Paper ISSN 0189-0514
Online ISSN 1427-4410
J. Anim. Prod. Res. (2021) 33(1):40-66

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BLOOD PROFILE OF BROILER CHICKENS FED DIETS OF DIFFERENTLY PROCESSED CASSAVA-SOYA BLENDS

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ABSTRACT

This study was conducted to determine the blood profile of broiler chickens fed diets of differently processed Cassava-Soya blends (CSB). Cassava pulp and full fat soyabean (dry and wet heated) mixed at ratios 50:50, 60:40, and 80:20 was subjected to two types of dehydration methods (frying and sun drying) to obtain 12 types of CSB. The blends were included at 15% level in the ration of broiler chickens in a 2x2x3 factorial arrangement. 360 one-day-old Cobb500 broiler chicks were used for this study were randomly allotted to the 12 dietary treatment groups in three (3) replicates with (10) birds each. Eight weeks of feeding trials (starter and finisher phases) were observed. Blood collection was carried out from the vain in the 4th and 8th week of the experiment and analyzed. Packed cell volume was significantly influenced by the interaction of heat treatment, dehydration method and mixing ratio of the CSB. Aspartate amino transferase (55.75 IU) and alanine amino transferase (27.42 IU) activities were significantly higher ($p<0.05$) in birds fed wet heated soyabeans than those fed dry heated soyabeans. Heterophil values of birds fed sun dried CSB containing dry heated soya beans at 80:20 mixing ratio was the highest (40.50 %) while those fed fried diet containing dry heated soya beans recorded the least (27.50 %) values of heterophil. It was concluded that dry heating of raw soyabean before use in CSB preparation at 50:50 mixing ratio of cassava-soya blend supported optimal PCV and liver enzyme (AST and ALT) values, when compared to those fed 60:40 and 80:20 mixing ratios.

Keywords: Blood parameters, broiler chickens, cassava-soya blends, hydrocyanide

INTRODUCTION

Feed cost is perhaps the most expensive input in poultry production as it constitutes about 70-80 percent of the total cost of production for intensively reared animal stocks (Ijaiya *et al*., 2002). Eruvbetine (2009) stated the need for effecting a feed revolution has in order to solve the problem of increasing requirement for food and feed in Nigeria. Unfortunately, according to an older study carried out by James (1994), poultry production has not been encouraged in Nigeria due to unavailability of feed stuff at moderate and justifiable economic prices, although this is gradually improving. Akinfala *et al*., (2002) described maize (*Zea mays*) as the main source of energy in diets for monogastric animals in Nigeria, which may constitute up to 60% of the ration. It is used as human food for various industrial cereal products and this brings about high competition for available maize between man and many other monogastric animals.

In Nigeria, the demand for maize is always higher than its supply which results in high cost of the grain and made it uneconomical to use as sole energy source in poultry diets (Udedibie and Asoluka, 2008). The increasing pressure on its use by the human population and livestock feed companies has resulted in an escalating price of maize in Nigeria. Means of reducing this cost is therefore uppermost in the minds of poultry farmers which had resulted in researches that could help reduce the cost of feeding yet with optimum output. This approach involves compounding of feed in a way that all the required nutrients are

supplied by using cheap energy sources and free amino acids supplements. Such cheap energy source could be cassava, which had been reported to have shown to be useful as feedstuff for livestock diets by Tewe (1982).

Cassava (*Manihot esculenta Crantz*) according to Phillips *et al*. (2004) is one of the most important food crops grown in the tropics, and a significant source of calories for more than 500 million people world-wide. The use of cassava in diets for animals is not a recent development, as scientists from all over the world have been actively involved in the use of cassava roots and leaves over the decades, as a potential source of energy in poultry diets and for other non-ruminants (Eruvbetine, 1995). However, despite the good prospect of cassava, it has a high percentage of hydrocyanide, poor in protein content and its amino acids profile shows that the Sulphur amino acids (cysteine, methionine) are present in trace amount (Gomez *et al*., 1988). Hence, improving the nutritional value of cassava food products through processing becomes a necessary intervention. It has also been identified that the major problem of cassava utilization is its powdery nature (Essers and Nout, 1989).

The high cost of procuring maize; the most commonly used energy source in poultry feeds, which had inadvertently led to increase in feed cost of monogastric animals, thereby consecutively bringing about increase in overall cost of poultry production, makes the need for looking for cheap alternative energy source such as cassava a research worth studying. Additionally, the low protein content of cassava makes it require protein fortification via oil seeds such as soyabean, and the presence of antinutrients in both cassava and soyabean brings about the need for finding the best cheap and affordable processing method. This current study thereby aimed to investigate the effect of differently processed cassava-soya blends on blood profile of broiler chickens.

MATERIALS AND METHODS

Study Area

The experiment was carried out at the Poultry Unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta (FUNAAB), Ogun state, Nigeria. The area falls within the rainforest vegetation zone of south western Nigeria on latitude 7^{o}13', 49.46'N, longitude 3^{o}26', 11.98'E with an altitude of 76 meters above sea level (Google Earth, 2020). The climate is humid with a mean annual rainfall of 1037mm. The annual mean temperature and humidity is 34.7 and 82% respectively (Federal University of Agriculture, Abeokuta, Meteorological Station).

Ethical Permit

The practices adopted in the conduct of the study was according to the guidelines approved by the project review committee of the College of Animal Science and Livestock Production, Federal University of Agriculture, Abeokuta, Ogun State.

Experimental Birds and Management

The feeding trial was conducted with a total number of three-hundred-and-sixty-day-old Cobb 500 broiler chicks. The birds were intensively managed on a deep litter system in two phases (the starter and the finisher phases). The starter phase lasted for four weeks (0-4weeks), while the finisher phase also lasted for four weeks (4-8 weeks). The deep littered pen and equipment were washed and disinfected prior to arrival of the birds. All the routine management practices including medications (vaccines and drugs) specified for Cobb 500 breed of chickens were strictly adhered to. Feed and water were supplied to the birds *ad libitum*. The experimental birds were managed under standard management conditions of broiler chicken rearing in the tropics.

Test Ingredients and Processing

Test ingredients for the experiments were cassava (*Manihot esculenta Crantz*) of the variety TMS 30572 and Soyabeans (*Glycine max*) of the variety TGX 923E. The cassava

tubers were obtained from local farmers within Abeokuta metropolis, Ogun state, while the soya beans were obtained from International Institute of Tropical Agriculture (IITA), Ibadan. The cassava tubers were processed according to the protocols described by Adeyemi and Balogh (1985). They were peeled, washed and grated in a commercial grating machine. The grated cassava pulps were packed in hessian bags and allowed to ferment while water was squeezed out gradually under pressure for 48 hours. Thereafter, the squeezed pulp was pulverized with hands and sifted on a local raffia made sieve to remove the fibers. The soyabean seeds of the variety TGX 923E were sorted to ensure homogeneity of samples, washed, sun dried till a constant moisture content is attained and divided into two, then subjected to two heat treatments (dry and wet heat treatments);

i. **Dry heat treatment**: Part of the cleaned raw soya beans was poured into a hot metal dry pan (common driers). The soya beans were dry heated by continuous stirring until the beans were slightly roasted to a golden-brown color, following the method of Cheva-Isarakul and Tangtaweewipat . (1995). The dry heated soya beans were spread to cool before milling into full fat soya meal.

ii. **Wet heat treatment**: The other part of the cleaned raw soyabeans was poured into a vat containing as much liters (unmeasured) of boiling water per batch of kg of soya beans. The soya beans were allowed to boiled at 100^{o}C for 30minutes according to the methods described by Kaankuka *et al*. (1996). Thereafter, the water was decanted and the boiled soya beans oven-dried till a constant moisture content is attained, before milling into full fat meal.

Cassava-soya blends were then prepared from mixtures of sieved cassava pulps and full fat soya beans (dry heated and wet heated) in the following ratios: 50:50, 60:40 and 80:20 (Table 1). The resulting mixtures were then further subjected to two types of dehydration methods (sun drying or frying) to make twelve different Cassava-soya blend sample treatments as shown in Table1.

Table 1: Processing techniques and mixing ratios of cassava-soya blends (CSB).

Treatments	Components	Mixing ratio	Processing techniques
CDF_1	CP +DHTS	50:50	Frying
CDF_2	CP +DHTS	60:40	Frying
CDF_3	CP +DHTS	80:20	Frying
CDS_1	CP +DHTS	50:50	Sun drying
CDS_2	CP +DHTS	60:40	Sun drying
CDS_3	CP +DHTS	80:20	Sun drying
CWF_1	CP +WHTS	50:50	Frying
CWF_2	CP +WHTS	60:40	Frying
CWF_3	CP +WHTS	80:20	Frying
CWS_1	CP +WHTS	50:50	Sun drying
CWS_2	CP +WHTS	60:40	Sun drying
CWS_3	CP +WHTS	80:20	Sun drying

CP – cassava pulp, DHTS – dry heat-treated soya, WHTS – wet heat-treated soya

Proximate Composition of Test Ingredients

Proximate composition (moisture, crude protein [CP], crude fiber [CF], ether extract [EE], Nitrogen Free Extract [NFE] and ash content) of the cassava-soya blends were determined by method described by AOAC (2005) while the metabolizable energy was calculated using Pauzenga equation as follows: ME = 35 x % CP + 81.1 x % EE + 35.5 x % NFE. NB: ME- Metabolizable energy, CP- Crude protein, EE- Ether extract, NFE- Nitrogen free extract. Hydrogen cyanide (HCN) content was determined according to the procedure of Anhwange *et al.* (2004) while the trypsin inhibition unit (TIU) was also determined.

Experimental Diets and Layout

The twelve dietary treatments were arranged in a 2x2x3 factorial experimental design to have 2 heat treatments of soyabean (wet and dry heat treatments), 2 dehydration methods of cassava-soya blends (sun drying and frying) and 3 mixing ratios of cassava-soya blends (50:50, 60:40, and 80:20). The cassava-soya blends (CSB) were included in the broiler chickens' diet at 15% inclusion. At the onset of the experiment, the 360 Cobb-500 one-day-old broiler chicks were randomly allotted to the 12 experimental groups (30 birds per treatment). Each treatment was replicated 3 times to have 10 chicks per replicate group on weight equalization bases. At the end of the starter phase, the experimental birds were mixed together and re-assigned on weight equalization bases to the same number of dietary treatment groups with the same number of replicates. This was done to remove any carryover effect of the starter phase to finisher phase. All diets were formulated following recommended procedures (NRC, 1994) as presented in Tables 2 and 3.

Table 2: Percentage (%) composition of experimental starter diets (0-4 weeks)

	Fried CSB blend						Sun dried CSB blend					
	Dry heated soyabean			Wet heated soyabean			Dry heated soyabean			Wet heated soyabean		
Ingredients	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**
CSB	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Maize	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
FFS	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00
Soyabean meal	15.05	15.05	15.05	15.05	15.05	15.05	15.05	15.05	15.05	15.05	15.05	15.05
Palm oil	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Bone meal	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Oyster Shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Vitamin/minerals	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Premix												
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100	100	100	100	100
Calculated Analysis												
ME(Kcal/Kg)	3187.03	3164.47	3170.18	3164.43	3168.12	3162.78	3168.83	3169.87	3163.32	3169.42	3170.31	3163.07
Crude Protin(%)	23.72	23.46	21.52	23.06	22.68	20.72	23.16	23.16	21.65	22.16	22.17	20.71
Crude Fibre(%)	3.67	3.68	3.73	3.67	3.68	3.73	3.68	3.73	3.6	3.67	3.68	3.73
Calcium(%)	1.20	1.20	1.21	1.20	1.20	1.21	1.20	1.20	1.21	1.20	1.20	1.21
Phosphorus(%)	0.68	0.67	0.67	0.68	0.67	0.67	0.68	0.67	0.67	0.68	0.67	0.67
Lysine(%)	1.20	1.21	1.21	1.20	1.21	1.21	1.20	1.21	1.21	1.20	1.21	1.21
Methionine(%)	0.47	0.47	0.46	0.47	0.47	0.46	0.47	0.47	0.46	0.47	0.47	0.46

CSB- Cassava-soya blend, FFS- Full fat soya, ME- Metabolizable energy

*Vitamin A: 40000000IU, Vit CWS3: 2500000IU, Vit E: 40000mg: Vit K_3: 800mg, Vit CDS3: 3000mg, Vit CDS2: 6000mg, Vit B_6: 5000mg, Vit $CDS1_2$: 25mg, Niacin: 6000mg, Pantothenic Acid: 20000mg, Folic Acid: 800mg, Biotin: 8mg, Manganese: 300000mg, Iron: 80000mg, Zinc: 20000mg, Copper: 25mg, Cobalt: 80mg, Iodine: 400mg, Selenium: 40mg, Chlorine: 800000mg.

Table 3: Percentage (%) composition of experimental finisher diets (4-8 weeks)

	Fried CSB blend						Sun dried CSB blend					
	Dry heated soyabean			Wet heated soyabean			Dry heated soyabean			Wet heated soyabean		
Ingredients	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**
CSB	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Maize	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
Full fat soyabean meal	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Soyabean meal	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Palm Kernel Meal	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Fish Meal	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Wheat Offal	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05
Palm Oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Bone meal	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Oyster Shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Vitamin/minerals Premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100	100	100	100	100	100
Calculated Analysis												
ME(Kcal/Kg)	2902.28	2902.54	2902.16	2902.28	2902.54	2902.16	2902.28	2902.54	2902.16	2902.28	2902.54	2902.16
Crude Protein(%)	20.52	20.22	19.72	20.52	20.22	19.72	20.52	20.22	19.72	20.52	20.22	19.72
Crude Fibre(%)	4.24	4.26	4.29	4.24	4.26	4.29	4.24	4.26	4.29	4.24	4.26	4.29
Calcium(%)	1.20	1.21	1.20	1.20	1.21	1.20	1.20	1.21	1.20	1.20	1.21	1.20
Phosphorus(%)	0.66	0.66	0.65	0.66	0.66	0.65	0.66	0.66	0.65	0.66	0.66	0.65
Lysine(%)	1.13	1.12	1.08	1.13	1.12	1.08	1.13	1.12	1.08	1.13	1.12	1.08
Methionine(%)	0.45	0.44	0.43	0.45	0.45	0.44	0.45	0.44	0.43	0.45	0.44	0.43

CSB- Cassava-soya blend, ME- Metabolizable energy

*Vitamin A: 40000000IU, Vit CWS3: 2500000IU,Vit E: 40000mg: Vit K_3: 800mg, Vit CDS3: 3000mg, Vit CDS2: 6000mg, Vit B_6: 5000mg, Vit CDS1_2: 25mg, Niacin: 6000mg, Pantothenic Acid: 20000mg, Folic Acid: 800mg, Biotin: 8mg, Manganese: 300000mg, Iron: 80000mg, Zinc: 20000mg, Copper: 25mg, Cobalt: 80mg, Iodine: 400mg, Selenium: 40mg, Chlorine: 800000mg.

Data Collection

Blood collection

At 28th and 56th days of the study, 5 ml of blood samples were drawn from the wing (Bronchial vein) of four birds per replicate. 2 ml of the blood samples were collected into a heparinized tube containing Ethylene Diamine Tetra Acetate (EDTA) for hematological indices, and 3 ml of the blood sample was collected into plain bottles.

Hematological parameters and serum biochemistry profile

The hematological indices determined include erythrocyte count, Packed Cell Volume (PCV), White Blood Cell (WBC) and WBC differentials. Mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration were calculated. Hemoglobin concentration was determined using van slyke apparatus, and PCV – hacksley hematocrit centrifuge (UK). WBC and its differentials were determined using the Neubauer count chamber following procedure described by Fudge (2000) and Cray and Zaias (2004). Serum biochemistry profile was determined colorimetrically using Jenway 6405 UV/VIS Spectrophotometer (UK). Serum protein was derived through methodology described by Tietz (1995). Bromo Cresol Green (BCG) method was employed for serum albumin as described by Donmas, *et al*. (1971), while alanine amino transferase (ALT), Aspartate amino transferase (AST) (IFCC 1986a, b), alkaline phosphatase (ALP) (Schmidt and Schmidt, 1975) and Cholesterol values were recorded.

Statistical Analysis

Data obtained in this study were subjected to analysis of variance in a 2x2x3 factorial arrangement, and were analyzed using the general linear model procedure of SAS 9.1.3 computer software statistical package (SAS, 2002). Significant ($p<0.05$) means were separated using Duncan's Multiple Range Test (1995) as contained in the procedure of the statistical package (Duncan, 1995).

RESULT AND DISCUSSIONS

Proximate composition of cassava-soya blends

The proximate composition of cassava-soya blends (CSB) is presented in Table 4. The analyses were carried out on dry matter (DM) basis. The proximate values (crude protein, ether extract, crude fiber, ash, nitrogen free extract), hydrogen cyanide and Trypsin Inhibition Unit) values of the CSB ranged from 18.81-37.72%, 0.47-1.40%, 4.43-5.37%, 1-2%, 55.47-75.57%, 1.60-1.77mg/kg and 2.1-7.8 mg/g respectively. CSB containing dry heated soya beans and dehydrated by frying at 50:50 Sample (CDF_1) recorded the least values for crude fiber (4.43 %) and hydrogen cyanide (1.60 mg/kg) but recorded the highest value for ether extract (1.40 %). CSB containing dry heated soya beans and dehydrated by sun drying at 80:20 (CDS_3) had the least value for metabolizable energy (3270 Kcal/kg) while CSB containing wet heated soya beans and dehydrated by sun drying at 60:40 (CWS_2) had the highest (3320 Kcal/kg). CSB containing dry heated soya beans and dehydrated by sun drying at 80:20 (CDS_3) had the least dry matter (66.59 %) content and ether extract (0.47 %). CSB containing dry heated soya beans and dehydrated by frying at 80:20 (CDF_3) recorded the least value for crude protein (18.81 %) while CSB containing wet heated soya beans and dehydrated by sun drying at 50:50 (CWS_1) had the highest crude protein (37.72 %) value.

The hydrogen cyanide had the highest (1.77 mg/kg) and least (1.60 mg/kg) values in CSB dehydrated by sun drying and containing wet heated soya beans (CWS_3) and CSB containing dry heated soya beans and dehydrated by frying 50:50 (CDF_1) respectively. CSB containing dry heated soya beans and dehydrated by sun drying at 50:50 (CDS_1) recorded the highest value for trypsin inhibition unit (7.80 mg/g) while CSB containing wet heated soya beans and dehydrated by frying at 60:40 (CWF_2) recorded the least (2:0 mg/g) value.

Table 4: Proximate composition of cassava-soya blends

Samples	Dry matter (%)	ME (Kcal/kg)	Crude Protein (%)	Ether Extract (%)	Crude Fibre (%)	Ash (%)	NFE (%)	Hydrogen Cyanide (mg/kg)	TIU (mg/g)
CDF_1	70.23	3281.62	33.47	1.40	4.43	2.00	58.70	1.60	7.50
CDF_2	70.00	3319.98	31.75	1.11	4.51	1.00	61.63	1.61	7.40
CDF_3	68.64	3281.54	18.81	0.58	5.03	2.00	73.58	1.65	7.30
CDS_1	66.82	3279.56	35.72	1.35	4.48	2.00	56.45	1.68	7.80
CDS_2	68.64	3305.90	33.19	1.06	4.91	1.00	59.84	1.72	7.70
CDS_3	66.59	3270.30	20.10	0.48	5.37	2.00	72.05	1.76	7.60
CWF_1	70.00	3310.66	36.37	1.34	4.59	1.00	56.68	1.61	2.10
CWF_2	71.59	3317.61	34.65	1.08	4.55	1.00	58.72	1.61	2.00
CWF_3	69.36	3273.96	19.63	0.52	5.28	2.00	75.57	1.66	2.20
CWS_1	67.73	3314.58	37.72	1.34	4.47	2.00	55.47	1.70	2.60
CWS_2	67.95	3320.51	35.12	1.02	4.49	1.00	58.37	1.73	2.50
CWS_3	66.59	3272.56	20.07	0.47	5.32	2.00	72.14	1.77	2.30

TIU-Trypsin inhibition unit; ME-Metabolizable Energy; (CDF_1 -CDF_3)- Fried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CDS_1-CDS_3)- Sun dried (cassava pulp+ dry heated soya beans) at 50:50, 60:40 and 80:20; (CWF_1-CWF_3)- Fried (cassava pulp+ wet heated soya beans) at 50:50, 60:40 and 80:20; (CWS_1-CWS_3)- Sun dried (cassava pulp + wet heated soya beans) at 50:50, 60:40 and 80:20.

Main effects of soyabean heat treatments, dehydration methods and mixing ratio of CSB on hematological indices and serum biochemistry of starter broiler chickens (4weeks)

Table 5 shows the main effects of soyabean heat treatments, dehydration methods and mixing ratio of CSB on hematological indices and serum biochemistry of starting broiler chickens. The packed cell volume, hemoglobin, monophil, mean corpuscular volume, mean corpuscular hemoglobin, aspartate amino transferase and alanine amino transferase were significantly ($p<0.05$) affected by the heat treatments of soya beans. Birds fed diets containing dry heated soya beans had the least values ($p<0.05$) for packed cell volume (20.33 %) and hemoglobin (6.64 g/dl) but had the higher values for aspartate amino transferase (39.17 U/L), Alanine amino transferase 27.11 *I.U*) and mean corpuscular volume (11.09 Fl). However, Red blood cell, white blood cell, heterophil, total protein, albumin and globulin were not significantly ($p>0.05$) affected by heat treatments.

The dehydration methods of CSB significantly ($p<0.05$) affected heterophil, basophil, albumin and alkaline phosphatase. Birds fed diets containing sun dried CSB recorded higher ($p<0.05$) values for alkaline phosphatase (26.42 *I.*U), heterophil (69.31%) and basophil (0.42%) but least value was recorded for albumin (2.45 g/dl), while birds fed diets containing fried CSB had least values for alkaline phosphatase (24.33 *I.*U), heterophil (34.34%) and basophil (0.25%) but recorded higher value for albumin (2.64 g/dl). Other parameters measured were not significantly ($p>0.05$) affected by dehydration methods of CSB.

Packed cell volume, heterophil, lymphocyte, basophil, monophil, mean corpuscular hemoglobin concentration, AST and alanine amino transferase were significantly ($p<0.05$) affected by mixing ratio of CSB. Birds fed diets containing 50:50 and 80:20 mixing ratio had similar values for packed cell volume of 22.00% and 22.50 % respectively, and likewise birds fed diets containing 50:50 and 80:20 had similar values for lymphocyte of (65.71% and 65.74%) and mean corpuscular hemoglobin concentration (32.78% and 32.31%) respectively.

Interaction effects of soyabean heat treatments and dehydration methods of CSB on hematological indices and serum biochemistry of starting broiler chickens (4 weeks)

Table 6 shows the interaction effects of soyabean heat treatments and dehydration methods of CSB on hematological indices and serum biochemistry of starting broiler chickens. The packed cell volume, hemoglobin, heterophil, mean corpuscular hemoglobin concentration, total protein, aspartate amino transferase was significantly ($p<0.05$) affected by heat treatments and dehydration methods of CSB. Birds fed sun dried diets containing dry heated soya beans had the highest ($p<0.05$) values for packed cell volume (25.00 %), hemoglobin (8.03 g/dl) and total protein (5.17 g/dl). Birds fed fried CSB containing wet heated soya beans had the lowest ($p<0.05$) values for packed cell volume (19.83 %) and hemoglobin (6.68 g/dl) but had the highest ($p<0.05$) values for mean corpuscular hemoglobin concentration (33.83 g/dl) and aspartate amino transferase (47.00 *I.U*). Also, birds fed fried CSB containing dry heated and wet heated soya beans had similar values for hemoglobin (6.60 g/dl and 6.68 g/dl) and total protein (4.28 g/l and 4.22 g/l) respectively.

Table 5: Main effects of soyabean heat treatments, dehydration methods and mixing ratio of CSB on haematological indices and serum biochemistry of broiler starter chickens (4weeks)

	Soyabean heat treatments				Dehydration methods of CSB				Mixing ratios of CSB				
Parameters	**Dry heated**	**Wet heated**	**SEM**	**p-value**	**Fried**	**Sun dried**	**SEM**	**p-value**	**50:50**	**60:40**	**80:20**	**SEM**	**P.Value**
PCV (%)	20.33[b]	23.33[a]	1.366	0.001	22.92	20.75	0.558	0.888	22.00[a]	21.25[b]	22.25[a]	1.025	0.008
Haemoglobin (g/dl)	6.64[b]	7.65[a]	0.375	0.013	7.32	6.98	0.153	0.896	7.18	7.10	7.16	0.469	0.409
RBC (x 10^{12}/l)	1.83	2.13	0.162	0.194	2.09	1.86	0.666	0.284	1.95	1.90	2.08	0.486	0.325
WBC (x 10^{9}/l)	10.84	11.34	0.427	0.249	11.17	11.02	0.174	0.111	10.79	11.24	11.25	0.320	0.161
Heterophil (%)	35.33	34.42	4.878	0.193	34.34 [a]	31.69 [b]	1.991	0.035	33.41 [b]	31.63 [c]	34.08 [a]	3.659	0.000
Lymphocyte (%)	61.42	64.67	1.717	0.349	64.83	67.39	0.701	0.577	65.71[a]	67.50 [a]	65.04 [b]	1.287	0.025
Eosinophil (%)	0.17	0.25	0.179	0.153	0.00	0.00	0.000	0.153	0.00	0.00	0.00	0.000	0.216
Basophil (%)	0.33	0.33	0.240	0.376	0.25 [b]	0.42 [a]	0.098	0.012	0.50 [a]	0.13 [c]	0.38 [b]	0.180	0.009
Monophil (%)	0.75 [a]	0.33[b]	0.226[c]	0.001	0.58 [a]	0.50 [a]	0.092	0.265	0.38 [c]	0.74 [a]	0.50 [b]	0.169	0.033
MCV (fl)	111.09[a]	109.53[b]	3.216	0.025	100.66	101.55	1.617	0.419	112.82	111.84	106.97	0.990	0.704
MCH (pg)	36.75 [a]	36.48 [b]	1.511	0.032	35.32	37.92	0.617	0.428	36.88	37.56	35.41	1.134	0.116
MCHC (g/dl)	32.82	32.78	0.750	0.769	32.01	33.58	0.306	0.519	32.78[a]	33.30 [a]	32.31 [b]	0.563	0.001
Total protein (g/l)	4.25	4.79	0.242	0.206	4.73	4.32	0.10	0.206	4.51	4.49	4.56	0.303	0.108
Albumin (g/l)	2.36	2.73	0.135	0.166	2.64[a]	2.45[b]	0.055	0.034	2.46	2.54	2.64	0.101	0.270
Globulin (g/l)	1.89	2.11	0.128	0.019	2.08	1.92	0.052	0.798	2.01	1.95	2.04	0.096	0.295
AST (µ/I)	39.17[a]	37.00[b]	2.526	0.007	37.25	38.92	1.031	0.067	42.25 [a]	38.75[b]	33.25[c]	1.895	0.033
ALT(*I.U*)	27.11 [a]	25.72 [b]	2.336	0.009	26.67	26.17	0.954	0.458	26.71[a]	25.67 [b]	26.88 [a]	1.752	0.031
ALP(*I.U*)	25.25	25.50	1.995	0.695	24.33 [b]	26.42 [a]	0.815	0.000	25.75	25.25	25.13	1.497	0.201

[abcd] Means on the same rows having different superscript were significantly ($p<0.05$) different

PCV – Packed Cell Volume; RBC- Red Blood Cell; WBC- White Blood Cell; MCV- Mean Corpuscular Volume; MCH- Mean Corpuscular Heamoglobin; MCHC- Mean Corpuscular Haemoglobin Concentration AST- Aspartate Amino Transferase; ALT- Alanine Amino Transferase; ALP -Alkaline phosphatase

Table 6: Interaction effects of soyabean heat treatments and dehydration methods of CSB on haemotological indices and serum biochemistry of broiler starter chickens (4 weeks)

	Fried CSB		Sun dried CSB			
Parameters	**Dry heated soyabean**	**Wet heated soyabean**	**Dry heated soyabean**	**Wet heated soyabean**	**SEM**	**p-value**
PCV (%)	20.83^{b}	19.83^{c}	25.00^{a}	21.67^{b}	0.789	0.023
Haemoglobin (g/dl)	6.60^{c}	6.68^{c}	8.03^{a}	7.27^{b}	0.217	0.002
RBC (x 10^{12}/l)	1.87	1.78	2.32	1.93	0.094	0.438
WBC (x 10^{9}/l)	11.08	10.60	11.25	11.43	0.246	0.086
Heterophil (%)	35.83^{b}	37.83^{a}	35.72^{b}	33.56^{c}	2.816	0.035
Lymphocyte (%)	62.84	61.11	63.45	65.67	0.991	0.825
Eosinophil (%)	0.17	0.17	0.33	0.17	0.103	0.153
Basophil (%)	0.33	0.33	0.17	0.50	0.139	0.376
Monophil (%)	0.83	0.67	0.33	0.33	0.131	0.265
MCV (fl)	111.39	111.40	107.76	112.28	0.000	0.059
MCH (pg)	35.83	37.92	35.05	37.92	0.873	0.656
MCHC (g/dl)	31.80^{b}	33.83^{a}	32.22^{ab}	33.33^{a}	0.433	0.044
Total protein (g/l)	4.28^{b}	4.22^{b}	5.17^{a}	4.42^{ab}	0.140	0.025
Albumin (g/l)	2.37	2.35	2.92	2.54	0.078	0.233
Globulin (g/l)	1.92	1.87	2.25	1.97	0.074	0.551
AST (µ/I)	31.33^{c}	47.00^{a}	43.17^{b}	30.83^{c}	1.458	0.001
ALT(*U*)	26.17	28.06	27.17	24.28	1.348	0.205
ALP(*U*)	24.83	25.67	23.83	27.17	1.152	0.583

^{abc} Means on the same rows having different superscript were significantly ($p<0.05$) different

PCV – Packed Cell Volume; RBC- Red Blood Cell; WBC- White Blood Cell; MCV- Mean Corpuscular Volume; MCH- Mean Corpuscular Heamoglobin; MCHC- Mean Corpuscular Haemoglobin Concentration AST- Aspartate Amino Transferase; ALT- Alanine Amino Transferase; ALP - Alkaline phosphatase

Interaction effects of soyabean heat treatments and mixing ratio of CSB on hematological indices and serum biochemistry of starting broiler chickens (4 weeks)

Table 7 shows the interaction effects of soyabean heat treatments and mixing ratio of CSB on hematological indices and serum biochemistry of broiler starting chickens. The packed cell volume, hemoglobin, monophil, total protein, globulin and aspartate amino transferase were significantly ($p<0.05$) affected by heat treatment and mixing ratio of CSB fed to starting broiler chickens. Similar values of packed cell volume were observed in birds fed diets containing wet heated soya beans at 50:50 (25.00 %) and 80:20 (24.25 %), also in birds fed CSB containing dry heated soya beans at 50:50 (19.00 %) and 80:20 (20.25 %) mixing ratio of CSB. Birds fed diets containing wet heated soya beans at 50:50 mixing ratio of CSB had the highest ($p<0.05$) value for hemoglobin (25.00 %) while those fed dry heated soya beans at 50:50 and 80:20 of CSB had the highest value for mesophil (0.50 %). The total protein values for birds fed dry heated soya beans at 50:50 and 80:20 of experimental diet had the least and similar values while those fed diets containing 80:20 and 50:50 wet heated soya beans of CSB also had similar value. The aspartate amino transferase values ranged from 30.75 *I.U* to 44 *I.U.* Birds fed diet containing dry heated soya beans at 50:50 mixing ratio of CSB had the highest (44.00 *I.U*) value for AST while those fed diets containing wet heated soya beans at 80:20 mixing ratio had the least (30.75 *I.U*).

Interaction effects of dehydration methods and mixing ratio of CSB on hematological indices and serum biochemistry of starting broiler chickens (4 weeks)

Table 8 shows the interaction effects of dehydration methods and mixing ratio of CSB on hematological indices and serum biochemistry of starting broiler chickens. The heterophil, eosinophil, basophil, MCH, Albumin, AST and ALP were significantly ($p<0.05$) affected by the interactions of dehydration methods and mixing ratio of CSB fed to starting broiler chickens. Birds fed diet containing sun dried experimental diet at 50:50 mixing ratio recorded the highest ($p<0.05$) value for heterophil (32.00 %), while those fed fried and sun dried CSB at 80:20 mixing ratio had similar values (34.00 % and 33.50 %). Eosinophil values for birds fed fried and sun dried CSB were similar for all the mixing ratios except for birds fed sun dried CSB at 60:40 (0.00%). Birds fed diets containing sun dried CSB had similar values for MCH at 50:50 (37.80 pg), 60:40 (38.85 pg) and 80:20 (37.10 pg) while those fed fried diets at 80:20 (37.10 pg) recorded the least value. The Albumin values for birds fed fried diet at 50:50 and 80:20 was similar (2.60 g/l), those fed sun dried at 60:40 (2.32 g/l) and 50:50 (2.35 g/l) were also similar. Birds fed fried and sun dried CSB at 50:50 and 60:40 respectively had similar values for AST (44.25 *I.U.* and 40.25 *I. U*) while those at 80:20 of fried and sun dried CSB also had similar values (33.00 *I. U* and 33.50 *I. U*). The ALP values of birds fed diet containing fried CSB at 50:50 (27.75 *I. U*) were similar with those fed diet containing sun dried CSB at 60:40 (26.00 *I. U*) and 80:20 (27.50 *I. U*).

Table 7: Interaction effects of soyabean heat treatments and mixing ratio of CSB on haematological indices and serum biochemistry of broiler starter chickens (4 weeks)

	Dry heated soyabean			Wet heated soyabean				
Parameters	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**SEM**	**p-value**
PCV (%)	19.00^{c}	21.75^{b}	20.25^{c}	25.00^{a}	20.75^{c}	24.25^{a}	1.366	0.000
Haemoglobin (g/dl)	6.25^{c}	7.13^{b}	6.55^{c}	8.10^{a}	7.08^{ab}	7.78^{b}	0.375	0.000
RBC (x 10^{12}/l)	1.70	1.93	1.85	2.20	1.88	2.30	0.115	0.474
WBC (x 10^{9}/l)	10.65	11.05	10.83	10.93	11.43	11.68	0.302	0.288
Heterophil (%)	33.25	31.50	31.20	35.25	33.70	36.25	3.449	0.277
Lymphocyte (%)	65.75	67.50	67.25	63.50	65.50	63.00	1.214	0.381
Eosinophil (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.588
Basophil (%)	0.50	0.00	0.50	0.50	0.25	0.25	0.170	0.455
Monophil (%)	0.50^{b}	1.00^{a}	0.50^{b}	0.25^{c}	0.25^{c}	0.50^{b}	0.226	0.033
MCV (fl)	111.76	112.69	109.45	113.64	110.37	105.43	0.000	0.771
MCH (pg)	36.88	37.25	36.13	36.88	37.88	34.70	1.511	0.091
MCHC (g/dl)	33.15	32.80	32.50	32.40	33.80	32.13	0.750	0.761
Total protein (g/l)	4.00^{c}	4.60^{ab}	4.15^{c}	5.03^{a}	4.38^{b}	4.98^{a}	0.171	0.013
Albumin (g/l)	2.20	2.63	2.25	2.72	2.45	3.03	0.095	0.480
Globulin (g/l)	1.80^{b}	1.98^{ab}	1.90	2.23^{a}	1.93^{ab}	2.18^{a}	0.128	0.023
AST (µ/I)	44.00^{a}	37.75^{bc}	35.75^{c}	40.50^{b}	39.75^{b}	30.75^{cd}	2.526	0.002
ALT(*I.U*)	25.25	26.83	29.25	28.17	24.50	24.50	2.336	0.156
ALP(*I.U*)	25.75	24.75	25.25	25.75	25.75	25.00	1.411	0.134

^{abc} *Means on the same rows having different superscript were significantly ($p<0.05$) different* PCV – Packed Cell Volume; RBC- Red Blood Cell; WBC- White Blood Cell; MCV- Mean Corpuscular Volume; MCH- Mean Corpuscular Heamoglobin; MCHC- Mean Corpuscular Haemoglobin Concentration AST- Aspartate Amino Transferase; ALT- Alanine Amino Transferase; ALP - Alkaline phosphatase

Table 8: Interaction effects of dehydration methods and mixing ratio of CSB on haemotological indices and serum biochemistry of broiler starter chickens (4 weeks)

	Fried CSB			Sun dried CSB				
Parameters	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**SEM**	**p-value**
PCV (%)	23.75	21.25	23.75	20.25	21.25	20.75	0.967	0.246
Haemoglobin (g/dl)	7.45	6.95	7.55	6.90	7.25	6.78	0.375	0.215
RBC (x 10^{12}/l)	2.08	1.93	2.28	1.83	1.88	1.88	0.166	0.281
WBC (x 10^{9}/l)	10.83	11.23	11.45	10.75	11.25	11.05	0.427	0.946
Heterophil (%)	36.50^{b}	32.00^{c}	34.00^{bc}	32.00^{a}	31.25^{c}	33.50^{bc}	4.878	0.011
Lymphocyte (%)	62.00	67.25	65.00	67.25	67.50	65.25	1.717	0.660
Eosinophil (%)	0.25^{a}	0.25^{a}	0.25^{a}	0.25^{a}	0.00^{b}	0.25^{a}	0.127	0.036
Basophil (%)	0.50^{a}	0.00^{c}	0.25^{b}	0.50^{a}	0.25^{b}	0.50^{a}	0.240	0.003
Monophil (%)	0.75	0.50	0.50	0.00	1.00	0.50	0.226	0.290
MCV (fl)	114.18	110.10	104.17	110.66	113.03	110.37	0.000	0.092
MCH (pg)	35.95^{b}	36.28^{ab}	33.73^{c}	37.80^{a}	38.85^{a}	37.10^{a}	1.511	0.031
MCHC (g/dl)	31.40	32.88	31.75	34.15	33.73	32.88	0.050	0.417
Total protein (g/l)	4.80	4.58	4.80	4.23	4.40	4.33	0.242	0.661
Albumin (g/l)	2.60^{ab}	2.73^{a}	2.60^{ab}	2.32^{b}	2.35^{b}	2.68^{a}	0.095	0.032
Globulin (g/l)	2.20	1.85	2.20	1.83	2.05	1.88	0.128	0.174
AST (µ/I)	44.25^{a}	34.50^{b}	33.00^{c}	40.25^{ab}	43.00^{a}	33.50^{c}	1.867	0.004
ALT(*I.U*)	25.75	24.50	22.75	25.75	26.00	27.50	2.335	0.657
ALP(*I.U*)	25.75^{a}	24.50^{ab}	22.75^{b}	22.75^{b}	26.00^{a}	27.50^{a}	1.995	0.004

^{abc} Means on the same rows having different superscript were significantly ($p<0.05$) different PCV – Packed Cell Volume; RBC- Red Blood Cell; WBC- White Blood Cell; MCV- Mean Corpuscular Volume; MCH- Mean Corpuscular Heamoglobin; MCHC- Mean Corpuscular Haemoglobin Concentration AST- Aspartate Amino Transferase; ALT- Alanine Amino Transferase; Alkaline phosphatase

Interaction effects of soyabean heat treatments, dehydration methods and mixing ratio of CSB on hematological indices and serum biochemistry of broiler starter chickens (4 weeks)

Table 9 shows the interaction effects of soyabean heat treatments, dehydration methods and mixing ratio of CSB on hematological indices and serum biochemistry of starting broiler chickens. The table recorded that PCV, WBC, Basophil, total protein, ALT, ALP, as well as MCH were significantly ($p<0.05$) affected. The PCV values of birds fed diets containing dry heated fried CSB at 50:50, 60:40, 80:20 and Dry heated, sun dried CSB at 60:40 was similar.

The WBC values of birds fed fried diets containing dry heated soya beans at 60:40, sun dried containing dry heated soya beans at 80:20 and sun-dried diets containing wet heated soya beans at 50:50, 60:40 and 80:20 was similar and recorded higher values. The total protein values of birds fed sun dried CSB containing dry heated soya beans at 50:50 and 80:20 represents the highest and were similar while those fed fried diets containing dry heated and wet heated soya beans, sun dried CSB containing wet heated soya beans at 80:20, 80:20 and 60:40 mixing ratios respectively were similar and represents the least.

Birds fed fried CSB containing wet heated soya beans at 50:50, 60:40 and sun dried CSB diet containing dry heated soya beans at 50:50 recorded similar ALT values and represents the highest while those fed fried CSB containing dry heated soya beans at 50:50 had the least values. Birds fed fried and sun dried CSB containing dry heated soya beans at 50:50 and 60:40 mixing ratios however, recorded similar ALT values which represents the highest ($p<0.05$) value while those fed sun dried CSB containing dry heated soya beans recorded the least ($p<0.05$) value.

Main effects of soyabean heat treatments, dehydration methods and mixing ratio of CSB on hematological indices and serum biochemistry of broiler finisher chickens (8 weeks)

Table 10 shows the main effects of soyabean heat treatments, dehydration methods and mixing ratio of CSB on hematological indices and serum biochemistry of finishing broiler chickens. PCV, hemoglobin, RBC, basophil, MCV, total protein, albumin and globulin were significantly ($p<0.05$) affected by heat treatment of soyabean fed to finishing broilers. Birds fed diets containing dry heated soya beans recorded higher ($p<0.05$) values of PCV, Hemoglobin, RBC, Basophil, Total protein and globulin when compared to birds fed diets containing wet heated soyabeans. However, birds fed diet containing wet heated soya beans had higher values of MCV and Albumin when compared to those fed dry heated soya beans.

It was shown by the table that the dehydration methods of CSB fed to the finishing broiler chickens significantly ($p<0.05$) affected the PCV, RBC, lymphocyte, MCV, MCH, MCHC, Total protein, Albumin and globulin of the birds. Birds fed diets containing fried CSB recorded higher values of PCV, RBC, Lymphocyte, MCH and globulin while birds fed diets containing sundried CSB recorded higher values of Albumin, total protein, MCHC and MCV. The mixing ratio of CSB significantly ($p<0.05$) affected PCV, heterophil, lymphocyte, basophil, monophil, MCHC, AST as well as ALT.

Birds fed diets at 50:50 mixing ratio of CSB recorded the highest values for hemoglobin, RBC and albumin. The PCV values for birds fed diets at 50:50 and 60:40 mixing ratio of CSB were similar. Birds fed at 60:40 mixing ratio of CSB recorded the least value for heterophil while those fed at 80:20 had the highest value. The Basophil values for birds fed at 60:40 mixing ratio recorded the highest while those fed at 80:20 had the least. MCHC values for birds fed diets at 50:50 and 60:40 mixing ratio were similar. Birds fed at 80:20 mixing ratio of experimental diet had the least value for AST while those fed at 60:40 recorded the highest value. The ALT values ranged from 24.25 *U* to 28.13 *U*, and birds fed diets at 50:50 and 80:20 mixing ratios of CSB were similar in values recorded for ALT.

Interaction effects of soyabean heat treatments and dehydration methods of CSB on hematological indices and serum biochemistry of finishing broiler chickens (8 weeks)

Table 11 shows the interaction effects of soyabean heat treatments and dehydration methods of CSB on hematological indices and serum biochemistry of finishing broiler chickens. The total protein, AST and Albumin were significantly ($p<0.05$) affected by the interaction of heat treatments and dehydration methods of CSB fed to finishing broilers. Birds fed fried CSB containing dry heated soya beans and those fed sun dried diet containing wet heated soyabeans had the same values for total protein (4.93 g/l) and represented the highest value. The albumin values for birds fed diets containing dry heated soya beans in fried and sun dried CSB were similar (2.77 g/l and 2.78 g/l) while those fed wet heated soya beans in sun dried CSB (3.07 g/l) recorded the highest value. The AST values for birds fed wet heated soya beans in fried and sun dried CSB were similar (48.33 *U* and 48.17 *U*) while those fed dry heated soya beans in sun dried diet (65.33 *U*) recorded the highest value.

Interaction effects of soyabean heat treatments and mixing ratio of CSB on hematological indices and serum biochemistry of finishing broiler chickens (8 weeks)

Table 12 shows the Interaction effects of soyabean heat treatments and mixing ratio of CSB on hematological indices and serum biochemistry of finishing broiler chickens. The hemoglobin RBC, eosinophil, monophil, total protein, albumin and globulin were significantly ($p<0.05$) affected by the interactions of heat treatment of soyabeans and mixing ratios of CSB fed to finishing broiler chickens. The hemoglobin values of birds fed diets containing dry heated soya beans at 50:50 (8.15 g/dl) and 60:40 (7.78 g/dl) mixing ratio of CSB were similar while those fed diets containing dry heated and wet heated soya beans at 80:20 (6.93 g/dl) mixing ratio of CSB recorded the least value.

Eosinophil values for birds fed diet containing dry heated and wet heated soya beans at 50:50 and 60:40 of CSB respectively were similar while those fed dry heated soya beans at 80:20 (0.50%) recorded the highest ($p<0.05$) and those fed wet heated soya beans at 50:50 (0.00%) had the least value. The total protein values of birds fed diets containing dry heated soya beans at 80:20 (5.08 g/l) and wet heated soya beans at 50:50 (5.00 g/dl) mixing ratio of CSB were the highest and were also similar, while those fed wet heated soya beans at 60:40 (4.60 g/l) of CSB recorded the least value. Albumin values for birds fed wet heated soya beans at 50:50 (3.05 g/l) and 60:40 (2.93 g/l) CSB were similar. Those fed wet heated and dry heated soya beans at 80:20 was also similar while those fed dry heated soya beans at 60:40 recorded the least.

Birds fed wet heated soya beans at 50:50 and 60:40 experimental diet were similar for albumin. Those fed wet heated and dry heated soya beans at 80:20 (2.83 g/l and 280 g/l) were also similar while those fed dry heated soya beans at 60:40 (2.73 g/l) recorded the least ($p<0.05$). The globulin values ranged from 1.68 g/l to 2.25 g/l.

Table 9: Interaction effects of soyabean heat treatments, dehydration methods and mixing ratio of CSB on haemotological indices and serum biochemistry of broiler starter chickens (4 weeks)

	Fried CSB						Sun dried CSB							
	Dry heated soyabean			Wet heated soyabean			Dry heated soyabean			Wet heated soyabean				
Parameters	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**SEM**	**p-value**
PCV (%)	21.00^{bc}	21.00^{bc}	20.50^{bc}	17.00^{c}	22.50^{b}	20.00	26.50^{a}	21.50^{bc}	27.00^{a}	23.50^{b}	20.00^{bc}	21.50^{bc}	0.521	0.039
Haemoglobin (g/dl)	6.70	6.75	6.35	5.80	7.50	6.75	8.20	7.15	8.75	8.00	7.00	6.80	0.159	0.249
RBC (X 10^{12}/L)	1.85	1.90	1.85	1.55	1.95	1.85	2.30	1.95	2.70	2.10	1.80	1.90	0.058	0.404
WBC (X 10^{9}/L)	10.90^{b}	11.55^{a}	10.80^{b}	10.40^{c}	10.55^{bc}	10.85^{b}	10.75^{bc}	10.90^{b}	12.10^{a}	11.10^{a}	11.95^{a}	11.25^{a}	0.128	0.001
Heterophil (%)	33.50	34.00	31.50	33.50	29.00	31.00	40.00	30.00	36.50	30.50	33.50	36.00	1.515	0.427
Lymphocyte (%)	65.50	65.00	67.00	67.33	69.50	67.50	58.50	69.50	63.00	68.50	65.50	63.00	0.661	0.327
Eosinophil (%)	0.00	0.00	0.50	0.00	0.00	0.50	0.50	0.50	0.00	0.50	0.00	0.00	0.057	0.588
Basophil (%)	0.50^{a}	0.00^{b}	0.50^{a}	0.50^{a}	0.00^{b}	0.50^{a}	0.50^{a}	0.00^{b}	0.00^{b}	0.50^{a}	0.50^{a}	0.50^{a}	0.066	0.009
Monophil (%)	1.00	1.00	0.50	0.00	1.50	0.50	0.50	0.00	0.50	0.00	0.50	0.50	0.085	0.290
Total protein (g/l)	4.30^{bc}	4.45^{b}	4.01^{c}	3.70^{d}	4.75^{ab}	4.20^{c}	5.30^{a}	4.70^{ab}	5.50^{a}	5.58^{a}	4.05^{c}	4.45^{b}	0.100	0.001
Albumin (g/l)	2.25	2.70	2.15	2.15	2.55	2.35	2.95	2.75	3.05	3.48	2.15	3.00	0.066	0.058
Globulin (g/l)	2.05	1.75	1.95	1.55	2.20	1.85	2.35	1.95	2.45	2.10	1.90	1.90	0.046	0.115
AST(*I.U*)	38.50	27.00	28.50	28.00	26.17	30.00	29.00	26.50	26.00	27.33	22.50	23.00	1.494	0.165
ALT(*I.U*)	22.50^{e}	27.50^{cd}	28.50^{cd}	49.50^{a}	48.50^{a}	43.00^{b}	50.00^{a}	42.00^{b}	37.50^{bc}	31.00^{c}	37.50^{bc}	24.00^{d}	0.657	0.005
ALP(*I.U*)	28.50^{a}	22.50^{c}	23.50^{c}	23.00^{c}	27.00^{ab}	27.00^{ab}	23.00^{ab}	26.50^{b}	26.00^{b}	27.33^{ab}	22.50^{c}	23.00^{c}	0.633	0.041
MCV (fl)	113.50	110.50	111.00	109.00	115.50	110.5	126.00	109.0	101.5	126.00	109.00	101.5	1.290	0.301
MCH (pg)	36.25^{b}	35.95^{b}	34.55^{bc}	37.50^{ab}	38.55^{a}	37.70^{ab}	35.65^{b}	36.60^{b}	32.90^{c}	38.10^{a}	39.15^{a}	36.50^{b}	0.439	0.045
MCHC(g/dl)	31.95	32.35	31.10	34.35	33.25	33.90	30.85	33.40	32.40	33.95	34.20	31.85	0.252	0.920

^{abdc} Means on the same rows having different superscript were significantly ($p<0.05$) different PCV – Packed Cell Volume; RBC- Red Blood Cell; WBC- White Blood Cell; MCV- Mean Corpuscular Volume; MCH- Mean Corpuscular Heamoglobin; MCHC- Mean Corpuscular Haemoglobin Concentration AST- Aspartate Amino Transferase; ALT- Alanine Amino Transferase; ALP - Alkaline phosphatase

Table 10: Main effects of soyabean heat treatments, dehydration methods and mixing ratio of CSB on haematological indices and serum biochemistry of broiler finisher chickens (8 weeks)

Parameters	Soyabean heat treatments				Dehydration methods of CSB				Mixing ratios of CSB				
	Dry heated	Wet heated	SEM	p-value	Fried	Sun dried	SEM	p-value	50:50	60:40	80:20	SEM	P.Value
PCV (%)	26.00^{a}	23.75^{b}	1.013	0.001	24.92^{a}	24.83^{b}	0.413	0.011	25.25^{a}	25.88^{a}	23.50^{b}	0.506	0.567
Haemoglobin (g/dl)	8.21^{a}	7.70^{ab}	0.329	0.000	7.97	7.94	0.134	0.127	8.13^{a}	7.93^{b}	7.81^{b}	0.165	0.955
RBC (x 10^{12}/l)	3.41^{a}	2.03^{b}	1.796	0.004	3.28^{a}	2.15^{b}	0.733	0.019	3.83^{a}	2.21^{b}	2.10^{b}	0.898	0.307
WBC (x 10^{9}/l)	11.89	11.60	0.429	0.053	11.54	11.95	0.429	0.548	11.63^{b}	12.09^{a}	11.53^{b}	0.214	0.236
Heterophil (%)	34.17	34.42	2.266	0.807	34.26	34.12	0.925	0.619	33.12^{b}	30.62^{c}	38.25^{a}	1.133	0.098
Lymphocyte (%)	64.75	64.74	5.928	0.007	64.75^{a}	64.86^{b}	2.420	0.016	66.00^{b}	68.50^{a}	56.85^{c}	2.964	0.145
Eosinophil (%)	0.33	0.17	0.196	0.427	0.33	0.27	0.080	0.427	0.13^{c}	0.25^{b}	0.38^{a}	0.196	0.530
Basophil (%)	0.25^{a}	0.17^{b}	0.160	0.001	0.08	0.33	0.065	0.240	0.25^{b}	0.38^{a}	0.00^{c}	0.082	0.099
Monophil (%)	0.50	0.50	0.253	0.400	0.58	0.42	0.103	0.529	0.50^{b}	0.25^{c}	0.75^{a}	0.129	0.076
MCV (fl)	76.24^{b}	116.29^{a}	12.153	0.718	75.98^{b}	114.49^{a}	2.706	0.004	115.93^{b}	117.104^{a}	111.90^{c}	2.706	0.130
MCH (pg)	35.19	37.43	1.710	0.762	36.71^{a}	35.91^{b}	0.698	0.006	35.12^{c}	36.10^{b}	37.71^{a}	0.698	0.141
MCHC (g/dl)	32.13	32.33	1.186	0.924	32.01^{b}	32.46^{a}	0.484	0.001	31.83^{b}	30.63^{c}	34.25^{a}	0.484	0.196
Total protein (g/l)	4.89^{a}	4.79^{b}	0.133	0.001	4.79^{b}	4.89^{a}	0.054	0.007	4.88^{ab}	4.73^{b}	4.93^{a}	0.063	0.906
Albumin (g/l)	2.81^{b}	2.93^{a}	0.142	0.000	2.78^{b}	2.96^{a}	0.058	0.019	2.96^{a}	2.83^{ab}	2.81^{ab}	0.071	0.189
Globulin (g/l)	2.13^{a}	1.88^{b}	0.167	0.007	2.02^{a}	1.99^{b}	0.068	0.033	1.94^{b}	1.96^{b}	2.11^{a}	0.084	0.616
AST (µ/I)	45.42	55.75	6.049	0.510	53.92	47.25	2.469	0.611	49.25^{b}	56.00^{a}	46.50^{c}	3.024	0.092
ALT(*I.U*)	24.00	27.42	2.109	0.313	26.17	25.25	0.861	0.714	24.75^{b}	28.13^{a}	24.25^{b}	1.009	0.733
ALP(*I.U*)	24.92	24.50	1.819	0.830	27.50	21.92	0.742	0.082	24.75^{b}	25.88^{a}	23.50^{c}	0.909	0.896

^{abcd} Means on the same rows having different superscript were significantly ($p<0.05$) different PCV – Packed Cell Volume; RBC- Red Blood Cell; WBC- White Blood Cell; MCV- Mean Corpuscular Volume; MCH- Mean Corpuscular Haemoglobin; MCHC- Mean Corpuscular Haemoglobin Concentration AST- Aspartate Amino Transferase; ALT- Alanine Amino Transferase; ALP - Alkaline phosphatase

Table 11: Interaction effects of soyabean heat treatments and dehydration methods of CSB on haemotological indices and serum biochemistry of broiler finisher chickens (8 weeks)

	Fried		Sun dried			
Parameters	**Dry heated**	**Wet heated**	**Dry heated**	**Wet heated**	**SEM**	**p-value**
PCV (%)	25.33	26.67	24.50	23.00	0.585	0.151
Haemoglobin (g/dl)	7.90	8.52	8.03	7.37	0.190	0.060
RBC (x 10^{12}/l)	4.38	2.43	2.18	1.87	1.037	0.121
WBC (x 10^{9}/l)	11.47	12.32	11.62	11.58	0.248	0.188
Heterophil (%)	32.67	34.18	35.67	31.50	1.308	0.214
Lymphocyte (%)	65.84	64.83	63.50	60.80	3.423	0.580
Eosinophil (%)	0.33	0.33	0.33	0.00	0.113	0.427
Basophil (%)	0.17	0.33	0.00	0.33	0.092	0.240
Monophil (%)	0.67	0.33	0.50	0.50	0.146	0.529
MCV (fl)	117.83	109.75	112.38	122.99	0.000	0.885
MCH (pg)	35.37	35.02	38.05	36.81	0.988	0.762
MCHC (g/dl)	31.18	33.08	32.83	31.83	0.685	0.300
Total protein (g/l)	4.93^{a}	4.85^{ab}	4.65^{b}	4.93^{a}	0.077	0.022
Albumin (g/l)	2.77^{c}	2.85^{b}	2.78^{c}	3.07^{a}	0.082	0.031
Globulin (g/l)	2.17	2.08	1.87	1.90	0.097	0.127
AST (I.U)	42.50^{b}	48.33^{ab}	65.33^{a}	48.17^{ab}	3.492	0.000
ALT(*I.U*)	23.67	24.33	28.67	26.17	1.298	0.088
ALP(*I.U*)	28.00	21.83	27.00	22.00	1.050	0.288

^{abc} Means on the same rows having different superscript were significantly ($p<0.05$) different

PCV – Packed Cell Volume; RBC- Red Blood Cell; WBC- White Blood Cell; MCV- Mean Corpuscular Volume; MCH- Mean Corpuscular Heamoglobin; MCHC- Mean Corpuscular Haemoglobin Concentration AST- Aspartate Amino Transferase; ALT- Alanine Amino Transferase; ALP - Alkaline phosphatase

Table 12: Interaction effects of soyabean heat treatments and mixing ratio of CSB on haemotological indices and serum biochemistry of finishing broiler chickens (8 weeks)

	Dry heated			Wet heated				
Parameters	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**SEM**	**p-value**
PCV (%)	24.75	26.50	26.75	25.75	25.25	20.25	1.013	0.404
Haemoglobin (g/dl)	7.78^{b}	8.15^{b}	8.70^{a}	8.48^{ab}	7.70^{bc}	6.93^{c}	0.329	0.005
RBC (x 10^{12}/l)	5.43^{a}	2.33^{c}	2.48^{b}	2.25^{c}	2.10^{cd}	1.73^{d}	1.796	0.044
WBC (x 10^{9}/l)	12.00	11.98	11.70	11.25	12.20	11.35	0.303	0.601
Heterophil (%)	30.50	30.25	37.25	35.25	29.00	35.25	2.266	0.157
Lymphocyte (%)	68.00	67.00	61.25	64.00	70.00	63.75	4.192	0.140
Eosinophil (%)	0.25^{b}	0.25^{b}	0.50^{a}	0.00^{c}	0.25^{b}	0.25^{b}	0.196	0.001
Basophil (%)	0.25	0.50	0.00	0.25	0.25	0.25	0.164	0.353
Monophil (%)	0.50^{b}	0.00^{c}	1.00^{a}	0.50^{b}	0.50^{b}	0.50^{b}	0.179	0.012
MCV (fl)	114.34	113.73	107.36	114.22	120.00	116.57	0.000	0.121
MCH (pg)	35.35	35.05	35.18	34.88	37.16	40.25	1.209	0.622
MCHC (g/dl)	31.38	30.78	34.24	32.28	30.48	34.25	0.838	0.240
Total protein (g/l)	4.75^{b}	4.85^{ab}	5.08^{a}	5.00^{a}	4.60^{c}	4.78^{b}	0.133	0.002
Albumin (g/l)	2.88^{ab}	2.73^{c}	2.83^{b}	3.05^{a}	2.93^{a}	2.80^{b}	0.100	0.000
Globulin (g/l)	1.88^{ab}	2.25^{a}	2.25^{a}	2.20^{ab}	1.68^{b}	1.98^{ab}	0.118	0.042
AST (I.U)	53.00	49.75	33.50	45.50	62.50	59.50	4.287	0.654
ALT(*I.U*)	23.50	24.75	23.75	26.00	31.50	24.75	1.491	0.078
ALP(*I.U*)	26.25	26.00	22.50	23.25	25.75	24.50	1.286	0.896

^{abc} *Means on the same rows having different superscript were significantly ($p<0.05$) different* PCV – Packed Cell Volume; RBC- Red Blood Cell; WBC- White Blood Cell; MCV- Mean Corpuscular Volume; MCH- Mean Corpuscular Heamoglobin; MCHC- Mean Corpuscular Haemoglobin Concentration AST- Aspartate Amino Transferase; ALT- Alanine Amino Transferase; Alkaline phosphatase

Interaction effects of dehydration methods and mixing ratio of CSB on hematological indices and serum biochemistry of finishing broiler chickens (8 weeks)

Table 13 shows the interaction effects of dehydration methods and mixing ratio of CSB on hematological indices and serum biochemistry of finishing broiler chickens. The lymphocyte, monophil, MCV and globulin were significantly ($p<0.05$) affected by the interactions of dehydration methods and mixing ratio of CSB fed to finishing broilers. Birds fed diets containing fried CSB at 60:40 had the highest value for lymphocyte while those fed fried diet at 80:20 had the least. Also, those fed sun dried diets at 50:50 and 60:40 had similar values (67.25 % and 66.00 %). The monophil values for birds fed fried diets at 50:50 and 80:20 and sun dried at 80:20 was similar. The MCV values for birds fed diet containing fried CSB at 60:40 and 80:20 and those fed sun dried at 50:50 was similar, while those fed sun-dried diet at 60:40 recorded the highest and those fed fried diet at 50:50 recorded the least. The globulin values for birds fed fried CSB at 60:40 and 80:20, and those fed sun dried at 50:50 and 80:20 was similar.

Interaction effects of soyabean heat treatments, dehydration methods and mixing ratio of CSB on hematological indices and serum biochemistry of finishing broiler chickens (8 weeks)

Table 14 shows the interaction effects of soyabean heat treatments, dehydration methods and mixing ratio of CSB on hematological indices and serum biochemistry of finishing broiler chickens. The hemoglobin, heterophil, lymphocyte and ALP were significantly ($p<0.05$) affected by the interactions of soyabean heat treatments, dehydration methods and mixing ratio of CSB fed to the birds. The hemoglobin values of birds fed diets containing wet heated soya beans in fried CSB at 80:20 (9.25 g/dl) and those fed dry heated soya beans in sun dried CSB at 50:50 was similar and represents the highest value. The heterophil values of birds fed sun dried CSB containing dry heated soya beans at 80:20 mixing ratio was the highest (40.50 %) while those fed fried diet containing dry heated soya beans recorded the least (27.50 %). The lymphocyte values of birds fed fried CSB containing dry heated soya beans at 60:40 and those fed sun dried CSB containing wet heated soya beans were similar and represent the highest.

Table 13: Interaction effects of dehydration methods and mixing ratio of CSB on haematological indices and serum biochemistry of broiler finisher chickens (8 weeks)

	Fried			Sun dried				
Parameters	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**SEM**	**p-value**
PCV (%)	26.00	25.00	23.25	24.50	26.50	23.75	0.865	0.167
Haemoglobin (g/dl)	8.38	7.78	7.75	7.88	8.08	7.88	0.446	0.122
RBC (x 10^{12}/l)	5.60	2.23	2.03	2.08	2.20	2.18	1.270	0.325
WBC (x 10^{9}/l)	11.48	11.88	11.28	11.78	12.30	11.78	0.433	0.764
Heterophil (%)	34.00	28.50	40.00	32.00	33.00	34.00	1.666	0.597
Lymphocyte (%)	65.00^{b}	70.75^{a}	58.75^{c}	67.25^{ab}	66.00^{ab}	65.00^{b}	4.928	0.007
Eosinophil (%)	0.00	0.50	0.50	0.25	0.00	0.25	0.135	0.530
Basophil (%)	0.25	0.00	0.00	0.25	0.75	0.00	0.115	0.700
Monophil (%)	0.75^{a}	0.25^{b}	0.75^{a}	0.25^{b}	0.25^{b}	0.75^{a}	0.169	0.002
MCV (fl)	46.43^{c}	112.11^{ab}	114.53^{ab}	117.78^{ab}	120.45^{a}	108.94^{b}	0.000	0.022
MCH (pg)	35.28	34.93	39.93	34.96	37.28	35.50	1.709	0.777
MCHC (g/dl)	32.13	30.48	33.43	31.53	30.78	35.07	0.838	0.174
Total protein (g/l)	4.85	4.70	4.83	4.90	4.75	5.03	0.134	0.487
Albumin (g/l)	3.03	2.70	2.60	2.90	2.95	3.03	0.140	0.061
Globulin (g/l)	1.83^{b}	2.00^{a}	2.23^{a}	2.05^{a}	1.93^{b}	2.00^{a}	0.118	0.006
AST (µ/I)	59.25	50.50	52.00	39.25	61.50	41.00	4.249	0.297
ALT(*I.U*)	26.00	28.25	24.25	23.50	28.00	24.25	2.491	0.392
ALP(*I.U*)	30.25	27.00	25.25	19.25	24.75	21.75	1.869	0.240

^{abc} *Means on the same rows having different superscript were significantly ($p<0.05$) different* PCV – Packed Cell Volume; RBC- Red Blood Cell; WBC- White Blood Cell; MCV- Mean Corpuscular Volume; MCH- Mean Corpuscular Heamoglobin; MCHC- Mean Corpuscular Haemoglobin Concentration; AST- Aspartate Amino Transferase; ALT- Alanine Amino Transferase; ALP - Alkaline phosphatase

Table 14: Interaction effects of soyabean heat treatments, dehydration methods and mixing ratio of CSB on haematological indices and serum biochemistry of broiler finisher chickens (8 weeks)

	Fried CSB						Sun dried CSB							
	Dry heated Soyabean			Wet heated Soyabean			Dry heated Soyabean			Wet heated Soyabean				
Parameters	**50:50**	**60:40**	**80:20**	**50:00**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**50:50**	**60:40**	**80:20**	**SEM**	**p-value**
PCV (%)	24.50	26.50	25.00	25.00	26.50	28.50	27.50	24.50	21.50	24.00	26.00	19.00	0.450	0.303
Hb (g/dl)	7.56^{b}	7.90^{ab}	8.15^{ab}	7.90^{ab}	8.40^{ab}	9.25^{a}	9.10^{a}	7.65^{b}	7.35^{bc}	7.85^{ab}	7.75^{ab}	6.50^{c}	0.136	0.028
RBC (X 10^{12}/L)	2.60	2.25	2.30	2.25	2.40	2.65	2.60	2.20	1.75	1.90	2.00	1.70	0.498	0.156
WBC (X 10^{9}/L)	11.60	10.90	11.90	12.40	13.05	11.50	11.35	12.85	10.65	11.15	11.55	12.05	0.157	0.066
Heterophil (%)	31.50^{cd}	27.50^{e}	39.00^{b}	30.00^{cd}	$32..50^{c}$	35.50^{bc}	36.50^{bc}	29.50^{d}	40.50^{a}	33.50^{c}	28.50^{d}	32.00^{c}	0.962	0.024
Lymphocyte (%)	66.50^{b}	72.00^{a}	59.50^{c}	69.50^{ab}	66.50^{bc}	63.00^{bc}	63.00^{bc}	69.00^{ab}	58.00^{d}	66.00^{b}	70.00^{a}	67.50^{b}	1.742	0.039
Eosinophil (%)	0.50	0.50	0.50	0.50	0.00	0.50	0.00	0.50	0.50	0.00	0.00	0.00	0.060	0.530
Basophil (%)	0.50	0.00	0.00	0.00	1.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.063	0.700
Monophil (%)	1.00	0.00	1.00	0.00	0.00	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.083	0.670
MCV(fl)	114.23	117.77	108.69	111.11	110.42	107.55	105.77	111.36	122.86	126.32	130.05	111.75	0.000	0.146
MCH (pg)	35.55	35.10	35.45	35.15	35.00	34.90	35.00	34.75	44.40	34.77	39.57	36.10	0.587	0.958
MCHC (g/dl)	31.15	29.80	32.60	31.60	31.75	35.88	33.10	31.15	34.25	31.45	29.80	34.25	0.401	0.150
Total protein (g/l)	4.75	5.15	4.25	4.75	4.55	5.25	4.95	4.90	4.75	5.25	4.95	4.80	0.053	0.191
Albumin (g/l)	2.85	2.80	2.65	2.90	2.65	3.00	3.20	2.60	2.55	2.90	3.25	3.05	0.049	0.821
Globulin (g/l)	1.90	2.35	2.25	1.85	2.15	2.25	1.75	1.65	2.20	2.25	1.70	1.75	0.055	0.088
AST(*I.U*)	53.50	36.50	37.50	52.50	63.00	29.50	65.00	64.50	66.50	26.00	60.00	52.50	2.580	0.969
ALT(*I.U*)	21.50	27.00	22.50	22.50	22.50	22.50	30.50	29.50	26.00	21.50	33.50	23.50	0.755	0.792
ALP(*I.U*)	33.50^{a}	25.50^{bc}	25.00^{bc}	19.00^{d}	26.50^{b}	20.00	27.00^{b}	28.50^{ab}	25.50^{bc}	19.50^{d}	23.00^{c}	23.50^{c}	0.748	0.020

^{abc} *Means on the same rows having different superscript were significantly ($p<0.05$) different* PCV – Packed Cell Volume; RBC- Red Blood Cell; WBC- White Blood Cell; MCV- Mean Corpuscular Volume; MCH- Mean Corpuscular Heamoglobin; MCHC- Mean Corpuscular Haemoglobin Concentration AST- Aspartate Amino Transferase; ALT- Alanine Amino Transferase; Alkaline phosphatase

DISCUSSION

Packed Cell Volume (PCV) value was significantly influenced by heat treatment, dehydration methods and mixing ratio while red blood cells (RBC) and white blood cell (WBC) counts were not affected. Dietary treatments had no influence on heterophil, lymphocyte and monophil. The hemoglobin levels of birds fed sun dried CSB containing dry heated soya beans at 50:50 ratio was the highest. Broiler chicks fed sun dried diet containing dry heated soya beans at 80:20 showed the highest PCV, WBC and albumin values. Inclusion of fried and sun dried CSB diets in chicks had no deleterious effect on the health of the birds; thus, an indication that the diets were adequate for starter broilers.

At the finisher phase, the hemoglobin level of birds fed fried diets tends to improve as the proportion of cassava included increases. This is indicative of prospects for good health status of the birds. Hemoglobin is known to be positively correlated with protein quality and protein level. Hemoglobin measures the ability of an animal to withstand some level of respiratory stress (Sainsbury,1983). The interaction effect of dietary treatments revealed that the PCV, hemoglobin (Hb), RBC as well as WBC did not follow a particular trend at both the starting and finisher phases. This does not agree with the findings of Tewe and Egbunike, (1992); Adeyemo and Sanni, (2013) who reported significant increase in the values of PCV, Hb, RBC and WBC as the level of cassava peels increased in the diets. PCV, RBC and hemoglobin are known to be positively correlated with protein quality and protein level in the diet (Adeyemi *et al*., 2008). As regards the corpuscular values (MCV, MCH and MCHC), all values obtained were not significantly affected at the starter and finisher phases. This conforms to the results of Egbunike *et al*. (2009). Adeyemi and Sanni (2013) reported a significant increase in the corpuscular values as the amount of cassava peels replacement with maize increased. However, the PCV, Hb, RBC, MCV, MCH and MCHC fell within the normal values reported in literatures (Post *et al*., 2007; Muhammad and Oloyede, 2009). The interaction of the treatments used at the finisher phase did not have any influence on the MCV, MCH and MCHC indicating that the diets were ideal or adequate for broiler finishers and also suggests that the diets promoted a better hematological *milieu* as observed in rats by Adejumo (2004).

Significant variations existed in the total serum protein values obtained in this study. Birds fed CSB containing the least crude protein value had the least serum protein value while those fed CSB containing the highest crude protein value had a corresponding higher serum protein value. Total serum protein has been reported as an indication of the protein retained in the animal body (Akinola and Abiola, 1991) while total blood protein and creatinine contents have been shown to depend on the quality and quantity of the dietary protein (Iyayi and Tewe,1998; Esonu *et al*., 2001). The adequacy of the diets is also shown by the stability of the serum protein, globulin and albumin values of the birds regardless of the soya beans treatment and inclusion level. The lowered eosinophil concentration noticed in the experimental birds irrespective of the heat treatments used could be an indication of health hazard. This could be due to infectious inflammatory conditions, stress condition or conditions induced by hydrocyanide (HCN) or tannin residues (Brig *et al.*, 1977).

Reduced immunity occurs in farm animals in a bid to fight against foreign bodies introduced such as bacteria and viruses. The marker enzymes AST and ALT differed significantly as the level of cassava inclusion varied in the feed. Birds fed fried diets containing wet heated soya beans at 80:20 recorded the least value for AST. Reduced AST obtained with broilers fed with this diet is indicative of absence of damages in liver and myocardial tissues (Monica, 1987). Ekpenyoung and Biobaku (1986) confirmed that AST are normally low in blood but become

high when the plane of nutrition is low or when there is occurrence of liver damage.

CONCLUSION

Measuring blood profiles can act as pathological indicators of response of chickens to toxic substance exposure as well as organ function. It has been widely reported that birds with good (normal) blood profile values are likely to show good performance. Replacing maize with 15% fried CSB blend with dry heated soyabean mixed at ratio 50:50 yielded increased normal values of liver enzymes and crude protein digestibility. It can thus be concluded that although all treatments recorded good values for blood profile, the mixing ratio 50:50 and dry heat treatment turned out best in this current research**.**

CONFLICT OF INTEREST

None of the authors has any financial or personal relationships that could inappropriately influence or bias the content of the paper.

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