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Protein and Calcium Concentrate Quality of Chacunda Gizzard Scad (*Anodontostoma chacunda*), Silver Rasbora (*Rasbora argyrotaenia*), Bali Sardinella (*Sardinella lemuru*)

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Abstract: Fish protein and calcium concentrate are one of the innovations of protein and calcium form development applied to low protein and calcium food. The chacunda gizzard shad, silver rasbora, and Bali lemuru were selected in fish protein and calcium concentrate production because these fish have many spines and their utilization has not been optimal yet. This study aims to know the protein and calcium protein concentrate profile of *Anodontostoma chacunda, Rasbora argyrotaenia, and Sardinella lemuru*. It used Complete Randomized Design with 3 treatments and 3 replications, A (*A. chacunda*), B (*R. argyrotaenia*), and C (*S. lemuru*). Results showed that FPC and FCPC of *A. chacunda* had a 19.6% yield, calcium 22.86 mg g^{-1}, 58.97% protein, 14.38% fat, 5.67% water, 15.87% ash, and 5.12% carbohydrate. The protein concentrate of *R. argyrotaenia* had a 21% yield, calcium of 30.58 mg g^{-1}, 58.13% protein, 20.08% fat, 5.65% water, 11.64% ash, and 4.49% carbohydrate. The protein concentrate of *S. lemuru* had a 16.6% yield, calcium of 24.65 mg g^{-1}, 71.32% protein, 6.39% fat, 5.70% water, 12.08% ash, and 4.51% carbohydrate. The hedonic test indicated that the panelists preferred the protein concentrate of *S. lemuru* over the other two fish protein based on appearance, aroma, and texture.

Keywords: Protein, Calcium, Fish, Yield, Physical Test

1. Introduction

Protein demand increases with population growth and living standards [1] so human needs to find new protein sources. In line with the recent development, the fish processing industry diversification has very advanced development so there are many new fisheries products, such as fish protein concentrate. It is a powder-like product processed by separating the fat and water in the fish to obtain a higher protein concentrate than the initial fish condition with a "stable protein". The concept of fish protein concentrate (FPC) is to use more efficiently the fishery resource by converting low-value fish into acceptable products for human consumption [2]. Fish protein concentrate can be used as a protein supply, and it can be added to low-protein food and is often applied to high-carbohydrate food [3].

Food and Agriculture Organization (FAO) classifies the fish protein concentrate into 3 types: type-A as unsmelled fish powder, no fish taste, and no color with a minimum protein content of 67.5%, maximum fat of 0.75%, maximum water content of 10%; type-B as fish powder with no specific aroma, taste, and color, but if it is added to food material it mostly leaves fish taste with a minimum protein content of 65%, maximum fat of 3%, and maximum water content of 10%; type-C is fish powder hygienically made with a minimum protein content of 60%, maximum fat of 10%, and maximum water content of 10% and leaves fish aroma and taste [4].

Fish protein concentrate (FPC) has several roles in improving food product texture, such as increasing gel formation ability, water binding, and emulsion besides increasing its protein content. Another privilege of the fish protein concentrate besides its high nutritional value is the protein function does not lose so it can be processed further to make various product types. It is also easily stored, durable, and transported. The food product with an addition of fish protein concentrate is developed to increase people's acceptability of the fish protein concentrate product [5]. Moreover, the presence of protein concentrate in different fish species can become an alternative opportunity as a substitute, fortified, and enrichment material in low-protein products. The effort of fish protein concentrate utilization is expected to overcome the malnutrition issues in many societies [6]. The fish protein concentrate has been extracted from various fish species, such as tilapia [7-9], threadfin bream (*Nemipterus* spp.) [10], etc. under different extraction techniques. This study aims to find the quality of protein and calcium concentrate of Chacunda gizzard shad (*Anodontostoma chacunda*), silver rasbora (*Rasbora argyrotaenia*), Bali sardinella (*Sardinella lemuru*).

2. Method

This study used chacunda gizzard shad (*A. chacunda*), silver rasbora (*R. argyrotaenia*), and Bali lemuru (*S. lemuru*) as raw materials. The fish were weeded, and all unnecessary parts, such as gills and internal organs were discarded. The fish were then cleaned and weighed. These were cooked in an autoclave at 121^{o}C for 30 min. to kill the bacteria, activate the enzyme, and ease the fish grinding. The samples were pressed into an oil tissue to absorb the left water. These were dried in the oven at 60^{o}C for 42 h. and obtained 101 g of chacunda meat, 111 g of rasbora meat, and 83 g of lemuru meat. The samples were then ground and sieved through a 60 mesh sieve so that the meat weight was obtained as much as 98 g of chancunda, 105 g of rasbora, and 83 g of lemuru. Each protein concentrate was tested for calcium content and proximate (protein, fat, water, ash, and carbohydrate).

Parameters measured in this study were yield and calcium (Ca) content using the SSA method, namely a quantitative analysis used to determine metal and metalloid content based on light absorption at a certain wavelength using an absorption optical radiation at a free gaseous atom. The proximate analysis was carried out for protein, fat, water, ash, and carbohydrate content using AOAC method. The organoleptic tests were also done for appearance, aroma, and texture using the hedonic method. All data comparisons were descriptively presented.

3. Results and Discussion

Yield

The proten concentrate processing gave the highest yield in *R. argyrotaenia* and the lowest in S. *lemuru* (Figure 1). Low yield could result from several factors, such as the heating method, cooking temperature, and drying which is the water content removal process of a material.

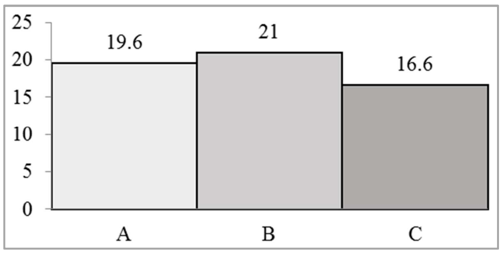

Figure 1. *Yield in the protein concentrate of A. chacunda (A), R. argyrotaenia (B), and S. lemuru (C).*

The end-drying product is a material free of water or containing low water content. The different yields in the three fish species could result from different nutritive components contained in the species [11].

Calcium (Ca)

Figure 2 shows calcium content above 20%. It could result from *A. chacunda*, *R. agryrotaenia*, and *S. lemuru* belonging to small pelagic fish groups which hold a lot of bones and they have similar habitats. Fish bones contain 5.63 g Ca kg^{-1} and 2.38 g phosphorous kg^{-1} [12].

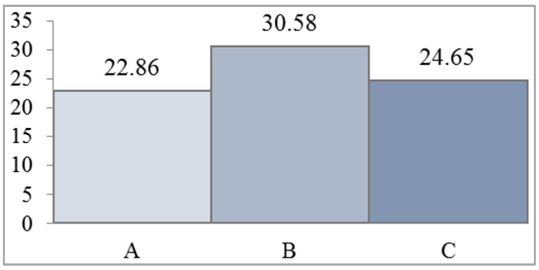

Figure 2. *Calcium (Ca) content in the protein concentrate of A. chacunda (A), R. argyrotaenia (B), and S. lemuru (C).*

The highest mean Ca content is recorded in the protein concentrate of *R. argyrotaenia,* followed by *S. lemuru*, and then *A. chacunda* (Figure 2). The high calcium content in the protein concentrate of *R. argyrotaenia* is affected by the fish feature as omnivores which feed on zooplankton, phytoplankton, moss, and insects. It could also result from the high content of cartilage and hard bones in this fish. This finding is in line with Vanny *et al*. (2016), that the cartilage and hard bones highly influence the calcium content in fish.

Protein

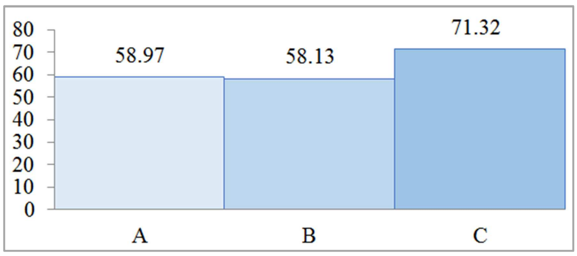

Figure 3. *Protein content in the protein concentrate of A. chacunda (A), R. argyrotaenia (B), and S. lemuru (C).*

FAO has established a standard protein content of the fish protein concentrate of as much as 67.5%. Figure 3 shows that the protein content of protein concentrate of *S. lemuru* has met the type-A protein concentrate, whereas the protein concentrate of *A. chancunda* and *R. argyrotaenia* have not met the minimum requirement of the FAO.

Fat content

The highest mean fat content was recorded in the protein concentrate of *R. argyrotaenia* and the lowest in the protein concentrate of *S. lemuru* (Figure 4).

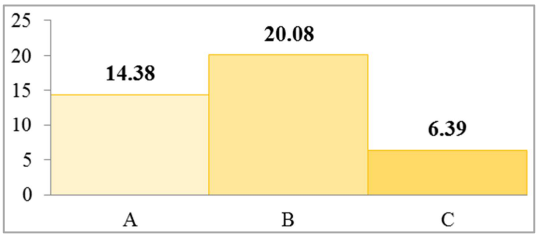

Figure 4. *Fat content in the protein concentrate of A. chacunda (A), R. argyrotaenia (B), and S. lemuru (C).*

The lowest fat content was recorded in the protein concentrate of *S. lemuru*, 6.39%. FAO has established the fat content of the fish protein concentrate as much as 0.75% for type-A, 3% for type-B, and 10% for type-C, respectively. Thus, the fat content of *S. lemuru* has met the type-C protein concentrate requirement, whereas the fat content of *A. chacunda* and *R. argyrotaenia* have not met the maximum fat content recommended by the FAO.

Water content

Histogram below demonstrates that the highest mean water content occurs in the protein concentrate of *S. lemuru*, 5.70%, and the lowest in the protein content of *R. agyrotaenia* (Figure 5).

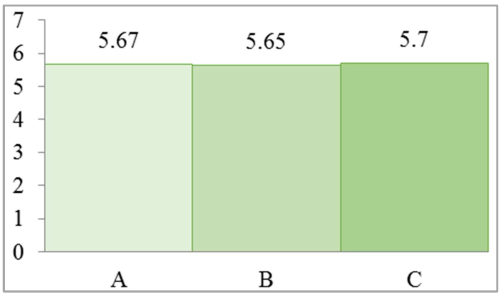

Figure 5. *Water content in the protein concentrate of A. chacunda (A), R. argyrotaenia (B), and S. lemuru (C).*

The water content in the three fish species used in the present study is still acceptable according to the FAO standard [13]. The water content in the fish protein concentrate is affected by their living environments. The fish habitat also influenced the fish meat nutrition. It could also be swayed by the area where the fish are caught and climate, total fat content, age, and growth [14].

Ash content

The ash content of the fish protein concentrate is presented in Figure 6. The highest mean ash content of the protein concentrate was recorded in *A. chacunda,* 15.8%, and the lowest in *R. argyrotaenia,* 11.64%. The different ash content in the protein concentrate with fish species could result from different minerals contained in each species.

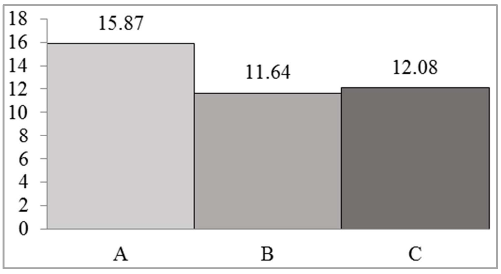

Figure 6. *Ash content in the protein concentrate of A. chacunda (A), R. argyrotaenia (B), and S. lemuru (C).*

Besides, the three fish species used in this study have different meat-spine ratios, some could have more spines and the others have more meat which causes the mixture of meat, scale, and spines uneven and yields different ash content in the fish protein concentrate. In fish meal processing, fine spine is not separated from the meat, but dried in mixed form. Fine bones are also mineral sources. The fish meal is processed by oven-drying at 60°C for 42 hours. This process also influences ash content. It is in line with previous study [15] that ash content is known as mineral or inorganic substances. The mineral is one of the food material components. Ash content in fish meal is affected by the raw materials used and its processing. The material processed through drying will increase the ash content, in which the higher the temperature the more the water is removed [16].

Carbohydrates

The carbohydrate content in the fish protein concentrate of *A. chacunda*, *R. argyrotaenia*, and *S. lemuru* is given in Figure 7. The highest carbohydrate content was found in the protein concentrate of *A. chacunda* followed by that of *S. lemuru*, and the lowest was recorded in *R. argyrotaenia*.

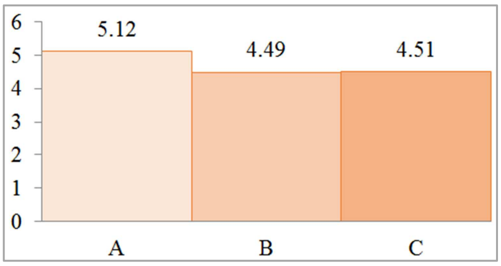

Figure 7. *Carbohydrate content in the protein concentrate of A. chacunda (A), R. argyrotaenia (B), and S. lemuru (C).*

The histogram shows that carbohydrate content in the protein concentrate is not affected by the fish species used in this study. It could result from the carbohydrate content influenced by the amount of water, ash, fat, and protein content. The carbohydrate content was estimated as carbohydrate by different, namely the subtraction of 100 with the percent of other components, such as water content, ash, fat, and protein [17]. The lower the other nutrition components are, the higher the carbohydrate content is, and vice versa [18].

Appearance

The score of appearance ranges from 0 to 9 for the unpreferred to the preferred one. Figure 9 indicates that the appearance-based highest preference is given in the protein concentrate of *S. lemuru* with a brighter and clean appearance and the lowest is given in *R. argyrotaenia* (Figure 8).

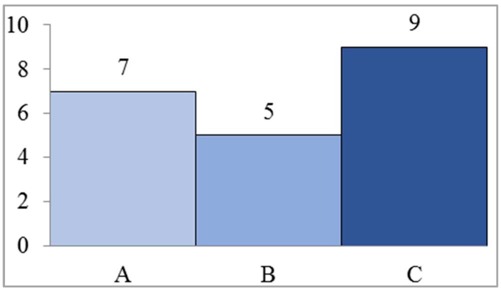

Figure 8. *Appearance in the protein concentrate of A. chacunda (A), R. argyrotaenia (B), and S. lemuru (C).*

Different appearances of the protein concentrate in the three fish species used in this study could result from different fat content with species. The fish fat contains carotenoids causing the fat colored [19]. During the drying process of the fish meat, pigment changes in which high-temperature heating makes the carotenoid unstable and changes the pigment color. Therefore, low-protein fish protein concentrate will have a lighter and cleaner appearance so it is preferred by the panelists.

Aroma

Figure 9 shows that the highest score was given in the protein concentrate of *S. lemuru*. It means that the protein concentrate of *S. lemuru* is the most preferred with a mild aroma, whereas the protein concentrate of *R. argyrotaenia* is unpreferred due to its strong fish smell.

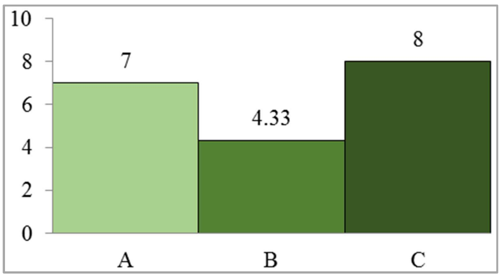

Figure 9. *Aroma in the protein concentrate of A. chacunda (A), R. argyrotaenia (B), and S. lemuru (C).*

The difference in the aroma of the fish protein concentrate could result from the fat types and composition. Fish containing high fat have a stronger aroma than those with low-fat content [20].

Texture

Figure 10 demonstrates that the highest preference level of the panelists for the texture of the fish protein concentrate is given in *S. lemuru*, while that of *A, chacunda,* and *R. argyrotaenia* have very low preference. It could result that the protein concentrate has a fine texture, does not agglomerate, and has low water and fat content. The protein concentrate of *A. chacunda* and *R. argyrotaenia* has an agglomerated texture and high-fat content.

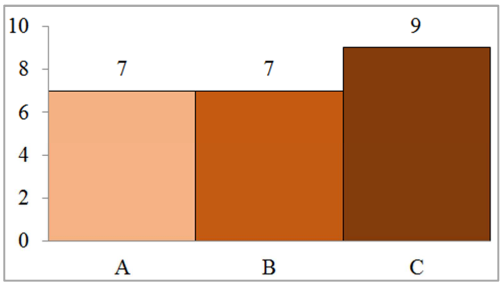

Figure 10. *The protein concentrate texture of A. chacunda, R. argyrotaenia, and S. lemuru.*

4. Conclusions

The protein concentrate of *A. chacunda* is the best based on the ash and carbohydrate content. The protein concentrate of R. argyrotaenia is the best based on the yield, calcium content, and water content, whereas the protein concentrate of *S. lemuru* is the best based on the protein and fat content. The sensory test indicated that panelists preferred the protein concentrate of *S. lemuru* since it has a fine texture and does not agglomerate. Also, the protein concentrate has low fat and water content, a faint fish aroma, and a brighter and clean appearance than that of *A. chacunda* and *R. argyrotaenia*. The fish protein concentrate should be done using a chemical extraction method to reduce the fat content by more than 50% and increase the protein level. Future research needs to be addressed to other low-value fish species and wasted fish to obtain an acceptable protein concentrate as food materials.

Conflicts of Interest

The authors declare no conflicts of interest.

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