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MANUFACTURING AND CHARACTERIZATION OF PATIN (PANGASIUS SP.) BONE FLOUR BASED ON SIZE VARIATION

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ABSTRACT
Research on the manufacturing and characterization of Pangasius bone meal based on the size variation aims to determine the physico-chemical characteristics of Pangasius bone meal and the effects of the milling process on the size of Pangasius bone meal. The research method used was an experimental method with a top-down way. The parameters observed were yields and chemical characteristics such as water, ash, fat, protein, calcium, phosphorus, particle size analyzer (PSA), and Fourier transform infrared (FTIR). The result showed a yield of Pangasius bone meal was 35.71%, water content was 9.96%, ash content was 20.80%, fat content was 17.54%, protein content was 42.61%, calcium content was 11.17%, phosphorus content was 11.75%. The particle size of flour without milling was 298.2 nm, and after milling was 228.1 nm, which belongs to the nanoparticle group. The FTIR was identified to contain a hydroxyl group, a carbonate group, and a phosphate group. (Abstract).

INTRODUCTION

Fish processing businesses almost always produce waste in the form of bone, head, and liquid solids that directly or indirectly harm the environment because they cause pollution. Nearly three-fourths of the total weight of fish is waste. The fish waste consists of bones, skin, fins, heads, scales, and innards, which is one of the biggest problems in the fish processing industry. Therefore, the utilization of fish waste as a product will reduce environmental pollution, and it also can increase the added value of fishery products. Solid waste originating from the fishing industry and household use is quite large, one of which is fishbone derived from Pangasius bone, as waste that has not been processed and utilized optimally.

The main minerals in bone are calcium and phosphorus, while other minerals are present in small amounts, namely sodium, magnesium, and flour. The mineral content of fish depends on the species, sex, biological cycle, and body part analyzed. Mineral content is also affected by environmental factors such as seasonality, development site, nutrient availability, temperature, and salinity of the water.

Fishbone meal is a dry solid product produced by removing most of the liquid or the fat in fish bones [1]. Flour is a form of material processed by milling or flouring. Flour has low water content, which affects its durability of flour. Besides being used as a raw material for making feed, the fish meal also can be used as a raw material for food processing. Fish meal for food products serves as a fortification material that can increase the nutritional content of a food product.

By reducing their particle size, fishbones can convert into nutritious food or additives for humans. Particle size is the size of the average diameter [2]. Knowledge of particle size is prominent in the food industry because it affects the production and handling of ingredients and formulations for the processing and quality control of food and beverage products. Particle size affects the solubility, reactivity, flowability of the material, texture, taste, and processing. The shape of the particles affects the flow and packing properties of a powder.

The diameter of the particle can measure in various ways. Large particles (> 5 mm) can be measured directly using a micrometer. For ethereal particles, measured using a standard sieve size.

METHODOLOGY

The research was conducted from January to March 2020. The research was carried out at the Fishery Product Processing Laboratory, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran. The material used is Pangasius bone waste, taken from the Fish Express industry. The tools used are a timer, knife, sieve, scales, tongs, pan, basin, pressure cooker, mash, oven, freezer, and Laboratory Pulverizer Automatic.

The research consisted of three stages, namely the manufacture of Pangasius bone meal, the manufacture of bone nanoparticles by the milling process, and characterization of the physicochemical properties of Pangasius bone meal, including yield, proximate analysis, analysis of calcium and phosphorus, particle size analyzer (PSA), and Fourier transform infrared (FTIR).

This research uses an experimental method in a top-down way, namely making nanostructures by reducing the size of the material. The top-down way uses a milling process to form nanoparticles. Data on the quality of the characteristics of Pangasius bone meal were analyzed descriptively and compared with the Indonesian National Standard (SNI) 01-2715-1996.

The processing of making Pangasius bone meal follows the modified Tanuwidjaja [3] method, in which the bones were clean from any remaining meat sticks. The bones were boiling for 30 minutes at 100^{o}C. Then the bones are washed with running water until clean. Next, cut the bones into small pieces of 5 cm. The parts of the bone are pressed for 3 hours so that the bones become soft. The bone pieces were then dried in an oven at 120^{o}C for 40 minutes. The dried bones were crushed using a mash and then sieved through a 30-mesh sieve. The homogeneous Pangasius bone meal is milled with a top-down method, namely by making nanostructures by reducing the size of the material. The tool used for grinding bone meal is the Lab Pulverizer Automatic. Furthermore, the Pangasius bone meal has characterized by its physicochemical properties.

RESULTS AND DISCUSSION

1. Physical Analysis of Pangasius Bone Meal

The Yield of Pangasius Bone

The yield of Pangasius bone waste is 2.240 grams of intact bone wet, resulting in a dry (whole) weight of 1.025 grams and a bone meal product of 800 grams, or about 35% of the wet weight of Pangasius bones. The result is close to the Pangestika [4] research result, which utilized Pangasius bone meal for cookies by 38.6% and the result is lower than the study by Khuldi et al. [5], *Chitala* sp. fish bone meal is 46% with a boiling frequency of 4 times.

2. Chemical Analysis of Pangasius Bone Meal

Proximate Analysis

The value of water content in this research is 9.9602%. The value of the water content is higher than the result of Putranto et al. [6] regarding the characterization of *Chitala* sp. fish bone meal by 3.12% and the research result of Rozi et al. [7] in yellowfin tuna bone meal by 9.27%. Based on Indonesian Standard, the water content belongs to Quality 1 in the quality standard of fish meals.

The value of ash content with the results of 20.802% includes Quality 1 in the quality standard of the fish meal according to SNI. This result is lower than the study by Khuldi et al. [5] *Chitala* sp. fish bone meal averaged between 73.01% - 74.46%. The results are also lower than the research by Angraini et al. [8] regarding the quality characteristics of fish bone meal from different types of fish, namely *Paraplotosus* sp. bone meal 54.56%, Catfish bone meal 53.41%, and Pangasius bone meal 54.60%.

The fat content produced in this research is 17.5401% is not included in the quality standard of fish meals based on Indonesian Standard. This result is greater than the research results of Nur et al. [9] on Pangasius bone meal using the Soxhlet extraction method, which is 3.36%, and also greater than Hemung's [10] research result of Tilapia bone meal is 5.82%.

The protein content produced in this research is 42.6167% belonging to Quality 1 in the quality standard of fish meal based on SNI. This protein content is relatively high compared to the protein content of Pangasius bone meal in Aprilliani's [11] research which was 33.50%, and that of Angraini et al. [8] 24.24% Catfish bone meal and Sembilang bone meal 25.51%.

3. Calcium and Phosphorus Content

The main minerals in bone are calcium and phosphorus. Besides that, other minerals are present in small amounts, namely sodium, magnesium, and flour [12]. Calcium in fish has a significant role in forming shiny and strong scales, maintains the body framework, helps regulate muscle activity, regulates acid-base balance, is an enzyme activator, and maintains osmotic balance [13]. In addition, phosphorus plays a significant role in forming phosphate, which is indispensable in energy transformation [14].

The results are 11.17% (Ca) and 11.75% (P). The results are lower than Mulia's [15] study, which contained 25.5% calcium and 15.1% phosphorus. The low content can occur because the acid or base extraction process is not carried out so that it does not hydrolyze the protein and fat contained in the bones so that the calcium and phosphorus content does not increase. Treatment with an acid solution and enzymes by heating the calcium maceration process increased the availability of calcium in the sample.

4. Characteristics of Particle Size Analyzer

Particle size analysis is a tool that can use to test the size distribution of nanometer-sized particles. This method can analyze the particles of a sample, which aims to determine the particle size and distribution of a representative sample. The working principle of PSA is to illuminate the laser light and analyze the intensity fluctuations of the light scattered by the particles.

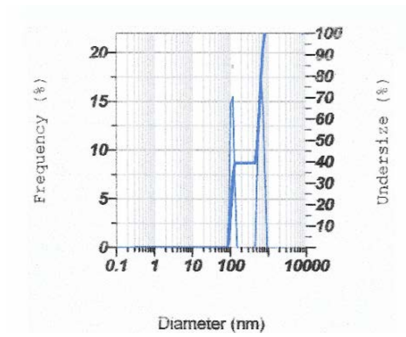

Figure 1. Before milling

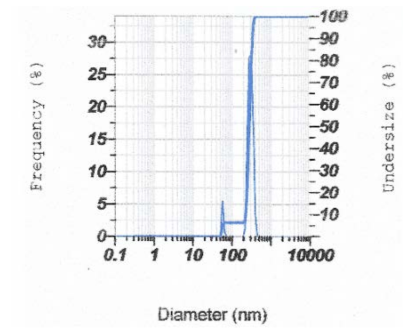

Figure 2. After milling

Based on the results of PSA testing, the average particle size of flour without milling was 298.2 nm, and after milling was 228.1 nm. The results of this study are smaller than those of Lekahena et al. [16] on tilapia bones, with the measurement results of the BB sample particles (raw material) being 655.69 nm after size reduction using a hammer mill. The process of softening bones by boiling can only change the texture of the bones because there are several water-soluble organic compounds such as proteins and fats.

Both samples had a homogeneous particle size distribution where the polydispersity index value was close to 0. The results showed that the Pangasius bone meal before or without milling was 0.495, and after milling was 0.428. A polydispersity index value close to 0 indicates homogeneous particle size dispersion if more than 0.5 indicates high heterogeneity [17].

5. Functional Group Characterization with FTIR (Fourier Transform InfraRed)

FTIR is conducted to identify the functional groups formed in Pangasius bone samples with spectra and absorption band maps. The working principle of FTIR is to identify the functional groups of a compound from the infrared absorbance of the compounds.

Pangasius bone meal was testing by FTIR in the IR area (4000–400 cm^{-1}). The functional group analysis can be seen on the graph of the IR spectrum results by dividing the chart into six regional ranges, namely: region range I (4000–2500), region range II (2500–2000), region range III (2000–1800), region range IV (1800–1650), region V (1650–1550) and region VI (1550–650). The results of the FTIR analysis can be seen in Figure 3. The red one for Pangasius bone meal before milling and the purple one for the bone meal after milling.

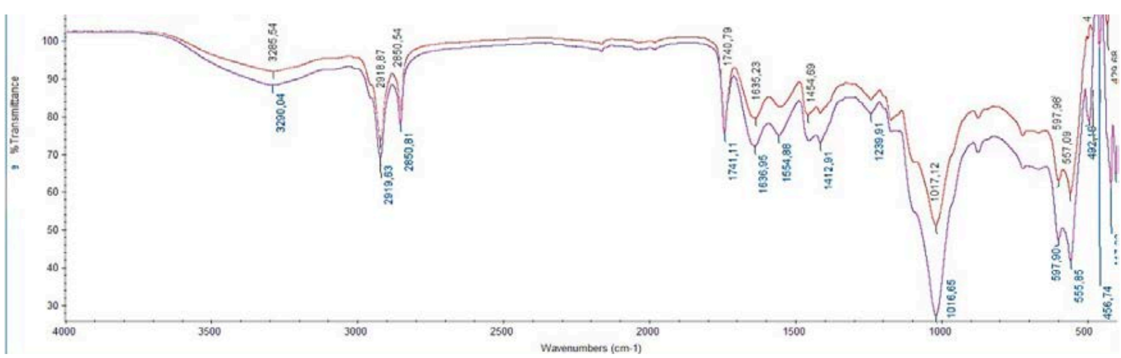

Figure 3. IR spectrum of Pangasius bone meal

Analysis of the infrared spectrum of Pangasius bone meal before milling was carried out by dividing the spectrum into six regions, namely,

1. The range of region I wave number 3285.54 cm^{-1} indicates the presence of hydrogen with weak intensity, while wave numbers 2918.87 cm^{-1} and 2850.54 cm^{-1} indicate the presence of C-H from alkanes with strong intension.
2. The range of region II has no significant absorption or peak.

3. The range of region III has no significant absorption or peak.
4. The range of region IV wave number 1740.79 cm^{-1} indicates the presence of C=O from carbonyl.
5. The range of region V wave number 1635.23 cm^{-1} indicates the presence of C=C bending of the alkene with weak intensity.
6. The range of region VI wave number 1454.69 cm^{-1} indicates the presence of C-H from alkanes with strong intensity, and wave number 1017.12 cm^{-1} contains phosphate groups.

Analysis of the infrared spectrum of Pangasius bone meal after milling was carried out by dividing the spectrum into six regions, namely,

1. The range of region I wave number 3290,04 cm^{-1} indicates the presence of hydrogen with weak intensity, while wave numbers 2919,63 cm^{-1} and 2850,81 cm^{-1} indicate the presence of C-H from alkanes with strong intension.
2. The range of region II has no significant absorption or peak.
3. The range of region III has no significant absorption or peak.
4. The range of region IV wave number 1741,11 cm^{-1} indicates the presence of C=O from carbonyl with strong intension.
5. The range of region V wave number 1636,95 cm^{-1} indicates the presence of a C=C bending of the alkene with weak intensity andwave number 1554,88 cm^{-1} indicates the presence of a C=C bending of the aromatic ring with weak intensity.
6. The range of region VI wave number 1412.91 cm^{-1} indicates the presence of C-H from alkanes with strong intensity. A wavelength of 1239.91 cm^{-1} indicates the presence of C-O from the ether with a strong intensity of indicate the presence of a carbonate group and a phosphate group, which following the statement of Mondal et al. [18], that the absorption band of wave number 1,400-1,500 cm^{-1} indicates the presence of carbonate groups. There is a phosphate group content in the absorption band of wave number 1016.65 cm^{-1}.

Conclusion

Based on the results of the research that has been carried out, it can be concluded that:

1. The results of the fat content, the content of calcium and phosphorus of Pangasius bone meal did not fulfil the requirements of Indonesian National Standard (SNI 01-2715-1996).
2. The average particle size of the Pangasius bone meal on both samples belongs to the nanoparticle group. In the particle size distribution, both samples have a homogeneous particle size distribution which is the polydispersity index value is close to 0.
3. In the FTIR analysis of Pangasius bone meal on both samples are identified as having the main component in the formation of hydroxyapatite.
4. It is advisable to carry out alkaline extraction in the processing of making Pangasius bone meal and boiling more than once so that the contents in the bones can completely hydrolyze.

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References

[1] Susan. M. Kaup, J. L. Greger, and Ken Lee, "Nutritional Evaluation with An Animal Model of Cottage Cheese Fortified with Calcium and Guar Gum," Journal of Food Science, vol. 56, no. 3, pp. 692-695, 1991.

[2] A. Martin, J. Swarbick, and, A. Cammarata, *Basic Physical Pharmacy and Physical Chemistry*. pp. 141-142, 1990.

[3] N. Tanuwidjaja, "Pemanfaatan Tepung Tulang Ikan Patin (*Pangasius pangasius* Ham. Buch) Dalam Pembuatan Mi Kering," Universitas Pelita Harapan, Thesis, 2002.

[4] W. Pangestika, F. W. Putri, dan K. Arumsari, "Pemanfaatan Tepung Tulang Ikan Patin dan Tepung Tulang Ikan Tuna Untuk Pembuatan Cookies," Jurnal Pangan dan Agroindustri, vol. 9, no. 1, pp. 44-55, 2021.

[5] A. Khuldi, I. Kusumaningrum, and A. N. Asikin, "The Effect of Boiling Frequency Against Characteristics of Belida (*Chitala* sp.) Bone Powder," Journal of Tropical Fisheries, vol. 21, no. 2, pp. 32-40, 2016.

[6] H.F. Putranto, A. N. Asikin, and I. Kusumaningrum, "Properties of Belida (*Chitala* sp.) Fish Bone Powder as Calcium Source Based on Protein Hydrolysis Method," Journal Ziraa'ah, vol. 40, no. 1, pp. 11-20, 2015.

[7] A. Rozi, and N. Ukhty, "Characteristic of Bone Meal Yellowfin Tuna (*Thunnus albacares*) as A Source of Calcium with Different Drying Temperature Treatment," Journal Fishtech, vol. 10, no. 1, pp. 25-34, 2021.

[8] R. M. Angraini, Desmelati, and Sumarto, "Characteristics of Fish Bone Flours Quality from Different Types of Fish (*Pangasius* sp., *Clarias* sp., *Paraplotosus* sp.)," Journal Berkala Perikanan Terubuk, vol. 47, no. 1, pp. 69-75, 2019.

[9] A. Nur, V. Besti, and H. D. Anggraini, "Formulation and Characterization of Rice Noodles High Protein and Calcium with Addition of Patin Fishbone Powder (*Pangasius hypopthalmus*) For Children Under Five Years Stunting," Journal MKMI, vol. 14, no. 2, pp. 157-164, 2018.

[10] B. Hemung, "Properties of Tilapia Bone Powder and Its Calcium Bioavailability Based on Transglutaminase Assay," International Journal of Bioscience, Biochemistry and Bioinformatics, vol. 3, no. 4, pp. 306-309, 2013.
[11] I. S. Aprilliani, "Pemanfaatan Tepung Tulang Ikan Patin (*Pangasius*)," Institut Pertanian Bogor, Thesis, 2010.
[12] FG. Winarno, *Kimia Pangan dan Gizi*. Jakarta, Indonesia, 2002.
[13] H. Djajasewaka, *Pakan Ikan*. Jakarta, Indonesia, 1985.
[14] WG. Piliang, dan Al Haj S. Djojosoebagio, *Fisiologi Nutrisi Volume 2*. Institut Pertanian Bogor Press, Bogor, Indonesia, 2006.
[15] Mulia, "Kajian Potensi Limbah Tulang Ikan Patin (*Pangasius* sp.) Sebagai Alternatif Sumber Kalsium Dalam Produk Mi Kering," Institut Pertanian Bogor, Thesis, 2004.
[16] V. Lekahena, D. N. Faridah, R. Syarief, Peranginangin, "Physicochemical Characterization of Nano Calcium from Tilapia Bone Extracted by Alkaline and Acid Solution," Journal Teknologi dan Industri Pangan, vol. 25, no. 1, pp. 57-64, 2014.
[17] M. R. Avadi, A. Mir, M. Sadeghi, R. Dinarvand, and M. Rafiee-Tehrani, "Preparation and Characterization of Insulin Nanoparticles Using Chitosan and Arabic Gum with Ionic Gelation Method," Nanomedicine: Nanotechnology, Biology, and Medicine, vol. 6, no. 1, pp. 58-63, 2010.
[18] S. Mondal, B. Mondal, A. Dey, and S. S. Mukhopadhyay, "Studies on Processing and Characterization of Hydroxyapatite Biomaterials from Different Bio Wastes," Journal of Minerals & Materials Characterization & Engineering, vol. 11, no. 1, pp. 55-67, 2012.