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Hydrothermal Precipitation of Calcium Hydroxyapatite with Layer's Chicken Biogenic Eggshells.

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***Abstract*:** *Environmental residues are valuable resources with the detection and recovery of useful compounds. The transformation of these waste materials into useful materials involves different techniques and approaches. Eggshell is a direct medium of $CaCO_3$ with a high grade material as the potential feedstock for calcium hydroxyapatite preparation. Calcium in mesoporous form of hydroxyapatite had been primed via hydrothermally functionalized orthophosphoric acid on chicken (layers) eggshell supported by 120 minutes thermal decomposition time of 1200°C. An output of 96.41% hydroxyapatite defined by FT-IR confirmed the eggshell a direct medium for the generation of calcium hydroxyapatite, appropriate to be used in application of bio-applications. As, bone structure development, gene delivery and medication, additive agent for toothpaste, and restorative bone void fillers in orthopedic*

Keywords: Hydrothermal, calcium-hydroxyapatite, layer's eggshell, calcium carbonate & biogenic**.**

1.0 INTRODUCTION

Eggshells are biomaterials with a lot of purposes that diminish their effect on ecological contamination. Eggshells supply directly adjusted calcium because of its measures of different minerals and are conceivably the basic source of calcium [1]. One absolute medium measured eggshell gives around one teaspoon of powder, which supplies 750-800 mg of basic calcium in addition to various microelements [2]. The eggshell powder has been articulated to build bone mineral thickness in individuals and creatures with osteoporosis [1]. Layers in the late-developing stage, their eggshell powder has been resolved to expand egg production and upgrade the incredible applications of shells [1]. Thus, disposed eggshells are consistently utilized as plant compost and are pleasant liming sources. This is because eggshells incorporate calcium that raises, or standardized the pH level of excessively acidic soil [1]. Consequently, eggshells of chicken are capable of being utilized as an elective stabilizer to the soil when considering that they have the indistinguishable chemical components. Such chemically balanced soil can be utilized as subgrade materials in road improvement [3]. Eggshell layer comprises of collagen that is a sort of protein, stringy and that associates with distinctive substantial tissues like bone, skin, ligaments, and muscles [4]. Collagen has been isolated from the skins and bones of a cow. It is adopted in medical sciences, biochemistry, pharmaceutical, cosmetic and food industries [1]. After the episodes of bovine-like spongio structure encephalopathy, foot and mouth ailment, immune system and hypersensitive responses, limitations on collagen use from these sources had been upheld [1]. Eggshell layer collagen is low in the immune system and unfavorably susceptible responses as appropriately as high in bio-security and is of practically identical characteristics to various mammalian collagens [1]. Hydroxyapatite; $Ca_{10}(PO_4)_6(OH)_2$ is amongst the limited resources that are categorized as a bioactive agent that can support and sustain bone ingrowth and Osseo integration when applied in orthopedics, maxillofacial and dental uses [11]. Hydroxyapatite modifications and coatings were often engaged in biomedical implants, especially stainless steel alloys and titanium, to augment the surface performance [5]. Hydroxyapatite could be used to block bone defects and cavities in the form of porous blocks, hybrid composites, and powders [6]. This could occur whenever large parts of bone need to be replaced or even when fracture implants are necessary. This may be developed from corals [7], body fluids [8], seashells [5], and eggshells [6, 9]. Hydroxyapatite nanocomposites were obtained through the use of eggshells in previous work, with phosphoric acid [10]. The investigational aspects of this synthesis were the measure with the weight percent fraction of the activated eggshell-phosphoric acid, the temperature and the mechanochemical synthesis duration [11].This project aimed at synthesizing hydroxyapatite via hydrothermal approach with eggshells of layers chicken and FT-IR characterization with the yield of production.

2.0 MATERIALS AND METHODS

Discarded eggshells of layer's chicken, measuring cylinder, Beaker, Petri-dish, conical flask, agate mortar, and pestle, drying cabinet, oven, muffle furnace, disodium hydrogen phosphate, orthophosphoric acid solution (0.6M; 58.8g/l), pH meter and FT/IR-4000, model.

2.1 Hydrothermal synthesis of Calcium-hydroxyapatite

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Eggshells were washed with distilled water, boiled for 30 min and oven-dried at 100oC for 30 min as described by Wu, S et al [12]. The shells were then pulverized and calcinated in a muffled furnace at 1200˚C for 120minutes resulting into calcium oxide

The calcinated eggshell powder is then placed in a beaker and dispersed in distilled water (hydrothermal), where CaO is chemically converted to Ca (OH) $_2$

The orthophosphoric acid solution of 0.6M was reacted with calcium hydroxide solution in attaining a pH of 8.5.

This forms a product precipitate as shown below:

$$10\,Ca(OH)_2 + 6H_3PO_4 \rightarrow Ca_{10}(PO_4)_6(OH)_2 + 18H_2O$$

The solution was kept for 2days at room temperature to agglomerate into precipitates that were kept at 100˚C to dehydrate in an oven and re-calcinated at 1200˚C for another 120 minutes in a muffled furnace, which eventually formed a white crystalline powder of hydroxyl-apatite [12].

3.0 RESULTS AND DISCUSSION

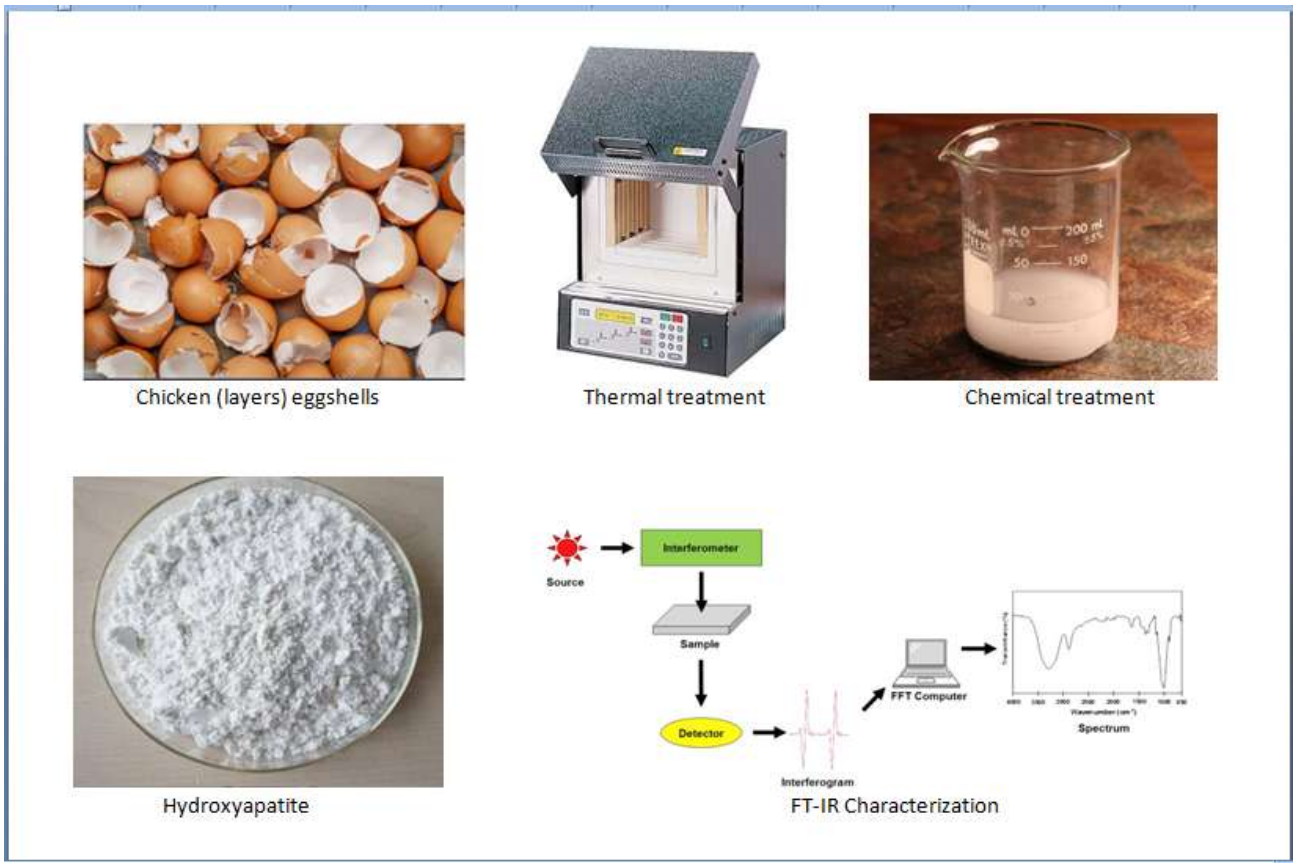

Figure 1. The synthesis diagrams

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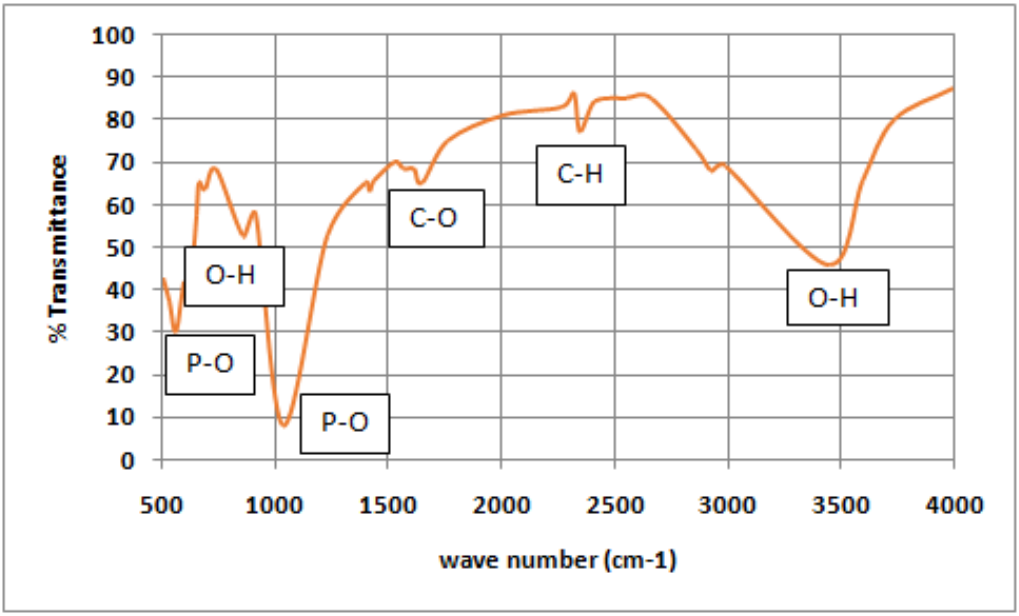

Figure 2. FT-IR spectrum of layers egg shells calcium-hydroxyapatite.

Table.1 Yield of the hydroxyapatite

Net weights of the Eggshells (Kg)	**0.565**
Theoretical weight of the hydroxyapatite (Kg)	**1.004**
Final weight of the synthesized hydroxyapatite (Kg)	**0.968**
Percentage yield of the hydroxyapatite (%)	**96.41**

Fourier transform infrared (FTIR) spectroscopy was engaged to characterize the different functional groups of Calcium-hydroxyapatite [Ca_{10} $(PO_4)_6(OH)_2$], powder obtained from layers eggshells. Figures 2 and Table 1 illustrates the FTIR spectrum of synthesized Hap and the yield respectively. The spectrum was recorded in the range of 500–4000cm^{-1}. The representative FTIR spectrum shows all characteristic absorption peaks of calcium-hydroxyapatite. The first indication for the formation of the hydroxyapatite is in the form of a strong complex broad FTIR band centered at about 1000- 1100cm^{-1} due to asymmetric stretching mode of vibration for the PO_4 group [13]. The band at 576.30cm^{-1} corresponds to the symmetric P-O stretching vibration of the PO_4 group [14]. As a major peak of the phosphate group, the vibrational peak is identified in the region between 1100-960cm^{-1} which are due to P-O asymmetric stretching of PO_4^{3-}. The band between 2005-2079cm^{-1} is due to the overtone of the 1040cm^{-1} band. The presence of a peak in the region 1400- 1450cm^{-1} was due to absorbed carbon dioxide. The crystalline powder induces two distinctive stretching modes of O-H bands at about 3497cm^{-1} and 456cm^{-1}which are typical of all hydroxyapatite FTIR spectra.

4.0 CONCLUSION

In this work, waste egg-shells were efficiently engaged in the production of hydroxyapatite that is applied and suitable for both biomedical and non-medical applications. In the light of this, research should be focus on the domestication of the techniques required towards economical benefits of job creation, handsome returns from poultry farming and prevent ecological pollution.

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