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Comparative Synthesis and Characterization of Hydroxyapatite from Duck and Turkey Femur Bones

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Abstract: *Hydroxyapatite (HAp) plays an important role in the medical field such as bone tissue engineering, dentistry applications such as teeth bleaching therapy, demineralizing agent in toothpastes, orthopedic and dental implant coating etc. Most materials used for hydroxyapatite production are expensive and contains chemicals that might have side effect on the human body when used. The need for alternative source for hydroxyapatite production that is cheap and non-toxic has made researchers to look at animal bone and other bio-wastes as good alternatives at the same time solving environmental pollution caused by this waste. This research work synthesizes hydroxyapatite from turkey and duck bones at 800ºC using calcination/thermal decomposition techniques and comparing the HAp from both bones. The result showed that hydroxyapatite were successfully synthesized from turkey and duck bone. The diffraction peaks 002, 221, and 300 at 2 theta angles 26º, 31º and 32º confirms the formation hydroxyapatite in turkey bone and diffraction peaks 002, 221, 300 and 202 at 2 theta angles 26 º, 31 º, 32 º and 33 º confirms the formation hydroxyapatite from duck bones. The SEM image for hydroxyapatite for both turkey and duck showed that they are porous microcrystalline aggregates with irregular shapes. Turkey HAp looks more crystalline and compact compared to that of duck which looks rough and aggregated. The EDX analysis for Turkey HAp and Duck carried out showed Calcuim/Phosphorus (Ca/P) ratio of 1.83 and 1.85 respectively with negligible difference and falls within the stoichiometric acceptable range for Ca/P in HAp. This makes Turkey and Duck HAp good candidate for medical and other biomedical applications.*

Keywords—Hydroxyapatite; Duck and Turkey bones; Thermal decomposition; X-ray diffraction (XRD); Scanning electron microscopy (SEM); Energy dispersive X-ray (EDX)

1. INTRODUCTION

Due to the important applications of hydroxyapatite ($[Ca_{10}(Po_4)_6(OH)_2]$) in the medical field such as in; Bone tissue engineering, teeth treatment, bleaching, toothpastes formation, orthopedic and dental implant coating etc., the need for cheaper and readily available source for its production is paramount. One of such source of hydroxyapatite is from animal bones. Animal bones are bio-waste and as such are easy to source for hydroxyapatite production.

Hydroxyapatite (HAp) is a bio-ceramics made up of calcium-phosphate compounds and has similar composition and morphology as in human hard tissues [1-2]. It is known for its biocompatibility and applications in tissue repair such as bones, teeth implants and other hard tissue treatment in medical and biomedical fields [2]. HAp is known for its ability to enhance human bone recovery since it acts like the natural apatite in human bones [3].

HAp can be obtained from waste biological materials such as sources bovine, fish, poultry bones, cattle etc., and are synthesized through different techniques such as sol-gel technique, hydrothermal, chemical precipitation, homogeneous precipitation, micro-emulsion and thermal method, solvothermal method [4]. Researchers have synthesized HAp from different bio materials such as such as chicken bone HAp doped with silver nanoparticles for antibacterial applications [4-5], bovine bone for dental implants [6], bovine and catfish bones for scaffold [7] and from other sources such as marine, mammalian, plant etc. [8].

This paper looks at the comparative synthesis of hydroxyapatite from turkey and duck femur bones through thermal decomposition technique.

2. MATERIALS AND METHOD

The followings are materials and equipment used for this research. Turkey and Duck femur bones (Precursors), distilled water, Muffle Furnace, platinum crucible, mortar and pestle, air oven, brass molds, bowl, pipette, beakers, weighing scale, measuring cylinder, stirrer, heating vessel.

2.1 Hydroxyapatite synthesis

Hydroxyapatite was extracted from the bones of turkey and duck using calcination/thermal decomposition method reported by [4], [9], [10] with some modifications. First, turkey and duck femur bones were washed and rinsed using distilled water to remove dirt's from the bones respectively. The bones were respectively placed in distilled water and boiled for one and half hours to removed adhered meats. After heating, the bones were broken to remove marrow and place in an acetone solution for two hours for deprotenization and removal of fats. The bones were then washed respectively with distilled severally to remove dirt's and acetone and dried for two hours at 80 ºC to remove moisture content and grounded to powder form. 2 grams of grounded powdered bones respectively, were sieved and further placed in a muffle furnace heated at 600°C for one hour first, and further to 800°C for another one and half hours to form whitish hydroxyapatite. The formed hydroxyapatite were moistened to form hydroxyapatite paste.

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3. RESULTS AND DISCUSSION

Fig. 4.1 (a) and (b) shows the grinded calcined turkey and duck bones at 600 °C in gray ash colour respectively with that from turkey bone looking darker compared to duck bones. This shows that at 600 °C, the bones were still amorphous and carbonated with turkey bones showing more of these characteristics because of its darker colour. Heating the samples further to 800 °C, the colour of the grounded bones changed to white indicating the formation of HAp as shown in Fig. 4.2 (a) and (b) for turkey and duck bones respectively. There is no difference in the colour and texture of the hydroxyapatite from turkey and duck bones.

Research has shown that the colours of the calcined bones changes from brown to white milky colour depending on the calcined temperature [9]. Also research has shown that the particle size of the bones and the temperature of calcination affect the crystallinity, composition and crystallite size of hydroxyapatite [11].

Fig. 4.3 shows the XRD pattern for Turkey bone HAp synthesized. The diffraction peaks with miller indices 002, 221, and 300 at 2 theta angles 26°, 31° and 32° confirms the formation HAp in turkey bone. Similarly the diffraction peaks 002, 221, 300 and 202 at 2 theta angles 26 °, 31 °, 32 ° and 33 ° in Fig. 4.4 confirms the formation HAp from duck bones. These diffraction peaks indicates the presence of HAp crystalline phase and the diffraction peak denoted X might be due to impurity present in the sample during characterization.

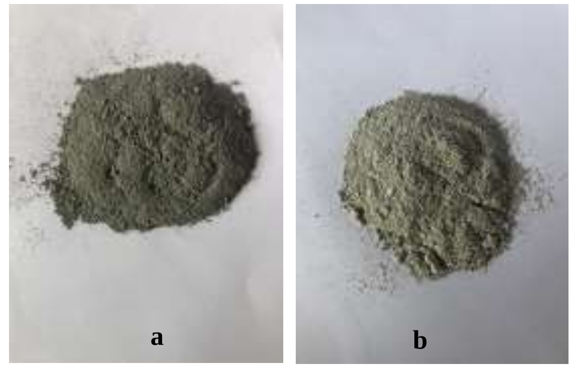

Fig. 4.1 Grinded calcined turkey and duck bones

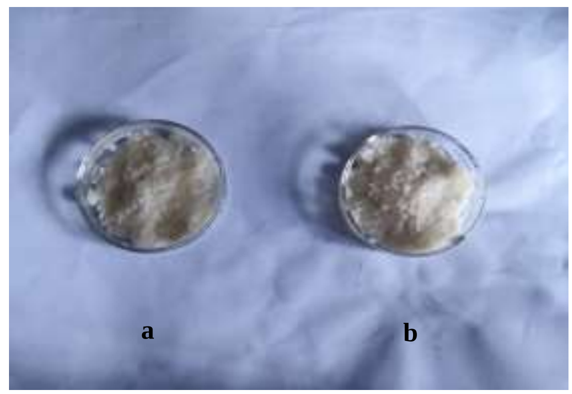

Fig. 4.2 HAp from turkey (a) and duck bones (b)

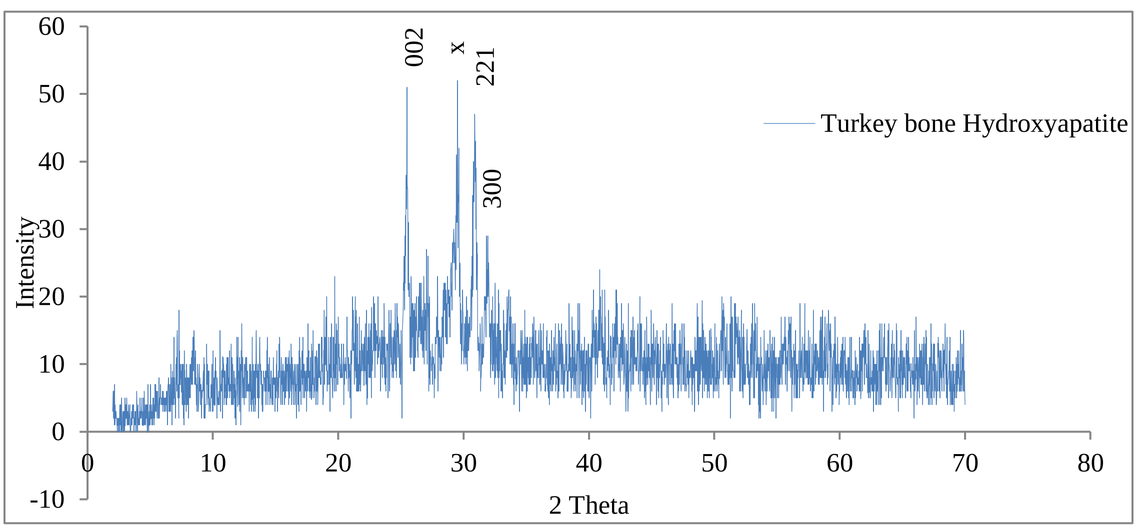

Fig. 4.3 XRD of Turkey bone hydroxyapatite

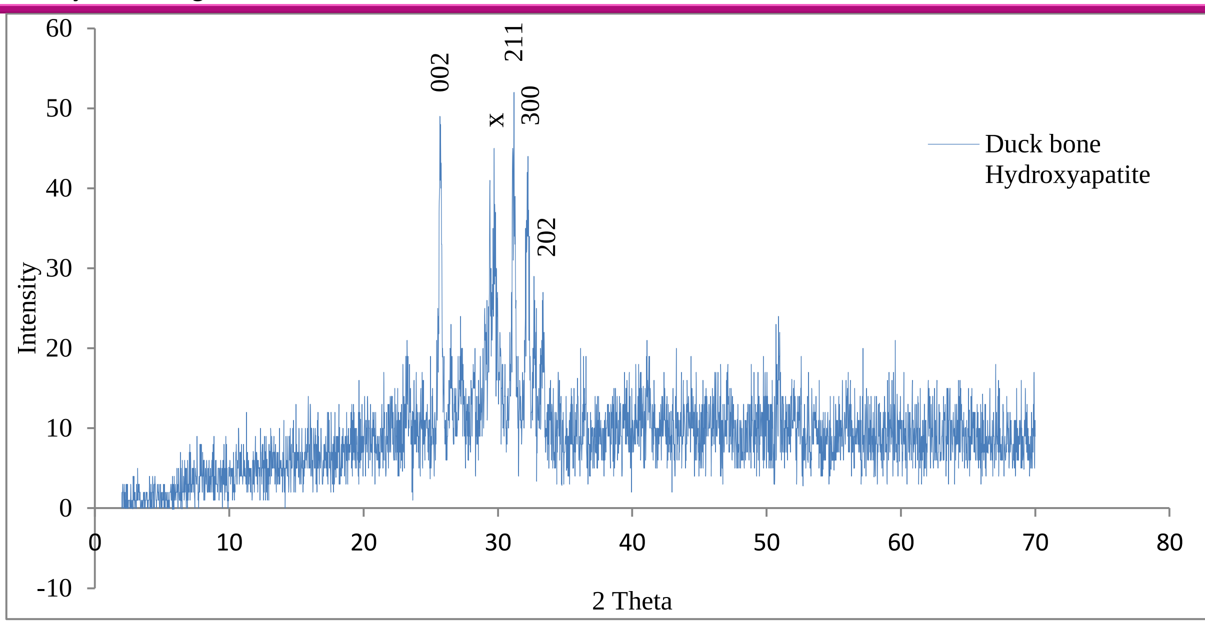

Fig. 4.4 XRD of Duck bone hydroxyapatite

Fig. 4.5 shows the SEM image for turkey HAp and Fig. 4.6 similarly shows the SEM image for duck HAp synthesized. From the figures it can be seen that the hydroxyapatites for both turkey and duck are porous microcrystalline aggregates with irregular shapes making them good candidate for bone restructure and other biomedical applications. The hydroxyapatite for turkey looks more crystalline and compact compared to that of duck which looks rough and aggregated. The calcium to phosphorus ratio of the hydroxyapatite formed was analyzed using energy dispersive x-ray (EDX) and the results summarized in table 1.

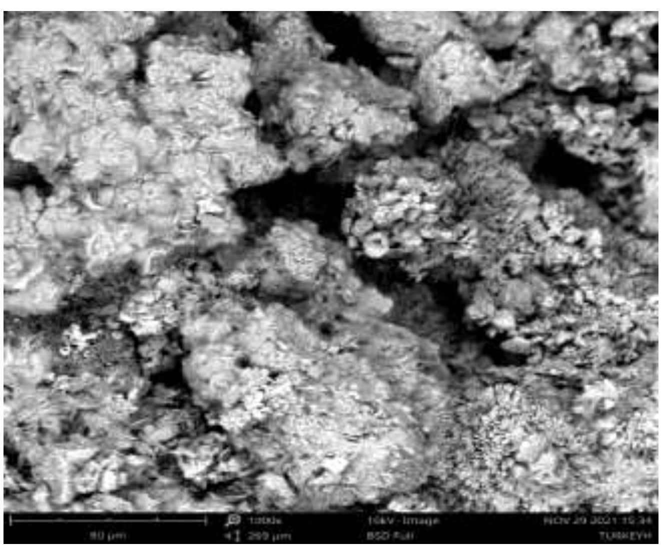

Fig. 4.5 SEM image of synthesized turkey hydroxyapatite

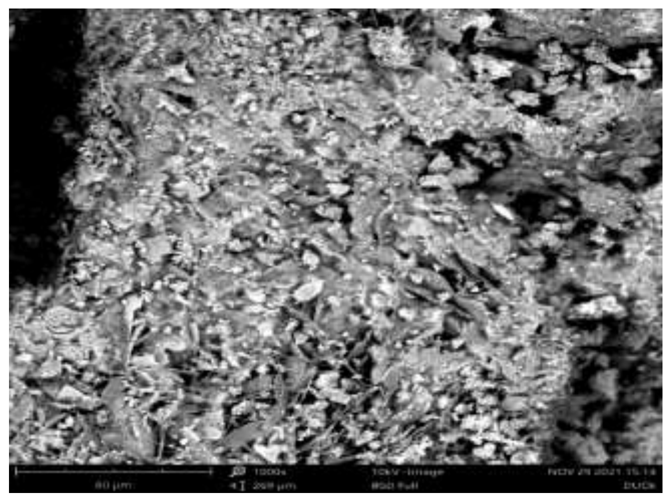

Fig. 4.6 SEM image of synthesized duck hydroxyapatite

Table 1. Summary of EDX elemental analysis for Turkey and Duck bone HAp in weight percent and Ca/P ratio

HAp Sample	Elements by weight percent		Ratio Ca/P
	Calcium	Phosphorus	
Turkey bone HAp	42.92	18.10	1.83
Duck bone HAp	42.30	18.05	1.85

In table 1, the EDX analysis showed that calcium and phosphorus are the major elements in HAps from turkey and duck bones with other elements such as Oxygen (O), Magnesium (Mg), carbon (C) present in varying weight percent. Table 1 showed that the Ca/P ratio for turkey and duck Haps falls within the acceptable stoichiometric ratio range for hydroxyapatite although higher than the standard hydroxyapatite molar ratio for Ca/P which is approximately 1.67 [12].

4. CONCLUSION

The result showed that hydroxyapatite was successfully synthesized from turkey and duck bone through calcination at 800^{o}C. The diffraction peaks 002, 221, and 300 at 2 theta angles 26^o, 31^o and 32^o confirms the formation HAp in turkey bone and diffraction peaks 002, 221, 300 and 202 at 2 theta angles 26^o, 31^o, 32^o and 33^o confirms the formation HAp from duck bones. The SEM image for HAp for both turkey and duck showed that they are porous microcrystalline aggregates with irregular shapes. The EDX analysis showed that the HAp composed dominantly of calcium and phosphorus by weight percent and the Ca/P ratio for both turkey and duck HAp falls within the acceptable range for stoichiometric HAp with negligible difference in Ca/P ratio for turkey and duck HAp. This makes turkey and duck HAp good candidate for bone restructure and other biomedical applications.

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