Nigerian J. Anim. Sci. 2018, 20 (1): 152-162

Haematology and serum chemistry of finisher broiler chickens fed maize-cassava diet supplemented with methionine and inorganic sulphur

[*1]Oguntoye, M.A., [2]Idowu, O.M.O., [3]Sogunle, O.M. [1]Akintunde, A.R. and [1]Danladi, Y.

[1]Department of Animal Science, Taraba State University Jalingo. [2]Department of Animal Nutrition, [3]Department of Animal Production and Health, Federal University of Agriculture Abeokuta.

***Corresponding author:** ingenuityma@gmail.com*

***Target audience:** Nutritionist; researchers; feed millers and poultry farmers*

Abstract

This study was conducted to assess the haematology and serum chemistry of broiler chickens fed maize-cassava diets supplemented with methionine and inorganic sulphur. A total of 270 day-old broiler chicks were randomly assigned to nine treatment groups of 30 birds making 10 birds per replicate group. Starter and finisher diets were formulated and fed for a period of 56 days. Dietary treatments were subjected to Completely Randomized Design in a 3 × 3 factorial experimental layout. Birds were fed diets supplemented with 0, 125, 250 mg/kg DL-methionine and 0, 125, 250 mg/kg inorganic sulphur from $CuSO_4$. Results of haematological parameters showed no significant ($p>0.05$) difference among the treatment groups except the packed cell volume. The higher value of 31.33% was obtained for PCV in the birds fed diet supplemented with 0mg/kg DL-methionine + 125mg/kg $CuSO_4$. Values recorded for biochemical indices varied significantly ($p<0.05$) among dietary treatments for total protein, globulin and cholesterol. High significant ($p<0.05$) values of 50.80 g/l and 29.85 g/l were obtained for total protein and globulin in the birds fed diet supplemented with 125 mg/kg DL-methionine + 250 mg/kg $CuSO_4$. Lower ($p<0.05$) value of 155.81mg/dl was recorded for cholesterol in birds fed diet supplemented with 250 mg/kg DL-methionine + 250 mg/kg inorganic sulphur. Based on the results obtained for haematological and serum chemistry parameters, it was concluded that supplementation of DL-methionine and inorganic sulphur in broiler diet at 125 mg/kg DL-methionine + 250 mg/kg inorganic sulphur level of supplementation improved dietary protein and had no inimical effect.

Key words: *Maize-cassava; DL-methionine; inorganic sulphur; haematology; serum chemistry.*

Description of Problem

The increased use of cereal grains for human consumption in most developing countries is in competition with their use for livestock feeding. There is need to focus attention on the need to explore the use of non-convectional sources of energy and protein in the diets of monogastric animals (1). For sustainability of livestock industry and solve the problem of protein deficit as reported by (2,3) agro by-products should be properly exploited, due to their cheapness and availability. Maize is currently the most widely used grain crop for feeding, being used to a level of between 40-60% as the conventional

energy source for poultry. Significant reduction in the cost of livestock feed could be achieved provided the maize content of feed reduced. It is for this reason that cassava, which is in abundance, cheap and has a stable price, is being considered for evaluation in the feeding of broiler chickens.

An estimate of about 10 million tonnes of cassava is processed for garri annually in Nigeria alone (4). Cassava root contain highly digestible energy and are capable of providing high yield of energy per hectare just like maize (5). It is believed that through processing, its toxicity could be reduced to a tolerable level, thereby enhancing its usability as a replacement for maize.

However, the use of cassava in animal feed is limited by some factors. These include bulkiness in its fresh form, dustiness in its dried unpelleted form, low protein content, hydrocyanide content and post-harvest deterioration. Several processing methods have been employed to reduce the cyanide content which include sun drying, fermentation and boiling (6). The low protein content of cassava tubers has been one of the major factors limiting its use in poultry diets and this could be addressed through amino acid supplemen-tation.

Methionine has been shown to be the first limiting amino acid in broiler chickens diets and is commonly used in commercial feeds (7). Apart from the fact that it is an essential amino acid, it can also be converted to cystine in broiler chickens (8). Methionine may also partly compensate for a deficiency of choline and vitamin B_{12} by providing the needed methyl group. Methionine is reported to function in the improvement of the efficiency of feed utilisation, reduction of mortality, and prevention of accumulation of excess fat and cannibalism (9).

Little attention has been paid to the importance of sulphur in animal nutrition since the intake of this element is mainly in the form of protein. Therefore, methionine and other sulphur-containing supplements could be utilised as the main source of sulphur for other metabolic activities apart from their primary functions as amino acids. This could cater for protein deficiency in cassava based diet by playing the role of precursor for biosynthesis. Haematological and serum biochemical values could serve as baseline information for comparison in condition for nutrient deficiency. Church and Pond (10) reported that ingestion of numerous dietary components have measurable effect on blood constituents. This study is thus to assess the haematology and serum chemistry of broiler chickens fed maize-cassava diets supplemented with methionine and inorganic sulphur.

Materials and Methods

Experimental site

The research was carried out at the Poultry Unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta. It lies within the forest vegetation zone of western Nigeria at latitude 7ºS13′ 49.46′N, longitude 3º26' 11.98'E with a mean annual rainfall of 1037 mm and average temperature of 34.7 ^{0}C (Google Earth, 2011).

Experimental birds and management

A total number of 270 day old unsexed broiler chicks of commercial strain (Marshal Broiler) were purchased from a reputable hatchery in Abeokuta. The chicks were weighed and allotted to nine

dietary treatment groups of three replicates each in a Completely Randomized Experimental Design. Each replicate consists of 10 chicks, to have a total of 30 birds per treatment group. The birds were brooded for two weeks. The birds were reared on deep litter housing system in two phases: starter phase (0-4 weeks) and finisher phase (5-8 weeks) respectively. Routine vaccinations and medications were strictly adhered to and feed and water were given *ad libitum*.

Experimental diet

The experimental diets were formulated for both starter and finisher phases to meet NRC (11) minimum nutrient requirement. There were 9 dietary treatments arranged in a 3 × 3 factorial arrangement of 3 levels of DL –methionine (0, 125 and 250 mg/kg) and 3 levels of inorganic sulphur supplementation (0, 125 and 250 mg/kg). The dietary treatments were formulated as follow: 0 mg/kg DL-methionine + 0 mg/kg Copper sulphate (D1), 0 mg/kg DL-methionine + 125 mg/kg Copper sulphate (D2), 0 mg/kg DL-methionine + 250 mg/kg Copper sulphate (D3), 125 mg/kg DL-methionine + 0 mg/kg Copper sulphate (D4), 125 mg/kg DL-methionine + 125 mg/kg Copper sulphate(D5), 125 mg/kg DL-methionine + 250 mg/kg Copper sulphate(D6), 250 mg/kg DL-methionine + 0 mg/kg Copper sulphate (D7),250 mg/kg DL-methionine + 125 mg/kg Copper sulphate (D8) and 250 mg/kg DL-methionine + 250 mg/kg Copper sulphate (D9) as shown in Table 1.

Source of test ingredients and preparation

The freshly harvested cassava tubers were obtained from Alabata village in Abeokuta. The tubers were cleaned and washed free from soil particles before peeling and chopped into small sizes (0.5cm). They were spread on a neat concrete floor for 4 days to dry before packing and stored until time of compounding.

DL –Methionine was supplied by Adisseo USA Incorporation. North Point Parkway. Alpharetta GA 30022 USA while the copper sulphate pentahydrate ($CuSO_4$. $5H_2O$) was obtained from Sigma Chemical Company (St. Louis, USA).

Blood Collection

Haematological analysis

Blood samples were collected through the wing vein from representative samples of the birds (3 birds per treatment) at 56thday of age into ethylene diaminetetracetic acid (EDTA) bottle. The parameters determined include packed cell volume (PCV), haemoglobin (Hb), red blood cell (RBC), white blood cell (WBC), Lymphocyte, Neutrophil, Eosinophil and monocyte. Haemoglobin (Hb) concentration was determined using improved Neubauer haemocyto-meter (12) while other haematolo-gical indices were measured according to standard methods (13).

Serum analysis

At 56th day of age, blood samples were drawn from the wing vein of 3 birds per treatments that is one from each replicates. 2 m1 of blood was collected into a clean syringe and put in plane bottle. The blood samples were allowed to clot, they were refrigerated for 6 hours and then spun in a centrifuge at 900 rpm for 20 minutes. The separated serum was stored in the freezer at -2°C prior to analysis.

Table 1: Gross Composition of maize-cassava based diet supplemented with varying levels of DL-Methionine and inorganic sulphur for finisher broiler chickens

DL-methionine levels (mg/kg)	0.00			125			250		
S levels supplemented (mg/kg)	0	125	250	0	125	250	0	125	250
Ingredients:	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**
Maize	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
PCRM	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Wheat offal	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Soy meal	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Palm oil	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
GNC	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0	21.0
Fish meal (72%CP)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Oyster shell	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Lysine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt (NaCl)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Supplements:									
DL-Methionine	-	-	-	125	125	125	250	250	250
$CuSO_4$	-	125	250	-	125	250	-	125	250
Determined analysis (%)									
Crude protein	18.38	18.38	18.38	18.38	18.38	18.38	18.38	18.38	18.38
Crude fibre	7.63	7.63	7.63	7.63	7.63	7.63	7.63	7.63	7.63
Ether extract	4.82	4.82	4.82	4.82	4.82	4.82	4.82	4.82	4.82
Methionine*	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Lysine**	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
S**	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Ca**	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74
P**	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
ME kcal/kg	2894.51	2894.51	2894.51	2894.51	2894.51	2894.51	2894.51	2894.51	2894.51

*Premix to supply per kg diet; 9,000,000IU of Vit A; 2,135,000IU of Vit D3; 20,000mg of Vit E; 1,340mg of Vit B1; 5,340mg of Vit B2; 1,670mg of Vit K3; 12,000mg of Pantothenate; 2,670mg of Vit B6; 13.4mg of Vit B12; 30,000mg of Niacin; 100mg of Biotin; 100mg of Folic acid; *0mg of Copper*; 63,340mg of Iron; 78,000 of Zinc; 1,17340mg of Manganese; 775mg of Iodine; 180mg of Selenium and 10,000mg of antioxida $CuSO_4$ = copper sulphate
** = Calculated Value PCRM = Peeled Cassava Root Meal

Blood sample obtained from the experimental birds were analysed for serum metabolites such as serum total protein, albumin, globulin creatinine, uric acid triacyglycerol, cholesterol high density lipoprotein (HDL), low density lipoprotein (LDL), serum glutamate oxaloacetate transaminase (SGOT), serum glutamate pyruphate transaminase (SGPT) and alkaline phosphate (ALP) were determined. The serum analysis was estimated using the commercial diagnostic kits (Qualigens India. Pvt. Ltd., Catalogue number 72201-04)

Statistical analysis

Data obtained were subjected to analyses of variance. Significant ($P<0.05$) means among variables were separated using Duncan Multiple Range F-Test as contained in SAS (14) package.

Results and Discussion

The results of main effects of varying levels of DL-methionine and inorganic sulphur on haematological parameters of finisher broiler chickens is presented in Table 2. DL-methionine supplementation had no significant ($P>0.05$) effect on all the parameters. Values obtained for the parameters across dietary treatment were within the range for healthy birds. White blood cell slightly increased with increasing level of DL-methionine. Highest significant ($P<0.05$) value of 27.71 $\times 10^9$ /L recorded for white blood cell falls within the normal range and was an indication that the birds were not susceptible to diseases. Low level of white blood cell suggested susceptibility to infection (15). Inorganic sulphur supplementation had no significant effect on all the parameters. Numerically, similar values were recorded for all the parameters across the dietary treatments. However, haemoglobin concen-tration increases numerically with increasing level of inorganic sulphur supplementation. High concentration of haemoglobin in the cytoplasm of red blood cell gives an indication of effective oxygen carrying capacity of the blood. Interaction effect of varying levels of DL-methionine and inorganic sulphur on haema-tological parameters of finisher broiler chickens is as shown in Table 3. Interaction effects revealed significant ($P<0.05$) influence on packed cell volume. Birds fed diet supplemented with 0 mg/kg DL-methionine and 125 mg/kg inorganic sulphur (D2) showed higher value of 31.33% for PCV compared to least value of 30.00% recorded for birds on diet supplemented with 125 mg/kg and 0 mg/kg inorganic sulphur (D4). The values recorded for PCV fall within the normal range. Values obtained in this study for PCV were below the mean value reported for PCV by (16) who stated 35.9% as mean value for PCV. Haemoglobin, WBC, RBC, glucose, lymphocyte, neutrophil, eosinophil and monocyte were not significantly ($P>0.05$) influenced by dietary treatments. The haemoglobin values ranged from 9.46 g/dl in birds fed control diet (D1) to 9.95 g/dl in birds fed diet 3. The values fall within the range of 7-15 recorded in the literature for healthy birds. This is an indication that the animal had sufficient blood pigment for proper transportation of oxygen, thus healthy living. Reduction in the concentration of haemoglobin suggested the presence of toxic factor such as haemaglutinin, which can have adverse effect on blood formation (17). The values for white blood cell ranged from 26.46×10^9/Lin birds fed diet 1 to 27.85×10^9 /L for birds on diet 5. The values fall within the normal range. High white blood cell is a strong indication of toxicity of diet or poor detoxification process, which leads to increase production of white blood cell to fight foreign substance in the body. The result revealed that various supplemen-tation levels of the test ingredients in the diet had no significant ($P>0.05$) detrimental effect on the experimental birds. Close range values of 2.10×10^{12} /L to 2.36×10^{12} /L were recorded for red blood cell in birds fed diet 9 and diet 1. The values obtained in this study favourably compared with the values 1.20-2.60 reported by (18). The values for

glucose ranged from 156.01mg/dl in birds fed diet 1 to 159.00mg/dl in birds fed diet 5 and 6. Glucose level increased progressively with increasing levels of inorganic sulphur in the birds fed diet 1, 2 and 3. Increased values of glucose could be linked to availability of soluble carbohydrate in the diet. Ranges of values of 61.33%-63.00%, 30.67%-32.00%, 1.00%-1.67% and 1.33%-1.67% were recorded for lymphocyte, neutrophil, eosinophil and monocyte respectively. The moderate values recorded for the birds indicated no infection or any allergic reaction.

Table 2: Main effects of varying levels of DL-methionine and inorganic sulphur on haematological parameters of finisher broiler chickens

	DL-methionine levels					Sulphur levels				
Parameters	**0**	**125**	**250**	**SEM**	**p-value**	**0**	**125**	**250**	**SEM**	**p-value**
Packed cell volume (%)	30.89	30.44	30.67	0.19	0.150	30.67	30.78	30.56	0.19	0.160
Haemoglobin (g/dl)	9.60	9.84	9.58	0.15	0.310	9.60	9.62	9.89	0.16	0.210
White blood cell(x10^9/L)	26.99	27.28	27.71	0.43	0.081	27.21	27.59	27.19	0.43	0.170
Red blood cell(x10^{12}/L)	2.23	2.26	2.12	0.06	0.070	2.20	2.21	2.20	0.06	0.081
Glucose (mg/dl)	157.11	158.67	157.22	1.28	0.151	156.78	158.11	158.11	1.28	0.060
Lymphocyte (%)	62.44	62.78	61.78	0.42	0.310	62.22	62.67	62.11	0.42	0.150
Neutrophil (%)	31.44	31.89	31.44	0.51	0.400	31.67	31.33	31.78	0.51	0.051
Eosinophil (%)	1.44	1.44	1.33	0.18	0.081	1.22	1.56	1.44	0.18	0.160
Monocyte (%)	1.56	1.33	1.67	0.19	0.060	1.56	1.44	1.56	0.19	0.091

Table 3: Interaction effect of varying levels of DL-methionine and inorganic sulphur on haematological parameters of finisher broiler chickens.

DL-methionine levels (mg/kg)		0.00			125			250			
Sulphur levels (mg/kg)	0	125	250	0	125	250	0	125	250	SEM	p-value
Parameters	D1	D2	D3	D4	D5	D6	D7	D8	D9		
PCV (%)	31.00^{ab}	31.33^{a}	30.33^{ab}	30.00^{b}	30.67^{ab}	30.67^{ab}	31.00^{ab}	30.33^{ab}	30.67^{ab}	0.33	0.000
Haemoglobin (g/dl)	9.46	9.65	9.95	9.88	9.73	9.91	9.48	9.47	9.80	0.28	0.151
WBC (x10^9/L)	26.46	27.16	27.35	27.44	27.85	26.56	27.73	27.76	27.65	0.74	0.080
RBC (x10^{12}/L)	2.36	2.20	2.13	2.11	2.30	2.36	2.14	2.12	2.10	0.09	0.091
Glucose (mg/dl)	156.0	157.3	158.0	158.0	159.0	159.0	156.3	158.0	157.3	2.21	0.237
Lymphocyte (%)	62.33	63.00	62.00	62.33	63.00	63.00	62.00	62.00	61.33	0.70	0.310
Neutrophil (%)	31.67	30.67	32.00	32.00	32.00	31.67	31.33	31.33	31.67	0.88	0.081
Eosinophil (%)	1.33	1.67	1.33	1.00	1.67	1.67	1.33	1.33	1.33	0.31	0.052
Monocyte (%)	1.67	1.33	1.67	1.33	1.33	1.33	1.67	1.67	1.67	0.33	0.081

^{ab}Mean values in the same row having different superscripts are significantly different (P<0.05) WBC= White blood cell RBC= Red blood cell PCV= Packed cell volume

The results of main effects of varying levels of DL-methionine and inorganic sulphur on serum chemistry parameters of finisher broiler chickens is presented in Table 4.DL-methionine supplementation had significant (P<0.05) influence on total protein, globulin, ALP, cholesterol, HDL and LDL. Higher (P<0.05) value of 47.14

g/l was recorded for total protein in the birds fed with diet containing 250 mg/kg DL-methionine. High total protein observed in this study was an indication of improved utilization of dietary protein. Methionine is required at high level when bird is predisposed to fast growth along with high production performance (19). Values obtained for total protein, globulin and ALP increased significantly (P<0.05) with increasing level of DL-methionine while cholesterol and LDL reduced with increasing level of DL-methionine. However, cholesterol and LDL recorded least values of 157.93 mg/dl and 85.40 mg/dl for diet supplemented with 250 mg/kg DL-methionine. Least values recorded for cholesterol and LDL in this current study for the birds fed with diet supplemented with 250 mg/kg DL-methionine could be associated with ability of methionine to act as methyl donor in the system. Methyl group reacts with dimethylethanolamine to form trimethylethanolamine which can be used directly for synthesis of lechitin (20). Lecithin facilitates the transport of fat through the body. Halder and Roy (21) reported that lipid and triacylglycerol varied significantly with DL-methionine supplementation in broiler diet.

Inorganic sulphur supplementation had significant (P<0.05) effect on total protein, albumin, globulin and HDL. Total protein, albumin and globulin increased with increasing level of inorganic sulphur supplementation. Birds fed diet supplemented with 250 mg/kg inorganic sulphur recorded highest (P<0.05) values of 48.03g/l, 20.03 g/l and 27.71 g/l for total protein, albumin and globulin respectively. This result revealed adequacy of the diet in supply of protein needed by the birds. This observation could be associated with the ability of sulphur to serve as precursor in the biosynthesis of protein. HDL recorded the least value of 56.19 mg/dl in the birds fed diet supplemented with 250 mg/kg inorganic sulphur. Observation in this current study could be linked to ability of the diet to enhance lipid metabolism. Uric acid, creatinine, SGOT, SGPT, ALP, traiacylglycerol, cholesterol and LDL were not significantly influenced by the supplementation of inorganic sulphur. The values recorded were in normal range for health chicken. Values obtained for liver enzyme (SGPT) ranged from 8.95-9.32 IU/L. This results could be associated to reaction of birds to dietary treatment (22). High level of liver enzyme is a treat to the liver function.

Interaction effect of varying levels of DL-methionine and inorganic sulphur on serum chemistry parameters of finisher broiler chickens is presented in Table 5. The interaction revealed significant (P<0.05) influence on total protein, globulin and cholesterol. Values obtained for total protein ranged significantly (p<0.05) from 44.00 g/l in the birds fed diet 2to 50.80 g/l in the birds fed diet 6. High value of total protein indicate the presence of quality protein of the diet. The result of this study is in contrary to the values of 60-75 g/l reported by (23). Values for albumin ranged insignificantly (p>0.05) from 18.19 g/l in the birds fed diet 2 to20.94 g/l in the birds fed diet 6. The higher the value of albumin the more the clotting ability of the blood hence, prevention of haemorrhage (24). Values obtained for globulin significantly (p<0.05) ranged from 24.25 g/l in the birds fed diet 4 to 29.85 g/l in the birds fed diet 6. The results obtained in this study could be attributed to adequacy of protein quality, quantity and degree of protein

utilization (25). Low level of globulin could result in high mortality. Values obtained for creatinine were statistically similar. The values ranged from 0.89 mg/dl in the birds fed diet 5 to 0.99 mg/dl in the birds fed diet 4 Values observed for creatinine in this study are in the normal range documented in the literature. Okorie *et al.* (24) reported 0.90-2.00 mg/dl for normal broiler chicken. High creatinine is an indication of muscle wastage and imply that animal is surviving at the expense of body reserve which can result to weight loss (26). Values recorded for liver enzymes of the birds ranged across the parameters measured. Values ranged from 87.38-91.12 IU/L, 8.44-9.83 IU/L and 99.52-111.16 IU/L for SGOT, SGPT and ALP respectively. The findings in this study agreed with Oduguwa (22) who reported values of 7.67-12.33 IU/L for SGPT in normal broiler chicken. Enzymes responsible for inter-conversion of amino acids through transfer of amino groups *in vivo*. Values obtained for serum cholesterol ranged from 155.81 mg/dl in birds fed diet 9 to 178.07 in the birds fed diet 2. Serum cholesterol levels significantly ($p<0.05$) decreased with increasing levels of supplementation. The results obtained in this study could be attributed to synergetic effect of DL-methionine and inorganic sulphur in lipid metabolism.

Table 4: Main effects of varying levels of DL-methionine and inorganic sulphur on serum chemistry of finisher broiler chickens.

	DL-methionine levels					Sulphur levels				
Parameters	0	125	250	SEM	p-value	0	125	250	SEM	p-value
Total protein (g/l)	44.89^{c}	46.98^{b}	47.14^{a}	0.74	0.000	45.69^{b}	45.31^{b}	48.03^{a}	0.74	0.001
Albumin(g/l)	19.72	20.09	19.20	0.51	0.160	20.06^{ab}	18.67^{b}	20.30^{a}	0.51	0.000
Globulin(g/l	25.16^{b}	26.89^{a}	27.94^{a}	0.55	0.013	25.63^{b}	26.64^{ab}	27.71^{a}	0.55	0.012
Uric acid (mg/dl)	9.54	10.58	9.60	0.42	0.150	9.38	9.83	10.51	0.42	0.170
Creatinine (mg/dl)	0.92	0.95	0.99	0.05	0.081	0.94	0.92	1.00	0.05	0.090
SGOT (IU/L)	87.73	89.07	88.85	1.26	0.210	87.96	89.11	88.58	1.26	0.081
SGPT (IU/L)	8.66	9.24	9.35	0.25	0.091	8.95	9.32	8.99	0.25	0.210
ALP (IU/L)	102.32^{b}	105.91^{ab}	110.43^{a}	2.46	0.014	106.10	106.91	105.64	2.46	0.072
Triglyceride(mg/dl)	102.42	98.17	97.35	2.01	0.081	100.21	99.08	98.65	2.01	0.200
Cholesterol(mg/dl)	173.94^{a}	164.82^{b}	157.93^{c}	2.26	0.000	168.20	167.19	167.30	2.26	0.081
HDL (mg/dl)	57.39^{ab}	54.88^{b}	60.52^{a}	1.74	0.031	58.51^{a}	58.09^{a}	56.19^{b}	1.74	0.001
LDL (mg/dl)	92.68^{a}	86.97^{b}	85.40^{c}	2.57	0.001	87.71	88.61	88.73	2.57	0.150

^{abc}Mean values in the same row having different superscripts are significantly different ($P<0.05$)

Table 5: Interaction effect of varying levels of DL-methionine and inorganic sulphur on serum chemistry of finisher broiler chickens.

DL-methionine levels (mg/kg)	0.00			125			250				
Sulphur levels (mg/kg)	0	125	250	0	125	250	0	125	250	SEM	p-value
Parameters	D1	D2	D3	D4	D5	D6	D7	D8	D9		
Total protein (g/l)	44.57^{b}	44.00^{b}	46.08^{b}	44.74^{b}	45.40^{b}	50.80^{a}	47.76^{ab}	46.53^{b}	47.13^{ab}	1.28	0.038
Albumin(g/l)	20.12	18.19	20.86	20.49	18.85	20.94	19.56	18.96	19.09	0.88	0.210
Globulin(g/l)	24.45^{cd}	25.81^{bcd}	25.23^{bcd}	24.25^{d}	26.55^{abcd}	29.85^{a}	28.20^{ab}	27.57^{abc}	28.04^{ab}	0.95	0.001
Uric acid (mg/dl)	8.63	9.79	10.20	10.10	10.52	11.11	9.41	9.19	10.21	0.72	0.081
Creatinine (mg/dl)	0.91	0.94	0.91	0.99	0.89	0.96	0.91	0.92	1.14	0.08	0.150
SGOT (IU/L)	88.06	87.38	87.74	88.08	88.82	90.32	87.74	91.12	87.69	2.17	0.320
SGPT (IU/L)	8.45	9.10	8.44	8.57	9.77	9.39	9.83	9.09	9.13	0.42	0.170
ALP (IU/L)	99.52	104.8	102.6	107.6	106.2	103.8	111.1	109.6	110.4	4.26	0.210
Triglyceride(mg/dl)	101.4	102.4	103.3	100.2	99.0	95.2	98.9	95.7	97.3	3.48	0.311
Cholesterol(mg/dl)	172.1^{ab}	178.0^{a}	171.5^{ab}	172.0^{ab}	165.8^{abc}	156.5^{c}	160.3^{bc}	157.6^{c}	155.8^{c}	3.91	0.042
HDL (mg/dl)	56.72	60.02	55.43	57.85	53.77	53.01	60.96	60.49	60.11	3.01	0.081
LDL (mg/dl)	86.82	92.85	98.35	91.88	85.31	83.72	84.41	87.68	84.11	4.45	0.051

^{abcd}Mean values in the same row having different superscripts are significantly different (P<0.05)

Conclusions and Applications

It was concluded that:

1. Supplementation of DL-methionine and inorganic sulphur in the ration of finisher broiler chickens significantly affected the haematology and serum chemistry of the birds.
2. Supplementation at 125 mg/kg DL-methionine + 250 mg/kg inorganic sulphur levels improved dietary protein and had no hazardous effect.
3. DL-methionine and inorganic sulphur supplementation in the ration of finisher broiler chickens significantly reduced serum cholesterol level.

References

1. Ravindra, V. and Ravindra, G. (1991). Changes in the nutritional composition of cassava (*Manihot esculenta)* leaves during maturity. Food Industry 27: 299-309.
2. NARP. (1996). National Agricultural Research Strategy plan: 1996-2010. Edited and compiled by S. Bukar. A. Adamu and J.S. Bakshi.
3. Tewe, O.O., Aderemi, F.A., Oguntimehin, G.B. (1987). Processing and utilization of cassava roots in diets for layers. IITA tropical roots and tuber crops Bulletin 9 (2), 9–12.
4. Okafor, N. (1992). Commercialization of fermented foods in the sub Sahara Africa. In: Application of Bacteriology to Traditional fermented food. 2nd edition. John Wale and sons, Nigeria. pp. 165-169.
5. Hahn, S.K., Reynolds, L. and Egbunike, G.N. (1992). Cassava as livestock feed in Africa. Proceeding of the IITA/ILCA and University of Ibadan Workshop on the potential utilization of cassava as livestock in Africa.
6. Tewe, O.O. and Kasali, O.B. (1986). Effect of cassava peel processing on the perfor-mance, nutrient utilization and physiopa-thology of the African giant rat (Cricetomy gambianus, water house). *Tropical Agriculture (Trinidad)* 63: 125-128.
7. Ohta, T., Toyomizu, M. and Ishibashi, T. (1993). Comparison of the effect of supplementation of

methionine and cystine on performance and abdominal fat of broilers, *Proceedings, World Conference on Animal Production*, Canada, pp. 112-113.

8. Mendoca, C.X.J.R. and Jensen, L.S. (1989). Influence of valine level on performance of older broilers fed low protein diet supplemented with amino acids, *Nutr. Rep. Intl* 40:427-452.
9. Obioha, F.C. (1992).*A Guide to Poultry Production in the Tropics,* 1st edition, Accia Publishers, Nigeria. pp. 47-79.
10. Church, D.C. and Pond, W.G. (1988). Basic Animal Nutrition and Feeding. 3rd edition. John Wiley and Sons, New York. Pp 550.
11. N.R.C. (1994). Nutritional Research Council Nutrient Requirement of poultry 9th edition. Revised edition National Academy of Science. Washington D.C.
12. Coles, E.H. (1986). Veterinary clinical pathology, 4th edition W.B. Sanders Company Philadelphia, London and Toronto.
13. Schalm, O.W. (1986).*Veterinary Haematology. The Pig: Normal haematology with comments on Response to Disease*, 4th Edition, Lea and Febiger, Philadelphia. Pp 523
14. SAS, (1999). Version 8, SAS. Institute Inc., carry NC., USA.
15. Akinmutimi, A.H., Oke, U.K. and Abasiekong, S.F. (2004). Observations on blood constituents of broiler finisher birds fed toasted Lima bean (Phaseoluslunatus). Procceding 9th Annual Conference. Animal Science Association of Nigeria (ASSAN) September 13th-16th 2004. Ebonyi State University Abakaliki. Pp 55-57.
16. Oyewole, J.O. and Ajibade, H.A. (1990). The osmotic fragility of erythrocyte of turkey of two age group. *Vet. Archiv*. 60: 91 – 100.
17. Oyawoye, E.O. and Ogunkunle, M. (1998). Physiology and biochemical effect of raw jack beans on broiler chicken. Procceding of 23rd Annual Conference of Nigerian Society of Animal Production. Gateway Hotels Abeokuta, Nigeria. Pp 141-142.
18. Ugwuene, M. C (2011). Replacement value of palm kernel meal for maize on carcass characteristics of turkeys. *Nigerian Journal of Animal Science*, 13: 86-95
19. Chattopadhyay, K., Mondel, M.K. and Roy, B. (2006). Comparative Efficacy of DL-methionine and Herbal methionine on performance of broiler chicken. *International Journal of Poultry Science* 5(11): 1034 – 1039.
20. Saunderson, L.C. and McKinley, J. (1990). Changes in body weight, composition and hepatic enzyme activities in response to dietary methionine, butane and choline levels in growing chicks. *British Journal of Nutrition*. 63:339-349.
21. Halder, G. and Roy, B. (2007). Effect of Herbal or synthetic methionine on performance, Cost Benefit Ratio, Meat and Feather Quality of Broiler Chicken. *International Journal of Agricultural Research;* 2: 987 – 996.
22. Oduguwa, O. O. (2006). Utilization of whole pods of Albizia saman in diets of growing rabbits. *Nigeria Journal of Animal Production* 33(2): 197-202.

23. Radostits, O.M., Biro, D.C. and Gay, C.C. (1994). *Veterinary Medicine* 8th edition, Saunder. Pp 328.
24. Roberts, A.M., Daryl, K.G., Peter, A.M. and Victor, W.R. (2003). *Harpers Biochemistry*, 25th edition, McGraw-Hill, New York. 25:765.
25. Okorie, K. C., Nkwocha, G. A. and Ndubuisi, E. C. (2011). Implications of feeding varying dietary levels of cassava leaf meal on finisher broiler: Performance, carcass, haematological and serological profiles. *Global research journal of science*. 1: 58-66, ISBN: 2276-8300.
26. Ross, J.G., Halliday, W.G. and Jones, R.M (1978). Haematological and blood chemistry: comparison value for clinical pathology. *Poultry Veterinary,* 102: 29-3.