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Effect of feeding red sorghum supplemented with graded levels of synthetic methionine on carcass characteristics, haematology and serum biochemistry of broiler chickens

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Abstract

A nine (9) weeks feeding trial was conducted on three hundred (300) day old unsexed Anak broiler chicks were raised on deep litter to determine their carcass characteristics, haematology and serum biochemistry when fed five (5) dietary treatments (T1, T2, T3, T4 and T5 supplemented with 0.1, 0.2, 0.3, 0.4 and 0.5%) synthetic methionine. Birds were divided into five treatments of 60 birds each and three replicates of 20 birds per replicate. At the end of the 8th weeks, six birds were randomly selected from each treatment, two per replicate. The birds were slaughtered for liveweight and various organs weight were determined. For the carcass, there was significant difference (P<0.05) in all parameters evaluated. Live, plucked and carcass weights plus dressing percentage increased with increased levels of methionine inclusion. So also, haematologial indices were not significantly (P>0.05) difference in all parameters measured. Same also, is the serum biochemical that wss not significantly (P>0.05) difference. Therefore, it can be concluded that red sorghum can be used to replace maize upto 100% in the diets of broilers without detrimental effects on carcass and haematological indices.

Keywords: Broiler; Red sorghum; Synthetic methionine; Carcass; Haematological; Serum

1 Introduction

Protein intake of an average Nigerian is very low compared to developed countries resulting in some adverse effects on the wellbeing of the citizen and their productivities. One of the major reasons is the high cost of feed ingredient which accounts for 60-80% of the total cost of production clearly indicates that the production of cereal grains for livestock business is grossly inadequate (1). Energy sources are the most important and expensive feedstuffs especially maize which accounts for the largest production of about 50-55% of the poultry diet (2). This invariably has led to stiff competition between humans and animals over the limited supply of grains therefore affecting the poultry industry in Nigeria (3). Thus, there is an urgent need to divert attention or think of other energy source(s) that will not be in high demand as maize universally. Poultry farmers in Nigeria spent fortune in importing maize to meet their demand to augment local production that is inadequate to meet the national demand for both man, industries and livestock. One of such potential source that has not been fully utilized is Red Sorghum which is less in demand for man, industries and livestock use as compared to maize. Sorghum is the cultivation and commercial exploitation of species of grasses within the genus sorghum (sorghum bicolor). The plants are cultivated in warm climate worldwide. It is native to tropical and sub-tropical regions of Africa and Asia (4). Sorghum has been, for centuries, one of the most important stable food for millions of poor people in semi-arid tropics of Africa and Asia. For semi impoverished regions of the world, sorghum

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remains a principal source of energy protein, vitamins and minerals. Sorghum grows in harsh environments where other crops do not grow well just like other stable foods, such as cassava, that are common in impoverished regions of the world. It is usually grown without application of any fertilizers or other inputs by a multitude of small-holder farmers in many countries (4). Sorghum is extensively used in poultry feeding in many countries of the world. One of the major limitations for its use in poultry feeds is its relatively high tannin content. The detrimental effects of high tannin sorghums on the growth and feed efficiency of the growing chickens are well documented by Hill and Hanna (5). They reported that as little as 0.5% tannin acid will depress growth. According to Aduku (6), sorghum is lower in energy than maize, it is higher but more variable in protein (8-12%) than maize. It contains less oil than maize, it's a main food grain for human and livestock and it is more drought resistant than maize. He observed that varieties in Nigeria contain tannin in a range of 0.012 to 0.215%. Tannin have a deleterious effect on the nutritive value of sorghum as there is reduction in amino acid availability with increasing tannin content. The detrimental effects of high-tannin sorghum on growing chicks may be alleviated by supplementing tropical diets with lysine and methionine (7). Hence this experiment was supplemented with graded levels of synthetic methionine. The question has always been raised as to whether naturally occurring sorghum tannins are as toxic as tannic acid. Davis (8) observed a growth depression regardless of the source of the tannin, but a higher sorghum tannins content was necessary to cause growth depression equivalent to commercial tannic acid. He also observed that supplementation of high tannin sorghum diets with methionine or chloride alleviated the growth depression. Elkin (9) found that addition of 0.15% methionine to a high-tanning sorghum-soybean meal brought the growth of broilers up to that obtained with similar diet containing a low-tannin sorghum grain. Other methods for improving the nutritional value of high tannin sorghum are the addition of fats and adequate grinding of the grain (10). Nielsen (11) concludes that the main effects of grinding is to improve feed utilization, which is accomplished by increasing the surface area of the grain relative to its reduced particle size. There are several causes of growth depression and toxic effects of tannins. Tannins affect the palatability of diets and thus reduce feed intake, but this is not a major factor in growth depression caused by high tannin diets (5; 12). Nielsen (11) reported a high variability in the metabolizable energy values of sorghum grains. These workers observed that both metabolizable energy and amino acid availability increased as the tannic acid content of the sorghum grains increased. (10) also showed that the metabolizable energy (ME) content of high tannin sorghum was lower than that of the low tanning sorghum varieties. Further, the high tannin variety contained higher levels of both acid detergent fibre and neutral detergent fibre than the low tannin variety. Besides the low negative effects of tannin in sorghum grains, the presence of phytates has also shown to reduce growth and increase incidence of locomotor disorder (13). Hidalgo (14) were able to improve the nutritional quality of Egyptian and Sudanese sorghum grains by the addition of phosphates. It has also been suggested that the treatment of sorghum by dry-mixing with di-calcium phosphate could enhance the use of high tannin sorghum in poultry feed (10). In general, low tannin sorghum are nearly equal to maize when fed to broilers, high-tannin sorghums, however, are lower in energy than maize. Against this background, when sorghum grains are used in place of maize in broiler and layer diets, xantophyl supplement and additional amount of fat are needed in the ration (10). Finally, sorghum grains must be adequately ground to ensure maximum utilization.

In 2020, Nigeria was the largest producer of grain sorghum, followed by United States and India (15). Sorghum is usually use in Nigeria to brew local drink (burukutu) and fairly used as tuwo meal. Sorghum contains slightly lower energy but more proteins than maize (ME 3200kcal/kg; Protein 10%), sorghum protein is deficient in lysine, methionine and arginine (16). He reported that light colouered (white) sorghum varieties can be used as principal energy source. Dark (Red) varieties are bird resistant and contain tannins in the seed coat and should be used with caution. He also observed that higher levels of tannin in sorghum may reduce palatability and thereby feed intake, while tannin free sorghum can be used as a sole source of energy in layer diet without affecting egg production, egg weight and energy efficiencies.

2 Material and methods

The study was conducted at the Poultry Units of teaching and Practical farm of Taraba State College of Agriculture, Jalingo. Taraba State is in the North-East geo-political zone of Nigeria. It lies between latitude 8" 53" North and between longitudes 11" 23" East of the equator in the savannah zone of Northern Nigeria (17).

2.1 Experimental Birds and Management

A total of three hundred (300) day old Anak white broiler chicks of mixed sexes were used for the experiment. The chicks were raised/brooded on a deep litter management system for a period of one week. During the brooding, all necessary management practices were strictly adhered to as appropriate. After brooding, the chicks were randomly allocated to various experimental treatments.

2.2 Experimental Diets and Design

Five dietary treatments were formulated in which red sorghum was supplemented with graded levels of synthetic methionine at 0.1, 0.2, 0.3, 0.4 and 0.5% for T_1, T_2, T_3, T_4 and T_5 respectively. Each dietary treatment is made up of sixty (60) birds and replicated into three replicates of twenty (20) birds each and coded R_1, R_2 and R_3. The experiment was conducted in a Completely Randomized Design (CRD) in a conventional poultry house. Feeding trials lasted for 8 weeks in two phases i.e. starter phase (1 – 4) weeks and finisher phase (5 – 8) weeks. Feed and clean water were provided *adlibitum* while routine medication and management practices were strictly followed.

2.3 Data Collection

2.3.1 Carcass Evaluation

At the end of the study, which lasted eight (8) weeks, six (6) birds were randomly selected from each treatment, two (2) per replicate. The birds were starved of feed overnight, but water was provided. The birds were weighed before slaughtered and weight recorded as liveweight. Thereafter, they were slaughtered by severing the neck from the jugular vein and the blood drained out. They were then immersed in hot water to pluck out the feathers, that weight was recorded as plucked weight. After which they were cut into various parts to get various organ weight including internal organs. All other weights were expressed as percentage of the liveweight

$$\text{Dressing \%} = \frac{\text{Dressed weight}}{\text{Livesweight}} \times 100$$

2.3.2 Serum Biochemical and Haematological Indices/Blood Collection

The same numbers of birds from each replicated were used as bloods were collected through jugular vein before slaughtering for the determination of haematological and serum biochemical indices. Prior to that, birds were starved of feed overnight to avoid temporary elevation of blood metabolites through feeding (18). However, clean drinking water was offered as usual. Five (5) millimeter (ml) of blood was collected from each bird into sample bottles containing ethylene diametetra acetic acid (EDTA) as anti-coagulant. The haematological indices determined includes Packed Celle Volume (PCV), comprising (lymphocytes, monocytes, Eosinophil and Heterophil), haemoglobin concentration (Hb), Red blood cell (RBC) and White blood cell (WBC). Samples of blood for biochemical were collected in anti-coagulant free tubes and allowed to clot. Sera were obtained after blood samples could stay for two hours at room temperature and centrifugal for 10 minutes at 2000rpm to separate the plasma from serum. Blood biochemical was analyzed to determine the level of toxicity and also determine total proteins, glucose, blood urea, iron calcium, phosphorus, magnesium and cholesterol. All the test were done based on endpoint calorimetric method except creatinine where kinetic calorimetric method was used.

2.4 Statistical Analysis

All data generated from the experiments were statistically analyzed using one way analysis of variance (ANOVA) as outlined in SPSS 15.0 version where the significant effects of the experimental diets were obtained in a Completely Randomized Design (CRD) according to Steel and Torrie (19). Differences between treatment means were separated using Duncan Multiple Range Test (DMRT) (20).

3 Results

Tables 1 and 2 shows the ingredient composition of the experimental broiler starter and finisher diets respectively. It shows starter diets (1 – 4) weeks in which the red sorghum ranges between 46.57 – 47.10% and soybean range of 33.60 – 33.73%, while methionine was supplemented at the levels of 0.1, 0.2, 0.3, 0.4 and 0.5% for T_1, T_2, T_3, T_4 and T_5 respectively. Table 2 reveals broiler finisher diets (5 – 8) weeks, with red sorghum having a range of 52.56 – 53.09% and soybean 22.61 – 22.74%, every other ingredient remains unchanged.

Table 1 Ingredients Composition of Broiler Starter Diets (1-4 Weeks) containing Red Sorghum Supplemented with varying levels of Synthetic Methionine (%)

Ingredient	**Diets**				
	T1	**T2**	**T3**	**T4**	**T5**
	(0.1%)	**(0.2%)**	**(0.3%)**	**(0.4%)**	**(0.5%)**
Red Sorghum	47.10	46.96	46.82	46.69	46.57
Soya bean	33.60	33.64	33.68	33.71	33.73
Wheat offal	9.00	9.00	9.00	9.00	9.00
Methionine	0.10	0.20	0.30	0.40	0.50
Fish Meal	5.00	5.00	5.00	5.00	5.00
Bone Meal	2.00	2.00	2.00	2.00	2.00
Lime Stone	1.50	1.50	1.50	1.50	1.50
Palm Oil	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20
Total	100	100	100	100	100
Calculated analysis					
Crude Protein	23.47	23.47	23.47	23.47	23.47
ME/kcal/kg	2934.88	2931.26	2928.12	2924.75	2921.41
Crude fibre (%)	3.49	3.49	3.49	3.49	3.49
Calcium (%)	1.62	1.62	1.62	1.62	1.62
Phosphorous (%)	0.80	0.72	0.72	0.71	0.72
Lysine (%)	1.33	1.33	1.33	1.33	1.33
Methionine (%)	0.52	0.58	0.62	0.65	0.66

Vitamin-mineral premix provided per kg; Vit. A 1500 IU; Vit.D3 3000 IU; Vit.E 30 IU; Vit.K 2.5mg; Thiamine B1 3mg; Riboflavin B2 6mg; Pyrodoxine B6 4mg; Niacin 40 mg; Vit. B12 0.02mg; Pantothenic acid 10mg;Folic acid 1mg; Biotin 0.08mg; Chloride 0.125mg; Mn 0.0956g; Antioxidant 0.125g; Fe 0.024g; Cu 0.006g; 10.0014g; Se 0.24g; Co 0.240g

Table 2 Ingredients Composition of Broiler Finisher Diets (5-8 Weeks) Containing Red Sorghum Supplemented with varyivels of Synthetic Methionine (%)

Ingredient	**Diets**				
	T1	**T2**	**T3**	**T4**	**T5**
	(0.1%)	**(0.2%)**	**(0.3%)**	**(0.4%)**	**(0.5%)**
Red Sorghum	53.09	52.97	52.82	52.70	52.56
Soya bean	22.61	22.63	22.68	22.70	22.74
Wheat offal	12.00	12.00	12.00	12.00	12.00
Methionine	0.10	0.20	0.30	0.40	0.50
Fish Meal	5.00	5.00	5.00	5.00	5.00

Palm Oil	3.00	3.00	3.00	3.00	3.00
BoneMeal	2.00	2.00	2.00	2.00	2.00
Lime Stone	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20
Total23	100	100	100	100	100
Calculated analysis					
Crude Protein	20.53	20.53	20.53	20.53	20.53
ME/kcal/kg	2989.12	2985.78	2982.38	2979.04	2975.66
Crude fibre (%)	3.05	3.05	3.05	3.05	3.05
Calcium (%)	1.62	1.62	1.62	1.62	1.62
Phosphorous (%)	0.78	0.76	0.76	0.76	0.76
Lysine (%)	1.09	1.09	1.09	1.09	1.09
Methionine (%)	0.51	0.53	0.56	0.59	0.61

*Vitamin-mineral premix provided per kg; Vit. A 1500 IU; Vit.D3 3000 IU; Vit.E 30 IU; Vit. K 2.5mg; Thiamine B1 3mg; Riboflavin B2 6mg; Pyrodoxine B6 4mg; Niacin 40 mg; Vit. B12 0.02mg; Pantothenic acid 10mg;Folic acid 1mg; Biotin 0.08mg; Chloride 0.125mg; Mn 0.0956g; Antioxidant 0.125g; Fe 0.024g; Cu 0.006g; 10.0014g; Se 0.24g; Co 0.240g

Table 3 Proximate Composition of Experimental Starter Diet (1-4 weeks) Containing Red Sorghum Supplemented with varying Levels of Synthetic Methionine (%)

Nutrients(g)		**Diets**			
	T1 (0.1%)	**T2 (0.2%)**	**T3 (0.3%)**	**T4 (0.4%)**	**T5 (0.5%)**
Dry Matter	88.10	87.70	85.10	86.80	87.20
Moisture Content	11.90	12.30	14.90	13.20	12.80
Crude Protein	23.35	22.70	22.35	23.70	23.70
Crude Fibre	3.80	3.80	4.80	5.00	3.80
Ash	4.30	4.80	4.80	4.50	4.10
Ether Extract	8.06	7.68	9.13	8.00	7.87
NFE	48.59	49.72	45.02	45.60	47.73
ME(Kcal/kg)	3241.76	3208.79	3190.42	3127.69	3143.70

NFE=Nitrogen Free Extract; ME= Metabolizable Energy; ME(kcal/kg) = 37 x % CP + 81 x % EE + 35.5 x % NFE (Pauzenga, 1985)

Table 4 Proximate Composition of Experimental Finisher Diet (5 -5 weeks) Containing Red Sorghum Supplemented with varying Levels of Synthetic Methionine (%)

Nutrients(g)	Diets				
	T1 (0.1%)	T2 (0.2%)	T3 (0.3%)	T4 (0.4%)	T5 (0.5%)
Dry Matter	87.90	87.90	88.40	88.70	88.00
Moisture Content	12.10	12.10	11.60	11.30	12.00
Crude Protein	20.50	20.50	21.90	20.85	21.05
Crude Fibre	4.60	4.20	6.00	5.60	4.60
Ash	4.40	4.70	4.40	4.20	4.70
Ether Extract	9.13	8.39	8.39	8.65	8.45
NFE	52.27	53.11	50.71	52.40	51.20
ME(Kcal/kg)	3241.62	3212.50	3179.10	3221.13	3206.90

NFE=Nitrogen Free ExtractME =Metabolizable Energy ME(kcal/kg) = 37 x % CP + 81 x % EE + 35.5 x % NFE Pauzenga, 1985)

Table 5 Carcass Yield and Internal Organs Characteristics of Broiler Chickens fed Red Sorghum Supplemented with Graded Levels of Synthetic Methionine (%)

Parameter	Diets					
	T1(0.1)	T2(0.2)	T3(0.3)	T4(0.4)	T5(0.5)	SEM
Live weight (g)	1705.00	1734.33	1759.00	1780.33	13.40^{NS}	
Plucked weight (g)	1538.67	1591.67	1609.66	1721.33	12.88^{NS}	
Eviscerated weight(g	1425.33	1375.67	1396.66	1410.33	11.98^{NS}	
Carcass weight (g)	1207.00	1215.33	1229.33	1231.33	10.80^{NS}	
Dressing %	17.79	70.07	69.89	69.16	4.87^{NS}	
% of liveweight						
Neck	6.02	6.44	7.01	6.55	0.27^{NS}	
Back	9.05	10.51	10.89	11.16	0.08^{NS}	
Back	6.65	6.69	6.69	6.76	0.27^{NS}	
Wings	10.01	10.78	10.86	11.59	0.39^{NS}	
Thighs	14.35^{bc}	15.84^{b}	16.35^{z}	16.18z	0.08^{NS}	
Drum sticks	14.11	14.72	14.48	15.41	0.16^{NS}	
Shanks	5.47	5.92	5.73	5.69	0.39^{NS}	
Breast	30.15	30.58	30.42	32.07	0.04^{NS}	
Gizzard	2.42	2.69	2.84	2.77	0.27^{NS}	
Kidney	0.65	0.73	0.78	0.64	0.51*	
Liver	2.82	2.92	3.13	3.05	0.09^{NS}	
Lungs	0.72	0.71	0.87	0.82	0.09^{NS}	
Spleen	0.12	0.17	0.15	0.24	0.07^{NS}	
Heart	0.57	0.54	0.59	0.56	0.26*	
Abdominal fat	0.69b	0.11	1.10ab	0.11c	0.53*	
Pancreas	0.25	0.21	0.29	0.31	0.04^{NS}	

a,b,c=Means with different superscriptions on the same row are significantly different; *=Significant (P<0.05);NS=Not significant (P>0.05);SEM=Standard Error of Means

Table 6 Haematological Indices of Broiler Chickens Fed Red Sorghum Supplemented with Graded Levels of Synthesis Methionine (%)

Parameters	**Diets**					
	T1(0.1)	**T2(0.2)**	**T3(0.3)**	**T4(0.4)**	**T5(0.5)**	**SEM**
PCV %	32.00	29.33	29.33	29.00	29.00	1.20^{NS}
TWBC (x10^{9}/l)	16.13^{ab}	14.37^{b}	16.77^{a}	16.13^{ab}	14.57^{ab}	0.69^{NS}
RBC (x10^{12}/l)	5.33	4.90	4.87	4.87	4.83	0.02^{NS}
Hb (g/dl)	10.63	9.77	9.73	9.63	9.63	0.40^{NS}
MCH (Pg)	20.00^{ab}	19.93^{b}	20.07^{a}	19.00^{b}	19.60^{b}	0.30^{NS}
MCHC (%)	33.34	33.26	33.30	33.22	33.33	0.06^{NS}
MCV (fL)	60.00^{ab}	59.87^{ab}	60.27^{a}	59.60^{b}	60.00^{ab}	0.17^{NS}
WBC						
Heterophil (%)	30.21	32.14	31.69	32.75	33.84	0.76^{NS}
Monocytes (%)	5.00	6.30	5.81	7.00	7.00	2.01^{NS}
Lymphocytes (%)	70.33	76.67	74.00	70.20	69.510	1.18^{NS}
Eosinophil (%)	3.10	2.66	2.61	2.00	4.01	0.33^{NS}

a,b,c = Means with different superscripts on the same row are significantly different; *=Significant (P<0.05);NS=Not significant (P>0.05);SEM=Standard of Means ;PCV = Packed Cell volume ;RBC = Red Blood cell ;WBC = White blood cel;l MCV =Mean Corpusular volume;MCHC = Mean corpuscular Haemoglobin concentration; MCH= Mean Corpusular Haemoglobin

Table 7 Serum Biochemical Indices of Broilers Chickens fed Red Sorghum Supplemented with Graded Levels of Synthesis Methionine (%)

Parameter	**Diets**					
	T1(0.1)	**T2(0.2)**	**T3(0.3)**	**T4(0.4)**	**T5(0.5)**	**SEM**
Protein (g/dl)	31.80^{b}	29.37^{c}	32.30^{b}	33.50^{a}	33.27^{ab}	0.49^{NS}
Albumin(g/dl)	20.03^{c}	15.47^{d}	19.87^{c}	20.87^{b}	22.43^{a}	0.42 ^{NS}
Albumin(g/dl)	11.77^{c}	13.90^{a}	13.10^{b}	12.63^{b}	10.87^{d}	0.27 ^{NS}
Cholesterol(mg/dl)	3.30^{b}	3.27^{b}	2.97^{c}	.97^{c}	3.57^{a}	0.07 ^{NS}
Glucose (mg/dl)	9.57^{c}	9.73^{c}	10.73^{b}	9.13^{d}	11.17^{a}	0.20 ^{NS}
Urea (mg/dl)	1.00^{b}	0.87^{b}	0.83^{b}	1.40^{a}	0.97^{b}	0.09 ^{NS}
Creatine (mg/dl)	14.47^{b}	12.17^{b}	12.20^{b}	20.47^{a}	13.80^{b}	1.30 ^{NS}

abc =Means with different superscript differed significantly (P<0.05); SEM = standard error of mean

4 Discussion

Proximate composition of broiler starter (1 – 4) weeks and finisher (5 – 8) weeks are as presented in Tables 3 and 4. In the starter, the crude protein ranged between 23.35 – 23.70%. This falls within the range of 22.24% - 24.21% recommended by Olomu (21). It also concord with Alaku (22), that young growing poultry requires greater amount of protein than adults. Table 4 represents the finisher phase. The crude protein (CP) ranges of 20.50 – 21.90% is slightly higher than 18.20% recommended by Olomu (21) and 20% recommended by (23 and 24).

It is in line with the opinion of Alaku (22) that older birds requires less crude protein (CP) than younger ones. Table 5 depicts the carcass yield and internal organs characteristic of broiler chickens fed red sorghum supplemented with graded levels of synthetic methionine. The table summarized the result of the studies on the carcass parameters and body organs. It shows that treatments had no significant effect ($p < 0.05$) across the treatment groups. As can be observed, liveweight, plucked weight eviscerated weight increased slightly with increased levels of methionine inclusion. However, dressing percentage (D%) decreased slightly with increased levels of methionine inclusion. These results are in agreement with that of Lakurbe (25) in an experiment to evaluate carcass characteristics and blood components of broiler chickens fed sorghum SK – 5912 (sorghum bicolar / moech) variety in a mixture with different plant protein sources. Kwari (26) in birds fed 100% dietary substitution of millet for sorghum and Ibe (27) who found no significant difference between birds fed sorghum and those fed millet based diets. The liveweight ranges from 1705 – 1780.3g (1.7 – 1.8kg), which is within 1351.66 – 1856g and 1.3 – 1.80kg recorded by Alfred (28) and Lalabe (29) and 1.5 – 3kg recorded by Wikivet (30) respectively. The carcass weight ranges from 1207 – 1231g which falls within 1106.66 – 1403.33g and 1102.67 – 1416.67g reported by Alfred (28) and Agbulu (31) respectively. The dressing percentage has its range from 69.16 – 70.79% and falls within 68.72 – 81.25%, 63.79%, 67 – 71% and 67.42 – 75.70% reported by (26, 32, 33, 34, and 35) respectively.

The result is in line with the report of Oluyemi and Robert (36) that dressing percentage is a function of the carcass weight and livewight of birds. Lower liver (2.82 – 3.14%) and intesterial weights obtained in this work could be attributed to the comparatively lower dietary content in the red sorghum based diet due to the efficacy of methionine supplementation. Dietary tannins are known to cause toxicity and inflammation of the liver (37). It is a common practice in feeding trials to use the weight of some internal organs like liver and kidney as indicators of toxicity. Bone (38) reported that if there are any toxic elements in the feeds, abnormalities in weights of liver and kidney would be observed. The abnormalities would arise because of the increased metabolic rate of organs in an attempt to reduce these toxic elements or converts them into non toxic metabolites (39). The results of haematological and serum biochemical indices are presented in Tables 6 and 7. Blood parameters is a reflection of the effects of dietary treatments on the animals in terms of the type, quality and amounts of the feed ingested and available for the animal to meet its physiological, biochemical and metabolic necessities (40; 41; 42).

Aletor (43) and Aletor and Egberongbe (44) indicated that the blood variables most consistently affected by dietary influences include RBC, PCV, plasma protein and glucose. For haematological indices, all parameters evaluated were not significantly ($P<0.05$) different across the treatments. The PCV (Packed Cell Volume) values were 29.00 in T_4 and 32% in T_5, RBC (Red Blood Cell) 4.83 x 10^{12}l in T5 to 5.3 x 10^{12}l in T_5 and WBC from 14.37 x 10^{9}l to 16.77 x 10^{7}l in T3. As can be observed, the values of PCV and RBC decreased slightly with increased levels of methionine. The result of PCV was observed to be within the range of 27.77 – 33.33% reported by Agbulu (31), but observed to be slightly lower than 35.90 – 41.10% reported by Wikivet (30), but also falls within the range of 24.90 – 45.20% for healthy chicken (45, 46). According to Oyewole and Ogunkunle (47), PCV is usually an index of toxicity reduction in the blood and suggest presence of toxic factor which has adverse effect on blood formation. Therefore, with reduction of PCV with increased inclusion levels of methionine confirms the dietary role of methionine in red sorghum diet to suppress the toxic effect of tannin. The WBG value is in agreement with Kawu (48) and Adeyemo (49). It is however lower than 4.03 – 4.32 x 10^{9}l reported by Wikivet (30). The high values indicate the ability of the birds to self-defence mechanism and to protect itself from external infection as WBC is known for such role. WBC plays prominent role in disease resistance especially with respect to the generation of antibodies and the process of phagocytes as reported by (50; 51) for Nigerian local chickens. The haemoglogin (Hb) concentration values ranged from 9.63 – 10.63g/dl which is within of 10.60 – 11.90g/dl reported by Lala (52) and slightly lower than 11.60 – 13.68g/dl reported by Wikivet (30). Adejumo (53) reported that Hb traits especially PCV and Hb were correlated with the nutritional status of the animal. It therefore reveals the nutritional quality of the experimental diets. The increased concentration of monocytes and lymphocytes is an indication of resistance developed by the experimental birds in an attempt to fight foreign bodies. Lymphocytes are implicated in antibody production as are reactive cells in inflammation and delayed hypersensitivity (54). The heterophils (30.21 – 33.83%) and eosinophil (2.00 – 4.01%) that are granulocytes of WBC were within normal range from 10.53% and 0.00 – 15% respectively for healthy chickens (55; 56; 45). Serum biochemical indices evaluated were influenced by the dietary treatments. This is in agreement with Kwari (26) and Ibe (27). As can be observed, the Albumin (15.47 – 22.43g/dl) that increased slightly with an increased levels of methionine inclusion was highest in T_5 (22.43g/dl), followed by T_4 (20.87g/dl) and the least in T_2 (15.47g/dl). It has been observed that correlation exists for the total protein and albumin content (57). Also, Annison (58) and Bamgbose (59) reported that the total protein and albumin rise is an indication of the total protein reserves in animal. Adeyemi (60) also reported that serum biochemical constituents are positively correlated with the quality of diet. The values of creatine was highest in T_4 (20.47mg/dl) followed by T_1 (14.47mg/dl) and the least in T_2 (12.17g/dl) and in agreement with Danladi (61). This according to Eggum (62) indicate adequacy of protein in terms of quality and quantity in the diets of birds and as such, there was no muscle wastage and subsequent degradation of muscle phosphorus creatine. Also, Okosun (63) and Bamgbose (59) in their study on cockerels found that serum creatine and uric acid were influenced by the sources and types of dietary protein use. Most of the values obtain fall within the range reported by Wikivet (30) and Mitrukan and Rawsley (45) for a normal bird.

5 Conclusion

Evidence from this study revealed that red sorghum diet can successfully replace maize as broiler diet without adverse effect on carcass, blood and serum biochemical indices when supplemented with synthetic methionine that suppressed the tyanic acid effect. It can be used 100% in broiler production wherever it is highly available anc cheaper than maize.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest.

Statement of ethical approval

The present research work does not contain any studies performed on animals/humans subjects by any of the authors.

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