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Research Article
Effect of Fermented Palm Oil Sludge with *Neurospora crassa* Added to Rations on Broiler Production Performance

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Abstract

Background and Objective: Palm oil sludge (POS) can potentially be used as poultry feed after being fermented with *Neurospora crassa*. An experiment was conducted to evaluate the effect of palm oil sludge fermented (POSF) with *Neurospora crassa* in broiler diets. **Materials and Methods:** One hundred and twenty 1-day-old broiler chicks (DOC) were used in this study. The diet was formulated based on equal amounts 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) 0% POSF, (2) 13% POSF, (3) 16% POSF, (4) 19% POSF and (5) 22% POSF in the broiler rations. Parameters measured were feed consumption, body weight gain, feed conversion, body weight and carcass weight of the broilers. **Results:** Feed consumption, body weight gain, feed conversion, body weight and carcass weight were not significantly affected ($p>0.05$). **Conclusion:** Palm oil sludge (POSF) fermented with *Neurospora crassa* can be used up to 22% in broiler rations.

Key words: Fermentation, palm oil sludge, broilers, *Neurospora crassa*, ration, performance

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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

Indonesia is the largest palm oil producer in the world, producing 30,948,931 tons of crude palm oil (CPO)[1]. Therefore, palm oil sludge (POS) can potentially be used as feed, especially for poultry. The continued development of oil palm plantations produces up to 2% POS waste. The nutrient content in POS is as follows: 11.1% crude protein, 17% crude fiber, 12% crude lipids, 48% Cu and 61.10% Zn[2]. Even with its high crude protein content, POS use remains limited in poultry rations. According to Sinurat[3], up to 5% POS can be used in broiler rations.

POS must be processed in advance due to its low quality content[3] and high fiber content as broilers lack the enzymes needed to breakdown fiber in their digestive tracts. Reducing the crude fiber content via biotechnological fermentation using cellulolytic fungi is necessary to improve the palm oil sludge quality and allow it to substitute soybean meal in poultry rations.

Cellulolytic fungi that can be used to ferment palm oil sludge include *Neurospora crassa, Neurospora sitophila* and *Neurospora sp.* Research conducted by Mirnawati *et al.*[4] showed that *Neurospora crassa* provides better food substance content and quality than *Neurospora sitophila*. This is evidenced by its 20.42% protein content, 23.02% crude fiber, 56.16% nitrogen retention, 48.41% grain fiber digestibility, 3.73% fat and 2024.28 kcal kg^{-1} metabolic energy[4].

Mirnawati *et al.*[5] fermented palm oil sludge with *Neurospora crassa* and added 200 ppm humic acid, yielding the following results: 23.74% protein content, 20.14% crude fiber, 60.97% nitrogen retention, 55.63% crude fiber digestibility and 2,70% crude fat. These results for the palm oil sludge fermented with *Neurospora crassa* were better than the previous results because of the added humic acid. Humic acid activates microorganisms by providing nutrients such as N, S and P for micro organismal growth[6], thus, microorganisms can grow and increase the fermentation product content and quality.

Based on these results, it is hypothesized that fermented palm oil sludge with *Neurospora crassa* can be used as a feed ingredient in poultry rations, although the feed material quality requires biological testing. The purpose of this experiment was to study the effect of adding several levels of *Neurospora crassa*-fermented palm oil sludge to broiler diets on the broilers' production performance, feed consumption (g/head/week), body weight gain (g/head/week), feed conversion, body weight (g/head/week), carcass percentage and abdominal fat percentage.

MATERIALS AND METHODS

Experimental animals and diet composition: One hundred and twenty 1-day-old chicks (DOC) were used in this experiment. The experiment was performed using a completely randomized design (CRD) with five treatments (0, 13, 16, 19 and 22% palm oil sludge fermentation) and four replications. Six broilers were included per experimental unit. The broilers were housed in box cages (80×70×60 cm). The diets were isocaloric (3000 kcal kg^{-1} ration), formulated with 22% iso-protein. Diet formulation, nutrient content and metabolizable energy content of the treatment diets are shown in Table 1. The dietary formulation consisted of commercial ration, yellow corn, rice bran, fish meal, soybean meal, POS-F, oil and topmix. The diet and drinking water were provided ad libitum.

PKC-F preparation procedure: Fermented palm oil sludge was the product of 80% POS and 20% rice bran fermented with *Neurospora crassa* and 200 ppm humic acid. The *Neurospora crassa* inoculum dose was 10% of the substrate and was incubated for 7 days. After harvesting the product, POS-F was dried, milled and mixed in the broiler diets.

Data collection: Data were collected for feed consumption (g/head/week), body weight gain (g/head/week), feed conversion, body weight (g/head/week) and carcass percentage (%).

Data analysis: All data were analyzed by one-way analysis of variance using a completely randomized design per Steel and Torrie[7]. Duncan's multiple range test (DMRT) was conducted for determining differences among treatments with significant level of 5%[7].

RESULTS AND DISCUSSION

The treatment effects on the feed consumption, body weight gain, feed conversion, body weight and carcass percentage of the broilers during the study are shown in Table 2.

Feed consumption: Based on the analysis of variance, adding fermented palm oil sludge (POSF) with *Neurospora crassa* to the rations did not significantly affect ($p>0.05$) the broilers' feed consumption.

The differences in feed consumption among treatments (R1, R2, R3, R4 and R5) were not significant, likely because the

Table 1: Composition of rations, nutrient content, and metabolizable energy of the treatment rations (%)

	Treatment rations				
Feed ingredients	RA	RB	RC	RD	RE
Commercial ration	22.00	22.00	22.00	22.00	22.00
Rice bran	2.75	2.40	1.50	0.70	0.80
Corn	40.50	32.75	32.00	31.20	29.50
Soybean meal	14.00	8.75	7.50	6.20	4.80
Fish meal	18.00	18.00	18.00	18.00	18.00
POSF	0.00	13.00	16.00	19.00	22.00
Coconut oil	2.25	2.60	2.50	2.40	2.40
Top mix	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
Protein (%)	22.19	22.19	22.18	22.15	22.10
Crude fat (%)	5.16	3.21	5.77	5.73	5.81
Crude fiber (%)	3.04	5.13	5.54	5.97	6.46
Calcium (%)	1.30	1.90	2.10	2.20	2.40
Phosphorus (%)	0.70	0.70	0.70	0.70	0.70
ME (kcal kg^{-1})	3035.10	3029.48	3033.00	3035.34	3028.68

POSF: Palm oil sludge fermentation

Table 2: Average feed consumption, body weight gain, feed conversion, body weight, and carcass percentage of the broilers

	Treatments (%)					
Parameters	RA	RB	RC	RD	RE	SE
Feed consumption (g/head/week)	553.69	601.19	599.72	598.63	612.80	22.65
Body weight gain (g/head/week)	368.88	373.74	373.50	376.30	397.09	6.73
Feed conversion	1.84	1.70	1.66	1.71	1.64	0.12
Body weight (g/head/week)	1655.44	1717.08	1718.94	1747.38	1797.25	3347.00
Carcass percentage (%)	66.06	66.08	67.43	67.99	68.86	0.17

Not significant (p>0.05)

rations containing fermented palm oil sludge had an aroma and flavor that the broilers preferred. The fermentation process can also change the feed material to be more easily digested and to eliminate toxins from the original material[8]. Materials that undergo fermentation often have better quality[5,9,10] thus, fermentation can improve the flavor and aroma, increase the ration's palatability and positively influence consumption. The results of this study are consistent with those of Mirnawati *et al.*[5] and Sinurat *et al.*[11], who found increased consumption by using fermented palm oil sludge in poultry rations.

Body weight gain: Based on the analysis of variance, adding palm oil sludge (POSF) fermented with *Neurospora crassa* to the rations did not influence (p>0,05) the broilers' body weight gain. These results indicate that up to 22% palm oil sludge fermented with *Neurospora crassa* can be added to achieve weight gain equal to that of the broilers receiving the control diet.

Body weight gain in treatment rations R1, R2, R3, R4 and R5 did not significantly differ because fermented palm oil sludge has good nutrient quality. Fermentation can improve digestibility, which is consistent with the opinions of Sukaryana *et al.*[8], Dairo and Fasuyi[12] and Mirnawati *et al.*[9], who reported that fermented materials have better nutrient quality.

This study found that up to 22% palm oil sludge fermented with *Neurospora crassa* can be used in broiler rations. The results of this study were higher than those of Mirnawati *et al.*[4], who reported that palm oil sludge fermented with *Neurospora crassa* without humic acid could only be used up to 13%. Humic acid contains N, S and P required for microbial growth[6], thus increasing the digestibility and nitrogen retention of the palm oil sludge after fermentation[5,9].

Feed conversion: The broilers' feed conversion ratio was not significantly affected (p>0.05) by the levels of palm oil sludge fermented with *Neurospora crassa* in the broiler rations. The feed conversions of treatment rations R1, R2, R3, R4 and R5 did not significantly differ because the weight gain and feed consumption parameters between treatments were not significant. Feed conversion is the ratio between the amount of feed consumed and the body weight gain for a given period.

The average feed conversion ratio of broilers for the 5 weeks was 1.64. This result was lower than that of

Mirnawati *et al.*[13], who reported that the broilers' feed conversion was 1.78. In addition, according to Ezhieshi and Olomu[14] the feed conversion ration was 1.89-2.33 whereas Ugwu *et al.*[15] reported 2.61-3.46.

Body weight: The analysis of variance showed that adding up to 22% palm oil sludge fermented with *Neurospora crassa* to the rations did not influence (p>0.05) broiler body weight. No significant effect of treatment for R1, R2, R3, R4 and R5 on broiler body weight was observed, indicating that fermentation improves product digestibility. Higher digestibility yields more degradable crude fiber and higher nitrogen retention[5,16]. Higher nitrogen retention will cause more weight gain. This result strengthened the correlation between nitrogen retention and weight gain[5].

The body weight obtained in this study is lower than that found in Mahanta's research[17], which ranged from 1825.17 g to 2059.83 g due to their use of herbal growth promoter supplementation. The same results were also obtained by Borah *et al.*[18] and Vidyarthi *et al.*[19].

Carcass percentage: Broiler carcass percentage was unaffected (p>0.05) by the levels of fermented palm oil sludge with *Neurospora crassa* in the diets. The carcass weight being not affected by treatment rations R1, R2, R3, R4 and R5 was caused by the non-significance of the body weight (p>0.05).

This is consistent with Nahashon's opinion[14] who stated that carcass weight is directly related to body weight. Other reasons included the equal quality of rations per treatment, the balanced food substance content in the feed material and the similar feed consumption amounts.

Haroen[20] also stated that diets containing similar nutrient utilization processes will show the same carcass weight. Nahashon *et al.*[21] indicated that the factors affecting carcass weight are genetics, sex, physiology, age, body weight and ration nutrition. The results of his study were higher than those that Priabudiman and Sukaryana[22] obtained for average carcass weight[22].

CONCLUSION

Based on the results of this study, up to 22% POS fermented with *Neurospora crassa* can be used in broiler rations to achieve 397.09 g/head/week body weight gain with a feed consumption of 612.80 g/head/week resulting in a feed conversion ratio of 1.64 with a final body weight of 1797.25 g/head and a 68.86% carcass percentage in broilers.

SIGNIFICANCE STATEMENT

This study discovers that fermentation with *Neurospora crassa* improve the quality of palm oil sludge. Moreover, this study also finds that up to 22% palm oil sludge fermented with *Neurospora crassa* can be used in broiler rations.

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