل الغمر وكل مجموعة تحتوي على سبع عينات غمرت يوميا وكما يلي:

المجموعة الاولى: غمرت في الماء المقطر لمدة ٢٤ ساعة (المجموعة القياسية).

المجموعة الثانية: غمرت في محلول الكورجا القاعدي لمدة ١٥ دقيقة.

المجموعة الثالثة: غمرت في محلول حامض الستريك لمدة ١٠ دقائق.

فحصت العينات بعد الغمر لفترات زمنية مختلفة، تم فحص عينات القدرة على الامتصاص بعد اسبوع وثلاثة اسابيع أما

القابلية الذوبانية للعينات فحصت بعد الاسبوع الثالث فقط.

أظهرت النتائج الأحصائية في هذه الدراسة لفحص القدرة على الامتصاص وجود فارق معنوي عالي جداءند غمر العينات في مختلف المحاليل المستخدمة و لفترات زمنية مختلفة كما وأظهرت النتائج فارق معنوي عالي جدا في القابلية الذوبانية للعينات بعد الاسبوع الثالث فقط.

Introduction

The accuracy of denture fit is an important factor in the retention of denture [1]. The base of the denture is largely responsible for providing the prosthesis with retention, stability and support by being closely adapted to the oral mucosa [2]. However, the process of bone resorption is irreversible and may lead to an inadequate fit of the prosthesis [3].

Gradual changes of oral tissues require that complete or partial dentures be relined to improve their adaptation to the supporting tissue [4]. Therefore, the use of soft denture lining materials has become increasingly popular and useful in removable prosthodontics because of their capability of restoring health to inflamed mucosa [5]. They act as cushion for the denture bearing mucosa through absorption and re- distribution of forces to the stress bearing areas avoiding local stress concentration and improving denture retention by engaging undercut [6,7]. These materials can be divided in two major groups: plasticized acrylic resin and silicone rubber. Both types are available in self-cured or heat – cured forms) [8].

The soft lining materials have disadvantages related to their physical properties and their response to microorganisms. During clinical use, soft liners present several problems one of these problems sorption solubility with different solutions. They are also subjected to colonization and infection by *Candida albicans* and other *Candida* species [9, 10]. Hence,

effective denture plaque control is essential for soft liners, because bacterial and yeast plaque is the major factor in the etiology of denture stomatitis. In addition, microbial growth on soft lining materials can result in their degradation [11].

Care must take in choosing an appropriate method of denture hygiene as inappropriate cleaning regimes can have deleterious effect on soft lining materials [12]. Denture cleansers are a popular method used by denture wearers for cleaning [13]. However, daily use of denture cleansers can affect the properties of denture acrylic resin bases and soft liners. Thus, the selection of denture cleansers should be considered to avoid or minimize changes in the properties of soft lining materials [11].

The purpose of this study is to evaluate the effect of two denture cleansers on sorption, solubility denture lining material after immersed for different time intervals.

Aim of the study

Evaluation of the effect of two types of denture cleansers (citric acid) and (alkaline peroxide) on sorption, solubility of silicone – based soft denture lining material at different time intervals.

Materials and equipments

Some of materials and equipments used in this study:

1. Ufi Gel P, Room temperature curing silicone (Direct, indirect reline) VOCO, Germany, (Fig .1).



Figure 1 Ufi Gel P soft liner

2. Denture cleanser materials:-
 - a. Alkaline peroxide tables, Corega, Ireland.
 - b. Citric acid solution (Citric acid, Isopropyl alcohol), South Australia, 5013.
3. Dental stone type III model, Elite Model thixotropic, Zermack- Italy.

4. Silica gel, BDH Chemicals Ltd. England, (Fig .2, a).
5. Filter paper, Filteron ,England, (Fig .2,b).
6. Dental metal flask, Broden, Sweden, (Fig .3, a).
7. Tension device, local made, (Fig .3, b).



(Fig. 2) a. Silica gel b. Filter paper



(Fig .3) a. Dental metal Flask
b. Tension device

8. Stainless steel disc (50 mm $\pm$ 1 in diameter and 0.5 mm $\pm$ 0.05 thickness, local made, (Fig.4).
9. Precision electronic balance, (accuracy 0.0001) china, (Fig .5).



(Fig.4) Stainless steel disc



(Fig .5) Precision electronic balance

10. Ivomate pressure pot, Ivoclar, Germany.
11. Incubator, BOD, Germany.
12. Desiccator, Germany.
13. Flat glass surface.

14. Cold mould seal, ISO DENT, Turkey
15. Distilled water, Baghdad, Iraq..
16. Hydraulic press, Bego, Germany.

Method

Samples grouping

Sample grouping was distributed into 3 groups according to the immersion solution each group 7 sample.

Group 1: Samples immersed in distilled water.

Group 2: Samples immersed in alkaline peroxide (corega) denture cleanser solution.

Group 3: Samples immersed in 4% citric acid denture cleanser solution.

Mould Preparation:

A Preformed stainless steel disc was prepared to obtain the silicon based soft lining material (Ufi Gel P) in form a disc (50mm±1mm in diameter and 0.5mm ± 0.05mm in thickness) according to [14].

The stainless steel disc was mounted in the lower half of the flask, and formed against flat glass surface, to create a flat smooth surface at the same level with each of dental stone and the border of the lower half of the flask, the flat glass surface was removed after the stone was set, then the stone surface was coated with separating medium. The upper half of the flask was then positioned on the top of the lower half and filled by a diestone mixture, after it set; the two halves separated from each others and removed the stainless steel disc.

Before packing the soft lining material, the two parts of the mould was thoroughly coated by a 90% alcohol and then coated by separating medium.

Sample preparation:

21 samples were prepared from Ufi Gel P silicon based soft liner material. This material was supplied as base/ catalyst system, the equal parts of base and catalyst were mixed according to their manufacturer's instructions (working time was 2 min. after starting of mixing) the mixture was spatulated using cement spatula

and placed in the mould, which was covered and place inside the tension device

(composed from two plates and two long screw) and left without tighten their screws (Fig .3), and then placed (the flask with tension device) into the hydraulic press and press up to 50kg for(5 min.) according to manufacturer's instructions, after that tighten the screws of tension device and the pressure of hydraulic press was relived and flask with tension device placed inside ivomate pressure pot for (15 min.) under heat(40-45C°) and pressure (3bars) according to manufacturer's instruction too complete polymerization of soft lining material .

After that, took tension device out and left to cool down for approximately (20 min.). Then, the cover of flask was removed and specimen removed from the mould and the excess material cut off by a scissor. Also, each time, the mould must be coated with 90% alcohol before packing the material and the painted by separating medium.

Preparation of cleanser solution

I- Alkaline peroxide solution (Gorega denture cleaning solution):

The solution prepared according to the manufacturer's instruction by addition of

one tablet alkaline peroxide to (150ml) of warm distilled water (50C°).

The solution should be prepared every (12 h) when it needs to be used for longer

than (12 h).

II- The experimental denture cleanser solution:

Afresh denture cleanser solution was prepared by dissolving the citric acid in isopropyl alcohol (the isopropyl alcohol) was chosen as solvent to the acid powder due to its antiseptic (15) as followed:-

4gm of Citric acid + 100ml of Isopropyl $\longrightarrow$ 4% w/v of citric acid denture cleanser solution

Then, prior to the use, each prepared denture solution was diluted with an equivalent volume of distilled water, such as 50ml.of prepared denture

cleanser solution to 50ml of distilled water to get 100ml. of fresh diluted denture cleanser solution.

50ml of Distilled water + 50ml prepared cleanser solution $\longrightarrow$ 100ml.of fresh diluted denture cleanser solution

Drying specimens

After processing and finishing, the discs were weighted and dried in a desiccators containing dried silica gel. Desiccators were transferred to an incubator at $(37^{\circ}\text{C} \pm 2^{\circ}\text{C})$ for 24h, the specimens were weighted every (24h) for (3-4days) by analytical balance of accuracy 0.001g. weight was determined. This weight value considered as the initial weight of specimens (W1).

Sorption test:

The disc was labeled according to the cleanser solution used and the specimen in each group was also numbered. Each disc of group 2 (G2) were immersed daily in fresh denture cleansers (15minutes in Corega denture cleaning solution according to the manufacturer instruction) and group 3 (G3) were also immersed daily in fresh prepared denture cleanser solution (10 min. in Citric acid solution) [16]; then, the samples of each groups washed thoroughly with tap water for 1min and then with distilled water (solution) [17] while the disc in group1 (G1) were only

immersed in a distilled water at (37°C) that was changed every day.

At periods 1 and3 week; the discs of all groups were removed from their containers with tweezers, excess water was removed by blotting with filter paper until they are free from visible moisture, waved in air for 15sec. and weighted one minute after removal from the water. This was the weight of the specimen after absorption or adsorption (W2) (The sorption of test specimen was calculated after 1 and 3 weeks).

Solubility test

The amount of solution soluble lost was measured only after 3weeks by placing the specimens back in the diessicator and then weighting them at regular intervals until a constant weight was reached. This weight was the final weight after dessication (W3) (the solubility behavior of test specimens was determined only after 3weeks) [18].Water sorption and solubility were measured both in mg/cm^2 followed revised [14] and as a present.

Calculation was made following next formula:

$$\text{Sorption (mg/cm}^2\text{)} = \frac{W_2 - W_1}{\text{Surface area}} \quad \text{or} \quad \text{Percent Sorption} = \frac{W_2 - W_1}{W_1} \times 100$$

$$\text{Solubility (mg/cm}^2\text{)} = \frac{W_1 - W_3}{\text{Surface area}} \quad \text{or} \quad \text{Percent Solubility} = \frac{W_1 - W_3}{W_1} \times 100$$

Statistical Analysis

The suitable statistical methods were used in order to analyze and assess the results, they include the followings:

1- Descriptive statistics:

A) Statistical tables including observed frequencies.

B) Summary statistic of the readings distribution (Mean, SD, SEM, Minimum & Maximum).

C) Graphical presentation (Bar- Chart).

2-Inferential statistics:

These were used to accept or reject the statistical hypotheses, they include the followings:

A) Analysis of variation ANOVA (f-test).

B) Least significant difference LSD (f-test).

Results

Sorption test

Table (1) shown the descriptive statistics of sorption test values of the tested groups including arithmetic means, standard deviation standard error, maximum and minimum values.

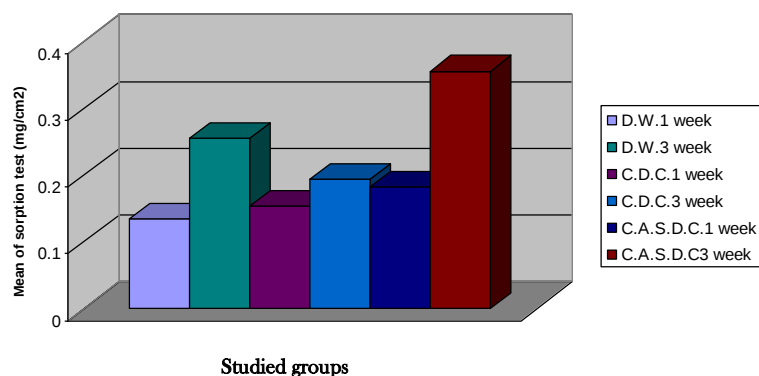
Table 1 Descriptive statistics of sorption test.

Immersion solutions	Intervals	Mean	Std. Deviation	Std. error	Range	
					Minimum	Maximum
Distilled water	After 1 week	.134486	1.52389 E-02	5.76E-03	.1221	.1629
	After 3 weeks	.255971	4.91283 E-02	1.86E-02	.1781	.3054
Corega denture cleanser	After 1 week	.153357	4.20335 E-02	1.59E-02	.1069	.2290
	After 3 weeks	.194871	2.81051 E-02	1.06E-02	.1374	.2189
Citric acid solution denture cleanser	After 1 week	.183229	3.21719 E-02	1.22E-02	.1527	.2341
	After 3 weeks	.356300	4.53247 E-02	1.71E-02	.3003	.4127

Sorption test (mg/cm²)

The same sample in each group had two reading after 1 and 3 weeks, and the descriptive and inferential

statistics of sorption test values of the tested groups shown in figure (1).



D.w.: Distilled water.

C.D.C.: Corega denture solution.

C.A.S.D.C.: Citric acid solution denture cleanser.

Figure 1 Bar graph represented Descriptive statistics of sorption test.

Effect of immersion time

Statistical analysis for sorption test using ANOVA test (Analysis of variance) shown that there were a statistically highly significant differences among the tested groups after 1 and 3 weeks immersion, table

(2). In order to statistically verify the significance among the different groups, a {(LSD) least significant differences} was performed to compare between cleanser solutions in different interval after 1 and 3 weeks (W1- W3), (Table 3).

Table 2 ANOVA test for sorption test.

ANOVA test (p-value)	Sig.
.000	HS

Table 3 Comparison between cleanser solutions in different interval (W1-W3).

The immersion materials		LSD	
		P-value	Sig.
Distilled water-1 week	Distilled water-3 week	.000	HS
Corega denture cleanser-1 week	Corega denture cleanser-3week	.044	S
Citric acid solution denture cleanser-1week.	Citric acid solution denture cleanser-3week	.000	HS

Dependent variable: Sorption test (mg/cm²)

Effect of immersion solution

Table (4) shown a comparison among 3 groups after 1 week using a

(LSD) to verify statistical significance among groups.

Table 4 Shown a comparison among 3 groups after 1 week.

The immersion materials		LSD	
		P-value	Sig.
Distilled water-1 week	Corega denture cleanser-1week	.349	NS
	Citric acid solution denture cleanser-1 week	.019	S
Corega denture- 1 week	Citric acid solution denture cleanser-1 week	.141	NS

Dependent variable: Sorption test (mg/cm²)

Also, in table (5) a (LSD) was used to appear a statistically significance among different groups to

compare among 3 groups after 3 weeks.

Table 5 Comparison among 3 groups after 3 weeks.

The immersion materials		LSD	
		P-value	Sig.
Distilled water-3week	Corega denture cleanser- 3 week	.004	HS
	Citric acid solution denture cleanser-3week	.000	HS
Corega denture-3 week	Citric acid solution denture cleanser-3week	.000	HS

Dependent variable: Sorption test (mg/cm²)

Solubility test

Table (6) shown the descriptive statistics of solubility test values of the

tested groups including arithmetic means, standard deviation, standard error maximum and minimum values

Table 6 shown the descriptive statistics of solubility test.

Immersion solutions	Mean	Std. Deviation	Std. error	Range	
				Minimum	Maximum
Distilled water	9.45E-02	2.67364E-02	1.01E-02	.0560	.1170
Corega denture cleanser	6.69E-02	3.09918E-02	1.17E-02	.0407	.1170
Citric acid solution denture cleanser	.146871	1.25761E-02	4.75E-03	.1221	.1578

Solubility test (mg/cm²)

And Figure (2) shown the descriptive statistics of the solubility test for the tested groups.

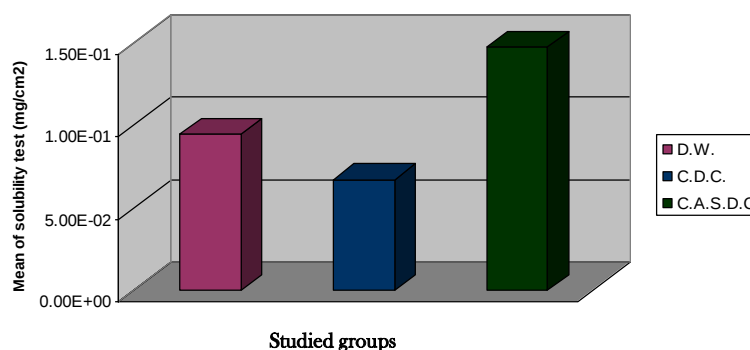


Figure 2 Bar graph represented the descriptive statistics of the solubility test.

Also, statistical analysis for solubility test using ANOVA test shown that there were a statistically

highly significant differences among the tested groups, table (7).

Table 7 ANOVA test for solubility test.

ANOVA test (p-value)	Sig.
.000	HS

While in table (8) a (LSD) using to verify the statistical significance among the tested groups only after three weeks.

Table 8 Comparison among 3 groups only after 3 weeks.

		LSD	
The immersion materials		P-value	Sig.
Distilled water	Corega denture cleanser	.051	NS
	Citric acid solution denture cleanser	.001	HS
Corega denture cleanser	Citric acid solution denture cleanser	.000	HS

Dependent variable: solubility test (mg/cm²)

Discussion

Effect of immersion time

The Ufi soft liner material immersed in all solutions, showed a general increase in sorption with time (when compared between 3 weeks and 1 week). This is due to the fact that the sorption or gain of water (solution) exceeded the loss of soluble components which could be attributed to the presence of fillers in the materials which were responsible for its absorption characteristics, in addition, the materials does not contain plastizer and residual monomer in its structure to reach out. The silicone rubber will take longer time to reach equilibrium in absorption, but less time to reach equilibrium in adsorption [19].

The result in agreement with the results obtained by [20], and disagreed with the result of [21, 22] who reported a decrease in resilient lining weight after specific immersion in denture cleansers or disinfectants.

Effect of the type of immersion solution

This material showed a high significant increase in sorption after period 3weeks of immersion in

different types of cleanser solutions (when compared citric acid solution with the Corega solution and compared them together with the distilled water), table (3), (4).

The explanation for these results related to the fact that the water uptake of elastomeric materials was dependent on the water soluble components and /or hydrophilicity of the matrix leading to formation of solution droplets[22].

Therefore, it was found from the result of table (5), (6) that the material immersed in citric acid demonstrated higher solubility value (higher loss of soluble components in citric acid) which in turn lead to more water uptake. Another important cause for the high sorption value in citric acid is the small size of the proton (H⁺) of the acid which facilitates its penetration between the polymer chains.

The Solubility of Ufi Gel material was significantly higher in citric acid compared with distilled water and Corega solution. This can be explained either according to [22] who suggested that storage in solvents may accelerate changes that cause loss of leachable

materials, or could depend on another explanation which might be due to that the proton (H⁺) of acid attached the (OH⁻) group which were present in the polymer chain leading to liberate of H₂O molecule, and then chain breaking; therefore, lowering the molecular weight of the polymer which lead to more solubility. On other hand a non significant differences was observed when Ufi Gel material immersed in Corega solution compared to that immersed in distilled water.

Conclusion

- 1- In general, deterioration of soft denture lining materials in the two denture cleansers studied appeared to be more significant with the time.
- 2- Soft denture lining became more sorption to the distilled water and both Citric acid and Corege denture cleansers when compared three week with one week immersion.
- 3- Corege denture cleanser had less effect on soft denture lining when compared it with distilled water and citric acid denture cleanser after one week immersion.
- 4- Citric acid denture cleanser had significant effect on the soft denture lining when compared with distilled water after one week immersion.
- 5- Soft denture lining was undergone maximum change in sorption when immersed in citric acid and compared it with Corega denture cleanser and distilled water after three weeks immersion, while it was less effected when immersed in Corega denture cleanser and compared with distilled water.
- 6- Distilled water had less effect on solubility of soft denture lining when compared with Corega denture cleanser, while it had a high significant increased in solubility when compared with citric acid denture cleanser.
- 7- Soft denture lining appeared maximum increased in solubility when

compared between citric acid and Corega denture cleansers.

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