Nig. J. Anim. Prod. 2023, 50(2):25 - 33 https://doi.org/10.51791/njap.v50i2.3778 *Nigerian Journal of Animal Production*

Influence of some cereal by-products on performance, carcass characteristics and blood profile of broiler chickens

Egbewande, O. O., *Mohammed, L., Musa, V. A.,Salahu, B. S. and Abdulmalik, U. W.

Department of Animal Production, Faculty of Agriculture, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria.

***Corresponding author:** mohdlawal@ibbu.edu.ng 08138376600

Abstract

An 8 week research was conducted to evaluate the growth performance, carcass characteristics and blood profile of broiler chickens fed sorghum offal, rice bran and cowpea shell as sources of fibre. Diet 1 contained wheat offal as the control, diet 2 contained sorghum offal, and diet 3 contained rice bran while diet 4 contained cowpea shell. The final weight of the birds fed the test ingredients showed that there was no significant ($p>0.05$) difference between birds fed T1 and T4. However, those fed T4 had the highest value (2.12kg) and the least final weight gain (1.49kg) was recorded among birds fed rice bran(T3). Similarly, no significant ($p>0.05$) difference was observed in most of the cut-up parts parameters except for the back where there was with birds fed with cowpea shell (T4) having the highest treatment mean and T2 having the lowest treatment mean. There were no significant ($p>0.05$) differences in packed cell volume, white blood cell and mean corpuscular haemoglobin of the birds. Significant ($p<0.05$) differences were however observed in haemoglobin, red blood cell, mean corpuscular hemoglobin and mean corpuscular volume. There were also significant ($p<0.05$) differences in the total protein, albumin and globulin contents of the birds fed wheat offal (T1) having the highest value (6.20g/dl) while those fed cowpea shell (T4) recorded the lowest mean value for total protein. The same trend occurs in globulin where birds in T1 had the highest value for globulin and those in T4 had the least. Birds in T4 had the highest mean value while those in T2 had the lowest for Albumin. Therefore, birds fed T4 (cowpea shell) performed as good and in some instance even better than those fed wheat offal (control diet) (wheat offal) and as such recommended.

Keywords: sorghum, rice, cowpea, performance, blood

Running title: Effect of sorghum offal, rice bran and cowpea shell on performance and blood profile of broiler chickens.

Influence de certains sous-produits céréaliers sur les performances, les caractéristiques des carcasses et le profil sanguin des poulets de chair

Résumé

Une recherche de 8 semaines a été menée pour évaluer les performances de croissance, les caractéristiques des carcasses et le profil sanguin de poulets de chair nourris avec des abats de sorgho, du son de riz et des coques de niébé comme sources de fibres. Le régime 1

contenait des abats de blé comme témoin, le régime 2 contenait des abats de sorgho et le régime 3 contenait du son de riz tandis que le régime 4 contenait des coquilles de niébé. Le poids final des oiseaux nourris avec les ingrédients testés a montré qu'il n'y avait pas de différence significative (p > 0,05) entre les oiseaux nourris avec T1 et T4. Cependant, ceux nourris avec du T4 avaient la valeur la plus élevée (2,12 kg) et le gain de poids final le plus faible (1,49 kg) a été enregistré parmi les oiseaux nourris avec du son de riz (T3). De même, aucune différence significative (p>0,05) n'a été observée dans la plupart des paramètres des parties découpées sauf pour le dos où il y en avait avec des oiseaux nourris avec des coques de niébé (T4) ayant la moyenne de traitement la plus élevée et T2 ayant la moyenne de traitement la plus faible. Il n'y avait pas de différences significatives (p > 0,05) dans l'hématocrite, les globules blancs et l'hémoglobine corpusculaire moyenne des oiseaux. Des différences significatives (p < 0,05) ont cependant été observées au niveau de l'hémoglobine, des globules rouges, de l'hémoglobine corpusculaire moyenne et du volume corpusculaire moyen. Il y avait également des différences significatives (p < 0,05) dans les teneurs totales en protéines, albumine et globuline des oiseaux nourris avec des abats de blé (T1) ayant la valeur la plus élevée (6,20 g/dl) tandis que ceux nourris avec des coques de niébé (T4) enregistraient la moyenne la plus faible valeur pour les protéines totales. La même tendance se produit pour la globuline, où les oiseaux en T1 avaient la valeur de globuline la plus élevée et ceux en T4 en avaient le moins. Les oiseaux en T4 avaient la valeur moyenne la plus élevée tandis que ceux en T2 avaient la valeur moyenne la plus faible pour l'albumine. Par conséquent, les oiseaux nourris avec du T4 (coquille de niébé) ont eu des résultats aussi bons, voire meilleurs dans certains cas, que ceux nourris avec des abats de blé (régime témoin) (abats de blé) et sont donc recommandés.

Mots-clés: sorgho, riz, niébé, performance, sang

Introduction

The increasing demand for animal protein in developing nations has resulted in the production of fast growing animals, such as poultry (Obinne and Okorie, 2008). This is ascribed to population growth in these countries. In Nigeria, the difference between production and consumption of animal protein is below the recommended level. This according Adesehinwa (2008) poses threat to food security which may eventually lead to malnutrition. As such, several attempts have been made to increase animal production in the country. Most of the efforts were directed to poultry production. The policy to increase the production of poultry is seen as definite way of bridging the gap between production and intake of animal protein (Adesehinwa, 2008). Atteh (2004) noted that the protein from poultry meat is of high quality, and in several cases it is used as a standard against which other animal proteins are compared. This is because broiler chicken grows very fast and provides tender meat for human consumption. However, the major problem facing the industry is availability of poultry feed at affordable prices.

Alternative feed ingredients also referred to as non-conventional feedstuffs are mostly agro-industrial by-products. The importance of agro-industrial by-products and the so-called "wastes" according to Sanni and Ogundipe(2005) in meeting the energy and protein requirements of farm animals is best appreciated when it is understood that feeding alone accounts for about 60 to 85% of the cost of intensively reared monogastric animals. In an attempt to increase poultry production, nutritionists

have tried to harness and utilize agro-industrial by-products that are not directly utilized by humans. Adeniyi and Balogun (2002) reported that research into the use of cheaper industrial by-products and wastes have been strengthened in the last few years to determine the efficiency of their utilization in terms of growth and production. 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. Increasing the level of fibre in poultry feeds may enhance performance (Sklan, *et al.,* 2003).

Incorporating different fibre sources in the poultry diets, according to Ojewola, *et al.* (2001), has the ability to produce lean carcass, lower production cost, promote bowel movement which aids digestion and supply nutrients such as vitamins, minerals and some unidentified factors which improve growth, reduce the cost of wheat barn and provide a close substitute. It is against this background that this study investigated the effect of replacing wheat offal with rice bran, sorghum offal and cowpea shell on the performance of broiler chickens.

Materials and methods

Experimental location

The research was conducted at the Poultry Production Unit, Teaching and Research Farm, Ibrahim Badamasi Babangida University, Lapai, Niger State. Geographically, the location lies between latitude 9°02 and 6°34 of the equator. Agro-ecologically, the area falls within the Southern Guinea Savannah Vegetation Zone of Nigeria with mean rainfall ranges between 1100 and 1600mm andmean temperature between 21°C and 36.5°C (Usman, 2013).

Sources of the test ingredients

The test ingredients and maize were obtained from local millers in Lapai market. Wheat offal, groundnut cake, premix, bone meal, methionine, lysine, fish meal and salt were obtained from a reputable feed ingredients shop at Gidan-Matasa, Minna, Niger State.

Experimental diets

Four experimental diets were formulated. The diets contained test ingredients to replace wheat offal at 100% weight for weight inclusion level (Tables1 and 2).

Diet 1 (T1) contained wheat offal and served as control.

Diet 2 (T2) contained sorghum offal.

Diet 3 (T3) contained rice bran.

Diet 4 (T4) contained cowpea shell

Table 1: Gross composition of experimental broiler starter diet

Ingredients (%)	Treatments			
	T1 (WO)	T2 (SO)	T3 (RB)	T4 (CS)
Maize	48.31	48.31	48.31	48.31
Groundnut cake	34.09	34.09	34.09	34.09
Wheat offal	10.00	-	-	-
Sorghum offal	-	10.00	-	-
Rice bran	-	-	10.00	-
Cowpea shell	-	-	-	10.00
Fishmeal	3.00	3.00	3.00	3.00
Bone meal	2.50	2.50	2.50	2.50
Limestone	1.00	1.00	1.00	1.00
Vitamin premix	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Lysine	0.30	0.30	0.30	0.30
Methionine	0.30	0.30	0.30	0.30
Total (%)	**100.00**	**100.00**	**100.00**	**100.00**
Calculated nutrient value:				
Crude protein (%)	23.93	23.43	23.58	24.03
Ash (%)	2.50	4.3	7.64	5.27
Crude fibre (%)	4.10	6.0	4.18	4.56
Ether extract (%)	4.48	5.00	12.50	2.65
ME (kcal/kg)	2804.34	2700	2860	2800

**Davo premix: Vitamin A (10,000,000 iu), Vitamin D3 (2,000,000), Vitamin E (20,000mg),Vitamin K3 (2,000mg), Vitamin B1 (3,000mg), Vitamin B2 (5,000mg), Niacin (45,000mg), Calcium pantothenate (10,000mg), Vitamin B6 (4,000mg), Vitamin B12 (20mg), Choline chloride (300,000mg), Folic acid (1,000mg), Biotin (50mg), Manganese (300,000mg), Iron (120,000mg), Zinc (80,000mg), Copper (8,500mg), Iodine (1,500mg), Cobalt (300mg), Selenium (120mg), Antioxidant (120,000mg).*
WO = wheat offal, SO = sorghum offal, RB = rice bran, CS = cowpea shell

Table 2: Gross composition of experimental broiler finisher diet

Ingredient (%)	T1 (WO)	T2 (SO)	T3 (RB)	T4 (CS)
Maize	54.20	54.20	54.20	54.20
GNC	26.20	26.20	26.20	26.20
Wheat offal	12.50	-	-	-
Sorghum offal	-	12.50	-	-
Rice bran	-	-	12.50	-
Cowpea shell	-	-	-	12.50
Fishmeal	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00
*Vitamin premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Lysine	0.30	0.30	0.30	0.30
Methionine	0.30	0.30	0.30	0.30
Total (%)	100.00	100.00	100.00	100.00
Calculated value:				
Crude protein (%)	21.40	20.77	20.90	21.52
Ash (%)	2.16	4.70	8.64	6.27
Crude fibre (%)	4.05	5.07	9.57	11.81
Ether extract (%)	4.44	5.67	7.50	1.65
ME (kcal/kg)	2840.11	2700	2860	2800

**Davo premix: Vitamin A (10,000,000 iu), Vitamin D3 (2,000,000), Vitamin E (20,000mg),Vitamin K3 (2,000mg), Vitamin B1 (3,000mg), Vitamin B2 (5,000mg), Niacin (45,000mg), Calcium pantothenate (10,000mg), Vitamin B6 (4,000mg), Vitamin B12 (20mg), Choline chlorid e (300,000mg), Folic acid (1,000mg), Biotin (50mg), Manganese (300,000mg), Iron (120,000mg), Zinc (80,000mg), Copper (8,500mg), Iodine (1,500mg), Cobalt (300mg), Selenium (120mg), Antioxidant (120,000mg).*
WO = wheat offal, SO = sorghum offal, RB = rice bran, CS = cowpea shell

Management of the experimental birds

A total of one hundred and sixty (160) day old broiler birds were purchased from a repurtable hatchery. The birds were allotted into four treatments of four replicates with 10 birds each in a completely randomized design (CRD). Prior to the arrival of the birds, all necessary scrubbing, cleaning and disinfecting of the pen with disinfectant was carried out. The pen was prepared and the floor was well littered with fresh wood shavings. The chicks were brooded on deep litter using charcoal pot and kerosene lanterns. Anti-stress was given immediately they arrived and feed was also served. The birds were placed on the experimental diet on their arrival. The birds were vaccinated with Gumboro vaccines at the age of one week, Newcastle disease vaccine (Lasota) at two weeks and Gumboro disease vaccine (booster) at three weeks. Similarly, all the necessary routine management practices were duly observed. The experiment lasted for eight weeks, where the birds were fed broiler starter diet for the first 4 weeks and broiler finisher diet for the last 4 weeks.

Data collection

Data were collected on weekly basis as the birds grow based on the following parameters:

Performance evaluation

Feed consumption from each treatment was determined on weekly basis by subtracting left-over from served feed given per group. Adequate measures were taken to safeguard against spillage and related wastage. The mean daily feed intake was calculated by dividing the amount consumed by the number of birds in the group.

Experimental birds were weekly weighed individually using a weighing balance and the weights recorded. The mean live weights of each treatments group were determined by dividing total weight by the total number in that group.

The body weight gain of each of the treatment group was obtained by calculating the difference between the mean live weights of the current week from the mean live weight of the preceding.

$$\text{Mean Feed intake (g/bird)} = \frac{\text{weight of the feed - left over}}{\text{no of birds per replicate}}$$

$$\text{Average feed intake (g/bird)} = \frac{\textit{Total feed intake}}{\textit{No. of the birds}}$$

Total weight gain = Final weight – initial weight

$$\text{Mean body weight} = \frac{\textit{weight of the bird in a replicate}}{\textit{No.of the birds in a replicate}}$$

Feed conversion ratio (FCR) was obtained on weekly basis. It was measured by dividing the mean feed intake per bird in grams by the mean live weight gain per bird for each treatment group.

$$\text{FCR} = \frac{\textit{Feed intake}}{\textit{Body weight gain}}$$

Mortality was recorded as it occurs throughout the feeding trial in each treatment.

$$\text{Mortality (\%)} = \frac{\textit{Number of dead birds}}{\textit{Initial number of birds stocked}} \times 100$$

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA). Significant means were compared using Duncan's Multiple Range Test (Steel and Torrie, 1980).

Proximate analysis of cowpea shell, rice bran and sorghum offal

Nutrients	Cowpea shell	Rice bran	Sorghum offal
Dry matter	92	42.55	62
Moisture	7.59	9.59	5.94
Crude fibre	57.80	12.35	11.20
Ether extract	4.65	2.35	11
Ash	8.27	15.41	3.05
Protein	20.65	17.90	14.54

Results and discussion

Table 3: Growth performance of broiler chicken fed test ingredients.

Parameters	Treatment				SEM
	T1 (WO)	T2 (SO)	T3 (RB)	T4 (CS)	
Initial weight (g)	42.03	42.04	42.03	42.04	
Final weight (kg)	1.96^{a}	1.62^{b}	1.49^{c}	2.12^{a}	8.05
Daily ^{weight} gain (g/bird)	35.00^{b}	28.93^{c}	26.61^{d}	37.86^{a}	0.07
Feed intake (kg)	4.93	4.90	4.52	5.02	4.68
Daily feed intake (g/bird)	88.04	87.50	80.71	89.64	3.52
Feed conversion ratio	2.52	3.02	3.03	2.37	0.56
Mortality (%)	5.00^{b}	5.00^{b}	7.50^{a}	2.50^{c}	0.07

^{a,b,c,d}: Means with different superscripts along the same row are significant ($p<0.05$)

WO = wheat offal, SO = sorghum offal, RB = rice bran, CS = cowpea shell

Results from Table 3 indicate that, there were no significant ($p>0.05$) differences in the daily feed intake, feed intake and feed conversion ratio among the treatments means. Significant ($p<0.05$) difference was observed in the daily weight gain across the treatments. Birds fed T4 (cowpea shell) showed significantly ($p>0.05$) higher average value of daily weight gain compared with those T1 (wheat offal), T2 (sorghum offal) and T3 (rice bran) in that order in average daily weight gain. The values of the daily weight gain obtained in this study were in agreement with the reports of Abeke, *et al.,* (2011) on rice offal (25.0 - 27.5g). The final weight (kg) of the birds fed the test ingredients showed that there was no statistical ($p>0.05$) difference from birds in T1 to T4. The highest final weight (2.12kg) obtained in birds fed cowpea shell may be attributed to the higher protein content (20.85%) as reported by Maidala and Bello (2019), compared with other test ingredients. However, the final weight (1.62kg) of birds fed sorghum offal in this study was lower than what (2.40kg) was reported by Egbewande and Ahmed (2018) for finisher broilers. The discrepancy may be due to storage method involved in each study. Birds fed T3 (Rice bran) recorded the highest percentage of mortality at 7.50% followed by T1 (WO) and T2 (SO) with 5.00% each, while T4 (CS) recorded the least mortality at 2.50%.

Table 4: Cut-up parts of broiler chickens fed test ingredients

Cut-up parts (%)	T1 (WO)	T2 (SO)	T3 (RB)	T4 (CS)	SEM
Dressed weight (kg)	1.46	1.12	1.01	1.62	4.37
Dressing percent	74.49	69.14	67.79	76.42	1.56
Head	2.51	2.47	2.47	2.84	3.11
Back	14.79[a]	12.79[b]	12.85[b]	15.23[a]	0.06
Neck	4.72	4.29	4.51	4.76	4.39
Drumstick	10.53	10.24	9.21	11.43	0.36
Shank	3.60	3.75	4.54	3.89	4.10
Wings	9.14	8.61	7.76	8.66	0.23
Thigh	10.16	9.53	9.53	11.12	0.32
Breast muscle	24.21	18.86	18.86	24.61	0.92

WO = wheat offal, SO = sorghum offal, RB = rice bran, CS = cowpea shell

Table 4 showed that the effects of sorghum offal, rice bran and cowpea shell as replacement for wheat offal on the carcass cut-up parts (head, neck, drumstick, shank, wings, thigh and breast muscle) had no significant ($p>0.05$) difference, except for the back that was significantly ($p<0.05$)different with the highest value (15.23%)obtained from T4 while the lowest value (12.79%) which was obtained from birds fed sorghum offal (T2).The value (12.79%) obtained for back from birds fed sorghum offal in this study is lower than the report of Egbewande and Ahmed (2018) for the same cut-up part although the authors reported no significant ($p>0.05$) difference among the treatments.

Table 5: Visceral organs of broiler chickens fed test ingredients

Visceral organs(%)	T1 (WO)	T2 (SO)	T3 (RB)	T4 (CS)	SEM
Heart	0.90[a]	0.92[a]	0.91[a]	0.68[b]	0.06
Kidney	0.52	0.48	0.69	0.52	0.61
Liver	2.53	2.69	2.55	2.15	0.21
Pancreas	0.37	0.26	0.36	0.38	0.31
Proventriculus	0.90[a]	0.92[a]	0.91[a]	0.52[b]	0.03
Gizzard	2.44[a]	2.50[a]	2.53[a]	2.34[b]	0.21
Spleen	0.60[a]	0.53[b]	0.51[b]	0.56[a]	0.04
Intestine	7.72	7.69	9.97	9.68	10.05
Abdominal fat	1.11	1.24	1.73	1.42	1.16

WO = wheat offal, SO = sorghum offal, RB = rice bran, CS = cowpea shell

Table 5 showed that the treatment means for kidney, liver, pancreas, intestine and abdominal fat was not significantly ($p>0.05$) different in birds fed test ingredients. However, there were significant ($p<0.05$) differences in the heart, Proventriculus, gizzard and spleen of the birds. The highest value of heart of the birds was obtained from T2 (0.92) while the lowest value was obtained from T4 (0.68) and the highest value of Proventriculus was obtained from T2 (0.92) while the lowest value was obtained from T4 (0.52).

There were no significant ($p>0.05$) differences in packed cell volume, white blood cell and mean corpuscular haemoglobin of the birds (Table 6). This is in line with the results obtained by Lakurbe *et al*. (2018) for packed cell volume and white blood cell of broiler chicken fed Sorghum offal. Significant ($p<0.05$) difference was however observed in the treatment means for Hemoglobin, Red blood cell, Mean corpuscular haemoglobin content and mean corpuscular volume, with the control (T1) having the highest value for haemoglobin and T2 having the lowest value, while T4 had the highest mean value for red blood cell while T2 had the lowest value. The haemoglobin (Hb) values obtained in this study were within the normal range for chickens (7-13g/dL) (Banerjee, 2004), and for broilers (8.6 – 10.7g/dL) (Madubuike and Ekenyen, 2006). The Red blood cells (RBCs) values reported in the study for the broiler chickens were within the normal range (2.5 – 3.5 $x10^3/mm^3$) for normal or healthy chickens (Banerjee, 2004) except for those fed sorghum offal (T2). All these were lower than the normal range of 4.21 -4.84 x 10-6/mL reported by WVA (2005) for red blood cell. Mean corpuscular volume (MCV) values obtained in this study agreed with reported values of Kalio and Ingweye (2018) but disagreed with the normal range (81.6 – 89.1*f*l) of WVA (2005). The MCHC values obtained in this study ranged from 23.86% in birds fed cowpea shell (T4) to 38.54% in birds fed wheat offal (T1 were below the range reported for broilers by Adeyemo and Sani (2013).

Serum biochemical showed that there were significant ($p<0.05$) differences in total protein, albumin and globulin contents of the birds with those fed T1 (control) having the highest value (6.20g/dl) while T4 had the lowest mean value5.00g/dl) for total protein. Birds fed T4 (CO) had the highest mean value (3.10g/dl)) and T2 had to lowest for Albumin while T1 had the highest value for globulin and T4 had the lowest level respectively.

Conclusion

The result of the study indicates that cowpea shell, which is available during harvest of cowpea, could be used successfully to replace wheat offal as a source of fibre in broiler feed without any depression or adverse effect on the growth performance and carcass characteristics of poultry birds.

References

Abeke, F. O., Wayebo, H. K., Sekoni, A. A., Otu, M. and Ubani, E. O. 2011. Effects of graded levels of rice offal on the performance of broilers starter. Proceedings of 36th Annual Conference of Nigerian Society of Animal Production, 13-16th March, 2011. University of Abuja. Pp. 355 - 358

Adeniyi, A. A. and Balogun, O. O. 2002. Utilization of flavor treated blood-mixture in the diets of laying hens. *Nigerian Journal of Animal Production*,29(1): 34-39.

Adesehinwa, A. O. K. 2008. Energy and protein requirements of pigs and the utilization of fibrous feedstuffs in Nigeria. *African Journal of Biotechnology*, 725(25): 34 – 39.

Adeyemo,**I**.**A**. and **Sani**,**A. 2013.** Haematological parametres and serum biochemical indices of broiler chickens fed *Aspergillus niger* hydrolyzed cassava peel meal based diet. *IJRRAS*, 15 (3): 410 – 415.

Atteh, J. O. 2004. Theory and practice of poultry production (1st ed., pp. 1–3). Ilorin: Adlek Printers.

Banerjee, G.C.2004.*A textbook of Animal Husbandry*. 8th Edition, Oxford and IBH Publishing Co. PVT. Ltd., 2004, New Delhi, India.

Egbewande, O. O. and Ahmed, Z. 2018. Effect of replacing maize with different

fibre sources in the diet of broiler chickens. *Annals, Food Science and Technology*, 19(3): 623 – 630.

Kalio, G. A. and Ingweye, J. N. 2018. Hematological responses of replacement levels of cassava peels and maize as energy sources in broiler diets. *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, 11(4,1): 73 – 77

Lakurbe, O. A., Doma, U. D., Bello, K. M. and Abubakar M. 2018. Haematological and serum biochemical indices of broiler chickens fed sorghum SK-5912 (L. Moench) variety as a replacement for maize. *Nigerian Journal Animal Production,* 45(3): 242–247

Madubuike, F.N. and Ekenyen, B.U.2006. Haematology and serum biochemistry characteristics of broiler chicks fed varying dietary levels of *Ipomoea asarifolia* leaf meal. *International Journal of Poultry Science*, 5(1): 9-12.

Maidala, A. and Bello, I. B. 2019. Nutritional evaluation of cowpea shell as source of fibre in the diet of broiler chickens. *International Journal of Agriculture and Earth Science*, 2(1):

Obinne, J.I. and Okorie, A.U. 2008. Effect of different crude protein and digestible energy levels on the growth performance of rabbits in the tropics. *Nigeria Journal of Animal Production,* 35: 210-216

Ojewola, G.S., Abasiekong, S.F and Ukachukwu, S.N 2001. Methionine supplementation in the productive efficiency, carcass characteristics and economics of growing indigenous turkey. *Tropical Journal of Animal Science*,4(2):161-170.

Sanni, S. A. and Ogundipe, S. O. 2005. Economics of some modules of poultry production in Kaduna State, Nigeria. *Nigerian Journal of Animal Production*, 32(1): 102 – 107.

Sklan, D., Smirnov, A. and Plavnik, I. 2003. The effect of dietary fibre on the small intestines and apparent digestion inthe turkey. *Br. Poult. Sci.* 44:735-740.

Steel, R. G. D. and Torrie, J. H.1980. Principles and Procedures of Statistics, McGraw Hill International Books Co., Sydney.

Usman, B.A. 2013. Vulnerability and adaptation capability of the rural poor farmers to climate change effect in Kwara State, Nigeria. *Lapai Sociological Review*, 4(1): 142 – 162.

WVA, 2005. World Veterinary Association. Save Poultry Industry by Heat Stress Management. Accessed from: vetscite.org/publish/issues/ 2005-04 on 5/8/08.

Date received: 6th June, 2023
Date accepted: 15th October, 2023