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Growth, Hematology and Serology of Broiler Chickens Fed Different Cultivars of Sorghum as Replacement for Maize in the Semi-Arid Zone of Nigeria

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Abstract: An experiment was conducted at the University of Maiduguri Poultry Research Farm to investigate the total replacement of maize grain with different cultivars of sorghum in broiler finisher diets. Two hundred and forty broiler chickens aged 28 days weighing 540.96±9.26 g were randomly allotted to 24 pens. Six finisher diets containing 20% crude protein were formulated for the experiment. Diet 1 (control) was based on maize which was replaced in the other diets by one of five cultivars of sorghum grain. Each of the diets was fed to 4 randomly selected pens of 10 birds per pen using a completely randomized design. Feed intake, weight gain and final body weight were all reduced ($p<0.05$) on the sorghum-based diets compared to the control. These values were further reduced ($p<0.05$) on the Tumbuna sorghum compared to the other sorghum diets. Feed Conversion Ratio (FCR) however, did not show any superiority ($p>0.05$) of the control over the other diets. The hematological and serum biochemical parameters did not show any advantage of maize over the sorghum grains. It was concluded that although total replacement of maize with the sorghum grains has no apparent effects on the health of finishing broiler chickens, it is not beneficial when growth is the major performance response evaluated.

Key words: Maize, sorghum grain, broiler chickens, performance

INTRODUCTION

The use of maize as sole energy source in poultry diet formulations is becoming unrealistic on account of the decline in the land cultivable to maize as a result of climatic changes, the use of maize grain as a staple food for humans and several industrial uses. This situation has called for investigation into the potentials of other readily available cereals for poultry feeding.

Sorghum (*Sorghum bicolor*) is a drought tolerant crop able to withstand a wide range of environmental conditions and has little industrial uses in Nigeria. The use of sorghum grain as energy source in poultry diets has been documented. It has been ascertained that sorghum grain is a suitable substitute for maize in poultry diets (Dowling *et al*., 2002; Travis *et al*., 2006). Nyannor *et al*. (2007) and Medugu *et al*. (2010) replaced maize with sorghum grain in broiler chickens diets and reported no significant difference in performance. However, sorghum grain is reported to contain some tannin (Hartis 1971; Hatano *et al*., 1989) which may adversely affect chick growth (Jansman *et al*., 1995; Teguia, 1995). According to Hartis (1971) the tannin concentration of sorghum grain varies with the cultivar, thus the need to investigate the potential of different cultivars in poultry feeding.

This study was conducted to compare the performance of broiler chickens fed diets based on maize and different cultivars of sorghum in the semi-arid zone of Nigeria.

MATERIALS AND METHODS

Study site: The study was conducted at the Poultry Unit of University of Maiduguri Livestock Research Farm, Maiduguri, Nigeria during the months of October-November, 2010. The area falls in the semi-arid zone with an annual rainfall of 500-600 mm (Ugherughe and Ekedolum, 1986). Sorghum and millet are the major cereal crops grown in the area.

Sources of sorghum and maize grains: Five popular sorghum varieties in the area, namely Ajagama (cream in colour), Chakalare (white), Tumbuna (brown), Bulwalana (white), Kafimoro (cream) and maize (white) were purchased from a grain market in Maiduguri metropolis, ground to the same particle size (2.00 mm) and used for the formulations.

Experimental diets: A control diet based on maize and five (5) other diets in which maize was replaced with the sorghum varieties were formulated at starter and finisher levels for the study (Table 1). The diets were formulated to contain about 20% protein.

Experimental birds and management: Two hundred and forty (240) broiler chickens were used for the experiment which lasted for 5 weeks. The chicks were brooded together for the first 28 days during which they were fed a commercial starter diet from ECWA FEED, Jos, Nigeria. At the end of the 28th day the birds were

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Table 1: Ingredient composition of the broiler finisher diets

	Diets					
Ingredients	Maize	Ajagama	Bulwalana	Chakalare	Kafimoro	Tumbuna
Maize	56.00	-	-	-	-	-
Ajagama	-	56.00	-	-	-	-
Bulwalana	-	-	56.00	-	-	-
Chakalare	-	-	-	56.00	-	-
Kafimoro	-	-	-	-	56.00	
Tumbuna	-	-	-	-	-	56.00
Wheat bran	12.00	12.00	12.00	12.00	12.00	12.00
Soybean	24.00	24.00	24.00	24.00	24.00	24.00
Fish meal	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	2.25	2.25	2.25	2.25	2.25	2.25
*Premix	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis						
ME (kcal/kg)	2910.00	2910.00	2910.00	2910.00	2910.00	2910.00
CP (%)	23.38	23.38	23.38	23.38	23.38	23.38
CF (%)	3.98	3.98	3.98	3.98	3.98	3.98
Calcium (%)	1.10	1.10	1.10	1.10	1.10	1.10
Phosphorus (%)	0.60	0.60	0.60	0.60	0.60	0.60

*Vitamin/mineral premix from Bio-mix Finisher supplied/kg: Vit A = 4,000,000.00 IU; Vit D_3 = 800,000.00 IU; Vit E = 9,200.00 mg; Niacin = 11,000.00 mg; Vit B_1 = 720.00 mg; B_6 = 1,200.00 mg; B_{12} = 6.00 mg; Pantothenic acid = 3,000.00 mg; Biotin = 24.00 mg; Folic acid = 300.00 mg; Choline Chloride = 120,000.00 mg; Cobalt = 80.00 mg; Copper = 1,200.00 mg; Iodine = 400.00 mg; Iron = 8,000.00 mg; Manganese = 16,000.00 mg; Selenium = 80.00mg; Zinc = 12,000.00 mg; Anti oxidant = 500.00 mg. ME = Metabolizable Energy, CP = Crude Protein, CF = Crude Fibre

weighed and divided into 24 groups of similar weight, housed in floor pens measuring 1.80 m^2 each with the floor covered with wood shaving as litter material. The birds were vaccinated against Gumboro (2 and 4 weeks of age) and Newcastle (3 and 5 weeks of age) diseases. Each of the diets in Table 1 was fed *ad-libitum* to 4 randomly selected pens of 10 birds per pen using a completely randomized design. Clean drinking water was equally supplied *ad-libitum* throughout the duration of the experiment.

Data collection: Data were collected on growth and blood parameters. A weighed quantity of feed was fed daily and feed intake calculated by difference between the fed and left-over. Weight change was monitored by weekly weighing and feed conversion ratio obtained as feed consumed divided by weight gained.

At the end of the experiment, 2 birds were randomly selected per pen, fasted over night from which blood was collected and used for hematological and serological measurements. Hematological samples were collected into sample tubes containing Ethylene Diamine Tetra-acetic Acid (EDTA) as anticoagulant while serological samples were collected into anticoagulant-free tubes.

Chemical analysis: The diets were analyzed for proximate composition according to AOAC (1990). The sorghum varieties were analyzed for tannin contents using the hydrochloric acid, methanol and phenol vanillin procedure described by Price *et al.* (1978). Blood samples were analyzed according to Bush (1991).

Statistical analysis: Data collected on growth, hematology and serology were analyzed for variance (Steel and Torrie, 1980) using a completely randomized design. Where significant differences existed, means were separated using the Duncan's Multiple Range Test (Duncan, 1955).

Table 2: Analyzed tannin content of the sorghum varieties

Varieties	Color	Tannin level (%)
Ajagama	Cream	1.24
Bulwalana	White	0.99
Chakalare	White	1.33
Kafimoro	Cream	1.01
Tumbuna	Brown	1.59

RESULTS AND DISCUSSION

Chemical analysis: The values recorded for tannin (Table 2) were within the range of 0.2-2% reported by Rotagno *et al.* (1973) for sorghum grain. Tumbuna (a brown sorghum) had the highest tannin content while the lowest was recorded in Bulwana (white grain). This is in agreement with the observation of Issa *et al.* (2007) that coloured sorghum grains contain more tannin than white ones.

The results of proximate analysis are presented in Table 3. The crude protein values varied within very narrow ranges suggesting similarities between maize and the

Table 3: Proximate composition of the experimental diets

	Diets					
Constituents (%)	Maize	Ajagama	Bulwalana	Chakalare	Kafimoro	Tumbuna
Dry Matter (DM)	90.40	90.30	88.60	91.10	89.60	90.20
Crude Protein (CP)	20.28	20.56	19.69	20.06	19.49	20.00
Crude Fibre (CF)	4.50	4.50	5.50	4.00	4.00	5.00
Ether Extract (EE)	3.50	4.00	7.00	4.00	5.00	6.00
Total ash	4.50	4.00	3.50	3.50	5.00	4.50
Nitrogen-Free Extract (NFE)	67.22	66.94	64.31	68.44	66.51	64.50
*ME (kcal/kg)	3,301.71	3,361.09	3,378.54	3,365.84	3,367.24	3,365.75
Calculated tannin content (%)	-	0.62	0.50	0.67	0.51	0.80

*Metabolizable energy calculated using the formula of Pauzenga (1985) as ME (kcal/kg) = 37 x %CP + 81 x %EE + 35.50 x %NFE

Table 4: Growth performance of finishing broiler chickens fed different sorghum varieties as replacements for maize

	Diets						
Parameters	Maize	Ajagama	Bulwalana	Chakalare	Kafimoro	Tumbuna	SEM
Initial weight (g/bird)	540.87	541.01	540.85	540.90	541.05	541.05	9.26^{NS}
Final weight (g/bird)	2,375.00^{a}	2,055.00^{b}	2,040.00^{b}	1,900.00^{b}	2,070.00^{b}	1,725.00^{c}	72.29*
Daily feed intake (g/bird)	146.96^{a}	136.05^{b}	111.33^{d}	102.67^{e}	118.38^{c}	103.51^{e}	1.46*
Daily weight gain (g/bird)	43.39^{a}	36.97^{b}	36.59^{b}	34.20^{bc}	36.99^{b}	30.22^{c}	1.99*
FCR (Feed: gain)	3.39^{ab}	3.68^{a}	3.04^{b}	3.09^{b}	3.20^{ab}	3.43^{ab}	0.15*
Mortality (%)	0	0	0	0	0	0	-

^{a,b,c,d,e}Means within the same row bearing different superscripts differ significantly ($p<0.05$). SEM = Standard Error of the Mean, NS = Not Significant ($p>0.05$), * = Significant ($p<0.05$), - = Not analyzed

sorghum varieties in crude protein content. The protein content of the diets met the requirement of finishing broilers as recommended for broiler chickens at finishing stage (NRC, 1994). The sorghum grain-based diets contained more fat than the control suggesting higher fat in the sorghum grains used than maize. The higher fat in the sorghum diets resulted in a higher Metabolizable Energy (ME) on these diets than the control as fat is the most concentrated form of energy. The ME values met the requirements of finishing broilers in the tropics (Jourdain, 1980; Olomu, 1995). The crude fibre content of all the diets was comparable to the 5% reported to be tolerated by finishing broiler chickens (Smith, 2001). The tannin content of the sorghum grain-based diets (calculated) varied from 0.50-0.80% with highest value in the Tumbuna sorghum diet.

Growth performance: The growth performance data of the broilers are presented in Table 4. Daily feed intake and daily weight gain were markedly ($p<0.05$) reduced on the sorghum-based diets compared to the control. The reduced feed intake was attributed to the higher energy in the sorghum diets compared to the control based on maize as poultry consume feed to meet their energy requirement. The poorest weight gain was recorded on the Tumbuna (brown grain) diet which translated into a significantly ($p<0.05$) lower final body weight of the birds on this diet. There were no significant ($p>0.05$) differences in daily gain and final weight amongst diets based on the other sorghum varieties but their values were significantly ($p<0.05$) lower than the control. Despite the reduced weight gain and final body weight of the birds on the sorghum grains diets, maize was not superior to sorghum in terms of Feed Conversion Ratio (FCR). There was no mortality during the experiment. The reason for the poorer daily gain and final weight on the sorghum based diets compared to the control was obscure, but probably it could be due to the manifestation of the astringent effect of tannin which was further pronounced on the Tumbuna diet with the highest (0.80%) tannic acid content. The FCR values were comparable to values reported for broiler chickens in the tropics (Jourdain, 1980; Olomu, 1995). Similarly, with the exception of the diet based on brown sorghum, the final body weights of the birds on all the diets were within ranges reported for broiler chickens in the tropics (Jourdain, 1980; Olomu, 1995; Jadhav and Siddiqui, 2010).

Blood parameters: The results of hematological and serum biochemical studies are presented in Table 5 and 6 respectively. Except for the monocytes which were significantly ($p<0.05$) reduced on the Tumbuna diet, the results of hematology did not show any superiority of maize over the sorghum grains. As monocytes help the immune system to identify harmful toxic substances, a higher monocyte value was expected on the Tumbuna diet with the highest tannin content. The reason for the lower monocytes on the Tumbuna sorghum-based diet in this experiment was not known. The values for all the hematological parameters observed were within the normal ranges reported (Dukes, 1975; Merck Veterinary

Table 5: Hematological parameters of finishing broiler chickens fed different sorghum varieties as replacements for maize

	Diets						
Parameters	Maize	Ajagama	Bulwalana	Chakalare	Kafimoro	Tumbuna	SEM
PCV (%)	35.67^{a}	32.00^{b}	33.67^{ab}	34.67^{a}	34.00^{ab}	34.67^{a}	0.84*
RBC (10^6/mm^3)	4.19^{a}	4.04^{ab}	4.08^{ab}	4.08^{ab}	4.13^{a}	3.89^{b}	0.06*
Hb conc. (g/dl)	13.63	13.13	13.13	13.47	13.27	13.87	0.47^{NS}
WBC (10^6/mm^3)	51.50^{abc}	49.33^{d}	51.16^{c}	51.33^{bc}	52.33^{ab}	52.50^{a}	3.43*
Heterophils (%)	34.00	31.67	34.67	33.00	32.33	34.67	0.98^{NS}
Lymphocytes (%)	50.67	54.00	51.00	52.33	51.33	50.67	1.39^{NS}
Basophils (%)	0.00	0.33	0.33	0.33	0.00	0.33	0.25^{NS}
Eosinophils (%)	6.33^{abc}	5.67^{bcd}	4.33^{d}	5.00^{cd}	7.67^{a}	7.00^{ab}	0.61*
Monocytes (%)	9.00^{ab}	8.33^{bc}	9.67^{a}	9.33^{ab}	8.67^{b}	7.33^{c}	0.42*

^{a,b,c,d}Means within the row bearing different superscripts differ significantly ($p<0.05$). SEM = Standard Error of the Mean; * = Significant ($p<0.05$), NS = Not significant ($p>0.05$)

Table 6: Serum biochemical values of finishing broiler chickens fed different sorghum varieties as replacements for maize

	Diets						
Parameters	Maize	Ajagama	Bulwalana	Chakalare	Kafimoro	Tumbuna	SEM
Total protein (g/dl)	5.23	4.83	5.60	4.70	5.03	5.60	0.90^{NS}
Albumin (g/dl)	1.93	1.83	1.87	1.93	1.93	1.93	1.20^{NS}
Total bilirubin (mg/dl)	5.00	6.00	4.33	5.00	6.00	5.00	0.57^{NS}
ALAT (IU/l)	7.33	7.33	6.00	7.33	6.33	6.36	1.78^{NS}
ASAT (IU/l)	88.67	87.33	99.00	103.67	93.00	88.67	6.12^{NS}
Creatinine (mmol/l)	61.67	70.67	64.33	61.67	60.67	59.60	4.85^{NS}
Urea (mmol/l)	2.57^{b}	2.57^{b}	3.03^{a}	2.63^{b}	2.90^{ab}	2.83^{ab}	0.12*
Potassium (mmol/l)	4.40	5.30	4.20	4.07	5.07	4.13	0.40^{NS}
Calcium (mmol/l)	1.73^{b}	1.70^{b}	1.73^{b}	1.73^{b}	1.87^{a}	1.73^{b}	0.04*
Chloride (mmol/l)	98.00^{a}	100.00^{a}	102.67^{a}	92.00^{b}	100.67^{a}	99.33^{a}	1.81*
Sodium (mmol/l)	142.00^{a}	142.00^{a}	140.67^{ab}	135.00^{b}	139.33^{ab}	140.67^{ab}	1.89*
Glucose (mmol/l)	8.77^{ab}	11.13^{a}	9.10^{ab}	9.07^{ab}	7.43^{b}	8.57^{ab}	1.00*
Cholesterol (mmol/l)	3.33^{a}	2.86^{ab}	2.50^{ab}	2.30^{b}	3.27^{a}	2.60^{ab}	0.30*

^{a,b,c}Means within the row bearing different superscripts differ significantly ($p<0.05$). SEM = Standard Error of the Mean, NS = Not Significant ($p>0.05$), * = Significant ($p<0.05$)

Manual, 1986; Awoniyi *et al*., 2000) for broiler chickens although most of the values assumed the upper limits of these ranges. The higher hematological values were attributed to the relatively high ambient temperature (32°C) during the experiment as heat stress has been reported to increase the hematological indices in broiler chickens (Dukes, 1975; Siegel, 1971; Siegel and Gross, 1980).

Similarly, the serum biochemical indices observed were all within normal ranges reported by Dukes (1975) and Swenson (1970) for broiler chickens. Like for the hematology, the values for serum biochemistry did not show any advantage of maize over the sorghum grains. It was concluded that although total replacement of maize with the sorghum grains has no apparent effects on the health of finishing broiler chickens, it is not beneficial when growth is the major performance response evaluated.

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