The Nutritional Content of Fish Meal from Bycatch in Batu Beriga Village, Bangka Belitung

by Sudirman Adibrata

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Sudirman Adibrata[1]*, Denny Syaputra[2], Robet Perangin-angin[3], Devi Wulansari[4], Kim V. Van[5]

[1]*Department of Aquatic Resources Management, Faculty of Agriculture, Fisheries and Biology, Universitas Bangka Belitung*
[2]*Department of Aquaculture, Faculty of Agriculture, Fisheries and Biology, Universitas Bangka Belitung*
Jl. Raya Balunijuk, Gedung Semangat, Kampus Terpadu UBB Balunijuk, Kecamatan Merawang, Kabupaten Bangka, 33172, Indonesia
[3]*Department of Fishing Techniques, Karawang Marine and Fisheries Polytechnic*
[4]*Department of Fishery Product Processing Techniques, Karawang Marine and Fisheries Polytechnic*
Jl. Lingkar Tanjungpura, Karangpawitan, Karawang, Indonesia
[5]*Fisheries Faculty, Vietnam National University of Agriculture*
Trau Quy-Gia Lam-Hanoi, Vietnam
Email: sudirman@ubb.ac.id

Abstract

Bycatch has the added value of being processed into meals for animal feed or fish farming needs. Therefore, this study aims to determine the nutritional content of local fish meals from the bycatch in Batu Beriga Village, Bangka Belitung. The method used for processing fish meal was a wet mill from bycatch. Quality parameters referred to the Indonesian National Standard (SNI) 01-2715-1996/Rev.92 regarding fish meal as raw material for feed. The results showed that 4 kg of wet fish could produce a meal of 0.4 kg. The nutritional content of the local fish meal is of high quality as it met the requirements of SNI Quality I, II, and III, allowing it to be released to the market. The laboratory tests showed water, ash, crude protein, crude fat, crude fiber, calcium, phosphorus, NaCl, Gross energy, Carbohydrate, and pH content of 5.06% (SNI Quality I maximum 10%), 18.51% (SNI Quality I maximum 20%), 68.13% (SNI Quality I minimum 1.5%), 5.71% (SNI Quality I maximum 20%), 1.54% (SNI Quality I maximum 8%), 4.09% (SNI Quality I range 2.5-5.0%), 6.82% (SNI Quality I range 1.6-3.2%), 1.78% (SNI Quality I maximum 2%), 4,609.67 Kcal/kg, 0.0%, and 6, respectively. Furthermore, amino acids from a local fish meal could be used as feed mixtures for aquaculture. Bycatch can be used to fish meals as a potential side business for fishers. In sustainable fisheries development, independence in animal feed should be established immediately, hence the dependence on other regions can be minimized.

Keywords: *Aquaculture, Artisanal fisheries, Bangka Belitung, Sustainability fisheries*

Introduction

Fish products are usually abundant at the beginning of fish harvest season. Bycatch from small pelagic fish during the fishing season can be oversupplied so that their price goes down (Adibrata *et al*., 2022). The small pelagic fish caught by fishers using stored-operated stationary lift nets do not necessarily command a high price when it is abundant. Furthermore, fisheries management is needed to maintain value stability (Perangin-angin *et al*., 2018). The estimated potential for small pelagic fish in the Indonesia Fisheries Management Area 711 (IFMA 711) is 536.92 tons.y^{-1} (Decree MMAF No. 19, 2022). The Indonesian fisheries catch are dominated by 36 and 25% small and large pelagic fish, respectively (Suman *et al*., 2016), and the remaining 39% comprises other species. The production of small pelagic fish from the Bangka Belitung Islands is 53.69 tons.y^{-1} and contributes 10% of the approximate potential of IFMA 711.

Small pelagic fish are processed into canned sardines and salted fish. Some damaged fish are converted to leftovers, resulting in low prices. Bycatch is discarded and accidentally added catch (FAO, 1996), which is not consumed by the market and is commonly dumped into the river, thereby causing environmental pollution (Afreen and Ucak, 2020). This condition encourages fishers to preserve the catch by maintaining its quality and value. In the conditions of COVID-19 pandemic, the development

*) Corresponding author

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of a small-scale economic and environmental sustainability fish processing industry by utilizing bycatch has potential to generate additional income for fisher households. A policy priority is economic and environmental sustainability issues, such as enhancing aquaculture species' resilience and health (Noor *et al*., 2021).

The bycatch can be processed into fish meals for animal and fish farming feed (Afreen and Ucak, 2020). Furthermore, the negative impact of its disposal can be reduced by processing it into fish meal. This activity is expected to increase fishers' income, reduce environmental pollution, and become a potential business opportunity (Sa'diyah *et al*., 2016). Fish meal, which consists of pelagic fish as raw material, is the primary protein source for aquaculture (Olsen and Hasan, 2012). It is more nutritious than fresh fish in terms of protein content with a supply of iron, calcium, phosphorus, and minerals (Jahan *et al*., 2017). Therefore, this study aims to determine the nutritional content of local fish meals made from bycatch fish in Batu Beriga Village of Central Bangka Regency, Bangka Belitung Province.

Materials and Methods

This research was conducted from June to October 2021. The samples of bycatch fish were collected from Batu Beriga Village, Lubuk Besar District, Central Bangka Regency, Bangka Belitung Islands Province (Figure 1). The samples were identified for their species according to Saanin (1968).

Bycatch samples (4 kg) were processed into fish meal according method of AOAC (2019). The fish meal then were analysed at the Laboratory of Feed Quality Testing and Certification Center (BPMSP), Bekasi for water, ash, crude protein, fat, fiber, calcium, NaCl, carbohydrate content using the methods of AOAC (2019). The amino acids content in the fish meal were also analysed using the method of AOAC (2019). The nutrition value of produced fish meal then were compare to Indonesian National Standard (SNI) 01-2715-1996/Rev.92.

Results and Discussion

The result of fish identification showed that the bycatch consists of goldstripe sardinella (*Sardinella gibbose*), yellowstripe scad (*Selaroides leptolepis*), and butterfly whiptail (*Pentapodus setosus*). From 4 kg of fresh bycatch fish sample could only be produced as much as 0.4 kg of fish meal (10%). The nutritional content of fish meal was shown in Table 1 and Figure 2.

Figure 1. Research Location in Batu Beriga Village, Central Bangka Regency

Table 1. The laboratory test results for fish meal nutrition

Parameter	Concentration (Value)	SNI Standards 01-2715-1996/Rev.92			Grouper Pellets
		I	II	III	
Water content (%) max.	5.06	10	12	12	9-10
Ash content (%) max.	18.51	65	55	45	
Crude protein (%) min	68.13	1.5	2.5	3.0	31-33
Crude fat (%) max.	5.71	20	25	30	4-6
Crude fiber (%) max.	1.54	8	10	12	3-5
Calcium (%)	4.09	2.5-5.0	2.5-6.0	2.5-7.0	
Fosfor (%)	6.82	1.6-3.2	1.6-4.0	1.6-4.7	
NaCl (%) max.	1.78	2	3	4	
Gross energy (Kcal.kg^{-1})	4,609.67				
Carbohydrate (%)	0.00				
pH	6.0				

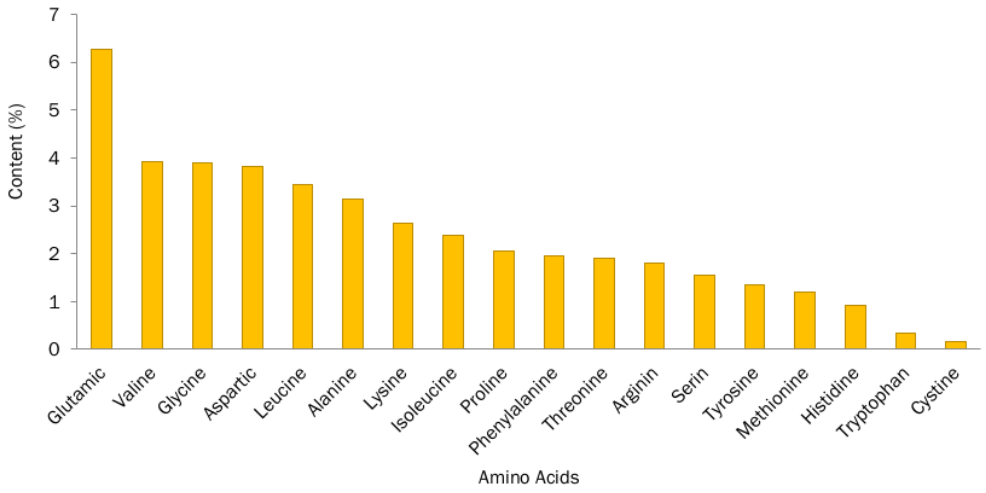

Figure 2. The amino acid content (%) in the fish meal made from bycatch fish

Bycatch is referred to small fish and other marine organisms which are not included in the primary catch (non-target species). The edible portion of monthly fish catch is only 42.81%, and the remaining 57.19% is waste (Cahyani *et al*., 2020). This shows that the proportion of bycatch is more significant than target species, thereby threatening the sustainability of the fishery (Perangin-angin *et al*., 2020). Therefore, bycatch should be managed to improve its value.

According to FAO (1996), bycatch and discharge have negatively impact to benthic communities and habitats, biological and ecological effects, as well as economic effects, that contribute to social problems. The majority of bycatch fish are low economic value species and size that require more time and effort to sort. In Bangka Belitung, bycatch and leftover fish are relatively high number and could be processed into fish meals, which could serves as an alternative protein source for food fortification (Cahyani *et al*., 2020). The use of fish meal in aquaculture production will support the global fish farming which is now the fastest-growing food-producing sector and a significant industry in many countries (Olsen and Hasan, 2012). Therefore should be further assess to achieve the United Nations sustainable development goals (UN SDGs) (Kok *et al*., 2020).

The raw materials for the fish meal include less economical fish, selective fishing by-products, abundant fish during the fishing season, and the remains from fish processing (New and Wijkström,

2002). Before being processed to be good fish meal, they require to be washed repeatedly to remove impurities on the fishes (Jahan *et al*., 2017). The fish meal produced in present work were matched with quality of SNI (Table 2), it meant that the fish meals from bycatch fish in the village of Batu Beriga has high quality. The quality of fish meal could be affected by the producing process. By applying low processing temperature (about 85°C) could generate a more stable and higher-value product (Hilmarsdottir *et al*., 2020). Compare to fish meal produced by Harris *et al*. (2012), this fish meal has better quality.

The world's demand of fish meal for animal feed is between 0.25 and 0.75 million tons and generally was imported (Tacon and Metian, 2015). Produced it from fish waste presents business opportunity and economic value to the community (Berutu *et al*., 2018). Establishing a household-scale fish meal factory is possible when the results of the business analysis include site selection, availability of raw materials, production processes, marketing, environmental impact analysis, and business analysis were feasible (Harris *et al*., 2012). Economic allocation is a proxy for the nutritional and added value of bycatch products due to their high demand (Kok *et al*., 2020).

The nutritional content of the fish meal

Water content is one of the essential feed characteristics as it affects the appearance, texture, and taste, especially in fish pellets. Furthermore, the water content in foodstuffs determines the freshness and durability. High concentration of water enhances the growth of bacteria, molds, and yeasts. Food ingredients will change (Syahfril *et al*., 2004). Table 1 shows that the fish meal sample has a water content of 5.06% that meets the requirements of SNI Quality I, II, and III for animal feed.

The ash content in fish depends on its living habitat, which is related to the mineral content in the body (Suwandi *et al*., 2014). The result of identification of by catch fish found that they were carnivores (goldstripe sardinella (*Sardinella gibbose*), yellowstripe scad (*Selaroides leptolepis*), and butterfly whiptail (*Pentapodus setosus*)), a predatory fish with sharp and strong teeth that eats pieces of aquatic animals and insects from the surrounding waters. The food ingredients are rich in mineral components reflected in the ash content. Table 1 shows the ash content value of the sample fish meal is 18.51%. Therefore, this value has met the requirements of SNI Quality I, II, and III.

Protein primarily acts as a source of essential amino acids that will synthesize non-essential amino acids and their synthesis in the body. The component depends on the amino acids and the habitat of the fish (Hardy, 2010). Protein primary functions in the body are for tissue growth and maintenance, forming essential body compounds, regulating water balance, maintaining body neutrality, and forming antibodies. Protein plays an essential role in the structure and function of the body, such as growth and reproduction antibodies (Hardy, 2010). Table 1 shows that the crude protein content of the fish meal sample is 68.13%. Therefore, this value has met the requirements of SNI Quality I, II, and III.

The fat content of present fish meal was 5.71% which meets the requirements of SNI Quality I, II, and III, in the range of the manufacturer's feed. The lower the fat content, the slower the rancidity of fish meal, and the longer its storage period. Fat is the primary source of energy after carbohydrates and protein. It is an efficient energy source and acts as a solvent for insoluble vitamins and a source of essential fatty acids (Dika *et al*., 2017). According to Berge and Barnathan (2005), the fatty acids in fish are saturated, monounsaturated, and polyunsaturated in the range of 15-25%, 35-60%, and 25-40%, respectively.

Crude fiber stimulates peristaltic motion in the digestive tract to support the microbes in the appendix that produce vitamins K and B12 and induce a feeling of satiety (Sutrisna, 2011). However, the level of its content should be taken into consideration when the fish meal is used as aquaculture feed. Crude fiber contains components that are difficult to digest, hence, it affects the digestibility of feed. The fiber of fish meal in present work was 1.54%, which is below the SNI Quality I, II, and III value.

Calcium (Ca), phosphorus (P), and NaCl are essential minerals required by the body to perform normal physiological functions (Shrimanker and Bhattarai, 2022). According to Table 1, the Ca, P, and NaCl values are 4.09, 6.82, and 1.78 % respectively. These meet the requirements of SNI Quality I, II, and III. Ca and P-values should be kept high and reduced when the fish meal is mixed with broiler feed, respectively (SNI, 1996). Meanwhile, the P-value and Ca values should be kept high when this fish meal is used as a poultry feed mixture (SNI, 1996). The gross energy of 4,609.67 Kcal/kg shows a high value, which can stimulate the agility of cultured fish. Carbohydrates are needed by the biota cultivated as a source of energy in the movement of fish. Fishes store carbohydrates as glycogen, which will be easily mobilized when energy is required (Borrel, 2011). Further, the fishes can extract 1.6 Kcal per gram of carbohydrate.

The high-quality fish meal provides a balanced essential amino acids, minerals, phospholipids, and

fatty acids reflected in regular fish diets (Hardy, 2010). A good quality of feed requires five basic elements, i.e. protein, carbohydrates, fat, vitamins, and minerals (Syahrizal and Panigoro, 2021). Protein is one of the crucial keys because of the complexity of the amino acid content that plays an essential role in growth (Hardy, 2010). Figure 2 shows an overview of the amino acid profiles from the largest to the smallest.

The most essential amino acid content is Glutamic acid which is included in the non-essential group. It is responsible as a neurotransmitter in increasing the perception of savory flavors in feed products to increase consumption. Additionally, glutamic acid also plays a role in detoxifying muscle cells and acts as an intermediary for the krebs cycle and carbohydrate metabolism (Aminoacidsguide, 2018). A fish feed with glutamate supplementation as much as 2.25% can improve the physiological response of the liver of fish exposed to high ammonia (Kurniasih *et al*., 2020).

Fish meal in this study contained 2.62, 1.20, and 1.90% Lysine, Methionine, and Threonine, respectively. These three amino acids play an important role in growth (Aminoacidsguide, 2018). Lysine makes up all proteins in the body, helps absorb calcium, and forms muscle protein. Meanwhile, Methionine is a proteinogenic amino acid that contains sulfur, plays a role in single-carbon metabolism, and facilitates the liver's detoxification process (Aminoacidsguide, 2018). The feed supplementation with Threonine, Lysine, and Methionine could increase mucin secretion produced by goblet cells in the jejunum even though the crude protein content in the feed is relatively low.

Syahrizal and Panigoro (2021) reported that feed intake with a combination of 0.20% methionine and 0.50% Lysine of 2.03 gr.day^{-1} significantly affected growth rate and feed efficiency. According to the amino acid profile description in Figure 2, its completeness indicates that the bycatch fish meal in this study can be used as raw material for independent aquaculture feed. Fishmeal constitutes an essential element in the feeding of the marine culture fish species due to its high nutritional value and its low cost.

The fish feed has a relatively high price in line with its quality. Therefore, self-supply from local feed production should begin immediately. The use of bycatch as a fish meal is a potential added business for fishers' households and supports feed security (Adibrata *et al*., 2022). In addition to being used as a source of protein and energy, fish meal is known as a unique balancer between amino acids, vitamins, essential fatty acids, and trace elements (Bimbo and Crowther, 1992). In spite of abundance of marine fishery resources in the area of Bangka Belitung, the province's enormous market potential is open widely. This productive potential should be executed into something more useful to form independence in order to improve the standard of living of coastal communities. In terms of nutritional value, fish and shrimp meal can act as essential source to meet protein and mineral needs (Jahan *et al*., 2017). Fish meal is an important issue in creating sustainable fish farming, such as using fishery by-products (Ido and Kaneta, 2020). The high demand of feed for marineculture purposes is shown by Adibrata *et al*. (2013) in cage culture of grouper Pongok Island for 16,032,000 of grouper that need to be self-supplied from local feed production. Therefore, optimal use of fishery resources (Cashion *et al*., 2017) is very much needed in sustainable development. There is a research urgency to develop strategies to improve the economic sustainability and environmental resilience of capture fisheries and aquaculture (Noor *et al*., 2021).

Conclusions

The nutritional content of local fish meals obtained from bycatch in Batu Beriga Village shows high quality. It is included in SNI Quality I, II, and III that can be competed since the quality is not lower to the manufacturer's fish meal. The results of laboratory tests showed SNI Quality I for the water content was 5.06%, ash content 18.51%, crude protein 68.13%, Crude Fat 5.71%, Crude fiber 1.54%, Calcium 4.09%, Phosphorus 6.82%, NaCl 1.78%, Gross energy 4,609.67 Kcal.kg^{-1}, Carbohydrate 0.00 %, and pH 6. Meanwhile, the Amino Acids from a local fish meal can be used as feed mixtures for marine culture. Bycatch can be used to fish meals as a potential side business for fishers. Therefore, the independence in the supply of aquaculture local feed can break the shackles of dependence on imports in the context of sustainable fisheries development.

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