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Full Length Research Paper

Nutritional evaluation of palm kernel meal types: 2. Effects on live performance and nutrient retention in broiler chicken diets

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Studies were conducted to determine the effect of palm kernel meal (PKM) types on productive performance and nutrient retention of broiler chickens. The three PKM types used in this study were obtained from different sources and were processed using different methods or different types of kernel. The results obtained indicated that for the starter phase, Okomu and Presco PKM diets gave mean body weight gain values (g/bird) of 924.1 and 922.0 which were similar to that of control diet (955.1) but superior to that of Envoy PKM diet (823.4). Feed intake values were 1802.0, 2087.1, 2017.8 and 1924.44 g/bird; feed cost per bird (₦) was in the order of 94.82, 87.28, 84.38 and 77.02 for control diet, Okomu, Presco and Envoy PKM diets, respectively. For the finishing phase, Okomu and Presco PKM diets which were comparable in all the parameters were superior to Envoy PKM in terms of final body weight and body weight gain. Feed intake values were 2869.5, 3280.9, 3106.4 and 2674.0 g/bird for control diet, Okomu, Presco and Envoy PKM diets (Diets 1, 2, 3 and 4), respectively. Feed cost per bird (₦) was 145.93 for Diet 1, compared with 127.45, 119.72 and 99.01 for Okomu, Presco and Envoy PKM diets, respectively. Percentage nutrient retention was optimal for animal performance on the PKM based diets. It can be concluded that mechanically processed PKM can replace 50% of maize in the diet without any adverse effect on performance of broiler chickens.

Key words: Palm kernel meal, productive performance, nutrient retention, broiler chicken, diets.

INTRODUCTION

Palm Kernel Meal (PKM) has been widely used in poultry diets as a protein source to replace conventional protein sources, at different levels (Fetuga et al., 1977; Armas and Chicco, 1977; Nwokolo et al., 1977; Yeong et al., 1981; Onwudike, 1986a and b). The results indicated that the birds could not perform optimally with high levels of PKM except with proper balancing of diets with synthetic amino acids or fish meal suggesting that PKM may not be suitable for use as a protein source. Besides, results of random chemical analyses of PKM revealed a wide range of crude protein levels not up to 20% (Ezieshi, 2007). Moreover, information concerning the effects of different types of PKM on broiler chicken has shown that PKM can be used to partially replace maize up to a level of 50% in layer diets (Otokunefor and Olomu, 2001). Further studies are required to investigate the effect of such replacement in broiler chicken diets. The aim of this study therefore, is to determine the effect of replacing maize with different PKM types on productive performance and nutrient retention in broiler chicken diets.

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MATERIALS AND METHODS

Diets

The study was conducted in two phases; starter and finisher phases. Four diets were tested during the starter phase. Diet 1 was the control diet and did not contain PKM. Diet 2 contained PKM from Okomu. Diet 3 contained PKM from Presco while Diet 4 contained PKM from Envoy. The PKM was used to replace 50% by weight of the maize contained in Diet 1. There was no attempt to make the diets isocalloric or isoproteinous. The levels of other ingredients remained constant. The composition of the starter and finisher diets is shown in Table 1.

Table 1. Percentage composition of experimental diets.

Ingredient	Starter				Finisher			
	Diet 1 (Control; No PMK)	Diet 2 (Okomu PKM)	Diet 3 (Presco PKM)	Diet 4 (Envoy PMK	Diet 1 (Control; No PMK)	Diet 2 (Okomu PKM)	Diet 3 (Presco PKM)	Diet 4 (Envoy PMK
Maize	60.00	30.00	30.00	30.00	65.00	32.50	32.50	32.50
Palm kernel meal	00.00	30.00	30.00	30.00	00.00	32.50	32.50	32.50
Soyabean meal	35.40	35.40	35.40	35.40	28.00	28.00	28.00	28.00
Wheat offal	0.00	0.00	0.00	0.00	3.00	3.00	3.00	3.00
Bone meal	2.55	2.55	2.55	2.55	2.00	2.00	2.00	2.00
Oyster shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Salt	0.35	0.35	0.35	0.35	0.30	0.30	0.30	0.30
Premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Cost/kg diet (₦)	52.62	41.82	41.82	40.02	50.22	38.52	38.52	36.57
Calculated composition								
Crude protein (%)	23.00	26.00	26.00	26.00	20.00	24.00	24.00	24.00
ME (Kcal/kg)	3000.0	2700.0	2700.0	2700.0	3000.0	2700.0	2700.0	2700.0
Calorie: Protein (%)	130.43	103.25	103.25	103.25	150.00	112.50	112.50	112.50
Crude fibre (%)	2.71	7.33	7.33	7.33	2.83	7.84	7.84	7.84
Total Phosphorus (%)	0.35	0.43	0.43	0.43	0.70	0.86	0.86	0.86
Calcium (%)	0.11	0.22	0.22	0.22	0.65	0.79	0.79	0.79
Lysine (%)	1.44	1.64	1.64	1.64	1.22	1.44	1.44	1.44
Methionine + Cystine (%)	0.77	0.81	0.81	0.81	0.60	0.86	0.86	0.86

Experimental design

A total of 180 hybro broiler type chicks were used for the study. At one week of age, the chicks were divided into 12 similar groups on equal weight basis at 15 birds per group. Each group constituted a replicate. The average chick weight was 85 g. Three of such groups were randomly assigned to each of the four dietary treatments in a randomized complete block design. The birds were reared on deep litter in an open-sided poultry house divided into pens, each measuring about 2.5 m^2. The birds were brooded from day-old to 5 weeks of age. They were vaccinated according to schedule. Coccidiostat and antibiotics were administered at regular intervals to prevent coccidiosis and bacterial infection. Throughout the experiment, the birds were observed daily and a record of mortality was kept. Weight gain and feed intake per bird was determined at weekly intervals and feed to gain ratio was computed accordingly. Average daily water intake was determined on weekly basis. The starter phase lasted from 1 to 5 weeks of age. At five weeks of age, three birds were randomly selected from each group and transferred to metabolism cages to determine nutrient retention. Thus, there were three replicates at three birds each per treatment. After three days adaptation period, a known quantity of feed was provided for each group. Total excreta voided per group were collected at 24 hourly intervals during a 3 day collection period. The excreta samples so collected were labeled, weighed and oven-dried at 105^oC to constant weight to determine the moisture content. The dried faecal samples for each group over the three days period were bulked and finely ground to obtain a homogenous mixture. Feed intake per group was determined at the end of the 3 day period. Representative samples of feed and excreta were analyzed for proximate composition using the procedure of A.O.A.C. (2001). From the proximate composition of the feed and excreta, percentage nutrient retentions were determined as follows: % Nutrient Retention = [(Nutrient intake (g) – Nutrient output (g)) / Nutrient intake (g)] x 100.

The broiler finisher trial lasted from six to nine weeks of age. At 6 weeks of age, all the birds were mixed up and randomly divided into 12 similar groups in terms of starting weight. Each group constituted a replicate. Three replicates were assigned to each treatment diet in a randomized complete block design. Four diets were tested as with the broiler starter trial. The replacement regimen was the same as described for the broiler starter diets (Table 1). The parameters studied and methods of data collection were similar to those described for the starter trial.

Data obtained were subjected to analysis of variance in a randomized complete block design using the method described by Steel and Torrie (1980). Duncan multiple range test was used to determine significant differences among means as recommended by Alika (2006).

RESULTS AND DISCUSSION

Experiment with broiler starter chicks (1 - 5 week of age)

The results (Table 2) indicated that final body weight and weight gain were not significantly affected by the replacement of 50% of the maize in the diet with Okomu and Presco PKM (Diet 1 v Diets 2 and 3). The birds fed the Envoy PKM containing diet had final body weight and weight gain significantly lower than the birds fed the other diets (Diets 1, 2 and 3 vs. Diet 4). The result further showed that the birds on PKM diets consumed signifi-

Table 2. Effects of Okomu, Presco and Envoy palm kernel on performance of broiler starter and finisher chickens.

Performance parameter	Diet 1 (Control; No PMK)	Diet 2 (Okomu PKM)	Diet 3 (Presco PKM)	Diet 4 (Envoy PMK	SEM*
Starter phase					
Final body weight (g/bird)	1040.6^{a}	1009.7^{ab}	1013.9^{a}	906.7^{b}	23.9
Weight gain (g /bird)	955.1^{a}	924.1^{a}	922.0^{a}	823.4^{b}	21.6
Feed intake	1802.0^{c}	2087.1^{a}	2017.8^{a}	1924.4^{b}	31.50
Feed to gain ratio	1.89^{c}	2.26^{ab}	2.19^{b}	2.33^{a}	0.031
Feed cost per bird (₦)	94.82^{a}	87.28^{b}	84.38^{b}	77.02^{c}	2.08
Feed cost per kg gain (₦)	99.45^{a}	94.51^{b}	91.59^{b}	93.25^{b}	1.89
Water intake (ml/bird/day)	104.9^{c}	143.7^{b}	141.8^{b}	152.7^{a}	3.6
Water to feed ratio	1.63^{c}	1.93^{b}	1.97^{b}	2.22^{a}	0.11
Water to gain ratio	3.08^{c}	4.35^{b}	4.31^{b}	5.19^{a}	0.07
Finisher phase					
Final weight (g/bird)	2173.83^{a}	2054.5^{b}	2060.3^{b}	1923.1^{c}	39.02
Weight gain (g/bird)	1165.9^{a}	1054.5^{b}	1043.6^{b}	912.4^{c}	33.59
Feed intake (g/bird)	2869.5^{b}	3280.9^{a}	3106.4^{a}	2674.0^{c}	43.36
Feed to gain ratio	2.46^{b}	3.11^{a}	2.98^{a}	2.94^{a}	0.09
Feed cost per bird (₦)	145.9^{a}	127.5^{b}	119.7^{c}	99.0^{d}	2.5
Feed cost per kg gain (₦)	124.0^{a}	120.2^{a}	115.1^{ab}	107.8^{b}	3.9
Water intake (ml/bird/day)	253.2^{c}	352.6^{b}	359.4^{b}	424.9^{a}	5.6
Water to feed ratio	1.85^{d}	2.25^{c}	2.43^{b}	3.34^{a}	0.06
Water to gain ratio	4.56^{c}	7.03^{b}	7.21^{b}	9.82^{a}	0.35

Means within a row with same or no superscripts are not significantly ($P > 0.05$) different.
*SEM: Standard error of means.

cantly more feed than those on the control diet without PKM. Feed intake was similar for the Okomu and Presco PKM groups. The use of Envoy PKM in the diet depressed feed intake significantly. Feed to gain ratios were significantly higher for the PKM diets. Envoy PKM diet gave the highest feed to gain ratio. Feed cost per bird and feed cost per kg gain were significantly higher in the control diet than in the PKM containing diets. Okomu and Presco PKM diets resulted in significantly higher feed cost per bird than the Envoy PKM diet while the difference in feed cost per kg gain amongst the PKM containing diets were not significant. Water intake was significantly higher on the PKM containing diets than on the control diet (Diet 1 vs Diets 2, 3 and 4). The results also showed that the birds fed the diet containing Envoy PKM consumed significantly more water than those fed Okomu and Presco PKM diets, both of which had similar values for water intake. Water to gain and water to feed ratios followed the same trend as water intake.

Experiment with broiler finisher chickens (6 - 9 weeks of age)

The results of this study (Table 2) indicated that final body weight and weight gain were significantly lowered when PKM was included in the diet (Diet 1 vs. Diets 2, 3 and 4). The Envoy PKM group of birds showed lower final body weight and weight gain when compared to the Okomu and Presco PKM groups, which had almost similar values. Feed intakes were significantly higher on the diets containing Okomu and Presco PKM (Diet 2 and 3 vs Diet 1) and significantly lower with Envoy PKM (Diet 4 vs Diet 1). Feed to gain ratio was significantly lower with the control diet (Diet 1) than with the PKM containing diets (Diet 2, 3 and 4), which resulted in values not significantly different from one another. The use of PKM in the diet resulted in a significantly lower feed cost per bird. Okomu PKM diet showed a significantly higher feed cost than Presco PKM diet, which also showed higher feed cost than Envoy PKM diet (Diet 2 vs. Diet 3 vs. Diet 4). There was no significantly difference in feed cost per kilogram gain between Diet 1 (control diet) and Diets 2 and 3 (Okomu and Presco PKM diets). Envoy PKM diet showed significantly lower feed cost per kg gain than the control and Okomu PKM diets.

Daily water intake was significantly higher with the inclusion of Okomu, Presco and Envoy PKM in the diet. The use of Envoy PKM in the diet resulted in higher water intake as compared to the use of Okomu and Presco PKM diets which gave almost similar values. Water to feed ratio were significantly higher with the PKM diets than with control diet. Among the PKM diets, the Envoy PKM diet gave a significantly higher water to feed ratio

Table 3. Effects of Okomu, Presco and Envoy palm kernel meal on percentage nutrients retention by broiler starter chicks (5 weeks of age).

Performance parameter	Diet 1 (Control; No PMK)	Diet 2 (Okomu PKM)	Diet 3 (Presco PKM)	Diet 4 (Envoy PMK	SEM*
Dry matter (%)	76.84[a]	69.37[b]	66.06[b]	68.07[b]	1.49
Crude protein (%)	57.82	59.98	57.90	64.67	2.71
Crude fibre (%)	50.05	53.57	51.51	58.31	5.18
Fat (%)	58.88[b]	63.11[a]	63.31[a]	47.62[c]	1.80
Ash (%)	52.88[a]	43.21[b]	44.92[b]	42.27[b]	1.32

Means within a row with same or no superscripts are not significantly ($P > 0.05$) different.
*SEM: Standard error of means.

than Presco PKM diet which further resulted in a higher value than Okomu PKM diet. Water to gain ratios were significantly higher with the PKM diet than with the control diet. Envoy PKM diet showed a significantly higher ratio than Okomu and Presco PKM diet.

Results of balanced studies

The results of the study on nutrient retention of broiler chicks are shown in Table 3. Dry matter retention was significantly lower ($P < 0.05$) on the PKM containing diets (Diets 2, 3 and 4) where 50% of the dietary maize was replaced with PKM. Types of PKM did not significantly affect dry matter retention. Crude protein and crude fibre retention were not significantly affected by dietary treatments. However the Envoy PKM group of birds appeared to have retained more crude protein and crude fibre. The inclusion of Okomu and Presco PKM in the diet resulted in higher fat retention as compared to the control diet without PKM and the Envoy PKM diet (Diets 2 and 3 vs. Diets 1 vs. Diets 4). The Envoy PKM diets gave the least fat retention value. Ash retention was significantly higher with the control diet than with the PKM diets, which gave similar values (Diet 1 vs. Diets 2, 3 and 4).

The results showed that the replacement of 50% of the maize in diet of broiler starter chicks with PKM did not significantly depress body weight gain but resulted in significant increase in feed intake and feed to gain ratio. The optimum performance of the birds fed the PKM-based diets may be because the birds consumed adequate nutrients to meet their body requirements. For instance, the starter chicks fed the PKM-based diets consumed more crude protein (600 to 700 g/bird) than those fed control diets (418 to 599 g/bird) and the finisher chickens fed the PKM-based diets consume more crude protein than those fed control diets (574 to 628 g/bird). Results of percentage nutrient retention showed that crude protein retentions on the PKM diets were in the range of 57 to 64%, indicating that the birds retained adequate of crude protein. Percentage crude protein retention on the control diet (57.82%) was not significantly different from those on the PKM diets. Energy consumption on the PKM diets were in the range of 6000 to 7000 kcal/kg for starter chicks and 7000 to 8000 kcal/kg for finisher chickens which were close to those of the control diet, 5406 kcal/kg for starter chicks and 8607 kcal/kg for finisher chicken. The increase in feed intake by the birds was probably an attempt by the birds to consume sufficient energy for optimum performance since the replacement of 50% of the maize in the diets with PKM resulted in a reduction in dietary energy level. Olomu and Offiong (1980) and Olomu (1995) had earlier reported increase in feed intake as metabolizable energy of the diet decreased. The increase in feed intake invariably resulted in increased intake of crude protein and associated essential amino acids that were necessary for the optimum performance of birds.

The poor performance of the birds fed Envoy PKM diet may be due to the lower metabolizable energy level of the diet as compared to Okomu and Presco PKM diets. The results of the balance study (Table 3) indicated that the Envoy PKM (solvent extracted) had the lowest ME as compared to Okomu and Presco PKM, which were mechanically extracted. The lower ME content of Envoy PKM is aggravated by the high crude fibre content of the material. The increase in feed to gain ratio may be related to the increase in feed intake.

Feed cost per bird decreased in most of the experiments inspite of the high feed intake observed. This is not surprising following the marked difference in prices between maize and PKM throughout the study period. Maize was at least 4 times more expensive than PKM. Similarly, feed cost per kilogram live weight gain decreased significantly with the broiler starter chicks and finisher chickens. This may be because the increased feed intake by the birds was not accompanied by a proportional increase in body weight gain.

The replacement of 50% dietary maize with PKM generally resulted in higher water intake by the birds. The higher water intake by the birds on PKM diets may be related to the increase in feed intake which was accompanied by increased fibre intake. Feed intake has been reported to increase water intake in poultry (Dixon,

1985). Crude fibre intake was higher on the PKM-based diets than on the control diet and with the increase in feed intake, crude fibre intake was much higher. According to Neumann (1977), large amounts of water were required in the gastro-intestinal tract to soften the fibrous tissues during digestion. Therefore, the higher water intake when the birds increased feed intake could be related to an attempt by the birds to obtain more water to aid in the digestion of the crude fibre complex.

Generally, dry matter retention was significantly lower when PKM replaced 50% of maize in the diet. Palm kernel meal in diets is implicated in low nutrient retention in chickens (McDonald et al., 1990; Olomu, 1995) due to its high crude fibre content. The results of the balance studies indicated that crude protein and crude fibre retention was not significantly affected by diets. It is therefore, not surprising that the birds fed PKM diets performed very well compared to those fed control diet without PKM. Fat retention was higher on the PKM diets (except Envoy PKM diet) than on control diets probably because of the higher fat content of the PKM compared to maize which was replaced. Ash retention was significantly lower when PKM replaced 50% of maize in the diets. However, the values of ash retention observed indicated that the birds retained sufficient minerals for optimum performance.

Conclusion

From the results of the foregoing studies, it can be concluded that the mechanically extracted PKM can replace 50% of maize in the diet as an energy source without adversely affecting the performance of broiler chickens.

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