PREPARATION OF CALCIUM PHOSPHATE FROM FISH BONE BY HEAT TREATMENT

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ABSTRACT: Calcium phosphate (CP) is one of the biomaterials which is widely used in various fields for multiple biomedical and clinical application. In this study calcium phosphate (CP) was synthesized from the fish bones collected from the local area. The synthesizing process of CP was done via simple heat treatment by calcination at different temperature ranging from 600 °C to 1000 °C. XRD analysis shows that the major phase was HA in all powders. Moreover, the intensity of HA powder obtained by treated by calcination at various temperature was increased as the temperature increased. However, as the temperature was increased more than 800°C, the HA peaks become less intense and broader as HA might transform to other phase; tri-calcium phosphate. SEM reveals that the HA powders were formed by agglomeration of small particles.

KEYWORDS: *Calcium phosphate; Hydroxyapatite; Tricalcium phosphate; Fish bone; Calcination*

1.0 INTRODUCTION

Calcium phosphate (CP) bioceramics have recently been explored particularly in the applications of bone tissue engineering as scaffolds that encourage regeneration of diseased and damaged hard tissues (Zhou & Lee, 2011;Mustafa & Tanner, 2011). The most potential CP materials are hydroxyapatite (HA) and tricalcium phosphate (TCP) due their near resemblance to human bone minerals (Ishak et al, 2016; Mustafa et al, 2018). CP is typically produced from chemical reagents such as precipitation, microwave irradiation, sol-gel, hydrothermal process, ultrasound irradiation, electrodeposition and spray pyrolysis (Othman et al, 2017 & 2018) . However, chemical synthesis has some restrictions such as expensive, complex synthesis method, high cost, time consuming and impurity incorporation. Therefore, naturally-derived HA has been studied. Recently, corals, cockles, eggshells, cuttlefish bone, fish bone, fish scale and bovine cortical bone have also been utilized to produce CP as these materials contain high percentage of calcium (Toibah et al, 2018 &2019; Paul et al., 2017; Ramesh et al., 2016). These biowaste materials which contribute most from food industry are abundantly accessible in Malaysia. Therefore, in order to add values to these biowastes, an attempt has been made to recycle these biowastes to prepare bioceramic for biomedical application. In this study, the CP was synthesized from waste fish bones (Lates calcarifer) collected from the kitchen waste. The synthesizing process of CP was done via simple heat treatment by calcination at different temperature ranging from 600 °C to 1000 °C.

2.0 EXPERIMENTAL PROCEDURE

The fish bones (Pangasianodon hypophthalmus) were collected from the kitchen waste and immersed in boiling water for 2 hours to remove the flesh, debris, and fat from the bones. The boiled fish bones were rinsed under flowing water several times before dried in the oven at 55°C for 24 hours. Then, the dried fish bones were crushed and calcined at different temperatures varying from 600°C to 1000°C at a heating rate of 5°C/ min for 2 h. The phase identification of the raw fish boned and calcined powders were analysed by XRD (X-Ray Diffractometer System X'Pert Pro, PANalytical). The morphology of the powders were observed using Scanning Electron Microscope (SEM: JSM6300, JEOL, Japan).

3.0 RESULTS & DISCUSSION

Figure 1 shows the XRD patterns for the CP powders derived from the waste fish bones which have been calcined at various temperatures ranging from 600°C to 1000°C. The result shows that the XRD patterns of the calcined powders matched well with JCPDS Card Number 09-0432 for HA. This result indicates that calcination of fish bones at these temperatures produced crystalline HA. The results indicate that HA powder was obtained even when the raw fish bones was calcined at the lowest calcination temperature; 600°C. Moreover, it is observed from the XRD analysis that when the calcination temperature was increased, the highest HA peak, corresponding to the (211) lattice plane become intense and narrow. However, when the calcination temperature was further increased more than 800°C, the decreased of the intensity of this HA peak was observed. This might due to the transformation of HA phase to TCP phase at higher temperature. Therefore, from the results obtained in this study, it can be concluded that the optimum temperature for the formation of HA from the fish bones with highest crystallinity is at 800°C.

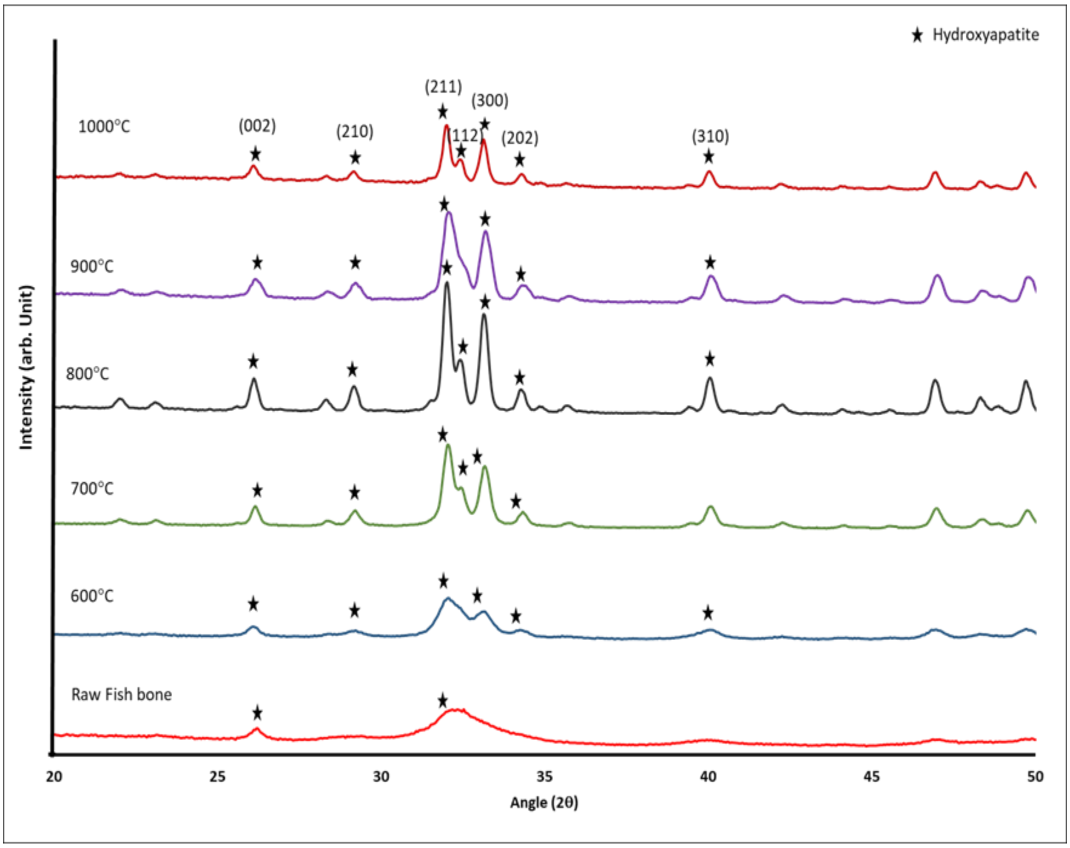

Figure 1. XRD patterns of raw fish bone and HA powder produced by calcination of fish bones at different temperature.

Figure 2 shows the SEM image of the morphology of the as-synthesized HA which was calcined at 900°C. There are no significant changes can be observed from the morphology of the HA powder obtained from the fish bone when calcined at different temperatures. Based on the morphology of the as-synthesized HA derived from the calcined fish bones, it was found that the powder is in large agglomerated shape. Individual fine particles with spherical and semi-spherical shapes which formed bigger agglomerated particles also can be observed in the SEM image.

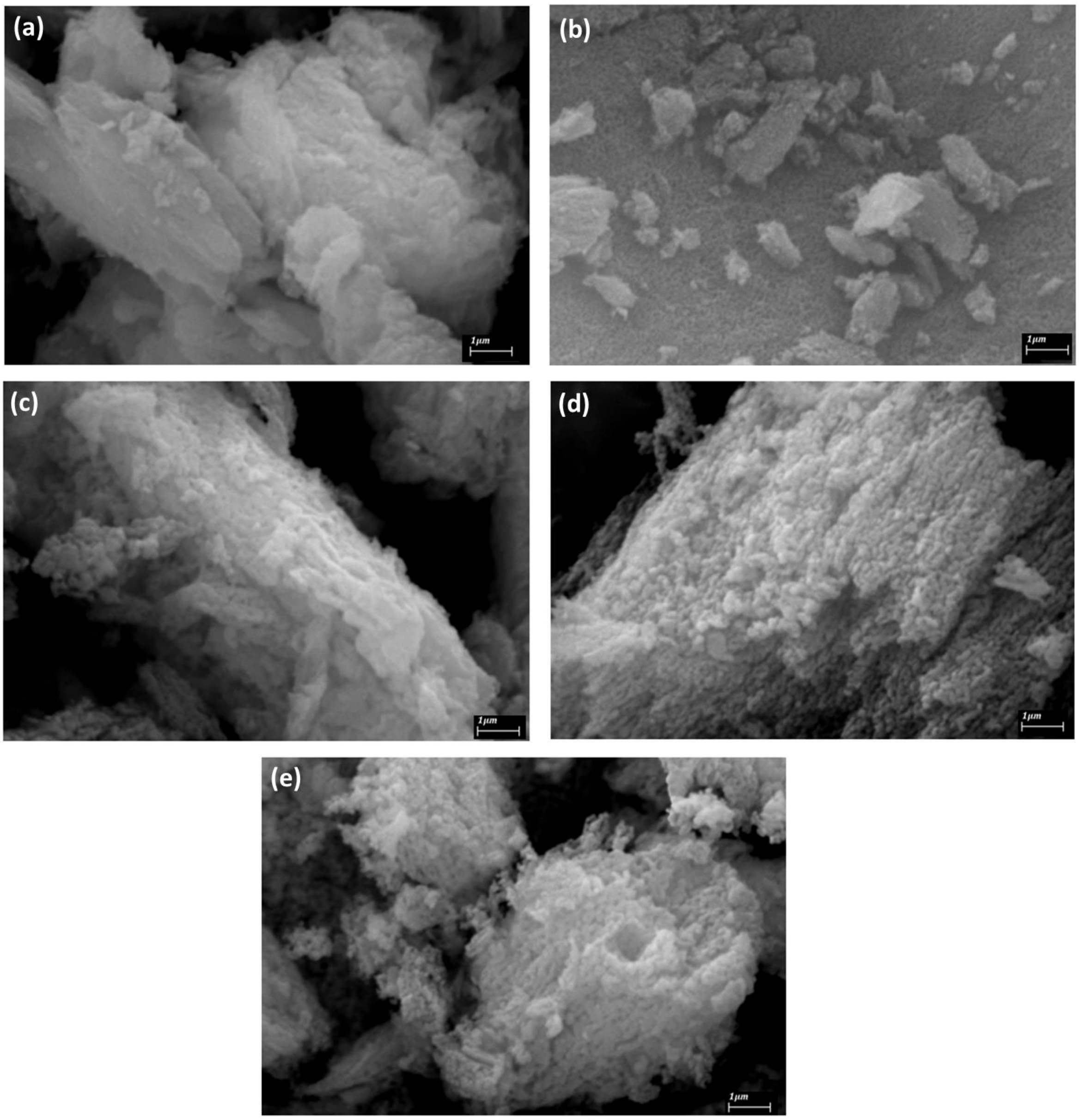

Figure 2. SEM image of HA powder derived from fish bone calcined at different temperature; (a) 600°C, (b) 700°C, (c) 800°C, (d) 900°C and (e)1000°C.

4.0 CONCLUSION

In this study, waste fish bones was successfully converted to useful bioceramic material of hydroxyapatite by calcination process. The XRD analysis confirms that the calcined powders were corresponding to HA powder. SEM reveals that the HA powders were present in agglomerated forms. Thus, it is concluded that fish bones are one of the alternative materials for the production of bioceramic for biomedical applications.

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