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Effects of Replacing Maize with Pearl Millet *(Pennisetum americanum)* on the Performance of Finishing Broiler Chickens in the Semi-Arid Zone of Nigeria

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ABSTRACT

An experiment was conducted to determine the replacement value of pearl millet *(Pennisetum americanum)* for maize in broiler finisher diets. A total of eighty (80) day- old Anak giant broiler strain was brooded together and assigned to the following treatments: T_1, T_2, T_3 and T_4 which contained 0, 25, 50 and 75% millet, respectively. The millet replaced maize quantity for quantity in the diets. Each treatment was replicated four times with five birds per replicate in a complete randomized block design experiment. At ten weeks of age, blood samples were collected from five (5) birds in each treatment via the brachial vein of the birds and analyzed for red blood cell (RBC) and white blood cell (WBC) counts. Packed cell volume (PCV) and haemoglobin (Hb) concentration were also determined. Mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) values were then calculated. The results showed that T_4 recorded the highest PCV, Hb, WBC, RBC, values while T_1 recorded the highest mean corpuscular volume (MCV) and MCH values Treatment effects on productive parameters such as feed intake, body weight and feed conversion ratios were determined. The result showed that T_2 recorded the highest feed intake (125.58 g) in comparison with T_1 (121.67 g), T_3 (123.58 g) and T_4 (122.49 g) treatment groups. The economic analysis also revealed that the cost of broiler production was relatively cheaper in T_4 compared to the other treatments. The gross revenues were T_1 (₦8,750), T_2 (₦7,800), T_3 (₦7,500) and T_4 (₦9,000). From the foregoing study, 75% of maize can be substituted with pearl millet in the diet of broiler chickens without any adverse effect on the performance. Furthermore, the substitution proves more economical as it reduces the total feed cost. It is recommended that the effects of various levels of inclusion on the carcass parameters of broiler chickens should be evaluated to determine particularly their effect on abdominal fat.

Key words: Pearl millet, maize replacement, broiler performance, Anak giant broilers

INTRODUCTION

Pearl millet (*Pennisetum americanum*), formerly Ptyphoids is an important cereal crop widely cultivated for grain throughout the Guinea Savannah and the Sahel zone of Nigeria. The crop also requires a very short growing season which makes it suitable for cultivation in the drier parts of the country where other cereal crops like maize and sorghum do not perform well.

Luis *et al.* (1982) compared the nutritional value of proso millet, sorghum and maize for broiler in iso-caloric and isonitrogeneous diets and observed that the three cereal crops had similar effects on weight gain and feed efficiency of the experimental birds. Similarly, Kraft *et al.* (1976) compared foxtail millet with maize in broiler diets and reported that millet diets gave higher value of average weight, although the differences from those of the maize diets were not significant. However, Sharma *et al.* (1979) also compared the nutritional values of cereals, and reported that in terms of protein deposition, millet ranked highest followed by maize and finally sorghum at lower inclusion rates. At higher inclusion rates, however, energy and protein deposition were better with millet.

Pearl millet is more readily available in the Sahel zone of Nigeria than other cereals and little is yet known concerning the feeding value of Nigerian varieties of millet for chickens. Ubosi *et al.* (1990) cautioned that energy level has to be checked because over consumption results in disease condition called fatty liver syndrome in caged laying chickens. The objectives of this study were to compare the feed values of maize and pearl millet using haematology, productive performance and cost effectiveness as response indicator in broiler chickens under the

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semi-arid condition of Nigeria.

MATERIALS AND METHODS

Location of study

The study was conducted at the Teaching and Research Poultry Farm, Department of Animal Science, University of Maiduguri, Maiduguri, Nigeria, from November 2004 to January 2005. This area falls within the semi-arid zone of Nigeria, characterized by a shorter rainy season (3 - 4 months) with a longer period of dry season. Annual rainfall in the zone ranges from 500 mm - 600 mm while the ambient temperature reaches 40°C and above in the months of April and May. The mean relative humidity ranges from 30 - 40% with a minimum in February and March when it drops to as low as 10% and rises to a maximum of about 90% in August (Ugherughe and Ekedolum, 1986).

Flock management and experimental design

Eighty Anak giant broiler chicks were purchased from ECWA hatchery in Jos, Nigeria, were brooded on the floor and vaccinated promptly against Newcastle and Gumboro diseases. They were fed commercial broiler starter diets from day-old to 30 days of age. On the 31st day of the study, the birds were randomly allocated to four treatment groups each consisting of twenty birds. Each treatment consisted of four replicates of five birds each. Feed and water were provided *ad libitum.*

Experimental diets

Four diets, T_1, T_2, T_3 and T_4 were formulated and fed to the birds during the finisher phase. The test material (pearl millet) replaced maize at 0 (control), 25, 50 and 75% levels in diets T_1, T_2, T_3 and T_4 respectively (Table 1).

Table 1. Composition of the experimental diets (%)

Ingredients (%)	Treatments (diets)			
	T_1	T_2	T_3	T_4
Maize	60.00	45.00	30.00	15.00
Millet	-	15.00	30.00	45.00
Soybean (full fat)	31.25	31.25	31.25	31.25
Beniseed	5.00	5.00	5.00	5.00
Bonemeal	3.00	3.00	3.00	3.00
Common salt	0.50	0.50	0.50	0.50
*Vitn/min premix	0.20	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated				
ME (Kcal/kg)	3371.57	3252.71	3469.49	3519.08
Crude protein	20.25	20.87	21.48	22.09
Calcium	1.79	1.80	1.80	1.80
Phosphorus	0.79	0.76	0.76	0.76
Lysine	1.04	1.07	1.10	1.11
Methionine	0.31	0.33	0.33	0.33

*Vitamin/mineral premix supplying the following per kilogram (kg): vit. A, 500,000 IU; vit. D3, 800,000 IU; vit. E, 12,000 mg; vit. K, 1500 mg; vit. B_1, 1,000 mg; B_2, 2,000 mg; vit. B_6, 1,500 mg; vit. B_{12}, 300 mg; niacin, 12,000 mg; pantothenic acid, 2,000 mg; choline, 60,000 mg; folic acid, 15,000 mg; manganese, 10,000 mg; iron, 15,000 mg; zinc, 800 mg; copper, 400 mg; iodine, 80 mg; cobalt, 40 mg; selenium, 80,000 mg; growth promoter, 4,000 mg. **Source:** Bio-organic Nutrient System Limited, Lagos, Nigeria

Data collection

Parameters measured over the experimental period were, feed intake, body weight gain, feed conversion ratio, mortality rate, blood constituents.

A pre-weighed diet was fed *ad libitum* everyday and left over feed at the end of each day was weighed. The

difference between the amount fed and the left-over feed represented the quantity of feed consumed.

Average feed consumption in a treatment was obtained by dividing the weight of feed consumed in that treatment by the number of birds in the treatment group and was expressed in grammes/bird/day.

Each bird was individually weighed at the beginning of the experiment and weekly thereafter and the weights were recorded in grammes. The average weight per treatment was obtained by dividing the total weight of birds in the treatment by the number of birds in that treatment group. The cost effectiveness of the experimental diets was determined at the end of the study. The parameters considered were, cost of feed (₦/kg), total cost o feed (₦), gross revenue (₦) and profit margin.

Blood collection

Blood samples were collected at the tenth week of the experiment from the brachial vein of the birds using sterile disposable 5 ml syringe and sterile 23 gauge needle. The samples from each treatment were collected in test tubes containing ethylene diamine tetra-acetic acid (EDTA). The acid was used to prevent blood coagulation.

Huematological analysis

The blood samples were analyzed using routine available clinical method as expounded by Bush (1975). The packed cell volume (PCV) or haematocrit was determined by using microhaematocrit method. Erythrocyte and leucocyte counts were carried out with the haemocytometer, while haemoglobin (Hb) concentration was estimated using the acid haematin or Sahli method.

Calculation of erythrocyte in dices

The erythrocyte indices mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated according to the formula of Jam (1986).

Chemical and statistical analyses

Proximate analysis of the experimental diet was carried out according to the methods of AOAC. (1990). All data collected were subjected to analysis of variance (Steel and Torrie, 1990) using a complete randomized block design. Where necessary means were separated using the least significant difference (LSD).

RESULTS AND DISCUSSION

Productive performance

The proximate composition of the experimental diets were analyzed on dry matter basis (%). The result obtained showed that T_4 recorded the highest value in almost all constituents, *viz*, dry matter, crude protein, crude fibre, ether extract, calcium, phosphorus and metabolizable energy while ash was highest in T_1 (Table 2).

Table 2. Proximate composition of the experimental diets on dry matter basis (%)

Constituents	T_1 (control)	T_2	T_3	T_4
Dry matter	87.00	84.50	86.00	89.00
Crude protein	20.00	19.50	20.50	21.00
Crude fibre	4.60	4.58	4.76	4.90
Ether extract	4.70	4.00	4.80	6.20
Ash	4.70	3.40	3.90	4.12
Calcium	1.60	1.70	1.80	1.90
Phosphorus	0.60	0.45	0.70	0.80
ME (Kcal/kg)	3371.57	3252.71	3469.49	3591.80

T_1 (control) = 0% millet; T_2 = 25% millet; T_3 = 50% millet; T_4 = 75% millet

Feed intake

The results of the average daily feed intake of the experimental birds for T_1 (121.67 g), T2 (125.58 g), T_3 (123.58 g) and T_4 (122.49 g)/bird/day are presented in Table 3. The mean feed consumption/bird/day did not differ significantly ($p>0.05$) among T_1, T_3 and T_4 dietary treatments. However, T2 recorded the highest value for feed intake and differed significantly ($p<0.05$) from the other treatments. The values did not follow any particular trend.

The difference in intake was as a result of palatability and acceptability of the test ingredients.

Weight gain

The means of the daily weight gains (g) for T_1 (42.11), T_2 (41.87), T_3 (41.98) and T_4 (45.44) were presented in Table 3. Birds in treatment 4 (T4) gained significantly ($p<0.05$) more weight than birds in other treatments while there was no difference ($p>0.05$) among treatments 1, 2 and 3. The higher value obtained for T_4 in this study agreed with the findings of Kraft *et al.* (1976) who reported that millet diets gave higher average body weight than maize in their study. In another study, Sharma *et al.* (1979) reported that in terms of protein deposition, millet ranked higher than most of the grains used in poultry feeds. It would appear that the level of fat and oil in millet favoured reasonable feed intake with corresponding weight gain (Appa Rao *et al.,* 1989, NRC, 1996).

Table 3. Effects of substituting maize with pearl millet on the productive performance of broiler finisher chickens

Parameters	Treatments (diets)			
	T_1 (control)	T_2	T_3	T_4
Initial body weight (kg)	0.47	0.43	0.42	0.53
Overall daily feed intake (kg)	127.67 ± 4.02^{b}	125.67 ± 6.00^{a}	123.58 ± 7.00^{b}	122.49 ± 6.03^{b}
Overall daily weight gain	42.11 ± 3.27^{b}	41.87 ± 3.32^{b}	41.98 ± 1.72^{b}	45.44 ± 2.03^{b}
Feed conversion ratio (FCR)	3.03 ± 3.00^{ab}	2.96 ± 0.02^{a}	2.94 ± 0.06^{ab}	2.69 ± 0.03^{b}
Final body weight (kg)	2.34	2.23	2.22	2.42

abc = means within the same row with different superscripts differ significantly ($p<0.05$)

Feed conversion ratio (FCR)

The mean values for FCR for T_1 (3.03 1), T_2 (3.001), T_3 (2.943) and T_4 (2.695) are presented in Table 3. There were no significant differences ($p>0.05$) among treatments T_1, T_2 and T_3. The effects of millet on FCR observed in this study agreed with the findings of Adamu *et al.* (2001) who reported that the use of millet as a source of energy for finishing broilers was superior to maize on account of efficiency of feed utilization and profit margin. In this study, T_4 contained the highest level of millet inclusion and recorded the most superior FCR in comparison with treatments T_1, T_2 and T_3.

Cost effectiveness

The cost analysis revealed that T_1 and T_2 were more costly than T_3 and T_4 while T_4 was the cheapest among the diets (Table 4). Invariably, the profit generated was higher in T4 than in the other treatments. Diet T_4 ,i.e., (75% pearl millet) was more rewarding because kg millet was cheaper than kg maize at the time of the study as a result it reduced the total cost of broiler production compared to T_1 (control) which was 100% maize hence lower economic advantage.

The gross revenue generated in this study indicated that T_4 recorded the highest among the treatments and this was due to the fact that birds in this treatment were the heaviest compared to their contemporaries. Where-as the profit margin followed the same trend that is the heavier the bird the higher the price and more the profit.

Table 4. Cost benefit analysis of substituting maize with pearl millet in broiler finisher chickens

Parameters	T_1 (control)	T_2	T_3	T_4
Cost of feed (₦/kg)*	42.86	42.67	40.69	39.99
Total cost of feed (₦)	3489.20	3400.00	3356.00	3171.56
Gross revenue (₦)**	8250.00	7800.00	7500.00	9000.00
Profit (₦)***	4760.80	4400.00	4135.00	5828.44
Cost/kg body weight (₦)	200.22	200.22	200.22	230.00

* = based on the following price prevailing at the end of the study: maize, ₦46.6/kg; millet, ₦37.5/kg; ** = calculated on the basis of ₦550.00, ₦520.00, ₦500.00, ₦680.00 each for broilers on diets 1, 2, 3 and 4, respectively; *** = calculated as gross revenue minus feed cost (₦); T_1 (control) = 0% millet; T_2 = 25% millet; T_3 = 50% millet; T_4 = 75% millet

Blood constituents

The values of the blood constituents are presented in Table 5. They include red blood cell and white blood cell counts, packed cell volume, haemoglobin, mean corpuscular volume, mean corpuscular hemoglobin and mean

corpuscular haemoglobin concentration.

Packed cell volume (PCV)

The values for PCV were 29, 31, 33.8, and 34.4% for T_1, T_2, T_3, and T_4 respectively (Table 5). The value obtained for T_4 was significantly ($p<0.05$) higher than that of the control (i.e., T_1). The increase in PCV is in line with the findings of Raymond and Reece (1990) who reported that increasing haematocrit values indicated an increased blood viscosity and it may also be attributed in part to higher inclusion levels of millet in T_2, T_3 and T_4 in comparison to the control diet T_1.

Table 5. Effect of substituting maize with pearl millet on the haematological constituents of broiler finisher chickens

Parameters	T_1 (control)	T_2	T_3	T_4
Pack cell volume (%)	29.20^{b}	31.40^{ab}	33.80^{ab}	34.40^{a}
Haemoglobin (%)	8.59^{b}	11.04^{ab}	11.46^{a}	11.98^{a}
White blood cell (10^3/mm^3)	16.40^{b}	17.90^{b}	19.40^{ab}	21.20^{a}
Red blood cell (10^6/mm^3)	2.86^{b}	3.45^{ab}	3.76^{ab}	3.00^{a}
MCV (fl)	101.97^{b}	91.17^{a}	89.98^{b}	80.67^{b}
MCH (g/dl)	29.77^{b}	35.17^{a}	33.90^{ab}	34.82^{ab}
MCHC (pg)	30.07^{ab}	32.09^{a}	30.31^{ab}	31.23^{ab}

abc = means within the same row with different superscripts differ significantly ($p<0.05$); MCV = mean corpuscular volume; MCH = mean corpuscular haemoglobin; MCHC = mean corpuscular haemoglobin concentration; T_1 (control) = 0% millet; T_2 = 25% millet; T_3 = 50% millet; T_4 = 75% millet

Haemoglobin concentration (Hb)

Hb concentration values obtained for the various treatments are presented in Table 5. The control (T_1) recorded the lowest value and did not differ significantly ($p>0.05$) from T_2 while T_3 and T_4 differed significantly ($p<0.05$) from T_1. All the values obtained were within the normal range as reported by Francis (1998). The low Hb concentration recorded for T_1 agreed with the findings of McDonald and Louis (1996) who noted that low Hb concentration can be a contributory factor for low heat expenditure that could limit oxygen concentration. The higher value for T_4 can in part be attributed to the high level of protein in millet as compared to maize-based diet (T_1).

Red blood cell (RBC) count

The RBC counts for T_1 (2.96), T_2 (3.45), T_3 (3.76) and T_4 (3.9×10^6/mm^3) are presented in Table 5. There were no statistical differences ($P>O.05$) among T_2, T_3, and T_4, but T_4 differed significantly ($p<0.05$) from the control (T_1). The superior value for T_4 was probably due to high nutrient content of the millet compared to maize (T_1 control) which is in line with the works of Adamu *et al.* (2001), who reported that the use of millet as a source of energy for finishing broilers improved the overall performance of the birds relative to maize.

White blood cell (WBC) count

The mean WBC values for the different treatments T_1 (16.4), T_2 (17.9), T_3 (19.4) and T_4 (21.2×10^3/mm^3) are presented in Table 5. T_4 recorded significantly ($p<0.05$) higher value than those of T_1, T_2 and T_3. The values for T_1, T_2 and T_3 did not differ ($p>0.05$) significantly from one another. The values obtained in this study were within the range of 5 - 25 $\times 10^3$/mm^3 for broiler as reported in Merck's Veterinary Manual (1973).

CONCLUSION AND RECOMMENDATION

The results obtained from this study showed that the diet that contained the highest level of millet (T_4) recorded superior performance in terms of feed intake, weight gain, haematological values and economic performance than those with maize. Millet can comfortably replace maize up to 75% in broiler diets. However, it is recommended that the effect of the various levels of inclusion on the carcases parameters of broiler chickens should be evaluated.

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