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Effect of different dietary levels of palm kernel cake on growth, percentage organ weights, haematological profile and serum biochemistry of pullets

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Palm kernel cake (PKC), a cheap, agro-industrial by-product has been found to be an alternative protein source in poultry diets. The study was carried out to investigate the effects of feeding graded levels of PKC on growth, percentage organ weights, hematological indices and serum biochemistry of pullets. One hundred and twenty-six (126) eight weeks old Lohmann Brown pullets were fed three experimental diets containing 0, 20 and 40% PKC levels till point of lay at 18th week of age. At the end of the feeding trial, one bird from each replicate was slaughtered and the blood collected for hematological and serum biochemistry analyses after which the dressing percentage and percentage organ weights were determined. Results from the experiment showed that increases in PKC levels resulted in significant increases ($P < 0.05$) in the final live weight and daily weight gain, but did not affect feed intake and feed conversion ratio ($P > 0.05$) of the pullets. There was a significant reduction ($P < 0.05$) in feed cost/kg weight gain, but dressing percentage, organ proportions and hematological profile were not affected ($P > 0.05$), even when dietary levels of PKC were increased to 40%. It was concluded that pullets could be profitably reared on diets containing up to 40% PKC.

Key words: Palm kernel cake, pullets, organ weights, hematology, serum biochemistry

Introduction

Presently, a deficit of food protein afflicts the greater majority of the human race. Most seriously afflicted are the populations of the Far East and much of Africa, the peoples of the West Indies and Central America and large groups in South America and Europe. In Nigeria, the deficiency of animal protein has been continuous because the numbers of cattle, poultry, sheep, goats and pigs are small in relation to human demand. Intake of animal protein in Nigeria was reported as 4.82 g/caput/day (Tewe, 1997) as against a minimum requirement of 35 g recommended by the FAO (1986) and ILCA (1980). A

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world Bank Assisted National Agricultural Research Strategy Plan (1996 - 2010) projected animal protein supply of 5.322 g/caput/day, for the estimated population of 159 million in 2010. There is, therefore, a massive pressure on animal production to satisfy the rising demand for animal protein. Livestock and poultry productivity have to be increased to enhance animal protein supply. Poultry production is believed to be a more feasible means of bridging the animal protein deficit because of its numerous advantages. Poultry is the most prolific farm animal, has a high growth rate and short generation interval and adapts well to different environments.

However, cereal grains such as maize, the major conventional source of energy in poultry and human diets is also a major raw material in brewery and confectionary industries. Legumes, such as groundnut which is a rich plant protein source for livestock, and especially poultry is also an important human food. Competition for the available maize and groundnut cake has resulted in the scarcity and high cost of these products which in turn has resulted in the rising cost of compound feeds in Nigeria. Presently feed cost alone represents 70-80% of the total cost of poultry production (Esonu, 2000; Ukachukwu *et al*, 2000). This has pushed the price of animal products far beyond the reach of an average Nigerian, resulting in inadequate protein intake for the majority of the citizenry.

Consequently, research efforts are now directed towards the use of agro-industrial by-products such as palm kernel cake (PKC) and farm residues as alternative cheap and less competitive sources of livestock feeds. Commercial exploitation of PKC as animal feedstuff in Nigeria is a recent event. Although PKC supplies both protein (15 – 16%) and energy to livestock and poultry it is regarded more as a protein source. It was ranked a little higher than copra cake but lower than fishmeal and groundnut cake, especially in its protein value (Chin, 2002).

The main objective of this study was to determine the effects of feeding graded levels of palm kernel cake on growth performance, carcass characteristics, hematological profile and serum biochemistry of pullets.

Materials and methods

Experimental Birds and Feeding Trial: One hundred and twenty-six (126) Lohmann Brown day-old pullets were raised for 8 weeks on proprietary chick mash and used in this study. Three levels of PKC (0%, 20% and 40%) were incorporated in three diets formulated to provide 11.09 - 11.11 MJ/Kg metabolizable energy (ME) and 16.1 – 16.3% crude protein (CP). The ingredient composition and calculated chemical composition of the experimental diets are shown in table 1.

Table 1. Ingredient composition and calculated chemical composition of experimental pullet diets

Ingredients (%)	**PKC levels (%)**		
	0	20	40
Maize	43.0	33.0	26.0
Maize grit	20.0	17.5	14.5
Soybean meal	7.0	7.0	2.0
Fish meal	4.0	4.0	2.0
Brewers dried grain	9.0	3.0	4.0
Palm kernel cake	0.0	20.0	40.0
Wheat offal	13.5	14.0	8.0
Bone meal	3.0	3.0	3.0
Salt	0.25	0.25	0.25
Vitamin/mineral premix	0.25	0.25	0.25
Calculated chemical composition			
Crude protein	16.31	16.28	16.10
Crude fibre	5.00	6.13	7.19
Crude fat	4.38	4.74	4.80
Calcium	1.27	1.24	1.27
Phosphorus	0.99	1.03	1.06
Ash	3.91	3.89	4.11
Metabolizable energy (MJ/Kg)	11.09	11.09	11.11

Forty two (42) birds were assigned to each treatment and subdivided into two replicates of 21 birds each. Feed and water were provided ad-libitum. Left over feed was weighed every morning and thereafter discarded. The feeding trial ended when the birds attained 18 weeks of age. Weights of birds were recorded at the beginning of the experiment (8th week of age) that is before the birds were assigned randomly to the treatment diets. Thereafter the weights were taken on weekly basis until the 18th week when the experiment was terminated. Determination of feed intake was undertaken on daily basis.

Slaughter of Birds and Blood Sampling: At the end of the experiment, one bird from each replicate was slaughtered and the weights of the carcass, organs, shanks, intestines, head, drumsticks and drumstick bones determined. During slaughter, blood samples for haematological analysis were collected in ethylene diaminetetra-acetic acid (EDTA) treated bottles while samples for serum biochemical analysis were collected in bottles without the anticoagulant. Blood samples were quickly stored in ice until analyses were carried out not later than twelve hours post sampling.

Blood analyses: Haemoglobin concentration (HBC), packed cell volume (PCV), total red blood cell (RBC), total white blood cell (WBC) and differential white cell counts (percentage neutrophils, lymphocytes and eosinophils) were determined following the methods described by Dein (1984).

The mean corpuscular haemoglobin (MCH), mean corpuscular volume (MCV) and mean corpuscular haemolgobin concentration (MCHC) were calculated.

HBC was determined with the cyanmethemoglobin method (HBM) using Gallen Kamp Colorimeter, while PVC was measured using Hematocrit tubes arranged vertically in a normal blood sedimentation rack. Blood sample was treated with sodium citrate, and thereafter with formaldehyde in order to haemolyse the white blood cells. Then Haemocytometer was used to determine RBC under a 10-fold magnification of the Olympus microscope. Total white blood cell (WBC) counts was also measured using the Haemocytometer counting chamber, except that prior to counting samples were treated with glacial acetic acid to haemolyse the red cells. After appropriate staining (with Leishman's stain), and washing off the stain following standard procedure, the differential white cell counts were determined under 100-fold magnification of the Olympus microscope.

Blood glucose level was determined using the glucose oxidase method (Trinder, 1969), whereas calcium level was determined by the calcium complexone technique (Lorentz, 1982), and phosphorus by the molybdate methol method (Dryer and Routh, 1963). Determination of blood creatinine level was according to Heinegard and Tiderstrom (1973), and cholesterol level by the enzymatic method of Abell *et al*. (1952).

Statistical Analysis: Data analyses were executed using analysis of variance for the completely randomized block design (CRBD), with replicates serving as blocks. When treatment and block effects were not significant, data were reanalyzed for dietary effect only using the completely randomized design (CRD). Significant differences between means were determined using the Duncan's New Multiple Range Test (DNMRT) as outlined by Obi (1990).

Results and discussion

The feed intake and live weight gain of pullets are shown in table 2. There were significant ($P < 0.05$) increases in the final live weight and daily gain of the growers with increase in the level of palm kernel cake. The daily weight gain of the growers was significantly lower ($P < 0.05$) in birds fed 0% PKC diet compared to those fed 20% and 40% PKC diets.

Table 2. Performance of pullets on different levels of palm kernel cake (PKC)

Parameters	PCK levels (%)			
	0	20	40	SEM
Av. initial live weight (g/bird)	375.00	370.00	360.00	2.89
Av. final live weight (g/bird)	1183.50^{b}	1275.00^{a}	1340.50^{a}	15.88
Av. daily gain (g)	11.55^{b}	12.93^{a}	14.00^{a}	0.20
Av. daily feed intake (g)	61.50	66.00	68.00	2.02
Av. feed conversion ratio	5.33	5.11	4.86	0.12
Av. feed cost/kg gain (N)	295.91^{a}	247.92^{b}	211.06^{c}	3.07

^{a,b,c} Means within a row with different superscripts are significantly different ($P < 0.05$)
Av = Average

Feed intake was not significantly different ($P > 0.05$) but generally increased with increasing level of PKC. These results are in agreement with the results of Onwudike (1986a) who noted that the protein from groundnut cake can be completely replaced by PKC protein in the diets for grower pullets without any deleterious effect on the performance of the birds. He also noted that palatability was not affected by PKC inclusion in both starter and grower pullets. There was a significant ($P < 0.05$) reduction in feed cost per kilogram weight gain of the pullets with increasing level of PKC in the diet. Onwudike (1986b) in his study on broilers has also concluded that the use of PKC to replace GNC will reduce cost of production while Osei and Amao (1987) reported a "considerable reduction" in feed costs by using PKC in broiler feeds.

The effect of the dietary levels of PKC on carcass and organ weights of the pullets is shown in table 3. Although percentage head, shanks, heart, liver + gall bladder and intestines were greater in the control group (O% PKC) than in the PKC groups, there were no significant differences ($P > 0.05$) in any organ proportion across the treatment groups. This shows that PKC inclusion up to the 40% dietary level has no significant effect on carcass and organ characteristics.

Table 3. Effect of feeding different levels of palm kernel cake (PCK) on dressing out percentage and percentage organ weights

Parameters	**PCK levels (%)**			
	0	20	40	SEM
Plucked weight (% live weight)	85.57	87.19	82.95	1.91
Dressing out percentage	64.74	66.52	60.98	1.99
Organ weights (% live weight)				
Head	3.34	2.99	3.13	0.19
Shanks	4.11	3.93	3.74	0.10
Heart	0.41	0.38	0.38	0.01
Liver + gall bladder	2.31	1.96	2.16	0.07
Full gizzard	4.44	5.45	6.00	0.28
Empty gizzard	3.46	3.86	4.17	0.23
Intestines	6.17	5.63	5.92	0.22
Drumstick	4.85	5.11	4.70	0.34
Drumstick bone	1.39	1.40	1.39	0.03

Adesida *et al*. (2010) reported that treatment effect were not significant in all carcass components when they fed 40% PKC diet to grower cockerels. Okeudo *et al*. (2005) observed that carcass weight, percentage drumstick content and dressing percentage were similar across the dietary groups when they fed finisher broilers graded levels of PKC up to the 30% inclusion rate. Okon and Ogunmodede (1996) showed that heads and intestines of broiler chicks reared on 25% PKC diet were smaller than those of broilers reared on 0% PKC diet. Although percentage plucked weight, dressing out percentage, percentage drumstick and drumstick bone weights were higher in the 20% PKC group than in their counterparts fed 0% and 40% PKC diets, the differences were not significant (P > 0.05).

There was a slight decrease in percentage shank weight while percentage gizzard weight increased with increasing PKC levels. These results support earlier reports indicating that percentage shank weight was smaller in broilers fed PKC diets than in their counterparts fed 0% PKC diet (Okeudo *et al.*, 2005). Onwudike (1986b) and Okeudo *et al* (2005) observed a significant increase in gizzard size with increasing inclusion of PKC in the diet, supporting the earlier reported positive influence of dietary fibre on gizzard size (Kubena *et al*., 1974; Deaton *et al*., 1977).

Hematological and serum chemical values of the pullets are shown in table 4. There were no significant differences in all the parameters measured (P > 0.05).

Table 4. Hematological and serum chemical parameters of pullets fed diets containing graded levels of palm kernel cake (PKC)

Parameters	PKC levels (%)			SEM
	0	20	40	
Hemoglobin (g/100 ml)	7.80	5.78	7.58	0.56
PVC (%)	23.00	17.00	22.00	1.73
RBC (x10^6 /µl)	3.96	3.36	3.76	0.20
MCV (fl)	20.00	17.00	21.00	0.82
MCH (pg)	197.26	170.69	201.47	6.96
MCHC (%)	19.00	16.50	19.50	0.91
Total WBC (x 10^3/l)	4.20	4.60	4.50	0.29
Heterophils (%)	39.00	45.50	35.00	5.20
Lymphocytes (%)	58.00	52.00	61.00	4.65
Eosinophils (%)	3.00	2.50	4.00	0.87
Serum biochemical parameters				
Glucose (mg/dl)	195.00	137.50	234.50	36.99
Calcium (mg/dl)	10.00	10.00	12.00	1.15
Phosphorus (mg/dl)	4.63	4.22	4.22	0.54
Creatinine (mg/dl)	0.72	0.54	0.72	0.13
Cholesterol (mg/dl)	120.00	156.00	148.00	21.91

PVC- Packed cell volume (Hematocrit)
RBC- Red blood cell counts
MCV- Mean corpuscular volume
MCH- Mean corpuscular hemoglobin
MCHC-Mean corpuscular hemoglobin concentration
Total WBC- Total white blood cell counts (leucocytes)

The hemoglobin (Hb) values, 7.80 and 7.58g/100 ml, recorded in the 0% and 40% PKC groups are within the normal range (7.0 – 18.6 g/100 ml) stated by Mitruka and Rawnsley (1977) for chickens, but the 5.78g/100 ml recorded by the 20% PKC group was a little lower, though the differences were not significant (P > 0.05). Afolabi *et al*. (2010) reported hemoglobin values of 11.5 ± 0.3 – 13.1 ± 0.5 g/dl when they fed varying dietary levels of PKC to local chickens. Hemoglobin values of 6.3 -7.8 g/dl (Mmereole, 1996) and 8.7 - 9.3 g/dl (Ikhimioya *et al*., 2000) have been reported for the Nigerian indigenous chicken.

The values for packed cell volume (PCV) ranged from 17 - 23 %. These values were lower than 24.9 – 45.2 % stated for healthy chickens by Mitruka and Rawnsley (1977), for the Nigerian indigenous chicken and 30 - 40% for laying hens (Esonu *et al*., 2006). Hematological values of poultry are influenced by age, sex, breed, climate, geographical location, season, day length, time of day, nutritional status, life habit of species, present status of individual and other factors (Duke, 1955).

The red blood cell (RBC) counts ranged from 3.36 - 3.96 (x 10^6/µl). The values for mean corpuscular volume (MCV), mean corpusscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) were 17 - 21 fl, 170.69 - 201.47 pg and 16.5 – 19.5 % respectively. These values differed from those reported for laying hens by Olorede and Longe (2000). Their figures for RBC, MCV, MCH and MCHC were 1.66 – 1.80 (x10^6/l), 169.09 - 172.00 fl, 46.9 - 49.1 pg and 29.0 - 29.2 % respectively. The differences may be attributed to age as they worked with older laying pullets while the birds used in this study were pre-laying pullets of 18 weeks of age.

The values for WBC ranging from 4.2 - 4.6 (x10^3/l) were lower while the values for RBC, 3.36 - 3.96 (x10^6/µl), heterophils (35.0 - 45.5 %), lymphocytes (52.0 - 61.0 %) and eosinophils (2.5 – 4.0 %) were within the normal range for a healthy chicken (Afolabi *et al.*, 2010; Ikhimioya *et al*, 2000; Mmereole, 1996; Mitruka and Rawnsley, 1977; Banks, 1974). However, Esonu *et al* (2006) have reported a WBC count of 8.0 - 9.3 (x 10^3/l) and a lower lymphocyte count of 41.0 – 46.0 % for laying hens. The differences may be due to the differing ages of the birds. Evidence suggests that hematological test results may vary depending on age, handling conditions, the immediate environmental conditions and many other factors (Fischbach and Dunning, 2004; Duke, 1955). Hematological values were slightly lower in the 20% PKC group than the 0% and 40% PKC groups except the total WBC and heterophils that were slightly higher. The MCHC of the 20% PKC group was lower than that of the 0% and 40% PKC groups. Nicoll *et al.* (2001) had made a similar observation as they reported that MCHC is decreased in high WBC condition. The hemoglobin and RBC values obtained in this study indicate that the birds were healthy and not anemic.

The glucose level was slightly higher in the 40% PKC group than in the 0% and 20% PKC groups. The high glucose level may be linked to the slightly higher energy of the feed consumed by the birds in this group.

The values for cholesterol (120 – 156 mg/dl) were higher than 96.9 – 106.6 mg/dl while creatinine (0.54 – 0.72 mg/dl) were lower than 0.83 – 0.92 mg/dl) reported by Olorede and Longe (2000) for laying hens. The higher calcium level (12 mg/dl) recorded by the 40% PKC group may be a result of the slightly higher calcium level of the feed consumed by this group.

Conclusion

Inclusion of PKC in pullet diets at the 20% and 40% levels resulted in superior daily weight gains compared with the 0% level. Neither feed intake nor feed conversion ratio was affected and there were progressive reductions in feed cost/kg weight gain indicating that up to 40% PKC could be included in pullet diets to minimize cost of production. Rearing pullets on diets containing up to 40% PKC level had no effect on dressing percentage, organ proportions, hematological and serum chemical indices.

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