

Carcass Characteristics and Blood Parameters of Broiler Chickens fed Four Local Varieties of Sorghum as Replacement for Maize in Semi-arid Zone of Nigeria

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Abstract: Effect of dietary replacement of maize with four local varieties of sorghum on carcass characteristics, haematology and serum biochemical indices of broiler chickens were determined. Two hundred and twenty-five (225) 14 day old broiler chicks were randomly assigned to five (5) dietary treatments containing forty five (45) chicks having three (3) replicates with fifteen (15) chicks each. The dietary treatments were: (maize), 1 control, 2 (“Masakwa” sorghum), 3 (“Kafi-moro”) sorghum, 4 (“Kamawanza” sorghum) and 5 (“Chakalere” sorghum). The design of the experiment was Randomized Complete Block Design (RCBD). The study covered both starter and finisher stages. The results showed that there were no significant ($p > 0.05$) difference in the live weight, slaughter weight, plucked weight, dressed weight and dressing percentage in all the treatment groups. Significant ($p < 0.05$) differences were observed in the thighs, neck, intestinal weight and caeca. Significant ($p < 0.05$) differences were also noticed in the packed cell volume, red blood cells, haemoglobin concentration, mean corpuscular haemoglobin concentration and white blood cells among treatment groups. Similarly, significant ($p < 0.05$) differences exists in neutrophils, monocytes and lymphocytes. Some significant ($p < 0.05$) differences were observed in the serum biochemical indices which include albumen, globulin, creatinine and conjugated bilirubin among treatment groups. These results conclude that replacement of maize with sorghum in broiler chicken diets had no adverse effects on carcass, haematological and serum biochemical indices.

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Keywords: Broiler chickens, carcass, haematology, serum biochemistry, maize, sorghum

Introduction

The increase in human population, high cost of conventional feeds as well as competition between man and animals for cereal grains have necessitated the search for alternative energy sources for formulating poultry diets. The premium energy source in poultry diets in the tropics and subtropical countries is the maize. Maize is expensive and scarce due to low production as a result of drought in semi-arid areas. The only measure to be taken to salvage this situation of low poultry production is to search for alternative. One of such alternative is sorghum. Sorghum is a crop that can be cultivated in the semi-arid regions of Asia and Africa and it is cheaper and more readily available than maize (1, 2). Issa et al. (3, 4) reported that sorghum grains can play an important role in poultry feeds in the Sahelian countries. Dowling et al. (5, 6) have shown that sorghum could be a suitable feedstuff in the poultry industry. Therefore, the objectives of this study were to evaluate the carcass characteristics, haematological and serum biochemical indices of broiler chickens fed maize and sorghum-based diets.

Materials and methods

Study Site

The study was conducted at the University of Maiduguri Teaching and Research Livestock Farm, Department of Animal Science Poultry unit. Maiduguri is located between latitude 11°05' and 12° North and longitude 13°05' and 14' East and at an altitude of 345 m above sea level (7). The mean temperature is 34°C, the maximum being 40.6°C and the minimum 25°C which is April and December respectively (8). The relative humidity ranges from 30 to 50%, it is about 70 to 80% in August and a minimum of 10% in February to March (7). The area falls in the semi-arid zone of West Africa which is characterized by short duration of rainfall (3 to 4 months) which varies from minimum of 478 mm to 500 mm to maximum of 600 mm to 621 mm with a long dry season of 8 to 9 months (9). The vegetation of the area consists of certain shrubs and grasses which thrive well with flat landscape punctuated randomly by occasional shrubs and scanty trees making it suitable for drought resistant crops such as millet, sorghum and cowpea (7).

Experimental stock and their management

Two hundred and twenty-five (225) day-old broiler chicks were used for the study. The chicks were weighed individually and allotted to five (5) experimental diets. They were assigned treatments in groups of forty five (45) which were replicated three (3) times with 15 chicks per replicate in a Randomized Complete Block Design (RCBD). Five (5) experimental diets were formulated using yellow maize (control) as treatment 1 and treatments 2, 3, 4 and 5 contained yellow (“Masakwa”), white (“Kafi-moro”), yellow (“Kamawanza”) and white (“Chakalere”) sorghum respectively.

The chicks were provided with the experimental diets with adequate drinking water *ad libitum* and other management practices which include vaccination against Gumboro and Newcastle diseases. The study lasted for 49 days. The ingredient composition and calculated analyses of the experimental diets are presented in **Table 1**.

Data collection:

Carcass measurements.

At the end of the experiment, nine (9) chickens were randomly selected from each treatment. Three (3) chickens per replicate were used for carcass evaluation, totaling forty-five (45) chickens from the treatments. The slaughtered weight, dressed weights,

head, neck, wings, thighs, shanks, abdominal fat and various organs such as heart, liver, lungs and gizzard were excised and weighed. The dressing percentage was calculated as follows:

$$\text{Dressing percentage} = \frac{\text{Dressed weight}}{\text{Slaughter weight}} \times 100$$

All cut –up parts and organs were expressed as percentage of the slaughter weight.

Haematology and serum indices

At the end of the experiment, blood samples were collected from three (3) chickens in each treatment for haematological and serum biochemical analyses. The haematological indices determined were packed cell volume (PCV), haemoglobin (Hb) concentration, red blood cell (RBC) counts and white blood cell (WBC) counts. The mean corpuscular volume (MVC), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated according to the formulae outlined by (10). The serum biochemical indices determined were levels of glucose, protein, albumen, globulin, uric acid, creatinine and cholesterol using the methods outlined by (11).

Statistical analysis.

All data collected were subjected to analyses of variance using the software, statistix 9.0 version (12).

Table 1: Ingredient composition and calculated analyses of the experimental broiler finisher diets

Ingredients (%)	Diets / Treatments				
	T ₁ (Maize)	T ₂ (Masakwa)	T ₃ (Kafi-moro)	T ₄ (Kamawanza)	T ₅ (Chakalere)
Maize	48.92	-	-	-	-
Sorghum (masakwa)	-	48.92	-	-	-
Sorghum (kafi - moro)	-	-	48.92	-	-
Sorghum (kamawanza)	-	-	-	48.92	-
Sorghum (chakalere)	-	-	-	-	48.92
Wheat bran	15.46	15.46	15.46	15.46	15.46
Soyabean meal	26.48	26.48	26.48	26.48	26.48
Fish meal	5.29	5.29	5.29	5.29	5.29
Bone ash	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
Salt (NaCl)	0.30	0.30	0.30	0.30	0.30
Premix*	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated analyses (%)					
Crude Protein (CP)	19.69	20.66	20.66	20.66	20.66
Ether extract (EE)	3.37	2.59	2.59	2.59	2.59
Crude fibre (CF)	4.08	4.37	4.37	4.37	4.37
Calcium (Ca)	1.34	1.16	1.16	1.16	1.16
Phosphorus (P)	0.92	0.88	0.88	0.88	0.88
ME (kcal/kg)	3200.00	3100.00	3100.00	3100.00	3100.00

ME = Metabolizable energy (kcal/kg).

* Premix supplying the following per kg of feed: Vitamin A = 12,000 IU, Vitamin E = 15000 mg, folic Acid = 1000 mg, panthothenic acid = 15000 mg, Vitamin B₁₂ = 15000 mg, Vitamin B₆ = 2,500 mg, Vitamin K = 2,000 mg, choline = 50,000 mg, manganese = 10,000 mg, Vitamin D₃ = 25,000 IU, Nicotinic acid = 40,000 mg, Vitamin B₁ = 2,000 mg, Vitamin B₂ = 6,000 mg, biotine = 6,000 mg, Vitamin C = 3,000 mg, copper = 15,000 mg, cobalt = 250 mg and selenium = 1,000 mg.

Results and discussions.

Data on proximate composition of the experimental diets are presented in **Table 2**. The diets obtained can provide adequate nutrients required for broiler chickens in line with the recommendations of (13).

Table 2: Proximate Composition of the experimental diets (%)

Nutrients	T ₁ (Maize)	T ₂ ("Masakwa")	T ₃ ("Kafi-moro")	T ₄ ("Kamawanza")	T ₅ ("chakalere")
Dry matter (DM)	95.05	96.50	96.25	96.80	96.15
Moisture content	3.00	3.50	3.75	3.20	3.85
Crude protein (CP)	19.00	20.25	20.30	20.00	20.20
Ether extract (EE)	3.50	3.00	3.15	3.25	3.00
Crude fibre (CF)	4.50	5.00	5.25	5.15	5.00
Ash	4.00	5.00	5.50	6.25	6.50
Nitrogen free extract (NFE)	66.00	63.25	62.05	62.15	61.45
Metabolizable energy (kcal/kg)	3335.50	3231.88	3209.00	3206.58	3171.88

ME (kcal/kg) = 37 x % CP + 81 x % EE + 35.5 x % NFE, calculated according to the formula of (20).

Carcass characteristics

The data on carcass and organs measurements expressed as percentage of slaughter weights is presented in **Table 3**. Results obtained revealed that except for thighs, neck, intestinal weight and caeca, which showed significant ($p < 0.05$) differences, there were no significant ($p > 0.05$) differences among treatments for carcass and organ measurements. The thighs were superior ($p < 0.05$) in T₂ ("Masakwa" sorghum) compared to the other treatments. The thighs were comparable to the value (13.01%) reported by

(14) when high – and – low tannin sorghum diets were fed to broiler chickens to replace maize as energy source. The dressing percentage (71.66 to 74.33%) of broiler chickens fed sorghum diets were similar to the values (73.52 to 73.59%) reported by (14) but lower than the value (81.25%) obtained by (15). Similarly, Ibe and Makinde (16) reported that dressing percentage of broiler chickens fed sorghum diets to replace maize was (69.85 to 73.11%). Thus it will be deduced that the diets were adequate for finishing broiler chickens.

Table 3: Carcass Characteristics of Broiler Chickens Fed Four Varieties of Sorghum Diets as Replacement for Maize.

Parameters	Diets / Treatments					SEM
	T ₁ (Maize)	T ₂ ("Masakwa")	T ₃ ("Kafi-moro")	T ₄ ("Kamawanza")	T ₅ ("Chakalere")	
Slaughter weight (g)	1616.70	1829.00	1592.70	1685.70	1821.50	176.15 ^{NS}
Plucked weight (g)	1540.20	1759.20	1510.30	1603.80	1745.80	168.60 ^{NS}
Dressed weight (g)	1166.70	1360.50	1140.20	1246.00	1311.20	130.40 ^{NS}
Dressing percentage (%)	72.00	74.33	71.66	74.00	72.00	1.17 ^{NS}
Cut-up parts expressed as (%) of SW						
Legs (%)	4.19	3.85	3.59	3.87	3.89	0.21 ^{NS}
Head (%)	2.61	2.36	2.29	2.34	2.36	0.16 ^{NS}
Wings (%)	8.07	8.24	7.13	8.09	7.72	0.59 ^{NS}
Thighs (%)	11.23 ^{ab}	12.00 ^a	9.26 ^c	10.37 ^{bc}	10.26 ^b	0.66 [*]
Drumstick (%)	10.05	9.73	8.51	9.85	9.56	0.71 ^{NS}
Breast (%)	21.14	22.29	18.82	20.187	20.160	1.89 ^{NS}
Back (%)	14.10	14.00	14.73	15.80	14.78	1.10 ^{NS}
Neck (%)	4.50 ^{ab}	4.84 ^{ab}	4.06 ^b	5.51 ^a	5.03 ^{ab}	0.57 [*]
Organ weights expressed as (%) of SW						
Full crop (%)	0.61	0.73	0.58	0.47	0.58	0.15 ^{NS}
Liver (%)	1.87	2.06	2.50	2.07	1.99	0.32 ^{NS}
Spleen (%)	0.09	0.09	0.10	0.13	0.07	0.03 ^{NS}
Gizzard full (%)	3.13	2.91	2.66	2.64	2.73	0.29 ^{NS}
Heart (%)	0.45	0.51	0.57	0.55	0.68	0.12 ^{NS}
Abdominal fat (%)	1.45	1.50	1.74	1.72	1.65	0.38 ^{NS}
Intestinal weight (%)	5.78 ^a	5.26 ^b	3.56 ^c	4.10 ^{bc}	5.74 ^a	0.55 [*]
Caeca (%)	0.72 ^b	0.82 ^b	0.89 ^b	1.10 ^{ab}	1.36 ^a	0.17 [*]

a, b = Means within a row with superscripts are significantly ($P < 0.05$) different

NS = Not significant ($P > 0.05$); * Significant ($P < 0.05$); SEM = Standard Error of Means; SW = Slaughter weights

Haematology and serum Indices**Table 4: Haematological Indices of Broiler Chickens Fed Four Varieties of Sorghum Diets as Replacement for Maize.**

Parameters	Diets / Treatments					SEM
	T ₁ (Maize)	T ₂ ("Masakwa")	T ₃ ("Kafi-moro")	T ₄ ("Kamawanza")	T ₅ ("Chakalere")	
Packed Cell Volume (PCV) (%)	29.00 ^b	32.50 ^{ab}	30.00 ^{ab}	31.50 ^{ab}	33.83 ^{ab}	1.81 [*]
Red blood cells (RBC) Count (x 10 ⁶ /mm ³)	2.52 ^b	2.70 ^{ab}	3.10 ^a	2.68 ^{ab}	2.70 ^a	0.20 [*]
Haemoglobin (Hb) Concentration (g/dl)	9.60 ^b	10.83 ^{ab}	10.00 ^{ab}	10.63 ^{ab}	11.27 ^a	0.62 [*]
Mean Corpuscular Volume (MCV) (fl)	11.58	12.50	9.77	11.90	12.50	1.19 ^{NS}
Mean Corpuscular Haemoglobin (MCH) (pg)	38.30	41.70	32.60	40.10	41.60	3.90 ^{NS}
Mean Corpuscular Haemoglobin Concentration (MCHC) (%)	33.10 ^b	33.33 ^{ab}	33.33 ^{ab}	33.77 ^a	33.30 ^{ab}	0.21 [*]
White Blood Cells (WBC) Count (x10 ³ /mm ³)	2.07 ^{ab}	1.95 ^{ab}	1.86 ^{ab}	1.82 ^b	2.31 ^a	0.20 [*]
Differential Counts (%)						
Neutrophils	36.00 ^{ab}	32.00 ^{abc}	44.66 ^a	21.33 ^c	27.83 ^{bc}	6.30 [*]
Eosinophils	1.66	1.50	1.00	1.16	2.83	1.51 ^{NS}
Monocytes	0.17 ^{ab}	0.00 ^b	0.00 ^b	0.50 ^a	0.00 ^b	0.21 [*]
Lymphocytes	62.16 ^{ab}	66.33 ^{ab}	54.33 ^b	77.00 ^a	69.67 ^a	6.64 [*]

a, b, c = Means with a row with different superscripts are significantly (P<0.05) different

NS = Not significant (P>0.05)

* = Significant (P<0.05)

SEM = Standard Error of Means

Table 5: Serum Biochemical Indices Broiler Chickens Fed Four Varieties of Sorghum Diets as Replacement for Maize.

Parameters	Diets / Treatments					SEM
	T ₁ (Maize)	T ₂ ("Masakwa")	T ₃ ("Kafi-moro")	T ₄ ("Kamawanza")	T ₅ ("Chakalere")	
Total protein (TP) (g/dl)	53.33	43.66	61.33	54.67	45.00	8.49 ^{NS}
Albumen (g/dl)	41.67 ^a	29.33 ^{ab}	38.00 ^{ab}	34.00 ^{ab}	28.00 ^{ab}	5.53 [*]
Globulin (g/dl)	11.66 ^b	17.67 ^{ab}	23.33 ^a	20.66 ^{ab}	17.00 ^b	4.44 [*]
Uric acid (mmol/L)	4.40	6.43	7.66	6.47	5.07	2.67 ^{NS}
Creatinine (mmol/L)	44.33 ^b	55.33 ^{ab}	60.33 ^a	51.66 ^{ab}	49.00 ^{ab}	5.98 [*]
Alkaline phosphate (iu/L)	128.67	193.00	203.67	147.33	176.33	48.72 ^{NS}
Aspartate Amino Transferase (ASAT) (IU)	77.67	74.00	70.00	65.00	62.67	11.09 ^{NS}
Alanine Amino Transferase (ALAT) (mmol/L)	52.33	55.67	52.33	53.67	58.67	4.39 ^{NS}
Total bilirubin (TB) (mmol/L)	3.20	4.57	4.87	4.13	4.46	0.88 ^{NS}
Conjugate bilirubin (CB) (mmol/L)	2.00 ^b	2.43 ^{ab}	2.93 ^a	2.53 ^{ab}	2.20 ^{ab}	0.37 [*]

a, b = Means within a row with superscripts are significantly (P<0.05) different

NS = Not significant (P>0.05), * Significant (p<0.05)

SEM = Standard Error of Means

The data on haematological and serum biochemical indices are presented in **Tables 4 and 5**. There were significant ($p < 0.05$) difference in haematological indices among treatment groups except for mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) which were not significantly ($p > 0.05$) different among treatments. The values for packed cell volume (PCV), red blood cells (RBC) and haemoglobin concentration (Hb) were similar in the sorghum-based diets and slightly better than maize-based diets. However, the values were within the normal range reported by (17, 18) for broiler chickens. For the differential counts, monocytes and lymphocytes were significantly ($p < 0.05$) higher in T₃ (“Kafi-moro”) and T₄ (“Kamawanza”) sorghum diets. Robert *et al.* (19) reported that increase in lymphocytes is an indication of an infection, but there was no infection or sign of ill-health recorded during the study. For the serum biochemical indices, total protein (TP), uric acid, alkaline phosphates, aspartate aminotransferase (ASAT), alanine amino transferase (ALAT) and total bilirubin were not significantly ($p > 0.05$) different among treatment groups. The range of TP (45.0 to 61.33g/dl) obtained in this study were higher than the values (25.8 to 5.22g/dl) reported by (21) and (29.00 to 34.00g/dl) reported by (14). Also the albumen values (28.0 to 41.67) were superior to the values (11.70 to 27.40g/dl) reported by (21) and (12.50 to 14.00g/dl) (14). Adeyemi *et al.* (22) reported that increase in total protein and albumen values are indications of good quality feeds and an index of physiological, pathological and nutritional status of an organism. The results of the haematological indices obtained in this study indicate that inclusion of sorghum in broiler chicken diet had no adverse effects on haematological indices, and invariably the health status of the chickens.

Conclusion

Results obtained from this study therefore, revealed that maize could be replaced with sorghum in broiler chicken diets without deleterious effects on carcass, haematological parameters and serum biochemical indices and the health status of the chickens. Further research should be carried out to investigate the effects of replacing maize with sorghum in cockerel and layers on carcass and haematological and serum biochemical indices.

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