Nigerian J. Anim. Sci. 2021, 23 (2): 232-239

Hematological parameters, carcass yield and guts dimension of broiler chicken fed African locust bean (*Parkia biglobosa*) fruit pulps meal as partial replacement for maize

[1]Lakurbe, O. A., [1]Ahmed, U., [1]Haladu, S., [1]Sadiq, M. S. and [1]Ibrahim, Y.

[1]*Department of Animal Science, Federal University, Kashere, Gombe State – Nigeria*

Corresponding Author: *auduobedtb@gmail.com;* ***Phone Number:*** *07030453905*

Target Audience: *Animal nutritionists, Poultry farmers, Feed millers and Researchers.*

Abstract

The effect of feeding processed African locust bean fruit pulps (ALFP) meal partially replacing maize on the haematological parameters, carcass and guts dimension of finisher broiler chickens Was investigated. Two hundred finisher broiler chickens were randomly allotted to five experimental diets in which ALFP replaced maize at 0% (control), 20% (raw), 20% (fermented), 20% (cooked) and 20% (toasted) as dietary energy sources tagged as diets 1, 2, 3, 4 and 5 respectively. The experimental diets were replicated four times with 10 birds per replicate in a completely randomized design (CRD). At the end of the experiment which lasted for 28 days, blood samples were taken from four birds per treatment for haematological analysis. Forty birds were randomly selected of ten birds per treatment and starved for 12 hours and final live weights were measured before slaughtering. The results of the haematological parameters showed that all values obtained for white blood cells, red blood cells, haemoglobin concentration, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration were all significantly ($P < 0.05$) affected, except the haematocrits. All carcass and guts dimensions were not significantly affected ($P<0.05$) by the experimental diets except the dressed percent, carcass weight, gizzard weight, abdominal weight and lungs weight. The differences observed do not follow a particular pattern and may not be attributable to dietary treatments. The study revealed that ALFP can be used as dietary energy sources to replace maize up to 20% in the diets of broiler chickens without adverse effects on their haematological parameters, carcass yield and guts dimensions.

Keywords: *African locust bean fruit pulps; Broiler; Carcass; Haematological parameters*

Description of Problem

The level of animal protein consumption in most developing countries of the world including Nigeria is very low. This low intake can be linked to high cost of the products arising mainly from high cost of feed. Acute shortage and high cost of feedstuffs have been identified among other challenges as a major obstacle to the expansion of the poultry industry in Nigeria (1, 2). In recent times, there has been a wide gap between production and supply of animal protein to feed the ever-increasing population of Nigerians, resulting in low per capita consumption of the product (3).

Poultry production especially broiler chicken is one of the fastest way of achieving adequate animal protein supply for the Nigerian populace due to their short generation interval and rapid growth rate (4). At present, the high cost of conventional feedstuffs has brought about the need to have alternative feedstuffs that can replace the expensive ones in order to reduce the cost of livestock production (5).

The growing demand for maize in the

last few years for both human, industrial and livestock consumption has pushed its market price to an alarming rate that has directly affected the production cost of farm animals, particularly the non-ruminants (6). In an attempt to boost poultry production, nutritionists have tried to harness and utilize agro industrial by-products that are not directly utilized by man. A large number of alternative feedstuffs that have potential as poultry feed ingredients abound in Nigeria (7). Research into the use of cheaper industrial by-products and wastes have been intensified in the last few years to determine the efficiency of their utilization in terms of growth and production (8). According to (9) the search for cheaper sources of feed ingredients for livestock feeding in Nigeria and many developing countries will continue, as long as protein requirement in human diet has not been met. There are several attempts to reduce the cost of poultry production by replacing some percentage of maize with other agro-industrial by-products such as maize offal, brewers dried grain, wheat offal, cassava peel meal, rice offal etc (10, 11). One alternative novel feed ingredient that is receiving attention is the African locust bean pulp (12). However, there is paucity of information on best processing methods to adopt in order to achieve optimum performance.

The fruit pulps of the African locust bean are sweet to the taste when it ripped, which indicates the presence of natural sugars and thus a potential energy source. According to (13), the powdery fruit pulps contain more carbohydrate than the seed, the carbohydrate being primarily reducing sugars, non-reducing sugars and other complex carbohydrates. The attractive yellow colour indicates the presence of phyto-nutrients possibly carotenoids, which are important precursors of retinol (vitamin A). It has a sour taste when unripe which indicates the presence of ascorbic acid (vitamin C). The fruit pulps has poor essential amino acids content with a score 1/8 (14). The ALBF is used in rural African during emergencies when grains stores are empty, which shows its non-toxicity and edibility (15, 16). The carbohydrate content of the fruit pulps was found to be 67.30% (17), which is much higher than the 49.49% carbohydrate in the Parkia seeds. Though proteins and fats also provide energy, carbohydrates are much cheaper and more easily digested and absorbed (18). While the use of African locust bean and its fruit pulps as an alternative source of protein and its fruit pulps as dietary energy in livestock diets abound in literatures. There is however paucity of information on the best processing method of its fruit pulps, hence the need to investigate it, in order to ensure optimum utilization of this feed resource for broiler chickens.

This study was designed to evaluate the haematological parameters, carcass yield and guts dimension of finisher broiler chickens fed differently processed African locust bean fruit pulps as partial replacement for maize.

Materials and Method

This experiment was conducted at the Animal Teaching and Research Farm of the Federal University of Kashere, Gombe state, Nigeria. Two hundred experimental birds were randomly allotted to five experimental diets that were replicated four times in a completely randomized design of ten birds per replicate. Feed and water were provided to them *ad libitum* during the experiment which lasted for four weeks. Five experimental diets for finisher phase (20%CP) were formulated in which differently processed African locust bean fruit pulps partly replaced maize. The ALPF were fermented, cooked and or toasted. The processed ALPF replaced maize at 0%

(control), 20% raw, 20% fermented, 20% cooked and 20% toasted coded as diets 1, 2, 3, 4 and 5 respectively. The percentage composition of the experimental diets is presented in Table 1.

At the end of the feeding trial, blood samples were collected using a 5ml syringes by puncturing the brachial vein (wing vein). Thereafter 2mls of blood was obtained from four (4) birds selected per treatment making a total of 20 birds in all. The collected blood samples were maintained in a test-tubes containing ethylene diamine tetra-acetate (EDTA). The samples were taken to laboratory and used for the determination of haemoglobin concentration (Hb), packed cell volume (PCV), red blood cell count (RBC), and white blood cell count (WBC) of the experimental birds.

Also forty birds (ten birds per treatment) were randomly selected, the birds were starved for 12 hours after which the final live weight was recorded before slaughtering. The birds were slaughtered and dressed, then carcass weights, eviscerated weights, plucked weights were determined. carcass weight was expressed as percentage of live weight of the birds to obtain the dressing percentage. Similarly, the guts weights (gizzard, small intestine weight, and large intestine weights) were determined by using a digital weighing scale while length of small intestinal, large intestine, ceacum were measured with a meter rule.

All the data obtained from the study were subjected to one way analysis of variance ANOVA using SPSS version 23 (19). Significant means were separated using Duncan's Multiple Range Test (DMRT).

Table 1: Percentage composition of the experimental diets fed to broiler chickens at the finisher phase (5 – 8 weeks)

			Diets		
Ingredients	1	2	3	4	5
Maize	48.72	38.89	38.89	38.89	38.89
ALFP	0.00	9.74	9.74	9.74	9.74
Soya bean	29.78	29.78	29.78	29.78	29.78
Wheat offal	15.00	15.00	15.00	15.00	15.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Limestone	0.70	0.70	0.70	0.70	0.70
+ Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.35	0.35	0.35	0.35	0.35
Methionine	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
CP (%)	20.00	20.00	20.00	20.00	20.00
ME (Kcal/kg)	3100	3000	3000	3000	3000
Crude fibre (%)	4.30	5.09	5.09	5.09	5.09
Calcium (%)	1.14	1.14	1.14	1.14	1.14
Phosphorus (%)	0.66	0.66	0.66	0.66	0.66

+ A bio-organics nutrient supplement containingVit A; 4000000 i.u,Vit. D3; 800000 i.u, Vit. E; 9200mg; Niacin 11000mg; Vit. B2 2000mg; Vit. B6, 1200mg; Vit. B12 6mg; Vit. K3 800mg; Pantothenic acid 3000mg; Biotin 24mg; Folic acid 300mg; Choline Chloride 120000mg; Cobalt 80mg; Copper 1200mg; Iodine 400mg; Iron 8000mg; Manganese 16000mg; Selenium 80mg; Zinc 12000mg; Anti-oxidant 500mg.

Results

The haematological indices observed in the study are presented in Tables 2. WBC (160.04±.46 – 133.98±1.11 $\times 10^3$/µl), RBC (2.45±.03 – 2.25±.01$\times 10^6$µl), HGB (6.80±.04 – 5.85±.25g/dl), MCB (142.90±.41 – 121.60±.51fl), MCH (29.10±.10 – 24.90±.07pg) and MCHC (22.00±.71 – 17.50±.20g/dl) were all significantly ($p < 0.05$) influenced while, haematocrits values (HTC) were not significantly different across the dietary treatments. In addition, diertary treatment significantly affect ($P<0.05$) procalcitonin (0.02±.00 -0.01±.00%), neutrophils (118.28±.87 – 20.87±.02$\times 10^3$/µl), lymphocytes (115.54±.30 – 40.57±1.92$\times 10^3$/µl), monocytes (2.35±1.15 – 0.02±.00$\times 10^3$/µl), eosinophils (0.02±.00 – 0.00±.00$\times 10^3$/µl) and basophils (10.94±.09 – 1.15±.01$\times 10^3$/µl).

The result of the carcass and internal organs characteristics of finisher broiler fed African locust bean fruit pulps based diets is presented in Table 3. dressing percentage (80.84±.53 – 77.01±1.16%), carcass weights (1.35±.04 - 131±.03 kg), were significantly ($p<0.05$) affected, while live weights results were similar across the treatment groups. Also, gizzard weights (4.20±.23 – 3.13±.09%), abdominal fats weights (1.27±.26 – 0.37±.03%), and lungs weights (0.48±.02 – 0.34±.05%) were ($P<0.05$) affected, but hearts weights, livers weights, spleen weights, pancreas weights, small intestine weights and lengths, and large intestine weights were all similar across the diets.

Discussion

The white blood cell (WBC) was highest in broilers fed cooked and toasted African Locust Beans Fruits Pulps (ALBFP) diets and was significantly different from those fed with fermented ALBFP and control diets. The lowest WBC value was obtained in those fed with raw ALBFP. The higher values of WBC obtained were in similar trend to those reported by (20). However, the red blood cells (RBC) were least in broilers fed with fermented and cooked ALBFP diets and the highest RBC was recorded in those fed with toasted ALBFP diet. The increase in the RBC was recorded by (21) who used parkia on broilers as energy source. And also (20) reported similar values. Haemoglobin value was significantly higher in broilers fed raw ALBFP compared to other groups similar to the report of (21). Haemoglobin values were similar across the remaining experimental groups of broilers and was below the normal range. Haematocrit contrary to haemoglobin values, was not significantly different among diet groups.

The highest mean corpuscular volume (MCV) was observed in broilers fed cooked ALBFP diet, followed by those fed with fermented ALBFP diet. While those fed raw ALBFP and control diets followed in MCV values. The MCV value was obtained in those fed toasted ALBFP diet. This showed that there was no normal trend in the increase of the MCV. However, (21) who used parkia on broilers as energy source reported lowered level of MCV. The highest value of MCV reported in the present study contradict the findings of (22) who reported highest value of MCV in the control.

The MCH values were similar between those fed control diet and fermented ALBFP. The least values for MCH were obtained in those cooked and toasted ALBFP based diets. This showed that the MCH was unaffected which is in line with the study of (21). The Mean Corpuscular Haemoglobin Concentration (MCHC) was significantly higher in broilers fed raw ALBFP based diet. This is followed by those fed control diet, fermented and toasted ALBFP based diets. The lowest MCHC value was obtained in those fed with cooked ALBFP based diet. The highest Platelet (PLT) was obtained in broilers fed toasted ALBFP diet, followed by those fed with raw, cooked and control ALBFP based diets. The least PLT was obtained in those fed with fermented ALBFP diet. However, The MCHC was almost within normal range.

The highest procalcitonin (PCT) was obtained in broilers fed toasted ALBFP diet. The procalcitonin values were similar across the remaining groups of broilers. The highest significance difference ($p < 0.05$) of Neutrophils (NEUT) was obtained in broilers fed with toasted ALBFP diet, this is followed by fermented, raw and control ALBFP based diet.

The highest lymphocytes (LYMPH) was obtained in broilers fed with Control and Cooked ALBFP based diet. The Lymphocytes values were found to be similar among raw and fermented ALBFP based diet. While those fed with toasted ALBFP based diet have a least significant difference among the treatment. Moreover, the highest Monocytes value was obtained in broilers fed with Control, followed by fermented and cooked ALBFP based diet. The raw and toasted ALBFP based diets have similar values of least significant difference among the treatment.

The highest mean value of Eosinophils (EO) was obtained in broilers fed with toasted ALBFP based diet. The EO values were similar across the remaining groups of broilers. The highest significance mean of Basophils (BASO) was obtained in broilers fed with cooked ALBFP diet, followed by control, fermented, raw and toasted ALBFP based diet.

The result of the carcass and internal organs showed significant difference for dressing percentage ($P<0.05$), plucked weight, ($P<0.05$), eviscerated weight, ($P<0.01$) and carcass weight, ($P<0.01$) while other gut dimension parameters observed showed none but gizzard and abdominal fat weights were significantly ($P<0.001$) affected across the diets. The result of carcass weight, pancreas weight and spleen is in agreement with the findings of (23) who observed the effect of different fat on carcass trait of Japanese quails.The result of the plucked weight is not in agreement with the findings of (24) who evaluated the effect of feeding broilers with millet, low and high tannin sorghum based diet compared with maize. This is in agreement with the findings of (25) who study performance, serum lipid profile and immune competence of broiler fed graded levels of finger millets and found significant difference for gizzard and spleen weight, this also agreed with the findings of (25) who reported significant difference in relative weight of spleen weight as influenced by variation in different energy sources. The low carcass weight observed in diet 2 (0.97 kg) and 3 (1.17 kg) may be attributed to low protein and presence of tannin in Africa locust fruit pulps based diet which depress nutrient digestion and utilization as reported by (26). (25) who reported that the relative weight and length of intestine were not significantly affected by variation in dietary energy sources, it also agrees with the findings of (27) who uses corn snacks waste on the performance of broilers. There result equally, agrees with the findings of (28) who observed no significant difference across the dietary treatment for dressing percentage, small intestine weight, large intestine weight, Abdominal fat weight, Caecal weight and pancreases weight of broiler chicken fed graded levels of germinated red jigari sorghum as replacement for maize.

Table 2: Haematological parameters of finishers broiler chicken fed African Locust Bean fruit pulp based diet.

Parameters	1	Diets 2	3	4	5	LOS
HTC (%)	31.20±.12	30.90±.45	30.90±.75	32.50±1.24	29.80±.04	NS
WBC(10^3/µl)	145.31±.83^{b}	133.98±1.11^{c}	145.49±1.16^{b}	158.73±4.25^{a}	160.04±.46^{a}	***
RBC(10^6/ µl)	2.34±.01^{b}	2.34±.02^{b}	2.25±.01^{c}	2.24±.02^{c}	2.45±.03^{a}	***
HGB (g/dl)	6.10±.03^{b}	6.80±.04^{a}	5.90±.08^{b}	5.85±.25^{b}	6.10±.04^{b}	***
MCV (fl)	133.30±.72^{c}	132.10±.27^{c}	137.30±.76^{b}	142.90±.41^{a}	121.60±.51^{d}	***
MCH (pg)	26.10±.35^{b}	29.10±.10^{a}	26.20±.33^{b}	25.00±.41^{c}	24.90±.07^{c}	***
MCHC (g/dl)	19.50±.29^{b}	22.00±.71^{a}	19.10±.08^{b}	17.50±.20^{c}	20.50±.20^{b}	***
PLT (10^3/µl)	12.00±.41^{bc}	13.00±.82^{b}	10.00±.00^{c}	13.00±.00^{b}	16.00±.82^{a}	***
PCT (%)	.01±.00^{b}	.01±.00^{b}	.01±.00^{b}	.01±.00^{b}	.02±.00^{a}	***
NEUT (10^3/ µl)	20.87±.02^{c}	49.86±.41^{c}	57.58±.17^{b}	32.06±.06^{d}	118.28±.87^{a}	***
LYMP(10^3/ µl)	115.54±.30^{a}	81.62±.88^{b}	83.74±.30^{b}	114.73±1.20^{a}	40.57±1.92^{c}	***
MONO(10^3/ µl)	2.35±1.5^{a}	.00±.00^{c}	.75±.03^{b}	1.00±.00^{b}	.02±.00^{c}	***
EO(10^3/ µl)	.00±.00^{b}	00±.00^{b}	00±.00^{b}	00±.00^{b}	.02±.00^{a}	***
BASO(10^3/ µl)	6.55±.30^{b}	2.32±.07^{d}	3.37±.01^{c}	10.94±.09^{a}	1.15±.01^{c}	***

*** = Highly significant, NS= Not significant, LOS= Level of significance, HTC= Haematocrit, RBC= Red Blood Cell, WBC= White Blood Cell, Hb= Haemoglobin Concentration, MCV= mean corpuscular volume, MCH= mean corpuscular haemoglobin, MCHC= mean corpuscular haemoglobin concentration, PLT= Platelet, NEUT = Neutrophils, LYMP = Lymphocytes , MONO = Monocytes. EO = Eosinophils . BASO = Basophils.

Table 3: Carcass and internal organs characteristic of finishers broiler chicken fed African Locust Bean fruit pulp based diet.

Parameter	T1	T2	T3	Diets T4	T5	LOS /SEM
Dressed percent	77.01±1.16^{c}	79.75±1.24^{abc}	80.84±0.53^{a}	80.32±1.22^{ab}	78.55±0.83^{bc}	*
Live wgt(kg)	3.23±1.81	1.61±1.81	1.67±0.02	1.67±0.03	1.41±0.02	NS
Plucked wgt(kg)	1.42±0.05^{b}	1.51±0.02^{ab}	1.57±0.05^{a}	1.57±0.03^{a}	1.41±0.04^{b}	*
Eviscerated wgt	1.32±0.03^{b}	1.41±0.02^{ab}	1.47±0.05^{a}	1.47±0.04^{a}	1.31±0.03^{b}	**
Carcass wgt(kg)	1.18±0.04^{b}	1.27±0.3^{ab}	1.37±0.05^{a}	1.35±0.04^{a}	1.31±0.03^{b}	**
Head(%)	3.05±0.07^{a}	2.93±0.05^{a}	2.83±0.10^{a}	2.57±0.09^{b}	2.59±0.09^{b}	***
Legs(%)	3.59±0.02	3.40±0.08	3.60±0.13	3.42±0.26	3.03±0.09	NS
Gizzard(%)	3.93±0.14^{ab}	4.20±0.23^{a}	3.99±0.10^{ab}	3.13±0.09^{c}	3.69±0.12^{b}	***
Heart(%)	0.50±0.03	0.55±0.03	0.53±0.02	1.29±0.55	0.47±0.02	NS
Liver(%)	1.90±0.08	1.80±0.11	1.98±0.05	1.54±0.02	1.68±0.08	NS
Abd. fat	0.37±0.03^{b}	0.59±0.08^{b}	0.49±0.07^{b}	1.27±0.26^{a}	0.72±0.13^{b}	***
Small Intestine(%)	6.24±0.60	7.63±0.28	67.53±39.59	5.55±0.78	5.19±0.58	NS
S/intestine L (cm)	133.24±39.39	221.57±6.54	176.61±38.75	195.93±4.07	199.62±15.16	NS
L/intestine (%)	9.04±8.42	0.54±04	3.88±2.07	0.59±0.04	0.52±0.03	NS
L/intestine L (cm)	10.80±0.49^{b}	12.27±0.56^{ab}	13.43±0.43^{a}	12.90±0.51^{a}	12.10±0.51^{ab}	**
Pancreas(%)	0.39±0.03	0.39±0.02	0.44±0.03	0.30±0.04	0.32±0.03	NS
Spleen(%)	0.10±0.01	0.09±0.01	0.07±0.01	0.08±0.01	0.27±0.12	NS
Lungs(%)	0.48±0.02^{a}	0.56±0.01^{a}	0.34±0.05^{b}	0.50±0.01^{a}	0.52±0.03^{a}	***

abcMeans bearing different superscriptions the same error in raw, NS =Not significant**,** LOS level of error , SEM=standard error of means, *significant ($p<0.05$), ** significantly $p<0.01$); *** highly significant

Conclusion and Applications

This study revealed that:

1. The haematological, carcass and guts characteristics were not adversely affected by the inclusion of variously processed African locust bean fruit pulps partially replacing maize as dietary energy sources.
2. African locust bean fruit pulps can be used to replace 20% of maize as dietary energy sources without negative effects on the haematological and carcass characteristics of finisher broiler chickens.
3. Our forest and or tree resources in addition to African locust bean fruit pulps should be investigated for potential usage as poultry feed resources to reduce pressure on cereal and legume grains in the diets of poultry.

References

1. Abeke, F.O. (2005). Evaluation of the nutritive value of lablab purpureus beans in replacing groundnut cake in Poultry diets. Ph.D.thesis, Animal Science Department, ABU, Zaria.
2. Bawa, G.S., Tegbe, T.S.B. and Ogundipe, S.O. (2003). Effect of Feeding Graded Levels of Lablab Seeds as a replacement for Soya beans on Performance Characteristics of Young Pigs. Proceedings of the 28th Nigerian Society for Animal Production conference, Ibadan, 28: 230- 232.
3. Christopher, D. Pierre, C. and Claude, C. (1997). The impact of livestock and fisheries on food availability and demand in 2020.*American Journal of Agricultural Economics.***79** (5): 1471-1475.
4. Obioha, F.C. (1992). A Guide to Poultry production in the Tropics (1st Ed). ACENA Publishers Ltd,Enugu, Nigeria.
5. Uchegbu, M.C. and Udedibie, A.B.I. (1998).Maize sorghum-based dried brewers` Grain in broiler finisher diets.*Nigerian journal of animal production,* **25** (1) :13
6. Nwajiuba, C., Nwoke, E. (2000). "Inflation and the Poultry Industry in Nigeria: Implications for profitability". In: Orji, U.I., Mgbere, O.O. (eds) Proceedings of the 5th Annual Conference of the Animal Science Society of Nigeria. Port Harcourt, Nigeria, pp. 206-208.Amos, T.T (2006)." Analysis of backyard poultry production in ondo state, nigeria". *International Journal of Poultry Science,* **5**(3):247-250.
7. Ologhobo, A. D., Apata, D. F., Oyejide, A. and Akinpelu, O. (1993). Toxicity of raw lima beans (*Phaseolus lunatus* L.) and Lima beans fractions for growing chicken. *British Poultry Science,* **34:505-**522.
8. Adeniyi, A.A. and Balogun, O.O. (2002). Utilization of flavour treated blood-rumen content mixture in the diets of laying hens. *Nigerian Journal of Animal Production,* **29**(1):34-39.
9. Fadipe, A. A. (1996). The Nigerian livestock sub-sector. Reviving it. A key note address at the 21st Annual Conference of Nigerian Society of Animal Production held at University of Uyo,
10. Ogbonna, J.U. Adebowale, E.A.Tewe, O.O. and Longe, O.G. (1993).Replacing Maize and Wheat offal in diets of Cockerels with Sundried Cassava peel meal. Effects on the digestibility of cell wall constituent. *Nigerian Journal of Animal Production*. **20**:111-121.
11. Dafwang, I.I. Shwarmen, E.B.N. (1996). Utilisation of rice offal in practical rations for Broiler chicks. *Nigerian Journal of Animal Production*. 23 (1 and 2): 21-23.
12. Bot, M. H., Bawa, G. S. and Abeke, F. O. (2013).Replacement value of maize with African locust beans (Parkia biglobosa) pulp meal on performance, haematological and carcass characteristics of broiler. *Nigerian Journal of Animal Science*, **15:59**-70
13. Uwaegbute, A.C. (1996). African Locust

beans in: foods from legumes and oils seed. (E. Nwokzla J.A. Smart ods). Chapman and hall, London. P 124-129.

14. Hassan, l. G. and Umar, K. J. (2005). Protein and amino acids composition of African locust bean *(Parkiabiglobosa)*. *Tropical and subtropical Agro-ecosystems,* **5:45-**50.
15. Owoyele, J. A., Shok, M. and Olagbemiro, T. (1987).Some chemical constituent of the fruit. Assessment of the welfare of food restricted male broiler breeder poultry with musculo-skeletal disease. *Res.Vet.Sci.*,**57**: 28-34
16. Akoma, A.O., Onuoha, S.A. and Ozigis, A.A. (2001). Physic-chemical attributes of wine produced from yellow pulp of *Parkia biglobosa* using traditional juice extraction Technique. *Nigerian Food Journal.***19**:76-79.
17. Gernah, D.I. Atolagbe, M.O. and Echegwo, C.C. (2007). Nutritional composition of the African locust bean (*Parkiabiglobosa*) fruit pulp. *Nigeria food Journal,* **25** (1):190-196.
18. Fox, B. A. and Cameron, A.G. (1989). Food Sciences, Nutrition and Health.15th Edition. Edward Arnold, London.
19. SPSS, (2015) Statistical Package for Social Sciences. Version 23.0 SPSS Inc. Pp. 16 – 19.
20. Lakurbe, O. A., Doma, U.D., Bello, K.M. and Abubakar, M. (2018). Carcass characteristics and blood components of broiler chickens fed sorghum sk-5912 (sorghum bicolorl. moench) variety in mixture with different plant protein sources. *Nigerian Journal of Animal Science***,** **20** (2): 250-257.
21. Bot, M.H. (2011). Evaluation of African locust beans (*Parkia biglobosa)* pulp for broiler chickens as an energy source. Ms.c thesis, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria.
22. Akanji, A.M., Fasina, O.E., Ogungbesan, A.M. and Adeleke, G.A. (2016). Laying performance, haematology and serum biochemical profile of hens fed unfermented and fermented African locust beans. *Journal of Tropical Agriculture, Food, Environment and Extension,* **15**(1):1-5.
23. Hazim, J., Al Daraji, H. A., AlMashadani, H. A., Mirza, W. K., AlHayani and Al Hassani, A. S. (2011). Effect of feeds containing different fats on certain carcass parameters of Japanese quails. *Journal of Agric. and Biological Science,* **6:6-**11.
24. Medugu, I.C., Kwari, I.D., Igwebuike, J., Nkama, I., Mohammed, I.D. and Hamaker, B. (2010). Performance and economics of production of broiler chickens fed sorghum or millet as replacement for maize in the semi-arid zone of Nigeria. *Agriculture and Biology Journal of North America,* 1(3):321-325.
25. Rama Rao, S. V., Raju, M. V. L. N., Reddy, M. R. and Panda, A. K. (2004). Replacement of yellow maize with pearl millet (*Pennisetum typhoides*), Foxtail millet (*Seteria italic*) or finger millet (*Eleucine coracana*) in broiler chicken diet containing supplemental enzymes. *Asian-Aust. Journal of Animal Science,* **17:836-**842.
26. Widodo, W. K., Kamal, M. and Ardhana, M. M. (1996). The effect of levels of two varieties of sorghum in diets on broiler performance. *Agrivita,* **19:107-**109.
27. Zand, N. and Froudi, F. (2011). Effect of feeding different levels of corn snscks waste on broiler performance. *African Journal of Biotechnology,* **10:1260-**1264.
28. Iliya, D. S. (2008). The effect of graded levels of germinated red jigari sorghum (*Sorghum bicolor,* L) on the performance of broiler chickens. M. Sc. Thesis, Abubakar Tafawa Balewa Univeersity, Bauchi, Nigeria.