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HEAMATOLOGICAL AND SERUM CHEMISTRY OF BROILERS FED DIFFERENTLY PROCESSED SORGHUM SPENT GRAIN

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ABSTRACT

Sorghum spent grain (SSG) commonly called Dussa collected locally from bear (burukutu) production center was divided into three portions to evaluate the effect of stacking on the blood profile of broiler chickens. First portion was sundried fresh to obtain fresh SSG (FSSG), second portion was sundried after stacking for 48 hours to obtain STK48 and the third portion was sundried after stacking for 72 hours to obtain STK72. 140 one-day-old Arbor Acre strain of broilers were used to evaluate the effect of feeding the differently processed sorghum spent grain (SSG) on growth performance and blood biochemistry. Each diet consists of two levels (i.e. 15 and 30% inclusion levels). Seven experimental diets were formulated and the birds were randomly assigned to the seven dietary treatments. The treatments were replicated four times with five birds per replicate in a completely randomized design (CRD) experiment in a 3x2 factorial arrangement. Except monocytes the other haematological parameters were not significant ($P>0.05$) affected while serum cholesterol, urea and creatinine were significantly ($P<0.05$) affected by the processing methods. 15% inclusion levels of SSG had the highest final weigh gain and there was no significant ($P>0.05$) effect on serum enzymes measured except AST. It could be concluded that fresh SSG at 15% inclusion holds good potential for broiler chicken production and fresh SSG should not be kept for more than 48 hours for better utilization and to maintain the normal physiological status of broiler chicken.

KEYWORDS

Stacking, Sorghum, Haematological parameters and Serum parameters.

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INTRODUCTION

Poultry meat and egg production have shown a considerable increase worldwide since 1970[1], and research has shown that poultry meat industry has been more dynamic than the egg industry over the years[2]. The two major factors for a successful and economically broiler production are their fast growth rate and efficient feed conversion, and feeds represents between 60-80% of the total cost of production out of which maize occupies the highest percentage and it thus appear there is currently no globally acceptable alternative to it in terms of energy supply[3]. Over the years, the bulk of research work has centered on how to reduce cost of animal protein through the use of non-conventional feed resources in order to make animal protein available to the populace. This animal protein is essential in human nutrition due to its balance amino acid profile and ease of utilization[4]. This can be achieved through efficient management that ensures effective disease prevention and control coupled with the availability of high quality feed fed *ad libitum*[5].

Blood is very vital to life and before any meaningful work can be done on the biology of birds, the blood must be studied in details[6]. Haematological profiles both in humans and in animal species is an important index of the physiological state of the individual. The ability to interpret the state of blood profile in normal and in diseased condition is among its primary tasks[7], this is because the blood transports nutrient and materials to different parts of the entire body system. Therefore, whatever affects blood, either drug, pathogenic organism, nutrition or management practices will affect the entire body systems in terms of health, growth, maintenance and production[8]. Variation in haematological and serum parameters are the best factors to examine the health status of organisms and deviation from the referenced values tells about the effect of either feed or managerial technique employed on the animals. It is necessary to properly determine blood characteristics for exotic birds exposed to non-convectional feed ingredients to determine their growth performance and blood chemistry.

Sorghum (*Sorghum bicolor* (L) moench), locally called guinea-corn, is one of the most extensively grown cereal grain in Nigeria[9] this is because the crop is environmentally friendly, water efficient and it requires little or no fertilizer or pesticides for its cultivation[10]. In the savannah and the semi-arid regions of Nigeria, millions of people consume sorghum as staple foods[11]. It is high in energy and it is recommended for the infants, pregnant and lactating mothers, the elderly and the convalescent. Apart from direct consumption, sorghum is used as raw material for large and small beer brewing industries and local beer called ‘brukutu’. The residue from sorghum (sorghum spent grain) obtained from local beer producing industries was use in this study to evaluate the effect of differently processed (stacked and fresh) sorghum spent grain and its inclusion on the growth performance and blood chemistry of broiler chickens.

MATERIAL AND METHODS

Site

The experiment was carried out at the poultry unit of the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria.

Collection and processing of test ingredients

Sorghum Spent Grain (SSG) locally called “Dussa” was procured from a local production centre at the army barrack, Mokola, in Ibadan, Oyo state and transported to the experimental site to sundry. The first portion of the test ingredient was sundried immediately to obtain the fresh SSG (FSSG), second part was stacked for forty-eight hours before sun drying to obtain stacked 48 hours SSG (STK48) and the third part was stacked for seventy-two hours before sun drying to obtain stacked 72 hours SSG (STK72). Each part of the test ingredient was sundried until 10-12% moisture content was obtained.

FORMULATION OF EXPERIMENTAL DIETS

Seven experimental diets were formulated with diet 1 serving as the control while diets 2 and 3 consist of 15and 30% inclusion of fresh sorghum spent grain (FSSG), diets 4 and 5 consist of 15 and 30% of stacked forty-eight hours SSG (STK48) and diets 6 and 7 consist of 15 and 30% stacked seventy–two hours SSG (STK72) respectively. The gross composition of the experimental diet is presented in Table No.1.

EXPERIMENTAL BIRDS AND MANAGEMENT

One hundred and forty (140) day old Arbor Acre broiler chicks were used for the study. The birds were weighed on arrival at the farm (Initial weight) and weekly thereafter. Using randomized completely design in a 3x2 factorial arrangement, the bird were assigned to seven treatments with four replicates of five birds each. Birds were housed on deep litter. Vaccines were administered according to veterinary instruction at the experimental site. A weighed quantity of feed was offered daily at 8.00am and 4.00pm. Daily feed intake was calculated by difference between the feed offered and the left over and the experiment lasted for 56 days.

BLOOD COLLECTION AND ANALYSIS

Blood samples were obtained from the jugular vein of two birds per replicate on the 42nd day into tubes containing EDTA (an anticoagulant) for haematology, while those for serum were without EDTA. Packed cell volume (PCV) and haemoglobin (Hb) were determined using Micro-Haematocrit method and Cyan Meth-Haemoglobin methods respectively[12]. Total serum protein was determined using Biuret method described by Reinold[13]. Albumin was analysed using bromocresol green method as described by Doumas[14]. RBC and WBC were determined using the method described by Schalm[15]. Serum cholesterol was determined according to the method of Flegg[16] while aspartate amino acid transaminase (AST), Alanine amino acid transaminase (ALT) and Alanine phosphatase activities were determine using the method of Reitman and Frankel[17] and Schmidt and Schmidt[18] respectively. Data collected were analyzed using the analysis of variance in a 3x2 factorial arrangement. Means were separated using Duncan Multiple range test of the same statistical package[19].

RESULTS AND DISCUSSION

The proximate composition of fresh and differently processed SSG is as reported by Shittu *et al*.[20]. There was slight difference in the crude protein (20.52, 21.09, 21.17 for fresh, STK48, STK72 respectively) of the STK72 due to the fermentation that occurred during the stacking of the sorghum spent grain.This may be as a result of microbial fermentation of the starchy sorghum material and this agrees with Jyoti[21] that fermentation enriches food with amino acids, vitamins, mineral and bioactive compounds. The performance of broiler fed with fresh and differently processed SSG is presented in Table No.2. Fresh SSG recorded the highest (P<0.05) (1.81kg) average final live weight while stacked STK72 recorded the lowest (1.5KG) final live weight. Daily weight gain and daily feed intake decrease as processing period increases[20].

Table No.2 also shows main effect of processing methods on the haematological indices of broiler chickens fed differently processed sorghum spent grain (SSG). Dietary treatment had no significant (P<0.05) effect on all the haematological parameters measured except monocytes. Basophils values increases numerically as the stacking period increases. Control records 0.00and 0.02, 0.06and 0.09% were recorded for FSSG, STK47 and STK72 respectively, this values were lower compare with the recommended range (0.36-1.12) by Mitruka and Rawnsley[12]. The value was small in the blood of birds, this agrees withHajime[22], that basophils are the rarest granulocytes and represent less than 1% of peripheral blood leukocytes. All the blood constant were not (P<0.05) affected by the treatment effect. Haematological parameters are good indicators of the physiological status of animal and its changes are of value in assessing the response of animal to various physiological situations[23]. The packed cell volume (PCV) values are used to determine red blood cells mass and the portion of whole blood volume occupied by red blood cells. The PCV were not affected by processing methods (P>0.05) and fall within the recommended PCV values (24.90–40.76%) by Mitruka and Rawnsley[12]. Non-significant effect (P>0.05) observed in all haematological parameters measured except monocytes record may imply that there were no malnourishment and anaemic condition in the treated birds. The value obtained under the treatment effect for Hb, RBC, WBC and eosinophils fall within recommendation[12] for normal birds. Ker *et al.*,[24] reported that low PCV and haemoglobin are due to iron deficiency. Non-significant (P>0.05) effect observed in Hb and RBC may be an indication that the test ingredients had the ability to improve the folacin and iron metabolism. Folacin and iron had been observed to increase the number of red blood cell and blood concentration of haemoglobin[25]. The result obtained on lymphocytes (69.25-72.31%) and basophils are within the reference values[12]. The heterophils, the avian polymorph nuclear leukocyte and counterpart of mammalian neutrophils value and basophils value were all within the normal range. This, coupled with WBC suggested that the birds were able to perform their phagocytic functions[26].

Table No.3 shows the serum enzymes as affected by the pre-treatment effect. Except AST that increased across the treatments other serum enzymes were not significantly (P>0.05) affected. Albumin (g/dl), globulin (g/dl), creatinine (µmol/l) and total cholesterol (g/dl) increase with increase in stacking period. Albumin synthesis has been reported to be related to the amount of available protein[27], this establish the fact that stacking affected the crude protein of the sorghum spent grain. The mean serum cholesterol and urea showed that their synthesis, metabolism and utilization were affected by dietary treatment although value observed were still within the range[28,29] when *Urticadioica* and yam peel were fed to broiler respectively. Creatinine is formed when feed is changed into energy through the process called metabolism and it is muscle mass dependent. Its increase is an indication of the damage that might have been done to the kidney. This implies that stacked sorghum spent grain has tendency to damage the nephron which can result into nephropathy. Supplementation of broiler diets with stacked SSG is a practical approach for reducing competition for maize between man and animal. The result of this study indicate that SSG should not be stacked more than 48hours in order to improve performance and to avoid damage that long stacking may pose to the organs' functionality although this was not investigated through histological study.

Table No.4 shows the effect of varied inclusion level of sorghum spent grains on the haematological and serum parameters of broiler finisher. Data obtained from blood parameters showed that the inclusion levels of SSG has no significant influence on all the haematological parameters except monocytes and eosinophil which are similar (p>0.05). It shows that the health status of the birds was not compromised by the varied inclusion of SSG. Blood according to Adeyemi *et al*[30] is a mean of assessing clinical and nutritional health status of animals exposed to feeding trial. Adejumo[31] reported that haematological trait especially the PCV and Hb were correlated with the quality of diets and nutritional status of the animals. Also serum parameters measured were not affected by different inclusion levels of SSG except AST, total protein (g/dL), globulin (gldL) and creatinine (µmol/L). Although total protein (g/dL) and globulin (gldL) were similar (p>0.005) between treatments but AST increase across while creatinine statistically reduces across treatment. AST increases with increase inclusion levels of sorghum spent grain. Variation in the AST is an indication of damage to the liver or kidney, it has been reported by Ingrid[32] that AST test is a sensitive indicator of liver, heart, kidney and pancreas function. Sometimes an inflammation of the pancreas will cause the level to rise and decreased levels may be a more severe sign of liver damage and B_2 or B_6 deficiency[32] also increased creatinine indicates poor kidney elimination of waste products.

Table No.5 shows the interactive effect of inclusion levels and processing methods on haematological biochemistry of broilers finishers. The results were not showing interaction among the two factors except the eosinophils. This establishes that the significant effect was due to the main effects alone. Eosinophil has been identified to increase in conditions of hypersensitivity due to hay fever and parasitic infections[32]. With the highest values from the control groups that shows that the inclusion level of fibre did not affect the eosinophil percentage of broilers.

Table No.6 shows the interactive effects of inclusion levels and processing methods on the serum biochemistry of broiler chickens fed fresh and stacked sorghum spent grain. There were no significant variation among most parameters measured except AST, albumin, urea and cholesterol. AST increases as the stacking period increases to 30% inclusion levels. AST is sensitive indicator of liver damage, an increase in the level as the stacking period increases may be an indication of hepatocytes damage. Albumin (g/dL) is a protein made by liver. Increase albumin may be due to dehydration or improper use of protein[32], which may be due to the lower efficiency of microbial protein percentages as the stacking period increases. Albumin concentration was higher at higher inclusion levels, this may be as a result of high protein percentage from the 30% inclusion levels of SSG[20]. Albumin synthesis has been reported to be related to the amount of available protein[27]. Urea also is a measure of kidney and liver function and protein utilization. Increase urea level is an indication of diet too high in protein or the kidneys are not functioning properly. Increase in the urea level may also be as a result of kidney overworked due to increase waste products[32].

Table No.1: Gross Composition of Experimental Broiler Finisher Diets (g/100gDM)

S.No	Ingredients/ Diets	Control	15%FSSG	30%FSSG	15%STK48	30%STK48	15%STK72	30%STK72
1	Maize	66.00	56.88	48.93	56.88	48.93	56.88	48.93
2	SBM	28.89	23.01	15.96	23.01	15.96	23.01	15.96
3	SSG	0.00	15.00	30.00	15.00	30.00	15.00	30.00
4	Fish Meal	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	L/Stone	2.00	2.00	2.00	2.00	2.00	2.00	2.00
6	DCP	1.30	1.30	1.30	1.30	1.30	1.30	1.30
7	Methionine	0.14	0.14	0.14	0.14	0.14	0.14	0.14
8	Lysine	0.12	0.12	0.12	0.12	0.12	0.12	0.12
9	Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30
10	Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
11	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Nutrients:								
12	ME(kcal/kg)	3073.75	2868.92	2714.52	2868.92	2714.52	2868.92	2714.52
13	Crude Protein	19.96	19.64	19.04	19.64	19.04	19.64	19.04
14	Energy : Protein Ratio	153.99	146.08	148.99	146.08	148.99	146.08	148.99
Fresh sorghum spent grain (FSSG), STK48= Fresh SSG stacked for 48hours, STK72= Fresh SSG stacked for 72 hours								

Table No.2: Effect of Pre-treatment Methods on the Performance and Haematology Characteristics of Broiler Chickens Fed Differently Processed SSG

		Processing Methods				
S.No	**Parameters**	**Control**	**FSSG**	**STK48**	**STK72**	**SEM**
		Performance				
1	Initial weight (g)/bird	39.45	39.37	39.38	39.08	-
2	Final weight (g)/bird	1.70[ab]	1.81[a]	1.67[ab]	1.56[b]	0.08
3	Daily weight gain (g)/bird	30.35[ab]	32.27[a]	30.12[ab]	27.81[b]	1.33
4	Daily feed intake (g)/bird	74.35[b]	83.39[a]	80.60[a]	72.74[b]	2.07
		Heamatological Parameters				
5	PCV (%)	26.13	25.75	29.75	25.94	1.30
6	Hb (g/dl)	8.71	8.17	8.96	8.64	0.25
7	RBC (x106/l)	2.02	2.28	1.99	2.22	1.67
8	MCV (µ3)	1.35	1.21	1.51	1.19	0.11
9	MCH(µµg)	3.33	3.21	3.12	3.33	0.04
10	MCHC(%gm/100ml)	4.49	3.82	5.56	3.97	0.30
11	WBC(x103)	19.19	20.32	20.10	19.62	1.04
12	Lymphocytes (%)	70.63	72.31	70.06	69.25	2.47
13	Heterophils (%)	22.38	23.38	24.38	30.00	2.43
14	Monocytes (%)	3.13[a]	1.88[b]	2.44[ab]	1.73[b]	0.37
15	Eosinophils (%)	3.88	3.00	2.00	2.50	0.65
16	Basophils (%)	0.00	0.02	0.06	0.09	0.04

SSG: Sorghum Spent Grains, SBM: Soybean meal, DCP: Dicalcium Phosphate, ME: Metabolizable energy
[ab]: Mean within column with different superscript differed significantly ($P<0.05$), FSSG=Fresh sorghum spent grain (SSG), STK48=Fresh SSG Stacked for 48hours, STK72= Fresh SSG stacked for 72hours,

Table No.3: Effect of Pre-treatment Serum Biochemical Characteristics of Broiler Chickens Fed Differently Processed SSG

S.No	**Parameters**	**Control**	**FSSG**	**STK48**	**STK72**	**SEM**
1	ALT(µ/l)	47.19	47.96	49.49	48.93	4.04
2	AST(µ/l)($x10^1$)	15.74[b]	17.41[b]	18.85[b]	23.14[a]	1.01
3	ALP(µ/l)($x10^1$)	17.62	17.23	17.35	17.51	0.16
4	Total protein(g/dl)	3.39[b]	4.38[ab]	4.79[a]	4.27[ab]	0.30
5	Albumin(g/dl)	0.42[a]	0.35[b]	0.42[a]	0.47[a]	0.06
6	Globulin(g/dl)	2.97[b]	4.03[ab]	4.37[a]	3.80[ab]	0.30
7	Creatinine(µmol/l)	0.43[a]	0.29[b]	0.30[b]	0.35[ab]	0.04
8	Urea(mmol/d)	0.85[b]	0.76[b]	0.74[b]	1.31[a]	0.07
9	Total cholesterol(g/dl)	70.50[b]	74.93[b]	69.23[ab]	81.23[a]	3.09

SSG: Sorghum Spent Grains, SBM: Soybean meal, DCP: Dicalcium Phosphate, ME: Metabolizable energy
[ab]: Mean within column with different superscript differed significantly ($P<0.05$), FSSG =Fresh sorghum spent grain (SSG), STK48=Fresh SSG Stacked for 48hours, STK72= Fresh SSG stacked for 72hours, ALP= Alanine phosphatase, AST = Aspartate amino acid transferase, ALT = alalnine amino acid transferase.

Table No.4: Effect of inclusion levels on Growth, Haematology and Serum biochemistry of broiler fed graded levels of sorghum spent grain (SSG)

		Inclusion levels			
S.No	**Parameters**	**Control**	**15%SSG**	**30%SSG**	**SEM**
		Performance			
1	Initial weight (g)/bird	39.45	37.77	39.08	-
2	Final weight (g)/bird	1.70^{ab}	1.80^{a}	1.57^{b}	0.07
3	Daily weight gain (g)/bird	30.35^{ab}	32.13^{a}	28.00^{b}	1.10
4	Daily feed intake (g)/bird	74.35	80.02^{a}	77.79^{a}	2.34
5	Feed Conversion ratio	2.45^{b}	2.47^{b}	2.78^{a}	0.07
		Heamatological Parameters			
6	MCHC(%gm/100ml)	4.49	4.17	4.07	0.29
7	WBC($x10^3$)	19.19	20.01	20.01	0.99
8	Lymphocytes (%)	70.63	69.25	71.83	2.32
9	Heterophils (%)	22.38	27.83	24.00	2.25
10	Monocytes (%)	3.13^{a}	2.48^{ab}	1.54^{b}	0.33
11	Eosinophils (%)	3.88^{a}	2.13^{b}	2.88^{ab}	0.61
12	Basophils (%)	0.00	0.23	0.25	0.11
13	ALT(μ/l)	47.19	51.61	50.99	3.67
14	AST(μ/l)	15.74^{b}	18.93^{a}	20.45^{a}	0.99
15	ALP(μ/l)($x10^2$)	17.62	17.32	17.39	0.24
16	Total protein(g/dl)	3.39^{b}	4.17^{ab}	4.79^{a}	0.27
17	Albumin(g/dl)	0.42	0.42	0.41	0.01
18	Globulin(g/dl)	2.97^{b}	3.75^{ab}	4.38^{a}	0.27
19	Creatinine(μmol/l)	0.43^{a}	0.32^{b}	0.31^{b}	0.04
20	Urea(mmol/d)	0.85	0.92	0.95	0.07
21	Total cholesterol(g/dl)	70.50	74.38	75.87	2.87

^{ab}: Mean within rows with different superscript differed significantly ($P<0.05$), PCV= parked cell volume, Hb= Haemoglobin, RBC = Red blood cell, MCV=Mean corpuscular volume, MCH= mean corpuscular haemoglobin, MCHC = mean corpuscular haemoglobin concentration, WBC=white blood cell, ALP= Alanine phosphatase, AST = Aspartate amino acid transferase, ALT = alalnine amino acid transferase**,** SSG=Sorghum spent grain**.**

Table No.5: Interactive effects of inclusion level and processing method on the haematological Parameters of Broiler chickens fed fresh and stacked sorghum spent grains

			Processing Methods			
S.No	**Parameters**	**Inclusion levels (%)**	**FSSG**	**SK48**	**SK72**	**SEM**
1	PCV (%)	0	26.13	26.13	26.13	0.83
		15	25.13	27.00	26.00	1.01
		30	26.38	32.50	25.88	2.58
		SEM	1.01	1.93	0.88	
2	Haemoglobin (g/dl)	0	8.71	8.71	8.71	0.27
		15	8.38	8.96	8.67	0.34
		30	7.96	8.96	8.62	0.33
		SEM	0.36	0.29	0.29	

3	RBC (x$10^{6/}$l)	0	2.02	2.02	2.02	0.25
		15	2.56	1.83	2.26	0.29
		30	1.99	2.13	2.16	0.77
		SEM	028	0.13	1.3	
4	MCV (μ^3)	0	1.35	1.35	1.35	0.15
		15	1.09	1.49	1.19	0.12
		30	1.34	1.58	1.20	0.15
		SEM	0.17	0.16	0.10	
5	MCH (μμ^3)	0	3.33	3.33	3.33	0.00
		15	3.33	3.32	3.33	0.01
		30	3.08	2.93	3.33	0.22
		SEM	0.01	0.15	0.00	0.22
6	MCHC(%gm/100ml)	0	4.49	4.49	4.49	0.49
		15	3.63	4.93	3.95	0.40
		30	4.01	4.19	4.00	0.20
		SEM	0.46	0.30	0.33	
7	WBC (X10^3)	0	1.92	1.92	1.92	1.51
		15	2.07	2.00	1.97	0.14
		30	2.00	2.05	1.95	1.20
		SEM	1.46	1.30	1.43	
8	Lymphocytes (%)	0	70.63	70.63	70.63	3.63
		15	69.38	71.00	67.38	3.19
		30	75.25	69.13	71.13	2.43
		SEM	2.28	2.49	4.07	
9	Heterophils (%)	0	22.38	22.38	22.38	2.55
		15	24.75	24.38	34.38	3.87
		30	22.00	24.38	25.63	2.42
		SEM	2.28	2.49	4.07	
10	Monocytes (%)	0	3.13	3.13	3.13	0.43
		15	2.13	3.00	2.33	0.42
		30	1.63	1.88	1.13	0.48
		SEM	0.27	0.55	0.51	
11	Eosinophils (%)	0	3.88	3.88	3.88	0.94
		15	3.63^{a}	1.00^{b}	1.75^{ab}	0.76
		30	2.38	3.00	3.25	0.60
		SEM	0.97	0.65	0.68	
12	Basophils (%)	0	0.00	0.00	0.00	0.00
		15	0.00	0.75	0.25	0.24
		30	0.25	0.38	0.13	0.25
		SEM	0.08	0.29	0.13	

^{ab}: Mean within column with different superscript differed significantly ($P<0.05$), STK48=fresh SSG stacked for 48hrs, STk72= fresh SSG stacked for 78hrs, PCV=parked cell volume, RBC = Red blood cell, MCV=Mean corpuscular volume, MCH= mean corpuscular haemoglobin, MCHC = mean corpuscular haemoglobin concentration, WBC=white blood cell.

Table No.6: Interactive Effects of Inclusion Level and Processing Method on the Serum Biochemistry of Broiler Chickens fed Fresh and Stacked Sorghum Spent Grains

			Processing Methods			
S.No	**Parameters**	**Inclusion Levels (%)**	**Fresh**	**SK48**	**SK72**	**SEM**
1	ALT (µ/l)	0	47.19	47.19	47.19	2.75
		15	47.47	60.65	46.71	5.21
		30	48.45	46.33	58.20	5.86
		SEM	1.88	5.66	6.27	
2	AST (µ/l)	0	1.57	1.57	1.57	0.90
		15	1.73	1.86	2.07	0.14
		30	1.74^{b}	1.84^{b}	2.54^{a}	0.10
		SEM	0.15	0.88	0.10	
3	ALP (µ/l)	0	1.76	1.76	1.76	0.25
		15	1.73	1.71	1.74	0.23
		30	1.71	1.75	1.75	0.14
		SEM	2.01	2.04	2.31	
4	Total protein (g/dl)	0	3.39	3.39	3.39	0.26
		15	4.23	4.12	4.16	0.29
		30	4.54	5.45	4.38	0.54
		SEM	0.20	0.60	0.29	
5	Albumin (g/dl)	0	0.42	0.42	0.42	0.01
		15	0.36^{b}	0.40^{b}	0.50^{a}	0.01
		30	0.35^{b}	0.44^{a}	0.43^{a}	0.01
		SEM	0.02	0.02	0.02	
6	Globulin (g/dl)	0	2.97	2.97	2.97	0.25
		15	3.87	3.73	3.66	0.29
		30	4.19	5.01	3.95	0.53
		SEM	0.20	0.60	0.28	
7	Creatinine (µmol/l)	0	0.43	0.43	0.43	0.09
		15	0.33	0.28	0.36	0.63
		30	0.26	0.31	0.35	0.03
		SEM	0.05	0.05	0.05	
8	Urea (mmol/l)	0	0.85	0.85	0.85	0.12
		15	0.75^{b}	0.76^{b}	1.25^{a}	0.09
		30	0.26^{b}	0.73^{b}	1.36^{a}	0.06
		SEM	0.11	0.09	0.07	
9	Cholesterol (g/dl)	0	70.50	70.50	70.50	2.66
		15	81.54^{a}	64.63^{b}	76.97^{b}	3.71
		30	68.31^{b}	73.82^{ab}	85.48^{a}	3.92
		SEM	3.41	2.89	3.99	

^{ab}: Mean within column with different superscript differed significantly ($P<0.05$), STK48=fresh SSG stacked for 48hrs, STk72= fresh SSG stacked for 78hrs, PCV=parked cell volume, RBC = Red blood cell, MCV=Mean corpuscular volume, MCH= mean corpuscular haemoglobin, MCHC = mean corpuscular haemoglobin concentration, WBC=white blood cell.

CONCLUSION

Processing methods did not affect haematological parameters except monocytes, but there were significant effect on most of the measured serum indices of broiler chickens. The results show that serum ALT which is liver specific enzyme was not affected but blood albumin, creatinine and urea increase with an increase in stacking period. Growth was affected by the processing method employed. Based on the results of this study, the use of fresh SSG in the diets of broilers chicken production is recommended to broiler producer.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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