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The Effect of Adding Fermented Shrimp Waste Extract in Ration on Metabolizable Energy Value and Nitrogen Retention in Native Chicken

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Abstract:

The study aimed to determine the level of use of fermented shrimp waste extract (FSWE) in the diet, which produced the highest metabolizable energy value and nitrogen retention in native chickens. The study used 100 male native chickens aged 12 weeks placed in 20 cage units. The study used a completely randomized design, 5 treatments, and 4 replications. The treatments consisted of R0 (basal ration that did not contain FSWE), R1 (basal ration with the addition of 0.5% FSWE), R2 (basal ration with the addition of 1.0% FSWE), R3 (basal ration with the addition of 1.5% FSWE), R4 (basal ration with the addition of 2% FSWE). The observed variables were the value of metabolizable energy, nitrogen corrected metabolizable energy, and nitrogen retention. The research data were analyzed using analysis of variance followed by Dunnet's test. The results showed that the addition of 1.5% FSWE in the diet resulted in the highest value of metabolizable energy and nitrogen retention in native chickens.

I. INTRODUCTION

The productivity of native chickens cannot be separated from the quality of the feed provided. Native chickens consume feed to meet their protein and energy needs. The provision of rations with good quality protein can undoubtedly affect the growth and development of chickens. The quality of protein is determined by the feed ingredients that make up the ration, especially the protein source feed ingredients that have better nutrient content [1]–[3]

Fulfilling the nutritional needs of livestock can be done by adding a feed supplement. One of the protein source feed ingredients that has a high enough protein content to be used as a feed supplement is shrimp waste extract. Shrimp waste results from the fishing industry, with high protein content. The obstacle found in shrimp waste is the presence of a limiting factor in the form of chitin which binds to proteins and minerals in glucosidic covalent bonds, so it is difficult for poultry digestive enzymes to digest [4], [5] One of the efforts to overcome this problem is to do the processing first utilizing fermentation. Fermentation using microorganisms such as

Bacillus lincheniformis, *Lactobacillus* sp, and *Saccharomyces cerevisiae* can improve nutritional quality, reduce or eliminate the adverse effects of certain feed ingredients and can increase the digestibility value of fermented ingredients because they can degrade materials that are difficult to digest so that they can be absorbed by the body [6], [7]. These three microorganisms are bacteria capable of producing relatively high amounts of proteases and chitinases [8]–[14].

Nitrogen retention and metabolizable energy are one of the methods to assess the protein quality and energy content of the ration. Metabolizable energy is the difference in the gross energy content of the ration with the gross energy released through excretion [15], [16]. The less energy expended, the higher the ration energy absorbed or digested by the body so that the efficiency of using ration energy is high [17]. Nitrogen retention is the amount of nitrogen in feed protein that can be retained and used by the animal's body [18]. The calculation of the value of nitrogen retention is taken from the amount of nitrogen consumption minus the amount of nitrogen in excreta and urine. The more nitrogen is retained in the poultry body, the smaller the amount of nitrogen in the excreta and urine [19].

The energy content by the nutritional needs of native chickens can produce optimal production. The nutrient content in feed ingredients that is important to note is protein. Protein is the main component of body organs and soft tissues of various poultry. These substances are needed for growth, management, and egg production and are part of all enzymes in the body [1], [3], [20]. The efficiency of protein use is indicated by nitrogen retention. This is because the more nitrogen is retained (absorbed), the more protein is absorbed because nitrogen retention and metabolizable energy are some of the most decisive factors in livestock productivity [15], [21].

Astaxanthin concentrations in the range of 10-20 g/ml indicate the level of antioxidant activity [22], [23]. The addition of probiotics (*Lactobacillus* sp.) in the feed at the level of 0.6% gave results on metabolizable energy and nitrogen-corrected metabolizable energy in quail [24], [25]. The results of another study showed that the addition of 1.17% dahlia tuber extract in the ration had a significant effect on the nitrogen retention value of local chickens [26], [27]. Additional feeding in the ration with a range of 0.6% to 1.17% affected the value of metabolizable energy and nitrogen retention. Based on the framework, it was hypothesized that the administration of 1% fermented shrimp waste extract resulted in the highest value of metabolizable energy and nitrogen retention in native chickens.

II. Materials and Methods

2.1 Experimental Animals

The livestock used in the study were 20 male native chickens obtained from the Center for Poultry Breeding Development, Jatiwangi-Indonesia. The study used roosters aged 12 weeks with an average DOC weight of 37.25 g and a coefficient of variation in body weight of 5.22%.

2.2 Experiment Cage

The cages used for sampling consisted of 20 metabolizable cages with a length, width, and height of 40 cm x 30 cm x 40 cm, respectively. Each cage unit is given a treatment number and a replication number to facilitate checking and data collection.

2.3 Feed Ingredients for Ration

The rations are prepared based on the standard requirements for protein content and metabolizable energy for native chickens in the growth phase, namely 18% crude protein and 2800 kcal/kg metabolizable energy [28]. The ration composition used in the study consisted of corn, soybean meal, MBM, rice bran, coconut oil, $CaCO_3$, topmix, bone meal, NaCl, and fermented shrimp waste extract (FSWE). The rations are prepared based on the standard requirements for protein content and metabolizable energy, as shown in Table 1.

Table 1. Research Ration Structure

Feed Ingredients	Ration Composition (%)
Corn	58.65
Soybean Meal	25.00
MBM	1,50
Rice Bran	10.21
Coconut oil	1.00
$CaCO_3$	0.40
Topmix	0.50
Bone Flour	2.39
NaCl	0.35

The ration treatment in this study consisted of:
R0 = Basal ration that does not contain FSWE.
R1 = Basal ration + 0.5% FSWE.
R2 = Basal ration + 1.0% FSWE.
R3 = Basal ration + 1.5% FSWE.
R4 = Basal ration + 2.0% FSWE

2.4 Procedure for Making Fermented Shrimp Waste Extract

Making fermented shrimp waste extract (FSWE) begins with washing the shrimp waste in running water. The washed shrimp waste is put into a stainless-steel jar for fermentation using *B. lincheniformis* inoculum with a dose of 2% and incubated in an auto-automatic machine. Shaker-bath for 2 days at 450C at 120 rpm. After the deproteination product was obtained, it was inoculated using *Lactobacillus* sp at a dose of 2% and incubated in an auto-shaker-bath machine for 2 days at a temperature of 350C at 120 rpm. After obtaining the demineralized product, it was fermented using *S. cerevisiae* as much as 3% and incubated in an auto-shaker-bath machine for 2 days at a temperature of 300C at 120 rpm. The bioprocess product (Astaxhantin 26.75%) was extracted with 0.15 ppm Se (selenium) mineral supplementation (73 ppm in the form of selenite), then filler was added. The final process is milling until it becomes flour with a particle size of 100 mash to be mixed with other ration ingredients [29].

2.5 Sampling Procedure

Sampling was carried out by transferring 20 12-week-old chickens to a metabolizable cage labeled according to the treatment. The method for obtaining excreta samples followed the method of Sibbald and Morse [18] by using the technique of satisfying and collecting excreta. Chickens aged 12 weeks fasted for 24 hours to empty the previous feed from the digestive tract. Chickens were fed according to the treatment as much as 100 grams. Excreta collection was carried out for 24 hours. The excreta were collected using aluminium foil box plates. The excreta that came out every 3 hours were sprayed with 5% boric acid solution with a concentration of 0.05 to avoid nitrogen evaporation. The excreta collected from the reservoir were cleaned of hair, and other impurities, then weighed to determine the wet weight and dry weight after drying with an incandescent lamp. The excreta were then weighed, and a 10% sample was taken and labeled according to the treatment to analyze the dry matter, protein, and gross energy content.

2.6 Experimental Design and Statistical Analysis

The study was conducted with an experimental method using a completely randomized design. The variables observed in this study were metabolizable energy, nitrogen corrected metabolizable energy, and nitrogen retention in native chickens and were calculated by the following formula:

(1) Metabolizable Energy (kcal/kg): [(Gross energy of ration × number of rations consumed) - (Amount of excreta × gross energy of excreta)]/number of rations consumed,

(2) Nitrogen Corrected Metabolizable Energy (kcal/kg): [(Gross energy of ration × amount of ration consumed) - (Amount of excreta × gross energy of excreta) - (ration consumed × ration nitrogen) - (amount of excreta × nitrogen in excreta) × 8.22]/ number of rations consumed,

(3) Nitrogen Retention (%): [(Nitrogen Consumption - Nitrogen Excreta)/ Nitrogen Consumption] × 100%.

The experiment was carried out with 5 treatments, each of which was repeated 4 times so that 20 experimental units were obtained with the ration treatment R0 = Basal ration that did not contain FSWE, R1 = Basal ration + 0.5% FSWE, R2 = Basal ration + 1% FSWE, R3 = Basal ration + 1.5% FSWE, R4 = Basal ration + 2% FSWE. Furthermore, the data obtained were analyzed using analysis of variance to determine the response to the treatment being tried, and differences between treatments were tested using Dunnet's test.

III. Results

Metabolizable energy is the difference in the gross energy content of the ration with the gross energy released through excretion [30]. The average metabolizable energy value in this study ranged from 2,256.53 kcal/kg to 3,074.38 kcal/kg (Table 2). The results of the analysis of variance showed that the use of fermented shrimp waste extract (FSWE) in the ration had a significant effect ($P<0.05$) on metabolizable energy. This can illustrate that the use of FSWE causes a positive response in native chickens to the amount of energy metabolized by the chicken's body.

Table 2. Average Metabolizable Energy Values, Nitrogen Corrected Metabolizable Energy, and Nitrogen Retention

Parameter	Treatment				
	R0	R1	R2	R3	R4
ME (kcal/kg)	2,256.53[a]	2,265.78[a]	2,642.72[a]	3,074.38[b]	2,820.46[b]
MEn (kcal/kg)	2,205.49[a]	2,213.77[a]	2,590.38[a]	3,020.96[b]	2,765.18[b]
NR (%)	66.14	70.21	70.29	70.58	71.72

ME: Metabolizable Energy Values; MEn: Nitrogen Corrected Metabolizable Energy; NR: Nitrogen Retention.
[a,b]Different superscripts within each row indicate significant differences ($P < 0.05$).

Nitrogen-corrected metabolizable energy is the nitrogen-corrected metabolizable energy value, which is the result of subtracting the calorific value of one gram of nitrogen (8.22) multiplied by nitrogen retention. The average nitrogen-corrected metabolizable energy values in this study ranged from 2,205.49 kcal/kg to 3,020.96 kcal/kg (Table 2). The analysis of variance showed that the use of FSWE in the diet had a significant effect ($P<0.05$) on nitrogen-corrected metabolizable energy.

Nitrogen retention is a method to determine the amount of nitrogen absorbed by the body by measuring the nitrogen consumed and nitrogen released in the form of excreta [31]. The average nitrogen retention value in this study ranged from 66.14% to 71.72% (Table 2). The analysis of variance showed that the use of FSWE in the diet had no significant effect ($P>0.05$) on nitrogen retention.

IV. Discussion

4.1 Effect of Treatment on Metabolizable Energy

The increase in the value of metabolizable energy (ME) in each treatment was caused by the addition of feed supplements in the formulation of native chicken rations. The addition of FSWE in the ration can help streamline energy metabolism in chickens, thereby increasing the ME value in native chickens. This shows that an increase in the nutritional quality of the ration is caused by the use of fermented product feed supplements. [29] stated that the fermentation product from deproteination by *B. licheniformis* followed by mineralization by *Lactobacillus* sp and *S. cerevisiae* had better metabolizable energy and protein digestibility values. This is because *B. licheniformis* is a bacterium capable of producing relatively high amounts of proteases and chitinases, and the acidic environment formed by *Lactobacillus* sp allows minerals bound to decaying proteins to be released; fermentation with S. cerevisiae can increase digestibility through the production of enzymes, carbohydrates, and proteases [9], [12], [13], [32], [33]. According to [34], the fermentation process causes changes in the properties of feed ingredients as a result of the breakdown of food substances by enzymes produced by microbes; fermented feed ingredients have better nutritional value than the original ingredients, this is evident from the difference in gross energy content and protein on basal rations or control rations with rations that have been added with fermented shrimp waste extract [35], [36].

Astaxanthin is a carotenoid group that is active as an antioxidant. [37]stated that Astaxanthin in shrimp waste shows strong antioxidant activity. It can suppress the growth of pathogenic bacteria in the intestines and improve the intestinal villi to maximize the digestibility of food substances from the feed consumed. This is reinforced by the opinion of [38] that the decrease in the population of pathogenic bacteria has a positive effect on increasing the metabolizable energy of chickens because it reduces the competition between pathogenic bacteria and their hosts in utilizing energy from feed that enters the digestive tract.

4.2 Effect of Treatment on Nitrogen Corrected Metabolizable Energy

The value of nitrogen-corrected metabolizable energy (MEn) was influenced by the consumption of gross energy and crude protein from the feed, protein quality, nitrogen consumption, and the balance of nutrients in the feed [30]. According to [39], the quality of low protein or one of the amino acids in a feed ingredient is lacking; the nitrogen retention will be below. [15] states that the results of calculating the metabolizable energy of feed without nitrogen correction are considered less predictive of the energy value of a feed because nitrogen stored in body tissues (Retained Nitrogen) when catabolized, the final result will be expressed as energy lost as urine. With the calculation of metabolizable energy corrected by nitrogen, it is hoped that it will not be affected by nitrogen.

4.3 Effect of Treatment on Nitrogen Retention

The value of nitrogen retention (NR), which had no significant effect on the study, was due to the protein consumption of the five treatments not being significantly different ($P>0.05$); in addition to the five treatment rations used, the protein and energy levels were relatively the same. With the protein digestibility value of the feed, which was not significantly different, the nitrogen retention value was not significantly different [15], [31]. This is by the opinion of [39] that the difference in the value of nitrogen retention in each treatment is influenced by the nutritional content, especially protein and energy in the ration. Factors that affect nitrogen retention are protein consumption, protein quality, protein digestibility, and nutrient content in the feed [15], [31]. The quality of protein in the feed is low or one of the amino acids is lacking, the value of nitrogen retention will be below [18], [40], [41]. The provision of rations with the same protein level caused relatively the same nitrogen absorbed, or nitrogen retention from the five treatments was not significantly different. This indicated that the addition of FSWE in the diet did not hurt the nitrogen retention value of native chickens. [25] states that the protein retained by broilers is 67% of the protein in the feed consumed. Only 67% were retained for tissue growth per day, hair growth, and replacement of lost endogenous nitrogen. The

nitrogen retention value in this study was 69.78% higher than the research conducted [31], where the nitrogen retention value of Sentul chickens aged 12 weeks on average reached 63.25%. According to [42], the amount of protein that can be absorbed by the body causes the chicken body to have the opportunity to retain more nitrogen.

V. Conclusion

The conclusion from this study is that the addition of fermented shrimp waste extract has an effect on the value of metabolizable energy (ME) and nitrogen-corrected metabolizable energy (MEn) but has no impact on the importance of nitrogen retention (NR) in native chickens. The addition of fermented shrimp waste extract (FSWE) to the highest ME and MEn values was 1.5% FSWE, and the highest NR was with the addition of 2% FSWE.

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