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Short Communication

Evaluation of the Nutritional Composition of Fish Meal Production

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Abstract *- Data on the nutritional components of raw materials is useful for determining the proportions of each raw material in animal feed formulations. The study aims to evaluate the nutritional composition of fish meals produced in Indonesia. The five companies in East Java, Indonesia, that produce fishmeal have been the subject of field investigations. The study results show that fishmeal's quality based on nutritional composition has various quality grades and is low, especially in the total volatile base nitrogen component. Variations in nutritional composition were also quite high within one company. The application of standard procedures and strict quality control at every stage of the production process is necessary to obtain uniform and high-quality fishmeal products at every period.*

Keywords *- Ash, Crude protein digestible, Fat, Fishmeal, Moisture, Protein, Total volatile base nitrogen.*

1. Introduction

The primary source of protein in animal feed formulations, aquaculture, and broiler chicks is fishmeal [1,2,3]. It is a good source of high-quality protein that has a good palatability, an abundant vitamin and mineral profile, and a generally balanced fatty acid and amino acid profile [4]. Fishmeal production is expected to increase to 5.8 million tonnes by 2030 [5], with the global fishmeal and fish oil market size estimated to reach USD 8.28 billion in 2024. It is expected to reach USD 14.55 billion by 2029 [6]. The need for fishmeal in Indonesia in 2023 as raw material for feed will still be imported at 121,447 tons [7]. The use of fish meal in feed formulations varies for fish (30–60%) [8] and poultry (5–10%) [9]. The presence of anti-nutritional components, incomplete amino acids, low digestibility, palatability, and competition with human needs means that other ingredients, such as soybeans, cannot completely replace fishmeal in animal feed formulations [10]. Fish meal normally has the following composition: 50%–60% protein, 5%–10% fat, 12%–35% ash, and 6%–10% moisture [11]. Non-uniformity of product quality between production periods is a problem faced by the fishmeal industry due to variations in fish raw materials and a lack of strict quality control. The nutritional content, especially protein and amino acids of fishmeal, varies greatly depending on species differences, seasonality in fishmeal production [12], production plan, lack of standard fabrication processes, and quality control norms [3]. Quality control and optimization of the use of fish meal as feed need to be carried out to ensure good livestock production performance and diet [13]. Most commercial fishmeal raw materials are made from small, bony, and oily fish, which consist of pelagic fish as raw material and are the main protein source for aquaculture [14]. Knowledge and testing of nutritional composition have an important role in determining the proportion of fish meal in animal feed formulations. This investigation attempts to evaluate the nutritional makeup of fish meals, encompassing the following elements: ash, crude protein digestibility, TVBN, fat, protein content, and water content.

2. Materials and Methods

The study on the nutritional composition analysis of fish meals was conducted at CV. Bumi Indonesia laboratory, Mojekerto, Indonesia, uses five fishmeal-producing companies.

2.1. Fish Meal Preparation

The raw materials for fishmeal are taken from five companies: Asia, Mtn, ATI, JS, and BI Pati. Sampling was carried out four times from each company, with a total of 7.14 liters for each sampling. Avalan fish (a mixture of all body parts except fish flesh) was cleaned, washed, and steamed at 80–90°C for 3 hours to deactivate enzymes and microorganisms and dried in a rotary dryer until the water content was 8–10%. The fish raw materials were coarsely ground using a gyratory crusher machine until the particle size was 1-2 cm. The tool used is a gyratory crusher machine. The coarse fishmeal was dried and finely ground using a hammer

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mill machine until the particle size was 0.5–1 mm. Fishmeal was packaged in two layers: an airtight plastic container and a food-grade plastic sack. The plastic sack packaging was sealed and double-checked to find out whether there were any leaks in the sack.

2.2. Analysis of Nutritional Composition

The nutritional composition analysis of fish meal was carried out using FOSS NIRS DS2500 by procedure manual 8.922.8001EN/2014-07-10 at a wavelength of 700–2500 nm [15], including protein content, water content, total volatile base nitrogen (TVBN), fat, digestible crude protein (DCP), and ash. A total of 3 g of fishmeal sample was put into a sterile cuvette and closed tightly. The cuvette is inserted into the sample port of the FOSS NIRS DS2500 tool, and the start button is pressed to begin the scanning process. The tool will display the measurement results of an NIR spectrum. Software that complies with NIRS DS2500 specifications was used for data analysis.

2.3. Statistical Analysis

Statistical analysis used the Statistical Package for the Social Sciences (SPSS) software version 26. Normality and variation of data were each tested with Kolmogorov-Smirnov at significance $P<0.2$ and Levene at $P<0.05$. Analysis of variance (ANOVA) and comparison of means were carried out using Tukey's test at a significance level of $P<0.05$ for all fishmeal nutritional composition variables.

3. Results and Discussion

3.1. Moisture Content

With a range of 6.47–8.72%, the current study's Table 1 demonstrates that there isn't altogether diversity ($P>0.05$) in the moisture content of fishmeal among producers. The range of moisture of fish meals from the five producers is included in the Grade I [16, 17] and Super [18] categories. De Koning states that the moisture content of fish meal should be 5-10% to avoid the development of microorganisms [19]. However, the variation indicated by the standard deviation of the water content of fishmeal from Asian producers is quite high, which is thought to be because standard procedures have not been strictly implemented, for example, temperature and length of the drying process.

3.2. Protein Content

The current study (Table 1) shows that the protein content of fish meal from the BI Pati is notably ($P<0.05$) less than those of the other four companies. The protein content of fish meal from JS, Asia, and Mtn is included in the Grade I [16] and super category [18], while ATI and BI Pati are included in the Grade II [16] and Grade I category [17,18]. Depending on the fish species and production process conditions, the protein content of fishmeal from all firms is within the range of 50–72%, as suggested by FAO [20, 21]. The protein content of fishmeal derived from tuna [22, 23] and Monterey sardine [20] is generally included in category A (quality superior). Fishmeal containing protein lower than 60% is included in category B, thought to be caused by protein denaturation during manufacture and high bone content [19].

3.3. Fat Content

The current study (Table 1) shows that the fat content of fishmeal from the five companies isn't altogether diverse ($P>0.05$). Nevertheless, the fat content of fish meal from Asia, Mtn, and ATI all fall into the Grade II (maximum 10%) category [16,17]. Meanwhile, the fat content of fish meal from BI Pati and JS falls into Grade III [16,17]. The fat content of fish meals from BI Pati and JS is also higher than the range of fat content reported by some researchers.

Mih and Lacherai [24] reported that the fat content of fish meal usually ranges from 6–10%. There are many factors in the fat content of fish, including species, size and age, season, water temperature, and geographical location [25,26]. The main factors influencing the fatty acid profile of freshwater fish meat are diet [27] and rearing conditions [28,29]. Goncalves et al. [26] report that the fat content of the fish meal is influenced by many factors, including fish species, fish size and age, season, water temperature, and geographical location [25].

3.4. Digestible Crude Protein Content

Data regarding the Digestibility of Crude Protein (DCP) in feed ingredients is useful in providing estimates of the nutritional quality of protein. The current study (Table 1) shows that the DCP content of fishmeal produced by the five companies isn't altogether diverse ($P>0.05$).

The value of DCP of fishmeal from Asia, BI Pati, Mtn, JS, and ATI was higher than the value of DCP of several researchers. Hussain et al. [30] reported that the DCP value of the fish meal was higher than that of blood and meat meal. Khanom et al. [31] reported that the DCP value of the fish meal was 89.61±0.42%. Fishmeal is the best source of high-quality protein with a balanced amino acid content, is very easy to digest, and has good palatability [30]. Watanabe et al. [32] reported that fish species influenced the DCP content of the fish meal.

3.5. Total Volatile Nitrogen Base Content

Total Volatile Nitrogen Bases (TVBN) consist of trimethylamine, ammonia, and dimethylamine, which result from the activity of spoilage microorganisms. They are used as a quality criterion for fish meals [33].

The current study (Table 1) shows that the total volatile base nitrogen content of fish meal from BI Pati and Asia were both significantly ($P<0.05$) higher than Mtn and ATI but not significantly different ($P>0.05$) compared to JS. However, the chemical quality of fish meal from 5 producers in this study based on the total volatile nitrogen content was included in grade 2 [17].

Table 1. Nutritional composition of fish meal from five producers, mean values with standard deviations in the same row marked with different superscript letters indicate significant differences (P<0.05)

Components	Fishmeal producers				
	Asia	Mtn	ATI	JS	BI Pati
Moisture (%)	7.25±3.30	6.47±1.85	7.77±0.30	8.46±0.61	8.72±1.09
Protein (%)	65.72±0.76^{b}	64.54±0.86^{b}	63.70±0.41^{b}	65.76±3.01^{b}	60.08±2.91^{a}
Fat (%)	8.37±1.97	9.88±0.84	9.78±2.06	12.01±1.85	10.44±1.62
Digistible crude protein (%)	92.34±1.55	90.50±0.61	87.49±7.09	89.70±1.29	92.23±1.01
Total volatile base nitrogen (%)	223.20±32.26^{b}	161.65±21.12^{a}	171.31±4.07^{a}	188.17±73.84^{ab}	220.94±20.48^{b}
Ash (%)	19.07±0.36^{a}	19.30±0.91^{a}	19.26±0.32^{a}	22.46±2.76^{b}	20.46±1.18^{b}

The difference in TVBN of fishmeal between producers is thought to be due to differences in drying conditions such as temperature, drying time, and storage time. De Koning [19] reported that the TVBN content depends on the temperature and drying time because some bases can evaporate during drying. Idakwo et al. [34] reported that TVBN formation increases gradually as the storage period increases.

High variations in TVN levels were also found in Asian and JS producers, which was thought to be due to the company's standard procedures for drying and storage processes not being strictly implemented.

3.6. Ash Content

The current study (Table 1) shows that the ash content of fish meal from JS and BI Pati were both significantly (P<0.05) higher compared to Asia, Mtn, and ATI. The ash content of fish meal from JS and BI Pati was included in the Grade II [16] and III [18] categories.

The ash content of fishmeal from Asia, Mts, and ATI was included in Grade I [16] and Grade II [18]. Species, size, production process, and bone content influence the ash content of fish meal.

4. Conclusion

The present study concluded that the nutritional composition of fish meal from producers in East Java, Indonesia, varies and is considered low, especially in the total volatile base nitrogen component. One company also experiences a high variation in nutritional components. Strict operational procedures and quality control, which start from raw material selection, manufacturing, and storage processes, determine high and stable fishmeal quality in each production period.

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