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PROXIMATE, MINERAL ANALYSIS AND GROWTH PERFORMANCE OF BROILER CHICKENS FED DIETS CONTAINING PALM OIL MILL EFFLUENT

Agida, C. A., Ukoha, O. A., Ukachukwu, S. N., and Amaefule, K.U.
Department of Animal Nutrition and Forage Science, Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State, Nigeria
Corresponding Author's email: agidachrisagboje@gmail.com

ABSTRACT
A 56-day feeding trial was conducted to assess the effect of replacement levels of 0, 6, 12, 18, and 24% of energy supplied by maize in a controlled diet with energy from palm oil mill effluent (POME) using 225 marshal strain broiler chickens allotted to the diets having 3 replicates with 15 birds per replicate. The experiment was conducted at the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State. Data collected were subjected to analysis of variance in CRD and Duncan's New Multiple Range Test to separate significant means using SPSS 200. Water and diets were offered ad-libitum. It was observed that air drying POME for 21 days improved the dry matter (21%), crude protein (10.17%), ether extract (19.20%), crude fibre (8.13%) and ash (6.38%) over the freshly collected POME. The mineral composition of POME was not significant ($p>0.05$). The growth performance of broiler chickens was significant ($p<0.05$) in all the parameters evaluated. Inclusion of POME up to 12% in the diets resulted to a comparable daily feed intake with the control diet. However, the average daily feed intake significantly ($p<0.05$) decreased as inclusion level of POME increased above 12%. Feed Conversion Ratio (FCR) was significantly ($p<0.05$) affected by the treatments. Diet 3 (12% POME) showed the best FCR (2.08) with protein efficiency ratio indicating that it was well utilized by the birds. Feed cost analysis was significant ($p<0.05$) in all parameters evaluated. Cost per kg weight gain was lower in diet 3 (12% POME). The results show that inclusion level of Palm Oil Mill Effluent at 12% in the diet replacement with maize is recommended for broiler chickens diet, with better performance and lower feed cost.

Keywords: POME, Maize, Growth performance, broiler chickens, and proximate composition

Introduction

Near zero cost alternative feedstuff search for Nigeria livestock industries is necessitated by high cost of conventional feeds which are in high demands for human and industries (Akinmutimi, 2004). There are also needs for the use of suitable feeds in nutrition of farm animals and to help control environmental pollution. This can go a long way in solving the problem of feed scarcity for farm animals hindering animal husbandry in South-East Nigeria (Anigbogu and Ibe, 2005). Goh and Rajion (2007) reported increased use of indigenous feed resources to reduce the cost of imported feed in developing countries. Nigeria's population growth demands increased supply of animal products, which directly require the increased demand for feedstuffs, especially energy feed sources, important among which are the cereal grains. However, there is competition for the cereal grains especially maize by both human and livestock and this has made it scarce and increased its cost. Palm oil mill effluent has been reported to constitute environmental pollution. Palm oil mill effluent (POME) is a liquid waste from palm oil mills which consists 95% water and 5% fibrous fruits residues and a small amount of palm oil (Kaida *et al.,* 1998). POME has a biochemical oxygen demand (BOD) of 25000-30000 mg/l which is highly polluting (Anon, 1982).

Studies have shown that POME has been treated in so many ways leading to the production of many by-products (APHA, 1998; APOC, 2001). In Nigeria, there is poor utilization of agro-industrial by-products like POME due to negligence in harnessing indigenous crops by-products and agro-processing wastes. POME, when properly harnessed by the application of both organic and biotechnological measures can serve the purpose of both energy and protein source for farm animals. POME, are little known and used in livestock feeds in Nigeria. It is an integral source of oil palm mill processing waste mostly collected during the processing of palm oil, through decanted local processing methods. Collection, processing and preservation of POME for livestock feeds have posed a technical problem. Rancidity of the POME is high due the colloidal oil suspension inherent in the material. It is a highly polluting material, due to its high biological oxygen demand (BOD), low PH and colloidal nature. It was estimated that a processing plant with a capacity of 10tons fresh fruit per hour would need a water treatment plant comparable to that required by a population of half a million inhabitants Heuze *et al.,* (2015) also estimated that an industrial oil palm mill produces about 2.5tonnes of effluent per ton of effluent of fresh fruit. The issue of anaerobic fermentation of POME is that it releases green gases (methane and carbon dioxide) that contribute to global warming (Heuze *et al.,* 2015). Communities located near oil mills may also suffer from odour emissions caused by poorly managed effluent treatment systems (Chavalparit; 2006).

There have been numerous attempts to convert POME into an important viable animal feed resource, while artificial drying methods have been discontinued, due to excessive fuel cost and the large capital investment required. The conversion of fresh POME into potential feedstuff involved fermentation (anaerobic, thermophillic and acidophilic), followed by concentration (centrifugation or decantation down to 15 to 20% dry matter) (Perez, 1997; Chavalparit, 2006; Heuze, 2015). Further drying was reported to have involved the use by absorption of dry feeds such as cassava roots, dehydrated grass or palm kernel meal (Perez, 1997) or by conventional drying methods (Chavalparit, 2006). The local oil palm processing industries in Nigeria has high potentials for the production of high-volume POME required to meet the value added advantages in all round usage as animal feed from agro-industrial by-products. This study was aimed at assessing the proximate, mineral composition and growth performance of broiler chickens fed diets containing palm oil mill effluent.

Materials and Methods

Experimental site

The experiment was carried out at the Poultry unit, Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Umuahia, Abia State. The farm is located on latitude 05^0 29^1 North and longitude 07^0 32^1 East. The farm lies in the altitude of 122m and within the rainforest zone of South-East Nigeria, which is bimodal rainfall pattern and total annual rainfall of 2177mm, maximum ambient temperature range of 22 to 36^0 C during the hot dry season of the year (November-March) and minimum ambient temperature range of 20to 26^0 C during the cold rainy season (April-October). The relative humidity ranges from 50-90% and is located in warm humid tropics (NRCRI, 2017).

Experimental birds and diets

Two hundred and fifty (250) day old unsexed broilers of marshal strain were brooded in a deep litter for 1 week and then allocated to five treatment diets designated D_1, D_2, D_3, D_4 and D_5 and replicated 3 times with 15 birds per replicate. The palm oil mill effluent was included in the diets at 0%, 6%, 12%, 18% and 24% respectively. Water and feed were given *ad libitum*, while other management practices were duly carried out. The feeding trial lasted for 56 days after which a bird was randomly selected from each replicate and slaughtered by severing the jugular vein and used for assessing the growth and carcass characteristics.

Data Collection: Growth

Voluntary daily feed intake was recorded by subtracting the leftover from the amount fed. Feed conversion ratio was expressed by the ratio of average daily feed intake to the average daily weight gained. Daily protein intake and protein efficiency ratio, were expressed according to (Kamran *et al.,* 2008). Broiler performance efficiency factor was expressed by the daily weight gained in kg divided by the feed conversion ratio multiply by 100 (Kamran *et al.,* 2008). Carcass proportion was calculated by the different cut parts divided by the live weight multiplied by 100. Feed cost analysis was also carried out thus: cost of a kg weight gained equals feed conversion ratio multipled by cost of a kg of feed, cost of feed consumed equals total feed intake in kg multiplied by cost of a kg of feed, cost of broiler performance efficiency factor equals ratio of cost of a kg of feed to broilers performance efficiency factor (Kamran *et al.,* 2008). Proximate composition, mineral and gross energy were determined using (AOAC, 1995) method of chemical analysis.

Statistical Analysis

The experimental design used was completely randomized design (CRD). The model is as shown below:

$$Y_{ij} = \mu \text{ x } Ti + e_{ij} \quad (1)$$

Where;
Y_{ij} = single observation
μ = the overall mean
Ti = effect of treatment / factor of interest
e_{ij} = the random error or residual error.

Data Analysis

Data collected were subjected to analysis variance (ANOVA) as described by Steel and Torrie (1980) and significant means were separated using Duncan's New Multiple Range Tests (1980).

Results and Discussion

Table 2 shows the proximate composition of palm oil mill effluent that were freshly collected (a) and air dried for 21 days (b). Drying the POME was observed to improve the dry matter (72.88%), crude protein (10.17%), ether extract (19.20%), crude fibre (8.13%), and ash (6.38%). This made it comparable to maize with about 9.89% crude protein (Ortega *et al*., 1986). The metabolizable energy content is relatively moderate (2810kcal/kg and 3953kcal/kg) makes it a good source of digestible energy in poultry nutrition. This is evident in the energy boost of the diets that had POME, than the control. The mineral compositions of the dried POME were not significantly different (p>0.05) from the fresh one. The calcium and phosphorus contents of fresh POME and the air-dried POME were similar (0.193; 0.381 respectively).

Growth performance of Broiler chickens fed diets containing varying levels of POME: The growth performance of broiler chickens fed diets containing different levels of POME is presented in Table 3. There were significant differences (p<0.05) in all the parameters evaluated. Inclusion of POME up to 12% in the diet resulted to a comparable daily feed intake with the control diet. The total feed intake and average feed intake were significantly (p<0.05) influenced by the treatments diet. However, the average daily feed intake significantly (p<0.05) decreased as inclusion level of POME increased above 12%. These results were different (p<0.05) from that reported by Faradonbeh *et al.,* (2011). The high feed intake observed in diets 1, 2, and 3 as compared to diets 4 and 5 could be due to the energy level and particle size of the test ingredient. Birds eat to satisfy their energy needs, thus, more feed intake in the control which reduced as energy level of diets increased and particle size of the tested ingredient. Faradonbeh *et al,* (2011) further reported increased feed intake to broiler chicken fed diets containing palm oil mill exudates improved taste or palatability of the diets. Atuahene *et al,* (2000) reported that 10% sun dried palm oil effluent of 11%moisture mixed with rice bran was fed to broiler chickens without affecting feed intake, weight gain and feed conversion efficiency.

Feed conversion ratio was significantly (p<0.05) influenced by the treatment diets. Birds on diet 2 had statistical similar feed conversion efficiency to the control. Birds fed diet 3 (12%) had the best feed conversion efficiency indicating that it was well utilized by the birds. Beyond this level of inclusion, FCR decreased (p<0.05) which could be attributed to high fibre content of the diets compared with the control and diets 2 and 3. The FCR observed from this experiment was different from that reported by Faradonbeh *et al.,* (2011). Protein efficiency ratio was significantly (P<0.05) influenced by dietary treatments. Birds fed diet 3, had the best protein efficiency ratio values implying that the birds utilized the protein more efficiently than the control and other groups. This indicates that, 6 to 12% POME inclusion in broilerchickens diet had the greatest efficacy replacement values on maize, possibly meeting the standard for protein/energy ratio.

Daily protein intake was significantly (p<0.05) influenced by the diet with diet 2 and 3 having relatively similar (p>0.05) values with the control diet. The result showed that diets 2, 3 and 1 had higher protein intakes, which increased with increased feed intake. Percentage broiler efficiency performance factor was significant, with the best efficiency performance on diet 3. POME inclusion levels in broiler chickens at 6 and 12% replacement values on maize can be achieve with no adverse effect on the birds performance index. Alikwe *et.al,* (2011) reported increased growth performance on birds fed 15% palm oil mill exudates. Improved performance was also observed in finisher broiler chickens at 5% palm oil mill sludgeinclusion in diets (Dada, 1999).

Data on carcass characteristics as presented in Table 4were significantly (p<0.05) influenced by the dietary treatment on de-feathered weight were significantly (p<0.05) influenced by treatment diets. However, were not significant (p<0.05) on breast cut, back cut, wings, thigh and dressing percentage. Birds on diets 2 and 3 were not significant with that on the control diets with de-feathered, dressed weight and percentage drum stick. Carcass yield is related to growth performance.

Cost benefit of broilers production fed POME as presented in Table 5, showed that cost per kg weight gain, cost of total feed consumed and cost of broiler performance efficiency factor were significantly (P<0.05) influenced by the treatment. Cost per kg weight gain had the least cost on broiler chickens fed diet 3. The result agrees with that reported by Bobadoye *et al,* (2006) and Alikwe *et al,* (2011) given an indication that supplementation of POME 20% with maize has economic benefit and can be used to reduce cost of feed in poultry production

Conclusion

Results show that replacing maize with, 6 and 12% palm oil mill effluent in broiler chickens diets had no adverse effect on growth performance. It is evident that from the feed cost analysis that broiler production will be enhanced with POME supplementation at minimum Feeding broiler chickens with POME inclusion reduced feed cost. The downward trend of the average feed intake as level of inclusion increased in the diet could be an indication of particle size of the tested ingredient.

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Table 1: Composition of experimental diets

Diets *	1	2	3	4	5
Ingredient (%)	**0**	**6.0**	**12.0**	**18.0**	**24.0**
Maize	57.9	51.9	45.9	39.9	33.9
Soya bean meal	35.6	35.6	35.6	35.6	3.56
POME	-	6.0	12.0	18.0	24.0
Fish meal	3.00	3.00	3.00	3.00	3.00
Bone meal	1.50	1.50	1.50	1.50	1.50
Oyster shell	1.00	1.00	1.00	1.00	1.00
Vitamin/mineral premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total (kg)	**100**	**100**	**100**	**100**	**100**
Crude Protein (%)	19.518	19.639	19.758	19.878	19.999
ME (kcal/kg)	2955.6	3142.8	3330.0	3517.2	3704.4
Ether Extract (%)	3.46	3.84	4.55	4.58	4.93
Crude Fibre (%)	2.92	4.02	5.18	6.20	7.23

Vitamin-mineral premix supplied (per kg of diet); Vitamin A, 1500Iu, Vitamin D3 1600Iu, Riboflavin 9.0g, Biotin 0.25mg, Partothenix acid 6.0mg, Vitamin B2 2.5mg, Vitamin B12 8.0mg, Nicotinic acid 8.0mg Iron 5.0mg, Manganese 10mg, Zinc 4.5mg, Cobalt 0.02mg, Selenium 0.01mg.

Table 2: Proximate and Mineral Composition of palm oil mill effluent

	POME(a)	**POME(b)**
Dry matter (%)	56.14	72.88
Crude protein (%)	7.50	10.17
Ether extract (%)	13.23	19.20
Crude fibre (%)	6.77	8.13
Ash (%)	4.72	6.38
Nitrogen free extract (%)	40.66	56.14
Metabolizable energy (kcal/g)	2810	3953
Na (%)	0.178	0.178
K (%)	0.372	0.371
Ca (%)	0.193	0.193
P (%)	0.381	0.381
Mg(%)	0.246	0.246
Fe (mg/kg)	156.571	156.570
Zn (mg/kg)	26.662	26.104
Cu (mg/kg)	3.431	3.430
Ma (mg/kg)	8.116	8.139

The analyses were determined on calculated dry matter basis.
POME (a) is freshly collected Palm Oil Mill Effluent,
POME (b) is air dried Palm Oil Mill Effluent at 21 days.

Table 3: Performance of broiler chickens fed diets containing palm oil mill effluent

Diets	**1**	**2**	**3**	**4**	**5**	**SEM**
Initial live weight (g)	50.00	50.00	50.00	50.00	50.00	
Total feed intake (g)	4362.30^{a}	4327.76^{a}	4243.48^{a}	3477.77^{b}	3651.95^{b}	115.92
Final live weight (g)	1933.33^{a}	1933.33^{a}	2093.33^{a}	1373.81^{b}	1472.22^{b}	81.31
Average daily weight gain (g/bird/days)	33.63^{a}	33.63^{a}	36.49^{a}	23.64^{b}	25.39^{b}	1.45
Average daily feed intake (g/bird/days)	77.90^{a}	77.28^{a}	75.78^{a}	62.10^{b}	65.21^{b}	2.07
Feed conversion ratio	2.32^{b}	2.30^{b}	2.08^{a}	2.64^{c}	2.57^{c}	0.06
Protein efficiency ratio	2.28^{b}	2.26^{b}	2.52^{a}	1.96^{c}	1.99^{c}	0.06
Daily protein intake (%)	14.72^{a}	14.92^{a}	14.47^{ab}	12.05^{c}	12.78^{bc}	0.37
Broiler efficiency performance factor (%)	1.43^{b}	1.47^{b}	1.76^{a}	0.90^{c}	0.99^{c}	0.09

Values on the same row followed by the same letter(s) superscripts are not significantly different (P>0.05). Values on the same row followed by different letter(s) superscripts are significantly different (P<0.05). SEM: Standard Error of Mean

Table 4: Carcass characteristics of broiler chickens fed diets containing palm oil mill effluent

Diets	1	2	3	4	5	SEM
De-feathered weight (g)	1750.00[a]	1640.00[ab]	I566.67[b]	1116.67[c]	1033.33[c]	84.94
Dressed weight (g)	1210.00[a]	1130.00[ab]	1061.67[b]	790.00[c]	763.33c	53.83
Dressing %	64.90	61.62	65.22	62.24	66.97	1.28
Breast cut %	28.49	28.57	25.70	28.15	25.53	0.90
Back cut %	18.63	20.98	19.89	21.33	21.31	0.91
Wings %	13.51	13.96	14.16	15.05	14.25	0.26
Drum stick %	13.82[b]	14.85[ab]	15.46[ab]	16.46[a]	16.46[a]	0.35
Thigh %	17.00	17.15	17.50	17.33	17.98	0.33

Values on the same row followed by the same letter(s) superscripts are not significantly different (P<0.05). Values on the same row followed by different letter(s) superscripts are significantly different (P<0.05). SEM: Standard Error of Mean

Table 5: Feed cost analysis on broilers production fed palm oil mill effluent

Diets	1	2	3	4	5	SEM
CWG (₦)	259.90[a]	252. 17[a]	223. 20[b]	276.90[a]	263. 86[a]	5.82
CTFC (₦)	488. 86[a]	474. 15[a]	455.58[a]	365.24[b]	374.94[b]	15.78
CBPEF (₦)	78.14[b]	78.14[b]	61.33[b]	118.02[a]	104.18[a]	6.03

Values on the same row followed by the same letter(s) superscripts are not significantly different (P<0.05). Values on the same row followed with different letter(s) superscripts are significant (P>0.05).
CWG = Cost of kg weight gain
CTFC = Cost of total feed consumed
CBPEF - Cost of broiler performance efficiency factor.
SEM: Standard Error of Mean