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Research Article
Utilization of Fermented Palm Kernel Cake with *Sclerotium rolfsii* in Broiler Ration

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Abstract

Background and Objective: Palm kernel cake (PKC) can potentially be used as feedstuff, especially for poultry. PKC needs to be processed in advance, by fermentation, with *Sclerotium rolfsii*. An experiment was conducted to evaluate the utilization of palm kernel cake fermented (PKCF) with *Sclerotium rolfsii* in the diet of broiler. **Materials and Methods:** Two hundred day-old chicks (DOC) were used in this study. The diet was arranged based on the equal amount of energy and protein, which were 3000 kcal kg^{-1} and 22%, respectively. The experiment used a completely randomized design (CRD) with 5 treatments and 4 replications. The treatments were arranged as follows: (1) 10% PKCF (control diet), (2) 15% PKCF, (3) 20% PKCF, (4) 25% PKCF and (5) 30% PKCF in broiler diet. The parameters measured were feed consumption, body weight gain, feed conversion, body weight, carcass weight, crude fiber digestibility and nitrogen retention of broiler. **Results:** Feed consumption, body weight gain, feed conversion, body weight, carcass weight, crude fiber digestibility and nitrogen retention were highly significantly decreased ($p<0.01$) with any treatment. **Conclusion:** The palm kernel cake fermented (PKCF) with *Sclerotium rolfsii* can be used up to 25% in broiler ration.

Key words: Utilization, fermentation, palm kernel cake, *Sclerotium rolfsii*, feedstuff, broiler, ration

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Currently, Indonesia is the largest palm oil producer in the world, with crude palm oil (CPO) production as high as 30.948.931 t[1]. The continuing development of palm oil plantations produce waste in the form of palm kernel cake (PKC), which is produced at the rate of 45-46%[2]. Based on the data above, PKC can potentially be used as feedstuff, especially for poultry. Nutrient content of the PKC is as follows: 16.07% crude protein, 21.30% crude fiber, 8.23% crude lipid, 0.27% Ca, 0.94% P and 48.4 ppm Cu[3]. Even with its high crude protein content, the use of PKC is still limited in poultry rations. According to Rizal[4], PKC can be used to replace 10% or 40% of soybean meal in the broiler ration.

PKC needs to be processed in advance due to its low quality content[5,6]. This is because of its high content of fiber in the form of β-mannan[7] and broilers do not have the enzymes to break down fibers and mannan in its digestive tract. The prior processing of PKC, using cellulolytic and mannanolytic fungi, is necessary to improve the quality of biotechnological fermentation[8-10], which will reduce the content of crude fiber and mannan and increase the quality of palm kernel cake, thus, it will be able to replace soybean meal in poultry rations. Mannanolytic and cellulolytic fungi that can be used for fermentation of palm kernel cake are *Eupenicillium javanicum*, *Sclerotium rolfsii* and *Aspergillus niger*. Mirnawati *et al*.[10] performed a PKC fermentation with mannanolytic and cellulolytic fungi (*Eupenicillium javanicum*, *Sclerotium rolfsii* and *Aspergillus niger*). In their study, *Sclerotium rolfsii*, with a fermentation time of 7 days, increased the nutrient content and quality of the fermented palm kernel cake (PKCF). The results obtained in this study were as follows: 26.90% crude protein, 14.86% nitrogen retention, 14.86% crude fiber, 58.41% crude fiber digestibility, 0.22% crude lipid and 2557.61 kcal kg^{-1} metabolizable energy.

Based on the above results, it is expected that palm kernel cake fermented with *Sclerotium rolfsii* can be used as a feed ingredient for poultry, although the quality of the feed material needed to be tested biologically. Therefore, this study was conducted to determine the percentage of palm kernel cake fermented with *S. rolfsii* that can be used in broiler rations.

MATERIALS AND METHODS

Experimental animal and diet composition: Two hundred day old chicks (DOC) were obtained from the poultry shop for this experiment. The experiment was performed in a completely randomized design (CRD) with five treatments (10, 15, 20, 25 and 30% PKCF in diets) and four replications. There were six broilers per unit used in this experiment. These broilers were kept in cage boxes (80×70×60 cm). The diets were formulated in iso protein (22%) and iso caloric (3000 kcal kg^{-1}) ration. Diet formulation, nutrient content and metabolizable energy content of treatment diets are shown in Table 1 and Table 2. Diet formulation consisted of yellow corn, rice bran, fish meal, soybean meal, PKCF, oil and topmix. Fermented diet and drinking water were provided *ad-libitum*.

Procedure of preparing PKCF: Fermented palm kernel cake was the product of 80% PKC plus 20% rice bran that was fermented with *Sclerotium rolfsii*. The dose of *Sclerotium rolfsii* inoculum administered was 10% of the substrate, which was incubated for 7 days. After harvesting the product, PKCF was dried, milled and then mixed in broiler diets.

Data collection: Collected data were feed consumption (g/head), body weight gain (g/head), feed conversion, body weight (g/head), carcass weight (g/head), crude fiber digestibility (%) and nitrogen retention (%) of broilers.

Table 1: Composition of ration (%), nutrients (%) and metabolizable energy (kcal kg^{-1}) of broiler by treatment

Feedstuff	R1	R2	R3	R4	R5
Corn	44.00	42.00	39.50	39.00	34.00
Rice Brand	3.00	2.00	1.50	2.00	1.00
Soybean Meal	23.00	21.00	19.00	19.00	15.00
Fish Meal	18.00	18.00	18.00	18.00	18.00
PKCF	10.00	15.00	20.00	25.00	30.00
Oil	1.50	1.50	1.50	1.50	1.50
Top mix	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
EM (kkal kg^{-1})	3005.00	3013.85	3014.00	3014.15	3005.60
Protein (%)	22.03	22.04	22.05	22.07	22.10
Crude lipid (%)	3.45	3.43	3.43	3.43	3.43
Crude fiber (%)	4.80	4.96	5.17	5.38	5.63
Ca (%)	1.51	1.48	1.46	1.43	1.41
Phosphor (%)	0.67	0.71	0.75	0.80	0.84
Lisin	1.76	1.94	2.14	2.40	2.63
Methionine	0.56	0.64	0.73	0.84	0.92

Table 2: Average of feed consumption, body weight gain, feed conversion, body weight, carcass weight, crude fiber digestibility (DCSK) and nitrogen retention on broiler by treatment

	Treatments				
Parameters	R1	R2	R3	R4	R5
Feed consumption (g)	2260.68[a]	2298.93[a]	2287.62[a]	2296.36[a]	2180.43[b]
Body weight gain (g)	1219.66[a]	1238.27[a]	1224.62[a]	1235.83[a]	1165.12[b]
Feed conversion	1.85[b]	1.85[b]	1.85[b]	1.86[b]	1.96[a]
Body weight (g)	1203.25[a]	1184.75[a]	1183.50[a]	1288.50[a]	1099.50[b]
Carcass weight (g)	799.750[a]	787.775[a]	781.675[a]	798.28[a]	676.15[b]
Crude fiber digestibility (%)	54.62[a]	53.56[a]	54.45[a]	54.42[a]	52.49[b]
Nitrogen retention (%)	57.50[a]	57.33[a]	57.14[a]	56.93[a]	55.86[b]

Different superscript letters on the same line show highly significant effects ($p<0.01$)

Data analysis: All the data were analyzed by one-way analysis of variance in a completely randomized design according to Steel and Torrie[11]. Duncan's multiple range test (DMRT) was performed for testing the difference among treatments ($p<0.05$)[11].

The ration composition, ingredient contents and metabolic energy of the treatments are presented in Table 1.

RESULTS AND DISCUSSION

The effect of treatments on the broiler performance (feed consumption, body weight gain, feed conversion, body weight, carcass weight, crude fiber digestibility and nitrogen retention) are illustrated in Table 2.

Feed consumption: Based on the analysis of variance, the use of palm kernel cake fermented (PKCF) with *Sclerotium rolfsii* in the ration significantly decreased ($P<0.01$) the feed consumption of broiler. Based on DMRT, R1, R2, R3 and R4 treatments had no significant effect ($p>0.05$) but R5 significantly decreased ($p<0.01$) the feed consumption of broiler.

The R1, R2, R3 and R4 treatments had no effect on feed consumption because the ration containing fermented palm kernel cake had the quality, taste and flavor preferred by broilers. Fermentation can also change the feed material to be easily digested, produce aroma and unique flavor and eliminate toxins from the original material[12]. Usually, materials that undergo the fermentation process have better quality, so they can improve the flavor and aroma, increase the digestibility of the ration and give a good influence on consumption. The results of this study are consistent with the previous studies conducted by Mirnawati *et al.*[13], Rizal *et al.*[14] and Sinurat *et al.*[15], who found an increase in the use of fermented PKC in poultry rations.

Treatment R5 decreased the consumption due to the use of 30% CCP in the ration, which provides a higher crude fiber content. The high fiber content in the diet lead to poor palatability and lower feed consumption, which was in accordance with Azizi *et al.*[16], who stated that the factors affecting feed intake are the amount of consumption and the content of nutrients such as energy, protein and fiber.

Body weight gain: Based on the analysis of variance, the use of palm kernel cake fermented (PKCF) with *Sclerotium rolfsii* in the ration significantly decreased ($p<0.01$) the body weight gain of broilers. Based on DMRT, the treatment rations of R1, R2, R3 and R4 had no significant effect ($p>0.05$) but R5 had a highly significant effect ($p<0.05$). This finding indicates that the use of palm kernel cake fermented with *Sclerotium rolfsii*, up to 25%, resulted in an equal weight gain compared to broilers receiving control diets.

Body weight gain in the treatment rations of R1, R2, R3 and R4 had no significant effect because the fermentation of palm kernel cake had good nutrient quality. Fermentation can improve digestibility, as noted by Sukaryana *et al.*[12] and Dairo and Fasuyi[17], because materials that undergo the fermentation process will have better nutrient quality.

In this study, palm kernel cake fermented with *Sclerotium rolfsii* can be used up to 25% in broiler rations. The results of this study were higher than those of Mirnawati *et al.*[13], who stated that palm kernel cake fermented with *Aspergillus niger* could only be given up to the level of 17% due to the higher mannanase activity of *Sclerotium rolfsii* than *Aspergillus niger*[10].

Feed conversion: Statistical analysis showed that the use of palm kernel cake fermented with *Sclerotium rolfsii* in the broiler ration significantly decreased ($p<0.05$) feed conversion. DMRT showed that palm kernel cake fermented with *Sclerotium rolfsii* in the treatment rations of R1, R2, R3 and R4 showed no significant effect ($p>0.05$) but R5 showed a highly significant decrease ($p<0.05$).

The non-significant effect of the treatment rations of R1, R2, R3 and R4 was due to non-significant result between weight gain, feed consumption and feed conversion. Feed conversion is the ratio of the amount of feed consumed and body weight gain in a given time period.

The average feed conversion of broiler for 5 weeks of the study was 1.86. This result is lower than that of Ezhieshi and Olomu[6], who obtained 1.89-2.33 and that of Ugwu *et al.*[18], who obtained 2.61-3.46.

Body weight: The analysis of variance showed that palm kernel cake fermented with *Sclerotium rolfsii* up to the level of 30% in the ration significantly decreased ($p<0.01$) body weight gain. Duncan's multiple range test showed that the treatment rations of R1, R2, R3 and R4 had no significant effect ($p>0.05$) but R5 significantly decreased ($p<0.05$) body weight gain. The quality of ration is one of the factors that influence the final body weight of broiler. Genetic and environmental factors also affect the growth rate of body composition that includes the distribution of weight, chemical composition and carcass components.

The non-significant effect of the treatment rations of R1, R2, R3 and R4 on the body weight of broiler resulted in good nutritional quality of fermented palm kernel cake as fermentation process can improve the digestibility of a product. The high digestibility of broiler chickens was due to the high activity of the mannanase enzyme of *Sclerotium rolfsii* that can degrade fiber. Mirnawati *et al.*[10] reported that *Sclerotium rolfsii* has higher cellulose and mannanase activity than *A. niger* and *E. javanicum*. Sundu and Dingle[19] reported that mannanase is effective in improving the nutritional value of PKC.

Carcass weight: The analysis of variance showed that palm kernel cake fermented with *Sclerotium rolfsii* up to 30% in the ration significantly decreased ($p<0.01$) carcass weight. Duncan's multiple range test showed that the treatment rations of R1, R2, R3 and R4 showed no significant effect ($p<0.05$) but R5 showed significant decreases in carcass weight.

The non-significant effect of carcass weight in treatment rations of R1, R2, R3 and R4 was caused by the non-significant effect of body weight ($p>0.05$). This is in accordance with the opinion of Nahashon *et al.*[20] that carcass weight was directly related to body weight. Additionally, the lack of differences of carcass weight was due to the equal quality of ration in each treatment, the balance of the food substance contents in the feed material and the similar amount of feed consumed.

This finding was in accordance with the opinion of Haroen[21] who reported that diets containing similar nutrient utilization processes showed the same carcass weight. Nahashon *et al.*[20] described the factors affecting broiler's carcass weight are genetic, sex, physiology, age, body weight and nutrition in ration. The results of this study were higher than the average carcass weight obtained by Priabudiman and Sukaryana[22] with the use of fermented palm kernel cake.

Digestibility of crude fiber: The analysis of variance showed that the use of PKC fermented with *Sclerotium rolfsii* significantly decreased ($p<0.01$) the digestibility of crude fiber. DMRT showed that the treatment rations of R1, R2, R3 and R4 showed no significant effect ($p>0.05$) but were significantly decreased ($p<0.01$) compared to treatment R5.

The non-significant effect of crude fiber digestibility in treatment rations of R1, R2, R3, R4 suggesting that the use of PKC fermented with *Sclerotium rolfsii* up to 25% would still give the same crude fiber digestibility. This fermentation product has better quality, high digestibility and a complete amino acid digestibility of crude fiber so that it will be easily digested. Crude fiber in the fermented PKC was degraded by cellulose and mannanase enzyme produced by *Sclerotium rolfsii*. Mirnawati *et al.*[10] stated that *Sclerotium rolfsii* has cellulose and mannanase activity higher than *A. niger* and *E. javanicum*. Sundu and Dingle[19] reported that mannanase is effective for improving the nutritional value of PKC.

The decrease in the digestibility of the fiber in treatment R5 was due to the high content of crude fiber in the ration. PKCF was further enhanced with the higher crude fiber contained in the ration. The high crude fiber in ration can reduce digestible components that will also determine the activity of enzymes that aid digestion. Despal[23] found that crude fiber has a negative correlation with digestibility, the higher the crude fiber was, the lower the digestibility of the crude fiber.

In this study, PKC fermented with *Sclerotium rolfsii* was used up to 25% in broiler rations. The results of this study were higher than those of Mirnawati *et al.*[10], who stated that the PKC fermented with *Aspergillus niger* may only be used in broiler chicken rations as much as 17%. This was due to the higher activity of mannanase enzyme of *Sclerotium rolfsii* than *Aspergillus niger*[17].

Nitrogen retention: The results of analysis of variance showed that use of PKC fermented with *Sclerotium rolfsii* significantly decreased ($p<0.01$) nitrogen retention in the broiler. DMRT showed that treatment rations of R1, R2, R3 and R4 showed no significant effect ($p>0.05$) but significantly decreased ($p<0.01$) compared to treatment R5.

The non-significant effect of nitrogen retention in treatment rations of R1, R2, R3 and R4 were due to the use of PKC fermented with *Sclerotium rolfsii*. This fermentation product had better quality and complete amino acid content. According to Dairo and Fasuyi[17], the fermentation process improved the amino acid profile, which was observed as increased nitrogen retention. This is consistent with the findings of Mirnawati *et al*.[24,25].

The increased use of PKCF to 30% in the ration is expected to decrease nitrogen retention while increasing the crude fiber content, thus reducing the quality of rations. In the opinion of Siri *et al*.[26], high crude fiber would bind other substances, such as protein and absorb water in the intestine, making it difficult to digest nutrient content in the rations[26].

SIGNIFICANCE STATEMENT

This study discovered that PKC fermented with *Sclerotium rolfsii* increase the quality and nutrient content of palm kernel cake which can be beneficial as a raw material for the preparation of poultry feed. This study will help researchers to uncover new method in preparing feedstuff for poultry ration using by-product of palm oil and fermentation with *Sclerotium rolfsii*, that have previously not been explored. Thus, these results present new insights regarding the appropriate level of PKC fermented with *Sclerotium rolfsii* as formulation of broiler ration.

CONCLUSION

Based on the results of this study, PKC fermented with *Sclerotium rolfsii* can be utilized up to 25% in broiler ration to achieve 1235.83 g/head body weight gain with feed consumption of 2296.36 g/head resulting in a feed conversion of 1.86, with final body weight of 1288.50 g/head, 798.28 gram/head carcass weight, 54.42% of crude fiber digestibility and 56.93% of nitrogen retention.

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