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Extraction of Calcium Phosphate from Animal Bones

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Abstract- **Calcium Phosphate is one of the most important compounds for our body or for industrial experimental in the recent time. As the need for Calcium Phosphate has been increasing, its production must be increased using cheaper and eco-friendly raw materials. So this paper is a summary of the attempt to extract Calcium phosphate from animal bones. The synthesis involved crushing the bones into small fragments, decomposition by using hydrochloric acid, filtration and precipitation. This method will also help reduce the wastes of animals such as bones. In this work,the effect of parameters such as pH and concentration of filtrate solution on the yield of Calcium phosphate was studied. Characterisation studies of the bone showed 38% calcium, 18% phosphurus and 19% oxygen.**

Keywords: — Calcium Phosphate, bones, waste, extraction

I INTRODUCTION

Calcium phosphate can be obtained in the form of a loose powder by precipitation from aqueous solution. These precipitates contain different amounts of H+ and OH- ions as well as water molecules, depending on the experimental conditions. Through hydrothermal techniques, the temperature can be raised above 100°C and in practice up to about 1000°C. The precipitations can also contain "foreign ions" when carried out in their presence in the aqueous solution. One way to obtain polycrystalline Calcium phosphate in the form of more or less dense bodies is by applying ceramic techniques whereby the porosity can be lowered either by "hot pressing" or by liquid sintering. In addition, the Calcium phosphates can be doped with "foreign ions" in these techniques. Both ways of synthesis are relevant to the production of Calcium phosphate[1].

Our aging populations are on the increase. Some experts predict that osteoporosis patients will soon occupy 30% of hospital beds. Statistics show that 20% of patients suffering from an osteoporotic hip fracture do not survive the first year after surgery, all this showing that there is a tremendous need for better therapies for diseased and damaged bone [2]. Human bone consists for about 70% of Calcium phosphate (CaP) mineral; therefore, CaPs are the probable materials of choice to repair damaged bone.

Fish bones can also be used as a raw material for the production of calcium phosphate. In one method[3] The biological apatite (calcium phosphate particles) was produced by heat treatment of fish bones , placed in salt solution, stirring at a temperature of 75 °C, and reacting with $CaCl_2 \cdot 2H_2O$ followed by filtration. Approximately 41.76 % yield of calcium phosphate was obtained .

Egg shells have been used as a source for calcium phosphate through the hydrothermal synthesis route where the yield was 21%[1].Oyster shells, carbonized fowl droppings, fly ash, coribcula shells are some of the sources tried for extracting calcium phosphate[4-7]. Calcium phosphates were prepared using corbicula shells and phosphoric acid[7] at high temperature. 90% yield of calcium carbonate was obtained through this process

Calcium phosphates were prepared from sea urchin shells and artificial phosphorus waste fluid(Atsushi,2016). The calcined shells were dissolved in hydrochloric acid solution, and then filtered. This sea urchin shell extract was mixed with the artificial phosphorus waste fluid prepared from sodium dihydrogen phosphate. It was then adjusted to pH 7 using sodium hydroxide solution. The obtained precipitate contained the organic coloring material from sea urchin shell calcined at lower temperature. The main component of the precipitate was CaHPO4.2H2O. The product yield of calcium phosphate which got around 55%.

II MATERIALS & METHODOLOGY

A. Materials

Dry old bones were collected form the valley. Hydrochloric acid and ammonia solution were of reagent grade. The synthesis method was developed in the lab of National University of science & Technology. The microanalysis of the bone fragments were analyzed using energy dispersive x ray spectroscope (EDX)

B. Methodology

Dry bones of animals was used as the raw material for extraction The bones were crushed into small pieces. Then these were immersed in hydrochloric acid period days during which the following reaction takes place.

$$2HCl + Ca_3(PO_4)_2 \longrightarrow 2CaCl_2 + Ca(H_2PO_4)_2$$

After that more amount of hydrochloric acid was added and the solution heated to reach a certain temperature. Then, this followed by filtration using a vacuum pump. After that, the filtrate was subjected to precipitation by adding NH_3 of different pH.

The reaction taking place during the precipitation reaction is as follows

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$Ca(H_2PO_4)_2 + 2NH_3 \longrightarrow Ca(HPO_4) + (NH_4)_2(HPO_4)$

The calcium triphosphate was precipitated. The filtered precipitate was dried and quantified. Parameter studies by varying immersion pH and reactant quantity was conducted to determine the optimized yield. The flow chart for the synthesis has been depicted in Fig 1.

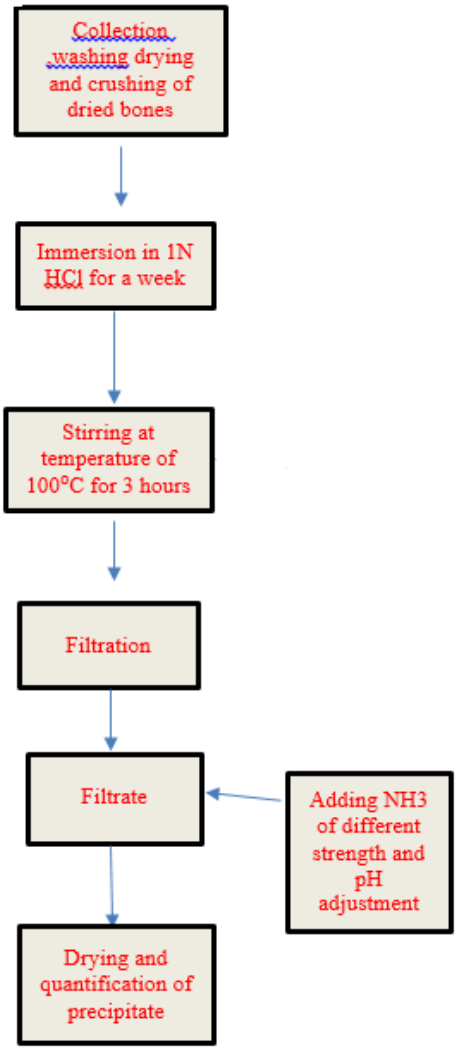

Fig.1 Flow chart for the synthesis of calcium phosphate

Fig 2 shows the Calcium phosphate obtained after precipitation and drying.

Fig.2 Precipitated and dried final product

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III RESULTS AND ANALYSIS

The process was carried out though several steps, the first step of the research was to collect a certain amount of animal bones. After that the collected bones are crushed into a specific size which has to be small and the weight of it was measured to be 200 grams. After that an amount of 54ml of the hydrochloric acid was added to the measured specimen and then it was kept for a week. Furthermore an amount of hydrochloric acid was added and heating was carried out at 100°C under stirring for a period of three hours. This was followed by filtration which took four days. After that NH_3 was added at different concentrations. Further, the values of pH for the respective solutions were taken as per the solution that was filtered through utilizing pH papers. Next, the calcium triphosphate was a result of mixing the filtration solution along with the ammonia in samples and after that the filtrate precipitation was dried and measured.

A. Precipitation under variant pH value

TABLE.1. Effect of pH on yield

S. No	Volume of filtrate(ml)	pH	Volume of distilled water(ml)	Amount of precipitate obtained(g)
1	22	3	36	3.5
2	22	4	36	4.3
3	22	5	36	6.5

As shown in Table 1 the amount of the filtrate ion was fixed at a value of 22ml .The pH was varied from 3 to 5. The amount of NH_3 was 6ml. the amount of distill water was the same in three specimens. The pH value of first sample was found to be 3 and gave an amount of 3.5 grams of the precipitation. The pH value of second sample was found to be 4 and gave an amount of 4.3 grams of the precipitation. The pH value of third sample was 5 resulting in a yield of 6.5 grams of the precipitation. As the pH increased the yield of Calcium phosphate has also increased.

B. Precipitation under constant pH value

TABLE.2 . Yield under under varying NH_3 concentration

S. No	Volume of filtrate(ml)	pH	Amount of NH_3(ml)	Volume of distilled water(ml)	Amount of precipitate obtained(g)
1	22	5	6	50	3.5
2	22	5	6	100	4.3
3	22	5	6	150	6.5

As shown in Table 2 the amount of the filtrate was fixed on a value of 22ml, the pH was maintained at 5 and the concentrations of NH_3 were varied from 4% to 10% v/v. Maximum yield was obtained at the highest concentration of NH_3. It was observed that the specimen loses its pH values after some

C. Characterization of dried bone

Table 3.0 shows weight percentage of the elements present in dried bones that was analysed using x-ray fluorescence spectrometer. The elements present in the bones as the largest quantities of dried bones are elements of the compound calcium phosphate. The weight percentage of calcium element was 38.97, the proportion of the amount of phosphorus element was18.66 wt % , the proportion of the amount of oxygen element was 40.48 wt% . It also shows that the oxygen component was the largest because the bone marrow contains immature cells called stem cells, which can grow into red blood cells that carry oxygen from the lungs to the rest of the body.

TABLE 3 Microanalysis of the elements in bone

Element	Wt.%
Na	0.01
Mg	0.00
Al	0.00
Si	0.55
P	18.66
S	0.64
K	0.00
Ca	38.97
Ti	0.00
Mn	0.04
Fe	0.64
O_2	40.48
Total	100

IV CONCLUSIONS

Calcium Phosphate were extracted from dry old bones of animals through chemical treatment. The paper provided a brief summary of the experimental studies performed there in. showing the effects of two parameters in production rate. The raw material was analyzed for components by using x-ray fluorescence spectrometer. By studying several Calcium Phosphate productions under different parameters such as the variation of pH, different concentration of Ammonia and Hydrochloric acid. The experiment results have shown that the maximum yield depends on the pH and ammonia concentration.The waste is being converted into a useful product by this process.

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