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Preparation And Characterization Of Eggshell Powder For Bio Application

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Abstract- Eggshell (EG) which were hithereto discarded as wastes were collected. Purified and powdered into particle size about (63µm). This powder was treated with different solution of 7% NaOH and 1% stearic acid and row powder applied to sonication (15 min and 10 min) and was characterized for their FTIR, XRD and particle size has been determined.

Keywords—Eggshell powder, chemical treatment, characterizations, FTIR, XRD, Particle size.

1. Introduction

Eggshell (ES) waste has been explored in recent years because it economically cheap, plentiful in nature and has intrinsic pore structure [1].Eggshell which constitutes about 11% of the total weight of the whole egg contains about 91% of $CaCO_3$. It is reported that 1.90.000 tons of eggshell is wasted in India and might be used as a calcium source in human nutrition. The biological behavior of this nature material has also shown that it could be used as a bone substitute in the field of maxillofacial surgery. Eggshell particles ranging from 400-600 µm were bioassay in the intramuscular pouches of rodents and their osteoinductive nature studied [2].The generalized eggshell structure, which varies widely among species, is a protein lined with mineral crystals, usually of a calcium compound such as calcium carbonate. These characteristics qualify(ES) as a good candidate for bulk quantity , inexpensive, lightweight and low –load bearing composite applications, such as the automotive industry, trucks, homes, offices, and factories[3][4].

2. Experimental Work

The collected eggshells were washed thoroughly, initially in tap water and later in distilled water. The adhering membrane was separated manually and shells were dried in a furnace at 80°C for two hours. Later the shells were crushed using a domestic mixer. A sieve of 63µm was used to obtain the required average grain size. The powder was then analyzed using X-ray fluorescence spectrometer and the results are shown in table 1.The eggshell powder (ESP) was treated with two different solutions of 7% NaOH and 1% stearic acid. The molecular formula of stearic acid is $C_{18}H_{36}O_2$. $CaCO_3$ samples were analyzed in a X ray Bruker Advance D8 (40kV y 40 mA) diffractometer with Cu-kα radiation (0.15406 nm). The Fourier transform infrared spectroscopy (FT-IR) was carry out in Spectrum 100 Perkin Elmer. The particle size distribution of the eggshell powder was measured using a HORIBA Laser Scattering Particle Size Analyzers (PSA: LA-950).

3. Results and Discussions

A. Fourier Transform Infrared (FTIR) Analysis

To study the characteristics of the eggshell powder (ESP) before and after chemical treatments, FTIR analysis was used. Eigures (1-4) Show the broad peak at 1412 cm^{-1} in pure and treated eggshell powder with stearic acid which is associated with the carbonyl group. Carbonate based materials are commonly detected by the broad stretching frequency of the C=O in carbonates ions around 1412cm^{-1}[5]. While tis peak is shifted to 1396.86cm^{-1} and 1339.43cm^{-1} in the case of eggshell treated with NaOH and 15 min sonication respectively. Furthermore, the FT-IR graph shows the absorption peak of calcite at 711.76 cm^{-1} and 871.53 cm^{-1} in all cases. These peaks may be associated with =C-H bending in-plane deformation and out-plane deformation modes respectively[6].

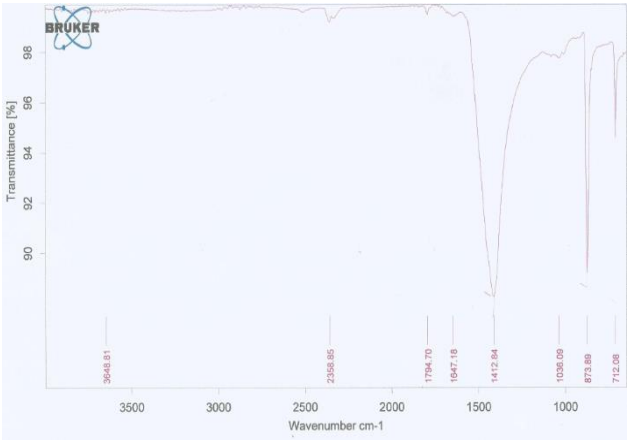

Figure 1. FTIR for natural eggshell powder

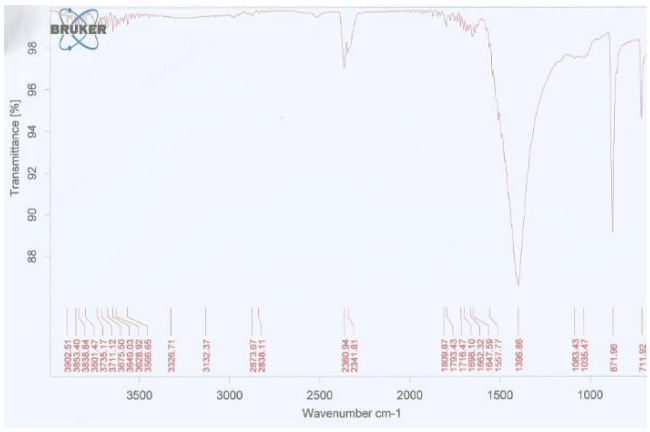

Figure 2. FTIR for eggshell powder treated with NaOH

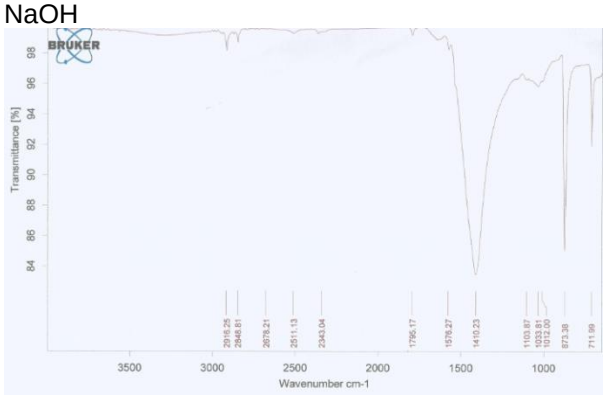

Figure 3. FTIR for eggshell powder treated with stearic acid

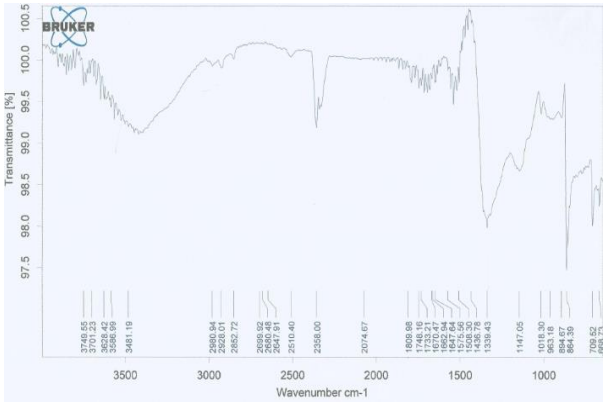

Figure 4. FTIR for sonication eggshell powder

B. X-Ray Diffraction Studies (XRD)

The XRD patterns of all samples were explored in Figures (5-8). The main peak appeared at2θ =29.5 Simultaneously, Figure 3 also shows several other small

peaks at 2θ = 23.2, 39.5, 47.3, 48.7, and 57.6 in all samples. This spectrum confirms the presence of calcium carbonate according to JCPDS Card No.82-1690, where the main characteristic peaks of calcium carbonate were investigated in the XRD graph of the eggshell powder. This outcome also confirms that the calcium carbonate is the main constituent in the eggshell powder (Elabbas et al., 2016; Li et al., 2016) [7]. In the case of sonication, the peak at2θ = 48.7 is more sharp compared with the other samples.

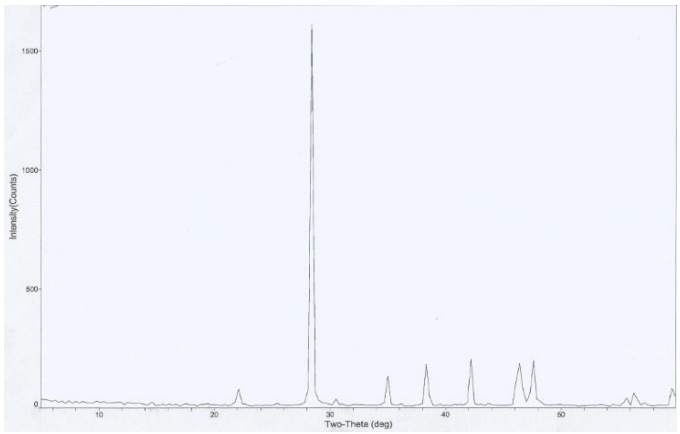

Figure 5. XRD for natural eggshell powder

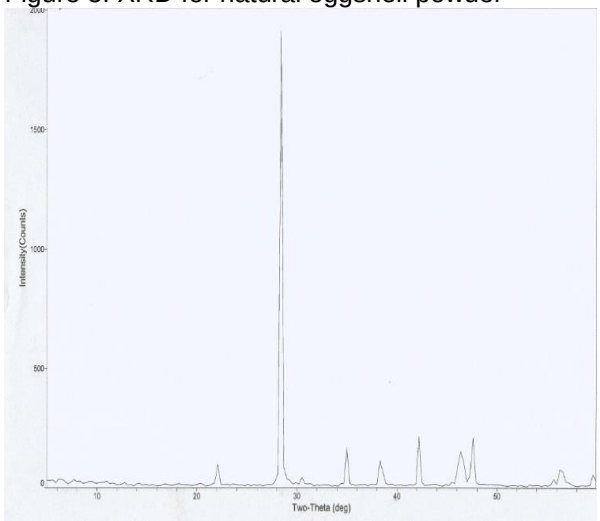

Figure 6. XRD for eggshell powder treated with NaOH

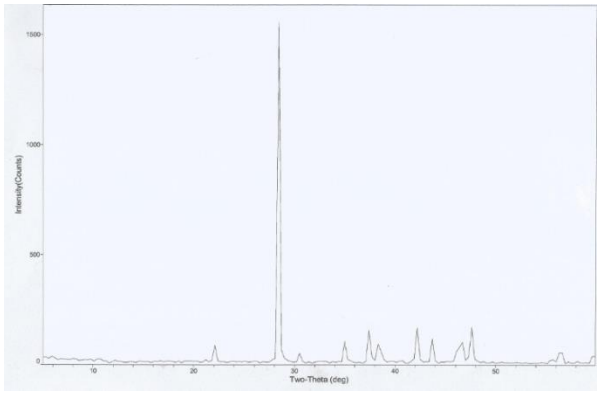

Figure 7. XRD eggshell powder treated with stearic acid

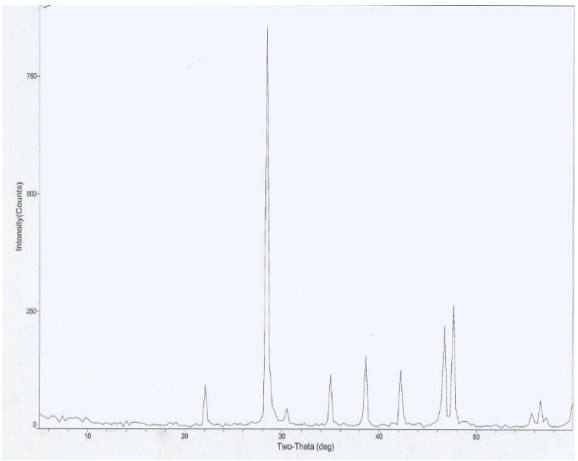

Figure 8. XRD for sonication eggshell powder

C. Particle size

Figures (9-12) show the particle size of pure and treatment eggshell powder. It can observed that at peak $d_{0.5}$ of pure, NaOH, stearic acid and sonication eggshell powder are 31.796µm, 33.111µm, 30.443µm and 36.048µm respectively. It can be indicated that with finely grounded of egg shell powder, it is predicted to appear the similar reaction of commercial calci-um carbonate to strengthen the physical strength of rubber composites with same loading and same particle size. In summary, the egg shell powder as bio-filler is feasible to test since the particle size of egg shell powder is highly similar to the commercial calcium carbonates [8].

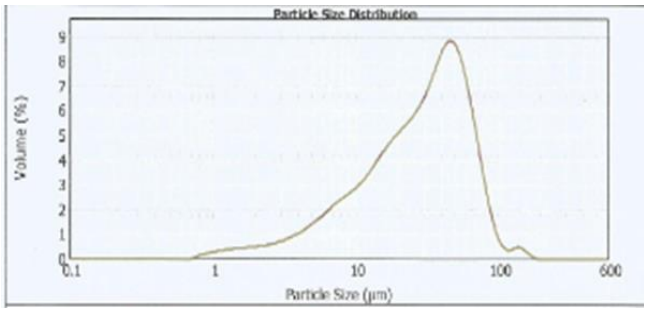

Figure 9. Particle size distribution for natural eggshell powder

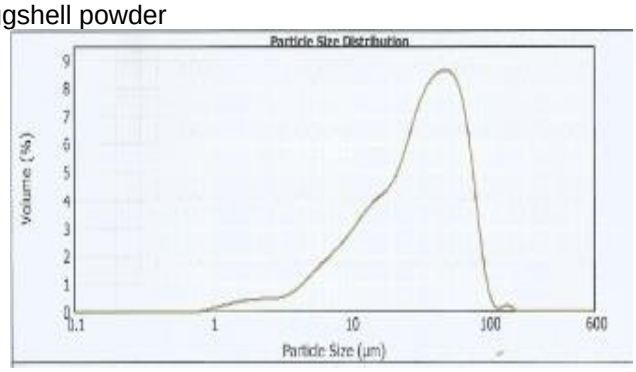

Figure 10. Particle size distribution for eggshell powder treated with NaOH

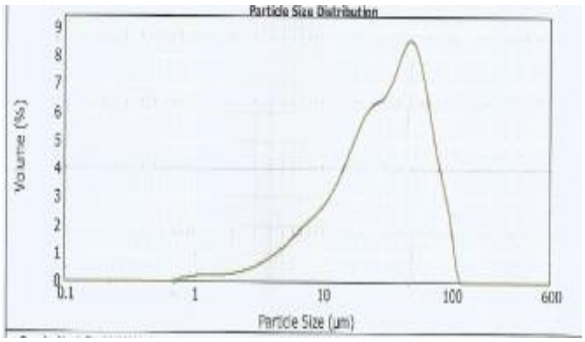

Figure 11. Particle size distribution for eggshell powder treated with stearic acid

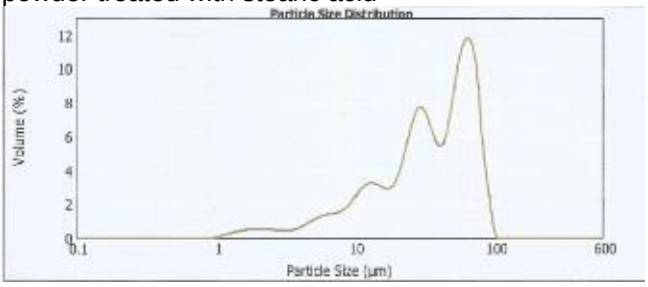

Figure 12. Particle size distribution for sonication eggshell powder

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