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Research Article

Effect of Mixed Ratios of *Turbinaria murayana* Seaweed Meal and Tuna Fish Waste Meal as a Protein Source in Poultry Feed

Sepri Reski[1]*, Maria Endo Mahata[1], Yose Rizal[1], Yelsi Listiana Dewi[2]

[1]Department of Animal Nutrition and Feed Technology, Faculty of Animal Science, Universitas Andalas, Padang, 25163. Indonesia

[2]Research Centre for Animal Husbandry, National Research and Innovation Agency, Cibinong Sciences Center, Jl. Raya Jakarta–Bogor, Cibinong 16915. West Java, Indonesia

*Corresponding author: seprireski@ansci.unand.ac.id

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ABSTRACT

This study evaluated the effect of different mixing ratios of *Turbinaria murayana* seaweed meal and tuna fish waste meal as alternative protein sources in poultry feed. The research was conducted using an experimental method arranged in a completely randomised design (CRD) with five treatments and four replications. The treatments consisted of different mixing ratios of *Turbinaria murayana* seaweed meal and tuna fish waste meal, namely 95:5%, 90:10%, 85:15%, 80:20%, and 75:25%. Data were analysed using analysis of variance (ANOVA), followed by Duncan's Multiple Range Test to determine significant differences among treatments. The results showed that varying the mixing ratios had no significant effect ($P>0.05$) on moisture content, organic matter, crude fiber, crude fat, and calcium levels, but significantly affected ($P<0.05$) crude protein and phosphorus contents. The 85:15% mixture produced the best nutritional composition as a protein source for poultry feed, with the following nutrient contents: moisture 6.73%, organic matter 82.33%, crude fiber 8.58%, crude protein 31.11%, crude fat 15.35%, calcium 4.10%, and phosphorus 0.30%.

Keywords: poultry, seaweed meal, *Turbinaria murayana*, tuna fish meal

INTRODUCTION

Poultry productivity is directly influenced by the availability of high-quality, cost-effective, and sustainable feed. In modern poultry production systems, feed accounts for more than 60% of total operational costs, making efficiency in formulation and ingredient selection a key strategy to improve the competitiveness of the livestock industry. Dependence on conventional feed ingredients such as soybean meal and fish meal presents a significant challenge, as these ingredients are expensive, subject to supply fluctuations, and largely reliant on imports. Therefore, innovation in utilizing locally available, nutrient-rich, and abundant resources is essential to support national feed self-sufficiency programs.

One underutilized but highly promising local resource is the brown seaweed *Turbinaria murayana*. This seaweed species is not only abundant in Indonesian waters but also contains important nutrients such as proteins, minerals, and bioactive compounds like alginate, fucoidan, and fucoxanthin, which have been reported to enhance immunity, reduce cholesterol levels in meat and eggs, and promote gut health in poultry (Mahata et al., 2015; Reski et al., 2024).

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According to Reski et al. (2021), *Turbinaria murayana* seaweed meal contains 6.08% crude protein, 0.97% crude fat, 14.98% crude fiber, 0.26% calcium, 0.42% phosphorus, 1599 kcal/kg metabolizable energy, and 13.51% alginate. However, its relatively low protein and mineral contents are major limitations when used as a sole protein source in poultry diets.

To overcome these limitations, a formulation strategy combining seaweed meal with other protein- and mineral-rich ingredients is necessary. One promising candidate is tuna fish waste, which consists of underutilized parts such as heads, bones, and skin. According to data from the Bungus Fish Auction Center (FAC) in Padang City, tuna fish waste production can reach nearly two tons per month. This waste still contains high-quality protein and essential minerals important for poultry growth, making it a promising alternative feed ingredient. Rahmasari et al. (2023) reported that approximately 50% of tuna fish waste consists of internal organs, heads, bones, and skin, with the head containing 17.80% moisture and 60.56% crude protein. Sihite (2013) found that unsorted fish waste contains 47.34% crude protein, 2.62% calcium, and 4.65% phosphorus. Additionally, Daud et al. (2020) reported that tuna fish skin contains 47.90% crude protein, while the head contains 54.03%. Besides its high nutritional value, utilizing fish waste also offers environmental benefits by reducing pollution and extending the value chain of fishery by-products (Coppola et al., 2021).

Combining *Turbinaria murayana* seaweed meal with tuna fish waste meal presents an innovative opportunity for developing poultry feed based on local ingredients. This formulation has the potential to partially replace imported feed ingredients such as fish meal and soybean meal. However, optimizing the mixing ratio is critical to ensure that the combination does not compromise nutritional quality, affect palatability, or pose risks to poultry health. Therefore, experimental research is needed to determine the optimal mixing proportions that can produce feed with chemical quality that meets poultry nutrition standards, including moisture, organic matter, crude protein, crude fat, crude fiber, calcium, and phosphorus levels.

MATERIAL AND METHODS

Materials

The primary material used in this study was *Turbinaria murayana* seaweed, collected from Sungai Nipah Beach, Pesisir Selatan Regency. The seaweed was soaked for two days to remove excess salt, then thoroughly washed and sun-dried until it reached a moisture content of 12%. After drying, it was ground into a fine meal (Reski et al., 2024). The other material used was tuna fish waste, consisting of heads, bones, and skin, obtained from the Bungus Fish Auction Center (FAC) in Padang City. The fish waste was washed and cleaned, then sun-dried until it reached a moisture content of 12% and subsequently ground into meal.

Methods

This study was conducted using an experimental method arranged in a completely randomized design (CRD) consisting of five treatments and four replications. The treatments were the different mixing ratios of *Turbinaria murayana* seaweed meal and tuna fish waste meal, namely 95:5%, 90:10%, 85:15%, 80:20%, and 75:25%. Each treatment was replicated four times. The parameters measured included moisture content, dry matter, organic matter, crude fiber, crude fat, crude protein, calcium, and phosphorus.

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Research Implementation

After processing the materials into meal form, formulation and mixing were carried out according to the specified treatments. Each treatment collected and analyzed a 500 g sample for its nutritional composition, including moisture content, organic matter, crude fiber, crude fat, crude protein, calcium, and phosphorus. The analyses were conducted at the Non-Ruminant Nutrition Laboratory, Faculty of Animal Science, Universitas Andalas. All samples were analyzed using the proximate analysis method following the procedures outlined by AOAC (2005).

Data Analysis

Data were analyzed using SPSS version 21.0 (IBM Corp., Armonk, NY). The data obtained from this study were analyzed using analysis of variance (ANOVA). When significant differences among treatments were detected, further analysis was conducted using Duncan's Multiple Range Test (DMRT) (Steel & Torrie, 1991).

RESULTS AND DISCUSSION

Table 1. Average nutrient composition of *Turbinaria murayana* seaweed meal (TMSM) and tuna fish waste meal (TFWM) mixtures at different ratios (moisture content, organic matter, crude fiber, crude fat, crude protein, calcium, and phosphorus)

Treatment Mixture Ratio (%)	Moisture Content (%)	Organic Matter (%)	Crude Fiber (%)	Crude Fat (%)	Crude Protein (%)	Calcium (%)	Phosphorus (%)
95:5	6.91	81.09	7.96	16.11	34.62^{a}	3.87	0.25^{c}
90:10	7.20	81.87	8.36	15.97	32.22^{b}	4.08	0.28^{c}
85:15	6.73	82.33	8.58	15.35	31.11^{b}	4.10	0.30^{bc}
80:20	6.50	83.11	8.59	15.15	28.63^{c}	4.40	0.38^{ab}
75:25	7.54	84.91	7.96	15.05	27.18^{c}	4.62	0.42^{a}
SE	0.26	0.88	0.55	0.38	0.56	0.19	0.03

Description: Different superscripts indicate significant different effects (P<0.05); SE: standard error

Effect of Treatment on Moisture Content

The moisture content of the *Turbinaria murayana* seaweed meal and tuna fish waste meal mixtures across treatments ranged from 6.50% to 7.54%, showing no significant differences (P>0.05). These values remain below the maximum recommended limit for feed ingredients, which is 12% (NRC, 1994), thus ensuring safety from microbial growth and spoilage during storage. These findings are consistent with Sihite (2013), who reported that tuna fish waste exhibits low moisture content after drying, reaching levels of 6–7%.

Effect of Treatment on Organic Matter

Organic matter tended to increase with higher proportions of tuna fish waste meal; however, the differences among treatments were not statistically significant (P>0.05). The organic matter content ranged from 81.09% to 84.91%. These results align with the findings of Daud et al. (2020), who reported that tuna fish waste, particularly from the head and bones, contains high levels of organic matter. The observed increase in organic matter indicates a potential for providing available nutrients to poultry, supporting the statement of Leeson and Summers

(2005), who emphasised the importance of organic matter as the primary source of essential nutrients in poultry diets, including carbohydrates, proteins, and fats.

Effect of Treatment on Crude Fiber

The crude fiber content ranged from 7.96% to 8.59%, showing no significant differences among treatments (P>0.05). The relatively high crude fiber content in the mixture of *Turbinaria murayana* seaweed meal and tuna fish waste meal is attributed to the seaweed, which contains structural polysaccharides such as alginate and cellulose (Mahata et al., 2015). Although crude fiber is necessary to stimulate gastrointestinal activity, excessive levels may reduce feed digestibility (Rezaei et al., 2014). The crude fiber content observed in this study remains within a safe range and may serve as a functional fiber that supports poultry digestive health. These values are lower than those reported by Sihite (2013), who found unsorted fish waste containing 10.10% crude fiber.

Effect of Treatment on Crude Fat

The crude fat content ranged from 15.05% to 16.11%, showing no significant differences among treatments (P>0.05). The high crude fat content is likely derived from the tuna fish waste's skin and residual flesh components, which are known to contain high fat levels (Coppola et al., 2021). Fat is a dense energy source essential for supporting growth and feed efficiency in poultry (Leeson & Summers, 2005). These findings are consistent with the study of Daud et al. (2020), who reported that the fat content of fish waste ranges from 9% to 16%, depending on the specific parts utilised.

Effect of Treatment on Crude Protein

Crude protein showed significant differences among treatments (P<0.05), with the highest value observed at the 95:5% mixture (34.62%) and the lowest at the 75:25% mixture (27.18%). Although fish waste is known to contain high levels of protein (Sihite, 2023; Daud et al., 2020), the decrease in crude protein content in treatments with higher proportions of *Turbinaria murayana* seaweed meal is attributed to the inherently low protein content of seaweed. As the proportion of seaweed increases in the mixture, the overall protein content decreases. This finding is consistent with Mahata et al. (2015), who reported that *Turbinaria murayana* contains relatively low protein levels (approximately 6.08%), thus increasing its proportion reduces the total protein content of the mixture.

Effect of Treatment on Calcium

Calcium content in the mixtures of *Turbinaria murayana* seaweed meal and tuna fish waste meal at different ratios showed no significant effect (P>0.05). This is consistent with the report by Daud et al. (2020), which stated that fish waste, particularly from the bones, is an excellent source of calcium. Calcium plays a crucial role in poultry's bone formation and eggshell production (NRC, 1994).

Effect of Treatment on Phosphorus

Phosphorus content showed an increasing trend and was significantly affected by treatment (P<0.05). The phosphorus content in this study ranged from 0.25% to 0.42%, increasing with higher inclusion levels of tuna fish waste meal. This finding aligns with Coppola et al. (2021),

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who reported that fish waste is rich in phosphorus. Phosphorus is an essential mineral that supports body metabolism and bone health (Leeson & Summers, 2005).

Conclusion

Based on the results of this study, the combination of *Turbinaria murayana* seaweed meal and tuna fish waste meal shows good potential as a protein source in poultry feed. The 85:15% formulation provided the best results with a balanced nutritional profile, including moisture content of 6.73%, organic matter 82.33%, crude fiber 8.58%, crude protein 31.11%, crude fat 15.35%, calcium 4.10%, and phosphorus 0.30%. Increasing the proportion of tuna fish waste meal significantly improved phosphorus content but reduced crude protein levels. Therefore, the 85:15% mixture is recommended as the optimal formulation to support the development of high-quality, sustainable, locally sourced alternative poultry feed ingredients for the poultry industry.

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