STUDYING THE EFFECT OF NATURAL BAMBOO AND RICE HUSK POWDERS ON COMPRESSIVE STRENGTH and HARDNESS OF ACRYLIC RESIN

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ABSTRACT

Denture base is the part of a denture that rests on the foundation tissues and to which teeth are Attached. Denture base may be complete or partial used for the alteration of missing natural teeth. The most popular material utilized for the fabrication of dentures base is the poly (methyl methacrylate) (PMMA) because is distinguished by many characteristic. The remarkable clarity of a methyl methacrylate resin, its relatively high strength and hardness, its color stability under all conditions of dental use, its insolubility in the mouth fluids, all of these properties combine to provide an excellent material for the prosthetics denture (S. S Carmen, 2010 and R. K. Alla 2013). This survey illustrate the effect of particle size of powders and weight fraction of natural Bamboo and Rice Husk powders on PMMA, with the selected size particles of (25µm and 75µm) and weight fraction (2, 4, 6 and 8wt. %), on compression strength and hardness, and these experience were accomplished at a temperature of laboratory. The results showed improved in the hardness and compression with concentration rate of Rice Husk and Bamboo powders in composite samples. Also, the highest values of compressive strength and hardness were (300MPa.) and (86) respectively for (PMMA-8%RH) and particle size (25 µm).

KEYWORDS: Acrylic Resin, Natural powders, Bamboo, Rice Husk, Denture

دراسة تأثير المساحيق الطبيعية للخيزران وقشور الرز على مقاومة الانضغاط والصلابه لراتنجات الاكريلك

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الخلاصه

قاعدة طقم الأسنان هي جزء من طقم الأسنان والتي تثبت على الأنسجة الأساسيه وتربط الأسنان. قد تكون قاعدة الأسنان كاملة أو جزئية تستخدم لاستبدال الأسنان الطبيعية المفقودة. المواد الأكثر شعبية المستخدمة في قاعدة طقم الاسنان هي راتنجات poly (methyl methacrylate) وذلك لانها تتميز بالعديد من المميزات. والميزات الملحوضه في هذه المادة قوته وصلابته العالية نسبيًا ، واستقراره بالألوان في جميع ظروف استخدام الأسنان وعدم قابليته للذوبان في سوائل الفم ، كل هذه الخصائص توفر مادة ممتازة لطقم الاسنان. يوضح هذا البحث تأثير حجم و وزن الجسيمات لمساحيق الخيزران وقشور الأرز الطبيعية ، مع جسيمات ذات الحجوم المختارة (٢٥µm و ٧٥µm) والكسر الوزني (٢ ، ٤ ، ٦ و ٨ wt.٪) ، على قوة الضغط والصلابة ، وقد تم إنجاز هذه التجربة عند درجة حرارة المختبر. أظهرت النتائج تحسن في الصلابة والضغط مع تركيز قشورالأرز ومساحيق الخيزران في عينات مركبة. أيضا ، كانت أعلى قيم قوة والضغط هي (٣٠٠ ميكا باسكال) و (٨٦) على التوالي لـنسبة ٨% قشور الرز وحجم الجسيمات (٢٥ ميكرومتر).

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INTRODUCTION

Dental materials are fabricated materials, designed for use in dentistry. Features of typical materials: It should be non-allergenic, biocompatible, Nontoxic, non-irritating, stable of mechanically, strong durable, fracture resistant, corrosion resistant, does not tumble over time, stable in dimensionally, few variation with solvents and temperature(Alla. R, 2013). The polymer PMMA is the most usually used material for this aim. One of the main obstacles of this material is count to be its inferior mechanical showing (E. G. A. Aldoaei, 2012). The acrylic resin Fracture of portable dentures happen usually during utilize through heavy force of occlusal or accidental damage; therefore, perfection in the mechanical performances of denture base structures have been sought by adding reinforcing composition to the PMMA matrix, thus creating reinforced denture base resins (A. M. El-Sheikh 2006).

Hanan, A., et al. 2013 investigated the influence of the extension of siwak particles with average particle size of (75µm) in three different weight fractions (3%, 5% and 7%) on the some mechanical characteristics of heat-polymerized PMMA resin of acrylic. They showed that siwak powder below 7 wt. % does not highly affect the impact strength, compressive strength andtensile strength of the acrylic resin in comparison to the control group, while (7 %) siwak powder which added showed a significant reduction in the strength of compressive, strength of impact and strength of tensile.

O. Eze et.al. 2013 estimated, the influence of bamboo powder filler on some mechanical properties of recycled low density polyethylene (RLDPE) composites were studied. They showed that the strength of tensile and elongation at fracture reduce with increasing filler loading for RLDPE composites while the stiffness modulus of elasticity of the composites rise with increasing filler loading.

Salih I. S. et. al. 2016 improve the properties of PMMA by supplement nanoparticles, which are fly ash, aluminum, zirconia and fly dust in different ratios of volume fractions of (1%, 2% and 3%) to (PMMA) resin (castavaria) is the new fluid resin (pour type) as a matrix. The results illustrate that the values of the hardness, flexural strength, compression strength and flexural modulus rise with the adding of nano particles (aluminum, fly dust, zirconia, and fly ash).

Salih I. S. et. al. 2017 prepares composites of PMMA which reinforced by the natural siwak, with the various lengths and various weight fraction. The results showed that the strength of tensile, modulus of elasticity, toughness of fracture and hardness tended to be better with length and concentration rates of siwak fiber, while the strength of impact and percentage of elongation at fracture reduce with fiber content in composite spacemen.

Touraj Nejatian et. al. 2015 enhances the packing and treatment condition of denture base resin which us heat-cured PMMA in order to enhance its biaxial flexural strength. The plain type of resin with a powder/monomer ratio of 2.5:1 or less, packed traditionally and cured in a bath of water for 2 h at 95 °C supply the highest BFS.

Nwosu-ObieoguKenechi et.al. 2016 illustrates reinforcement of plastic composites with Rice Husk. Synthetic pals composites are growing as they are been used in almost all areas of life as far as the industry concerned, this has led to its escalation of price, environmental defilement and being mostly by products of petroleum, the materials are non-renewable. The results show that the compression strength and flexural strength properties of PMMA composites (PMMA-nHA), (PMMA-ZrO_2) and hybrid laminated composites specimens, increased with rising the volume fractions of (nHA and ZrO_2) powders.

Jawad, K. Olewi et. al. 2018 investigated the effects of adding nano-ZrO_2 particles and micro-lignin particles. With a different volumes fraction of 0.5%, 1%, 1.5% and 2% on mechanical properties of polymer composite materials. The compressive strength and hardness rise with increasing the volume fraction.

This research is aim to studying the action of natural powders on some mechanical properties of the heat-cure acrylic resin that used in dental applications.

MATERIALS AND METHODS

The DURACRYL PLUS heat-curing base resin, fabricated by Spofa Dental Company used as a matrix in this research. The reinforcing materials which use for acrylic resin are Rice Husk and bamboo powders in two different particles sizes (25 & 75 µm) and four concentrations (2, 4, 6 & 8 %).

The resin is mixed in the weight rate 2.5:1 (two and a half parts of powder, one part of liquid). The mixing ratio is significant because it influence the acrylic resin cytotoxicity, the dimensional setting changes and controls the workability of mixture. Table 1 shows the PMMA mechanical and physical properties as obtaining from the company (ASTM Standard Annual Book).

Using a hand for around 30 seconds the mixture was mixed by wood stick to stop the chemical interaction at room temperature constantly in one direction and then poured into the mold which is made from metallic.

The stages in mixing monomer and polymer acrylic materials include (sandy or granular, sticky, full dough, rubbery and hard). The curing process of acrylic was complete by putting the metallic mould in the curing device at (70ºC) and (2.5 bar) pressure according to company instructions. The mould stays inside curing system for about (30 min.) in this temperature to finish process of polymerization and to get better physical properties. The temperature was increased for around (30 min) to the (100 ºC) and stay at this temperature for one hour. Then the process of cooling the mould begins inside thecuring devicein order to remove the residual monomer.

The powders are treated with solution of 5% (w/v) sodium hydroxide at 25°C for one day, keeping a powder-to-liquor ratio of 1:30 (w/v) and then washed the treated powders many time by use distilled water to eject overflow alkali sticking on their surface, then the distilled water which was neutralized (PH-7) a few drops of acetic acid Put it in and washed with distilled water again, then the treated powders stayed for 5 days to dried at room temperature and finally kept in a hot air furnace at (50-60°C). The process of mixing between the monomer liquid (MMA) with reinforcing particles (Bamboo or Rice Husk) should be homogeneous and constantly.

The powder was added to the mixture and mixed progressively. The samples of acrylic resin were de-molded to eject from the mould holes with has upper and lower surface very smooth, and to remove the stress which residual followed by heat treatment at 100°C for 2 h.

EXPERIMENTAL PART

Compressive test

The compressive test was performed according to international standard (ASTM D695) with the spacemen dimension (0.5*0.5*1 cm) by using the same tensile machine at strain rate (the cross head speed) was (2mm/min) and the compressive load was applied progressively until failure occurs in the specimen (ASTM Standard Annual Book).

Hardness Test

The hardness test was performed according to international standard (ASTM D2240) by using Dorumeter hardness test, type (Shore D) at load applied equal to 50 N and depressing time of measuring equal to (15sec). Hardness test type (Shore-D) was carried out on PMMA specimen before and after reinforcing by natural powders. Each specimen was tested five times at different position at same time to obtain higher accuracy results and the average value was taken for each specimen. The surface of specimens must be smooth in zone testing also the depth of indentation and hardness value in this test measure on scale has graduation between (0 to 100) hardness numbers.

RESULTS AND DISCUSSION

Compressive test

Figures (1 and 2) the dependence of compression strength on weight fraction of the reinforcing (Bamboo & Rice Husk) powders in PMMA resin. The compression strength values rise with increasing of the weight fraction for both particle sizes (25 µm and 75 µm) for both materials.

The increase in compression strength is due to ability of powder to strengthen the matrix, improve mechanical bonding between powder and matrix (PMMA), improvement of the mechanical properties that are associated with the addition of natural particles which have high compression strength comparing with PMMA matrix. That is evidence by DSC test provide better compressive strength by increasing powder (P.K. Mallick, 2007 and Jawad. K, 2018).

Thus, the compression strength values increase from (180 MPa.) for PMMA to (280 MPa.) for (PMMA -8% Ba) composite specimen at particle size (25 µm) and to (300 MPa.) for (PMMA -8% RH) composite specimen at particle size (25 µm).

Figure (3) illustrates the comparing between compression strength of PMMA and PMMA composite when reinforced by (Bamboo and Rice Husk) powders for both particle sizes at weight fraction (8%). The addition of both types of powders at both particle size lead to significant increases the value of compression strength in comparison with the PMMA pure. Also the highest value of compression strength was obtained in composite material when adding Rice Husk powder at particle size (25 µm).

Hardness Test

The Figure (4) discusses the dependence of the hardness on weight fraction of Bamboo powders at both particle sizes in PMMA resin. The hardness values rise with increasing of the weight fraction for both particle size (25 µm and 75 µm) of Bamboo powders. While Figure (5) discusses the dependence of the hardness on weight fraction of Rice Husk powders at both particle size in resin PMMA. The hardness values rise with increasing of the weight fraction for both particle sizes (25 µm and 75 µm) of Rice husk powders.

The hardness of PMMA composite that content Bamboo powders or Rice Husk powder at particle size (25 µm) is higher than the hardness at particle size (75 µm). The increase in the hardness value because of these powders have superior mechanical properties such as hardness, yield strength, modulus, etc. that lead to increasing the hardness of composite material when increase these powder ratio.

Also, the composite material because stiffer and harder after solidification. Furthermore increasing the wettability of these powders as result the alkaline treatment of these powders, and formation of strong bonding between the matrix and these powders (R. Hemanth, 2014).

Thus, the hardness values increase from (80) for PMMA to (84.5) for PMMA composite with (PMMA -8% Ba) at particle size (25 µm) and to (86) for (PMMA -8% RH) composite specimen at particle size (25 µm).

Figure (6) discusses the comparing between the hardness of PMMA and PMMA composite when reinforced by (Bamboo and Rice Husk) powders for both particle size at weight fraction (8%).

CONCLUSIONS

The results show the compression strength values increase from (180 MPa.) for PMMA to (280 MPa.) for PMMA composite with (8% Ba) at particle size (25 µm) and to (300 MPa.) for PMMA composite with (8% RH) at particle size(25 µm), the hardness values increase from (80) for PMMA to (84.5) for PMMA composite with (8% Ba) at particle size(25 µm) and to (86) for PMMA composite with (8% RH) at particle size(25 µm).

Table 1: Some Mechanical, Physical and thermal Properties of Heat Cure PMMA.

property	value
Tensile strength	48.3-72.4 (Mpa)
Yield strength	53.8-73.1 (Mpa)
Shear strength	122 (Mpa)
Poisson's ratio	0.35-0.45
Young's modulus	2.38 – 3.24 (Gpa)
Thermal conductivity	0.17-0.25(W/m.K)
Thermal diffusivity	0.123-0.125 (mm^2/s)
Compressive strength	75-81.4 (Mpa)
Elongation	2-10 (%)
Water absorption	2-3 (%)
Density	1.17-1.2 (gm/cm^3)
Flexural modulus	2.9 -3.1 (Gpa)
Fracture toughness	1.6 - 4 Mpa.√m

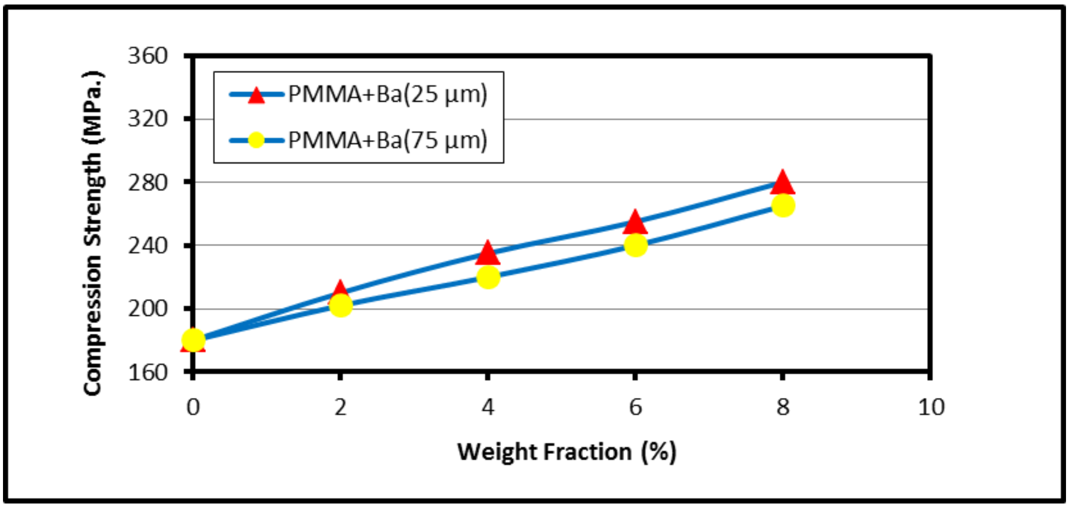

Fig. 1: The Compression strength and Weight Fraction of Bamboo Powder at both particles sizes for PMMA Composite Specimens.

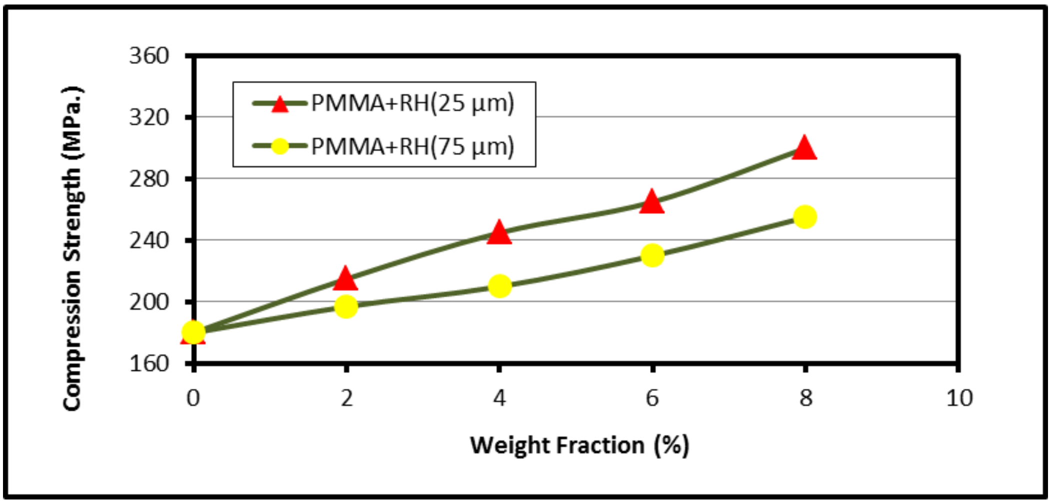

Fig.2: The Compression strength and Weight Fraction of Rice Husk Powder at both particles sizes for PMMA Composite Specimens.

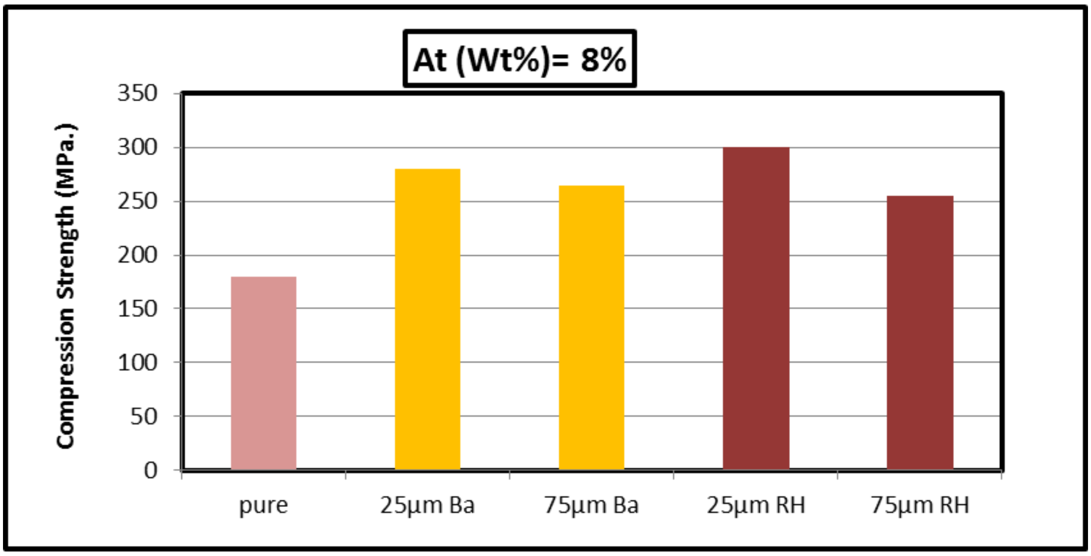

Fig. 3: The Compression strength of pure PMMA and PMMA Composite Reinforced by (Ba and RH) Powders for both particles sizes at weight fraction(8%).

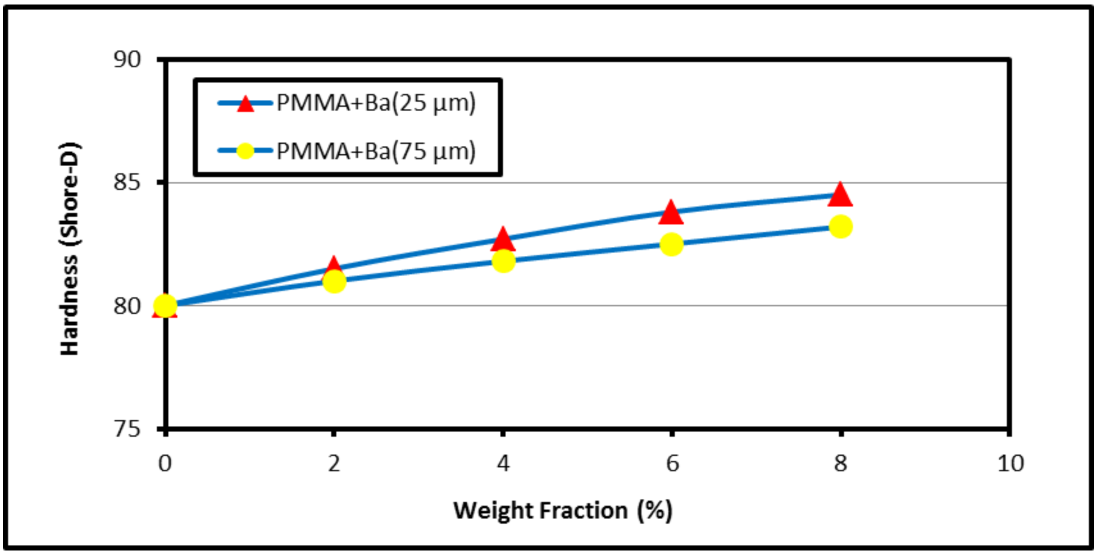

Fig. 4: The Hardness and Weight Fraction of Bamboo Powder at both particles sizes for PMMA Composite Specimens.

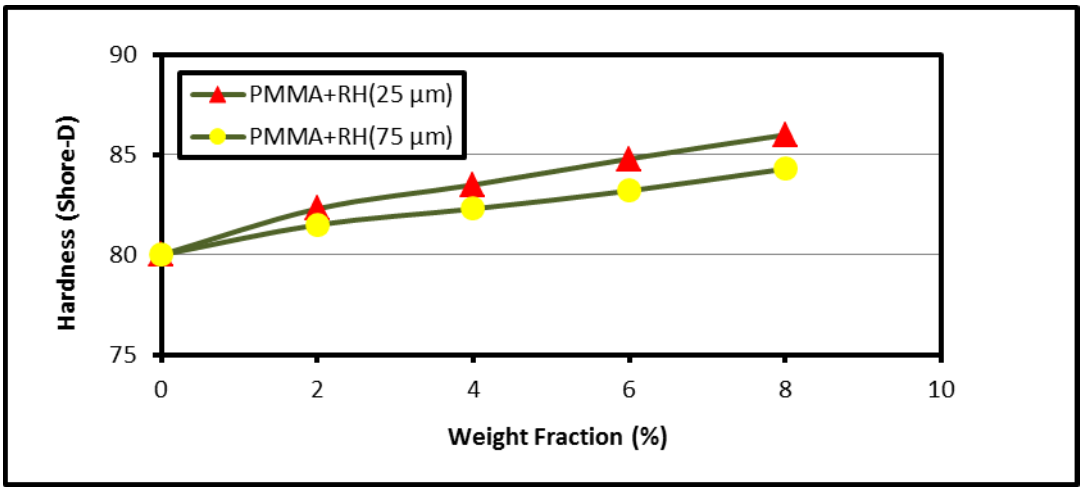

Fig. 5: The Hardness and Weight Fraction of Rice Husk Powder at both particles sizes for PMMA Composite Specimens.

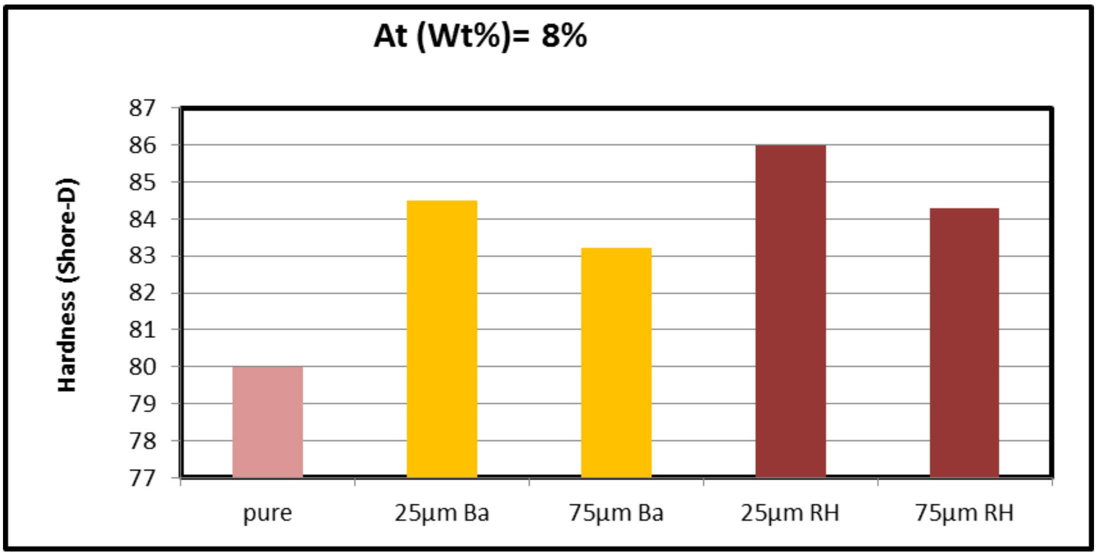

Fig.6 :The hardness of pure PMMA and PMMA Composite Reinforced by (Ba and RH) Powders for both particles sizes at weight fraction (8%).

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