Phenotypic anatomization of four indigenous chicken populations in Southwestern, Nigeria

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Abstract

Assessment of the population characteristics of identified breed is an important component of livestock characterization, as it can be used as the basis for the development of a breeding programme. Studies on biodiversity of indigenous chickens in many parts of Africa revealed presence of high genetic variability within ecotype populations. Four hundred indigenous chickens consisting of 115 Fulani chicken, 115 normal feathered, 85 frizzle feathered and 85 naked neck were sampled in all the states in South-West, Nigeria using judgment sampling method. Quantitative traits measured were body weight, body length, breast girth, shank length, keel length, thigh length, wing length, wing span and comb length. The body weight and linear body data was analyzed using General Linear Model procedure of Statistical Analysis System-SAS Version 9.1. The mean value including standard error of mean ranged from body weight (1.36±0.03) to wing span (36.96±0.22). Breast girth had the highest correlation coefficient with body weight {(r = 0.66, (P<0.01); (P<0.05)} while wing length had the lowest correlation coefficient with body weight {(r = 0.11, (P<0.01); (P<0.05)}. Simple regression model had the highest coefficients of determination (R^2) value and standard error of 0.54±0.18 in breast girth while wing length had lowest coefficients of determination (R^2) value and standard error of 0.19±0.01. The R^2 value with standard error for multiple regressions ranged from 0.68±0.25 to 0.18±0.12. Positive correlation between body weight and linear body parameters suggested that an improvement in body weight may lead to an improvement in linear body parameters. In an environment where scale is not readily available, body parameters could be used to predict the body weight of chicken.

Keywords: Phenotypic characterization, indigenous chicken, linear regression, coefficients of determination.

Analyse phénotypique de quatre populations de poules locales dans le sud-ouest du Nigeria

Résumé

L'évaluation des caractéristiques des populations d'une race identifiée est une étape essentielle dans la caractérisation du bétail. Ces données peuvent servir de base au développement d'un programme d'élevage. Les études sur la biodiversité des poules locales dans plusieurs régions d'Afrique ont révélé une grande variabilité génétique au sein des populations d'écotypes. Quatre cents poules indigènes, comprenant 115 poules Fulani, 115 à plumage normal, 85 à plumage frisé et 85 à cou nu, ont été échantillonnées dans tous les États du sud-ouest du Nigeria en utilisant une méthode d'échantillonnage raisonné. Les traits quantitatifs mesurés comprenaient le poids corporel, la longueur du corps, le tour de poitrine, la longueur du tarse, la longueur du bréchet, la longueur de la cuisse, la longueur de l'aile, l'envergure des ailes et la longueur de la crête. Les données pondérales et morphométriques ont été analysées à l'aide du modèle linéaire général (procédure GLM) du logiciel Statistical Analysis System (SAS) version 9.1. Les valeurs moyennes, incluant l'erreur standard, variaient entre le poids corporel (1,36 ± 0,03 kg) et l'envergure des ailes (36,96 ± 0,22 cm). Le tour de poitrine présentait le coefficient de corrélation le plus élevé avec le poids corporel (r = 0,66 ; P < 0,01 ; P < 0,05), tandis que la longueur de l'aile avait le coefficient le plus faible (r = 0,11 ; P < 0,01 ; P < 0,05). Le modèle de régression simple a affiché le coefficient de détermination (R^2) le plus élevé et l'erreur standard la plus faible (0,54 ± 0,18) *pour le tour de poitrine, alors que la longueur de l'aile avait le R^2 le plus bas (0,19 ± 0,01). Pour les régressions multiples, les valeurs de R^2 avec erreur standard variaient entre 0,68 ± 0,25 et 0,18 ± 0,12. La corrélation positive entre le poids corporel et les paramètres morphométriques suggère qu'une amélioration du poids corporel pourrait entraîner une amélioration des dimensions corporelles. Dans un environnement où les balances ne sont pas facilement accessibles, ces paramètres pourraient être utilisés pour estimer le poids des poules.*

Mots-clés : Caractérisation phénotypique, poule locale, régression linéaire, coefficients de détermination.

Introduction

Phenotypic characterization is used to identify and document diversity within and between distinct breeds based on their observable attributes (FAO, 2012). Phenotypic traits include observable traits such as height, weight, eye colour, hair colour, horn size, hoof colour, comb length and shank length. Assessment of the population characteristics of identified breed is an important component of livestock characterization. This can be used as the basis for the development of a breeding program. Studies on biodiversity of indigenous chickens in many parts of Africa had revealed presence of high genetic variability within ecotype populations (Mwacharo *et al.*, 2007; Muchadeyi *et al.*, 2007; Halima *et al.*, 2009) indicating the potential for genetic improvement in these chickens through selective breeding. Indigenous chickens are genetically diverse, so it is important to analyse their populations in order to identify populations and individuals of particular merit. Indigenous chickens are those chickens that belong to an area where they evolved. They are also called native or local chickens. Indigenous chickens exhibit large variation in body size, plumage colours, feathering pattern, eggshell, ear lobe and shank colours (Adene, 2004; Ilori *et al.*, 2016).

The relationship existing among the linear body parameters provides useful information on the performance and carcass value of animals. Relationships between body weight and linear body measurements are important for predicting body weight and can also be applied speedily in selection and breeding program. The use of body measurements to predict body weight of different animal species have been reported (Attah *et al*., 2004; Sowande and Sobola, 2007; Goe, 2007). However, there is little information on the prediction of body weight of chickens using linear body measurements as reported by Momoh and Kershima (2008). Therefore, there is a need to determine the relationship between morphological features in Nigerian indigenous chickens and to model the relationship between body weight and linear body parameters in Nigerian indigenous chickens.

Materials and Methods

Experimental location

This study was carried out in different geographical zones in South-West region of Nigeria consisting of Lagos, Ogun, Oyo, Osun, Ondo and Ekiti States (Figure 1).

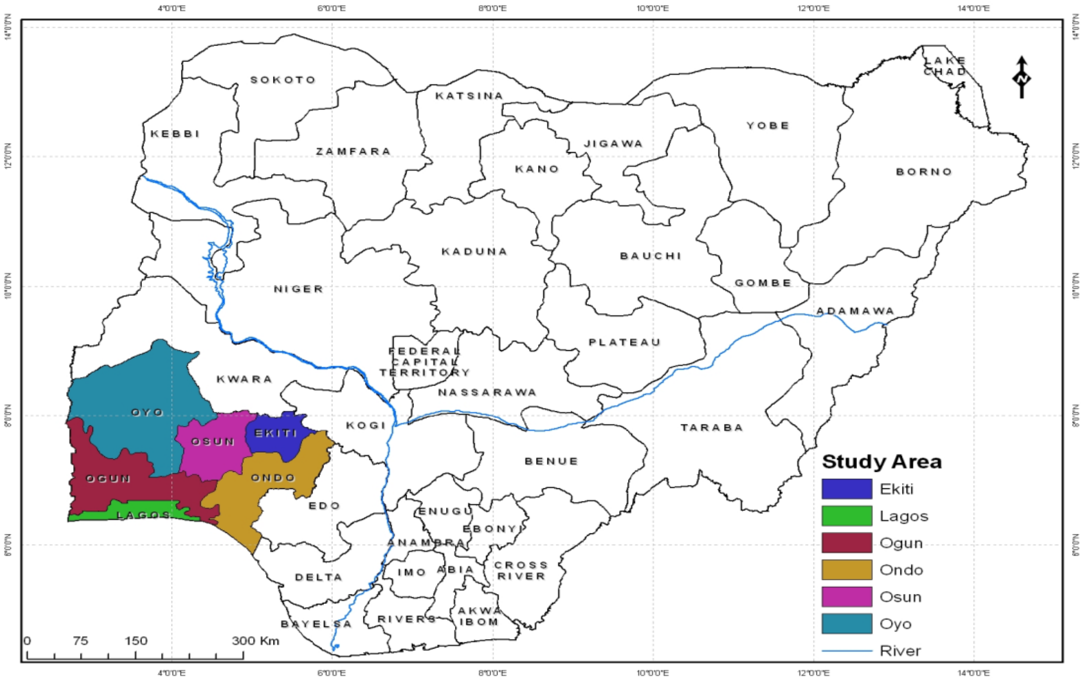

Figure 1: Experimental study areas of four chicken populations in Southwestern, Nigeria

Sampling technique

The four chicken populations were sampled in all the states in South-West {Lagos (Epe, Ikorodu and Ikeja); Ogun (Ijebu-Ode, Ifo and Odeda); Oyo (Ibadan, Ogbomoso and Awe); Osun (Ile-Ife, Ila-Orangun and Ejigbo); Ekiti (Emure, Okemesi and Iyin); Ondo (Igbara-Oke, Oka Akoko and Okitipupa)} Nigeria using judgment sampling method in order to minimize bias in sampling the indigenous chickens in South-West region of Nigeria.

Chicken populations and sample size

Four hundred (400) indigenous chickens consisting of one hundred and fifteen (115) Fulani chicken {Lagos (15), Ogun (20), Oyo (20), Osun (20), Ekiti (20) and Ondo (20)}, one hundred and fifteen (115) normal feathered {Lagos (15), Ogun (20), Oyo (20), Osun (20), Ekiti (20) and Ondo (20)}, eighty-five (85) frizzle feathered {Lagos (10), Ogun (15), Oyo (15), Osun (15), Ekiti (15) and Ondo (15)} and eighty-five (85) naked neck {Lagos (10), Ogun (15), Oyo (15), Osun (15), Ekiti (15) and Ondo (15)} were sampled in all the states in South-West, Nigeria. These chickens were given little feed supplementation by the owners, ranging kitchen wastes/maize/sorghum/commercial feed and perch on the tree/fence at the back of the house.

Data collection

Quantitative traits measured were : body weight (BW) was measured with the aid of hanging scale, body length (BL), breast girth (BG), shank length (SL), keel length (KL), thigh length (TL), wing length (WL), wing span (WS) and comb length (CL) were measured with the use of flexible tape.

Data analysis

The body weight and linear body parameters data collected was analyzed using General Linear Model procedure of Statistical Analysis System-SAS Version 9.1. Correlation was obtained using correlation procedure embedded in the same software.

Statistical model

(a) Linear regression models

$Y = B + \beta X$ . . . . (1) Simple linear regression model

$$Y = B + \beta_1 X_1 + \beta_2 X2 + . . . + \beta_k X_k$$ . . . . (2) Multiple linear regression models

Where:

Y = dependent variable (body weight)

Xs = independent variables (linear body parameters)

B = the intercept

βs = the slope

Results

Descriptive statistics of body weight and linear body measurements

Evaluation of descriptive statistic of body weight and linear body measurement are given in Table 1. The mean value including standard error of mean for body weight, body length, comb length, breast girth, keel length, shank length, tight length, wing length and wing span were 1.36±0.03, 34.85±0.27, 4.23±0.12, 27.38±0.18, 13.44±0.09, 8.40±0.06, 11.47±0.07, 14.04±0.11 and 36.96±0.22, respectively. The minimum and maximum ranged of body weight and body linear measurement were; body weight (0.5-3.0), body length (16-48), comb length (0-13), breast girth (20-41), keel length (8-20), shank length (6-13), tight length (8-16), wing length (9-17) and wing span (25-52).

Table 1: Descriptive statistics of body weight and linear body measurements

Parameters	N	Minimum	Maximum	Mean	SEM
BW	400	0.5	3	1.36	0.03
BL	400	16	48	34.85	0.27
CL	400	0	13	4.23	0.12
BG	400	20	41	27.38	0.18
KL	400	8	20	3.44	0.09
SL	400	6	13	8.40	0.06
TL	400	8	16	11.47	0.07
WL	400	9	27	14.04	0.11
WS	400	25	52	36.96	0.22

N = Number of observation; SEM = Standard error of mean

Correlations of body weight and linear body measurements

Table 2 shown summaries of correlation of body weight and linear body measurement. Body weight were positively significantly {($P<0.01$); ($P<0.05$)} correlated with linear body measurement. Breast girth had the highest correlation coefficient with body weight {($r = 0.66$, ($P<0.01$); ($P<0.05$)} while wing length had the lowest correlation coefficient with body weight {($r = 0.11$, ($P<0.01$); ($P<0.05$)}. However, correlation between wing span and body length had the highest correlation coefficient {($r = 0.72$, ($P<0.01$); ($P<0.05$)} in all the linear body measurement. The positive correlation coefficients signified that increase in body weight could result in increase in linear body measurement.

Table 2: Correlations of body weight and linear body measurements

	BW	BL	CL	BG	KL	SL	TL	WL	WS
BW									
BL	0.43**								
CL	0.44**	0.42**							
BG	0.66**	0.38**	0.39**						
KL	0.14**	0.28**	0.50**	0.34**					
SL	0.29**	0.26**	0.49**	0.37**	0.54**				
TL	0.37**	0.49**	0.45**	0.44**	0.42**	0.69**			
WL	0.11*	0.14**	0.49**	0.33**	0.63**	0.45**	o.41**		
WS	0.45**	0.72**	0.59**	0.41**	0.48**	0.49**	0.56**	0.47**	

**(P<0.01); *(P<0.05); BW = Body weight; BL = Body length; CL = Comb length; BG = Breast girth; KL = Keel length; SL = Shank length; TL = Tight length; WL = Wing length; WS = Wing span

Predictive equations relating body weight to linear body measurements

Predictive equation relating body weight to linear body measurements are presented in table 3a and 3b. Body weight and linear body measurement had positive significant {(P<0.01); (P<0.05)} associations. Simple regression model had the highest coefficients of determination (R^2) value and standard error of 0.54±0.18 in breast girth. This was followed by body length, wing span, keel length, tight length, shank length, comb length and wing length with values of 0.52±0.18, 0.50±0.24, 0.50±0.22, 0.21±0.09, 0.20±0.06 and 0.19±0.01, respectively (Table 3a). The highest R^2 value with standard error for multiple regressions was 0.68±0.25, followed by 0.56±0.24, 0.54±0.24, 0.54±0.24, 0.54±0.23, 0.50±0.20, 0.23±0.18 and 0.18±0.12, respectively (Table 3b). The highest values of R^2 indicated the best predictive equation model used for predicting body weight accurately. Therefore the best predictive equation model for simple and multiple linear regressions relating body weight to linear body measurement of South-West, Nigerian chickens were given below:

Y =-1.69+0.11BG . . . Simple regression

Y = -1.28+0.00BL+0.07CL+0.10BG-0.07KL+0.01SL+0.01TL-0.06WL+0.03WS . . . Multiple regression.

Y is the estimated body weight.

Table 3a: Simple linear regression predictive equations relating body weight to linear body measurements

Parameters	Predictive equation	Std. Error	R^2	LS
BL	-0.33+0.05BL	±0.18	0.52	**
CL	0.88+ 0.11CL	±0.06	0.20	*
BG	-1.69+0.11BG	±0.18	0.54	**
KL	0.71+0.05KL	±0.24	0.50	*
SL	0.12+0.15SL	±0.09	0.21	*
TL	-0.42+0.16TL	±0.22	0.50	**
WL	0.94+0.03WL	±0.01	0.19	*
WS	-1.94+0.06WS	±0.23	0.52	**

**(P<0.01); *(P<0.05); Std. Error = standard error; R^2 = coefficient of determination; LS = level of significance

Table 3b: Multiple linear regression predictive equations relating body weight to linear body measurements

Model	**Predictive equation**	**Std. Error**	**R^2**	**LS**
Constant,BL	Y= -0.33+0.05BL	±0.12	0.18	*
Constant,BL,CL	Y = -0.15+0.03BL+0.08CL	±0.18	0.23	*
Constant,BL,CL,BG	Y = -1.94+0.02BL+0.05CL+0.09BG	±0.20	0.50	**
Constant,BL,CL,BG,KL	Y = -1.12+0.02BL+0.07CL+0.10BG-0.09KL	±0.23	0.54	**
Constant,BL,CL,BG,KL,SL	Y = -1.20+0.02BL+0.07CL+0.10BG-0.09KL+0.03SL	±0.24	0.54	**
Constant,BL,CL,BG,KL,SL, TL	Y = -1.19+0.02BL+0.07CL+0.10BG-0.09KL+0.03SL-0.00TL	±0.24	0.54	**
Constant,BL,CL,BG,KL,SL, TL,WL	Y = -1.04+0.02BL+0.08CL+0.10BG-0.07KL+0.02SL+0.01TL-0.04WL	±0.24	0.56	**
Constant,BL,CL,BG,KL,SL, TL,WL,WS	Y = -1.28+0.00BL+0.07CL+0.10BG-0.07KL+0.01SL+0.01TL-0.06WL+0.03WS	±0.25	0.68	**

**(P<0.01); *(P<0.05); Std. Error = standard error; R^2 = coefficient of determination; LS = level of significance

Discussion

The body weight observed in this study is lower than the value reported by Ukwu *et al.,* 2014 for body weight and linear body measurements in Nigerian indigenous chickens and higher than the value reported by Momoh and Kershima, 2008 for Nigerian local chickens. The mean body length in this study is closer to the value (35.79) reported by Addis *et al.,* 2013 and higher than the value (21.82) reported by Ukwu *et al.,* 2014. The mean comb length examined in this study is higher than the value (2.76) reported by Addis *et al.,* 2013. The value recorded for mean breast girth is in the same range with the value (27.50) reported by Fayeye *et al.,* 2006 for naked neck, frizzle and normal feathered Nigerian Chickens. Addis *et al.,* 2013 reported lower value of keel length than the value reported in this study. The mean shank length reported by Momoh and Kershima, (2008) for Nigerian local chickens was lower than the mean shank length recorded in this study, however, Ukwu *et al.,* 2014 reported the same mean shank length in this study. The value (18.95) reported for mean thigh length and the value (17.82) for mean wing length by Ukwu *et al.,* 2014 is higher than the value reported in this study. The mean wing span value (37.04) indicated by Addis *et al.,* 2013 is of the same range with the mean wing span observed in this study. Body weight is positively and significantly correlated with linear body measurement. This implies that there exists a positive linear relationship between body weight and linear body parameters. This result suggests that an improvement in body weight of Nigerian local chickens in South-West region could lead to an improvement in linear body parameters. A similar result was reported by Momoh and Kershima (2008) for Nigerian local chickens.

This result also collaborate the reports of Yahaya *et al.* (2012) and Alabi *et al.* (2012) that positive correlation exist between body weight and linear body measurement in broilers and naked neck/venda chickens of South Africa, respectively. The predictive equation relating body weight to linear body measurement of Nigerian native chickens in South-West region shows significant association with body weight and linear body measurement. Breast girth having the highest values of coefficient of determination (R^2) could be the best predictor of body weight of Nigerian native chickens in South-West region. The highest R^2 value for multiple regressions in the present study is 0.68, while the highest R^2 value for simple regression is 0.54. The predictive equation shows that there are significant relationships between body weight and linear body measurement. The R^2 value obtained in this study are closer to those reported by Addis *et al.* (2013) for indigenous chicken ecotypes in North Gonder zone of Ethopia and Momoh and Kershima (2008) for Nigerian local chickens reared on free range but lower than that obtained by Ukwu *et al.* (2014) for statistical modeling of body weight and linear body measurements in Nigerian indigenous chickens.

Conclusion and Recommendation

The results indicated that there was a positive correlation between body weight and linear body parameters suggesting that an improvement in body weight may lead to an improvement in linear body parameters. The study showed that body weight could be predicted with high degree of accuracy using linear body parameters. Therefore in an environment where scale is not readily available, body parameters could be used to predict the body weight of chicken.

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