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Evaluation of Retentive Ability and Some Properties of Modified Denture Adhesive Materials

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الخلاصة

أهداف الدراسة : لتقييم درجة الحموضة، واللزوجة وقوة ثباتية المواد اللاصقة للأطقم المحورة الصنع ومقارنتها مع المواد اللاّصقة التجارية. **المواد وطرائق العمل**: تم تحديد درجة حموضة المواد اللاّصقة للأطقم عند تركيز ٢٥% بإستخدام جهاز pH meter، كما تم تحديد لزوجة المواد بإستخدام جهاز ostwold شركة Aldrich. أما بالنسبة لدرجة ثباتية المواد، فقد تم قياسها بواسطة جهاز صُنع خصصيصاً لقياس مدى ثبوتية المواد المصنعة بإستخدام أقراص ذات قطر مقدارة٦سم وسمك٣ملم بإستخدام قالب خاص. **النتائج**: أثبتت نتائج الدراسة أن Bonyplus قد أعطى أعلى درجة حموضة بين المواد المختبَرة كما وجد بأن مادة CMC قد أعطت أعلى نسبة لزوجة، بينما أعطى Bonyplus أقل نسبة لزوجة، كما أعطى CMC أعلى نسبة ثبوتية، بينما أعطى الماء المقطر أقل نسبة ثبوتية. **الإستنتاج**: أظهرت النتائج أن جميع المواد اللاّصقة للأطقم كان لها درجة حموضة مقاربة للمتعادلة كما تبين من نتائج فحص اللزوجة والثبوتية أن المواد اللاّصقة الجديدة كان لها لزوجة ودرجة ثبوتية أعلى من المواد التجارية.

ABSTRACT

Aims: To evaluate pH, viscosity and retentive ability of modified adhesive materials and compared it with commercially available adhesive materials. **Materials and Methods:** The pH–value of 0.25% denture adhesive materials were determined using pH meter**.** The viscosity was determined by Ostwald viscometer (Aldrich Company). The retentive ability was measured by specially manufactured retention testing machine using an acrylic resin disc samples which have 6cm diameter and 3mm thickness prepared from a special mold. **Results:** The findings of the present study showed that the "Bonyplus" gave the highest pH values of all materials tested. Also, showed that the "CMC" gave the highest viscosity values, while "Bonyplus" gave the lowest one. The "CMC" gave the highest retention while the "Distilled water" gave the lowest one. **Conclusions:** All denture adhesive materials tested have a pH equal to that of neutral. The viscosity test showed that the newly prepared materials have a higher viscosity than commercial denture adhesive materials. The retention test showed that the newly prepared materials have a higher efficiency than commercial denture adhesive materials.

Key Words: Retentive ability, Properties, denture, adhesive material.

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INTRODUCTION

Improving retention and stability of dentures is of considerable interest in prosthetic dentistry. Approaches to the problem over the years have included overdentures, implants, and denture adhesives [(1)].

Denture adhesives as aids to denture retention and stability are marked in many forms such as paste, creams, powders, semi – viscous liquids, thin sheets and wax impregnated adhesive cloths. However, the paste, liquid and powder forms are the most common formulations used by denture wearers [(2)].

Many studies have been published on the effect of denture adhesives on denture retention and stability, and on masticatory performance. It was found that the use of denture adhesive improves significantly denture retention and stability [(3-5)].

Other studies have shown that, although the use of denture adhesives increased the denture retention, there was no significant increase in the masticatory performance [(6, 7)].

The aims of the present study are to evaluate pH, viscosity and retentive ability

of modified adhesive materials and compared it with commercially available adhesive materials.

MATERIALS AND METHODS

In the present study, locally available denture adhesive material Sodium-carboxymethylcellulose (Natural product, India) was modified by addition of some additives in 2%. The additive materials used were thymol crystal (BDH Company), Sodium fluoride (SINAflor Avicenna LABs, Damascus) and Chlorhexidine (powder Iraq NDI). They were tested for toxicity by Silver Nitrate Test and Betten droffs test [8, 9]. These denture adhesive materials were tested in comparison with three commercially available denture adhesive materials Fittydent (paste) Fittydent (international GMBH, Austria): Bonyplus (paste) (Bonyf AG, Switzerland) and Calcident (powder) (Sofa Dental, Germany) (Table, 1).

Table (1): The main ingredient of denture adhesive materials used in this study

Material Name	Composition			
	CMC	Thymol crystals	Sodium Fluoride	Chlorhexidine powder
CMC (powder)	20 gm	----------	----------	----------
CMC+Thymol powder	20 gm	0.4gm	----------	----------
CMC + sodium fluoride powder	20 gm	----------	900 ppm	----------
CMC + Chlorhexidine powder	20 gm	----------	----------	0.4gm
CMC+ thymol + sodium fluoride + chlorhexidine powder	20 gm	0.4gm	900ppm	0.4gm

1. pH Test: The pH–value of 0.25% denture adhesive materials was determined using pH meter (Philips Company, Japan). The test was carried out for each of the eight denture adhesive materials.

2. Viscosity Test: In order to evaluate the viscosity of denture adhesive materials the density of adhesive samples was determined by measuring its mass per unit volume using electronic balance (Mettler PM460, Germany) and volumetric flasks [10], then the viscosity of denture adhesive materials was determined by Ostwald viscometer (Aldrich Company)[11].

3. Retention Test: To control the diameter and the thickness of the acrylic resin disk samples, a standard metal mold was constructed which has a dimension of 10mm in thickness and 6cm in diameter, the cover has a projected surface of 7mm thickness to fit inside the mold leaving a space of 3mm for the sample to be formed, in the middle of the mold a hole of 1.5cm in diameter placed in which a piston of same diameter inserted for packing the acrylic resin and removal of the sample after curing.

In the upper surface of the piston a depression of 0.5cm was prepared that would gave the handle by which the sample was grasped during testing procedure, lower ring was constructed to fit over the piston with a lower cover (Figure,1):

Acrylic resin disks of 6cm in diameter and 3mm in thickness were made (Figure 2).

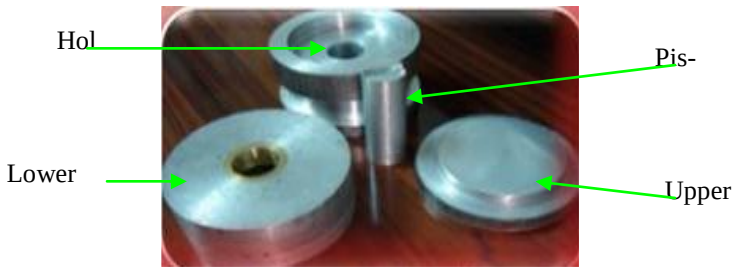

Figure (1): Metal Mold Used for Acrylic Resin Sample Discs Preparation

Figure (2): Acrylic Resin Sample for Retention Test

The samples were prepared with heat-cured acrylic resin Dentures (Pink Color) (Major Prodotti Dentari S.P.A ITALY). The samples then packed directly into the metal mold and processed (according to the manufacturer's instruction) then samples were removed and incubated in distilled water at 37±1 °C for 48 hours [(12)], before testing; this was done for each test. The testing apparatus consist of an upper metal plate with window to hold the glass plate on which the acrylic sample was adhered; four stands of 40cm height were used to hold the upper metal plate with the lower metal plate for fixing the device. The system was connected to water flow with flow rate of 20ml/min to a weight bucket which was attached by a hook to the testing acrylic resin disk sample.

A stopper was designed to stop water flow when the required weight was reached and disk samples were separated from the glass plate (Figure 3).

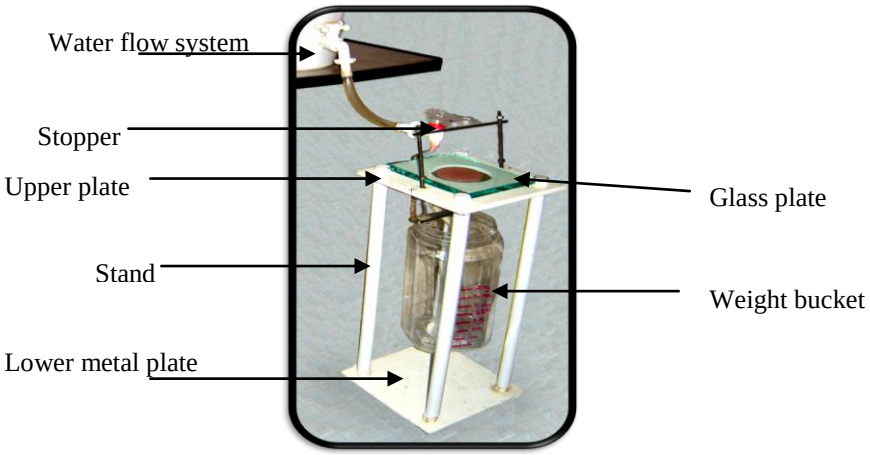

Figure (3): Testing Apparatus for Retention Test

The method used for measuring the retention action of the denture adhesive materials was similar to that used by Panagiotouni *et al*., [(13)] and Muramatsu *et al*., [(14)]. The adhesive action of disk specimens to a clean glass surface wetted with 0.05ml of distilled water was tested. A 0.2gm of the adhesive materials were placed on a wetted acrylic disc using glass rode to distribute the material evenly on the surface then a clean glass plate was placed on the top of acrylic plate so that the materials was sandwiched by the two plates. After applying a load of 3kg for 10 seconds, the resulting assembly was allowed to stand at a temperature of 37±3°C for 10minutes in water bath, and then incubated in portable incubator. The force necessary for separation of acrylic resin plate from the glass plate was measured using the testing apparatus (Figure 3).

A load was applied slowly at a rate of 20ml/min by the addition of water to weight bucket. After separation the total weight was measured. Each procedure was repeated seven times by the use of a different disk sample each times; the glass surface was cleaned very carefully after each test by aqueous solution of detergent, rinsed with distilled water to remove the adhesive material and dried with clean absorbent tissue.

The overall experimental procedure was done at room temperature of 25±2°C. The statistical methods were used to analyze and assess the results of the present

study include: descriptive statistic which include mean, Analysis of Variance (ANOVA) in order to show whether there are significant differences among groups and Duncan's Multiple Range test was performed in order to compare between significant groups.

RESULTS

Table (2) demonstrates the pH values, density values and viscosity values of different denture adhesive materials. The findings of the present study showed that the "Bonyplus" gave rise to the highest values of pH of all materials tested. Also, they showed that the "CMC" gave the highest values of density, while "Fittydent" gave the lowest one.

One way analysis of variance (ANOVA) of the viscosity values of denture adhesive materials showed a significant difference ($P< 0.001$) among them as shown in Table (3).

Table (2): The pH values density values and viscosity values of different denture adhesive materials

Adhesive Materials	pH values	Density values (gm/ml)	Viscosity Mean (Centipoises)
Fitty dent	6.08	0.99436	0.14154097
Bonyplus	7.06	0.99740	0.08870679
Calcident	6.50	0.9994	0.13137778
CMC	6.33	1.00740	0.19244040
CMC + Thymol	6.28	0.9999	0.15872536
CMC + sodium fluoride	6.30	0.99748	0.15590519
CMC + Chlorhexidine	6.48	0.99620	0.15586554
CMC + thymol + sodium fluoride + chlorhexidine	6.42	0.99512	0.14477376
Distilled water	6.50	0.99328	

Table (3): ANOVA Demonstrates Viscosity Value of Different Denture Adhesive Materials

	Sum of Square	df	Mean Square	F- value	*P*
Between groups	0.042	7	0.006		
Within groups	0.001	48	0.000	274.198	0.000
Total	0.043	55			

The results of Duncan's multiple range test (Figure, 4) showed that there is a significant difference ($P\leq 0.05$) between some denture adhesive materials.

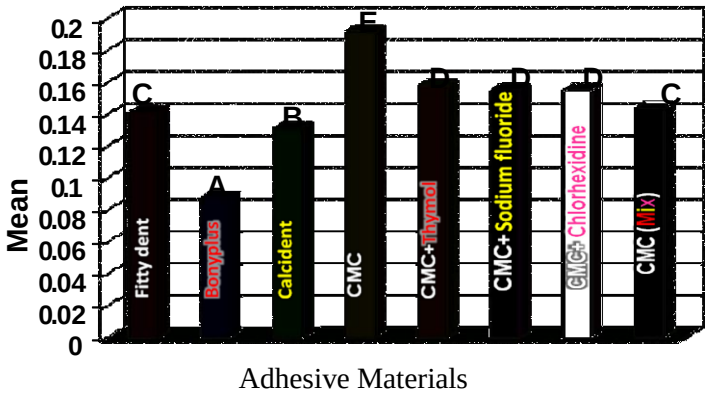

Figure (4): Histogram illustrated the Duncan Multiple Range Test of Viscosity Values of Different Denture Adhesive Materials.* Different litters mean significant difference ($P \leq 0.05$). CMC: Carboxymethylcellulous. CMC(Mix): CMC+thymol+sodium fluoride+chlorhexi

The results also showed that there was no significant difference ($P> 0.05$) between "Fittydent" and "CMC + sodiumfluoride + thymol + Chlorhexidine "and between "CMC + thymol" and "CMC + sodium fluoride" and CMC + Chlor-

hexidine" groups materials. The descriptive statistics included mean, standard deviation, and standard error values of retention action of different denture adhesive materials were listed in Table (4). The findings of the present study showed that the "CMC" gave the highest retention while the "Distilled water" gave the lowest one. One way analysis of variance (ANOVA) of the retention action of denture adhesive materials showed a significant difference ($P< 0.001$) among them as shown in Table (5).

Table (4): Descriptive Statistics Demonstrate Retention action of Different Denture Adhesive Materials

Adhesive Materials	No.	Mean (gm)	Standard deviation	Standard error
Fitty dent	7	1437.00	44.829	16.943
Bonyplus	7	870.2857	28.447	10.752
Calcident	7	949.1429	69.805	26.384
CMC	7	2049.714	91.7763	34.6882
CMC + Thymol	7	1804.142	43.059	16.275
CMC + sodium fluoride	7	1772.00	78.981	29.852
CMC + Chlorhexidine	7	1746.00	80.376	30.379
CMC + thymol + sodium fluoride + chlorhexidine	7	1399.7143	61.102	23.094
Distilled water	7	210.00	16.329	6.172

Table (5): (ANOVA) for Demonstrates Retention actions of Different Denture Adhesive Materials

	Sum of Square	df	Mean Square	F- value	*P*
Between groups	19112367	8	2389045.861		
Within groups	208004.0	54	3851.926	620.221	0.000
Total	19320371	62			

DISCUSSION

According to the results of this study in Table (2), all the denture adhesive materials that tested have a neutral pH due to their compositions, as they consist of water soluble synthetic polymers that have a neutral pH with little adverse effect on e remaining natural teeth unlike some denture adhesive that contain constituents capable of forming aqueous solution of pH below which hydroxyapatite dissolve and this is in line with lamb[15], so all of the material tested could be used for patients wearing partial denture or a complete denture opposed by natural teeth. Tables (2and 3) and Figure (4), indicated that CMC alone have the highest viscosity compared to others denture adhesive materials which may be attributed to the degree of polymerization of the material that affect the viscosity of the solution and this is in agreement with British Pharmacological Codex [16]. While CMC plus Thymol, CMC plus NaF and CMC plus chlorhexidine, showed no significant difference between them. This may be attributed to the addition of additives to the CMC which acts as impurities to the CMC and lead to reduction of its viscosity. The addition of all additives together to the CMC result in more reduction in its viscosity with the formation of product that have a viscosity near that of commercially denture adhesive (fittydent) while calcident and bonyplus showed lower viscosity which may be attributed to their constituent. Denture adhesive augment the same retentive mechanisms already operating when a denture is worn. They enhance retention through optimizing interfacial forces by increasing the adhesive and cohesive properties and viscosity of the medium lying between the denture and its basal

seat and eliminating voids between the denture base and its basal seat [17]. In the present study Tables (4, 5) and Figure (5) showed that CMC alone gave the highest retention force compared to the other denture adhesive materials and this may be attributed to the higher viscosity of the material filling the voids between the two testing plates and this is in accordance with Roydhouse [18], and Lindstrom *et al.*, [19] who stated that as the viscosity of the fluid increases, the retentive force increases proportionally. Also, this explanation is in agreement with Barbenel [20] who stated that the retentive force is directly proportioned to the viscosity of the fluid. Therefore, a greater retentive force is produced by a fluid of high viscosity. This has been shown to be true clinically for natural saliva and for saliva with the viscosity enhanced by denture adhesive. While there was no significant difference between "Fittydent" and "CMC + thymol + sodium fluoride + chlorhexidine", and between "CMC + thymol" and "CMC + sodium fluoride and "CMC + chlorhexidine" This may be also attributed to the effect of viscosity since there was no significant difference in the viscosity between them. Calcident and bonyplus gave lower retention force, since they have the lowest viscosity than all other materials tested.

CONCLUSIONS

All denture adhesive materials tested included the prepared and commercial have a pH equal to that of neutral. The viscosity test showed that the newly prepared materials have a higher viscosity than commercial denture adhesive materials. The retention test showed that the newly prepared materials have a higher efficiency than commercial denture adhesive materials.

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