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Performance and Economics of Production of Broiler Chickens Fed Different Dietary Energy Sources

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ABSTRACT

An experiment was conducted to evaluate the performance and economics of broiler chickens fed different dietary energy sources. Five diets containing maize, red sorghum, white sorghum, Gero millet and Dauro millet were formulated and coded diets 1, 2, 3, 4 and 5, respectively. Two hundred and ten day old Marshall Breed of broiler chicks were randomly allotted to five dietary treatments in a completely randomized design and each treatment was replicated three times. Feed and water were provided *ad libitum* and the feeding trial lasted for eight weeks. At the starter phase, daily feed intake (33.05-47.52 g; $p<0.05$), daily weight gain (9.74-19.43 g; $p<0.001$) and feed conversion ratio (2.46-3.43; $p<0.05$) were affected by the dietary treatments. At the finisher phase daily weight gain (27.20-45.80 g) was significantly ($p<0.001$) influenced while daily feed intake and feed conversion did not differ significantly. The best feed cost in naira per kilogram body gain was obtained on diet 4 (Gero millet) with a value of ₦ 181.78 kg^{-1}. It can be concluded that Dauro millet based diet gave the best performance; however, Gero millet base diet seems to be most economical for broiler feeding.

Key words: Broiler chickens, Gero millet, Dauro millet, red sorghum, white sorghum

INTRODUCTION

Cereal grains especially maize has been for long used as conventional energy source in broiler production. This is simply because maize served as the basis against which other grains are compared (Atteh, 2002). Olomu (2011) reported the metabolizable energy and crude protein of maize to be 3510 kcal kg^{-1} and 8.80%, respectively, the ever escalating cost of maize is as a result of increased competition for its usage by man and other livestock species (Egbunike and Achiobong, 2002) and its in adequate production to meet the needs of man and his livestock (Babatunde *et al*., 1990). These reasons made it critical to look inward and consider our local varieties of cereal like sorghum and millet which are relatively cheap in their area of cultivation and can favourably compete with maize in broiler diets (Ibitoye *et al*., 2012).

Sorghum is comparable to maize in nutrient composition but contain some anti-nutritional factors which give it some agronomic advantages but lowers the nutritional value of the grain for

non-ruminants (Jacob *et al*., 1996). Another disadvantage of tannin to non-ruminant is the reduction of dry matter intake and protein digestibility (Gualtieri and Rapaccini, 1990). Sorghum was reported to contain about 0.2-2.0% tannin and when used to replace maize it adversely affect growth and feed efficiency in broilers (Douglas *et al*., 1990). On the other hand Lucbert and Castaing (1986) reported that nutritional value of sorghum with tannin levels less than 10 g kg^{-1} is comparable to maize in broiler feeding. Millet has high nutritional value with no tannin and higher protein and mineral than maize and sorghum (NRC., 1996), millet has high protein than maize and sorghum. NRC (1996) reported that millet neither reduces feed efficiency nor rate of gain nor can compete favourably with maize in broiler ration without any effect on the performance. Olomu (1995) reported the metabolizable energy of sorghum and millet to be 3270 and 2555 kcal kg^{-1} while the crude protein stands at 9.5 and 12%, respectively, though the energy value of sorghum and millet is lower than maize, the two cereals are superior to maize in protein and fat content. It is against this background that this study was carried out to investigate the best out of the two varieties of sorghum (white and red) and millet (Gero and Dauro).

MATERIALS AND METHODS

Experimental site: This experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Abubakar Tafawa Balewwa University Bauchi, Nigeria. The State shares boundary with Yobe to the North, Jigawa to the East, to the North-West Kano to the West, Plateau, Taraba to the South and Gombe to the East. The State has a total land mass of about 49119 m^2 which represents about 5.3% out of Nigeria's total land mass 909,890 m^2 (NBS., 2010). The State lies between longitude 8°50^1 to 11° East of the Greenwich meridian and latitude 9°3^1 to 12°3^1 North at an altitude of 600 m above sea level.

Management of the experimental birds: Two hundred and ten day old Marshal Breed of broiler chicks were obtained from Zartech limited Jos, the chicks were brooded for the period of 1 week on deep litter. They were fed *ad libitum* on commercial diet throughout the brooding period. Two weeks before the arrival of the chicks the experimental pen was thoroughly washed, cleaned, disinfected and dried. Upon the arrival of the chicks brooding commenced at once, water and feed were supplied *ad libitum* during the whole period of the trial. Routine management, vaccines and medications were administered according to the methods of Oluyemi and Roberts (2007). After the brooding period of about 1 week the birds were randomly allotted to five dietary treatments with 42 birds per treatment and each treatment was replicated three times with 14 birds per replicate, in a Completely Randomized Design (CRD). The birds were fed the experimental diets for 4 weeks during the starter phase and finisher phases, respectively.

Experimental diets: Five diets containing different energy sources with maize as control were formulated; other diets consist of two varieties of sorghum (red and white), millet (Gero and Dauro). The diets were designated as 1, 2, 3, 4 and 5, respectively. Maize, sorghum and millets were the principal sources of energy while major sources of protein in the diet were roasted full fat soya beans and fish meal. The diet were formulated to supply approximately 3000 kcal kg^{-1} ME, 23 and 20% crude protein for both starter and finisher diets, respectively, methionine and lysine were used as supplement in the diet. The ingredients and calculated analysis of the experimental diet for both starter and finisher phases are shown in Table 1 and 2, respectively.

Table 1: Ingredients and calculated analysis (%) of diets containing different energy sources fed to broiler chickens at the starter phase (1-4 weeks)

	Diets				
Parameters	1	2	3	4	5
Ingredients					
Maize	43.33	-	-	-	-
Red sorghum	-	46.88	-	-	-
White sorghum	-	-	46.88	-	-
Gero millet	-	-	-	45.15	-
Dauro millet	-	-	-	-	45.15
Soybeans	35.47	32.12	2.12	33.85	33.85
Wheat offal	12.00	12.00	2.00	12.00	12.00
Fish meal	5.00	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
ME (kcal kg^{-1})	3087.00	3029.00	3029.00	2849.00	2849.00
Crude protein (%)	23.00	23.00	23.00	23.00	23.00
Crude fibre (%)	4.10	3.96	3.96	6.01	6.01
Calcium (%)	1.35	1.36	1.36	1.35	1.35
Phosphorous (%)	0.85	0.94	0.94	0.84	0.84
Ether extract (%)	8.96	8.04	8.04	8.80	8.80

Table 2: Ingredients and calculated analysis (%) of diets containing different energy sources fed to broiler chickens at the finisher phase (5-8 weeks)

	Diets				
Parameters	1	2	3	4	5
Ingredients					
Maize		54.26	-	-	-
Red sorghum	-	58.43	-	-	-
White sorghum	-	-	58.43	-	-
Gero millet	-	-	-	56.27	-
Dauro millet	-	-	-	-	56.27
Soybeans	24.74	20.57	20.57	22.73	22.73
Wheat offal	12.00	12.00	12.00	12.00	12.00
Fish meal	5.00	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00

Table 2: Continue

Parameters	Diets 1	2	3	4	5
Calculated analysis					
ME (kcal kg^{-1})	3101.00	3029.00	3029.00	2804.00	2804.00
Crude protein (%)	20.00	20.00	20.00	20.00	20.00
Crude fibre (%)	3.70	3.60	3.60	4.80	4.80
Calcium (%)	1.47	1.73	1.73	1.48	1.48
Phosphorous (%)	0.79	0.90	0.90	0.79	0.79
Ether extract (%)	7.50	6.30	6.30	7.20	7.20

Statistical analysis: All the data generated during the experiment for all the parameters studied were subjected to analysis of variance technique as outline by Steel and Torrie (1980). The differences between the treatment means were further separated using Duncan's Multiple Range Test (DMRT) (Duncan, 1955).

RESULTS

The highest feed consumption ($p<0.05$) value of 47.52 g was obtained in birds fed diet 5 (Dauro millet) which was closely followed by the intake on diet 2. However, the feed intake on diet 1 (control), 3 and 4 were similar. There was a significant ($p<0.001$) difference in the daily weight gain of the chicks at the end of the starter phase (Table 3). The highest gain of 19.43 g was recorded among the birds fed diet 5 (Dauro millet based diet), while the lowest weight gain of 9.74 g was recorded among the birds fed diet 3 (white sorghum based diet). However, chicks fed diets 1 (control), 2 and 4 have similar daily weight gains.

There was significant ($p<0.05$) difference in the feed conversion ratio of the chicks at the end of the starter phase. The highest feed conversion ratio of 3.43 was recorded among the birds fed diet 3 (white sorghum based diet) which is similar to diet 2 and closely followed by birds on diet 1 (control), while the lowest feed conversion was recorded in diet 5 (Dauro millet based diet) which is also similar to 1 (control) and diet 4. The mortality observed at the starter phases ranged from 1-3 (Number) on diets 2 and 1, respectively. However, there was no mortality on diets 3 and 4. The daily feed intake at the finisher phase ranged from 86.21-118.87 g. However, no significant difference was observed across the dietary treatments.

Significant ($p<0.001$) difference was observed for daily weight gain of the birds at the end of the finisher phase (Table 3). No significant difference was observed across the dietary treatments for feed conversion at the end of the finisher phase. The mortality recorded in this phase of the experiment was low.

The daily feed intake (Table 3) observed at the overall phase varied from (61.49-80.70 g) on diets 4 and 5, respectively, were not affected by the dietary treatments. There was very highly significant ($p<0.001$) difference for birds at the overall phase. A significant ($p<0.05$) difference was observed for feed conversion in the overall performance. The highest feed conversion of 3.37 was recorded in birds on diet 3 (white sorghum based diet) which was similar to diet 1 (control) and 2, while the lowest feed conversion was observed in birds on diet 5 (Dauro millet based diet) which was also similar to diet 4. Generally, the mortality observed at the overall performance ranged from 1-3 (Number) across the dietary treatments. The economic analysis of experimental diets fed to broiler is presented in Table 4. The result of the economic analysis showed that the total feed

Table 3: Performance characteristics of broilers fed diets containing different energy sources

	Diets					
Parameters	1	2	3	4	5	SEM
Starter phase (1-4 weeks)						
Daily feed intake (g)	37.64^{bc}	41.29^{b}	33.05^{c}	36.76^{bc}	47.52^{a}	1.36*
Daily weight gain (g)	12.68^{b}	12.92^{b}	9.74^{c}	13.52^{b}	19.43^{a}	0.37***
Feed conversion ratio	2.98^{ab}	3.19^{a}	3.43^{a}	2.72^{ab}	2.46^{b}	0.12*
Mortality (No.)	3.00	1.00	0.00	0.00	2.00	-
Finisher phase (5-8 weeks)						
Daily feed intake (g)	106.79	94.30	89.94	86.21	113.87	4.07^{ns}
Daily weight gain (g)	31.69^{b}	31.15^{b}	27.20^{b}	34.68^{b}	45.80^{a}	1.07***
Feed conversion ratio	3.38	3.08	3.31	2.49	2.53	0.14^{ns}
Mortality (No.)	0.00	1.00	1.00	0.00	0.00	-
Overall (1-8 weeks)						
Daily feed intake (g)	72.23	67.80	61.50	61.49	80.70	2.64^{ns}
Daily weight gain (g)	22.18^{bc}	22.04^{bc}	18.47^{c}	23.95^{b}	32.26^{a}	0.62***
Feed conversion ratio	3.18^{a}	3.14^{a}	3.37^{a}	2.60^{b}	2.49^{b}	0.11*
Mortality (No.)	3.00	2.00	1.00	1.00	2.00	-

^{a,b,c}Means in the same row with different superscripts are significantly different (*p<0.05, ***p<0.001), SEM: Standard error of the mean

Table 4: Economic analysis of experimental diets on performance of broiler chickens (1-8 weeks)

	Diets				
Parameters	1	2	3	4	5
Total feed intake (kg)	4.04	3.79	3.44	3.44	4.57
Feed cost (₦)	68.82	69.87	66.36	70.81	74.87
Total feed cost (₦)	278.08	264.81	228.28	243.59	338.41
Total weight gain (kg)	1.24	1.23	1.03	1.34	1.81
Feed cost (₦) per kg gain	224.22	215.29	221.61	181.78	286.90

intake was higher in diet 5 (4.57 kg) and the lowest were observed on diet 3 and 4 (3.44 kg), respectively. Lowest feed cost was found on diet 3 (₦ 66.36) while diet 5 (₦ 74.87) recorded the highest feed cost. Highest total weight gain was observed on diet 5 (1.81 kg) while diet 3 (1.03 kg) recorded the lowest value. Highest value of feed cost per kg gain was observed in diet 1 (₦ 224.22 kg^{-1}) while the lowest was diet 4 (₦ 181.78 kg^{-1}).

DISCUSSION

The daily feed consumption was high for birds fed diet containing Dauro millet as source of energy. This is in agreement with the study of Adamu (2005) who replaced yellow sorghum for maize and found significant difference in the daily feed intake. The feed intake observed in diet 2 (41.29 g) red sorghum based diet was higher than diet 1 (37.64 g) maize base diet, though statistically similar agrees with the findings of Sannamani (2002) who observed that chicks fed red sorghum had statistically similar feed intake as corn, this was supported by Jacob *et al.* (1996) who reported that low tannin sorghum has similar nutritional value with maize. The feed intake in diet 5 (47.52 g) Dauro millet was higher than values observed in the other cereals, this is attributed to high CP and high oil content of about 5-6% and lower portion of less digestible prolamines (Subramanian and Jambunathan, 1980), millet is also free of tannins that can interfere or

slowdown digestibility. The lower feed intake in maize diet could be attributed to the level of oil in maize which affect voluntary intake by birds (Zand and Foroudi, 2013). During the finisher phase, the daily feed intake was not significant across the dietary treatment. This is in agreement with the finding of Adamu *et al.* (2001) who replaced millet for maize. Similarly, Mohammed (2009) found no statistical difference in the daily feed intake when he replaced quality protein maize for normal maize, it is equally in line with the study of Elangovan *et al.* (2005) who fed reconstituted high tannin red sorghum based diets to broiler chicks and found no significant difference across the dietary treatments, these results is in conformity with the findings of Pour-Reza and Edriss (1997) who stated that all dietary maize portion of broiler diets can be replaced with low-tannin sorghum without adverse effect on feed intake. In the combine phase feed intake was also not significantly influenced by the dietary treatments, with Dauro millet having high feed intake. This is also in line with the study of Elangovan *et al.* (2005) who fed reconstituted high tannin red sorghum based diets to broilers and found no statistical difference at the overall phase, this is probably due to decrease in the extracted tannin content (Mitaru *et al.*, 1983). The high feed intake in Dauro millet based diet suggested that millet is free from anti nutritional properties (Phytate and tannins) and contain more mineral and higher protein than maize (Cromwell and Coffey, 1993; NRC., 1996).

The daily weight gain was significantly influenced by the dietary treatment during the starter phase. This is in agreement with the study of Adamu (2005) who replaces yellow sorghum for maize and found significant difference in the daily weight gain, the millet group (Dauro millet and Gero millet) has the highest body weight gain which agreed with the findings of Bramel-Cox *et al.* (1992), this could be due to higher oil content than other common cereal grains in the diet which has been reported to enhance growth, feed conversion ratio, improve appetite and ameliorate the growth depressive effects of heat stress (Fuller, 1981; Moran, 1986). Significant difference ($p<0.001$) was also observed during the finisher phase for daily weight gain. This is in conformity with the finding of Bai (2002) in which they conducted a study on broiler which quality protein maize replace normal maize and obtained significant difference in weight gain. The results of this study contradict the findings of Ibitoye *et al.* (2012), who found no significant difference among the treatments for body weight gain when diets containing different energy sources were used in broiler feeding. Poor weight gain observed on white sorghum based diet, might be due to poor nutrient digestibility as a result of high level of tannin. This is supported by Cao *et al.* (1998), who stated that digestibility of nutrients were less for soft sorghum (white sorghum) than for medium (red or yellow) and hard (cream) sorghum. In the overall phase (1-8 weeks) the result showed a significant difference across the dietary treatment ($p<0.001$) for weight gain, this is in agreement with the findings of Adamu *et al.* (2001) who obtained a significant difference in weight gain by broilers fed different energy sources. Lowest weight gain was observed in the white sorghum based diet, this reduction in body weight gain was also reported by several other studies of Douglas *et al.* (1990), Elkin *et al.* (1996) and Sannamani (2002). The results of this study contradict the findings of Kwari *et al.* (2014) who fed different energy sources and their combination to broilers and found no significant difference across the dietary treatments.

The result for feed conversion ratio in both the starter and overall phases showed significant difference ($p<0.05$) across the dietary treatments. While the result of the finisher showed no significant difference across the treatments, however, the best feed conversion ratio was seen in diet 4 (2.49). The poor FCR obtained in diet 2 and 3 of the starter phase could be due to presence of tannin in the sorghum based diets which reduces the utilization of energy, protein and specific amino acids (Douglas *et al.*, 1990; Elkin *et al.*, 1996). Ibitoye *et al.* (2012) reported that lowered

crude protein and anti-nutritional factors in the sorghum based diet may likely depress nutrient digestion absorption and utilization. Better feed conversion ratio observed in millet based diet was also reported by Sullivan *et al.* (1990), Bramel-Cox *et al.* (1992). The highest feed cost (₦ 74.87) was observed in diet 5 (Dauro millet based diet) while the lowest value (₦ 66.36) was observed in diet 3 (white sorghum based diet), this could be attributed to difference in prices of the grains as at the time of the experiment. The cost of total feed intake was also higher (₦ 338.41) in diet 5 (Dauro millet based diet) while the lowest value (₦ 228.28) was recorded in diet 3 (white sorghum based diet) this could be attributed to low feed consumption of the diets due to presence of anti-nutritional factors tannin which affect the palatability of the diet. Higher feed cost ₦ per kg gain (215.29 ₦ kg^{-1}) was observed in diet 2 (red sorghum based diet based diet) compared to diet 5 (Dauro millet based diet) which recorded the lowest value (186.97 ₦ kg^{-1}). The fed cost per kilogram body weight gain values (186.97-215.29 ₦ kg^{-1}), obtained in this study conformed with the values of (189.96-231.36 ₦ kg^{-1}) obtained by Bello *et al.* (2011) in broiler birds fed dietary levels (0,10, 20, 30 and 40%) of palm kennel cake.

CONCLUSION

Based on the results of the performance and economic analysis in this study, it can be deduce that the two varieties of millet (Dauro and Gero) are better substitute to maize than the two varieties of sorghum (red and white) considered, hence the two varieties of millet can be use in broiler feeding without adverse effect on the performance and as well cut down the cost of feed and broiler production, especially in an area where the climatic conditions favours millet production in large quantity.

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