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The effect of feed containing fermented shrimp waste on the conversion of protein, carcass weight, and abdominal fat of native chicken

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Abstract

Shrimp waste contains protein that binds to chitin and is difficult to digest by poultry, so it is necessary to carry out a fermentation process using *Bacillus licheniformis*, *Lactobacillus* sp., and *Saccharomyces cerevisiae*. This study was conducted to determine the Effect of using fermented shrimp waste products that resulted in the optimal conversion of meat protein, carcass weight, and abdominal fat in native chickens. The method used was a completely randomized design with five feed treatments, namely, feed without fermented shrimp waste (R0), feed fermented shrimp waste with 5% (R1), 10% (R2), 15% (R3), and 20% (R4). Experimental feed was given to 125 native chickens, divided into 25-unit cages, and reared up to 8 weeks of age. The observed variables were feed and meat protein conversion, carcass weight, and abdominal fat weight. The study results concluded that fermented shrimp waste did not affect the value of meat protein conversion and abdominal fat weight. The use of 5-10% fermented shrimp waste in feed produces optimal native chicken carcass weight.

Keywords: Abdominal Fat; Carcass; Fermented Shrimp Waste; Native Chicken; Protein Conversion

1. Introduction

The need for feed in the livestock industry is essential to support the production results of livestock cultivation. A large number of feed requirements in the cultivation of native chickens makes the cost of providing feed high. Therefore, it is necessary to have business efficiency in making feed with good feed management. The requirements in selecting feed ingredients are that they are present in large quantities, do not compete with human consumption, and are cheap.

The main problem in making chicken feed is protein source feed ingredients, such as relatively expensive fish meal, causing high prices for chicken feed. To overcome these problems, alternative protein sources are needed with high protein content at relatively low prices and are available, such as shrimp waste. In Indonesia, 170 shrimp processing businesses have a production capacity of around 500,000 tons per year. Based on the total production of shrimp, about 80-90% is exported in frozen shrimp without heads and skins. Head and shell weights reach 40% of the importance of whole shrimp, so the volume of shrimp head and shell waste produced reaches 203,403 - 325,000 tons per year [1]–[3]. The large availability of shrimp waste in Indonesia has great potential in utilizing waste as an alternative feed ingredient to improve the quality of free-range chicken carcasses.

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Constraints in shrimp waste are proteins and minerals that are firmly bound to chitin so that it is difficult for chicken digestive enzymes to digest [4]–[7]. Therefore, it is necessary to do biological processing first so that the proteins and minerals that bind to chitin can be decomposed so that the digestive tract of chickens can digest them.

Shrimp waste fermentation technology is an alternative and inexpensive way to increase the nutritional value of shrimp waste. The shrimp waste fermentation process can be carried out in two stages: deproteination using *Bacillus licheniformis* and demineralization using *Lactobacillus* sp. and *Saccharomyces cerevisiae*. After deproteination and demineralization, proteins and minerals bound to chitin can be decomposed so the chicken digestive system can digest that protein [4], [7]–[9].

The use of fermented shrimp waste products is expected to replace or reduce the use of fish meal in native chicken feed formulas. The protein content of quality feed can support tissue formation for chicken growth to produce quality carcass meat [1], [10]–[14]. The conversion value is the value of the resulting product in the form of physical performance for many protein consumptions. The conversion of feed protein and meat protein is related to the efficiency of the feed given to native chickens [5], [14]–[16]. Thus, this study aimed to determine the effect of using fermented shrimp waste in feed on the conversion of meat protein, carcass weight, and abdominal fat in Indonesian native chickens.

2. Material and methods

The study was conducted using 125 native chickens aged one day obtained from the Center for Poultry Breeding Development, Jatiwangi, Majalengka-Indonesia. Native chickens were reared for eight weeks. The research object was placed in 25 cages randomly containing five chickens each. The pen used is made of bamboo, wood, and wire with a 0.7 m × 0.5 m × 0.7 m and is equipped with a round feeder and around water bottle made of plastic and a 15-watt incandescent lamp. The coefficient of variation of the chicken's initial body weight was 7.53% (homogeneous). Feed ingredients' nutrient content and metabolic energy are presented in Table 1, feed formulations are shown in Table 2, and nutrient content and metabolic energy of experimental feed are presented in Table 3.

Table 1 Nutrient Content and Metabolizable Energy of Feed Ingredients for Ration

Feed Ingredients	ME**)	CP**)	EE**)	CF**)	Ca**)	P**)	Lys**)	Meth**)
(kcal/kg) ……………………………………%………………………………								
FSW*)	2614	39.29	7.03	7.79	6.81	2.83	3.04	1.46
Rice bran	1630	12.00	13.00	12.00	0.12	0.21	0.71	0.27
Yellow corn	3370	8.60	3.90	2.00	0.02	0.10	0.20	0.18
Soybean meal	2240	44.00	0.90	6.00	0.32	0.29	2.90	0.65
Fish meal	2970	58.00	9.00	1.00	7.70	3.90	6.50	1.80
Bone meal	0	0	0	0	23.3	18.0	0	0
$CaCO_3$	0	0	0	0	40.0	0	0	0

*) FSW, fermented shrimp waste

**) ME, metabolizable energy; CP, crude protein; EE, extract enter; Ca, calcium; P, phosphorus; Lys, lysine; Meth, methionine

Table 2 Arrangement of Experimental Ration

Feed Ingredients	R0	R1	R2	R3	R4
	………………………………%………………………				
FSW*)	0.00	5.00	10.00	15.00	20.00
Rice bran	28.00	26.75	24.75	23.00	18.00
Yellow corn	58.00	58.00	58.00	58.00	60.00
Soybean meal	4.75	2.50	2.25	1.50	0.00
Fish meal	8.00	6.50	3.75	1.25	0.00
Bone meal	0.75	0.75	0.75	0.75	1.00

$CaCO_3$	0.50	0.50	0.50	0.50	1.00
Amount	100	100	100	100	100

*) FSW, fermented shrimp waste

Table 3 Nutrient Content and Metabolizable Energy of Experimental Ration

Nutrient Content	R0*	R1*	R2*	R3*	R4*	Necessity
Metabolizable energy (kcal/kg)	2,755	2,770	2,781	2,792	2,838	2,750
Crude protein (%)	15.08	15.03	15.05	15.03	15.18	15
Extract ether (%)	6.66	6.70	6.54	6.43	6.09	4.0-7.0
Crude fibre (%)	4.89	4.97	5.08	5.19	4.92	3.0-6.0
Calcium (%)	1.05	1.27	1.39	1.54	2.03	0.9-1.1
Phosphor (%)	0.58	0.65	0.68	0.72	0.84	0.7-0.9
Lysin (%)	0.97	0.95	0.90	0.86	0.86	0.8-1.0
Methionine (%)	0.35	0.38	0.40	0.42	0.45	0.38-0.42

*R0 = Ration without the use of fermented shrimp waste, R1 = The ration contains 5% fermented shrimp waste, R2 = Ration contains 10% fermented shrimp waste, R3 = Ration contains 15% fermented shrimp waste, R4 = Ration contains 20% fermented shrimp waste

2.1. The observed variables include

2.1.1. Feed protein conversion

Feed protein conversion is a value that can be seen from the total body weight of livestock in the form of physical performance on many protein consumptions by the livestock concerned—measured by dividing protein consumption by body weight gain [17].

2.1.2. Meat protein conversion

The value of the resulting meat production is physical performance on many protein consumptions by the livestock concerned. It is measured by dividing feed protein consumption by meat protein production[17].

2.1.3. Water content of chicken meat

2.1.4. Carcass weight

Carcass weight was obtained from empty carcasses (chicken without blood, feathers, head neck, and internal organs other than kidneys).

2.1.5. Abdominal fat weight

Abdominal fat was obtained from calculating fat weight, namely fat contained in the abdominal cavity around the gizzard, reproductive organs, the layer that attaches between the cecum and intestinal tract, and around the cloaca.

2.2. Statistical analysis

The study was conducted using an experimental method, using a completely randomized design with five kinds of feed treatments, and each was repeated five times. The treatment feed used in the study was feed without the use of fermented shrimp waste (R0), feed containing 5% fermented shrimp waste (R1), feed containing 10% fermented shrimp waste (R2), feed containing 15% fermented shrimp waste (R3), the feed contains 20% fermented shrimp waste (R4). The ration is based on the crude protein content of 15% and metabolic energy of 2,750 kcal/kg.

3. Results

The calculation of feed protein conversion and meat protein conversion determines the efficiency level of feed containing fermented shrimp waste in native chickens in converting each gram of protein into many weights gain and meat protein production, carcass weight, and abdominal fat. The results of feed protein conversion and meat protein conversion, and carcass weight and abdominal fat from each feed treatment can be seen in Table 4.

Table 4 Average feed protein conversion, meat protein conversion, carcass weight, and abdominal fat in native chickens

Variable	Treatment				
	R0*	**R1***	**R2***	**R3***	**R4***
Feed protein conversion (index)	0.69	0.67	0.60	0.64	0.63
Meat protein conversion (index)	8.41	7.61	8.54	8.99	9.01
Meat water content (%)	73.32	73.11	72.48	73.56	73.54
Carcass weight (g)	298.40 bc	316.16 c	304.19 bc	277.91 ab	266.74 a
Abdominal fat weight (g)	7.40	7.02	6.58	5.82	5.31

*R0 = Ration without the use of fermented shrimp waste, R1 = the ration contains 5% fermented shrimp waste, R2 = Ration contains 10% fermented shrimp waste, R3 = Ration contains 15% fermented shrimp waste, R4 = Ration contains 20% fermented shrimp waste
R4 = Ration contains 20% fermented shrimp waste

Based on Table 4, the protein conversion of feed in each treatment ranged from 0.60 – 0.69, and the meat protein conversion was between 7.61 - 9.01, the water content of chicken meat was between 72.48% - 73.56%, the carcass weight was between 266.74 g – 316.16 g, and abdominal fat weight between 5.31 g – 7.40 g. The results of statistical analysis of the use of fermented shrimp waste in feed gave a significant effect ($P<0.05$) on carcass weight of native chickens but had no significant impact ($P>0.05$) on feed protein conversion, meat protein conversion, meat water content, and abdominal fat weight.

The results of the Duncan Multiple Range Test showed that the treatment of feed that did not contain fermented shrimp waste (R0) was not significantly different ($P>0.05$), with feed having 5% (R1) and 10% (R2) fermented shrimp waste. But resulted in substantially higher carcass weight ($P<0.05$) compared to feed treatment containing fermented shrimp waste as much as 15% (R3) and 20% (R4). The different carcass weight of each treatment was due to using fermented shrimp waste in the feed formula. The higher the use of fermented shrimp waste, the lower the carcass weight because the fermented shrimp waste still contains chitin which the poultry digestive system cannot digest. At 5% and 10% levels, Fermented shrimp waste resulted in optimal carcass weight.

The feed protein conversion was not significant (Table 4), indicating that fermented shrimp waste up to 20% in feed can still be used as an alternative feed ingredient to replace fish meal. Fermented shrimp waste can replace fish meals in the free-range chicken feed formula. Shrimp waste from fermented products includes low prices, good quality, and non-food properties.

4. Discussion

Consumption of feed containing fermented shrimp waste did not affect the palatability of native chickens. This is because the fermented shrimp waste has a non-stinging aroma, and the physical form (feed particles) is the same as fish meal, by the statement of [18]–[21] that the palatability of feed is generally influenced by smell, taste, colour, and texture.

Feed consumption does not significantly affect the consumption of feed protein. [22] Stated that large protein consumption will follow large amounts of feed. This is because the amount of protein consumption is determined by the amount of feed consumed and the protein content in the feed. [23] A statement that feeds protein conversion has a relationship with protein consumption. The use of fermented shrimp wastes up to a level of 20% in feed resulted in relatively the same protein consumption.

The high and low protein content in meat can be seen from the water content. According to [24], the water-binding capacity of beef is influenced by the protein content of the heart; a higher water-binding power will follow the high protein content of meat. Treatments R3 and R4 had meat with a higher water-binding ability (Table 4), so the protein conversion value of the heart was relatively higher. The use of fermented shrimp waste does not affect the protein conversion value of chicken meat. This is because the conversion of meat protein is influenced by two things, namely body weight gain and protein consumption, by the opinion of [25] that the amount of protein consumption affects body weight gain. After all, meat protein conversion is obtained from the multiplication of meat production and meat protein content. There was no significant effect from the five feed treatments, indicating that the use of fermented shrimp wastes up to a level of 20% had the same protein quality as the feed treatment without fermented shrimp waste (R0 with protein source from a fish meal). These results prove that the fermentation process in shrimp waste with *B. licheniformis*, *Lactobacillus* sp., and *S. cerevisiae* can improve the protein quality of shrimp waste (equivalent to a fish meal) and can be used as a substitute for fish meal in the formula of native chicken feed [5], [26]–[28]. [29] Stated that increasing the quality of protein in the feed will increase protein in the body. Materials that undergo a fermentation process have a higher nutritional value than the original ingredients. This is because fermentation produces certain enzymes that can break down protein into amino acids to be more easily absorbed by the body [18], [30]–[32].

The protein content of feed significantly affects the accumulation of abdominal fat in chickens. [3] suggested that the decrease in abdominal fat deposits with a reduction in the energy content of the feed occurred due to reduced activity of several enzymes related to the lipogenesis process in the liver, including the enzyme nicotinamide adenine dinucleotide phosphate-malate dehydrogenase, glucose-6-phosphate (G- 6-PDH), 6-phosphogluconate dehydrogenase and fatty acid synthase (FAS) enzymes in chicken bodies. FAS enzyme is an essential enzyme in the de novo lipogenesis pathway in the chicken liver, where the ability of chickens to synthesize fatty acids in the body is primarily determined by the activity of the FAS enzyme in the liver.

Abdominal fat deposits on the body of broilers are influenced by several factors, namely genetics, nutrition, sex, age of chickens, and environmental factors [33]–[35]. Genetically, native chickens do not contain a lot of body fat; even [35] states that native chickens have a shallow abdominal fat content. Therefore, there is no significant difference in abdominal fat in each treatment in the research conducted. According to [36], the fat stored in the body is small in the early growth period. Still, at the final growth stage, the fat accumulation process takes place quickly, and fat will be stored under the skin, around the digestive organs, including the gallbladder, intestines, and muscles.

Fermentation of shrimp waste using *B. licheniformis*, *Lactobacillus* sp., and *S. cerevisiae* showed that shrimp waste could be used in larger quantities than unfermented shrimp waste. In the deproteination process, using *B. licheniformis* can increase the crude protein content, as in [27]. The use of *B. licheniformis* in the deproteination process of shrimp waste for two days resulted in the highest crude protein content (47.19%). Fermented shrimp waste products in feed can support the growth of native chickens to produce high carcass weight. As stated by [37], carcass production is closely related to living weight, the lower live weight, the lower carcass weight, and vice versa. In addition, [28] stated that the degradation of chitin bonds with the protein in shrimp waste using *B. licheniformis,* which was also followed by *Lactobacillus* sp. to release minerals bound with hydrolysed protein, could increase protein digestibility, thereby optimizing the resulting carcass weight. *B. licheniformis* is a bacterium capable of producing relatively high proteases and chitinases [38]–[40]. *Lactobacillus* sp. is microbes that decompose glucose, sucrose, maltose, and lactose into lactic acid to make mineral deposits [41], [42]. *S. cerevisiae* is a yeast that can produce enzymes amylase, lipase, protease, and other enzymes that help digest food substances in the digestive organs [10], [30], [43], [44].

5. Conclusion

Based on the research and discussion conducted, it can be concluded that fermented shrimp waste affects carcass weight but has no effect on protein conversion of feed and meat and abdominal fat weight of native chickens. The use of fermented shrimp waste products up to 10% resulted in optimal carcass weight for native chickens.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflicts of interest.

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