



Pangasius Bone Powder (Definition, Production, Analysis Physicochemical Characteristics and Potency): A Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Fish bones are a wasted and unused product though it contains high minerals, especially calcium and phosphorus, so that fish bones can be used as raw materials for making bone powder. The manufacture of pangasius bone powder generally goes through a heating process that aims to remove fat from the bones and can denature the protein. The physicochemical characteristics of pangasius bone powder greatly determine the use of the product and are related to the quality of the product. The physicochemical characteristics consisted of yield, bulk density, water content, ash content, fat content, protein content. The main potential of pangasius bone powder is as a source of calcium and phosphorus in meeting mineral needs for the body.

Keywords: *Pangasius bone powder; fishbone waste; quality; potency.*

1. INTRODUCTION

Pangasius bone powder is a dry product in the form of powder made from fishbone waste. Fish waste has the highest proportion in the bone part

at 11% and the head part at 11.25% [1]. In addition, fish bones contain high calcium and phosphorus levels as much as 14% of the total bone structure [2]. Pangasius (*Pangasius pangasius*) is a fish that has a high protein

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content of 14.53%, contains unsaturated fatty acids of 2.2% and the meat of pangasius tends to be soft because it contains only a few tendons which make pangasius easily digested by the body [3]. So that pangasius are consumed by the wider community and are often used as raw materials for processed foods that are produced in large quantities [4]. This can be evidenced by the increase in pangasius production in 2017 by 245.75 thousand tons and increased to 492 thousand tons in 2018 so that pangasius is a commodity with a high average production of 31.76% [5]. The level of consumption that tends to increase will have an impact on the higher amount of pangasius waste.

Fish waste is part of fish that is discarded or that is not utilized. The waste generated from the pangasius processing industry is quite a lot, which is 67% of the total pangasius [6]. The amount of waste produced is due to the fact that only the meat is used for processing activities, while the head, viscera (intestines), thorns and skin are removed. The main waste in the fishing industry is the head, entrails, tail, fins and bones. which are usually made in the manufacture of fish filets [7].

Pangasius bone powder is a product that in its manufacturing process utilizes pangasius bone waste. The manufacture of pangasius bone powder that utilizes bone waste can increase the economic value of pangasius bone waste that has not been utilized optimally. In addition, the use of fish bones for the manufacture of pangasius bone powder applies the concept of zero waste where the production process does not produce waste so that it can contribute to overcoming environmental pollution which is usually caused by industrial waste. Pangasius bone powder contains a lot of minerals, especially calcium and phosphorus which are useful for the formation of bones and teeth, so that pangasius bone powder can be used as a source of meeting daily calcium needs for the body so as to prevent mineral deficiency and osteoporosis.

Pangasius bone powder is obtained through heating, extraction, drying and grinding processes. The heating process in making pangasius bone powder usually uses a pressure cooker with a temperature of 120°C and a pressure of 1 atmosphere which aims to soften the bones, remove fat contained in the bones and can denature protein, the extraction process uses NaOH base which aims to maximize the fat

removal process, drying using an electric oven that aims to reduce the water content in the bones and grinding to reduce the size of the bones.

2. PANGASIOUS BONE POWDER

Pangasius bone powder is a product of fish waste in the form of dry preservation which is ground into powder. Pangasius bone powder has the characteristics of being in the form of a fine white powder and has a distinctive smell of fishbone. Fishbones are one of the wastes from the fishery processing industry. Fishery industrial waste can be defined as anything that is left and wasted from an activity and processing fishery products. The main waste in the fishing industry is the head, entrails, tail, fins and bones. Which are usually made in the manufacture of fish filets. Pangasius waste which has the highest proportion is bone and fish head with a presentation of 11% bone and 11.25% head, respectively [1].

Fishbones are one form of waste from the fish processing industry which has the highest calcium content among other fish body parts because the main mineral elements of fish bones are calcium, phosphorus and carbonate. In addition, other minerals are also found in small amounts such as elements of Sr, Mn, Al, Mg, Zr, and K. Fishbones contain a lot of calcium in the form of calcium phosphate as much as 14% of the total bone structure. The amount of calcium contained in the fish bones makes the pangasius bones which at first only become waste from the processing industry can be used as raw materials for making pangasius bone powder. Fish bones contain a lot of mineral salts such as calcium phosphate and creatine phosphate which have the potential to increase the nutrition of food products [8]. In addition, fish bones also have a fairly good quality of calcium and are easy to obtain [9].

The manufacture of pangasius bone powder consists of several stages, namely washing, boiling, heating, extraction, drying and milling. The process of washing pangasius bones using running water. After the washing process is followed by a boiling process which aims to remove the meat that is still attached, this boiling process uses a temperature of 80°C for 30 minutes, the cleaned bones are then drained and weighed as much as 300 g for each treatment. The heating process use a pressure cooker with a temperature of 120°C and a pressure of 1

atmosphere with the aim of softening bones, removing fat from bones and denaturing proteins. Extraction using 1.5 N NaOH base for 2 hours at 60°C which aims to remove fat. Fishbones that have been extracted with base are placed on a filter cloth and then rinsed using running water until the pH is neutral. The drying process was carried out for 35 minutes using an electric oven which aims to reduce the water content in the fish bones. Powder milling is carried out with the aim of reducing the size of the powder by using a mortar and pestle, after it is in the form of powder then the pangasius bone powder is sifted.

2.1 Characteristics of Pangasius Bone Powder

The characteristics of powder determine its use in food products and are related to the quality of the product. Several chemical parameters that are important in determining the quality of fishbone powder are water content, fat content, ash content, protein content and mineral element content. In addition, physical parameters such as yield and bulk density are also important in determining the quality of the bone powder. In addition to physical and chemical parameters, information related to functional groups in a chemical bond contained in a material is also important to know.

The National Standardization Agency stipulates SNI 01-3158-1992 regarding the quality standard of bone powder. This standard is a reference for the feed industry to determine the quality associated with the price of the fish powder. According to National Standardization Agency [10] bone powder is divided into two levels of quality, which are presented in Table 1.

2.2 Analysis of Pangasius Bone Powder

2.2.1 Physic characteristics

2.2.1.1 Yield

Yield is a comparison of the amount (quantity) of the product produced from a reaction. procedure [11]. Yield is an important parameter to estimate the number of parts that can be used as food [12]. The yield was obtained from the ratio of the weight of the powder produced to the weight of the bone raw material. The yield calculation is

obtained from the percentage comparison between the final weight and the initial weight of the process so that the calculation results are expressed in percent (%). The greater the yield, the higher the economic value of the product, as well as the value of the effectiveness of the product [13].

The yield of pangasius bone powder obtained from Kaya's [14] research was 81.73%. Yield is the percentage result between the final product produced and the initial product. Yield is very important to know to get a picture of a product that can be used properly or to know the economic value of the product. The higher the yield of a product, it can be said that the product has a high economic value as well.

2.2.1.2 Bulk density

Bulk density is one of the physical parameters that shows the porosity of a material [15]. Density is the ratio of the weight of the material to the volume it occupies [16]. Foodstuffs with a high bulk density indicate a small density of space products, while a low density value of kamba indicates a high density of powder [17]. Calculation of the density of the kamba is very important, in addition to consumption, especially in terms of packaging and storage.

Bulk density is one of the parameters that is often used to plan a storage warehouse, volume of processing equipment, type of packaging or means of transportation [18]. Bulk density measurements were carried out using a measuring cup. The sample was weighed as much as 10 g, then put into a 100 mL measuring cup and read the volume. Calculation of bulk density is obtained from the percentage comparison between sample weight (grams) and sample volume (mL) so that the calculation results are expressed in percent (%).

Bulk density pangasius bone powder produced by Kaya [14] research is 0.80 g/mL. This value indicates that at a volume of 1 mL, the weight of flour is 0.80 g. The greater the density value of Kamba flour, the smaller the storage or packaging space and transportation costs. A large bulk density value is more desirable because the porosity or empty space between the particles is getting smaller and the volume of the material is small so it doesn't require too large a storage area.

Table 1. Fishbone powder quality requirements

No.	Characteristics of Bone Powder	Requirement	
		Quality I	Quality II
1.	Water content (%) Maximal	8	8
2.	Fat content (%)	3	6
3.	Calcium content (%) Minimal	30	20
4.	Phosphate content (as P ₂ O ₅), (weight/dry weight) (Min)	20	20
5.	Phosphate content (P), % (weight/dry weight)	8	8
6.	Fineness of sand/silica, % (weight/dry weight) (Max)	1	1
7.	Fineness (Mesh 25), (weight/dry weight) (Min)	90	90

Source: National Standardization Agency (1992)

2.2.2 Chemical characteristics

2.2.2.1 Water content

Water content is the amount of water content in a food product and is expressed as a percentage (%) [19]. Foodstuffs contain water content in different amounts so it is necessary to analyze the water content. Moisture content is a very important chemical parameter to determine the quality and resistance of food to damage that may occur. The higher the water content of a food ingredient, the greater the possibility of damage, both as a result of internal biological activity (metabolism) and the entry of destructive microbes [20].

Water content analysis was carried out using the thermogravimetry method according to AOAC (2000) [21] the vochdoos bottle was weighed and then put into an oven heated at 105°C. Cool in a desiccator, then weighed again and recorded as W1, the sample is weighed as much as 2 grams (W). The sample was put into a vochdoos bottle and then in the oven again. Cool in a desiccator with a closed vochdoos bottle and then heated again at 105°C for 3 hours, then weighed until the weight is constant (W2) in a closed state. Calculation of water content is done by comparing the weight before and after treatment in percent units.

The water content in foodstuffs affects the durability of these foodstuffs. In addition, the water content also determines the acceptability, freshness, appearance, and taste of the food ingredients so that the lower the water content in an ingredient, the longer the shelf life [22]. Food products with a moisture content of less than 14% are safe enough to prevent mold growth, while food in the form of powder to be stored for a long time must have a moisture content below 10%.

The water content of the pangasius bone powder in Kaya's [14] study was 6.53%, while the water

content of the pangasius bone powder in the Angraini study [23] was 6.21%. The resulting water content value is not too different because it is still in the range of 6% and is still in accordance with SNI 1992 concerning pangasius bone powder where the maximum water content for quality I and quality II is 8%.

2.2.2.2 Ash content

Ash content is the amount or content of minerals contained in a material. The ash content of a food product shows the residue of organic matter remaining after the organic matter in the material is destroyed [24]. Measurement of ash content aims to determine the amount of mineral content in food ingredients [25]. The principle of the ash content testing process is to decompose organic substances into H₂O, CO₂ and other gases that evaporate during ashing using a temperature of 550°C-600°C, while the rest is in the form of mineral oxides (ash).

Analysis of ash content was carried out using thermogravimetry method and using a kiln AOAC (2000) [21]. The porcelain cup was put into the furnace and then heated at 600°C for 1 hour, cooled in a desiccator and then weighed (W1). The sample is weighed as much as 2 grams and then put into a porcelain dish (W), burned on a burner flame for 45 minutes, put in a furnace at 600°C for 4 hours until the ash is whitish, cooled in a desiccator and then weighed until the weight remains (W2). Calculation of ash content is done by calculating the ratio of weight before and after the heating process with the furnace.

Fish bone powder generally has a high ash content, this is because the main components of bone composition are minerals so that pangasius bone powder contains a high ash content. The high ash content in bone powder indicates that the fish bone raw material used contains more than 50% minerals including calcium [12]. Bone

contains living cells and an intracellular matrix in the form of mineral salts [9]. Mineral salt is a component consisting of calcium phosphate as much as 80% and the rest consists of calcium carbonate and magnesium phosphate causing high bone powder ash content [26]. The high ash content is beneficial when viewed from a nutritional point of view because most bone powder contains elements of calcium and phosphorus which are needed by the body [27].

2.2.2.3 Protein content

Proteins consist of long chains of amino acids, which are bound to each other in peptide bonds. Nitrogen is the main element of protein because it is present in all proteins, which have a proportion of 16% of the total protein [28]. Analysis of protein content requires several reagents in the process used for distillation and titration, these reagents include catalyst (Kjeltab), 98% sulfuric acid (H_2SO_4), 40% NaOH solution, 0.1 N HCl solution, boric acid (H_3BO_4) 4 %, 99.8% ethanol and an indicator solution consisting of a mixture of 100 mL 0.1% Methylene red (in 95% ethanol) with 200 mL of 0.2% Bromocresol Green (BCG) (in 95% ethanol).

Protein content analysis was performed using the semi micro-Kjeldahl method AOAC [21]. Samples were weighed as much as 0.5-1 grams (W), put into a 250 mL digestion tube, added 2 tablets of kjeltab (Cu) or 7 grams of $CuSO_4 \cdot 5H_2O$ +0.8 grams K_2SO_4 , added 15 mL of concentrated H_2SO_4 , digested with a digester block inside a fume hood for 30-45 minutes or until the solution is clear turquoise, remove and cool then add 75 mL of distilled water, add 60 mL of 40% NaOH. The receiving solution is prepared: 25 mL of H_3BO_4 in a 250 mL Erlenmeyer flask and 3 drops of mix indicator are added, distillation is carried out and then titrated with 0.1 N HCl until it reaches the point where the color changes. Protein content was calculated by calculating the difference in titration volume and normality time for HCl blanks and 0.014, the waste conversion factor (ie 6.25), dilution factor divided by sample weight multiplied by 100%.

The protein content of the pangasius bone powder in Kaya's [14] study was 22.23%, while the protein content of the Angraini *et al.*, [23] study was 25.38%. The protein content value of the pangasius bone powder produced has a slight difference because the manufacturing process has a different procedure. The

pangasius bone powder in Kaya's research [14] has a lower protein value because the procedure uses a boiling process twice so that the protein content in pangasius bones will be more soluble than the pangasius bones in the research of Angraini *et al.*, [23]

2.2.2.4 Fat content

Fats are one of the groups include to the lipid group, namely organic compounds that have one distinctive property that is not soluble in water, but soluble in organic solvents such as ether, benzene, chloroform, and others. Fat is an important component in foodstuffs because fat can determine the characteristics of foodstuffs. Fat is found in almost all foodstuffs and the fat content in these foods will vary. Therefore, it is very important to analyze the fat content of a food so that the calorie needs of a food ingredient can be calculated properly [29].

Fat content analysis was performed using the Soxhlet extraction method AOAC [21]. The fat flask was in the oven at 105°C for 2 hours, then cooled in a desiccator, the fat flask was weighed (W1). A sample of 2 grams was weighed (W), wrapped in filter paper and put into a sleeve, the fat flask and the sleeve were filled with 70 mL of ether. The extraction process was carried out for 4-6 hours, the fat flask was in the oven at 105°C for 2 hours then cooled in a desiccator then the fat flask was weighed (W2). Fat content is calculated using the formula for the ratio of the initial weight and final weight in percent.

Fat content affects changes in the quality of food products during storage. Fat is related to quality because fat damage can reduce nutritional value and cause taste and odor deviations [30]. High fat content can cause powder to have a fish taste and cause oxidative rancidity as a result of fat oxidation, the taste of fish bone powder is easily rancid and the appearance of powder is brownish yellow so that lower fat content is expected [31].

2.3 Potential of Pangasius Bone Powder as a Source of Calcium

Pangasius bone powder is a product that is rich in calcium and phosphorus so that it can be used as an alternative source of meeting the needs of calcium and phosphorus for the body. Considering calcium is the most important mineral element for the human body. Fishbones

Table 2. Potency of Pangasius bone powder

No.	Fortification Products	Potency
1.	Cookies Pangestika <i>et al.</i> , [35]	These cookies contain 120.2 mg/100 g of calcium. These cookies can be used as healthy and nutritious snacks because they contain high enough calcium.
2.	Biscuits Kaya [14]	Biscuits contain 3.54 mg/g bk calcium, if all nutrients can be absorbed properly by the body, consumption of 7 pieces (35 g) of formulated biscuits contributes 9.01% calcium needs and phosphorus 8,43%. The percentage is based on the nutritional adequacy rate of nutrients with a dietary energy value of 2000 kcal.
3.	Rice Noodles Nur <i>et al.</i> , [36]	Rice noodles high in calcium to overcome the problem of stunting, which is one of the nutritional problems in Indonesia. This high calcium vermicelli can be used as complementary food for lunch for children aged 12-24 months because it contains 230 kcal of energy, 6.5 g protein, 4.7 g fat, 40.3 g carbohydrates, 82.1 mg calcium and 90.3 mg phosphorus.
4.	Crackers Fajaria <i>et al.</i> , [37]	These crackers can be used as a simple snack and can be consumed every day. Pangasius bone crackers have a calcium content of 568.354 mg/100g, 8.96% water content, 0.63% ash content, 0.22% fat content, 1.46% protein content, phosphorus content 20.28 mg/100g. Phosphorus levels needed by women and men are around 700-1250 mg/day, so if people consume pangasius bone crackers in the amount of 100 g, pangasius bone crackers can contribute 1.6% of the total phosphorus levels determined by the Ministry of Community.
5.	Waffle Arza and Anggela [38].	Pangasius bone powder is a cheap source of Ca and nutrients for human health because it can increase the calcium content in waffles by 19%.
7.	Toothpaste Sidoretno and Nasution [39]	Toothpaste that uses pangasius bone flour as a cleaning agent/abrasive. The results of the organoleptic preparations were in the form of a slightly dense paste, smelled of menthol, brownish-cream in color, and homogeneous. The results of testing the physical and chemical quality of the toothpaste all showed that the pangasius bone powder toothpaste met the physical and chemical quality of the toothpaste. Toothpaste made from pangasius bone powder can be used as an innovative product in the future.

have the main minerals in the bones, namely calcium and phosphorus. Fishbones contain a lot of calcium in the form of calcium phosphate as much as 14% of the total bone structure. The calcium content of fish bones is about 2% of the total weight of fish [32]. This form of calcium is found in bone ash which can be well absorbed by the body, which ranges from 60-70% [33].

The body needs calcium to form and repair bones and teeth, helps nerve function, muscle contraction, blood formation and plays a role in heart function. All calcium that enters the body (through food or intake) is mostly stored by the body and is not excreted through urine or feces [34]. Calcium is included in the macro minerals needed in large quantities, which is more than 100 mg/day. Pangasius bone powder can be used as a calcium supplement to meet daily calcium by fortifying with products. Several studies have developed products with pangasius bone powder fortification in Table 2.

3. CONCLUSION

Industrial waste from fisheries such as fish skin, fish bones, fish heads, and internal organs are usually left to waste and pollute the environment, even though part of the waste can be processed into high value products. Fish bone is a waste that contains calcium so that it can be used as raw material for making fish bone powder. Pangasius bone powder has a characteristic that is in the form of a fine white powder and a distinctive smell of fish bone. Fish bone powder was obtained through a heating process at a temperature of 120°C, alkaline extraction process of NaOH, drying and grinding. Pangasius bone powder is a product that is rich in calcium and phosphorus so that it can be used as an alternative source of meeting the needs of calcium and phosphorus for the body. The properties that determine the quality of pangasius bone powder consist of physical characteristics (yield and bulk density); chemical characteristics (moisture content, ash content, fat content and protein content).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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