APATITE GROWTH OPTIMATION ON CHICKEN MUCOUS BY FOURIER TRANSFORM INFRARED (FTIR) CHARACTERIZATION

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ABSTRACT

ADIPURWA MUSLICH. Apatite Growth Optimation on Chicken Mucouse by Fourier Transform Infrared (FTIR) Characterization. Supervised by AKHIRUDDIN MADDU and YESSION WIDYA SARI.

Some experiments had been conducted to grow apatite from supersaturated solution of calcium phosphate ions on chicken mucous. The calcium and phosphate ions were originated from Ca(NO₃)₂ and (NH₄)₂HPO₄. Carbonate ions from (NH₄)₂CO₃ was also used as starting solution. Experiments were carried out within about 5 hours at temperature 37°C and pH 7. Value of Ca⁺ : PO₄³⁻ was 1.67, while molar ratio of CO₃²⁻ : PO₄³⁻ was 0.5 : 1. Molarity of molar ratio CO₃²⁻ : PO₄³⁻ varied approximately 0.15 : 0.30, 0.51 : 1.02, and 0.90 : 1.80. Mass of mucous powder was constant 0.75 gram. The analysis result of Fourier Transform Infrared (FTIR) showed that the precipitation was apatite carbonate type A and B. In these experiments it was found out that the mucous reduce the crystallinity of apatite precipitant, and the growth of apatite crystal was optimum at solution with molar ratio CO₃²⁻ : PO₄³⁻ about 0.15 : 0.30.
APATITE GROWTH OPTIMIZATION ON CHICKEN MUCOUSE BY FOURIER TRANSFORM INFRARED (FTIR) CHARACTERIZATION

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As one of the rule to obtain the Science Bachelor Degree
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Alhamdulillah, the author thanked God to have finished this paper. This paper, “Apatite Growth Optimization on Chicken Mucouse by Fourier Transform Infrared (FTIR) Characterization” is the requirements for finishing the scholarship at Department of Physics, Bogor Agricultural University.

This paper is also expected to give more information, especially in hydroxyapatite synthesis for substitute bone. As we know that bone is the most implanted tissues after blood. And the major solid components of human bone are collagen and apatite minerals, like hydroxyapatite. So, furthermore this paper expected to give contribution in medical implantation. However, physical analysis is needed in many science area to analyze the properties of materials, including in medical. This paper has many flaws. The author hopes much suggestion from all contributors to make this paper better and useful for everyone.

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Author
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INTRODUCTION

Background
Bone is a passive motion tool that has a lot of usages, one of those is to prop the body. The bone is unique among the tissues of the body, in the level of its resistance to compressive forces. This resistance results from its composition. Collagen and other organic molecules give bone strength, while hydroxyapatite is responsible for the resistance to compression.

Bone is classified as hard tissues which can experience regenerative growth. In medical field, bone reconstruction has done to repair the bone fracture or defect. There are techniques deals with bone reconstruction such as allograft (bone reconstruction using bone from other person), and xenograft (bone reconstruction using animal bone). That techniques have weakness, in comparison, disturbed by immunological response. In addition, the cost of bone allograft, which require careful handling, are expectional high.

Autograft (bone reconstruction using health bone from that person) is the most satisfy bone reconstruction because the implant bone contains important cells which are needed. Moreover the disadvantages of autograft were prolongation of operation time, increased loss of blood, the risk of infection, nerve and vascular injury, thrombosis, fracture risk, additional scar, postoperative pain and cost of additional operation.

Problems
Calcium phosphate compound is needed to make synthetic biomaterial that used to replace the disfunction bone. To make it grows in human body, it must contain amorphous phase which is regenerative bone phase. The growth is persisted just only in matrix.

In this research, calcium phosphate compound was made by synthetic method from some chemical compound which contain calcium phosphate then it is decanted in chicken mucouse. So apatite crystal was formed at the surface of mucouse. This mucouse was used as matrix of apatite growth. The calcium phosphate compound was identified by using Fourier Transform Infrared Spectroscopy (FTIR).

Aim of research
1. Resulting apatite mucouse as filler materials which can handle limitation problem of bone implantation.
2. Giving information about material’s characteristic. So, it can be more biocompatible than allograft or xenograft biomaterial.

Time and place of research
This research hold in 2 different laboratories. The preparation and precipitation hold in Biophysics Laboratory, Physics Department of IPB, Darmaga. Characterization by using FTIR hold in Biofarmaca Study Center IPB. This research started from March 2006 until January 2007.

THEORY

Formation of Hydroxyapatite Crystal from Solution
Calcium phosphate is compounds of great interest in an interdisciplinary field of involving chemistry, biology, medicine and geology. Hydroxyapatite (HAp) is a calcium phosphate including hydroxide and its Ca/P ratio is represented as 1.67. This hydroxyapatite is a member of the apatite group of mineral, and its chemical formula is Ca_{10}(PO_{4})_6(OH)_2. Hydroxyapatite is the other physiologically calcified tissues. This hydroxyapatite (HAp) is responsible for the load resistance. Synthetic HAp is developed to result biomaterial which has good behavior and biocompatible with hard tissue.

Calcium phosphate compound in stable crystal phase Ca_{10}(PO_{4})_6(OH)_2 or hydroxyapatite has correlated with hard tissue. Poorly crystalline Hydroxyapatite (HAp) is the major mineral component of bone and
most stable calcium phosphate phase at a normal temperature and pH between 4 and 12. Hydroxyapatite crystal unit has hexagonal structure with lattice parameter $a = b = 9.432 \text{Å}$ and $c = 6.881 \text{Å}$ (Figure 1).

Apatite is a general term crystalline mineral. There are many apatite compound, including fluorapatite, chloroapatite, carbonate apatite, and hydroxyapatite. Biological apatite is found in human or animal teeth and bones. Mineral is the main inorganic compound in calcified hard tissues (e.g. bone and teeth). Physically, interaction between mineral and organic compound yield mechanical properties. Organic give tensile strength, while mineral is responsible for the resistance to compression. Interfacial bonding between the mineral and organic constituents is based, in part, on electrostatic interaction between negatively charged organic domain and the positively charged mineral surface.

Generally, there are three essential methods for preparing hydroxyapatite crystal, including the process from solid reaction to solid crystal, from solution to solid crystal, and from vapor to solid crystal. Wet method (using solution reaction) is useful for preparing very small crystal of hydroxyapatite.

Synthesis of hydroxyapatite is affected by calcium and phosphate concentration in solution. Solution with $\text{Ca}^{2+}$ and $\text{PO}_4^{3-}$ concentration less than 2mM is called as low supersaturation condition, and solution with $\text{Ca}^{2+}$ and $\text{PO}_4^{3-}$ concentration more than 10 mM is called as high supersaturation condition.

### Table 1

<table>
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<th>Bone</th>
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<tr>
<td>Inorganic</td>
<td>60</td>
<td>70</td>
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<tr>
<td>Organic</td>
<td>30</td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td>Water</td>
<td>10</td>
<td>13</td>
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Hydroxyapatite crystals form directly without presence of metastable calcium phosphate phase in low supersaturation solution. Precipitation of calcium phosphate in high supersaturation condition results a metastable phase between amorphous and crystalline calcium phosphate. The presence of carbonate ions in conversion amorphous phase become crystal apatite phase will influence the form of hydroxyapatite crystal. This carbonate ions will cause demorfolgy and reduce the size of crystal, also non stoichiometry.

In hydroxyapatite structure, carbonate can substitute OH- ion, and form type A carbonate apatite, and if substitute $\text{PO}_4^{3-}$ ion will form type B carbonate apatite. Generally, precipitation at low temperature will form carbonate apatite type B, while apatite from dry reaction at high temperature will produce carbonate apatite type A. Apatite precipitation from calcium and phosphate saturation solution can produce hydroxyapatite crystal. Hydroxyapatite crystal in calcium phosphate compound is affected by pH solution. Value of Ca/P in hydroxyapatite is change gradually with pH increase.

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**Figure 1** Hydroxyapatite structure.

**Figure 2** Change in Ca/P ratio to pH value of reaction solution.