Characterization of Charcoal From Kerandang (*Channa pleurophthalma* Bleeker) Fish Fins Waste As A Source of Hydroxiapatite

Aryani¹ and P H Riyadi²

¹Department of Fisheries, Faculty of Agriculture, University of Palangka Raya, Comp. H. Timang Yos Sudarso Street, Palangka Raya 73112, Central Kalimantan, Indonesia.
²Department of Fish Product Technology, Faculty of Fisheries and Marine Science, University of Diponegoro, Prof. H. Soedarno Street, Tembalang, Semarang 50275, Central Java, Indonesia.

Email: aryani@faperta.upr.ac.id

Abstract. This study aims to characterize the charcoal from the fins waste of the Kerandang fish, namely from the dorsal (DF), pectoral (PF), ventral (VF), anal (AF), and caudal fin (CF). The charcoal as a source of hydroxyapatite. Qualitative characterization used a Scanning Electron Microscope (SEM), Fourier Transfer Infra-Red (FTIR), and X-Ray Diffraction (XRD). The charcoal's chemical composition consists of Carbon, Oxygen, Sodium, Magnesium, Phosphor, Sulfur, and Chlorine, Potassium, and Calcium. The highest carbon element was 67.74% in the caudal fins. The lowest chemical element in the element sulfur is 0.197% in the dorsal fins. SEM photos show that the charcoal from the caudal fins has more pores than the other fins. The FTIR results show that the functional groups contained in the charcoal from the fins are NH, OH, CO, C=O, C=C, S1-O, and CH groups, with wave numbers 1032-1036 cm⁻¹. The absorption area of the S1-O group (silica), where the silica group from charcoal, has the highest intensity. XRD results showed that the charcoal from fish fins of Kerandang contained 100% hydroxyapatite.

1. Introduction
The waste generated from the by-products of fish processing in large quantities can cause undesirable environmental impacts if not managed, so efforts are needed so that the waste has added value. Charcoal is a hydroxyapatite source, which is made from wood or vegetable and can also be made from animals. Hydroxyapatite (Ca₁₀(PO₄)₆(OH)₂) is an inorganic mineral that can be found in bones, including animal bones, namely from fish bones as hydroxyapatite fishbone, for example, from tilapia fish bones [1], tuna fish bones [2], carp and cob bones [3]. The hydroxyapatite product from fish waste is used to overcome environmental pollution due to heavy metal disposal [4, 5, 6].

So far, no research has been carried out on charcoal characterization from Kerandang fish fins waste as a source of hydroxyapatite. Through qualitative research on charcoal finned fish fins waste, it can explore the potential of Kerandang fish fins charcoal as a source of hydroxyapatite. The charred fish fins used in this study were the dorsal fins, pectoral fins, ventral fins, anal fins, and caudal fins of Kerandang (*Channa pleurophthalma* Bleeker) fish.
2. Research Methods

2.1. Material
This study’s raw material was the waste of Kerandang fish fins, namely dorsal, pectoral, ventral, anal, and caudal fins obtained from fishers or fish collecting traders Sebangau Kereng Bengkirai Lake in Central Kalimantan.

2.2. Preparation
The raw material for each of the Kerandang fish fins waste is collected, cleaned, dried for 2-3 days, and then burned until it becomes charcoal using an ordinary oven with a maximum temperature of 200°C for 1 hour. Result of burning in the form of powder charcoal (Simplicia) [7].

2.3. Analysis
2.3.1. Chemical composition
The chemical composition of Kerandang fish fins was detected using an EDX detector device using the Scanning Electron Microscope (SEM) method.

2.3.2. Scanning Electron Microscope (SEM)
Visually characterization of the porosity structure of charcoal in the upper section (transverse) was carried out using a 20 kV Scanning Electron Microscope (SEM) using a granular sample [8]. We were shooting in the upper section using a magnification of 5000 times. Observation of the porosity formed on the sample surface includes pore size and frequency.

2.3.3. Fourier Transform Infra Red (FTIR)
FTIR characterization was carried out to determine the functional groups. This characterization was carried out by mixing the sample powder with dry potassium bromide (KBr) (1: 99). The sample powder mixture and KBr are then molded and compacted so that they form a thin pellet, and then their absorption is measured at a wavenumber of 600-4000 cm⁻¹[9].

2.3.4. X-Ray Diffraction (XRD)
Characterization of the structure using XRD to determine the degree of crystallinity, height, width, distance and number of aromatic layers in the sample.
This characterization is done by interpreting the diffraction pattern of scattered X-rays in the sample. About 2 grams of sample powder is put into an aluminum cuvette, then the surface of the sample powder is compacted and leveled using a piece of glass. The glass is pressed while being moved over the surface of the cuvette containing the sample powder, so that the sample powder becomes solid and the surface is flat and parallel to the surface of the cuvette, then irradiated with X-rays. The determination of the degree of crystallinity is based on height (Lc), width (La), distance (d) and number of aromatic layers (N) were performed in sample [10].

2.3.5. Analysis of data
Observation data were tabulated and analyzed descriptively.

3. Results and Discussion
3.1. Chemical composition
The results of the observation of the chemical composition of Kerandang fish fins charcoal detected using the EDX detector device using the Scanning Electron Microscope (SEM) method are as shown in Table 1.
Table 1. Chemical Elements of Kerandang Fish Fins Charcoal (Channa pleurophthalma Bleeker)

| Waste | Carbon (%) | Oxygen (%) | Sodium (%) | Magnesium (%) | Phosphorus (%) | Sulfur (%) | Chlorine (%) | Potassium (%) | Calcium (%) |
|-------|------------|------------|------------|---------------|----------------|------------|--------------|---------------|-------------|
| DF    | 65.765     | 20.370     | 0.855      | 0.197         | 3.746          | 0.159      | 0.445        | 0.832         | 7.631       |
| PF    | 62.784     | 22.239     | 1.063      | 0.282         | 4.208          | 0.168      | 0.681        | 0.817         | 7.753       |
| VF    | 61.488     | 26.040     | -          | -             | 2.448          | -          | -            | 3.744         | 6.280       |
| AF    | 62.984     | 22.033     | 1.173      | 0.281         | 4.289          | -          | 0.703        | 1.099         | 7.438       |
| CF    | 67.744     | 20.287     | 0.697      | 0.259         | 3.756          | -          | 0.388        | 0.431         | 6.440       |

Notes: DF = dorsal fins, PF = pectoral fins, VF = ventral fins, AF = anal fins, CF = caudal fins

Ash is the main component of charcoal, which is insoluble in water or other organic solvents, consisting of Carbon, Oxygen, Sodium, Magnesium, Phosphorus, Sulfur, Chlorine, Potassium, and Calcium. The carbon element of 61.488-67.744% dominates the ash content in the fins charcoal of Kerandang fish, and the lowest in the element of sulfur at 0.159-0.168%. The carbon element dominates the chemical elements in the fish fins charcoal because the pyrolysis temperature is not as high as the temperature when processed into activated charcoal, so there has been no damage to the carbon bonds cause a decrease in value. The activation temperature is too high, the risk of further oxidation of the carbon, which can damage the C-C bonds of carbon [11].

3.2. Scanning Electron Microscope (SEM)
The results of the observation of the pores of the Kerandang fish fins charcoal using SEM magnification of 1800 times as shown in Figure 1.

In the upper section of the Kerandang fish fins charcoal (Figure 1), there are no open pores except for the caudal fins of the Kerandang fish. This shows that the caudal fins of the Kerandang fish are a heavy material with a petite pore size after carbonization at 200°C to produce charcoal. The pores in the upper section of the charcoal from the fish fins of the carbonized Kerandangs are not perfect because the surface is still covered with hydrocarbons and ash. In the charcoal carbonization of Kerandang fish fins, it can be seen that there are still quite a lot of hydrocarbons. These compounds cover the charcoal's pores and surface, which can cause its absorption ability to be low. At higher temperatures, the absorption rate decreases due to the faster collision reaction between molecules to damage the texture of the charcoal [12,13].
3.3. **Fourier Transform Infra Red (FTIR)**

Result of Kerandang fish fins charcoal FTIR as shown in Figure 2.
The results of infrared (IR) absorption spectrum analysis can provide clues about changes in the functional groups of the sample material due to the carbonization process through the pyrolysis process. The functional groups of different materials due to undergoing the carbonization process are shown in Figure 2; the wavenumber indicates the IR radiation absorption.

The IR absorption spectrum pattern of the Kerandang fish fins charcoal changes after carbonization due to the influence of temperature; namely, there is a breakdown of the chemical structure shown by changes in the absorption spectrum. These changes are in the form of decreased absorption intensity, loss of absorption, shifted absorption, and the formation of new absorption in a specific wavenumber area. The carbonization process in making charcoal results in changes in functional groups. The higher the carbonization temperature, the more functional groups are oxidized or decomposed. They are lost, or the absorption rate reduces or causes a shift in the absorption wavenumber [14, 15]. The functional groups identified in the fins charcoal of Kerandang fish include N-H, O-H, C-O, C=O, C=C, S1-O, and C-H groups, with wave numbers 1032-1036 cm\(^{-1}\) being the absorption area of the S1-O group. It is where the silica group from the Kerandang fish fins charcoal has the highest intensity.

### 3.4. X-Ray Diffraction (XRD)

The results of the diffraction pattern of X-ray scattering on the dorsal fins charcoal of Kerandang fish using a diffractometer as shown in Figure 3, pectoral fins in Figure 4, ventral fins in Figure 5, anal fins in Figure 6 and caudal fins in Figure 7.

#### Figure 2. Result of Kerandang fish fins charcoal FTIR

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#### Figure 3. The results of Kerandang fish dorsal fins charcoal XRD
Figure 4. The results of Kerandang fish pectoral fins charcoal XRD

Figure 5. The results of Kerandang fish ventral fins charcoal XRD

Figure 6. The results of Kerandang fish anal fins charcoal XRD

Figure 7. The results of Kerandang fish caudal fins charcoal XRD
The identification results using XRD based on the pictures above show that all the fins charcoal of Kerandang fish contains 100% hydroxyapatite. This shows that besides originating from fish bones, fish fins waste from Kerandang fish has excellent potential as a hydroxyapatite source because it contains organic waste with bone as the main component. Fishbones have a portion of 10% of fish's total body weight, which is one of the fish processing wastes [16, 17].

Hydroxyapatite can be produced from natural sources, inexpensive, uncomplicated, and generally uses the thermal calcination method for natural hydroxyapatite insulation [18, 19, 20]. The carbonation method shows that natural hydroxyapatite is stable at temperatures lower than 1,100 °C. The highest temperature and the smaller size will produce the best hydroxyapatite. Pyrolysis at 200°C does not cause the bone to turn into hydroxyapatite crystals [21].

This fishbone waste can be used as a base for making hydroxyapatite. Nowadays, porous hydroxyapatite is a fundamental requirement for the reconstruction of broken or fractured bones. The pores that are formed function as a medium for the formation of growing bone cell tissue to improve bone regeneration properly [22, 23].

Hydroxyapatite products from fish fins are expected to bring value to entrepreneurs as waste products can be used to become hydroxyapatite to resolve environmental degradation as a result of heavy metal disposal.

4. Conclusion
The chemical elements of Kerandang fish fins consist of Carbon, Oxygen, Sodium, Magnesium, Phosphorus, Sulfur, Chlorine, Potassium, and Calcium; the highest is a Carbon element of 61.488-67.744%, and the lowest is a sulfur element of 0.159-0.168%. The pores in the carbonized fish fins charcoal are not yet perfect because the surface is still covered with hydrocarbons and ash, and there are no open pores apart from the caudal fins of the Kerandang fish. The functional groups identified in the charcoal of Kerandang fish fins include N-H, O-H, C-O, C=O, C=C, S1-O, and C-H groups, with wave numbers 1032-1036 cm\(^{-1}\) being the absorption area of the S1-O (silica). It is where the silica group from the Kerandang fish fins charcoal has the highest intensity. The testing results using XRD showed that all the fins charcoal of Kerandang fish contained 100% hydroxyapatite. It is hoped that this research will increase public awareness of the importance of utilizing waste, for example, for the community needs to overcome environmental pollution due to heavy metal disposal.

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