

Palm oil Sludge as Energy Substitute in Finisher Broiler Diets: A Pathway Out of the Current Feed Energy Crisis?

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Target audience: Poultry farmers, Feed millers, Livestock extension agents

Abstract

The high cost of energy feed ingredients has pushed feed prices to astronomical levels thereby making cost of mature broiler chickens out of reach of the average consumer. In a bid to keep poultry producers in business the search for cheaper alternative feed ingredients would continue to ensure that consumers have access to live chickens at affordable costs. This experiment investigated the effect of different levels of inclusion of enzyme supplemented Palm Oil Sludge (POS) in the diet of finisher broiler birds. One hundred and twenty 4 week-old birds of the Ross 308 strain were randomly allotted to four treatment diets in a completely randomized design with three replications. Each treatment group contained 30 birds with 10 birds per replicate. Four diets were formulated such that palm oil sludge (POS) replaced maize at 5, 10 and 15% respectively, designated as T₂, T₃ and T₄. The control treatment T₁ contained no palm oil sludge. The experiment lasted for 28 days. The results showed that the birds on T₄ recorded significantly higher weight gains, better feed conversion ratio, reduced feed intake and lower feed costs when compared to the other treatments. Birds on 15% inclusion level recorded final body weight of 2.42kg compared to 2.25kg for the control treatment. It can be concluded that inclusion of enzyme supplemented Palm oil sludge at 15% in finisher broiler diet resulted in increased weight gains and cheaper feed cost which is therefore recommended for adoption by farmers and feed millers in this era of exorbitant cost of feed and mature broiler birds.

Keywords: Broiler birds, cost efficiency, energy, south eastern Nigeria, palm oil industry

Description of problem

The quest for food security for the teeming world population has been a top priority of governments around the world. (1) notes that the world is moving backwards in its efforts to end hunger, food insecurity and malnutrition in all its forms due to conflict, climate extremes, economic shocks combined with high cost of nutritious food. It

is estimated that the number of malnourished people of the world grew by 150 million people between 2019 and 2022, after a decade of steady decline. Animal protein in the form of meat, milk and eggs remain a very vital part of the food security equation especially in sub-Saharan Africa hence its potential to improve access to good nutrition for adults and children under 5 years cannot

be over emphasized. In order to meet this target, food production must be intensified and nations around the world must promote coordinated and focused policy action in this regard. It is only by aligning efforts and strengths that countries can wipe out the root causes of what make the poor food insecure, malnourished and trapped in a vicious circle of chronic deprivation (1). Poultry meat from broilers represents a veritable source of filling the animal protein supply gap due to their fast growth and high turn-over rate. Unlike pork, poultry meat is widely accepted and does not experience cultural restrictions (2), but is challenged by exceedingly high feed costs. Thus, in order to supply inexpensive and economical products, it is necessary to use alternative feed ingredients that are more affordable, and readily available regionally, and of low human preference. Cereals constitute the major energy feedstuff and also make up more than two thirds of the finished feed for different classes of poultry. However, the high cost of conventional energy sources such as maize and cassava, sorghum, and millet due to high competition from food and beverage industries has created higher demand for the “conventional” by-products from these industries for livestock feeding. As a result, by-products of food and beverage industries, which were hitherto cheap and easily affordable have experienced astronomical rise in prices as well. This has challenged nutritionists to continue the search for cheaper and more suitable alternatives. In the south east of Nigeria, palm fruit processing for oil palm production is a major industrial activity and produces a by-product after the extraction of the oil known as palm oil sludge (POS). Palm oil sludge is the material that remains after the sterilisation and

clarification processes and the resulting decanting of the oil during the milling of the oil palm fruit. It is a semi solid mass considered as mill effluent which could sometimes pose environmental issues when discharged into the surrounding ecosystem. Although POS is biodegradable, it must first be treated because of its acidic nature, extremely high biochemical oxygen demand (BOD), chemical oxygen demand (COD), and heavy metal content (3). Its nutritional contents are comparable to maize in terms of energy and protein contents. It has a crude protein (CP) of 96 g/kg and metabolisable energy (ME) of 17.76 MJ/kg (4). This makes it relatively perfect match to maize with 90 g/kg CP and 14.37 MJ/kg. (5) reported DM 68.4%, ME 23 MJ/kg, Crude protein 11%, crude fibre 7.9%, NDF 28.2%, ADF 22.1%, ether extract 29.2, ash 8.7%. (6) reported that palm oil sludge (POS) used in place of maize at a level of 15 to 30% increased the daily feed intake and the average daily weight gain of pigs in addition to a significant reduction in feed cost. (7) reported improved growth performance of broilers fed palm oil sludge. It must be noted however, that the high moisture content of the sludge creates the need for further processing before incorporation into animal diets. Many researchers had proposed aerobic purification, anaerobic digestion and biodegradation as suitable treatment methods. However, these methods were considered as either impractical or uneconomical (8). A more promising method is the use of absorbents such as rice bran, dried cassava meal or palm kernel meal. However, processing methods must take cognizance of contaminants and risk of pathogenic bacteria.

Despite the huge potential of the POS as a

credible energy alternative, their inclusion in broiler finisher diets is not popular and has not been widely reported especially in south east Nigeria. Hence this study investigated the effects of inclusion of enzyme supplemented POS at different levels in broiler finisher diet.

Materials and Methods

The experiment lasted for 4 weeks and was carried out at the Teaching and Research Farm of the Department of Animal Science and Technology, Federal University of Technology, Owerri, Imo State. Imo State lies between latitude 4° 4' and 6° 3' N, and longitude 6° 15' and 8° 15' E. Owerri is about 100m above sea level with mean annual rainfall of 2500 mm, temperature range of 26.5 – 27.5 °C, and humidity range of 70 – 80%. Dry season duration (months with less than 65 mm rainfall) is three months, which takes place during the months of December, January and February. The palm oil sludge (POS) used for this study were collected from a small scale palm oil mill at Umugwo, Ohaji Egbema Local Government Area, Imo State, Nigeria. The POS sludge was collected in a jute sack and left for two weeks to drain excess water. The resulting semi solid mass was further sun-dried on a clean concrete slab to arrive at a solid mass with reduced moisture content. The dried crumbs were further dried to reduce moisture and then milled using hammer mill to obtain smooth particles suitable for inclusion as feed ingredient. A multi-enzyme complex known as Maxigrain, containing; cellulase, beta-glucanase, xylanase, and phytase purchased from feed dealer in Owerri, Imo State was added into the feed at the rate of 0.5% per 100kg during mixing. .

Experimental Diets

Four experimental diets namely T₂, T₃ and T₄ were formulated to contain 5 %, 10 % and 15% of palm oil sludge respectively and a control diet T₁ without POS inclusion. The experimental diets were supplemented with exogenous enzymes at 0.5% each. Clean water and feed were freely supplied to the animals throughout the experiment.

Experimental Birds and Management

One hundred and twenty 4-week -old broiler birds of ROSS 308 strain were randomly allotted to four treatment groups each with three replications. Each treatment group had 30 birds with 10 birds per replicate. Birds were housed in a deep litter pen covered with wood shavings. Routine vaccination and medication schedule was strictly followed throughout the duration of the experiment. Data collected were feed intake, final weight gain, and daily weight gain, feed conversion ratio and feed cost per kg of feed.

Results of the growth performance indices and other parameters were subjected to Analysis of Variance using the Proc GLM procedure of (9), and means were separated using Duncan New Multiple Range Test (DNMRT.).

Results and Discussion

There were significant differences ($P < 0.05$) in final weight among treatment means with T₄ recording the highest weight gain while results were similar for T₃, T₂ and T₁. The increase in final weight gain as the level of inclusion of palm oil sludge increased could be attributed to the higher energy contents of the test diets and the presence of exogenous enzymes. This is consistent with findings of (10) who reported that broilers fed higher energy diets performed better during the

Table 1. Composition of experimental diets

Ingredients (Unit)	T ₁	T ₂	T ₃	T ₄
Maize Offal	52.00	47.00	42.00	37.00
Palm oil sludge	0.00	5.00	10.00	15.00
Soybean Meal	23.00	23.00	23.00	23.00
PKC	6.00	6.00	6.00	6.00
Wheat offal	6.00	6.00	6.00	6.00
Brewers Dry grain	6.00	6.00	6.00	6.00
Fish meal	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00
Vitamin premix*	0.25	0.25	0.25	0.25
NaCl	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20
Methionine	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00
Exogenous enzymes		0.50	0.50	0.50
Metabolizable energy (unit)	2901.66	2935.40	2970.67	3004.44
Crude protein (unit)	20.08	20.33	20.67	20.99

Vitamin premix* Vit. A -10,000,000iu, Vit. D₃-2000,000iu, Vit. E-20,000mg, Vit B₁-3,000mg, Vit B₂-5,00mg, Vit B₆ -4,000mg, Vit B₁₂- 20mg, Niacin- 45,000mg, Calcium Pantothonate- 10,000mg, Choline Chloride - 300,000mg, Folic Acid - 1,000mg, Biotin - 50mg, Manganese - 300,000mg, Fe - 120,000mg, Zn-80,000mg, Cu- 8,500mg, Iodine - 1,500mg, Cobalt- 300mg, Selenium - 120mg, Anti-Oxidant-120,000mg.

Table 2. Growth performance characteristics of finisher broilers fed varying level of Palm oil sludge.

Parameter (g)	T ₁	T ₂	T ₃	T ₄	SEM
Initial weight	1116.40 ^a	1166.50 ^a	1190.47 ^a	1144.67 ^a	43.66
Final weight	2253.33 ^{ab}	2310.00 ^{ab}	2200.00 ^b	2416.67 ^a	49.72
Weight gain	1136.98 ^{ab}	1143.50 ^{ab}	1009.50 ^b	1272.00 ^a	67.94
Daily weight gain	40.60 ^{ab}	40.34 ^{ab}	36.05 ^b	45.42 ^a	2.42
Daily feed intake	172.29 ^a	161.79 ^c	166.93 ^b	170.26 ^{ab}	1.44
Feed conversion ratio	4.32 ^{ab}	3.98 ^{ab}	4.64 ^a	3.75 ^b	0.24
Feed cost/Kg	225.20	219.20	213.20	207.40	
Cost/Kg weight gain	868.94	759.45	975.71	611.43	

^{a, b, c} Means within a row with different letter superscripts differ significantly ($P < 0.05$)

finisher phase with significantly higher final body weight gain. The inclusion of exogenous enzyme in the diets containing palm oil sludge have been shown to improve performance and nutrient digestibility (11). There was a significant ($P < 0.05$) difference in the daily feed intake among the test diets with T_1 recording the highest feed intake although not significantly different from T_4 followed by T_3 and then T_2 . The decreased daily feed intake for birds on T_3 to T_4 could be due the higher energy levels in T_3 and T_4 . Higher energy level in feed has been reported to decrease feed intake since the birds have adequate supply of energy hence a reduction in feed intake (12). (8) reported no variation in the performance of broilers chickens fed 10 % of oil palm slurry (OPS) mixed with varying levels of rice bran although the treatment with the highest content of OPS had a higher gain in weight although not significant. (13) reported increased feed intake and weight gain, with increasing levels of palm oil inclusion in starter broilers although feed conversion ratio was not significant. This is at variance with the findings from finisher broilers used in this study.

Birds in T_4 recorded a significantly ($P < 0.05$) better feed conversion ratio than birds in the other treatments. There were no significant ($P > 0.05$) differences in feed conversion ratio between birds on control diet (T_1), T_2 and T_3 . The better feed conversion ratio in birds on diets containing palm oil sludge could also be attributed to the reduced feed intake due to adequate energy level of the test diet and the efficiency of the addition of exogenous enzymes in the diets which may have catalysed the feed digestion process, thereby making more nutrients available for absorption. This fact was also corroborated

by (12) who reported superior feed conversion ratio in broilers on higher energy diets. Daily weight gain for T_4 was significantly ($P < 0.05$) higher than birds in T_3 , though not significantly ($P > 0.05$) higher than T_1 . (10) also reported better feed conversion ratio with birds on higher energy feeds. Also, (14) reported that body weight gain, feed conversion efficiency (FCR), average daily gain (ADG), weekly body weight gain and daily feed intake were not significantly ($P > 0.05$) effected by up to 20% level of inclusion of Palm oil sludge in broiler diets. Although feed intake was not significantly affected by increase in POS inclusion in this particular study, feed conversion ratio reduced proportionately with increasing level of POS in the diet, although not significant from the control treatment.

Feed cost/kg were lower for the treatment diets with T_1 having the highest cost followed by T_2 , T_3 and then T_4 . Also cost/kg weight gain for T_1 and T_2 also were similar. However, T_1 had the highest cost/kg weight gain than the test diets. The decrease in feed cost/kg from T_1 to T_4 was due to the reduction in total cost of maize following the substitution with the palm oil sludge. (13) also reported that inclusion of palm oil sludge in broiler diets was economical and cost effective. Although four mortalities were recorded during the course of this experiment; one mortality in T_1 (control), two mortalities in T_2 and one mortality in T_3 , there was no evidence to indicate that the mortality were as a result of the inclusion of palm oil sludge in the diet since the T_1 also recorded mortality and there was no mortality in T_4 .

Conclusion and applications

From the result of this study, it is evident that:

1. The inclusion of enzyme supplemented

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Conclusion and applications

From the result of this study, it is evident that:
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palm oil sludge at 15% significantly improved growth performance indices such as weight gain, feed conversion ratio as well as reduction in feed cost thereby reducing the cost of broiler production.

2. The inclusion of palm oil sludge in the diets did not show any adverse effect on the growth performance of the finisher broilers.

3. Palm oil sludge could be a valuable substitute for maize in broiler finisher diet and is recommended for feed millers and poultry farmers for use in feed formulation.

4. It is recommended that further research should be carried out on the inclusion higher levels of palm oil sludge and the necessary quality control checks on feed and carcass, since inclusion of palm oil sludge at 15% from this present study, did not show any deleterious effect rather, it improved growth performance indices measured.

References-

1. FAO (2022). Food and Agriculture Organization of the United Nations. The state of food security and Nutrition in the World 2022. <https://fao.org>
2. Bawa, A. (2019). Agriculture and Food Security in Northern Ghana. *Asian Journal of Agricultural Extension, Economics & Sociology*, September, 1 – 7. <https://doi.org/10.9734/ajaees/2019/v3i1230127>
3. Ezeoke, F. C., & Nwoye, I. I. (2022). Organoleptic properties, carcass characteristics and internal organ profile of finisher broilers fed sundried cassava peel meal blended with palm oil sludge. *International Journal of Agriculture and Environmental Research*, 8(6), 1–22.

4. Devendra, C. (1977). Utilization of feeding stuff from oil palm. Proc. National Workshop on Oil Palm By product Utilization. 14th-15th December, 1977. Kuala Lumpur. pp 131–166.
5. Feedipedia 2016. Animal Feed Resources Information System - INRA CIRAD AFZ and FAO © 2012-2016 | [http://www.feedipedia.org/node/15395\[08/12/2016 18:13:18\]](http://www.feedipedia.org/node/15395[08/12/2016 18:13:18])
6. Hertrampf, J. (1988). Unconventional feedstuff for livestock. *MuhleMishfulterChnik* 125(9): 103-109
7. Bobadoye, A.O., Onibi, G.E. and Fajemisin, A.N. (2006). Performance Characteristics and muscle fat contents of broiler finishers fed diets containing palm oil sludge as a partial replacement for maize. *Journal of Agriculture, Forestry and the Social Sciences* 4(2): 162-169.
8. Atuahene C.C., Donko A. and Ntim I. 2000. Blend of Oil Palm Slurry and Rice Bran as feed ingredient for Broiler Chickens. *Animal Feed Science & Technology* *3 (2000) 185-193.
9. SAS 2002. Statistical Analysis Systems, Carey, North Carolina USA.
10. Yunana, Y.L., Kabir, M. and Mallam, I: (2019). Effect of varying levels of energy and protein on performance of Ross breed broiler chickens. *Nigerian Journal of Animal Science* 2019, 21 (2): 253-259
11. Saleh F., Ohtsuka A., Tanaka T and Hayashi. K. (2003), Effect of enzymes of microbial origin on in-