Scientific Papers. Series D. Animal Science. Vol. LXIII, No. 2, 2020
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

EFFECTS OF PLUMAGE COLOUR ON MEASUREABLE ATTRIBUTES OF INDIGENOUS CHICKEN IN NORTH CENTRAL NIGERIA

Joseph Joseph OKOH[1], Samuel MBAP[2], Yusuf MANCHA[2], Tahir IBRAHIM[2]

[1]Department of Animal Science, Faculty of Agriculture, Federal University of Kashere, Kashere, Gombe, Nigeria
[2]Department of Animal Production, Abubakar Tafawa Balewa University, Bauchi, Nigeria

Corresponding author email: okohjoe@yahoo.com

Abstract

The influence of plumage colour on measureable attributes of 6176 adult indigenous chickens of mixed sex from four states of the North Central Zone of Nigeria namely; Nasarawa, Niger, Benue, Kogi and the Federal Capital Territory (FCT) Abuja were assessed. The overall average body weight of the chickens was 1.95±0.03kg. The body weights of black, white, black/white, brown, black/brown, grey and mottled chicken however were 1.87±0.04, 1.94±0.04, 1.95±0.03, 1.93±0.03, 2.01±0.04, 1.96±0.04 and 1.94±0.14 kg respectively. Only body length did not vary by plumage colour. The others; body weight and width, shank, comb and breast length, breast height (P<0.001), beak and wing lengths (P<0.001) varied significantly. Generally, no colour was out rightly superior to others in all body measurements. However, body weight and breast height were both highest in black/brown chickens which also had the second highest breast length. Body width, shank, beak, comb and wing lengths were highest in grey chickens but lowest in those with white colour and combinations. Egg qualities were on the other hand mostly lowest in grey chickens. In selection for genetic improvement in body measurements, black/brown and grey chickens should be favoured. However, in view of the known negative relationship between body weight and egg attributes, selection in favour of grey plumage may result in chickens of poor egg attributes. Therefore, grey chickens should be selected against egg quality.

Key words*: body weight, characteristics, indigenous chicken, measurements, plumage colour.*

INTRODUCTION

Poultry production in Nigeria has undergone some transformation since the 1940s when exotic breeds and intensive production were introduced (Permin and Pedersen, 2000). The indigenous species utilized has been the un-improved domestic chicken (*Gallus gallus domestica*), guinea fowl (*Numida meleagris*), ducks (*Cairina spp*) among others.

The indigenous poultry species of an area are birds that have developed characteristics peculiar to a particular geographical location. Thus chicken which have adapted to the geography and environment of Nigeria are regarded as Indigenous Nigerian Chicken (Oluyemi et al., 1982). These birds have not attained their full potential, this is mostly due to several prevailing circumstances such as sub-optimal conditions, namely poor nutrition and other management practices, diseases, predators (Alemu and Tadelle, 1997) and lack of genetic improvement (Teketel, 1986).

Improvement in the sub-optimal conditions are key to better performance (Okoh et al., 2010). In addition, changes in genetic make-up of birds could produce strains that are ultimately superior to others. Selection to improve performance is a traditional procedure that can be applied even at farmers' level. For the procedure to be successfully carried out (at farmers' level) there should be available some easily observable phenotypic attributes (which the farmer can appreciate) that can indicate performance.

Plumage colour is a chicken's characteristics that can clearly be observed on the outside. Plumage colouration is due to melanin pigmentation and has genetic basis (Marl and Brusbargh, 1971; Mancha, 2004). The colour variations are also due to mixing as a result of crossing between colour types resulting in several other colour categories (Smith, 1965). If plumage colour is found to be related to performance of birds, it could be a useful indicator for selection.

This study apart from providing useful information on the variation in characteristics of chicken in the area according to plumage, could contribute to efforts at genetic changes and improvement.

MATERIALS AND METHODS

The study was carried out in the North Central Zone of Nigeria between January 2014 to March 2018. The area has an average elevation of 1,300 m above sea level. The longitudes and latitudes of the areas are; Benue (7º,12'N; 7º,29'N and 8º,45'E; 9º,24'E), Kogi (7º,12'N; 7º,56'N and 7º,11'E; 6º,58'E), Nasarawa (8º,35'N; 8º,37'N and 8º,09'E; 9º,02'E), Niger (9º,27'N; 9º,46'N and 6º,31'E; 7º,01'E) and the Federal Capital Territory (FCT) (9º,09'N; 9º,20'N and 7º,14'E; 6º,49'E) (Microsoft Encarta, 2008).

The North Central agro – ecological zone of Nigeria experiences a sub humid tropical climate with two distinct seasons, rainy and dry. The rainy season lasts from April to September and received from 1000- 2500mm of rain, while the dry begins in October and ends in March. The two seasons are due to the moisture laden south westerly-wind from the Atlantic Ocean and the dry dusty north-easterly from the Sahara Desert (BSN, 1982). Temperatures are high throughout the year averaging 30º C. Mean annual temperatures per state are Benue 30ºC, Nasarawa 31ºC, Kogi 29º C, Niger 30º C and the Federal Capital Territory 29ºC. The relative humidity ranged from 47 to 85 %. The study area experienced mean daily sunshine duration of 8 hours (TAC, 2002). The vegetation varies considerably. It is best described as savannah, a region of tall grasses and trees.

Farming is the main occupation in the area. Crops cultivated includes: Yam, Soya beans, Rice, Cowpea, Cassava, Sweet potatoes, Sorghum, Maize, Millet, Cocoyam etc. Livestock and poultry are mainly kept as part time farming activities; Cattle, sheep, goats, chicken, ducks, geese, turkeys, pigeons and guinea fowls are kept.

Birds used for the study were scavenging indigenous chickens found within the study area and data were collected as Out - and - On stations.

Traditional management was practiced in the study area. Marked areas were provided for birds at night but are allowed to scavenge freely in the day. Supplementary feeds in the form of house-hold refuse and grains were usually given in the morning before scavenging and later in the evening before gauge (calibrated in mm).

Internal egg characteristics were taken as follows:

Albumen width was determined by carefully separating the albumen and the width measured in rest. Water was supplied at various locations around the home. No vaccination was given and, diseases were controlled by using ethno-veterinary knowledge or slaughter of affected chicken.

Five local government areas (LGAs) were randomly selected from the four states and the Federal Capital Territory (Abuja) and 100 sets of questionnaires were distributed per LGA. Observable characteristics of plumage colours were identified. Body measurements were also carried on 6176 indigenous chickens as outlined by Adekoya et al. (2013) as follows:

- body weight was measured using a sensitive platform scale in kilogram to two decimal places. Linear measurements in centimetres were carried out using a flexible measuring tape;
- body length was measured between the first cervical vertebrate and the pygostyle;
- body width was measured as the distance between the right and the left flank of the body (hind breast);
- beak length was measured as the length of the upper beak rim;
- shank length was determined as the distance from the knee or knuckle (hock joint) to the region of the tarsus;
- wing length was determined as the distance from the caput humeral to the third carpal digit;
- bomb length was taken from the posterior of the comb as the longest distance;
- breast length was measured with a tape as the chicken was held on its back;
- breast height was determined as the distance from the base of the keel to the junction of the neck.

Egg characteristics were determined as follows:

- egg colour was carried out by visual observation and the use of colour chart;

- egg weight was measured using a sensitive platform scale in grams to two decimal places;
- egg length was determined as the distance between the two ends using a Vernier Calliper;
- egg width was measured as the diameter of the broadest part of the egg using a Vernier calliper;
- egg shell weight- The egg was broken and the shell, excluding membrane, immediately weighed in grams using a sensitive scale;
- shell thickness was measured, excluding the shell membrane, using a digital micrometre screw millimetres on a tripod using a micrometre screw gauge;
- albumen height was measured by pouring out the content of the egg into a plate and measured on a tripod micrometre screw gauge (calibrated in mm);
- yolk width was determined by carefully separating the yolk and measured in millimetre on a tripod using micrometre.

The Haugh Unit (HU) value was estimated from the relationship:

$HU = \log (H + 7.73 - 1.7W^{0.36}) 100$

where: H = albumen height; W= egg weight (Haugh, 1937)

Linear measurements, productivity parameters and egg characteristics were also subjected to analysis of variance using the SPSS version 17 (2008). The following model was utilized

$\mathbf{Y_{ijk} = \mu + P_i + S_j + e_{ijk}}$.

Where;

Y_{ijk} = an observation on variable;

μ = overall population mean;

P_l = effect of plumage colour;

S_i = effect of sex (for body measurements only);

e_{ijk} = residual error (Assumed to be randomly, independently and normally distributed with mean equal to zero).

Significantly different means in a subset were separated using the Ryan Einot Gabriel Welsch F- Tests in Statistical package for Social Sciences SPSS Version 17 (2008). Pearson's Correlation co-efficient was computed to test the relationship within and between body traits and egg parameters.

RESULTS AND DISCUSSIONS

The mean body measurements by plumage colour were as presented in Tables 1. Only body length did not vary significantly with plumage. The others (body weight, width, shank, comb, breast lengths and height were significantly ($P<0.01$) affected by plumage. Beak and wing lengths were also affected ($P<0.001$). In general, however, variation in body measurement with colour appears to be haphazard showing no particular trend, that is, no colour was out rightly superior to others in all measurement. However, body weight (2.011±0.040 kg) and breast height (11.77±0.13 cm) were both highest in black / brown chicken. Black/brown chicken also have the second highest breast length (18.24±0.18 cm).

Table 1. Mean body measurements of local chicken by plumage

	Mean ± Standard Error								
Parameter	Black	White	Black/White	Brown	Black/Brown	grey	Mottled	Overall	LS
Body weight(kg)	1.87±0.04^{b}	1.94±0.04^{b}	1.95±0.03^{b}	1.93±0.03^{b}	2.01±0.04^{a}	1.96±0.04^{b}	1.94±0.14^{b}	1.95±0.03	**
Body length(cm)	19.78±0.22	19.44±0.23	19.38±0.21	19.83±0.21	19.39±0.22	19.79±0.25	19.35±0.21	19.57±0.08	NS
Body width (cm)	18.45±0.23^{b}	17.58±0.24^{c}	18.25±0.22^{b}	18.45±0.22^{b}	18.33±0.22^{b}	18.61±0.26^{a}	18.55±0.22^{b}	18.32±0.08	**
Shank length(cm)	9.79±0.41^{b}	8.74±0.42^{b}	8.68±0.39^{b}	9.59±0.38^{b}	9.59±0.39^{b}	10.01±0.46^{a}	8.92±0.39^{b}	9.33±0.14	**
Beak length(cm)	3.03±0.05^{b}	2.93±0.05^{c}	3.13± 0.05^{b}	3.05±0.05^{b}	3.27±0.05^{a}	3.18±0.06^{b}	3.16±0.05^{b}	3.11±0.02	***
Comb length(cm)	2.65±0.04^{b}	2.51±0.41	2.51±0.03^{c}	2.71±0.03^{a}	2.51±0.03^{c}	2.75±0.04^{a}	2.71±0.03^{a}	2.65±0.01	**
Wing length(cm)	14.07±0.32^{b}	14.01±0.33^{b}	14.35±0.30^{b}	14.41±0.30	14.34±0.31^{b}	15.74±0.35^{a}	14.17±0.30^{b}	14.44±0.11	***
Breast length(cm)	18.37±0.19^{a}	17.77±0.19^{b}	17.77±0.18^{b}	17.95±0.18^{c}	18.24±0.18^{a}	18.22±0.21^{a}	18.23±0.18^{a}	18.084±0.06	**
Breast height(cm)	11.72±0.14^{a}	11.60±0.14^{a}	11.67±0.13^{a}	11.72±0.13^{a}	11.77±0.13^{a}	11.71±0.16^{a}	11.36±0.13^{b}	11.65±0.55^{a}	**

LS = Levels of Significant. NS = Not Significant (** = P<0.01, *** = P<0.001). Means in row with different superscripts are significantly different

Table 2. Mean body measurements by plumage and sex

Mean ± Standard Error										
Parameter	Sex	Black	White	Black/White	Brown	Black/Brown	grey	Mottled	Overall	LS
Body weight (kg)	M.	2.14±0.05^{a}	2.22±0.06^{a}	2.22±0.05^{a}	2.25±0.05^{a}	2.32±0.04^{a}	2.28±0.05^{a}	2.27±0.06^{a}	2.25±0.03	**
	F.	1.59±0.07^{b}	1.65±0.05^{b}	1.61±0.05^{b}	1.60±0.06^{b}	1.69±0.05^{b}	1.64±0.08^{b}	1.62±0.05	1.63±0.03	
Body length (cm)	M.	20.49±0.31^{a}	20.62±0.34^{a}	20.23±0.33^{a}	20.71±0.032^{a}	20.62±0.33^{a}	20.01±0.30^{a}	20.16±0.33^{a}	20.55±0.16	**
	F.	19.08±0.39^{b}	18.26±0.30^{b}	18.54±0.30^{b}	18.96±0.33^{b}	18.15±0.30^{b}	18.57±0.45^{b}	18.54±0.30^{b}	18.59±0.16	
Body width (cm)	M.	18.88±0.32^{a}	17.97±0.35^{a}	18.41±0.34^{a}	18.77±0.33^{a}	18.69±0.34^{a}	18.77±0.31^{a}	18.76±0.34^{a}	18.61±0.17	**
	F.	19.08±0.40^{b}	17.20±0.31^{b}	18.09±0.31^{b}	18.13±0.34^{b}	17.97±0.31^{b}	18.45±0.47^{b}	18.34±0.31^{b}	18.04±0.17	
Shank length (cm)	M.	9.25±0.56^{a}	8.38±0.61^{a}	8.38±0.59^{a}	8.93±0.58^{a}	9.47±0.60^{a}	9.64±0.58^{a}	8.52±0.60^{a}	8.94±0.29	**
	F.	10.33±0.71^{b}	9.09±0.54^{b}	8.99±0.55^{b}	10.25±0.60^{b}	9.71±0.54^{b}	10.37±0.82^{b}	9.32±0.55^{b}	9.72±0.29	
Beak length (cm)	M.	3.32±0.07^{a}	3.22±0.08^{a}	3.36±0.08^{a}	3.19±0.07^{a}	3.49±0.08^{a}	3.46±0.07^{a}	3.49±0.08^{a}	3.36±0.04	**
	F.	2.75±0.07^{b}	2.65±0.07^{b}	2.89±0.07^{b}	2.90±0.08^{b}	3.06±0.07^{b}	2.90±0.11^{b}	2.82±0.07^{b}	2.85±0.04	
Comb length (cm)	M.	3.10±0.05^{a}	3.11±0.06^{a}	2.90±0.05^{a}	3.16±0.05^{a}	3.08±0.05^{a}	3.28±0.05^{a}	3.27±0.05^{a}	3.13±0.02	**
	F.	2.20±0.07^{b}	2.25±0.05^{b}	2.12±0.05^{b}	2.25±0.05^{b}	1.94±0.05^{b}	2.27±0.08^{b}	2.16±0.05^{b}	2.16±0.02	
Breast length (cm)	M	18.58±0.26^{a}	18.13±0.28^{a}	18.13±0.27^{a}	18.23±0.27^{a}	18.35±0.28^{a}	18.48±0.26^{a}	18.65±0.28^{a}	18.39±0.13	
	F	18.16±0.33^{b}	17.23±0.25^{b}	17.40±0.25^{b}	17.66±0.28^{b}	18.13±0.25	17.97±0.38^{b}	17.81±0.25^{b}	18.39±0.13	**
Breast height (cm)	M	12.45±0.19^{a}	12.25±0.21^{a}	12.24±0.20^{a}	12.49±0.20^{a}	12.61±0.21	12.50±0.31^{a}	11.66±0.21^{a}	12.31±0.10	
	F	11.01±0.24^{b}	10.95±0.19^{b}	11.09±0.19^{b}	10.96±0.21^{b}	10.94±0.19^{b}	10.92±0.28^{b}	11.06±0.19^{b}	10.99±0.10	**

LS = Levels of Significant. NS = Not Significant (** = P<0.01). Means in column with different superscripts are significantly different.

Body weight, breast height together with breast length and girth are true measure of size in birds (Obioha, 1992). It would therefore appear that black/brown chickens were bigger than others. Body weight, shank, beak, comb and wing lengths were highest in grey plumage chicken but mostly lowest in chicken with white colour and combinations. They were clear and significant (P<0.01) sex dichotomy in body measurements with, as expected, the males being superior except in shank length (Table 2). Shank length were consistently longer in females for all colours and this did not translate into size (weight) advantage.

For egg quality measurements only egg weight, shell weight and thickness did not vary with plumage colour. The others varied significantly (P<0.01) (Table 3). Egg length, width, albumen height and width, yolk width and Haugh unit were highest in mottled (4.00±0.16 cm), white (4.00±0.07 cm), black/white (4.81±0.10 cm), white (19.11±0.28 cm), mottled (13.35±0.23 cm) and black/white (93.00±0.01 cm) chicken respectively. They were however, mostly lowest in grey chicken. It would therefore appear that the grey chicken has the poorest egg quality.

Correlation values were positive and significant at 1%. A few were correlated at 5% but most of them were not. Body weight showed a positive and significant (P<0.01) correlation with body length (0.493), breast height (0.476), and length (0.255), these characteristics are a measure of size in birds (Chineke, 2001). Most egg characteristic were negatively correlated with body weight.

The observation that grey chicken appears to have some of the highest body measurement but poorest egg quality attributes is in accordance with the negative relationship that is known to occur between body weight and egg production in birds (Moran, 1990). This is also supported by the generally negative relationship between them.

Table 3. Mean egg measurements by plumage

Mean ± Standard Error									
Parameter	Black	White	Black/White	Brown	Black/Brown	grey	Mottled	Overall	LS
Egg weight (g)	39.31±0.80	40.05±0.86	38.25±1.14	39.68±0.95	39.28±0.82	40.08±1.03	38.06±0.82	39.27±0.82	NS
Egg length (cm)	3.77±0.07^{b}	3.68±0.08^{b}	3.75±0.18	3.84±0.16	3.66±0.16	3.65±0.21	4.00±0.16	3.63±0.15	**
Egg width (cm)	3.83±0.07^{b}	4.00±0.07^{a}	3.94±0.10^{b}	3.96±0.08^{b}	3.80±0.09^{b}	3.71±0.11^{c}	3.74±0.09^{c}	3.87±0.06	**
Eggshell weight (g)	4.07±0.13	4.27±0.14	4.49±0.19	4.07±0.16	4.33±0.15	3.97± 0.19	4.47±0.15	4.08±0.09	NS
Eggshell thickness (mm)	1.03±1.12	1.93±1.20	0.81±1.60	2.35±1.33	0.42±1.00	0.72± 1.25	0.46±0.99	0.53±0.01	NS
Albumen height(cm)	4.48±0.10^{b}	4.57±0.10^{b}	4.81±0.10^{a}	4.67±0.08^{b}	4.47±0.12^{b}	4.33±0.16^{c}	4.55±0.1^{b}	4.48±0.06	**
Albumen width(cm)	18.87±0.1^{d}	19.11±0.28^{a}	19.01±0.10^{a}	18.58±0.23^{b}	18.75±0.20^{d}	18.46±0.26^{b}	19.05±0.12	18.89±0.17	**
Yolk width (cm)	13.32±0.20^{a}	13.28±0.21^{b}	12.60±0.28^{c}	12.57±0.24^{c}	12.07±0.24^{c}	12.41±0.30^{c}	13.35±0.23^{b}	13.09±0.16	**
Haugh unit	92.02±0.56^{b}	92.33±0.61^{b}	93.80±0.80^{a}	92.88±0.66^{b}	91.89±0.70^{c}	90.90±0.88	92.50±0.70^{b}	92.44±0.47	**

Note: - Ns = Not Significant, (**P<0.01). Means in row with different superscripts are significantly different

Table 4. Correlation of body weight and egg characteristics

	BW	BL	BWi	SL	WL	BeL	CL	BHT	BrL	EW	EL	EWi	ShT	ShW	AW	AHT	YWi	HU
BW		0.493**	0.210**	-0.051	0.293**	0.445**	0.670**	0.476**	0.255**	-0.019	-0.089	-0.005	-0.077	0.168*	-0.067	-0.061	-0.035	-0.057
BL			0.238**	- 0.021	0.284**	0.314**	0.570**	0.462**	0.301**	-0.036	-0.101	0.024	0.067	0.064	0,027	0.030	-0.002	0.037
BWi				-0.016	0.052	0.190**	0.203**	0.124*	0.095	0.024	0.030	0.009	-0.020	-0.039	0.036	-0.100	-0.154	-0.097
SL					-0.034	-0.001	-0.044	0.049	0.015	0.002	0.002	-0.081	-0.008	0.008	0.181*	0.117	0.100	0.113
WL						0.093	0.384**	0.311**	0.054	0.199	0.033	-0.113	-0.099	-0.019	-0.054	0.052	0.040	0.006
BeL							0.518**	0.290**	0.067	-0.037	0.183	-0.005	-0.029	-0.029	-0.100	-0.039	-0.079	-0.031
CL								0.508**	0.212**	0.012	-0.012	-0.100	0.070	-0.043	0.091	0.149*	0.155	0.142
BHT									0.215**	0.143*	0.068	-0.093	-0.018	0.264**	-0.074	0.108*	0.128*	0.075
BrL										-0.012	-0.063	-0.093	-0.029	-0.029	-0.100	0.039	-0.079	-0.031
EW											-0.076	-0.163	-0.018	0.040	-0.010	-0.122	0.003	-0.319
EL												0.099	-0.042	0.006	0.064	0.123	-0.153	0.129
EWi													-0.502	-0.005	-0.055	-0.145	0.126*	0.181*
ShT														0.007	0.003	0.129	-0.001	0.121*
ShW															0.016	-0.044	0.138*	-0.042
AW																0.065	0.008	0.069
AHT																	0.108*	0.97**
YWi																		0.114*
HU																		

* = Significant at P< 0.05 ** = Significant at P<0.01 .BW = Body weight, BL, = Body length, BWi= Body width, SL = Shank Length, WL, = Wing length BeL= Beak Length, CL= Comb Length, BHT= Breast Height, BrL= Breast Lenght. EW= Egg weight, EL= Egg Length, EWi= Egg width, ShT= Shell thickness ShW= Shell weight AW= Albumen weight, AHT = Albumen Heigth, YWi= Yolk width, = Haugh Unit

CONCLUSIONS

In this study, black/brown and grey plumage chicken were generally bigger than other categories but white were smallest. Grey chicken were however poorest in egg quality attributes.

For improved body weight, selection could be carried out in favour of black/brown and grey chicken. However, because of the lower egg quality attributes of grey chicken, care may probably have to be taken, this is because selection in favour of grey chicken may result in mostly poor quality eggs.

ACKNOWLEDGEMENTS

This research work was carried out with the support of the Tertiary Education Trust Fund (TETfund) and the Federal University of Kashere, Gombe State, Nigeria. The Local chicken farmers are also acknowledged for their support in making available their chicken for data collection. I appreciate Mrs Rosemary Ene Okoh and Justice Okoh for their support during my long absent from home for data collection.

REFERENCES

Adekoya, K.O., Oboh, B.O, Adefenwa, M. A. and Ogunkanmi, I. (2013). Morphological characterization of five Nigerian indigenous chicken types. *Journal of science Research Development,* 14, 55 – 66.

Alemu, Y. and Tadelle, D. (1997). The status of poultry research and development in Ethiopia. *Research bulletin*, 4, Debre Zeit, Ethiopia.

BSN (Benue State of Nigeria) (1982). The Government and People of Benue State. *Benue State Gazette. Benue State Ministry of Information.* Onaiviprestery press. Pp 1-9.

Chineke, C. A. (2001). Interrelationship existing between body weight and egg production traits in Olympia black layers. *Nigerian Journal of Animal Production*, 28 (1), 1-8.

Haugh, R. R. (1937). The haugh unit for measuring egg quality. *US Egg Poultry Magazine*. 43, 522-555, 572-573.

Mancha, Y. P. (2004). Characterization of Indigenous Chickens in Northern Part of the Jos Plateau. *A Ph.D Thesis Animal Production Programme, School of Agriculture*, Abubakar Tafawa Balewa University. Bauchi.

Marl, G., Brumbaugh, J. A. (1971). The possible function of location vesicles in melanogenesis of regenerating fowl feather. *Journal of Cell Biology*, 48, 41-48.

Microsoft Encarta, (2008). Geography Search.

Moran, E. T. (1990). Effect of egg weight, glucose administration at hatch, and delayed access to feed and water on the poult at 2 weeks of age. *Poultry Science,* 69, 1718 - 1723.

Obioha, F.C. (1992). A Guide to Poultry Production in the Tropics. *Accra Publishers Enugu*., 11-22, 177-181.

Okoh, J. J., Adeka, A. I., Idogah, E. E., Aku, M. I. (2010). The Effects of major gene on feather traits of local chickens in Benue State of Nigeria. In: Fast Tracking Animal Agriculture In A Challenging Economy. O. J. Babayemi; O. A. Abu; E.O. Ayeola (Editors). *Proceeding of the Nigeria Society for Animal Production 35th Annual Conference*, Ibadan, 95-98.

Oluyemi, J. A, Longe, G. O., Songu, T. (1982). Requirement of Nigerian indigenous fowl for protein and amino acids. *Ife Journal of Agriculture*, 4, 105-110.

Permin, A., Pedersen, G. (2000). Problems related to poultry production at village level. Possibilities. *Proceeding of smallholder poultry projects in Eastern and Southern Africa*, 22-25 May, Morogoro, Tanzania.

Smith, A. J. (1965). Poultry, The Tropical Agriculturist. *Macmillion Education Limited*. London and Oxford, 130.

SPSS (2008). Statistical Package for the Social Sciences, Version 17.

TAC (2002). Technical Air Command Makurdi. Meterological Station. Makurdi Weather Elements records.

Teketel, F. (1986). Studies on the meat production potentials of some indigenous strains of chickens in Ethiopia. *Ph.D. Thesis, J. L. University Giessen, Germany*.