Nig. J. Anim. Prod. 2018, 45(2): 40 - 48

Nigerian Journal of Animal Production

Growth performance, correlation and regression estimates of seven-chicken strains in South-Western Nigeria

Atansuyi, A. J., Ihendu, U. C. and Chineke, C. A.
Department of Animal Production and Health,
The Federal University of Technology, Akure, Ondo State, Nigeria
E-mail of corresponding author: ajatansuyi@futa.edu.ng (+2348034832175)

Abstract

This study was conducted to determine the growth performance, correlation and regression estimates of seven-chicken strains in South-western Nigeria using a total of 300 day-old chicks. The birds were divided into seven groups based on their strain. The seven strains are Normal feather (NF), Fulani ecotype (FE), Frizzle feather (FF), naked neck (NN) and Transylvania indigenous strains while Hubbard and Marshal were meat-type exotic chickens. There were forty- five (45) unsexed day-old chicks in each strain except the Frizzle feather that were 30 in number. Completely randomized design (CRD) was used for the trial that lasted for 8 weeks. The birds were fed experimental diets ad libitum throughout the period of the study. Results showed that there were significant differences (p<0.05) in the initial and final weights of the birds. It was observed that exotic strains weighed heavier (3569.73gHB) than their indigenous counterparts (1391.11gNF). However, the Fulani ecotype weighed heaviest (1840.99g) among Nigeria indigenous strains during the experimental period. This showed that FE strains are generally heavy breed chicken and could be incorporated into a meat producing indigenous chicken if improved upon. The result of the correlation coefficients showed that a very strong, positive and highly significant (P<0.001) relationship existed between body weights and linear body measurements as most of the values are (>0.40). All the body parameter examined had significant (p<0.01) and direct relationship with the body weight. Shoulder-to-tail length (STL) had the highest coefficient of 0.98.The high correlation estimates obtained in this study could be as a result of pleiotropy, heterozygosity or linkage of genes in the birds. The three functions were highly significant (p<0.05) for all the parameters studied. This shows that the functions well described the parameters. On the basis of coefficient of determination (R^2), the body weight of poultry birds at any age can be predicted most accurately with BRG using cubic function.

Keywords: Growth performance, linear body measurements, strains, correlation and regression.

Introduction

The indigenous chickens via Fulani ecotype, naked neck, frizzle and normal feather, found in Nigeria constitute about 80% of the 120 million poultry birds (RIM, 2002). These breeds of chickens contain genes or alleles pertinent to their adaptation to a particular environment and breeding goals (Romanov *et al.*, 1996). Indigenous breeds of chicken are hardy, possess appreciable level of resistances against infectious organisms and adapt well to adverse weather conditions. Hence, malnutritional diseases in rural areas arising from shortage in animal protein intake can be assuaged through the genetic improvement of indigenous chickens (Olawoyin, 2006). The genetic improvement on them can be achieved through the evaluation of body size and conformation (Ibe, 1998). Birds live weight is of importance for determining its food requirements for growth, maintenance and production and for correct dosage in drug administration. Direct determination of live weight involves the use of weighing scales. Proper and accurate estimation of body weight is difficult under field conditions due to lack of weighing scales. Body measurements have been used to predict body weight in chicken particularly where weighing scale is not available (Verma and Hussain, 1983; Gilbert *et al.*, 1993). Linear body measurements such as shank length, drumstick length, breast girth, wing length and body length is used to relate increment in these body parts to the birds overall growth and performance (Gueye, 2003). Changes in linear measurements are indication of tissue growth evidenced in the muscle and fat tissues. These parameters increase in the birds as they grow (Tegbe and Olurunju, 1988; Oke *et al.*, 2006). Correlation coefficients indicate the strength of a linear relationship between two traits and thus, provide useful information about the traits involved for the purpose of breeding and improvement plan (Kityali, 1998). The coefficients of body conformation to growth performance varied from strong to low, positive to negative and significant to non-significant across the ages (Kityali, 1998). Hitherto, little research work has been carried out on indigenous chickens, despite the fact that they are more numerous than commercial chickens. Even though, some researches had been done in the area of breed evaluation and supplementary feeding (Brannang and Pearson, 1990; Abebe, 1992; Negussie and Ogle, 2000; Tadelle and Ogle, 2001), these studies were not tangible enough to show the relative effect of genetic and non-genetic factors on the performance of the local chickens (Alemu and Tadelle, 1997).

Therefore, this study was carried out to evaluate the growth performance and determine the correlation and regression estimates of growth traits of the experimental birds using linear and non-linear functions.

Materials and methods

Experimental site

The study was carried out between June – December, 2016 at the Teaching and Research Farm, Livestock Section (Poultry Unit) of the Federal University of Technology, Akure, Ondo State, Nigeria with Latitude 07° 16¹ and 07° 18¹ N and Longitude 05° 09¹ and 05° 11¹ E. There is a unimodal rainfall pattern which starts from April to October with an average of 1556mm per annum in the state. The average ambient temperature was about 30 - 32°C and relative humidity of 80%.

Experimental animal and layout

A total of 300 day-old chicks of different strains were purchased from a reputable research Farms in Abeokuta, Ogun State, Nigeria. This was made up of 45 pure breeds each of normal feather, naked neck, Fulani ecotype, Transylvania as well as 30 pure strains of frizzle feather chickens. The remaining 90 day-old broiler chicks were marshal and hubbard at 45 for each strain and were also collected from a reputable Hatchery in Ibadan, Oyo State, Nigeria. The study which lasted 8 weeks had the birds distributed into seven treatments according to their genotypes in a completely randomized design (CRD) arrangement with each bird constituting an experimental unit.

Pre-experimental management

All the chicks used for the study were tagged individually on the wings for ease of identification. The initial weights were obtained and the birds were distributed into seven treatments according to their genotypes. There were 45 birds in each genotype except frizzle feather birds that were 30 in number.

Experimental diets

The diet used for the experiment was formulated at the Federal University of Technology, Akure Teaching and Research Farm Feed mill. It was formulated to meet the NRC (1994) requirements and was fed to the birds' *ad libitum* during the period of the experiment. The gross composition (g/100g) of the diet is shown in Tables 1 below.

Table 1: Gross composition of experimental diets (g/100 g)

Ingredients	Composition
Maize	50.00
SBM	21.00
Wheat offal	14.00
PKC	2.00
GNC	6.60
Fish meal	1.50
Bone meal	1.50
Limestone	1.00
Methionine	0.40
Lysine	0.10
Premix	0.50
Salt	0.50
Total	**100**
Calculated Analysis:	
Crude protein (%)	20.40
ME (MJ/kg)	11.20

SBM = Soybean meal, PKC = Palm kernel cake, GNC = Groundnut cake,
ME = Metabolizable energy

Data collection

During the experimental period, birds were individually weighed every week and their weights were recorded accordingly. Likewise, quantities of feed consumed per week per genotype were recorded by deducting the ort from the quantity of feed offered for that week. Weekly feed consumption, weight gain by the birds and feed conversion ratio (FCR) were calculated.

The formula used for calculating the indices above is given as:

FI = FG – WB and FCR = FI/ WG

Where: FI = Feed Intake, FG = Feed given and WB = Weigh back otherwise known as ort and

FCR = Feed conversion ratio, WG = Weight gain.

The linear body dimensions determined was: shank length (SHL), drumstick length (DSL), nose to shoulder length (NTS), trunk length (TRL), shoulder to tail length (STL), breast girth (BRG) and wing length (WGL). The descriptions of the linear body dimensions determined are given below:

- Shank length (SHL): This is the distance from the knee joint to the foot.
- Drum stick length (DSL): This is the distance between the hinge and hock joints.
- Nose to Shoulder (NTS): This is the distance from the nose to the point of the shoulder.
- Trunk length (TRL): This is the longitudinal distance from the point of the shoulder to the tuberosity of the ischium.
- Shoulder to tail length (STL): This is the distance from the point of the shoulder to

pin bone or to the end of coccygeal vertebrae.

- Breast girth (BRG): This is measured as the body circumference just behind the wing.
- Wing length (WGL): This is measured on the dorsal midline to the highest point of the wing.

All measurements were made in the morning before feeding the birds. Each bird was gently restrained in an unforced position before taking any measurement. Feed and body weights were measured using (5kg max.) sensitive weighing scale (g) while the linear body measurements were done with metric measuring tape (cm).

Statistical analysis

Data generated were used to analyze the chicken strains for growth performance, correlation and regression estimates. The data were subjected to one way analysis of variance (ANOVA). The body weight, body linear dimensions and growth performance of the seven-chicken genotypes were compared using the ANOVA option of SAS version 13.0 statistical package (SAS, 2008). Duncan Multiple Range Test (DMRT) was used to separate the means where significant differences existed using the same statistical package at $P<0.05$ probability level. The statistical model used for the analysis is shown below:

$Y_{ij} = \mu + T_i + \Sigma_{ij}$

Where: Y_{ij} = Performance of j^{th} bird in i^{th} strain (j = 1-45)

μ = overall mean

T_i = Fixed effect of the strain (i = 1-7)

Σ_{ij} = Error term

Results and discussions

The growth performance of different strains of experimental birds is shown in Table 2. There were significant differences ($p<0.05$) in the initial weight among all the strains. It could be observed that exotic strains weighed heavier than the Nigerian indigenous strains. This could be as a result of their higher body size and compared with Nigerian indigenous. Marshal recorded the highest (40.16g), followed by hubbard (39.73g) while frizzle feather (FF) recorded the least (27.58g) initial weights. There were significant differences ($p<0.05$) in final weight (FWT) and total weight gain (TWG) among the strains. The significant differences ($p<0.05$) observed in this study was similar to the report of Adedeji *et al.* (2006) where the final, total and weekly weight gain indicated that exotic breed were superior to indigenous breed. This report also corroborates the findings of Yousif *et al.* (2014) that exotic strains were significantly higher than the indigenous ones in terms of growth in their studies on evaluation of carcass characteristics and meat quality of indigenous chicken breeds and exotic broiler strains raised under hot climate. The significant differences ($p<0.05$) in initial weight and final weight among the chicken breeds showed that this trait is highly influenced by genetic factors (Liptoi and Hides, 2006). The superiority in body weight of exotic birds over their indigenous counterpart suggests that they have a better growth potential (Adedeji *et al.*, 2015). This also showed that indigenous chickens are genetically unimproved and are generally light breed birds. Similarly, significant differences ($p<0.05$) in total feed intake (TFI) indicated the exotic were superior in feed consumption than the indigenous strains. Hubbard strain consumed highest feed (4421g) while FF consumed the least (2512g). Also, FE recorded the highest values of TFI (3012g) among the indigenous chickens followed by NN (2597g). This showed that FE strains are generally heavier and could be regarded as heavy indigenous chicken breed. This could earn the breed the opportunity of being considered for incorporation into a meat producing indigenous chicken if improved upon. The total and weekly feed intake for exotic and indigenous birds revealed that exotic strains consumed more feed than indigenous strains. Hubbard broiler was superior to other exotic and indigenous strains in feed intake which could be the reason why it is the heaviest among the strains. This is in concordance with the findings of Binda *et al.* (2012) that Hubbard feed intake was three times that of the indigenous strains.

Finally, feed conversion ratio (FCR) was significantly different ($p<0.05$) among all the strains inferring that the exotic strains utilized their feed efficiently better when compared with Nigeria indigenous counterparts. This could be attributed to their genetic makeup since the breed is the only major source of variation in this experiment. This finding is in variance with that of Abdullah *et al.* (2010) but similar to that reported by Korver *et al.* (2004) that the overall FCR of different strains of broiler were significantly different ($p<0.05$).

The variation observed in all these parameters indicated that exotic strains (HB, MB and TB) performed better than the Nigerian indigenous strains (NF, NN, FF and FE) in terms of growth rate. Hubbard recorded highest values in FWT (3569.73g) and TWG (3530.00g) while NF had the lowest final weight (1391.11g) and total weight gain (1362.41g), respectively. Also, FE weighed heaviest (1840.99g) followed by NN (1451.76g) among Nigeria indigenous strains while NF was the least in final body weight (1391.11g) and 1362.41g total weight gain during the experimental period.

Table 2: Effect of strains on growth performance of experimental birds

Parameter	NF	NN	FF	FE	TB	MB	HB	±SEM
IWT (g)	28.70^c	28.63^c	27.58^c	28.98^c	36.50^b	40.16^a	39.73^a	0.61
FWT (g)	1391.11^d	1451.76^d	1404.95^d	1840.99^c	1966.80^b	3559.73^a	3569.73^a	184.70
TWG (g)	1362.41^d	1423.13^d	1377.37^d	1812.02^c	1930.30^b	3519.58^a	3530^a	132.09
TFI (g)	2552^f	2597^e	2512^g	3012.40^d	3084.6^c	4221^b	4421^a	0.02
FCR	1.89^a	1.92^a	1.88^a	1.68^b	1.60^b	1.20^c	1.25^c	0.20

$^{a, b,, c, d , e, f, g}$ =means on the same row but with different superscripts are statistically ($p<0.05$) significant, FE = Fulani Ecotype Chickens; FF = Frizzled Feather Chickens; HB = Hubbard Breed; MB = Marshal Chickens; NF = Normal Feather Chickens; TB = Transylvanian Breed; Naked Neck Chickens; ±SEM = Standard Error of Mean; IWT= Initial Weight Gain; FWT= Final Weight Gain; TWG= Total Weight Gain; TFI = T3otal Feed Intake; FCR = Feed Conversion Ratio; g =grammes

Table 3 shows simple phenotypic correlation of body weight and linear body measurements of experimental birds. The Table showed that very strong and highly significant ($P<0.01$) correlations existed between body weights and linear measurements of seven chicken strains for all the parameters. This shows that all the body parameters measured had strong, significant ($p<0.01$) and direct relationship with the body weight. The high and positive correlation between body weight and body measurements was in concordance with the findings of Egena *et al.* (2014). Shank length (SHL) from this study was phenotypically the lowest but also significantly ($p<0.01$) correlated to body weight. The shank length of the birds in this study was similar to the work of Ibe (1992) who reported low shank length to body weight. This implies that improvement in body weight cannot bring about appreciable improvement in SHL. The correlations of some body parts like shank length, trunk length, shoulder to tail length and wing length with body weight in this study disagreed with the findings of Kadir *et al.* (2010) who reported higher values of these parameters. The relative high relationship between body weight and shoulder-to-tail length (STL) observed in this study were also reported by (Atansuyi *et al*., 2017) who recorded high correlation between body weight and STL. This shows that the genetic association between STL and body weight is high and could be due to pleiotropy or heterozygozity of genes. This implies that improvement in BRG will bring about improvement in growth rate and body weight in poultry birds.

Table 3: Phenotypic and Genetic correlations of body weight and linear body measurement

Parameter	BWT	SHL	DSL	TRL	STL	BRG	WGL	NTS
BWT	1.00	0.32**	0.90**	0.71**	0.53**	0.83**	0.79**	0.88**
SHL		1.00	0.52**	0.53**	0.49**	0.44**	0.55**	0.44**
DSL			1.00	0.86**	0.90**	0.95**	0.86**	0.95**
TRL				1.00	0.98**	0.92**	0.81**	0.87**
STL					1.00	0.95**	0.83**	0.91**
BRG						1.00	0.84**	0.93**
WGL							1.00	0.88**
NTS								1.00

BWT = Body weight, BRG = Breast girth; TRL = Trunk Length; STL = Shoulder-to-Tail Length; SHL = Shank Length; DSL = Drumstick Length, NTS = Nose-to-Shoulder Length; WGL = Wing Length; ** = highly significant (P<0.01)

Table 4 shows body weight prediction equations, standard error of mean and coefficient of determination (R^2) for the fitted linear, quadratic and cubic functions from linear body measurements with their respective level of significance. All linear body measurements were highly significant (p<0.01) for the fitted functions and have strong relationship with body weights. The linear body measurements generally had positive values for regression coefficients for all the fitted functions. However, there are some negative coefficients. The regression coefficients of the linear function for all linear body measurements were positive with the highest and lowest being recorded for trunk length (2.94) and shank length (1.99) respectively. The regression coefficients for quadratic function were positive with SHL (590.75), DSL (66.83), TRL (0.69) and BRG (42.86) while others were negative. Also, the regression equation was either positive or negative for the cubic function with the following parameters being positive: TRL (200.67), STL (200.67), BRG (282.32) and WGL (305.53). The lowest SEM was recorded for DSL (0.23) being linear equation while the highest was recorded for SHL (778.13) being quadratic function.

On the basic of R^2, linear function was highest with DSL (68.10%) and lowest in WGL (50.8%). Quadratic function was equally highest in DSL (72.2%) and lowest in SHL (39.60%) while cubic function was highest with BRG (79.9%) and lowest in SHL (41.20%). This shows that the goodness of fit was best in BRG with cubic function. However, the three function for all the parameters were highly significant (p<0.05). Based on the result of present study with R^2, the body weight of poultry birds at any age can be predicted most accurately with BRG using cubic function. However, any of the functions and parameters could equally be used. Breast girth (BRG) can be used for the selection of breeding stock for growth rate in poultry birds. The growth pattern result from this study showed that it was in agreement with the findings of Adeniji and Ayorinde (1990) that body weight of birds can easily be predicted from any given value of body measurements (body length, body girth, keel length, shank length, drumstick length and shank thickness) in the Cobb broiler strain using linear and stepwise regression equation. The relationship between body weights and other body measurements (shank length, drumstick length, trunk length, nose-to-shoulder, shoulder-to-tail length and wing length) were best described by cubic function for all parameters (drumstick length, nose to shoulder length, trunk length, shoulder to tail length, chest girth and wing length) except for shank length where linear model was best. This is an indication that breast girth with the combination of drumstick length, trunk length, shoulder to tail length, nose to shoulder, shank length and wing length can be used to predict the value of body weight at any age in poultry birds because all the functions and parameters were highly significant. Cubic and quadratic model had theoretical advantage over the linear model with respect to its goodness of fit to the data. However, the properties of the model and the data should be examined and appropriate model be chosen (Oni *et al.*, 2001). The result of this study is also in tandem with the findings of Adeniji and Ayorinde (1990); Monsi (1992); Adeleke *et al*. (2004) that increasing breast girth or keel length through selection will result in corresponding increase in body weight.

Table 4: Prediction of body weight from linear body measurements using linear, quadratic and cubic functions

Parameters	Prediction Functions	±SEM	R^2 (%)	LS
SHL	$Y_1 = 1.22+1.99x$	0.28	56.2	**
	$Y_2 = 1836.58+590.75x_1-22.14x_2^2$	78.13	39.6	**
	$Y_3 = 755.54-498.93x_1+116.51x_2{}^2 -5.46x_3^3$	67.83	41.2	**
DSL	$Y_1 = 0.84+2.14x$	0.23	68.1	**
	$Y_2 = -304.35+66.82x_1+7.45x_2^2$	80.99	76.9	**
	$Y_3 = 1285.69-434.89x+54.22x_2^2 -1.32x{}_3^3$	70.68	77.9	**
NTS	$Y_1 = 0.14+2.4x$	0.27	57.3	**
	$Y_2 = 970.67 – 179.91x_1 + 13.23x_2^2$	24.76	72.2	**
	$Y_3 = 742.27 – 127.04x +9.44x_2^2 + 0.09x_3^3$	24.87	72.2	**
TRL	$Y_1 = 0.21 + 2.94x$	0.27	58.6	**
	$Y_2 = -94.54 + 0.69x_1 +5.96x_2^2$	29.93	60.4	**
	$Y_3 = -999.36 + 200.67x_1- 8.677x_2^2 +0.29x_3^3$	30.11	60.4	**
STL	$Y_1 = 0.09 + 2.41x$	0.27	58.6	**
	$Y_2 = 108.66 – 26.99x_1 + 5.96x_2^2$	23.97	61.1	**
	$Y_3 = 78.57- 39.19x_1 + 8.80x_2^2 - 0.06x_3^3$	23.21	61.3	**
BRG	$Y_1 = 0.37 + 2.07x$	0.24	66.8	**
	$Y_2 = - 182.67 +42.86x_1 + 1.57x_2^2$	23.97	61.1	**
	$Y_3 = - 1722.01 + 282.32x_1-9.76x_2^2 +0.17x_3^3$	48.72	79.9	**
WGL	$Y_1 = 0.532 + 2.13x$	0.29	50.8	**
	$Y_2 = 814.57 – 143.28x_1 +11.39x_2^2$	42.25	58.9	**
	$Y_3 = -978.23 +305.53x_1 –22.759x_2^2+0.81x_3^3$	37.58	59.4	**

Y_1 = Linear function, Y_2 = Qudratic function, Y_3 = Cubic function, SHL = Shank length, DSL = Drumstick length, NTS = Nose to shoulder length, TRL = Trunk length, STL = Should er to tail length, BRG = Breast girth and WGL =Wing length.

Conclusion and recommendations

The study revealed that the Nigeria indigenous chickens are genetically unimproved and could be regarded as light breed birds. Also, Fulani ecotype weighed heaviest among the Nigeria indigenous chicken strains. This showed that the strain could be regarded as heavy indigenous chicken breed and could earn it the opportunity of being considered for incorporation into a meat producing indigenous chicken in Nigeria if improved upon. There were positive, high and significant correlation between the body weight and linear body measurements in the experimental birds. This could proof useful not only in the prediction of body weight of in indigenous poultry species in South Western Nigeria but also in selection and breeding of these birds for improvement especially with the choice of shoulder-to-tail lerngth. The high correlation estimates obtained in this study could be as a result of pleiotropy, heterozygozity or linkage of genes in the birds. The regression analysis in this study also indicated that body weight of birds could easily be predicted from any given value of the linear body measurements. Cubic growth function had the best fit from breast girth in all the strains. Shoulder-to-tail lerngth could be used to predict body weight of poultry birds. However, further researches on these strains should be carried out to determine their optimum dietary intake for better growth performance. Shoulder-to-tail lerngth could be selected for over the other body traits and used in future breeding programmes for the improvement of indigenous poultry species. Cubic function could be preferred to predict body weight of chickens over the other growth functions used in this study.

References

Abdullah, Y. A., Nafez, A. A., Murad, M. S. R., Rasha, I. Q. and Majdi, A. A. I. 2010. Growth performance, carcass and meat quality characteristics of different commercial crosses of broiler strain of chicken. *Japan Poultry Science*, 47: 13 – 21

Adedeji, T. A., Amusa, S. A. and Adebambo, O. A. 2015. Effect of Chicken Genotype on Growth Performance of Pure and Crossbred Progenies in the Development of a Broiler Line. *International Journal of Agricultural Innovation and Research*, 4(1): 2319-1473

Adedeji, T. A., Adebambo, O. A., Peter, S. O., Ojedapo, L. O. and Ige, A. O. 2006. Growth performance of crossbreds and purebreds resulting from different sire strain in humid tropical environment. *Journal of Animal and Veterinary Advances*, 5(8): 674-678.

Adeniyi, F. O. and Ayorinde, K. L. 1990. Prediction of body weight of broilers at different ages from some linear body measurements. *Nigerian Journal of Animal Production*, 17:42-47

Atansuyi A. J., Oladeji, I. S., Olukayode, A .S. and Chineke, C. A. 2017. Relationship between body weight and body principal components of four-chicken genotypes in South-Western Nigeria. *Proceedings of 6th ASAN-NIAS Joint annual Meeting held* at M&M Events Limited, Tafawa Balewa Way, Beside Nicon luxury Hotel, Area 11, Garki, Abuja, Nigeria. 10th – 14th September, 2017, Abuja, Nigeria, Page 336 – 338.

Egena, S. S. A., Ijaiya, A. T., Ogah, D. M., Aya, V. E. 2014. Principal component analysis of body measurements in a population of indigenous Nigerian chickens raised under extensive management system. *Slovak journal of Animal science*, 2:77-82.

Gueye, E. F. 2003. Production and consumption trend of chicken in Africa. *World Poult*. 19: 12-14.

ILRI, 2006. Safeguarding livestock diversity: The time is now. *International Livestock Research Institute (ILRI) Annual Report*. Pp 22-39.

Gueye, E. H. F. 1998. Village egg and fowl meat production in Africa. *Journal of World Poultry Science,* 54: 73-86.

Ibe, S. N. 1998. Improving productive adaptability of the Nigerian local chicken. *Proceedings of NSAP Silver Anniversary Conference/WASAP Inaugural Conference,* March 21-26, University of Agriculture, Abeokuta, pp: 464-465.

Ibe, S. N. 1992. Incorporating adaptability genes in poultry breeding programmes in Nigeria. *Proceedings of the XIX Worlds Poultry Congress*, Sept. 20-24 Amsterdam, 693-696.

Kityali, A. J. 1998. Village chicken production systems in rural Africa, *FAO, Anim. Prod. And Health paper,* Rome, Italy. p_p60-65

Korver, D. R., Zuidhof, M. J. and Lawes, K. R. 2004. Performance characteristics and economic comparison of broiler chickens fed wheat- and triticale-based diets. *Poultry Science,* 83:716-725

Liptoi, K. and Hidas, A. 2006. Investigation of Possible Genetic Background of Early Embryonic Mortality in Poultry. *Word's Poultry Science Journal,* 62: 326-337.

Verma, D. M. and Hussaini, K. C. 1983. The estimate of body measurement of calves from heart girth measurement. Indian Veterinary Medical Journal 53:112-114

Yousif, I. A., Binda, B. D., Elamin, K. M., Malik, H. E. E. and Babiker, M. S. 2014. Evaluation of Carcass Characteristics and Meat Quality of Indigenous Fowl Ecotypes and Exotic Broiler Strains Raised Under Hot Climate. *Global Journal of Animal Scientific Research,* 2(4): 365-371

Tegbe, T. S. and Olorunju, S. A. 1998. The prediction of live weight of crossbred pigs from three measurements. *Nig. J. of Anim. Prod*. 15: 9-13

Received: 11th November, 2017
Accepted: 2nd March, 2018