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NUTRITIONAL ANALYSIS OF FISH FEED MADE FROM TUNA FISH SKIN WASTE *(Thunnus albacares)*

Analisis Nutrisi Pakan Ikan Berbahan Baku Limbah Kulit Ikan Tuna *(Thunnus albacares)*

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ABSTRACT

South Sulawesi is one of the main producing areas of yellowfin tuna (*Thunnus albacares*) in Indonesia. The tuna processing process produces solid waste, especially skin, which is generally not optimally utilized. Tuna skin contains protein, collagen, calcium, and phosphorus, so it has the potential to be used as a feed additive. This study aims to analyze the nutritional content of fish feed made from tuna skin waste (*Thunnus albacares*) as an alternative to utilizing fishery waste into value-added products. The study was conducted by making feed with varying percentages of tuna skin addition, then analyzed the nutritional content including water content, ash content, crude fiber, protein, and fat based on standard methods. The results showed that the addition of tuna skin increased protein and fat levels, with the highest value in the treatment of 40% tuna skin containing 36.98% protein, 11.72% fat, 6.60% fiber, 11.35% water content and 7.85% ash content. All parameters still meet the quality standards of fish feed (SNI 9043-4:2022). This shows that tuna skin waste has the potential to be used as an economical, environmentally friendly fish feed additive, and supports the sustainability of fish farming.

Keywords: Tuna Skin, Fishery Waste, Nutrition, Fish Feed

ABSTRAK

Sulawesi Selatan merupakan salah satu daerah utama penghasil tuna sirip kuning *(Thunnus albacares)* di Indonesia. Proses pengolahan ikan tuna menghasilkan limbah padat, terutama kulit, yang umumnya belum dimanfaatkan secara optimal. Kulit tuna mengandung protein, kolagen, kalsium, dan fosfor, sehingga berpotensi dijadikan bahan tambahan pakan.Penelitian ini bertujuan untuk menganalisis kandungan nutrisi pakan ikan berbahan baku limbah kulit ikan tuna *(Thunnus albacares)* sebagai alternatif pemanfaatan limbah perikanan menjadi produk bernilai tambah. Penelitian dilakukan melalui pembuatan pakan dengan variasi persentase penambahan kulit ikan tuna, kemudian dianalisis kandungan nutrisinya meliputi kadar air, kadar abu, serat kasar, protein, dan lemak berdasarkan metode standar. Hasil penelitian menunjukkan bahwa penambahan kulit ikan tuna meningkatkan kadar protein dan

lemak, dengan nilai tertinggi pada perlakuan 40% kulit ikan tuna mengadnung protein 36,98% lemak 11,72%, Serat 6,60, Kadar air 11,35 dan kadar abu 7,85 seluruh parameter masih memenuhi standar mutu pakan ikan (SNI 9043-4:2022). Hal ini menunjukkan bahwa limbah kulit ikan tuna berpotensi dimanfaatkan sebagai bahan tambahan pakan ikan yang ekonomis, ramah lingkungan, serta mendukung keberlanjutan budidaya perikanan.
Kata Kunci: Kulit Ikan Tuna, Limbah Perikanan, Nutrisi, Pakan Ikan

INTRODUCTION

Yellowfin tuna skin is a byproduct of the fishing industry, the utilization of which is still limited. Tuna is known as a type of fish with a high protein content. Generally, tuna is marketed in various forms, such as fresh chilled fish, frozen loin, frozen fillet, frozen steak, and canned tuna. This processing process produces waste in the form of bones and skin, which in some industries are still not optimally utilized. Most tuna skin waste is simply discarded and becomes solid waste (Moranda *et al*., 2018). The protein content of yellowfin tuna (*Thunnus albacares*) skin is higher than that of albacore tuna skin, which is around 20.54±0.26%, although still lower than that of mackerel, which reaches 24.63±0.12%. The waste from the processing of fishery products is estimated to reach 20–60% of the total raw material (Nurilmala 2017). In the tuna processing industry, the waste composition includes approximately 17% heads, 8% skin, 5% internal organs, 4% bones, and 2% fins (Sayana & Siraajudheen, 2017). Feed is a key factor in the success of a fish farming business. The availability of feed with adequate quality and quantity will impact the effectiveness of the cultivation (Akerina *et al*., 2022). In the process of making fish feed, the selected raw materials should contain adequate nutrients, especially as a protein provider. One potential alternative protein source is tuna waste, which can be used as a base ingredient in fish feed formulations (Akerina *et al*., 2022). Proximate analysis is a method used to determine the nutritional content of food and feed ingredients. This technique divides the components based on their chemical content and functional role (Miftahul *et al*., 2022). Through nutritional testing on tuna skin waste, it is hoped that this material can be determined to what extent it can replace or complement conventional feed ingredients, such as fish meal. Based on these problems and opportunities, this study was conducted to assess the nutritional content of fish feed made from tuna skin waste. This research is expected to provide a more economical, high-quality, and environmentally friendly alternative fish feed. The analysis included testing for moisture content, ash content, crude fiber, protein, and fat.

RESEARCH METHOD

Time and Location

This research was conducted from May to August 2025. Feed production took place in Tokka Hamlet, Bontomarannu Village, Moncongloe District, Maros Regency. Chemical testing, including moisture content, ash content, crude fiber, protein, and fat, was conducted at the Pangkep State Agricultural Polytechnic and the Integrated Laboratory of the Balik Diwa Institute of Maritime Technology and Business, Makassar.

Method

This study analyzed feed nutrition using five main parameters: moisture content, ash content, crude fiber, protein, and fat. Moisture content was measured using an oven drying method at 105°C according to SNI 01-2354.2-2006. Ash content was determined by burning the sample in a furnace at 550°C for 8 hours until the residue was white or gray (SNI 01-2354.1-2006). Crude fiber—which reflects the content of cellulose and lignin and affects feed digestibility by livestock—was analyzed according to SNI 01-2891-1992, by heating the sample with a 1.25% sulfuric acid solution and 3.25% sodium hydroxide, then filtering, drying, and weighing the residue. Protein content was determined using the Kjeldahl method (SNI 01-2354.4-2006), which includes sample destruction with concentrated sulfuric acid at a temperature of approximately 410°C until the solution is clear, ammonia distillation after adding NaOH, capture in boric acid, and titration with HCl; protein content is obtained from total nitrogen multiplied by a conversion factor. Fat content was measured using the organic solvent extraction method (SNI 01-2354.3-2006), namely by extracting the sample at the boiling point of the solvent for approximately 8 hours, evaporating the solvent, and then weighing the fat gravimetrically.

Tools and Materials

The tools used in this research to make feed included an oven, blender, and pelletizer. Meanwhile, the tools used to test nutrition included a desiccator, tongs, a horn spoon, an ashing furnace, a Kjelda flask, an Erlenmeyer flask, a burette, an electric heater, a condenser, a round-bottom flask, a measuring cylinder, a volumetric pipette, a measuring pipette, a fat flask, a Soxhlet/fat extraction apparatus, and a porcelain cup.

The materials used in this research to make feed included fish meal, tuna skin, fine bran, vitamins, and vitamins. The materials used to test nutrition included H2O2, H2SO4, methyl red indicator, NaOH, 4% H3BO3, 0.2 N HCl, bromcresol green indicator, 20% potassium iodide solution, 4N sulfuric acid, 1% starch indicator solution, 0.1N sodium thiosulfate solution, and diethyl ether.

Research Design

The experimental design used was a Completely Randomized Design (CRD) experiment with 3 treatments and 3 repetitions to obtain 9 experimental units and using the experimental laboratory method or trial method. Experimental research is research where treatments are used to find the effect of certain treatments on treatments under regular conditions. The sampling technique used in this study was purposive sampling technique, namely by taking samples intentionally according to the required sample requirements or criteria. The composition of the ingredients for making tuna skin waste feed refers to research (Santikawati et., al 2024) which was modified by the addition of tuna skin waste flour. Sample A (Fish feed with the addition of 0% tuna skin waste), Sample B (Fish feed with the addition of 30% tuna skin waste) and Sample C (Fish feed with the addition of 40% tuna skin waste)

Data Analysis

The results of the proximate analysis of fish feed are presented in diagram form to demonstrate differences in nutritional composition between treatments. The data were then analyzed descriptively by comparing the parameters of water, protein, fat, ash, and crude fiber content. This analysis aims to provide an overview of the nutritional quality of the resulting feed.

RESULTS

The results of the research on fish feed made from tuna (*Thunnus albacares*) skin waste can be seen in Table 1.

Table 1. Results of chemical testing of fish feed made from tuna skin waste (*Thunnus albacares*)

Parameters	Sample			SNI 9043-4:2022
	A	B	C	
Moisture Content	11.24	11.24	11.32	Max 12 %
Ash Content	7.29	7.56	7.85	Max 13 %
Crude Fiber	7.93	7.55	6.60	Max 8 %

Protein	30.42	33.71	36.98	Min 35%
Fat	8.07	9.32	11.72	Min 5 %

Chemical Test Results

Chemical test results include water content, ash content, crude fiber, protein and fat.

a. Water Content

The results of the water content test on fish feed made from tuna (*Thunnus albacares*) skin waste can be seen in Figure 1.

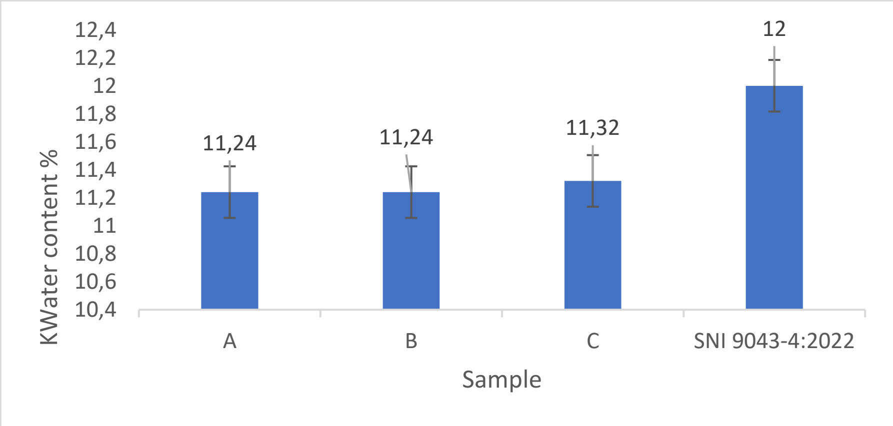

Figure 1 Water content graph.

Figure 4.2 shows that the highest increase in the crude ash content of fish feed was in treatment C (30% addition of tuna skin) at 11.37%. Followed by treatment B (20% addition of tuna skin) at 11.24% and in treatment A (0% without addition of tuna skin) at 11.24%.

b. Ash content

The results of the ash content test on fish feed made from tuna (*Thunnus albacares*) skin waste can be seen in Figure 2.

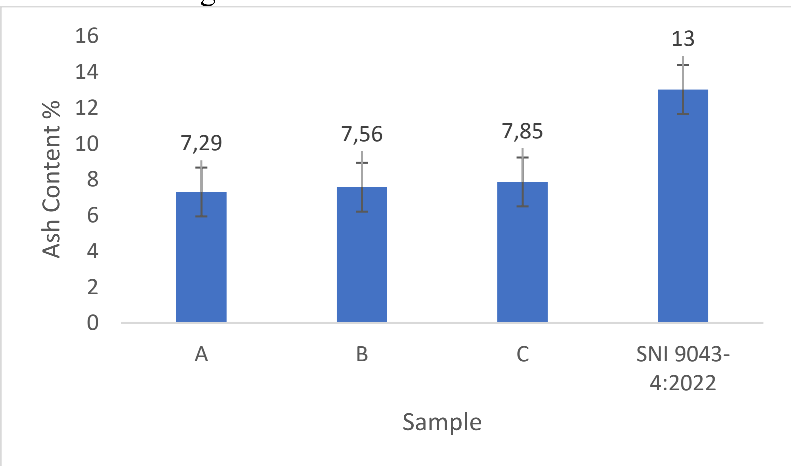

Figure 2 Ash content graph.

Figure 2 shows that the highest increase in the crude ash content of fish feed was in treatment C (30% addition of tuna skin) at 7.85%. Followed by treatment B (20% addition of tuna skin) at 7.56% and the lowest in treatment A (0% without addition of tuna skin) at 7.29%.

c. Crude Fiber

The results of crude fiber tests on fish feed made from tuna (*Thunnus albacares*) skin waste can be seen in Figure 3.

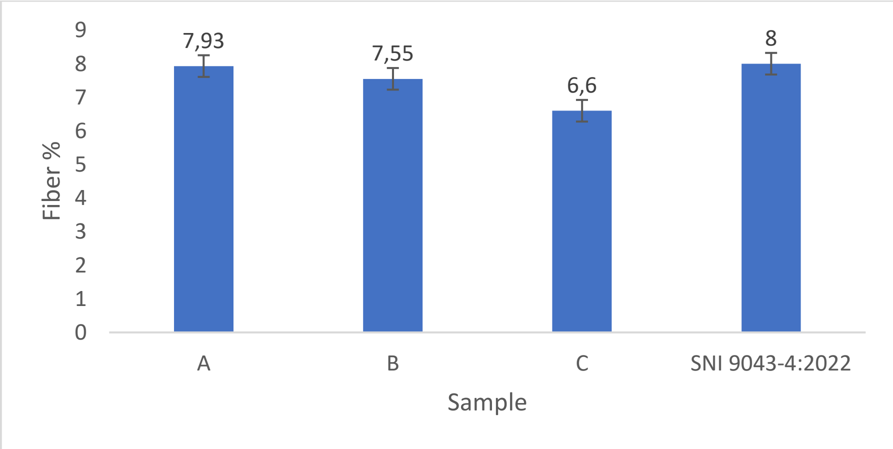

Figure 3 Crude Fiber Graph.

Figure 3 shows that the highest increase in crude fiber content of fish feed was in treatment A (0% addition of tuna skin) at 7.93%. Followed by treatment B (30% addition of tuna skin) at 7.55% and the lowest in treatment A (0% without addition of tuna skin) at 6.6%.

d. Protein

The results of protein tests on fish feed made from tuna (*Thunnus albacares*) skin waste can be seen in Figure 4.

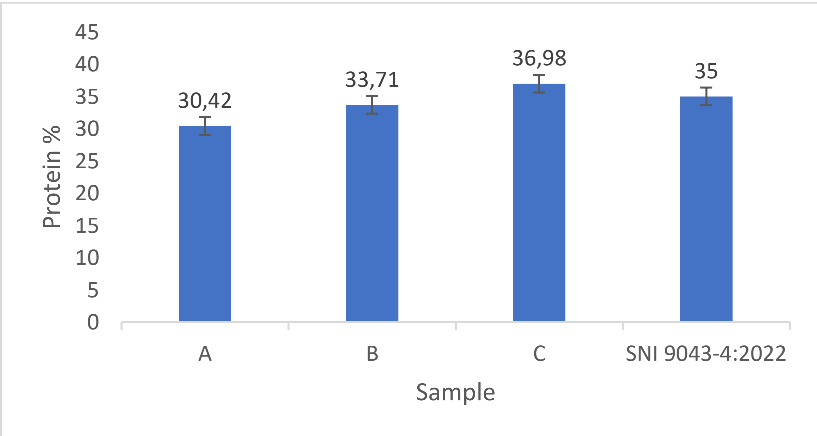

Figure 4 Protein Content Graph.

Figure 4 shows that the highest increase in fish feed protein content was in treatment C (40% addition of tuna skin) at 36.98%. Followed by treatment B (30% addition of tuna skin) at 33.61% and the lowest in treatment A (0% without addition of tuna skin) at 30.42%.

e. Fat

The results of the fat test on fish feed made from tuna (*Thunnus albacares*) skin waste can be seen in Figure 5.

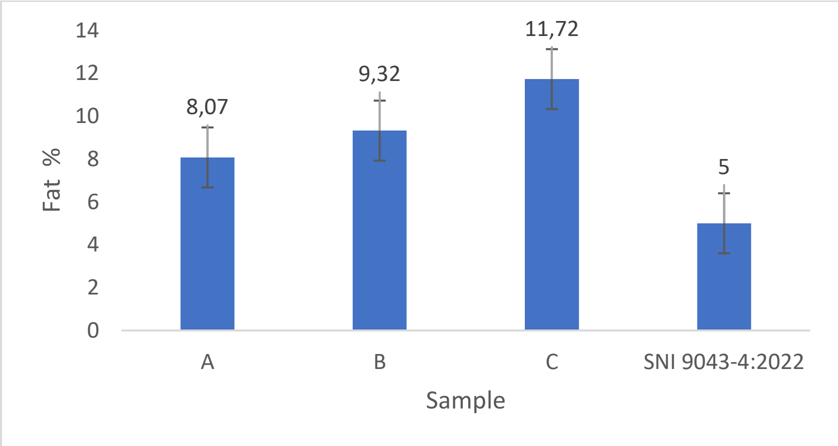

Figure 5 Fat content graph

Figure 5 shows that the highest increase in fish feed fat content was in treatment C (40% addition of tuna skin) at 11.72%. Followed by treatment B (30% addition of tuna skin) at 9.32% and the lowest in treatment A (0% without addition of tuna skin) at 8.07%.

DISCUSSION

a. Water content

The results of moisture content testing on tuna skin feed samples showed values of 11.24%, 11.24%, and 11.32%, with an average of 11.27%. All of these values are below the maximum limit of 12%, as stipulated in the Indonesian National Standard (SNI 01-2891-1992) and other dry food ingredient quality standards. These values indicate that the formulated feed product has good storage quality and is not easily damaged by microorganisms, especially fungi. According to research by Nurilmala *et al*. (2017), high moisture content in tuna skin feed or gelatin accelerates spoilage and quality degradation, especially under open or tropical storage conditions.

Research by Maulidya *et al*. (2025) also showed that flour from tuna skin waste, after drying, has an average moisture content of 10–11%, with physical quality that is still good for fish feed formulation. The moisture content of 11.27% obtained in this study indicates that the drying process was effective, and the resulting feed met quality and storage stability standards. According to Winarno (2004), a moisture content of ≤12% is highly recommended for food and feed products because this limit is a safe threshold for inhibiting enzymatic activity and microbial growth. Above this limit, food ingredients tend to undergo chemical reactions more quickly, such as fat oxidation and undesirable fermentation.

b. Ash content

Ash content is a parameter that describes the total inorganic mineral content remaining after the organic components in a sample are burned at high temperatures. The results of ash content tests on tuna skin-based feed showed values of 7.29%, 7.56%, and 7.85%, respectively, with an average of 7.57%. This value is quite high compared to the ash content of ordinary food ingredients, but is still appropriate for fish feed products, especially those made from skin waste which tends to have a high mineral content such as calcium, phosphorus, and magnesium. This is supported by research by Nurilmala *et al*. (2017) which stated that tuna skin waste contains ash content between 6.5%–8.2%, depending on the drying and initial processing methods. According to Hadinoto and Idrus (2018), tuna skin has the highest ash content compared to other body parts such as meat and offal. This is due to the presence of collagen components, dermal minerals, and microscopic scale/bone residues that are not completely dissolved during processing.

c. Crude fiber

The results of the crude fiber content analysis in tuna skin-based feed showed values of 7.93%, 7.55%, and 7.55%, with an average of 7.68%. This value reflects that the feed formulation used contains a fairly high amount of fiber, but still within the tolerable range for most fish species, especially omnivorous fish such as tilapia or catfish. The decrease in crude fiber content in fish feed is thought to be closely related to the decrease in the percentage of rice bran used in the feed formulation. Rice bran is known as a raw material rich in crude fiber, so if its amount in the feed is reduced, the total crude fiber content in the feed will also decrease significantly. According to Handajani and Widodo (2010), rice bran is the main source of crude fiber in tilapia feed, and its availability significantly affects the final fiber content in the feed. The same thing was also explained by Putra and Andriani (2017), who stated that reducing the composition of rice bran in catfish feed has a direct impact on low crude fiber because substitute ingredients such as fish meal or soybean meal have a lower fiber content.

d. Protein

The protein content test results for tuna skin-based feed showed values of 30.42%, 33.71%, and 36.98%, with an average of 33.70%. The addition of tuna skin to feed can increase protein levels because tuna skin contains a fairly high amount of protein, primarily in the form of collagen. Collagen itself is a type of structural protein composed of long chains of amino acids, including essential amino acids that are essential for living organisms to grow, repair tissue, and maintain health. Essential amino acids cannot be synthesized by the body, so their availability must be met through food or feed intake. Tuna skin is known to have a fairly high protein content and good nutritional value. Its collagen content makes tuna skin a high-value alternative protein source. This collagen has a complete amino acid composition, so when added to feed, it can enrich the nutritional composition of the feed. Thus, organisms consuming feed supplemented with tuna skin will obtain a more optimal protein intake, which is very important for supporting the growth process, muscle development, and overall health. The research also showed that collagen extracted from tuna skin using an enzymatic method can produce collagen protein of excellent quality and is easily utilized by the digestive system. This means that not only does it have a high protein content, but its bioavailability can also be maximized by the body. Furthermore, tuna itself is generally known as a very rich source of animal protein, so utilizing its body parts, such as skin, as a feed ingredient, will help improve the nutritional quality of the feed, especially in terms of protein content (Nurjanah & Nurhayati, 2021). Further research by Ariana *et al*., (2018) confirmed that flour from tuna skin waste has a protein content of 31–34%, which nutritionally supports fish growth and feed efficiency.

e. Fat

The results of fat content analysis of three samples of tuna skin-based feed showed respective values of 8.07%, 9.32% and 11.72%, with an average fat content of 9.70%. This value is in the medium to high range, but is still reasonable and safe to use in freshwater and marine fish feed formulations, depending on the target species. The increase in fat content is strongly suspected to be caused by the increase in the percentage of tuna skin added to the feed formulation. Tuna skin is a part of the fish body that contains a lot of fat and collagen, where the fat content ranges from 12–20% depending on the type and processing method (Santoso *et al*., 2011). Increasing the amount of tuna skin added to the feed formulation will directly increase the total fat content included in the sample. Research by Fitriani *et al*. (2019) in the Indonesian Journal of Fishery Product Processing reported that fresh tuna skin that has not been completely cleaned of the fat layer can contain between 11% and 13% fat, which is very comparable to the maximum value obtained in this study (11.72%).

CONCLUSION

Based on the results of research on the nutritional content of fish feed made from tuna (*Thunnus albacares*) skin through proximate tests, it can be concluded that the feed formulation based on tuna skin waste produces a fairly complete nutrient composition and meets the fish feed standards according to SNI 01-6140-1999 and SNI 9043-4:2022. Therefore, tuna skin waste has great potential as an alternative fish feed raw material that has high nutritional value, is economical, and supports sustainable fishery waste management.

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