Discovery

Association between body weight and body conformation traits of guinea fowl (*Numida meleagris*) genotypes in Southern Nigeria

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The objectives of this study were to determine the phenotypic correlations among body weight and linear body parameters (LBPs) of the black and pearl guinea fowl and their crosses, as well as to derive multiple regression equations that can be used to establish models for predicting body weight. The following three genotype groups were established: Pearl male X pearl female (P X P) Homozygous pearl thorough bred line; black male X black female (B X B) Homozygous black thorough bred line and Black male X pearl female (B X P) Heterozygous crossbred line. A total of 317 guinea fowl keets were obtained and used for the study. There were 100 PXP, 118 BXB and 99 BXP keets. The coefficient of determination of body weight by linear body measurements was generally significantly (P < 0.001) high between 8 and 12 weeks of age among the genotype groups. Body circumference plus breast length were the best prediction variables in the PXP group at this period. Body circumference plus shank length were the best prediction variables in the BXB group, while the combination of body circumference with breast length and thigh length were the best prediction variables in the BXP group at this period. Significantly (P < 0.01) high and positive correlation coefficients were generally obtained between body weight and linear body parameters from four to 14 weeks of age among the three genotype groups of guinea fowl. It was concluded based on the results obtained from this research that improvement in body weight of guinea fowls can be achieved with very high degree of accuracy, by selection based on body circumference solely, body circumference plus breast length, body circumference plus shank length or thigh length, at 12 weeks of age among the genotype groups. Furthermore, selection made between 4-14 weeks of age based on any of the linear body parameters in guinea fowl will lead to a corresponding improvement in body weight.

INTRODUCTION

In Nigeria, the guinea fowl has remained unimproved owing to the insufficient research information on this species of poultry. It has not been adequately characterized to standardize its productivity. Guinea fowl production in Nigeria is at a rudimentary level, despite its abundant number and numerous benefits. A large scale domestication of this bird has not been done as little attention has been given to its commercial production (Afunmilayo, 2016; Dossa Armand Makponse et al. 2018). The prevailing situation is small flocks maintained in free range in the rural areas of the northern part of Nigeria. Though the guinea fowl can thrive in both dry and wet climates, its production in the southern part of the country is next to zero.

Body conformation traits of animals basically showcase the length of the long bones of the animals and they reflect the way in which the shape of the animal's body is changing, when taken sequentially over a long period of time. Linear body parameters (LBPs) have been exploited as predictors of live weight and carcass composition (Momoh and Kershima, 2008; Oke *et al.*, 2004; Amin, 2014). Utilizing data on LBPs

and body weight (BWT) at different ages, regression models can be used to predict carcass and body parts of an animal (Khosravania, 2006). The prediction of BWT or carcass components using a single LBP have been opined as unreliable, therefore discouraged (Amin, 2014). The use of multiple traits in regression analysis can yield more accurate results in predicting and improving carcass performance in birds. Yakubu *et al.* (2012) used multiple regression analysis to interpret the complex relationships among BWT and some LBPs.

The relationship existing between body weight and physical characteristics such as neck- length, back-length, breast length, keel length, shank length, and thigh length reflect on the feed efficiency as well as performance of the birds (Ubani *et al.,* 2011). Besides, the information on the interrelationships can help breeders to organize the breeding programme to achieve an optimum combination of body weight and good conformation for maximum economic return (Okon *et al.,* 1997).

This research information will serve as a guide for choice of selection and breeding methods of this bird. It will also guide in the establishment and integration of guinea fowl into the poultry production industry, especially in the southern part of Nigeria.

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MATERIALS AND METHODS

The study was carried out at the poultry unit of the Teaching and Research Farm of Animal Science Department, University of Calabar, Nigeria. A total of 317 guinea fowl keets were used for this research. There were 100 PXP, 118 BXB and 99 BXP keets altogether. The following linear body traits were taken bi-weekly using a tailor's measuring tape and recorded in centimeters.

- Thigh length - distance from the beginning of the fibula to the hock joint.
- Shank length – distance from the beginning of the hock joint to the last ring before the tarse metatarsus digit 3.
- Breast length – distance from the point of depression to the sharp edge.
- Body circumference – the circumference of the bird around the chest region.

Body weight was taken fortnightly in the morning prior to feeding using a top loader weighing scale recorded in grammes. All leg measurements were taken on the left leg to ensure uniformity. Data generated was subjected to Analysis of Variance in a Randomized Complete Block Design using SAS (2010) computer application programme. The phenotypic correlations among body weight and linear body parameters were determined using the Pearson Correlation Analysis.

Data were analyzed using the following linear model:
$$Y_{ik} = \mu + G_i + e_{ik}$$

Where Y_{ik} = observed value of the $_{ik}$th birds
μ = overall mean
G_i = effect of the $_i$th genotype
e_{ik} = random error.

Multiple regression analysis was carried out using the model:
$$Y = a + b_1x_1 + b_2x_2 + -----b_kx_k$$

Where Y = dependent variable (BWT)
a = intercept (the value of the dependent variable when the independent variable is zero)
b = regression coefficient associated with independent variable
x_k = independent variable (LBPs)

RESULTS AND DISCUSSION

Prediction of bodyweight (BWT) from linear body parameters (LBPs)

The results of a step wise multiple regression of BWT on LBPs of genotypes of guinea fowl at 4-8 and 10-14 weeks of age are presented in Tables 1 and 2 respectively. Significant (P < 0.001) regression coefficients were observed in the breast length at 4 weeks of age across the three genotypes, with coefficients of determination of 54.40, 50.30 and 27.80 percent for the PXP, BXB and BXP genotypes respectively.

At the fourth week of age, in the present study, BL was the only predictor of BWT among the genotype groups, having coefficients of determination: 55.4, 50.3 and 27.8 percent in the PXP, BXB and BXP groups respectively. This implies that selection for BWT at this age made on the basis of BL, would lead to significant genetic improvement, especially in the PXP and BXB genotypes. The levels of reliability of these prediction equations were equally high (0.744, 0.709 and 0.528 respectively). Durosaro et al. (2012) in their study with turkeys, reported

higher significant coefficients of determination of determination of BWT by BL the 4th week age (R^2 = 70.19 and 72.57 using linear and quadratic functions respectively).

Coefficients of determination of BWT were moderate and significant (P < 0.001) among the genotype groups at six weeks of age. The predicting variables were SL in PXP and BC in BXB and BXP genotypes. At the eight week of age, the use of BL alone in a linear regression model, accounted for 60.1 percent variability in BWT (with 77.5 percent accuracy) in the PXP genotype. The addition of BC to the prediction model raised the percentage of determination to 64.2 percent, with 80.1 percent reliability. The BXB genotype had BC alone accounting for 67.1 percent variability in BWT at this age. The addition of SL to the model increased the coefficient of determination to 74.8 percent, with an increased reliability percentage. A further addition of BL to the multiple regression model increased the prediction coefficient to 78.8 percent in this genotype. The BXP genotype however, had BC with a fair prediction coefficient of 32.3 percent at this age. The trend of high prediction coefficients obtained by BC, BL and SL across the genotype groups could be attributed to the high linear correlations between BWT and these traits at this age. This trend is in agreement with the reports of Momoh and Kershima (2008) in Nigerian local chickens, and of Ogah (2011 and 2013) in guinea fowls. The coefficient of determination is the percentage of variation in the value of dependent variable that can be explained by variations in the value of the independent variable or, the goodness of fit of a regression, and the higher the value, the better the variance that the dependent variable is explained by the independent variable.

At the 10th week of age, the trend of prediction by BC continued. In the PXP genotype, BC alone accounted for 63.9 percent variability in BWT at this age. In the BXB genotype, when only BC was used, the coefficient of determination was 81.3 percent. This increased to 83.2 percent when SL was added to BC for prediction of BWT in this genotype. It is interesting to note that the magnitude of reliability of using the two models for prediction of BWT in this genotype were very high (90.2 and 91.2 percent respectively). This supported the assertion of Durosaro et al. (2012) that the magnitude of the coefficient of determination for each LBM in the regression equations showed the relative contribution of each LBM to the BWT.

At the 12th week of age, BC; BC plus BL; and BC plus SL plus SL, gave 71.3, 82.7 and 84.8 percent respectively in the PXP genotype. Their levels of reliability were equally very high (0.844 - 0.921) at this age. In the BXB genotype, BC; BC plus BL gave significant R^2 values of 64.6 and 69.7 percent respectively. Meanwhile, in the BXP genotype, BC; and BC plus TL gave significantly (P < 0.001) high R^2 values of 72.2 and 82.7 percent respectively. It can be deduced that improvement in BWT can be achieved at this age by selecting the afore mentioned traits singly or in combination, as the case may be.

At the 14th week of age, good improvement in BWT can be achieved when PXP birds with high BL and SL values recorded by these traits at this age. For birds of the BXB genotype, selection and improvement should be based on BC alone or BC in combination with TL. Similarly, a good genetic improvement in BWT would be achieved when birds are selected on the basis of their TL in the BXP genotype at this age. These results corroborate the report of Ogah (2011), that BWT can be predicted with a fair degree of accuracy from BC, BL and TL.

In summary, BWT can be best predicted with very high degree of accuracy, using BC solely; BC plus BL; and BC plus SL or TL respectively, at 12 weeks of age, among the three genotypes. Furthermore, remarkable improvement in BWT can be achieved in the

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Table 1 Stepwise multiple regression of body weight on linear body measurements in three genotypes of guinea fowl at 4-8 weeks of age

Genotype	Equation	R-square	r	SE	LOS
P×P$_{wk4}$	BWT=-15.073+27.526BL	0.554	0.744	24.832	***
B×B$_{wk4}$	BWT=-4.394+23.850BL	0.503	0.709	23.483	***
B×P$_{wk4}$	BWT=66.145+15.217BL	0.278	0.528	25.348	***
P×P$_{wk6}$	BWT=-74.124+85.133SL	0.271	0.520	47.624	***
B×B$_{wk6}$	BWT=-82.621+22.184BC	0.426	0.652	40.455	***
B×P$_{wk6}$	BWT=-74.274+21.555BC	0.338	0.582	39.174	***
P×P$_{wk8}$	BWT=-337.910+73.318BL	0.601	0.775	62.656	***
P×P$_{wk8}$	BWT=-373.472+40.030BL+20.478BC	0.642	0.801	60.003	***
B×B$_{wk8}$	BWT=-455.015+46.874BC	0.671	0.819	55.000	***
B×B$_{wk8}$	BWT=-628.802+33.303BC+87.118SL	0.748	0.865	48.771	***
B×B$_{wk8}$	BWT=-678.558+24.936BC+76.426SL+23.956BL	0.788	0.888	45.220	***
B×P$_{wk8}$	BWT=-134.518+30.635BC	0.323	0.568	74.853	***

Wk=week, BWT=body weight, BL=breast length, BC=body circumference, SL=shank length, TL=thigh length, SE=standard error, LOS=level of significance ,*** significant at P<0.001

Table 2 Stepwise multiple regression of body weight on linear body measurements in three genotypes of guinea fowl at 10-14 weeks of age

Genotype	Equation	R-square	r	SE	LOS
P×P$_{wk10}$	BWT=-654.243+58.145BC	0.639	0.799	79.181	***
B×B$_{wk10}$	BWT=-584.639+53.963BC	0.813	0.902	50.522	***
B×B$_{wk10}$	BWT=-730.819+48.036BC+48.897SL	0.832	0.912	48.493	***
B×P$_{wk10}$	BWT=-565.741+53.864BC	0.591	0.769	82.018	***
B×P$_{wk10}$	BWT=-734.914+32.324BC+51.023BL	0.660	0.813	75.591	***
B×P$_{wk10}$	BWT=-992.228+25.301BC+42.268BL+38.055TL	0.698	0.836	72.139	***
P×P$_{wk12}$	BWT=-1018.250+75.437BC	0.713	0.844	61.610	***
P×P$_{wk12}$	BWT=-1054.102+54.925BC+38.499BL	0.827	0.909	48.406	***
P×P$_{wk12}$	BWT=-1014.262+41.020BC+30.047BL+66.001SL	0.848	0.921	45.912	***
B×B$_{wk12}$	BWT=-589.168+56.361BC	0.646	0.804	73.975	***
B×B$_{wk12}$	BWT=-703.402+42.625BC+32.019BL	0.697	0.835	69.279	***
B×P$_{wk12}$	BWT=-874.536+68.138BC	0.722	0.849	64.095	***
B×P$_{wk12}$	BWT=-1300.832+49.041BC+59.912TL	0.827	0.909	51.182	***
P×P$_{wk14}$	BWT=4.178+62.711BL	0.480	0.693	75.004	***
P×P$_{wk14}$	BWT=-309.250+52.062BL+67.708SL	0.565	0.751	69.454	***
B×B$_{wk14}$	BWT=-635.354+61.253BC	0.622	0.788	69.506	***
B×B$_{wk14}$	BWT=-747.451+48.741BC+26.500TL	0.667	0.817	65.958	***
B×P$_{wk14}$	BWT=-277.737+74.443TL	0.531	0.729	73.845	***

Wk = week; BWT= Bodyweight; BL= Breast length; SL= Shank length; BC= Body circumference; TL= Thigh length; SE= Standard error; LOS= Level of significance; *** Significant at P<0.001

Table 3 Correlations of body weight and linear body parameters in three genotypes of guinea fowl

Genotype	Correlating parameters	BC	SL	TL	BL
P×P	BW$_4$	0.650**	0.676**	0.709**	0.744**
	BW$_6$	0.358*	0.520**	0.321*	0.052
	BW$_8$	0.773**	0.426**	0.585**	0.775**
	BW$_{10}$	0.799**	0.632**	0.489**	0.630**
	BW$_{12}$	0.844**	0.837**	0.701**	0.754**
	BW$_{14}$	0.675**	0.529**	0.648**	0.693**
B×B	BW$_4$	0.696**	0.414**	0.506**	0.709**
	BW$_6$	0.652**	0.591**	0.6161**	0.616**
	BW$_8$	0.819**	0.743**	0.681**	0.715**
	BW$_{10}$	0.902**	0.639**	0.619**	0.809**
	BW$_{12}$	0.804**	0.692**	0.681**	0.697**
	BW$_{14}$	0.788**	0.556**	0.645**	0.696**
B×P	BW$_4$	-0.137	0.457**	0.478**	0.528**
	BW$_6$	0.582**	0.502**	0.370*	0.535**

BW_8	0.568**	0.469**	0.446**	0.471**
BW_{10}	0.769**	0.675**	0.665**	0.755**
BW_{12}	0.849**	0.736**	0.764**	0.664**
BW_{14}	0.676**	0.524**	0.729**	0.688**

** Correlation significant at $P<0.01$; * Correlation significant at $P<0.05$; BW_4, BW_6, BW_8, BW_{10}, BW_{12}, BW_{14} = Body weight at weeks 4, 6, 8, 10, 12 and 14 respectively; BC= Breast circumference; SL= Shank length; TL= Thigh length; BL= Breast length

BXB genotype at 8 to 10 weeks of age, by selection based on BC solely or BC plus BL. These findings were in agreement with the observations of Peter *et al.* (2006), Momoh and Kershima (2008) and Yakubu *et al.* (2009) in Nigerian local chickens; Teguia *et al.* (2007) and Banrjee (2011) in ducks. Adeleke *et al.* (2004) and Durosaro (2012) reported that the best accuracy of prediction of BWT in turkeys and chickens were obtained with BC in all the age groups.

Correlations between body weight and linear body parameters in the three genotypes

Table 3 shows the results of the correlations between body weight and linear body measurements of the three genotypes of guinea fowl.

High and positive correlation coefficients were obtained between BWT and BC at the 8, 10 and 12th weeks of age (0.773, 0.799 and 0.844 respectively) in the PXP genotype. Moderate values were recorded between the two traits at the 4 and 14th weeks of age (0.650 and 0.675 respectively); while a low correlation coefficient was recorded at the 6th week of age between BWT and BC in this genotype group.

High, positive and significant ($P < 0.01$) associations were recorded between BWT and BC among the genotype groups, at all ages (except at the fourth week of age in the BXP genotype) in the present study. This trend of association have been reported in several species of poultry by other authors (Momoh and Kershima, 2008; Adeleke *et al.,* 2011; Ogah, 2011, 2013 and Amin, 2014). In agreement with the present study, Adeleke *et al.* (2011) reported phenotypic correlation coefficients between the two traits as ranging from 0.75 to 0.92 between 1 and 20 weeks of age in Nigerian indigenous chickens. The authors reported the corresponding genotypic correlation as ranging from 0.93 to 0.99. Momoh and Kershima (2008) obtained a correlation coefficient of 0.74 between BWT and BC in Nigerian indigenous chickens, while Ogah (2011) and (2013) reported the association to be 0.75 and 0.78 respectively in guinea fowl. Momoh *et al.* (2014), however obtained moderate positive association s between the two traits at 6 weeks of age in Japanese quails ($r = 0.45$), while Ojo *et al.* (2010) obtained 0.38 between the traits at the same age in Hubbard broiler chickens. These were close to the results obtained at six weeks of age in the PXP genotype in the present study. The high and positive coefficients of correlation obtained between BWT and BC among the genotype groups, suggest that an increase in BWT can be achieved through mass selection for increased BC. On the other hand, because of the negative association obtained between BWT and BC at four weeks of age in the BXP genotype, selection for any one of the traits at this age, will have a negative consequence on the other. Selection index might be the method of choice for the improvement of any of these two traits, at the fourth week of age, in this genotype.

SL was positively and significantly ($P < 0.01$) correlated with BWT at all ages among the genotype groups in the present study. This observation was consistent with the reports of Ojo *et al.* (2010) in Hubbard broiler chickens, Adeleke *et al.* (2011) in Nigerian indigenous chickens, Ogah (2012) in Nigerian local guinea fowls and Amin (2014) in turkeys. It however, was at variance with the report of a low, non-significant but positive association ($r = 0.083$) by Momoh *et al.* (2014) in Japanese quails. Ojo *et al.* (2010) reported a correlation coefficient

range of 0.600 to 0.737 between four and eight weeks of age in Hubbard broiler chickens. Besides, Amin (2014) and Adeleke *et al.* (2011) gave 0.85 - 0.92 and 0.46 - 0.74 respectively as ranges of phenotypic correlation between BWT and BC. The correlation coefficient of 0.67 reported by Ogah (2013) in guinea fowls was within the range obtained in the present study. The magnitude of associations between the two traits among the genotype groups, suggest that selection for one trait would lead to a corresponding improvement in the other, at all ages.

CONCLUSION

Based on the findings of this research, improvement in body weight of guinea fowls can be achieved by selection based on body circumference solely, body circumference plus breast length, body circumference plus shank length or thigh length, at 12 weeks of age among the genotype groups. Remarkable improvement can be made in the BXB genotype at 8-10 weeks age if selection can be carried out based on body circumference alone or body circumference plus breast length.

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