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The Effect of Different Beverage Solutions on the Hardness of Different Acrylic Denture Teeth

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الخلاصة

الاهداف: تهدف الدراسة الى تقييم تأثير أنواع مختلفة من المشروبات على صلابة أنواع مختلفة من الأسنان المصنوعة من مادة الاكريليك والمتوفرة تجاريا. **المواد وطرائق العمل:** ستون (٦٠) عينة تم تحضيرها من ثلاث أصناف لأسنان صناعية في هذه الدراسة ،الأسنان الخلفية من كل صنف تم وضعها في مادة الاكريليك ذاتية البلمرة بعد ذلك حضر سطح الانطباق لكل سن بصورة مستوية ،ثم تم تغطيسها في الماء المقطر (control)، البيبسي، الشاي والقهوة لمدة ثلاثين يوما ومن ثم قياس صلابة الأسنان المستخدمة و ذلك باستخدام جهاز (Vickers microhardness tester). **النتائج:** اظهرت النتائج إن الأسنان نوع (RMH) تمتلك صلابة أعلى من الأسنان الأخرى المستخدمة في هذه الدراسة. إن البيبسي أكثر تأثيرا من الشاي والقهوة في تقليل صلابة الأسنان المستخدمة. **الاستنتاجات:** إن البيبسي أدى إلى تقليل صلابة الأسنان المستخدمة خلال فترة التغطيس البالغة ثلاثين يوما. إن صلابة الأسنان نوع (RMH) اقل تأثرا بأنواع مختلفة من المشروبات المستخدمة في الدراسة.

ABSTRACT

Aims: To determine the effect of different beverage solutions on the hardness of different acrylic denture teeth which are commercially available. **Materials and Methods:** Sixty samples were prepared from three brands of artificial teeth in this study. The posterior teeth of each brand were placed in auto polymerizing acrylic resin and the occlusal surfaces were ground flat, then immersed in distilled water (control), Pepsi, coffee and tea solutions for 30 days and then the hardness were tested using Vickers microhardness tester. **Results:** The RMH denture teeth materials showed the highest hardness than other denture teeth materials. Pepsi was more effective than tea and coffee in reducing the hardness of different acrylic teeth materials. **Conclusions:** Pepsi reduced the hardness of different acrylic teeth materials during the 30 days immersion. The hardness of RMH denture teeth materials was less affective by the different beverage solutions.

Keywords: hardness, acrylic teeth, beverage solutions.

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INTRODUCTION

Acrylic resin is the most used material in prosthodontics. While its hardness turns denture adjustment easier, its integrity may be damaged by brushing, mastication and immersion in chemical products.(1) It is an advantage for the artificial teeth to be of low density, in order that they do not increase the weight of the denture unduly. The artificial teeth should be strong and tough in order to resist fracture. Progressive wear of the occlusal surfaces, resulting in insufficient posterior tooth support, will lead to changes in the vertical and horizontal jaw relations and may cause functional and esthetic impairments.(2) The artificial teeth should be hard enough to resist abrasive forces in the mouth and during cleaning, but should allow grinding with a dental bur, so that adjustments to the occlusion can be made by the dentist at the chairside.(3) Currently, there are various types of commercial artificial denture teeth available, such as porcelain teeth, conventional acrylic resin teeth, and improved acrylic resin teeth, including high cross-linked acrylic resin teeth and composite resin teeth.(4) Acrylic resin teeth and porcelain teeth are widely used in the fabrication of complete and removable dentures. (5) Porcelain teeth have a higher resistance and hardness and better color stability than resin teeth, although they are brittle and fracture easily during use. Acrylic resin teeth, which have been widely used in the clinic, have some ad-

vantages over porcelain teeth. Acrylic resin teeth have excellent fracture toughness, easy occlusal adjustment, and high bond strength to denture base materials, but their wear resistance has been questioned.[6]

A drink, or beverage, is a liquid which is specifically prepared for human consumption. In addition to filling a basic human needs, beverages form part of the culture of human society.[7,8] Solvent in the diet may chemically soften denture teeth and be a contributing factor to a greater wear.[9]

The aim of this present study is to investigate the effect of different beverage solutions on the hardness of different acrylic teeth.

MATERIALS AND METHODS

The readily prepared solutions was Pepsi (Baghdad soft drinks company, Iraq, Baghdad). While the solutions that were prepared were tea with sugar and coffee with sugar. The coffee and tea solutions were prepared by adding 30 gm. of coffee (Alameed coffee, Jordan) and 30 gm. of tea powder (Alwazah tea, Finlays, Sri Lanka) to one litter of boiling distilled water, then simmered for 5 minutes and filtered through filter paper [10], then 40 gm. of white sugar were added to tea and coffee solutions and stirring for 5 minutes.[11]

Three types of commercially available acrylic resin denture teeth were used in this study and these types are; group 1 (RMH , two layer synthetic resin teeth, Syria), group 2 (AcryRock, cross linked, fluorescent acrylic teeth, Italy) and group 3 (Seif, cross linked wear resistant acrylic teeth, Syria). The posterior teeth of these three types were used, the acrylic teeth were embedded in auto polymerizing acrylic resin (Ivoclar\vivadent,Schaan, Liechtenstein) using a metallic ring with 2 cm diameter.[12] The metallic ring was lubricated with separating medium (Dentaire,S.A.,Vevey,Suisse), and placed over a glass slab that also was lubricated with separating medium, then the auto polymerizing acrylic resin was placed inside the metallic ring, then the artificial teeth were embedded in the auto polymerizing acrylic resin (Figure 1).

Figure (1): The acrylic teeth were embedded in auto polymerizing acrylic resin using a metallic ring mold.

The occlusal surfaces of artificial teeth were ground flat by removing (1.5mm) of the occlusal surface using laboratory carbide bur (1\16 inch) and micromotor handpiece (STRONG 204, KOREA) with rotating speed (12000 RPM) then smoothed by sand paper (1200 Grit) by using mandrel and polished by pumice.[13,14] The base of each artificial tooth was labeled by waterproof pen in order not to be mistaken with other teeth (Figure 2).

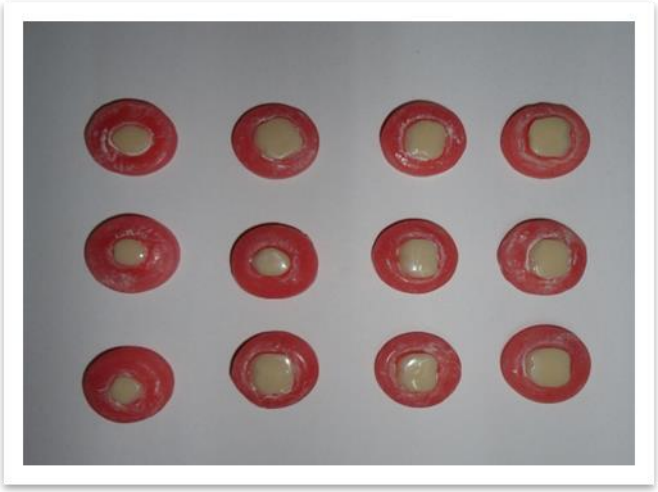

Figure (2): Different acrylic teeth materials prepared.

Each group of artificial teeth were divided into subgroups, which including (group A, B, C and D), group A artificial teeth were immersed in distilled water at 37°c (control) for 30 days , group B artificial teeth were immersed in Pepsi solution, group C were immersed in tea solution, and group D were immersed in coffee solution. Samples immersed in beverage solutions for 10 minutes (Tea and coffee at 50±1°C while Pepsi at 20±1 °C) and immersed in distilled water for 5hrs and 10 minutes at 37°C.[15] This cycle repeated three times daily, then immersed in distilled water for 8 hrs. daily at 22±1°C room temperature. After each immersion cycle, the specimens were washed with distilled water, gently dried with gauze and maintained in distilled water at 37ºC until the next immersion cycle. This cycle repeated for 30 days [16], then samples tested by Vickers microhardness tester (WOLPERT Tester, Germany) (Figure 3).

Figure (3): WOLPERT Vickers microhardness tester.

The control specimens were kept in distilled water during the course of the experiment (30 days), with daily change of the solution. Three indentations were made and measured at different points on each specimen, and the average value was determined to provide an overall mean value representative of the materials. The load applied to the specimen was 1 kg, and the indentation area was measured under the microscope (Figure 4), this microscope was part from the Vickers microhardness tester and the sample was placed inside this device and after applying the load, the area of indentation was seen by microscope and measured by microcale inside the microscope.[17]

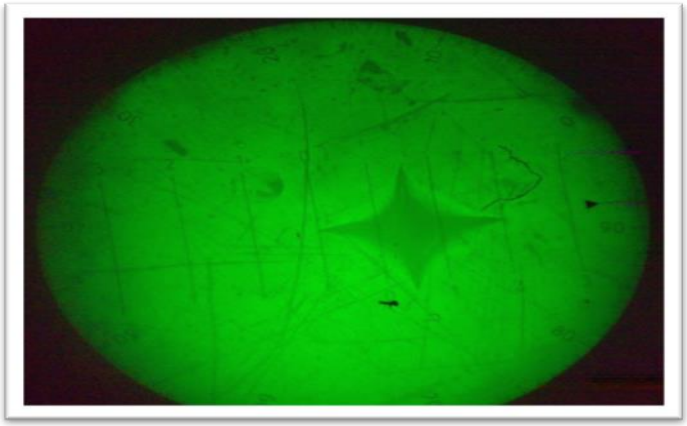

Figure (4): Surface indentation under microscope.

RESULTS

Duncan's multiple range test in the Table showed that there were a significant differences in the effect distilled water, Pepsi, coffee and tea beverage solutions on the hardness of acrylic denture teeth ($p \leq 0.05$). There were no significant differences between coffee and tea beverage solutions in their effect on hardness of different acrylic denture teeth materials. There were a significant differences in hardness between the types of acrylic teeth ($p \leq 0.05$). The means with small letters relate to the interrelationship between the types of teeth and types of beverage solutions and their effect on hardness of teeth and has a significant differences ($p \leq 0.05$) according to Duncan's multiple range test Table(1).

Table(1): Duncan's multiple range test of surface hardness of different denture teeth materials in different beverage solutions.

Teeth types / **Solutions**	**RMH (G1) Mean± SD**	**AcryRock(G) Mean± SD**	**Seif (G3) Mean± SD**	**Means**
Distilled Water	26.362±0.08 a	22.824±0.03 d	21.518±0.07 i	23.568±2.11 A^+
Pepsi	22.286±0.06 g	21.624±0.06 h	20.292±0.06 k	21.400±0.86 C^+
Coffee	23.186±0.05 c	22.712±0.11 e	21.312±0.05 j	22.403±0.82 B^+
Tea	23.284±0.06 b	22.592±0.11 f	21.302±0.05 j	22.392±0.85 B^+
Means	23.77±1.58 A	22.438±0.49 B	21.106±0.49 C	

Figure (5) showed that the RMH (G1) denture teeth materials had the highest Vickers hardness number (VHN) than other denture teeth materials while the Seif (G3) denture teeth materials had the lowest VHN than other denture teeth materials.

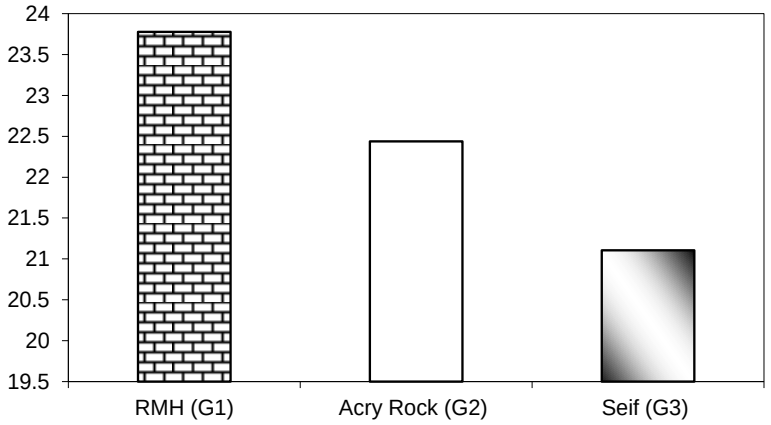

Figure (5): The hardness of different denture teeth materials.

Figure (6&7) showed that the teeth stored in Pepsi had the lowest VHN than other teeth stored in distilled water, coffee, and tea. The tea and coffee beverage solutions had the same effect on hardness of acrylic teeth materials. The teeth stored in distilled water had the highest VHN than teeth stored in other beverage solutions.

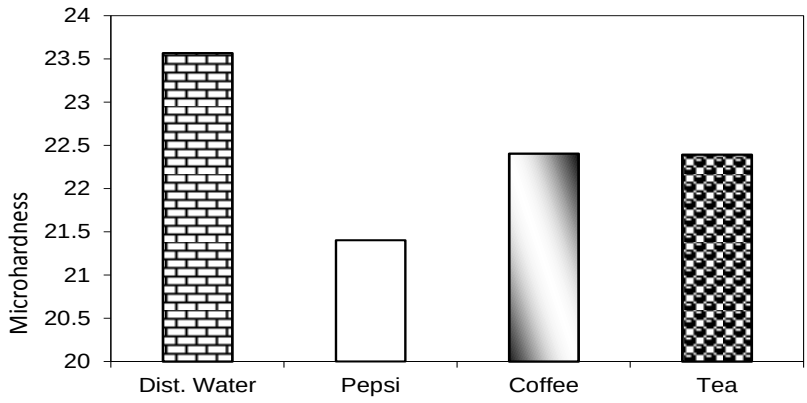

Figure (6): The effect of beverage solutions on the hardness of different denture teeth materials.

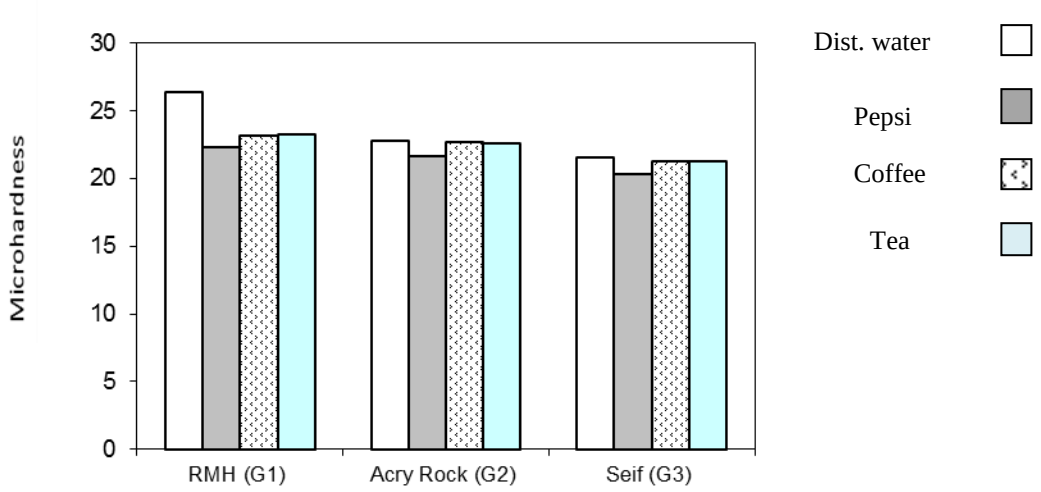

Figure (7):Interrelation effect of teeth materials and type of beverage solutions and their effect on the hardness.

DISCUSSION

The Vickers microhardness test is based on the ability of the surface of any material to resist the penetration of a specific tip with a given load for a specific time. Although artificial teeth and the materials used in provisional prostheses are made of acrylic resins, the greater hardness of artificial teeth is probably attributable to the fabrication process, since the conditions for handling and polymerizing these materials in an industrial environment enhances their physical and mechanical properties[18].The Table and Figure (5) showed that the RMH denture teeth materials had the highest hardness and this attributed to the manufacturing process. The two layer surface manufacturing may related to this increasing in hardness[19]. In order to achieve an aesthetic of high quality, artificial teeth are made at least of two layers. The exterior cutting and/or enamel layer is general exposed to the greatest mechanical strain. High abrasion resistance is the most important requirement of this layer[20].The AcryRock denture teeth materials showed hardness better than that of Seif denture teeth materials and this may contributed to the procedure of cross-linking of the two materials. The acrylic has a linear polymer chain structure, while all modified resin teeth have cross-linked structure. An optimal amount of cross-linking improves the mechanical properties of acrylic resin. Beside adding cross-linking agent to MMA monomer, acrylic resin can improved by interpenetrating polymer network(is a polymer comprising two or more networks which are at least partially interlaced on a polymer scale but not covalently bonded to each other), which sinters the cross-linking agent into acrylic polymer chain[21]. The Table and Figure (6) showed that the Pepsi was the most effective beverage solution in reducing the hardness of acrylic teeth materials. This result may be attributed to the acidic and basic composition of Pepsi which cause the hydrolysis of PMMA. The PMMA contain ester group which easily hydrolyze by acidic and basic content to carboxylate and alcohol. The first step in the reaction involve the attachment of oxygen atom of carbonyl group with the proton(acidic hydrogen), in this step there will be increase in the electrophilicty of the carbon of the carbonyl group then the

attach of nucleophile (H2O) will increase then the alkoxy group will leave and form carboxylic acid and alcohol[22]. The Table and figure (6&7) showed that there were no significant differences between tea and coffee in their effect on hardness of different denture teeth materials but there was a significant differences in their effect on hardness from that of Pepsi. The effect of tea and coffee on hardness is less than that of Pepsi. The tea sometimes considered a super food because of its antioxidant content can cause tooth erosion, but not as much as citric juices, soda and energy and sports drinks[23]. Black tea has a low acid composition and its consumption leads to only small and short-lived decreases in pH at the tooth surface. [24]

CONCLUSIONS

The Pepsi was reduce the hardness of different acrylic teeth materials during the 30 days immersion. The hardness of RMH denture teeth materials was least affected by the different beverage solutions. Tea and coffee are less effective in reducing the hardness of different acrylic denture teeth materials than Pepsi.

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