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UTILIZATION OF SAILFISH *(ISTIOPHORUS PLATYPTERUS)* BONE WASTE TO PRODUCE CALCIUM-RICH FISH BONE FLOUR

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Abstract

The sailfish (*Istiophorus platypterus*) is a fast-swimming fish considered to have low economic value due to its relatively tough flesh; consequently, the meat is typically processed via smoking, while the bones—considered waste—are discarded without further optimal utilization. In this study, the fish bones were processed into fish bone flour to create a product of economic value. An experimental method was employed using a single sample type (fish bone flour) with three replicates, and the data were analyzed using descriptive statistics. The results showed a whiteness degree of 68.38%, a bulk density of 0.097%, and a water absorption capacity of 126.77%. These parameters indicate that the product possesses a relatively bright color, a lightweight and porous structure, and high-water absorption capability. Regarding chemical parameters, the mean values obtained were 6.98% protein content, 4.39% moisture content, 57.20% ash content, and 1.36% calcium content. The moisture content was relatively low, indicating a sufficiently dry product with the potential for a longer shelf life. The ash content of 57.20% was the highest value recorded, reflecting a high content of minerals or inorganic components within the material. The calcium content of 1.36% indicates the product's potential as a source of calcium.

Keywords: Whiteness degree, Protein, Moisture content, Fish bone,Calsium

INTRODUCTION

The sailfish (Istiophorus platypterus) is an economically important species classified as a large pelagic fish. The flesh of this fish is highly favoured by the public and is processed into smoked fish, whilst the waste in the form of fish bones is discarded. These fish bones possess a strong skeletal structure and are rich in minerals, which, when subjected to a processing procedure, yield a product of high economic value, namely fish bone meal. Fish bone meal production represents one of the efforts that supports the zero waste principle within the fishery product industry. Fish bone meal generally contains calcium, ash, and other minerals; hence, it can serve as an alternative calcium product given the high cost of calcium products currently available on the market. This is supported by numerous previous studies demonstrating that fish bone waste can be processed into meal with a high mineral content and can be utilised as both a raw material and a food fortification ingredient.

One such study is the utilisation of catfish (Pangasius sp.) and tuna bone meal, which has been developed as a supplementary ingredient in food products to enhance nutritional value, particularly calcium content (Pangestika et al., 2021). The utilisation of sailfish bones as fish bone meal is believed to be capable of increasing the economic value of waste generated by the fishery processing industry, which had not previously been utilised optimally and responsibly.

METHOD

The research employed a laboratory experimental method and was conducted at the Basic Chemistry Laboratory of Pattimura University (Universitas Pattimura), Ambon.

In the production of fish bone meal, the various equipment and materials utilised were as follows: a 100-mesh sieve functioning to sift the bone meal, a spatula for stirring the meal, a blender/chopper for grinding the bones, and a pressure cooker for boiling the fish bones. A digital oven was used for drying the fish bones, a baking tray for placing the fish bones, a jar for storing the fish bone meal, a digital scale for weighing the fish bones, and other supporting equipment to facilitate the sailfish bone meal production process. The materials required for the production of fish bone meal were 1 kg of sailfish bones and 250 ml of calamansi (Citrus microcarpa) juice.

The research procedure commenced with the preparation of 1 kg of sailfish bones that had been cleaned of scales, blood, and residual flesh adhering to the bones. Subsequently, the fish bones were thoroughly washed and soaked in 250 ml of calamansi juice for 15 minutes to remove residual flesh and eliminate the fishy odour from the bones. Following this, the fish bones were washed again until clean and drained, after which the bones were boiled at a temperature of 90°C for 2 hours. The sailfish bones were then removed, washed again until clean, and drained for 20 minutes. Subsequently, the fish bones were dried using a digital oven for 1.5 hours at a temperature of 120°C. After drying at the specified temperature, the sailfish bones were removed and ground using a chopper. The ground fish bones were then sieved through a 100-mesh sieve to produce fish bone meal. The resulting sailfish bone meal was then ready for laboratory analysis. For further clarification, the process can be observed in the flow diagram below.

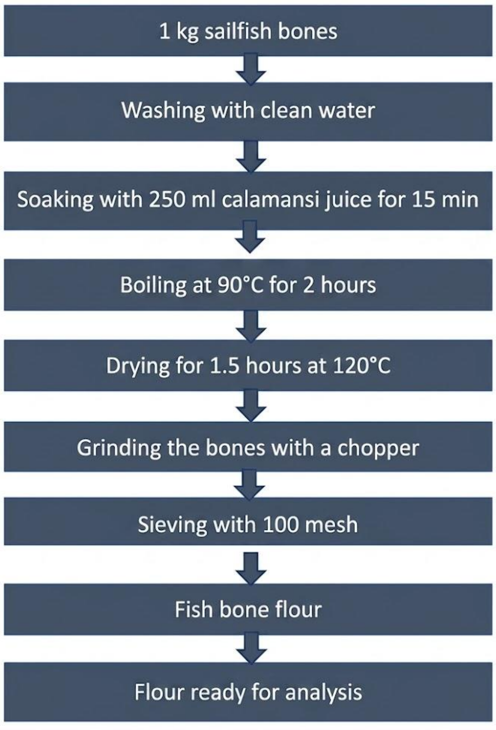

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Figure 1. Research flowchart for sailfish bone flour.

The data in this study were analyzed using descriptive tests with IBM SPSS version 25 software, enabling accurate processing of data across various chemical parameters—including calcium, ash content, moisture content, and protein—as well as physical parameters such as bulk density, whiteness, and water absorption capacity..

RESULTS AND DISCUSSION

The discussion of the research results below covers various parameters derived from laboratory testing of fish bone flour: chemical parameters—specifically moisture, protein, ash, and calcium content—and physical parameters—namely whiteness, bulk density, and water absorption capacity.

A. Chemical parameters

The results of the descriptive analysis of the chemical parameters mentioned above are shown in Figure 1 below.

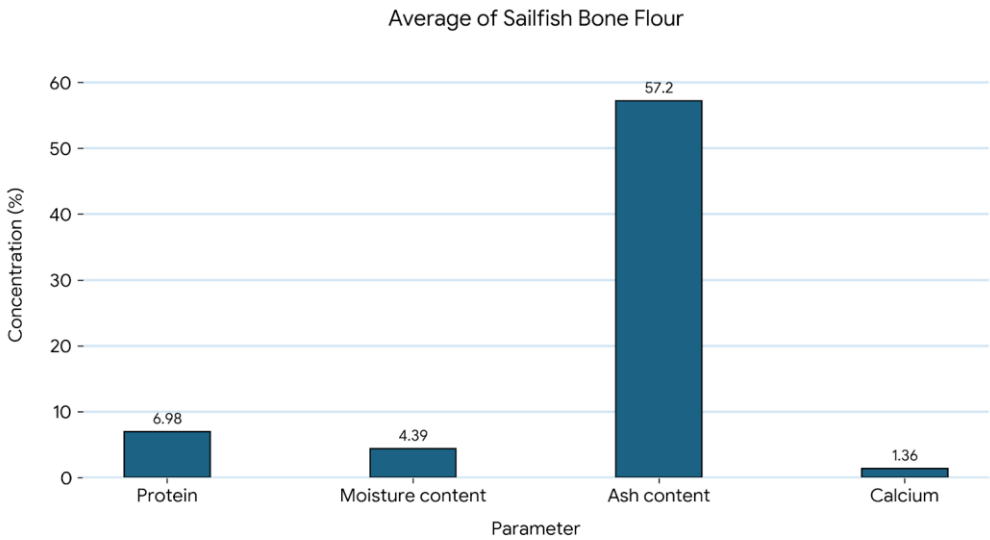

Figure 2. Results of descriptive analysis of mean chemical parameters for sailfish bone flour.

Based on the histogram in Figure 2 above, the results of the descriptive analysis for each parameter are as follows:

a. Proteins

Figure 2 demonstrates that the protein content of sailfish bone meal had a mean value of 6.98%. This protein value indicates that sailfish bones also contain protein, although the primary component constituting bone is calcium. Fish bone meal is generally more dominated by minerals. Research on various types of fish bone meal has demonstrated that chemical characteristics may differ depending on the fish species and processing method (Marasabessy et al., 2018; Sunarma et al., 2025). The protein content of sailfish bone meal was lower compared to the protein content of red snapper bone meal, which was recorded at 26.7% (Kaliky, 2024). The protein content for fish bone meal based on the Indonesian National Standard (SNI) is 45–46% (BSN, 2006).

The protein content of sailfish bone meal at 6.98% indicates that protein components are still present in the product. This value was lower than the ash content, which demonstrates that mineral components are more dominant than protein components. The protein content in fish bone meal can be influenced by the processing procedure, particularly the boiling or extraction process, which may remove a portion of the organic components. Marasabessy et al. (2018) reported a protein content of snapper bone meal at 0.96%, whilst research on catfish (Pangasius sp.) bone meal obtained a protein content of 26.94% on a dry weight basis. This discrepancy demonstrates that fish species and processing methods exert a considerable influence on the chemical composition of fish bone meal (Marasabessy et al., 2018; Sunarma et al., 2025)..

b. Water content

The moisture content of sailfish bone meal as shown in Figure 2 above was 4.39%, indicating that the sailfish bone meal was in a relatively dry condition. This condition is satisfactory from a storage perspective, as a low moisture content can assist in reducing the likelihood of microorganism growth and decelerating deterioration reactions. This result is relatively comparable with the study by Husna et al. (2020), who obtained a moisture content of triggerfish bone meal ranging from 3.79% to 4.15% across various extraction treatments. This demonstrates that the processing of fish bones can yield meal with a low moisture content. According to the Indonesian National Standard (1992), the maximum moisture content for bone meal is 8%. A low moisture content in fish bone meal can extend the shelf life of the product.

c. Ash content

The ash content of sailfish bone meal as shown in Figure 2 was 57.20%. This value was lower compared to the ash content of red snapper bone meal, which was recorded at 59.93% (Kaliky, 2024). The ash content indicates that sailfish bone meal contains a relatively high mineral component. This finding is consistent with the characteristics of fish bones, which constitute mineralised tissue containing minerals, particularly calcium and phosphorus. The study by Husna et al. (2020) obtained an ash content of triggerfish bone meal ranging from 87.52% to 90.05%, whilst Sunarma et al. (2025) reported an ash content of catfish (Pangasius sp.) bone meal at 68.22% on a dry weight basis. The discrepancy in these values may be attributed to the fish species, the bone portion utilised, the extraction process, and the analytical methods employed.

d. Calcium

The calcium content of sailfish bone meal as shown in Figure 2 above was 1.36%, indicating the potential of this material as a source of the mineral calcium. Fish bones are known to possess potential as a calcium source; therefore, their utilisation as meal can increase the added value of fishery by-products. Marasabessy et al. (2018) demonstrated that fish bone meal can be utilised as a calcium source, whilst Husna et al. (2020) obtained a calcium content of 31.83–35.75% in triggerfish bone meal. Meanwhile, Sunarma et al. (2025) reported a calcium content of 52.8% in catfish (Pangasius

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sp.) bone meal, and Kaliky (2024) also reported that the calcium content of red snapper bone meal was 44.82%. The calcium value of 1.36% in the present study was relatively lower compared to the findings of those studies. This was attributed to the fact that during the initial stages of sailfish bone meal production, namely boiling and soaking in calamansi juice, only a small amount of calcium was precipitated within the bone matrix; consequently, only a small quantity of calcium was obtained during the milling process.

A. Physical Parameters

The results of the descriptive analysis of the mean values for whiteness, bulk density, and water absorption capacity are shown in Figure 3 below**.**

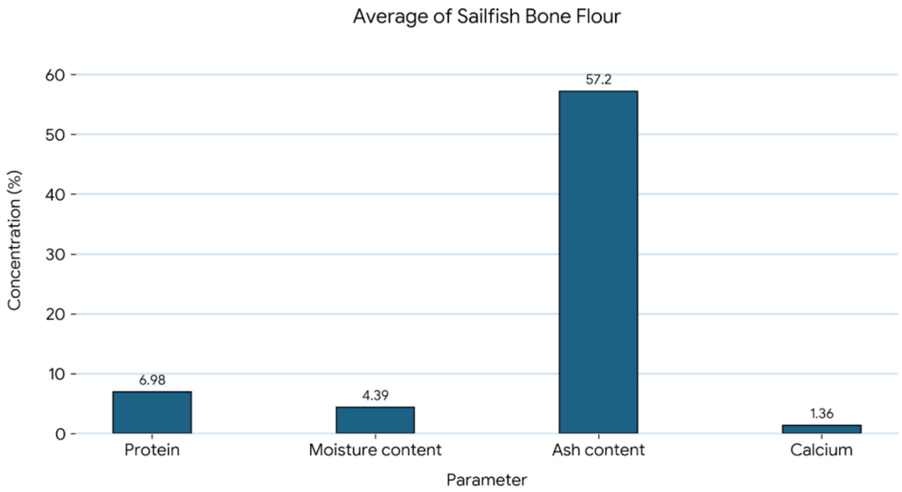

Figure 3. Results of descriptive analysis of mean physical parameters of sailfish bone flour.

As shown in Figure 3 above, the product characteristics based on the obtained mean data can be described using three parameters: whiteness, bulk density, and water absorption capacity.

1. Whiteness Degree

The mean whiteness degree value of 68.38 indicates that the product possesses a satisfactory level of brightness. The whiteness degree value can be influenced by the characteristics of the raw material, the processing procedure, heating temperature, drying, and the possible occurrence of browning reactions. A higher whiteness degree value generally corresponds to a brighter and more visually appealing product colour, as illustrated in Figure 3 below.

Figure 4. Layer fish bone meal; source: personal collection.

2. Densitas Kamba

The bulk density of sailfish bone meal had a mean value of 0.097 as shown in Figure 2. This parameter describes the weight of a material within a given volume, including the void spaces between particles. A low bulk density value indicates that the product tends to be lightweight and possesses a porous structure; consequently, a larger packaging volume is required for the same product mass. This characteristic can be influenced by particle size, particle shape, moisture content, and the drying process.

3. Water Absorption Capacity

The mean water absorption capacity of sailfish bone meal as shown in Figure 3 was 126.77%, indicating that the product is capable of absorbing a considerably high quantity of water. This capacity is associated with the presence of hydrophilic components, particularly starch, protein, fibre, or other components possessing functional groups capable of binding with water. A high water absorption capacity can provide advantages during processing, particularly when the product is intended for use as a material requiring hydration or reconstitution processes.

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