Haematology, serum biochemistry and relative organ weight of broiler fed raw and roasted kenaf seed meal as a replacement for full fat soybean meal

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Abstract

An experiment was conducted with 240, unsexed day old Arbor Acre broiler chicks to evaluate the benefit of replacing full fat soya (FFSM) with whole kenaf (*Hibiscus cannabinus* L.) seed meal (WKSM) in the diets on the haematology, serum biochemistry and organs weight of the broiler chicken in a 2 x 3 factorial arrangement, consisting two processing methods (raw kenaf seed meal RKM and roasted kenaf seed meal HKM) and 3 inclusion levels (10%, 20% and 30%). Blood samples were collected from the birds through the wing web vein for haematology and serum biochemistry, while sample of organs were collected from the birds after they were sacrificed after the 8 week feeding trials. Results showed that the processing methods significantly ($p < 0.05$) influenced the mean values obtained for neutrophil and lymphocytes, while haemoglobin (Hb), total protein, globulin, uric acid, cholesterol, alanine amino transferase (ALT) (EC 2.6.1.2) and aspartate amino transferase (AST) (EC 2.6.1.1) were significantly influenced ($p < 0.05$) by both processing methods and levels of inclusion. Weight of gizzard, spleen, lungs and heart were also influenced by both the processing methods and levels of inclusion of WKSM. The PCV, haemoglobin concentration and total protein values were within the range of 26.33 to 32.68%, 8.83 to 11.03g/dl and 37.70 to 50.43g/L. The results suggest that WKSM possess good dietary protein quality for optimal growth of broiler chicken. Inclusion levels above 20% to broiler will significantly alter the haematological and serum biochemical variables and probably induce anaemic conditions and dysfunction of visceral organs which can lead to their poor performance.

Key words: Kenaf seed, broilers, haematology, serum biochemistry, organ weight

Introduction

The production of convectional protein and energy sources is still grossly inadequate in most of the least developed countries of the world and oftentimes the demand exceeds supply. With the increasing human population in these countries of the world, there is stiff competition between man and livestock for the available feed resources, particularly those of energy and protein sources. Hence, feed producers and animal scientists are always searching for alternative feed resources that can substitute for or partially replace the

conventional feedstuffs. Therefore, in order to reduce feed cost, which accounts for about 60 to 70% of production cost (Nworgu *et al*; 1999), research efforts are being geared towards evaluating alternative feed ingredients for poultry (Eruvbetine and Oguntola; 1997, Igwebuike *et al* 2001; Ojewola *et al*; 2003; Oyebimpe *et al*, 2006). However, Atteh and Ologbenla (1993) observed that such alternative and emerging crops should not only have comparative nutritive value but should be cheaper than the conventional sources, and should also be available in large quantities.

One of such emerging crops is Kenaf (*Hibiscus cannabinus* L.)

Kenaf (*Hibiscus cannabinus*) is an annual herbaceous plant which has great potential for fibre, energy and feedstock. Kenaf has been planted in Africa for more than 4000 years and can also be found in many countries such as China, India, U.S.A and Thailand (Dempsey, 1975). Its leaves have an acidic flavour and are used for the production of local soups. Kenaf is extensively cultivated in tropical Africa, Asia, Central America and the Caribbean for the jute-like fibre. Kenaf seed has a crude protein content of 30.88%, with an organic matter content of 95.15% and ether extract content of 18.55% on a dry matter basis. The fatty acid content include palmitic acid (33.21%), stearic acid (50.02%), oleic acid (31.26%), and linoleic (30.51%) (Rajashekher *et al.*, 1993). It has a high potential as feedstuff. The present trial aims at determining the effect of feeding RKM and HKM on the performance and serum biochemistry of broiler chicken.

Materials and Methods

Collection and preparation of kenaf seed meal

The kenaf seeds were collected from the Institute of Agriculture Research and Training, Ibadan. The seeds were thoroughly cleaned to remove all the foreign materials. After cleaning, the seeds were divided into two equal part, one part of the seeds was roasted for about 10 – 15 minutes in a flat pan over an open fire by a constant stirring, until a golden brownish colour was obtained. It was then allowed to cool. Both the HKM and RKM were ground and stored in an air tight container until required for the preparation of experimental diets.

Preparation of Experimental diet

A total of eight diets were formulated such

that full fat soya bean meal (FFSBM) was replaced by RKM and HKM on weight to weight basis. The replacement was in the order of 0, 10, 20, and 30% of the soybean with differently processed kenaf meal. The birds were fed with starter and finisher diets for the first 4 weeks and the last 4 weeks of the experiment respectively. All the diets were formulated to be isocaloric and iso nitrogenous. The gross composition of the starter and finisher diets are as shown in (Tables 1 and 2).

Experimental animals and management

A total of two hundred and forty (240) unsexed day-old Arbor Acre broiler chicks were used for this study. The chicks were randomly assigned to 8 dietary groups of three replicates with 10 birds per replicate in a 2x4 factorial design of two factors (RKM and HKM) and four levels of inclusion (0, 20, 30 and 40%). The birds were acclimatized for 7 days before the commencement of the experiment. They were housed in an open sided pen, which has been provided with facilities for lighting, feeding and watering. Feed and water were provided *ad libitum*, litter was properly monitored and managed to prevent caking which could lead to outbreak of coccidiosis. Routine vaccinations and medications were carried out as at when due.

Haematological and biochemical indices

At the 8th week, two birds per replicate were bled using hypodermic needle and syringe, through the jugular vein. Blood was drained into two different carefully labelled bottles for haematological and serum biochemistry investigation. The blood samples for haematological parameters were collected into the bottle pre-treated with ethylene diamine tetraacetate (EDTA), an anticoagulant. Blood samples for biochemical indices were collected into another sample bottle containing no anti-

coagulant. These samples were spurned in the centrifuge at 3,000 rpm and the clearer portion (serum) decanted (after centrifugation) into small sample tubes and stored in a freezer. The haematological indices examined include Red Blood cell count (RBC), white blood cell (WBC), Packed cell volume (PCV), Leucocytes differential count (monocyte, lymphocyte, eosinophil) mean cell volum (MCV), mean cell haemoglobin concentration (MCHC), mean cell haemoglobin (MCH) and haemoglobin concentration (Hb). Serum biochemical indices investigated were total protein, globulin, albumin, albumin: globulin ratio, creatinine, glucose, uric acid, cholesterol, alanine amino transferase (ALT) (EC 2.6.1.2) and aspartate amino transferase (AST) (EC 2.6.1.1).

The packed cell volume (PCV) was determined by spinning about 75 μ l of each blood samples in heparinised capillary tube in a haematocrit centrifuge for about 5 minutes and read on haematocrit reader (Benson et al., 1989). Erythrocyte and Leucocytes counts were determined using Neubaur chamber method as described by (Lamb, 1981). The blood sample collected in each treatment was diluted at a ratio of 1: 200 for RBC counts using red cell diluting fluid while a dilution ratio of 1: 20 (blood: white cell diluting fluid) was used for WBC counts. Samples of RBC and WBC counts were obtained using the relationship:

$$\text{RBC}/\mu\text{l} = \text{Numbers of red blood cells counted} \times 5 \times 10 \times 200$$

$$\text{WBC}/\mu = \text{Numbers of white blood cells counted} \times 0.25 \times 10 \times 20.$$

Haemoglobin was estimated using cyanomethaemoglobin method. 0.02ml of blood was expelled into 4ml drakkins solution. The mixture was allowed to stand for 5minutes for full colour development. Sample haemoglobin concentration was obtained using this relationship.

$$\text{Sample haemoglobin} = \frac{\text{Reading of test x standard haemoglobin concentration}}{\left(\frac{\text{g}}{\text{l}} \right) / \left(\frac{\text{m l}}{\text{m l}} \right)} \\ \text{Reading of Standard}$$

The haemoglobin (Hb) concentration and the blood constants: mean cell haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and mean cell volume were determined using cyathaemoglobin method and appropriate formula, respectively (Jain, 1986).

$$\text{MCH} = \frac{\text{Haemoglobin (g per 100 ml)} \times 10}{\text{RBC count million per cu.mm}}$$

$$\text{or MCH} = \frac{\text{Haemoglobin (g/L)}}{\text{RBC (10}^{12}\text{/L)}}$$

$$\text{MCHC} = \frac{\text{Haemoglobin (g/dl)} \times 100}{\text{PCV \%}}$$

The smear of each blood samples in the bottles containing EDTA was made on a clean slide, air dried and fixed in methanol for three minutes. The smear was stained in Giemsa stain for 30 minutes, rinsed in water and air- dried .The cell count for each sample was carried out (Lamb, 1981). During the process, the slide was viewed under the microscope and cells were counted. From the cell counted, the percentage of different cells (neutrophils, eosinophils, lymphocytes and monocytes) was determined.

The serum total protein was determined by the Biuret method (Reinhold, 1953) using a commercial kit (Randox Laboratories Ltd, U.K), while albumin value was obtained by bromocresol green method (Doumas and Biggs, 1971). The globulin and albumin: globulin ratio were determined according to the method of Coles (1986). The serum creatinine and urea nitrogen were estimated by deproteinisation and Urease- Berhelot colorimetric methods, using a commercial kit (Randox Laboratories Ltd, U.K). Also the free cholesterol was determined by

nonane extraction and enzymatic colorimetric methods, respectively using commercial kit (Quimica Clinica Applicada, S.A), while the serum enzymes; Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) were obtained using the Randox Laboratories Ltd, UK test kits.

Organ weight evaluation

Two birds were sacrificed per replicate at the end of the feeding trial, and live weight and weight of the internal organs such as gizzard, liver, heart, spleen, pancreas, lung and kidney were recorded. The weights of the internal organs were expressed as a

percentage of the live weight.

Statistical analysis

Data generated was subjected to analysis of variance using SAS statistical package SAS, (2003). Significant mean were separated using Duncan's (1955) Multiple Range Tests.

Results

The results of main effect of processing methods and levels of inclusion on haematological indices of broilers is presented in Table 3 while the interactions of raw and roasted kenaf seed meal and

Table 1. Composition of the experimental diets (starter phase)

Ingredients%	Levels of WKSM in the diet (%)							
	RKM				HKM			
	0	10	20	30	00	10	20	30
Maize	49.00	49.00	49.00	49.00	49.00	49.00	49.00	49.00
Groundnut cake	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Full fat soya meal	30.00	20.00	10.00	-	30.00	20.00	10.00	-
Raw kenaf meal	-	10.00	20.00	30.00	-	-	-	-
Roasted kenaf meal	-	-	-	-	-	10.00	20.00	30.00
Fish meal (72% CP)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Wheat offals	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin/mineral premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	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
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis%								
Crude protein	23.14	22.38	21.68	21.54	23.14	22.38	21.68	21.54
Crude fibre	3.58	3.90	3.92	3.95	3.58	3.90	3.92	3.95
Ether extract	8.12	8.36	8.39	8.14	8.12	8.36	8.39	8.14
**M.E. MJ/Kg	12.22	12.00	11.80	11.80	12.22	12.00	11.80	11.80
Lysine	1.30	1.30	1.29	1.27	1.30	1.30	1.29	1.27
Methionine	0.44	0.42	0.42	0.42	0.44	0.42	0.42	0.42

*Vitamin-mineral premix (2.5kg/1000kg): vitamin A (10,000,000 IU), vitamin D3 (3,000,000 IU), vitamin E (30,000 IU), vitamin K (2.3 gm), vitamin B1 (2.0 gm), Riboflavin (3.6 gm), Pyridoxine (3.0 gm), vitamin B12 (160 mg), Biotin (60 mg), Niacin (31 gm), pantothenic acid (8 gm), folic acid (1 gm), manganese (85 gm), zinc (50 gm), iron (25 gm), copper (6 gm), iodine (1 gm), selenium (1.25 gm), cobalt (220 mg), antioxidant (125 gm), choline chloride (200 gm).

**M.E. = Metabolizable energy.

Table 2: Composition of experimental diets (finisher phase)

Ingredients%	Levels of WKSM in the diets (%)							
	RKM				HKM			
	0	10	20	30	00	10	20	30
Maize	52.00	52.00	52.00	52.00	52.00	52.00	52.00	52.00
Groundnut cake	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Full fat soya meal	30.00	20.00	10.00	-	30.00	20.00	10.00	-
Raw kenaf meal	-	10.00	20.00	30.00	-	-	-	-
Roasted kenaf meal	-	-	-	-	-	10.00	20.00	30.00
Fish meal(72% CP)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Wheat offals	3.80	3.80	3.80	3.80	3.80	3.80	3.80	3.80
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Limestone	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin/mineral premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	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
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis%								
Crude protein	21.96	21.27	20.57	20.50	21.96	21.27	20.57	20.50
Crude fibre	3.96	4.59	4.55	4.51	3.96	4.59	4.55	4.51
Ether extract	8.38	8.40	8.35	8.38	8.38	8.40	8.35	8.38
**M.E MJ/Kg	12.64	12.41	12.27	12.27	12.64	12.41	12.27	12.27
Lysine	1.24	1.22	1.23	1.20	1.24	1.22	1.23	1.20
Methionine	0.40	0.38	0.36	0.37	0.40	0.38	0.36	0.37

*Vitamin-mineral premix (2.5kg/1000kg): vitamin A (11,000,000IU), vitamin D3(3,000,000IU), vitamin E (30,000IU), vitamin K (2.3gm), vitamin B1 (1.7gm), Riboflavin (5.2gm), Pyridoxin(3.7gm), vitaminB12 (18mg), Biotin (76mg), Niacin (37gm), panthotenic acid (9.2gm), folic acid (0.9gm), manganese (83gm), zinc (50gm), iron (25gm), copper (6gm), iodine (1gm), selenium (120gm), cobalt (220mg), antioxidant (126gm), choline chloride (180gm).

**M.E = Metabolizable energy.

levels of inclusion on haematological indices of broilers is as shown in Table 4. Among the haematological parameters measured, neutrophil and lymphocytes were significantly influenced by processing methods. While haemoglobin concentration (Hb) was significantly ($P<0.05$) influenced by the levels of inclusion. Birds fed 30% level of inclusion of kenaf seed meal had the lowest (9.26g/dl) value of Hb while those fed 10% had the highest (10.92%) value. However, birds fed HKM had significantly ($P<0.05$) higher neutrophil value (35.75%) than birds on RKM (28.00%) and control (29.00%). While birds on RKM had highest lymphocytes value (73.22%) compared with those fed control (69.00%) and HKM (61.33%). The results of the interactions effect of RKM and HKM and levels of inclusions revealed that all the parameters measured were not significantly ($P>0.05$) influenced by the interaction effect except the haemoglobin concentrations. The Hb of broilers fed both RKM and HKM increased as the levels of inclusion increased.

The results of main effect of processing methods and levels of inclusion on serum biochemical indices of broilers are presented in Table 5 while the interactions of raw and roasted kenaf seed meal and levels of inclusion on serum biochemical indices of broilers are shown in Table 6. Among the serum biochemical indices examined, significant ($P<0.05$) differences were recorded as effect of treatment on birds' serum total protein, serum globulin, uric acid, alanine amino transferase (ALT) and aspartate amino transferase (AST). The values obtained for cholesterol and creatinine were significantly ($P<0.05$) influenced by the levels of inclusion. Birds on 30% inclusion levels had the highest (48.93g/L) values for total protein and (21.78g/L) for globulin, while those on 0%

inclusion level had the lowest (37.70g/L) and (15.33g/L) for total protein and globulin respectively. However, the value recorded for globulin was increased with increasing level of inclusion of both RKM and HKM. Among the processing methods, RKM had the highest (62.37 IU/L) value for AST while birds on HKM had the lowest (12.73 IU/L) value.

The interaction effect of raw and roasted kenaf seed meal and level of inclusion significantly ($P<0.05$) influenced the mean values obtained for serum total protein, serum globulin, serum cholesterol, creatinine and ALT. However the values obtained for total protein, globulin and AST were increasing as the levels of inclusion of both RKM and HKM increases.

The results of main effect of processing methods and levels of inclusion on the relative organ weights of broilers are presented in Table 8 while the interactions are shown in Table 9. The processing methods significantly ($P<0.05$) influenced the mean values obtained for gizzard and kidney. While the weights of gizzard, liver, pancreas and kidney were significantly influenced by the levels of inclusion. It was revealed that weights of gizzard, liver and pancreas were increasing as the levels on inclusion of kenaf seed meal increases. The weights of gizzard, liver, pancreas and kidney were significantly ($P<0.05$) influenced by the interaction effects of RKM, HKM and levels of inclusion. Weights of the gizzard ranges from (2.47-4.21%) with birds on 30% HKM having the highest value and birds on control having the lowest.

Discussion

Blood parameters is a reflection of the effects of dietary treatments on the animals in terms of the type, quality and amounts of the feed ingested and available for the animal to meet its physiological,

biochemical and metabolic necessities (Ewuola *et al.*, 2004; Olorode, *et al.*, 2007; Odetola, *et al.*, 2012). Reports by Aletor (1989), and Aletor and Egberongbe (1992) indicated that the blood variables most consistently affected by dietary influences include RBC, PCV, plasma protein and glucose. Levels of inclusion of RKM and HKM have no effect on all haematological parameters except Hb, no effect was observed for albumin and serum urea. This

is an indication that inclusion levels of RKM and HKM did not have effect on the health status of the broiler. The same effect was also observed for the processing methods. Creatinine levels points to extent of muscular activity and the levels of creatinine (mg/dl) of control 1.03, RKM (0.90- 0.93) and HKM (0.95- 1.13) fell within 0.90- 1.85 reported for chicken by Mitruka and Rawnsley, (1977). The creatinine levels in this study which

Table 3: Main effect of processing methods of kenaf meal and levels of inclusion on haematological indices of broiler chicken

PARAMETERS	Processing methods				Levels of Kenaf meal				
	Control	RKM	HKM	SEM	0%	10%	20%	30%	SEM
Packed cell volume(%)	30.33	28.89	31.17	1.40	30.33	32.50	29.67	27.60	1.63
Haemoglobin (g/dl)	10.23	9.67	10.50	0.45	10.23 ^{ab}	10.92 ^a	9.97 ^{ab}	9.26 ^b	0.54
White blood cell ($\times 10^3/\text{mm}^3$)	29.83	29.22	27.70	14.07	29.83	26.59	29.34	29.81	6.50
Red blood cell ($\times 10^3/\text{mm}^3$)	2.51	2.40	2.56	0.17	2.51	2.72	2.42	2.26	0.16
MCHC (%)	33.77	33.47	33.70	0.13	33.77	33.62	33.57	33.54	0.14
Mean corpuscular haemoglobin (Fl)	41.00	40.44	41.36	0.72	41.00	40.38	41.22	41.05	0.76
Mean cell volume(μ^3)	121.47	120.78	122.74	2.00	121.47	120.13	122.75	122.33	2.15
Neutrophil (%)	29.00 ^{ab}	28.00 ^b	35.75 ^a	2.14	29.00	29.17	31.83	29.00	3.48
Lymphocytes (%)	69.00 ^{ab}	73.22 ^a	61.13 ^b	2.29	69.00	68.50	64.67	69.80	3.51
Basophil (%)	0.00	0.11	0.25	0.12	0.00	0.17	0.33	0.00	0.13
Monocyte (%)	1.67	0.89	2.00	0.70	1.67	1.33	1.83	1.00	0.81
Eosinophil (%)	0.33	0.78	0.63	0.41	0.33	0.67	1.33	0.00	0.39

abc: Mean on the same row with difference superscripts differ significantly($P < 0.05$). RKM = Raw whole kenaf seed meal, HKM = Roasted whole kenaf seed meal. MCHC = Mean corpuscular haemoglobin concentration.

Table 4 : Interaction effect of raw and roasted kenaf meal and levels of inclusion on haematology of broiler chicken

Blood Parameters	Control	RKM				HKM			SEM
	0 %	10%	20%	30%	10%	20%	30%		
PCV (%)	30.33	28.00	28.00	26.33	32.67	31.33	29.50	2.98	
Haemoglobin (g/dl)	10.23 ^a	9.37 ^{ab}	9.37 ^{ab}	8.83 ^b	11.03 ^a	10.57 ^{ab}	9.90 ^b	0.98	
WBC (x10 ³ /mm ³)	29.83	29.17	30.03	28.47	24.02	28.65	31.82	25.87	
Red blood cell (x 10 ⁶ /mm ³)	2.51	2.75	2.31	2.15	2.69	2.53	2.42	0.30	
MCHC (%)	33.77	33.43	33.43	33.53	33.80	33.71	33.56	0.28	
MCH (fI)	41.00	39.70	40.63	41.00	41.06	41.81	41.13	1.67	
Mean cell volume(μ ³)	121.47	118.73	121.43	122.17	121.52	124.07	121.57	4.94	
Neutrophil (%)	29.00	25.67	29.67	19.67	32.67	34.00	43.00	6.31	
Lymphocytes (%)	69.00	73.00	67.67	79.00	64.00	61.67	56.00	5.82	
Basophil (%)	0.00	0.33	0.00	0.00	0.00	0.67	0.00	0.10	
Monocyte (%)	1.67	0.33	1.00	1.33	2.33	2.67	0.50	1.64	
Eosinophil (%)	0.33	0.67	1.67	1.00	0.67	1.00	0.00	0.97	

*abc: Mean on the same row with difference superscripts differ significantly ($P < 0.05$). RKM = Raw whole kenaf seed meal,

HKM = Roasted whole kenaf seed meal. PCV = Packed cell volume, WBC = White blood cell,

MCHC = Mean corpuscular haemoglobin concentration. MCH = Mean corpuscular haemoglobin,

decreases with levels of inclusion of RKM and HKM shows that there was no muscular wastage due to anti-nutritional factors. This is in line with the findings of Eggum, (1980) in which high creatinine indicated a high degradation of muscle phospho- creatinine to form creatinine.

The cholesterol level of broilers on control which was lower than those of 10% RKM, but higher than those of the other kenaf based diets, and the decrease in cholesterol level with increasing substitution of RKM and HKM for full fat soya in the diets could be explained by the presence and increasing contents of anti-nutritional factors as the levels of inclusion increased. This agrees with the findings of Potter *et al.* (1979), Oakenful, (1981) and Michael (2005) that anti-nutritional factor assert a physiological effect on lowering the level of plasma

cholesterol concentration in experimental animals. The cholesterol content of birds in this study fell within the values of 135.33 ± 11.22 to 149 ± 3.79 and 52 to 148mg/dl respectively reported for chickens by Mitruka and Rawnsley, (1977) and Akinola and Abiola, (1999). Although dietary fibre have been reported to lower blood cholesterol, total lipids and blood glucose (Hale, *et al.*, 1986). Variation observed in the values of serum glucose were not significant ($P > 0.05$) as the inclusion levels increases, this indicate available energy for the birds. Except for 10% RKM the values obtained for serum cholesterol fall within the range reported by Mitruka and Rawnsley, (1977) for domestic chickens.

Table 5 : Main effect of processing methods of kenaf meal and levels of inclusion on serum biochemistry of broiler chicken

Parameters	Processing methods				Levels of Kenaf meal				SEM
	Control	RKM	HKM	SEM	0%	10%	20%	30%	
Glucose mg/dl	168.60	168.82	161.95	8.99	168.60	194.22	165.25	158.33	10.24
Total Protein g/L	37.70 ^b	47.08 ^a	43.26 ^a	2.48	37.70 ^c	42.18 ^{bc}	45.87 ^{ab}	48.93 ^a	1.47
Albumin g/L	22.37	26.69	24.94	1.27	22.37	24.55	26.77	27.15	1.74
Globulin g/L	15.33 ^b	20.39 ^a	18.33 ^{ab}	1.21	15.33 ^b	17.63 ^{ab}	19.10 ^{ab}	21.78 ^a	1.46
Albumin/Globulin	1.48	1.40	1.41	0.08	1.48	1.49	1.46	1.29	0.19
Uric Acid mg/dl	9.97 ^a	10.74 ^a	7.85 ^b	0.43	9.97	9.43	9.75	9.53	0.83
Cholesterol mg/dl	140.87	139.61	128.43	6.49	140.87 ^a	141.65 ^a	138.97 ^a	118.70 ^b	6.19
Creatinine mg/dl	1.03	0.96	1.04	0.04	1.03 ^{ab}	0.97 ^{ab}	1.08 ^a	0.09 ^b	0.04
Alanine amino transferase IU/L	183.40 ^b	205.06 ^b	258.68 ^a	13.98	183.40 ^b	215.93 ^{ab}	241.02 ^a	224.73 ^{ab}	19.57
Aspartate amino transferase IU/L	34.00 ^b	62.37 ^a	22.73 ^c	4.64	34.00 ^b	38.23 ^b	34.42 ^b	51.75 ^a	11.57

abc: Mean on the same row with difference superscripts differ significantly ($P < 0.05$). RKM = Raw whole kenaf seed meal, HKM = Roasted whole kenaf seed meal.

Table 6: Interaction effect of raw and roasted kenaf meal and levels of inclusion on serum biochemistry of broiler chicken

Parameters	Control		RKM		HKM		SEM
	00%	10%	20%	30%	10%	20%	
Glucose mg/dl	168.60	195.20	156.67	156.67	175.90	175.90	12.23
Total Protein g/L	37.70 ^b	43.30 ^{ab}	50.43 ^a	50.43 ^a	44.23 ^{ab}	44.23 ^{ab}	1.30
Albumin g/L	22.37	25.23	28.43	28.43	27.13	27.13	1.53
Globulin g/L	15.33 ^b	18.07 ^{ab}	22.00 ^a	22.00 ^a	17.10 ^{ab}	17.10 ^{ab}	2.02
Albumin/Globulin	1.48	1.56	1.35	1.35	1.65	1.65	0.24
Uric Acid mg/dl	9.97	10.20	11.07	11.07	8.53	8.53	0.52
Cholesterol mg/dl	140.87 ^{ab}	151.77 ^a	120.90 ^b	120.90 ^b	131.77 ^a	131.77 ^a	5.90
Creatinine mg/dl	1.03 ^a	0.93 ^{ab}	0.90 ^b	0.90 ^b	1.13 ^a	1.13 ^a	0.06
ALT IU/L	183.40 ^b	200.50 ^{ab}	201.93 ^{ab}	212.73 ^a	231.37 ^{ab}	280.10 ^a	15.08
AST IU/L	34.00	61.40	60.00	65.70	8.83	8.83	4.40

abc: Mean on the same row with difference superscripts differ significantly ($P < 0.05$). RKM = Raw whole kenaf seed meal, HKM = Roasted whole kenaf seed meal. ALT = Alanine amino transferase, AST = Aspartate amino transferase

Table 7: Main effect of processing methods of kenaf meal and levels of inclusion on serum relative organ weight of broiler chicken

Parameters	Processing Methods				Levels of Kenaf seed meal				
	Control	RKM	HKM	SEM	0%	10%	20%	30%	SEM
Gizzard (%)	2.47 ^c	2.93 ^b	3.51 ^a	0.19	2.47 ^c	2.91 ^{bc}	3.01 ^b	3.80 ^a	0.20
Liver (%)	2.08	2.30	2.39	0.15	2.08 ^b	2.39 ^{ab}	2.12 ^{ab}	2.55 ^a	0.14
Heart (%)	0.43	0.50	0.52	0.05	0.43	0.52	0.48	0.53	0.04
Spleen (%)	0.14	0.14	0.15	0.02	0.11	0.16	0.13	0.15	0.02
Pancreas (%)	0.28	0.35	0.36	0.05	0.28 ^b	0.27 ^b	0.37 ^{ab}	0.44 ^a	0.05
Lung (%)	0.54	0.59	0.53	0.03	0.54	0.52	0.58	0.59	0.03
Kidney (%)	0.53 ^b	0.65 ^a	0.62 ^{ab}	0.04	0.53 ^b	0.66 ^a	0.57 ^{ab}	0.69 ^a	0.04

abc: Mean on the same row with difference superscripts differ significantly ($P < 0.05$).

RKM = Raw whole kenaf seed meal,

HKM = Roasted whole kenaf seed meal

Table 8: Interaction effect of RKM, HKM and levels of inclusion on relative organ weights of broiler chicken

Parameters	Control	RKM				HKM			SEM
	00%	10%	20%	30%	10%	20%	30%		
Gizzard (%)	2.47 ^c	2.55 ^{bc}	2.71 ^b	3.53 ^a	3.26 ^{bc}	3.30 ^b	4.21 ^a	0.18	
Liver (%)	2.08 ^b	2.32 ^{ab}	2.06 ^b	2.54 ^a	2.46 ^{ab}	2.19 ^{ab}	2.56 ^a	0.15	
Heart (%)	0.43	0.53	0.46	0.51	0.50	0.49	0.57	0.05	
Spleen (%)	0.11	0.16	0.13	0.14	0.15	0.14	0.18	0.03	
Pancrease (%)	0.28 ^b	0.30 ^b	0.41 ^a	0.34 ^{ab}	0.24 ^b	0.33 ^{ab}	0.39 ^a	0.05	
Lung (%)	0.54	0.48	0.65	0.63	0.56	0.51	0.52	0.03	
Kidney (%)	0.53 ^b	0.69 ^a	0.58 ^{ab}	0.69 ^a	0.63 ^a	0.55 ^{ab}	0.69 ^a	0.04	

abc: Mean on the same row with difference superscripts differ significantly ($P < 0.05$).

RKM = Raw whole kenaf seed meal, HKM = Roasted whole kenaf seed meal

Conclusion

This study has demonstrated that both RKM and HKM possess good dietary protein quality for optimal growth of broiler chicken. However, the result revealed that feeding both RKM and HKM above 20% to broiler will significantly alter the haematological and serum biochemical variables and probably induce anaemic conditions which can lead to their poor performance.

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Received: 21/10/12

Accepted: 25/10/13