



BLOOD PROFILE OF BROILER CHICKENS FED SUPER SOSAT MILLET TO REPLACE MAIZE IN GROUNDNUT CAKE BASED DIETS

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ABSTRACT

A six - week experiment using 300 broiler chickens fed Super SOSAT (SSM) pearl millet to replace maize at up to 100% level in groundnut cake based diets was conducted to evaluate their blood profile. Results for haemoglobin parameters showed that except for Packed cell volume (PCV) and Mean Corpuscular Haemoglobin Concentration, no haematological parameter was significantly ($P>0.05$) affected the treatments. The PCV of birds fed diet 2 (30.67 %) which was similar to 28.67 % for diet 5, was significantly ($P<0.05$) higher than those of birds fed other diets. White blood cells count of birds ranged from $3.73 \times 10^3/\mu\text{l}$ (diet 4) to $4.87 \times 10^3/\mu\text{l}$ (diet 5), Red blood cells from $1.13 \times 10^6/\mu\text{l}$ (diet 3) to $1.50 \times 10^6/\mu\text{l}$ (diet 4), haemoglobin from 6.93 g/dl (diet 2) to 8.40 g/dl (diet 4) and Mean corpuscular volume (MCV) between 184.33 and 256.00 fl on diets 4 and 2 respectively. Mean corpuscular haemoglobin (MCH) ranged from 55.57 pg (diet 5) to 71.67 pg (diet 3). However, a significant ($P<0.05$) difference was recorded on MCHC with birds fed diets 4 (30.33 g / dl) and 3 (31.33 g / dl) which were similar to those in diets 1 (27.00 g/ dl) and 5 (27.67 g/ dl), had higher ($P<0.05$) values compared to those on diet 2 (20.00 g/dl). The results for serum biochemical indices indicated that with the exception of chloride, all the other parameters were not significantly ($P>0.05$) affected by the dietary treatments. Higher ($P<0.05$) values of chloride were recorded in birds fed diet 1 (96.67 mmol / l) and lower on diet 4 (81.33 mmol / l). Values for birds on other diets (88.33 – 93.33 mmol / l) did not differ from diets 1 and 4. Values for creatinine were between 79.00 and 90.00 mmol / l on diets 2 and 5 respectively. Cholesterol values ranged from 3.60 to 5.10 mmol / l on diet 3 and 4. Cholesterol levels, which were within the normal range did not differ significantly between diets, suggesting mild metabolic changes, but these were not statistically significant. The result for glucose indicated a range of 6.20 mmol / l on the control diet to 8.43 mmol / l on diet 4. There were also no significant effects on total protein and the values ranged from 7.87 (diet 2) to 10.20 g / dl (diet 5). All the values for haematological and serum biochemical parameters obtained in this study were within the normal range for healthy birds. It is concluded that super SOSAT millet can completely replace dietary maize in broiler chickens without significant metabolic disruptions. Based on the result of this study, super SOSAT millet can be used to replace maize in broiler chickens' diets at up to 100% without compromising health status of the birds.

Keywords: Broiler, Chickens, Super, SOSAT, Millet, Blood.

INTRODUCTION

Poultry meat is considered as one of the highest quality animal protein source to human (Singh *et al.*, 2023) and it's production can proffer faster and cheaper means of arresting the menace of lack of adequate animal protein intake in developing countries (Kehinde *et al.*, 2021). In poultry production, it is known fact that feeding alone accounts for over 70% of the total cost of production in Nigeria. However, poultry production is faced with constraints such as poor growth rate and competition between man and livestock for feed ingredients especially grains which had led to high cost of production. Maize, the most expensive feed ingredient accounts for the largest proportion of about 50 – 55% of the poultry diets. (Ijadunola *et al.*, 2012). The demand for maize (the chief energy source for poultry) by man as food and other industrial uses coupled with low production locally has



placed additional constraints on its continual use in poultry diets (Adamu *et al.*, 2012). It is therefore, necessary to search for suitable substitute for maize in a developing country such as Nigeria (Elangovan *et al.*, 2004). There is the need to evaluate other grains like pearl millet (*Pennisetium glaucum*) of Super SOSAT variety as an alternative to maize in broiler chicken diets. Any reduction in the cost of feed will extensively reduce the overall cost of production and increase the profit margin of the farmer (Yakubu *et al.* 2020). Millet is the most widely grown cereal crop that has been successful cultivated in the semi-arid region of Africa and its cost is relatively less in the areas of cultivation. It has little industrial uses in Nigeria (Nyannor *et al.*, 2007). As a feedstuff, it is mainly grown to produce silage, hay (FAO, 2002).

On the other hand, study of the blood parameters (haematological and biochemical) has been found useful for disease prognosis and for therapeutic and feed stress monitoring (Nanbol *et al.*, 2016). Haematological and biochemical studies are important because blood is the major transport system in the body. It conveys and transports nutrients and materials to different parts of the body. Therefore, whatever affects the blood, be it drugs, pathogenic organisms or nutrition will certainly affect the entire body adversely or moderately in terms of growth, maintenance and reproduction (Oke *et al.*, 2007). In broiler chicken, the haemoglobin value, red blood cell count, white blood cell and haematocrit (PCV) value improved with increase in age, showing that the values were lowest in chicks and highest in adults. Haemoglobin, red blood cell, white blood cell and packed cell volume showed high significance with the weekly growth performance of the birds (Puspamitra *et al.*, 2014). The pack cell volume (PCV) values of broiler chickens are between 36 - 50% and low PCV values are taken to indicate anaemia and fatigue, higher values to indicate dehydration (Dawn, 2010). Reports have also shown that increase in haemoglobin suggests the production of more blood cells in bird as they tried to develop immunity against toxins in the diet. Reference intervals (RI) for values of each parameter have been established. They form the basis for the interpretation of health data that are collated during clinical examination and laboratory testing (Nanbol *et al.*, 2016). This study was therefore designed to study the blood profile of broiler chickens fed Super SOSAT millet as a replacement for maize in groundnut cake based diets.

MATERIALS AND METHODS

Experimental Site

The experiments were conducted at the Poultry Unit, Teaching and Research Farm, Abubakar Tafawa Balewa University, Bauchi. The town, Bauchi, is located within the southern guinea savannah on latitude 10.31 N and longitude 9.84 E. Furthermore, it is 616 metres above sea level characterized by two well-defined seasons; Rainy season (May-October) and dry season (November-April). The average annual rainfall is 1009mm, highest relative humidity 94 % (August) and the lowest 35 % (February). Temperatures are between 13 – 17°C (December – February) and 36 – 37° C (March – April) (World Atlas, 2015). According to ICRISAT (1984), these agro - meteorological indices are also favorable for millet cultivation.

Management of Experimental Birds

Three hundred (300) unsexed, day-old, broiler chickens of the *Cobb* strain were purchased from Pieridox hatchery in Jos, Plateau State for the experiment. Two weeks prior to the birds' arrival, the experimental pens were cleaned, washed, disinfected and fumigated. Furthermore, feeders, drinkers and all other necessary equipment were also cleaned. A week after, litter material (wood shavings) were spread in the experimental pens to a floor depth of approximately 3 inches. Adequate heating/lighting facilities were also provided. Brooding, this lasted for a period of 14 days, commenced with the arrival of chicks. Two (2) electric bulbs of 200 watts capacity each were used to provide the necessary warmth needed in the brooding room. The birds were fed chick mash during this period. They were also given the first dose of IBDV (Gumboro vaccine) at 7 days, followed by an anti-stress drug for two consecutive days. Another vaccine, New Castle Disease Vaccine NCDV (LASOTA) was also administered on the 13th day. At the end of this brooding period, the birds were randomly assigned to five dietary treatments in a completely randomized design (CRD). Each treatment was replicated thrice containing 20 birds each giving a total of sixty birds (60) per treatment.



Experimental diets and clean drinking water were served *ad libitum* throughout the six-week trial period. Birds were also given the second dose of Infectious Bursal Disease vaccine (Gumboro vaccine) (Booster) on the 21st day and another one for NCDV a week after. All vaccines and drugs were administered orally. The experiment was conducted in a completely randomized design (CRD).

Data Collection

At the end of the experiment, blood samples from 30 randomly selected birds, two per replicate, were collected to analyze some haematological and biochemical parameters of the chickens. To avoid temporary elevation of blood metabolites through feeding, the birds were fasted overnight (Bush, 1991). However, potable drinking water was provided as usual. The following morning, blood was collected using sterile syringe and needle sets (5 ml, 21G). Accordingly 5 ml of blood from the left-wing vein of each bird was drawn. Venous blood, mostly found on the left side of the body, is usually the specimen of choice for routine laboratory test (Baker *et al.*, 1998). Samples for haematological study were collected in properly labeled sterilized non-vacuum tubes containing a potassium salt of ethylene diamine tetra-acetic acid (K_3EDTA) as an anti-coagulant. However, samples for serological analysis were collected in EDTA-free tubes. In the laboratory, serum was obtained by allowing the samples to stand at room temperature for a period of 2 hours and then centrifuged at 2000 round per minute (rpm) for 10 minutes to separate the plasma from the serum. The blood samples were analyzed for haematological parameters according to routine clinical methods (Baker *et al.*, 1998). PCV was determined using the micro-haematocrit (capillary tube) method as described by Gamal (2012). Haemoglobin concentration was determined using the Sahli's method as described by Balasubramaniam and Malathi (1992). The RBC count was determined using the Haemocytometer (Neubauer) method as described by Campbell (1986) and Mary (2012). Erythrocyte indices were calculated from RBC, PCV and Hb values using the following relationships as described by Jain, (1993). MCV, MCH and MCHC values were calculated. The serum metabolites (total protein, albumin, globulin, total cholesterol, triglycerides, creatinine, uric acid,), enzymes (alanine aminotransferase (ALT), aspartate aminotransferase (AST)), electrolytes (calcium, sodium, potassium) were analyzed using the UV/Visible Spectrophotometer as described by Nicole *et al.* (2009).

Experimental Diets

Five experimental diets for both starter (23 % CP) and finisher (20 %) phases were formulated. Super Sosat Millet (SSM) replaced maize at 0, 25, 50, 75 and 100 % levels, designated as diets 1 (control), 2, 3, 4, and 5 respectively. Groundnut cake was the main plant protein source used in the diets. Broiler starter and finisher diets were fed for 3 weeks each. Ingredients and percentage composition of dietary SSM as replacement for maize are presented in Tables 1 and 2.



Table 1: Ingredients Composition (%) and Calculated Analysis of Dietary Levels of Super Sosat Millet as Replacement for Maize in Groudnut Cake Meal-Based Diets Fed to Starter Broiler Chickens (1-3 weeks)

Ingredients	DIETS				
	1	2	3	4	5
Maize	46.80	35.10	23.40	11.70	0.00
Super SOSAT millet	0.00	11.70	23.40	35.10	46.80
Groundnut cake meal	33.40	33.40	33.40	33.40	33.40
Palm oil	3.00	3.00	3.00	3.00	3.00
Wheat Offal	7.00	7.00	7.00	7.00	7.00
Fish meal	5.00	5.00	5.00	5.00	5.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Limestone	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
Methionine	0.15	0.15	0.15	0.15	0.15
Lysine	0.15	0.15	0.15	0.15	0.15
TOTAL	100	100	100	100	100
Calculated Analysis (%)					
ME (Kcal/kg)	2893.00	2874.00	2856.00	2839.00	2817.00
Crude Protein	23.00	23.00	23.00	23.00	23.00
Ether Extract	3.30	3.74	4.18	4.69	5.07
Crude Fibre	4.68	4.62	4.56	4.50	4.44
Calcium	1.47	1.47	1.47	1.48	1.48
Phosphorus	0.88	0.88	0.88	0.88	0.88
Methionine	0.45	0.44	0.43	0.43	0.42
Lysine	1.13	1.12	1.12	1.11	1.11

ME; Metabolizable energy

**Vit/mineral premix supplied/Kg of Diet: Vit. A, 12,500 IU; Vit. D₃, 2,500 IU; Vit. E, 30 IU; Vit. K, 2.5 mg; Riboflavin, 6 mg; Pantothenic acid, 10 mg; Vit. B, 2 mg; Niacin, 30 mg; Vit. B₁₂, 22 mg; Biotin, 0.05 mg; Folic acid, 1 mg; Chlorine chloride, 0.3 mg; Antioxidant, 0.125 mg; Iron, 100 mg; Manganese, 100 mg; Zinc, 100 mg; Iodine, 1.5 mg; Cobalt, 0.5 mg; Selenium, 0.1 mg and Copper 10 mg.*

Table 2: Ingredients Composition (%) and Calculated Analysis of Dietary Levels of Super Sosat Millet as Replacement for Maize in Groudnut Cake Meal-Based Diets Fed to Finisher Broiler Chickens (4-6 weeks)

Ingredients	DIETS				
	1	2	3	4	5
Maize	51.83	38.87	25.92	12.96	0.00
Super SOSAT millet	0.00	12.96	25.92	38.87	51.83
Groundnut cake meal	20.27	20.27	20.27	20.27	20.27
Palm oil	3.00	3.00	3.00	3.00	3.00
Wheat Offal	15.00	15.00	15.00	15.00	15.00
Fish meal	5.00	5.00	5.00	5.00	5.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Limestone	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
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20	0.20
TOTAL	100	100	100	100	100
Calculated Analysis (%)					
ME (Kcal/kg)	2981.00	2967.00	2951.00	2933.00	2914.00
Crude Protein	20.00	20.00	20.00	20.00	20.00
Ether Extract	4.28	4.77	5.27	5.96	6.25
Crude Fibre	4.49	4.43	4.36	4.29	4.23
Calcium	1.46	1.46	1.46	1.47	1.47
Phosphorus	0.92	0.92	0.92	0.92	0.92
Methionine	0.45	0.44	0.43	0.43	0.42
Lysine	1.02	1.02	1.02	1.01	1.01

ME; Metabolizable energy

*Vit/mineral premix supplied/Kg of Diet: Vit. A, 12,500 IU; Vit. D₃, 2,500 IU; Vit. E, 30 IU; Vit. K, 2.5 mg; Riboflavin, 6 mg; Pantothenic acid, 10 mg; Vit. B, 2 mg; Niacin, 30 mg; Vit. B₁₂, 2.2 mg; Biotin, 0.05 mg; Folic acid, 1 mg; Chlorine chloride, 0.3 mg; Antioxidant, 0.125 mg; Iron, 100 mg; Manganese, 100 mg; Zinc, 100 mg; Iodine, 1.5 mg; Cobalt, 0.5 mg; Selenium, 0.1 mg and Copper 10 mg.

Experimental Design

The experiment was conducted in a completely randomized design (CRD) with three replications.

Statistical Analysis

All data collected were subjected to one - way analysis of variance (ANOVA) using the statistical package, for Social sciences (SPSS) version 23 and differences between treatment means were separated using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Haematological Parameters

Haematological parameters of broiler chickens fed Super SOSAT millet as replacement for maize in groundnut cake meal based diets is presented in Table 3. The results indicated that except for Packed cell volume (PCV) and Mean Corpuscular Haemoglobin Concentration (MCHC), no blood parameter was significantly ($P>0.05$) affected. The result further revealed that most of the haematological parameters of broiler chickens fed diets containing SSM did not show any significant effect of diets. This supports earlier report by Kawu *et al.* (2020). The PCV of birds fed diet 2 (30.67 %) which was similar to 28.67 % for diet 5, was significantly ($P<0.05$) higher than those of birds fed other diets. Values for PCV were similar to those reported by Medugu *et al.* (2010) which indicated lower PCV values in birds fed SSM based diets White blood cells (WBC) count of birds ranged from $3.73 \times 10^3/\mu\text{l}$ (diet 4) to $4.87 \times 10^3/\mu\text{l}$ (diet 5), Red blood cells (RBC) from $1.13 \times 10^6/\mu\text{l}$ (diet 3) to $1.50 \times 10^6/\mu\text{l}$ (diet 4), haemoglobin (Hb) from 6.93 g/dl (diet 2) to 8.40 g/dl (diet 4) and



Mean corpuscular volume (MCV) between 184.33 and 256.00 fl on diets 4 and 2 respectively. Mean corpuscular haemoglobin (MCH) ranged from 55.57 pg (diet 5) to 71.67 pg (diet 3). However, a significant ($P<0.05$) difference was recorded among diets in MCHC which indicated that birds fed diets 4 (30.33 g / dl) and 3 (31.33 g / dl) which were similar to those in diets 1(27.00 g/ dl) and 5 (27.67 g/ dl), had higher ($P<0.05$) values compared to those on diet 2 (20.00 g/dl). The high level of MCH in diet 3 (71.67 pg), is an indication that this level of Super sosat millet may have enhanced the oxygen-carrying capacity of red blood cells by increasing haemoglobin content. All haematological values obtained in this study are within the reference range for healthy birds (WikiVet, 2012; Kareem *et al.*, 2024), indicating that the birds were healthy and adequately nourished.

Table 3: Haematological Parameters of Broiler Chickens Fed Super SOSAT Millet as Replacement for Maize in Groundnut Cake Meal Based Diets

Parameters	DIETS					SEM
	1	2	3	4	5	
Packed Cell Volume (%)	27.00 ^b	30.67 ^a	25.67 ^b	27.00 ^b	28.67 ^{ab}	0.97*
White Blood Cell ($\times 10^3/\mu\text{l}$)	4.77	4.00	4.10	3.73	4.87	0.63 ^{NS}
Red Blood Cell ($\times 10^6/\mu\text{l}$)	1.17	1.20	1.13	1.50	1.43	0.11 ^{NS}
Haemoglobin (g/dl)	7.40	6.93	8.17	8.40	8.00	0.75 ^{NS}
MCV (fl)	242.33	256.00	226.00	184.33	200.33	21.74 ^{NS}
MCH (pg)	63.00	57.67	71.67	58.00	55.67	6.83 ^{NS}
MCHC (g/dl)	27.00 ^{ab}	20.00 ^b	31.33 ^a	30.33 ^a	27.67 ^{ab}	2.61*

*MCH= Mean Corpuscular Haemoglobin, MCHC= Mean Corpuscular Haemoglobin Concentration, MCV=Mean Corpuscular Volume; ^{ab}Means bearing different superscripts within the same row differ; * = ($P<0.05$); ns= Not significant; SEM = Standard Error of Means*

Serum Biochemical Indices

The serum biochemical components of broiler chickens fed Super SOSAT millet as replacement for maize in groundnut cake meal based diets is shown in Table 4. Serum biochemical analysis is used to determine the level of heart attack, liver damage and to evaluate protein quality and amino acid requirements in animals (Rasheed and Olusegun, 2017). The results indicated that with the exception of chloride, all the other parameters were not significantly ($P>0.05$) affected by the dietary treatments. The concentration of serum potassium ranged from 4.43 mmol/l on diet 3 to 5.43 mmol / l on diet 4. Higher ($P<0.05$) mean values of chloride were recorded in birds fed diet 1 (96.67 mmo / l) and lower on diet 4 (81.33 mmol / l). Values for birds on other diets (88.33 – 93.33 mmol / l) did not differ from diets 1 and 4. Values for hydrocarbonate concentration ranged from 20.66 mmo / l on diet 5 to 24.33 mmol / l on diet 2, while that of creatinine were between 79.00 and 90.00 mmol / l on diets 2 and 5 respectively. Cholesterol values ranged from 3.60 to 5.10 mmol / l on diet 3 and 4. Cholesterol levels, which were within the normal reference range did not differ significantly between diets, suggesting mild metabolic changes, but these were not statistically significant. The result for glucose indicated a range of 6.20 mmol / l on the control diet to 8.43 mmol / l on diet 4. There were also no significant effects of diet on total protein and the values ranged from 7.87 (diet 2) to 10.20 g / dl (diet 5). The hepatic biomarker, aspartate transaminase ranged from 7.33 to 9.33 iu / l on diets 4 and 5 respectively, also did not show significant influence of Super SOSAT millet. All the values for serum biochemical parameters obtained in this study are within the reference range for healthy birds (WikiVet, 2012).



Table 4: Serum Biochemical Parameters of Broiler Chickens Fed Super SOSAT Millet as Replacement for Maize in Groundnut Cake Meal Based Diets

Parameters	DIETS					SEM
	1	2	3	4	5	
Potassium (mmol/l)	4.90	5.23	4.43	5.43	4.43	0.09 ^{NS}
Chloride (mmol/l)	96.67 ^a	87.66 ^{ab}	93.33 ^{ab}	81.33 ^b	88.33 ^{ab}	4.09 [*]
Hydrocarbonate (mmol/l)	23.66	24.33	23.67	21.66	20.66	1.67 ^{NS}
Creatinine (mmol/l)	87.00	79.66	85.67	80.33	90.00	6.31 ^{NS}
Cholesterol (mmol/l)	4.40	4.70	3.60	5.10	4.47	0.62 ^{NS}
Glucose (mmol/l)	6.20	6.40	6.83	8.43	6.37	1.26 ^{NS}
Total Protein (g/dl)	7.90	7.87	8.26	8.63	10.20	1.20 ^{NS}
Albumin (g/dl)	3.23	4.00	4.67	3.90	4.60	0.45 ^{NS}
Aspartate transaminase (iu/l)	7.67	8.00	8.00	7.33	9.33	1.41 ^{NS}

^{ab}Means bearing different superscripts within the same row differ; * = ($P < 0.05$); ns = Not significant; SEM = Standard Error of Means

CONCLUSION AND RECOMMENDATION

In conclusion however, super SOSAT millet can completely replace dietary maize in broiler chickens without significant metabolic disruptions. Most haematological and biochemical parameters were stable, suggesting overall safety for blood health and metabolism. Based on the result of this study, it is recommended that super SOSAT millet can replace dietary maize in broiler chicken at up to 100% without compromising health status of the birds.

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