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Proximate analysis of by-catch fish and the treatments towards the good aquaculture practices

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Abstract

Fish canning is one of the ways to maintain the quality of by-catch fish. It also offers an added value such as fish powder and fish diet. The study aims to determine the proximate analysis of by-catch fish powder and fish diet in Bangka Belitung. The method used in the study was Indonesian National Standard or known as SNI 01-2715-1996/Rev: 92 about the raw material of animal feed as fish powder and fish diet with six different treatments. The study found that the proximate analysis on by-catch fish powder and fish diet with probiotics was considered as SNI quality III and was equal with feed manufacturing. Probio_FM could degrade the proximate such as ash content, crude protein, crude fat, crude fiber, Calcium, Phosphorus, and NaCl. It was also found that the fish diet could be prolong endurance and applied as the feed of a fish farm.

Keywords: Bangka Belitung, aquaculture, by-catch, fish diet, probiotics, proximate

Introduction

Fisheries have been an essential source of food and a source of livelihood and economic benefits for those involved in fish harvesting, culture, processing, and trading (Ababouch, 2009). Fish and seafood have a highly perishable. Several chemical and biological changes can occur in the flesh of the fish immediately after capture, leading to its rejection for human consumption due to spoilage. Unfortunately, post-harvest losses in fish continue to be significant, particularly in developing-country coastal areas. With an estimated 10 to 12 million tonnes, they account for more than 8% of global fish production but can reach 30% in some developing countries (Ward, 2007). Fish canning is one of the ways to retain the quality of the fish, which then offers added value. It optimizes the oversupply of fish during the fishing seasons. In general, the fish resource in Indonesia was dominated by small pelagic fish with 36% and big pelagic with 25% (Suman *et al.*, 2016), while the rest, 39% belong to the other types of fish. The potential small pelagic fish in Fishery Management Area (FMA) 711[1] is estimated at 330,284 tons/year (Kepmen KP No. 50 tahun 2017). If 10% of them are in Bangka Belitung Islands Province, there are 33,028.4 tons/year that can be utilized.

Small pelagic fish are oversupplied during the fishing seasons. The fishermen accumulate the fish at the boat applied with ice. The fish is no longer fresh when the fishermen arrive at the landing site. It becomes the concerned issue faced by the fishermen. The fish is not qualified as the canned fish. Its price then reduces. Furthermore, by-catch becomes another challenge faced by the fishermen. It combines discarded catch and incidental catch (FAO, 1996). The by-catch tends to be thrown back to the river, leading to environmental pollution. Optimizing the by-catch through the development of the fish processing industry with society-based offers the business opportunity as the family's additional income.

[1] The Fisheries Management Area (FMA) 711, which covers the area between the islands of Sumatra and Kalimantan, and extends into the South China Sea. FMA 711 includes 6 provinces and 27 districts or cities.

The fish powder can be applied as an ingredient in the animal feed, such as fish diet. The ideal feed should contain the balanced nutrition needed by the fish to reach optimal growth (Iskandar and Fitriadi, 2017). Theoretically, fish powder processing is the process of mounting cells and separating between water and oil from the moist powder to the dry one. The probiotics of Probio_FM in fish powder processing have more advantages than the conventional ones as they can maintain the quality of fish nutrition and produce fish powder that contains prebiotics, probiotics, and postbiotics (Hendalia *et al.*, 2021). The applied Probio_FM in the feed offered some benefits such as better feed digestibility, good condition of cage environment, and lower feed costs (Astuti *et al.*, 2019). Between 1950 and 2010, 27% of marine fishing landed (~20 million tons per year) was reconstructed globally to use other than direct human consumption (DHC) (Cashion *et al.*, 2017). Not only the fish powder and the fish substitute be able to increase the growth and the survival rate of biota, but also it can ensure the health the welfare of aquatic biota. In addition, it can produce nutritious, safe, and accepted by the consumers (New and Wijkström, 2002).

Finding an alternative feed source is a vital issue to achieve sustainable aquaculture. The by-catch should be economically and ecologically utilized (Ido and Kaneta, 2020). The use of fish powder and fish oil for the aquafeed has increased along with the development of carnivorous species. The supply of aquafeed industry has improved (New and Wijkström, 2002). The nutrient supply and the input of animal feed should immediately grow together. Tacon and Metian (2015) argued that the fish powder was used in feed formulation with a usage rate of about 15% on fish or shrimp feed and 5% on poultry feed.

When feed productions remains constant and other sectors compete for similar feed source, the price will be high. When the demand for animal feed in the Bangka Belitung Islands Province can be fulfilled from the local fish powder producer, the price can be lower than of fish powder from Java Island even though transportation cost are reduced. The primary powder source of protein in concentrate feed for aquaculture species with limited availability is fish powder from pelagic fish (Olsen and Hasan, 2012). The availability of a local resource necessitates research into alternative proteins in aquaculture management. The study intends to investigate the proximate of local fish powder from the by-catch and probiotics of Probio_FM in the fish diet.

Materials and Methods

Time and Place

The study was conducted from October to December 2021. Three stages were applied which were: i) research preparation; ii) production of fish powder and fish diet; and iii) proximate analysis of fish powder and probiotics of Probio_FM in the fish diet. The production of fish powder and fish diet was made in Bangka Regency while the proximate analysis was conducted in *Laboratorium Balai Pengujian Mutu dan Sertifikasi Pakan* (BPMSP), Bekasi. The location of the research was shown at figure 1.

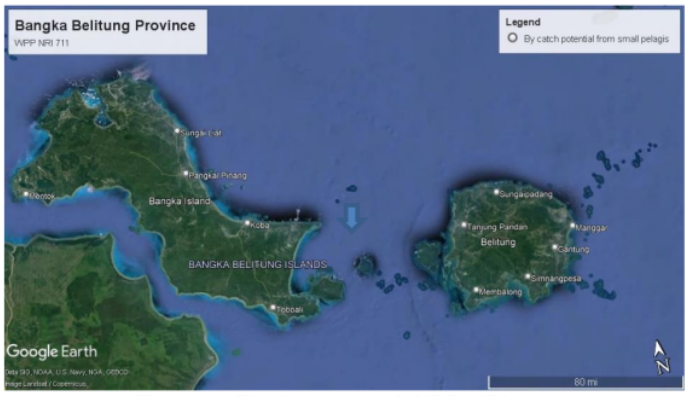

Figure 1. The Location of WPP NRI 711

Materials and Equipment

Small pelagic fish as by-catch such as sandy crayfish, trout, lais fish, and tembang fish or known as *Sardinella fimbriata* were used as the materials in producing the fish powder and fish diet. Furthermore, Probio_FM, palm kernel cake, coconut pulp, and bran were applied as the materials. A fish grinding machine, tarpaulin, solar dryer dome, digital scale, hand sealer, and other supporting equipment.

Methods

The process design of proximate analysis on fish powder and fish diet for home industry scale as illustrated in figure 2 below:

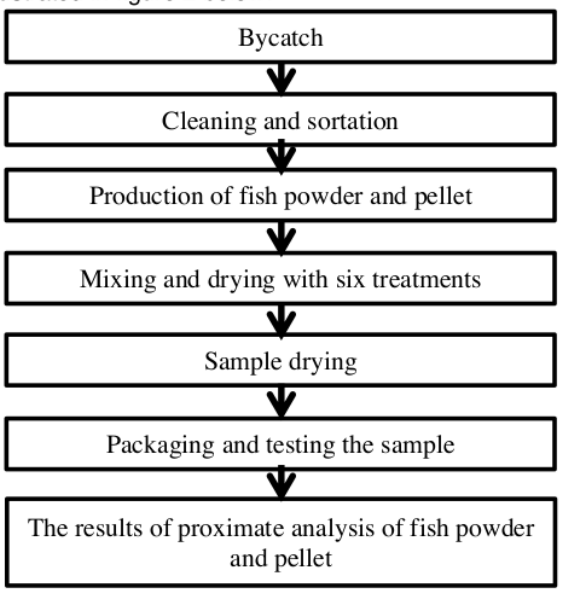

Figure 2. Process of proximate analysis

The observed quality parameters in the study were based on Indonesian National Standard or known as (SNI) 01-2715-1996/Rev.92 on fish powder as fish meal raw materials.

Table 1 Treatment of Fish Powder

No	Materials	Treatments
1.	Ground rough fish (4 kg)	I
2.	Ground rough fish (4 kg), Probio_FM (80 ml)	II
3.	Ground rough fish (4 kg), palm kernel cake (800 gr)	III
4.	Ground rough fish (4 kg), palm kernel cake (800 gr), Probio_FM (80 ml)	IV
5.	Ground rough fish (4 kg), palm kernel cake (800 gr), Probio_FM (80 ml), coconut pulp (500 gr)	V
6.	Ground rough fish (5 kg), palm kernel cake (2 kg), Probio_FM (100 ml), coconut pulp (1 kg), bran (2 kg)	VI (Fish diet)

Results and Discussion

Results

The fish powder, fish diet, and proximate data resulted in the study. The results were shown in Figures 3-6 and table 3.

Tabel 2 Proximate Analysis Method

No	Parameters	Methods
1.	Moisture content (%) max	MP 01 BPMSP (Gravimetri)
2.	Ash content (%) max	MP 05 BPMSP (Gravimetri)
3.	Crude protein (%) min	AOAC 2001.11 2019
4.	Crude fat (%) max	AOAC 2003.06 2019
5.	Crude fibre (%) max	MP 06 BPMSP (Gravimetri)
6.	Calcium (%) (Ca)	AOAC 968.08 2019
7.	Phospor (%) (P)	AOAC 965.17 2019
8.	NaCl (%) max	MP 09 BPMSP
9.	Gross energy (Kkal/Kg)	MP 21 BPMSP (Bomb Caloimeter)
10.	Carbohydrate (%)	MP 20 BPMSP (Volumetri)

Figure 3. (a) Drying Process of Fish Powder and (b) Producing Fish Diet

Table 3 The Score of Proximate Analysis

No	Parameters	Treatments						Quality ofSNI 01-2715-1996/Rev.92			Fish Diet 781
		I	II	III	IV	V	VI	I	II	III	
1	Moisture content (%) max	11.64	11.18	8.92	9.54	10.40	11.29	10	12	12	9-10
2	Ash content (%) max	12.37	16.26	11.11	10.98	12.11	9.59	65	55	45	
3	Crude protein (%) min	66.96	64.20	42.17	44.64	46.81	25.75	1.5	2.5	3	31-33
4	Crude fat (%) max	5.23	5.17	9.16	9.22	11.33	10.68	20	25	30	4-6
5	Crude fibre (%) max	0	0.70	12.01	6.73	6.48	14.91	8	10	12	3-5
6	Calcium (%)	2.46	3.56	2.39	2.28	2.37	1.65	2.5-5.0	2.5-6.0	2.5-7.0	
7	Phospor (%)	2.21	3.03	2.05	2.00	2.06	1.15	1.6-3.2	1.6-4.0	1.6-4.7	
8	NaCl (%) maks	2.01	1.64	1.03	1.03	1.03	0.47	2	3	4	
9	Gross energy (Kkal/Kg)	4578.83	4256.34	4514.05	4487.76	4513.95	4370.16				
10	Carbohydrate (%)	0	0	12.67	10.98	6.76	21.32				

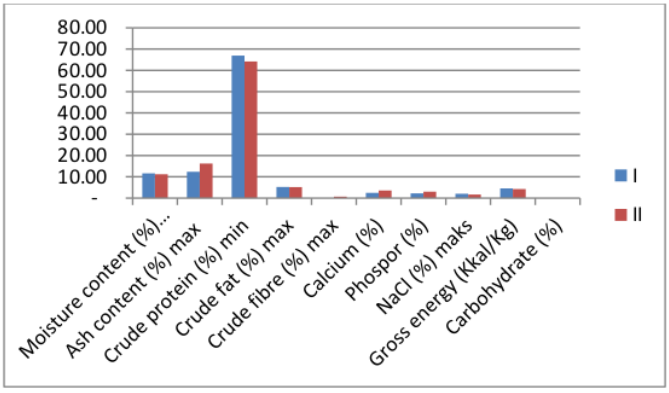

Figure 4. Proximate Composition of Fish Powder at 1st and 2nd Treatment

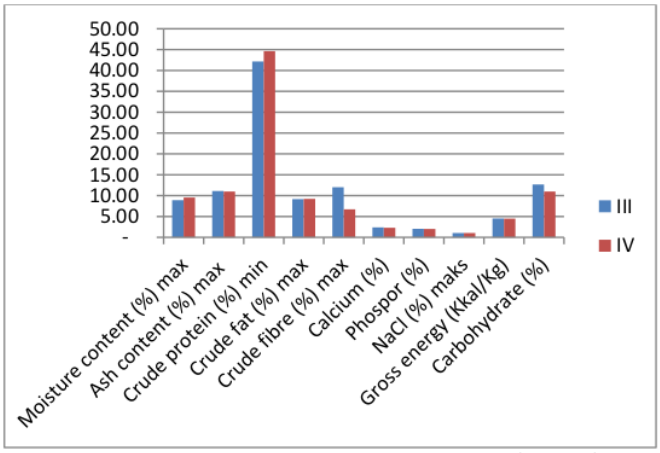

Figure 5. Proximate Composition of Fish Powder at 3rd and 4th Treatment

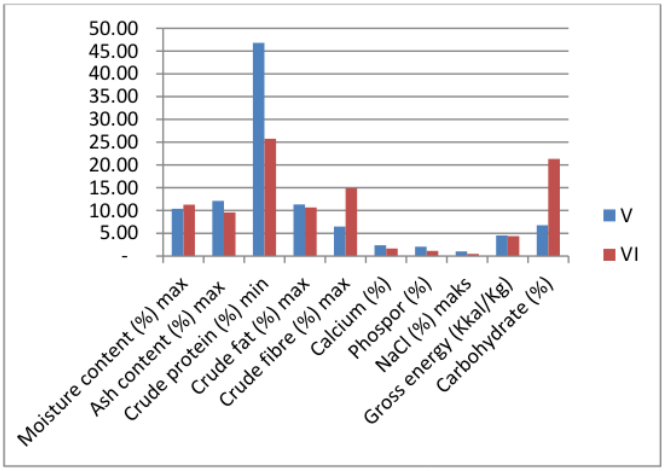

Figure 6. Proximate Composition of Fish Powder at 5th Treatment and with Fish Diet at 6th Treatment

Discussion

General Description of the Study Area

The Bangka Belitung Islands Province consisted of six regencies and one city. Its sea was included in the fisheries management area (WPP NRI) 711. People's livelihood in the province were primarily dominated by three sectors which were plantation, mining, and fisheries (BPS, 2021). The number of small pelagic fish in the area was potentially estimated at 330,284 tons/year (Kepmen KP No. 50 Tahun 2017). This should be optimized and take into account the quality aspect. Fish located at low-level pollution such as in Kariba Lake with the proximate analysis had some dry ingredients, protein, and the highest ash content. It correlated with the low level of pollution and high oxygen content in the water (Jim *et al*., 2017).

The economic development in the mining sector in the province should anticipate the other sectors not be disturbed especially fisheries and the environment so that the management could be sustainable. Sustainable development should be progressed as it described that the socio-economic development should relate with the current situation of the environment. Besides offering fresh fish, the fishermen made the fish processing such as salted fish, snacks, and ready-to-eat fish. The potential use of by-catch should be optimized by ensuring the best practices so that the benefit would be gained. To determine the best practices, it should be based on the research on potential and the use level of by-catch (Suman *et al*., 2016).

By-catch and Leftover Fish

Based on FAO (1996), by-catch was defined at fisheries technical paper 339 as follows:

a. target catch which meant the catch that consisted of one or more species that was a main targeted catch;
b. incidental catch which was not the main target but was caught and remained anyway;
c. discarded catch which was part of the total organic material of animal origin in the catch that turned to be thrown away due to economic, rules, or personal consideration;
d. by-catch which meant a combination between discarded catch and incidental catch.

By-catch had become an issue faced by the fishermen who lived far from the market. The small fish and the other marine organisms that were non-target species were included as the by-catch. The edible portion of the moonfish was 42.81% while the rest was 57.19% as the waste processing (Cahyani *et al*., 2020). Part of fish as the leftover fish had a bigger portion than the part that was edible.

FAO (1996) fisheries technical paper 339 stated that the negative effect of the by-catch not only on the community, benthic habitats, biological and ecological impact, but also the economic impact that turned to the social issue. The majority of the by-catch had low economic value and required extra time and energy to sort. By-catch and leftover fish received attention as they had a relatively tremendous number if they were collected and produced as fish powder. The fish powder could become an alternative source of protein for food fortification (Cahyani *et al*., 2020). The use of sea materials in aquaculture required an understanding of the efficiency score to achieve the sustainable development goals of the United Nations (Kok *et al*., 2020).

Fish Powder and Its Substitution

In the last decade, the global fish and shell farm had rapidly grown in the food processing industry. The industry was vital as many countries needed the input of the fish powder (Olsen and Hasan, 2012). Usually, the raw materials of fish powder were the uneconomic fish, selective by-catch, fish glut, and the leftover fish from the fish processing industry (New and Wijkström, 2002). The fish powder could be used as one of the concentrate ingredients on ruminants to improve the feed efficiency and body weight gain with the optimal level of use at 10% (Marjuki, 2008). The modified technique of fish powder production was able to produce a fish powder with the third quality of SNI (Harris *et al*.,

2012). The fish powder and fish oil factory could save energy, reduce the cook temperatures around 85°C and produce a stable and valuable product (Hilmarsdottir *et al*., 2020). More than 70% of the total global aquaculture production relied upon the supply of external feed (Tacon and Metian, 2015).

The process of fish powder production was simple. It emphasized energy efficiency rather than the quality of materials, protein, or oil. The alternative of fish powder and oil was by producing the fish silage (Einarsson *et al*., 2019). The results of proximate analysis of protein and ash content did not fulfill the nutritional requirements of fish while the crude fat and fiber fulfilled the nutritional requirements of fish (Iskandar and Fitriadi, 2017). The fish powder processing from the fish waste became a business opportunity and had economic value to increase the welfare of the society (Berutu *et al*., 2018). The economic allocation was a proxy in nutritional value and added value on the by-catch as a result of relative demand (Kok *et al*., 2020). The price of commercial feed in the market was relatively high considering its quality. However, the dependency on the commercial product should be minimized by emphasizing the production of local feed.

Proximate Analysis and Nutritional Value on Fish Powder and Fish Diet

Moisturize Content (%)

The moisturizing content was the percentage of the water content of a particular material that can be identified with a wet or dry basis. The moisturized content was one of the vital characteristics of feed because the water was able to affect the appearance, texture, and taste, especially on the fish diet. Furthermore, it also affected the freshness, durability in which the high level of moisturizing content caused bacteria, mold, and yeast to grow quickly. It then affected the change of the feed materials (Syahfril *et al*., 2004).

At the first and second treatment of fish powder, the study discovered that Probio_FM accelerated in reducing the moisturize content (Figure 4) while third, fourth, fifth, and sixth treatments (Figure 5 and 6) showed the adding other prebiotics such as palm kernel cake (fourth treatment) and bran (sixth treatment) as well as Probio_FM increased the moisturize content compared without mentioned prebiotics and Probio_FM. To avoid the accelerated evaporation of water from sunlight, it was possible by applying low-temperature heating or vacuum pressure. However, in general, all requirements of animal feed about moisturize content fulfill the requirement of the third quality of SNI.

Ash Content (%)

The ash content in the fish relied upon the fish habitat related to mineral content in the fish (Suwandi *et al*., 2014). The food materials that were from the sea were rich in mineral components that could be viewed by the ash content. In the first and second treatments, the ash content of the fish powder was found that Probio_FM increased the ash content (Figure 4) while the third, fourth, fifth, and sixth (Figure 5 and 6) discovered that adding other prebiotics and Probio_FM reduced the ash content compared without prebiotics and Probio_FM. Overall, for the requirement of animal feed, all treatments on the value of ash content had fulfilled the requirement of the third quality of SNI.

Crude Protein (%)

The primary function of protein was as essential amino acids that could be used to synthesis non-essential amino acids and protein synthesis in the body. The protein component relied upon amino acids and fish habitat. Protein had a main function for growth and body maintenance, essential components, fluid balance, body neutrality, and antibody formation. Based on figures 4-6, the protein in the fish was the highest value after water. It plays vital role in the body's structure and function, such growth and reproduction. Fish with 15-25% is included as high protein fish (Dika *et al*., 2017). All treatments figured that the protein content was considered as the third quality of SNI, while in the sixth treatment, the value of protein content was below the commercial fish diet. The dose of the other prebiotic elements should be reduced. The acid element and fermented activity degraded the protein.

The protein was suggested to break down and change into amino acids to be simpler and easier being absorbed by livestock farms. Based on first, second, fifth, and sixth illustrated that Probio_FM was assumed to degrade the protein value due to the utilization of nitrogen and ammonia derived from the process fish protein hydrolysate of probiotic bacteria.

Crude Fat (%)

The crude fat on the fifth treatment with a score of 11.33% showed the high-fat content and accelerated the rancidity of fish powder. The lower value of fat content, the longer the storage time of fish powder. The fatty acid in the fish consisted of saturated fatty acids (15-25%), monounsaturated fatty acids (35-60%), and polyunsaturated fatty acids (25-40%) (Berge and Barnathan, 2005). The boiling fish was able to separate the fat quickly from the fish but the protein reduced quickly. The function of the fat was as the main source of energy production after carbohydrate and protein for the muscle growth. Its function was also as the efficient energy source and as solvent of vitamin that was not absorbed in the water and as essential fatty acids (Dika *et al*., 2017).

Crude Fibre (%)

The function of crude fiber was to stimulate the movement of the peristalsis tract as a microbe media in the appendix that produced vitamin K and B12, as well as to provide feeling full. All treatment resulted in various crude fibers. Table 3 showed that in the third and fourth treatment, the adding Probio_FM reduced the crude fiber while in the fifth and sixth treatment, the adding coconut pulp and bran were otherwise. Probio_FM was assumed in degrading the value of crude fiber.

Calcium (%), Phosphor (%), and NaCl (%)

The calcium content (Ca), Phosphor (P), and NaCl were part of essential minerals that were needed to functionalize the physiology normally. Table 3 displayed that Probio_FM was assumed to degrade the level of Ca, P, and NaCl. All treatment excluded treatments sixth showed that the content of Ca, P, dan NaCl fulfilled the third quality fo SNI while the sixth treatment on Ca and P had a value below the standard.

Gross energy (Kcal/Kg) and Carbohydrate (%)

The high cost of gross energy hindered the flexibility of fish farming. The carbohydrate content was considered important in the fifth and sixth treatments after the addition of coconut pulp and bran. The fish required carbohydrate for energy to keep moving. It was assumed that the Probio FM would degrade the value of gross energy and carbohydrate. The addition of coconut pulp and bran increased the carbohydrate content in the sixth treatment.

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Feed Security

The fish powder was known as the source of protein and energy. It is balanced amongst amino acid, vitamin, essential fatty acid, and trace elements (Bimbo and Crowther, 1992). The potential market in the province was large as tremendous fisheries resources. It should be utilized to improve the quality of life. In terms of nutrition, the fish and shrimp powder had a crucial role in fulfilling the need for protein and minerals (Jahan *et al*., 2017). The potential fish farming (grouper), brackish water fish (milkfish, shrimp), and freshwater fish (catfish, tilapia) are related to the feed necessary.

The carrying capacity for grouper using the KJA system in the water area of Pongok Island could be around 16,032,000 grouper fish farming. (Adibrata *et al*., 2013). Considering the opportunity of fish farming, it required a significant value of nutrition from the tremendous feed source. The production of local feed should be implemented to reach feed security. The fishermen exchange rate figured that they played a vital role in the province's economic growth.

4. Conclusion

The proximate analysis on by-catch fish powder and fish diet with probiotics Probio_FM was considered as the third quality of SNI. It was equal to commercial feed. However, the Probio_FM degraded some components such as ash content, crude protein, crude fat, crude fiber, calcium, Phosphor, and NaCl. Probio_FM could extent the durability of fish powder and fish diet. The laboratory test showed that the fish diet with probiotics was qualified as feed for fish farming.

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PAGE 2

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PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10