Journal of Agriculture and Social Research (JASR) Vol. 11, No. 1, 2011

PERFORMANCE AND ENERGY METABOLISM BY BROILER CHICKENS FED MAIZE AND MILLET OFFALS AT DIFFERENT DIETARY LEVELS

EZIESHI*, E. V., O. M. OBAZELE AND J. M. OLOMU
Department of Animal Science, University of Benin, Benin City, Nigeria
Corresponding author's Email: ev.ezieshi@yahoo.com

ABSTRACT
Studies were conducted to evaluate the effect of replacing maize grain with different dietary levels of maize and millet offals on performance and energy metabolism in broiler chickens. Proximate composition and metabolizable energy (ME) values were determined. Feeding trial was also conducted to comparemaize and millet offals as replacements for maize at 50 and 75% levels. The results revealed that maize offal contained 12.80% crude protein (CP), 12.07% Crude fibre (CF), 11.72% ether extract (EE), 5.42% ash and 49.91% nitrogen-free extract (NFE). Millet offal contained 20.05% CP, 8.5% CF, 5.03% EE, 5.25% ash and 52.45% NFE. The recorded ME value of maize offal was 2,225 kcal/kg while, that of millet offal was 2,506 kcal/kg compared to the 3510 kcal/kg observed for maize grain. The feeding trial indicated that at the starter and finisher phases, the replacement of maize with either ingredient increased body weights of the birds with millet offal performing better than maize offal ($p<0.05$). Feed intake tended to increase but not significantly ($p>0.05$) on the test diets compared to the control. However, the birds fed the millet offal diets consumed less feed compared to those fed the maize offal diets. The feed cost decreased on the test diets with the millet offal diets saving more cost than the maize offal diets. However, the decrease was not significant ($p>0.05$) It can be concluded that millet offal performed better than maize offal in terms of body weight gain, feed intake and feed cost per bird. However, it has been found that either of the ingredients can replace up to 75% dietary maize without any visible adverse effect on performance. .

Key words: Dietary, Maize offal, Millet offal performance broiler chickens.

INTRODUCTION

In terms of total cost, energy is the most expensive item in poultry diets because of the amount required (Olomu, 1995). Maize is a conventional energy source and is, currently, the most widely used grain crop in the Nigerian poultry industry because it provides the bulk of most poultry diets. However, the competition between its use for food by man has continued to push the price of maize higher thereby, causing instability in the poultry industry. Thus, the need to search for alternative energy sources to save the poultry industry from collapsing has since been identified because, the production of maize in quantities that could meet the country's needs has not yet been realized Onuh (2006). The use of non-conventional agricultural and agro-industrial by-products such as maize and millet offals offers the best alternative for the reduction of feed cost and prices of animal products.

Maize and millet offals are local industrial by-products obtained during the processing of maize and millet grains into pap. Both by-products are, readily, available all-year-round throughout the country and are not edible to man. They have been used over the years by small scale poultry farmers to supplement commercial mash as a way of reducing feed cost with little or no regard to their effect on performance. Results from previous studies revealed that different levels of maize offal from pap can be included in poultry diets without adverse effects on the performance of birds (Ezieshi and Olomu, 2004a; Onuh, 2006; Onuh *et al.*, 2006;). Similarly, millet offal has been successfully included in broiler chicken diets as an energy source (Ezieshi and Olomu, 2008). This study, therefore, was aimed at comparing maize offal and millet offal with maize grain in terms of their dietary contribution in broiler chickens.

MATERIALS AND METHODS

Site of study: The study was conducted in the Teaching and Research Farm of the Faculty of Agriculture, University of Benin, Benin city, Edo State, Nigeria

Experimental Diets: The maize and millet offals used for the study were obtained from different pap producers in Benin City and environs. These by-products, which were obtained wet were subsequently sun-dried and then milled before being incorporated into the diets. The study was conducted in two phases: the broiler starter and finisher phases. Five diets were tested during each phase and the replacement regimen was the same for both phases. Diet 1 served as control diet and was formulated to meet the nutrient requirements of broiler starter or finisher birds according to the recommendation of Olomu (1995). In Diets 2 and 3, maize offal replaced 50% and 75%, respectively of the maize contained in Diet 1. In Diets 4 and 5, millet offal replaced 50% and 75%, respectively of the maize in Diet 1. The levels of other ingredients were uniform in all the diets. Thus, no attempt was made to make the diets iso-carloric or iso-proteinous. The percentage compositions of the starter and finisher diets are presented in Tables 1 and 2, respectively.

Table 1: Percentage composition of starter diets

	Control	**Maize offal diets**		**Millet offal diets**	
Ingredients	1(0%)	2(50%)	3 (75%)	4(50%)	5(75%)
Maize	60.00	30.00	15.00	30.00	15.00
Maize offal	00.00	30.00	45.00	00.00	00.00
Millet offal	0.00	00.00	00.00	30.00	45.00
Soyabean meal	35.40	35.40	35.40	35.40	35.40
Bone meal	2.55	2.55	2.55	2.55	2.55
Linestone	1.00	1.00	1.00	1.00	1.00
Premix*	0.50	0.50	0.50	0.50	0.50
Salt	0.35	0.35	0.35	0.35	0.35
Methionine	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10
Calculated Composition	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Crude protein (%)	23.00	23.65	24.25	26.00	27.78
Matabolizable energy (kcal/kg)	3000.0	2591.34	2398.59	2691.84	2525.04
Crude fibre (%)	2.71	5.70	7.20	4.63	5.57
Total phosphorus (%)	0.35	0.54	0.63	0.37	0.39
Calcium (%)	0.11	0.19	0.24	0.11	0.12
Methiomine + Cysteine (%)	0.324	0.414	0.459	0.360	0.378
Lysine (%)	1.44	1.54	1.58	1.45	1.46

***Supplied per kg diet.** Vit A, 10,000 i.u, vit D_3, 2000 i.u, vit E, 40mg; vit K_3, 2.0mg; vit B_1, 2.4mg; vit B_2, 4.8mg; Niacin 32mg; Panthotenic acid, 8mg; Biotin, 0.1mg, vit B_{12}, 0.02mg; folic acid, 0.08mg; choline chloride, 240mg; manganese, 80mg; iron, 40mg; zinc. 36mg; copper, 1.6mg; iodine, 1.24mg. cobalt, 0.2mg; selenium, 0.1mg.

Table 2: Percentage composition of finisher diets

	Control	**Maize offal diets**		**Millet offal diets**	
Ingredients	1(0%)	2(50%)	3 (75%)	4(50%)	5(75%)
Maize	64.20	32.10	16.05	32.10	16.05
Maize offal	00.00	32.10	48.15	00.00	00.00
Millet offal	00.00	00.00	00.00	32.10	48.15
Palm kernel cake	4.00	4.00	4.00	4.00	4.00
Soyabean meal	28.00	28.00	28.00	28.00	28.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Linestone	1.00	1.00	1.00	1.00	1.00
Premix*	0.25	0.25	0.25	0.25	0.25
Salt	0.35	0.35	0.35	0.35	0.35
Methanine	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10
	100.0	**100.0**	**100.0**	**100.0**	**100.0**
Calculated Composition					
Crude protein (%)	20.00	21.37	22.01	23.88	25.79
Matabolizable energy (kcal/kg)	3000.0	2629.7	2423.4	2719.9	2558.7
Crude fibre (%)	3.20	6.40	7.997	5.25	6.23
Total phosphorus (%)	0.33	0.53	0.64	0.36	0.37
Calcium (%)	0.10	0.20	0.24	0.11	0.12
Methiomine + Cysteine (%)	0.30	0.40	0.44	0.34	0.36
Lysine (%)	1.22	1.37	1.23	1.24	1.32

*Supplied per kg diet: vit. A, 12,000 i.u; vit. D_3, 2,500i.u; vit E, 30mg; vit. K. 2mg; vit. B_1, 2.25mg; vit. B_2, 6mg; vit. B_6, 4.5mg; vit. $B_{12,}$ 0.015mg; niacin, 40mg; pantothenic acid 15mg; folic acid, 1.5mg; biotin, 0.05mg; Chlorine chloride, 300mg; manganese, 80mg; zinc, 50mg; iron, 20mg; copper, 5mg; iodine, 1mg, selenium, 0.2mg; cobalt, 0.5mg; Antioxidant, 125mg.

Management of Birds and Experimental Design: A total of one hundred and fifty Anak broiler-type day-oil chicks were used for the study. The chicks were brooded in the first four weeks during which they were vaccinated according to schedule. Coccidiostat and antibiotics were administered at regular intervals throughout the experimental period to prevent coccidiosis and other bacterial infections. The birds were reared on deep litter in a standard tropical poultry building with half-walls and partitioned into 15 experimental pens, each measuring about 2.5m by 1.5m . The chicks were fed commercial starter mash for one week to stabilize them prior to the commencement of the study. At one week of age, the chicks were then divided into 15 groups of 10 birds each, adjusting the groups to approximately equal weights. Average weight per bird was 71.5 g. Three groups were, randomly, allotted to each dietary treatment as replicates in a completely randomized design. Throughout the study, feed and water was provided for the birds *ad libitum.*

Feeding Trial: Studies were conducted to, comparatively, evaluate maize and millet offals as replacements for maize in broiler chicken birds. The birds were observed daily and a record of mortality was kept. Body weight gain and feed intake were determined on weekly basis and feed-to-gain ratio was computed, accordingly. Average daily water intake was also determined by providing a known quantity of water for each group daily. At the end of each day, the balance water for each group was measured. The difference between initial and final volumes was taken as the water intake for that group. The starter phase lasted from one to six weeks of age. At the end of the starter phase, the birds were fed a common finisher diet for one week to cancel the effect of the starter diets. At seven weeks of age, the birds were again divided into 15 groups on equal weight basis at 10 birds per group. Average weight per bird was 1,200 g. Experimental design and method of data collection were the same as in the starter phase. The finisher phase lasted from seven to 10 weeks of age.

Metabolizable Energy Study: To determine the metabolizable energy values of the maize and millet offals, six weeks old Anak broiler chickens were used. The birds were managed in standard wire cages equipped with dropping pans. At the beginning of the study, the birds were divided into nine similar groups on equal weight basis at three birds per group. Three groups were, randomly, assigned to each of the three dietary treatments. Among the treatments, a standard broiler finisher diet served as the basal diet. Diet 1 is as indicated in Table 2. Diet 2 contained 80% of the basal diet and 20% maize offal while, Diet 3 contained 80% basal diet and 20% millet offal. To acclimatize the birds to the cages and feed, a 3-day adaptation period was allowed. After this period, total excreta voided were collected quantitatively for three days at 24-hourly intervals. Feed and water were provided *ad libitum* during the period while, the feed was maintained at low levels in the troughs to avoid spillage. The feed for each group was weighed at the start and end of the collection period to determine feed consumption during the trial period. On each collection day, the excreta was collected and separated from feathers and other debris before being weighed, labeled and oven-dried to a constant weight to determine dry matter content. The three-day faecal collection for each group was bulked and finely ground to obtain a homogenous mixture. Samples of the diets, dried excreta, maize offal and millet offal were assayed for gross energy (GE) using an adiabatic bomb calorimeter. The apparent metabolizable energy (AME) of the basal diet and substituted diets were then calculated as follows:

$$\text{AME (kcal/kg)} = \frac{\text{GE of feed} - \text{GE of excreta}}{\text{Feed intake}}$$

From the metabolizable energy of the basal and substituted diets, the metabolizable energy values of the maize offal and millet offal were calculated using algebraic equations.($0.8x + 0.2y = b$ kcal/kg)

Proximate analysis: Samples of sun-dried maize and millet offals were assayed for proximate composition to determine the contents of crude protein (CP), crude fibre (CF), ether extract (EE), and ash. Nitrogen-free extract (NFE) was computed, accordingly (A.O.A.C., 1990).

Statistical analysis: Data collected during the period of study were subjected to analysis of variance (ANOVA) as a completely randomized design to determine significance. When the ANOVA showed significant *F*-test, mean separation was done using the least significant difference at the 5% level of probability (S.A.S., 1999).

RESULTS

Table 3 shows the results of proximate analysis of sun-dried maize offal and millet offal. The results revealed that maize offal contained 91.92% DM, 12.80% CP, 12.07% CF, 11.72% (EE), 5.42% ash and 49.91% (NFE). Millet offal contained 91.08% DM, 12.65% crude protein, 8.5% crude fibre, 5.03 ether extract, 5.25% ash and 52.45% nitrogen-free extract. Maize offal recorded 2225 kcal/kg metabolizable energy while millet offal recorded 2506 kcal/kg metabolizable energy.

Table 3: Proximate composition and apparent metabolizable energy values of maize and sun-dried maize offal and millet offal

	Maize**	Maize offal	Millet offal
Dry matter (%)	91.80	91.92	91.88
Crude protein (%)	8.80	12.80	20.65
Crude fibre (%)	2.10	12.07	8.50
Ether extract (%)	4.10	11.72	5.03
Ash (%)	1.00	5.42	5.25
Nitrogen-free extract (%)	75.80	49.91	52.45
Apparent metabolizable energy (kcal/kg)	3510	2,225	2,506

** (Olomu, 1995)

Table 4: Effects of replacing maize grain with maize and millet offals on the performance of broiler starter chicks (0 to 5 weeks of age)

Diets	Control	Maize offal diet		Millet offal diet		
Parameter	Diet1 (0%)	Diet 2 (50%)	Diet3 (75%)	Diet4 (50%)	Diet5 (75%)	SEM
Final body weight (g/bird)	926.6	946.0	953.1	933.9	961.6	19.11
Total body weight gain (g/bird)	807.3	822.8	837.6	806.0	831.7	19.98
Total feed intake (g/bird)	1783	1940	1976	1926	1902	59.86
Feed-to-gain ratio	2.21	2.36	2.36	2.39	2.30	0.10
Water intake (ml/bird/day)	123.5[b]	130.00[b]	144.00[ab]	149.9[ab]	164.2[a]	9.12
Water-to-gain ratio	5.36[b]	5.55[b]	6.03[ab]	6.31[ab]	6.90[a]	0.35
Water-to-feed ratio	2.46	2.35	2.55	2.72	3.04	0.23
Energy consume (kcal/bird)	3541	4720	4273	5152	4804	672.36
Protein consume (g/bird)	400.1[c]	509.3[ba]	556.1[a]	500.6[b]	528.3[ba]	14.91
Feed cost per kg/gain (₦)	284.1	287.2	377.0	302.2	275.8	35.78
Feed cost/bird (₦)	127.8	138.2	114.9	126.5	119.2	8.48

Means within row with same or no superscripts are not significantly different ($p>0.05$)
SEM: Standard Errors of Mean.

Table 5: Effect of replacement maize and millet offal for maize on performance of broiler starter chickens.

Diets (% replacement)	Control	Maize offal diet		Millet offal diet		
Performance Parameter	Diet 1 (0%)	Diet 2 (50%)	Diet 3 (75%)	Diet 4 (50%)	Diet 5 (75%)	SEM
Final body weight (g/bird)	1955	1959	1914	1960	1983	44.15
Total body weight gain (g/bird)	754.5	759.1	740.7	760.2	783.3	44.24
Total feed intake (g/bird)	2441[bc]	2724[a]	2598[b]	2519[bc]	2361[c]	57.42
Feed-to-gain ratio	3.24	3.603	3.507	3.337	3.027	0.17

Water intake (ml/bird/day)	561.20	534.5	529.70^{b}	525.8	536.20	21.04
Water-to-gain ratio	15.67	14.82	12.28	14.09	14.54	1.19
Water-to-feed ratio	4.830^{a}	4.117^{ab}	3.493^{b}	4.387^{a}	4.787^{a}	0.207
Energy consume (kcal/bird)	7426^{a}	6705^{b}	5622^{c}	6851^{b}	6042^{c}	145.08
Protein consume (g/bird)	490.10^{c}	658.4^{a}	678.3^{a}	601.7^{b}	609.0^{b}	14.39
Feed cost per kg/gain (₦)	288.10	285.7	261.2	275.3	240.0	13.95
Feed cost/bird (₦)	217.10^{a}	216.0^{a}	192.9^{b}	207.8^{b}	187.2^{b}	4.55

Means within row with same or no superscripts are not significantly different (p>0.05) different.
SEM: Standard Errors of Mean.

The results of the trial with broiler starter chicks (1 to 5 weeks of age) are presented in Table 4. The results indicated that final body weights, total body weight gain, total feed intake and feed-to-gain ratio were not significantly (p>0.05) affected by dietary treatments. However, there was the tendency for body weights and feed intake to increase with the replacement of maize with either maize offal or millet offal. There was a general increase in water intake as maize offal and millet offal replaced maize. However, the increase in water intake was only significant (p<0.05) when millet offal replaced 75% of dietary maize. From the results of the study, the replacement of maize with millet offal resulted in higher water intake per bird compared to maize offal. Water-to-gain ratio followed the same trend as water intake.

Although water-to-feed ratio was not, significantly, affected by diets, it appeared to be higher on the millet offal diets than on the maize offal diets which yielded almost similar ratios with the control diet. The result showed that energy consumed was not significantly (p>0.05) affected by diets. Protein consumed was significantly (p<0.05) higher on the test diets, which contained maize offal or millet offal compared to the control diet. Feed cost per kilogram gain and feed cost per bird were not significantly (p>0.05) affected by dietary treatments.

The results of the trial with broiler finisher chickens (seven to 10 weeks of age) are presented in Table 5. The results indicated that final body weight and body weight gain were not significantly (p>0.05) affected by dietary treatments. Total feed intake by the birds were significantly (p<0.05) higher with the maize offal diets (Diets 2 and 3) compared to the millet offal diets (Diets 4 and 5). However, the difference in feed intake between Diet 3 (75% replacement of maize with maize offal) and Diet 4 (25% replacement of maize with millet offal) was not significant (p>0.05). The values of feed intake (per bird) 2,590 g and 2,519 g observed with Diets 2 and 3, respectively were not significantly (p>0.05) higher than that of the control diet (2,441 g), the value of which compared with the feed intake values on the millet offal diets (Diets 4 and 5).

Dietary treatments had no significant effect (p>0.05) on feed-to-gain ratio, water intake by the birds and water-to-gain ratios. Water-to-feed ratio was higher on millet offal diets compared to the maize offal diets. The ratio obtained on the control diet was not significantly (p>0.05) higher than those obtained on the millet offal diets. Energy consumed was significantly (p<0.05) higher on the control diet than on the test diets, Diets 2, 3, 4 and 5. The results further showed that the value of energy consumed decreased significantly (p<0.05) as percentage replacement of either maize offal or millet offal increased.

The control diet recorded lower (p<0.05) protein intake compared to maize offal and millet offal diets while, the maize offal diets recorded higher protein intake values than the millet offal diets (Table 5). Feed cost per bird was not significantly (p>0.05) affected by the replacement of dietary maize with either maize offal or millet offal at 50% level. However, the replacement of 75% of dietary maize with maize offal and millet offal resulted in significant decreases ($p<0.05$) in feed cost per bird. Feed cost per kilogram live weight gain was not significantly ($p>0.05$) affected by diets.

DISCUSSION

From the results of the study with broiler starter chicks, body weights appeared to be higher on the test diets that contained either maize offal or millet offal compared to control maize grain-based diet. This is not surprising since the chicks consumed more nutrients including the limiting amino acids (Table 4) which was necessary, particularly, at a time when growth was critical. The slight increase in feed intake following the replacement of maize with either of the offals may be attributed to the lower ME levels of the test diets compared to the control (Table 4). The increase in feed intake by the birds may be an attempt by the birds to consume sufficient energy for optimum performance since the replacement of maize with maize and millet offals resulted in a reduction in dietary energy.

The mean body weights observed in the study are within the range of values earlier reported (Ekenyem *et al.,* 2006, Ezieshi and Olomu, 2008). The mean feed-to-gain ratio of 2.30 recorded was within acceptable range for broiler starter chicks (Olomu, 1995). Water intake by the birds was naturally higher on the maize offal and millet offal diets than on the control diet. This may be related to the increase in feed intake which was accompanied by increased CF intake from the diets.

According to Neumann (1977), large amounts of water are needed in the gastro-intestinal tract to soften the fibrous tissues during digestion. Therefore, the increased water intake on the test diets could be an attempt by the birds to obtain more water to aid in the digestion of CF complex. Increase in feed intake has also been reported to increase water intake in poultry (Vantsawa *et al*, 2007, 2008).

Although dietary treatments did not affect feed cost per kilogram live weight gain per bird, the feed cost per bird appeared to decrease when either of the test ingredients replaced maize at 75% level. This may be related to the difference in price between maize grain and maize offal or millet offal, at the time of the study. The results of the trial with broiler finisher chickens indicated that final body weights were uniform for all the dietary treatments suggesting that all the groups received adequate nutrients for optimum performance. The higher feed intake observed on the maize offal diets (Diets 2 and 3) compared to control diet (Diet 1) and millet offal diets (Diets 4 and 5) is not surprising since the diets had lower ME levels compared to other diets (Table 5). Olomu (1995) had earlier reported that birds eat to meet their energy requirements. Similarly, the birds fed the millet offal diets (Diet 4) consumed more feed than those fed the control diet. It was also observed that as the replacement level increased with each of the test ingredients, feed intake decreased contrary to the principle of less energy, more feed as explained above. The test ingredients, maize offal and millet offal, are characteristically bulky. Therefore, their increased level in the diet resulted in increased bulk of the feed which ultimately limited feed intake at a point. This observation is in agreement with earlier reports (Ezieshi and Olomu 2004a, b) that most agro-industrial by-products are bulky and that increased levels in the diet limit feed intake.

The trend of feed-to-gain ratios observed with the diets suggests that body weight gain was positively correlated with feed intake. Water intake appeared to be similar for the entire group contrary to the reports from an earlier study (Ezieshi and Olomu, 2008). This is inspite of the difference in feed intake and dietary CF levels. The reason for this cannot be fully explained. However, mean values of water intake observed agree with those reported for broiler finisher chickens (Ezieshi and Olomu, 2004a). The trend of energy and protein consumed reflected the dietary energy and protein levels. The results showed that feed cost per bird was only reduced significantly with 75% replacement of maize with either maize offal or millet offal. This may be partly due to the reduced feed intake on such diets.

CONCLUSION

From the results obtained in this study, it can be concluded that maize offal and millet offal contain moderate amounts of nutrients and were able to replace up to 75% of dietary maize at reduced cost of feed production. It can also be concluded that the birds fed the millet offal diets performed, relatively, better in terms of body weight gain and feed intake compared to those fed the maize offal diets. Feed cost was also lower on the millet offal diets than on the maize offal diets.

REFERENCES

A.O.A.C. (1990). Association of Official Analytical Chemists. Official Methods of Analysis. 15th ed. Association of Official Analytical Chemists, Washington, DC.

Ekenyem, B.U., Madubuike, F.N. and Dike, O.F. (2006). Effects of partial replacement of yam peel meal for maize on performance and carcass characteristics of finisher broiler chicks. *International Journal of Poultry Science,* 5(10): 942-945.

Ezieshi, E.V. and Olomu, J.M. (2004a). Comparative performance of broiler chickens fed varying levels of palm kernel cake and maize offal. *Pakistan Journal of Nutrition,* 3(4): 254-257.

Ezieshi, E.V. and Olomu, J.M. (2004b). The effect of replacing maize with maize offal on the performance of broiler chickens, *Journal of Agriculture, Forestry and Fisheries,* 5(1): 5-9.

Ezieshi, E.V. and Olomu, J.M. (2008). Biochemical Evaluation of millet offal as feed for broiler chickens. *Pakistan Journal of Nutrition,* 7(3): 421-425.

Neumann, A.L. (1997). Dry roughage and their uses in finisher ratios. In: *Beef Cattle*. 7th edition, John Wiley and Sons, New York. Pp. 523–557.

Olomu, J.M. (1995). *Monogastric Animal Nutrition - Principles and Practices*, a Jachem publication. Benin City. Pp 320.

Onuh, P.N., Nwokpa, P.E. and Chukwu, L.O. (2006). Performance of broiler chicks fed maize offal-based diets supplemented with Roxazyme G enzyme. *International Journal of Poultry Science,* 5: 607-610.

Onuh, S.O. (2006). Evaluation of the performance of finishing broilers fed different agro-industrial by-products. *Journal of Sustainable Tropical Agricultural Research* 17:113-115.

S.A.S. (1999). SAS/STAT Version, 8th Edition. SAS Inst. Inc. Cary N.C., U.S.A.

Vantsawa, P.A., Ogundipe, S.O., Dafwang, I.I. and Omage, J.J. (2007). Replacement value of dusa (locally processed maize offal) for maize in the diets of egg-type chicks (0-8 weeks). *Pakistan Journal of Nutrition,* 6: 530-533.

Vantsawa, P.A., Ogundipe, S.O., Dafwang, I.I. and Omage, J.J. (2008). Replacement value of *dusa* (locally processed maize offal) for maize in the diets of pullets and subsequent early-laying characteristics. *Pakistan Journal of Nutrition,* 7: 574-577.