PHENOTYPIC EVALUATION OF GROWTH TRAITS IN TWO NIGERIAN LOCAL CHICKEN GENOTYPES

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ABSTRACT

A study was conducted to evaluate growth traits, including body weight, body length, chest girth, leg length, shank length and shank circumference, using data obtained from 150 mixed sex birds originating from improved Nigerian local chicken (75 normal feather and 75 naked neck genotypes) of 4 – 16 weeks of age. Body weight of each genotype and at various ages was regressed on other growth traits studied. During the early growth phase (4 – 8 weeks), there were significant variations ($p<0.05$) between the normal feather and naked neck birds in body weight, body length, leg length and shank circumference with the normal feather having higher values. No disparity ($p>0.05$) was observed in the two genotypes for all traits by the 16th week of age. Strong and highly significant ($p<0.001$) correlation coefficients (r) were estimated between body weight and other growth traits in the normal feather (0.62 – 0.94) and naked neck (0.73 – 0.94). Apart from the 4th week of age, strong and positive correlations were obtained between body weight and the other traits ($p<0.001$). Significant and high coefficient of determination R^2 was obtained when body weight was regressed on the other growth traits in the normal feather and naked neck population (0.89 and 0.90 respectively). The R^2 was also high (>0.77) for all ages except at 4 weeks of age (0.04), indicating that most of these traits could be used to forecast body weight precisely at various ages.

Keywords: Local chicken, Normal feather, Naked neck, Body weight, Growth traits, Linear model

INTRODUCTION

Growth is one of the major characteristics of all living organism. It involves dynamic physiological changes which commences when the zygote is formed at the moment of fertilization and continues till maturity of the individual. Kor *et al.* (2006) noted that growth in all animals apart from relating to increase in body cells and volume is a complex process controlled by both genetic and non-genetic factors. Hence, growth in farm animals is a reflection of an intricate balance between a great number of endogenous (hormonal, immunological and genetic) and exogenous (environmental) factors. Though growth performance of an animal is a phenotypic attribute influenced by the environment, to a larger extent however, it is a manifestation of the genetic constitution of the animal.

Growth performance and body conformation traits are therefore important parameters in assessing the potential of genetic improvement and development of any livestock breed/strain. Such knowledge is essential in planning breeding programmes and in adopting breeding choices/strategies. There are also essential in poultry production being fundamental attributes for assessing growth and feed efficiency as well as important yardstick in management and economic decision making (Assan, 2015).

Body weight is usually used as a measure of growth in farm animals; however numerous studies have shown that other growth traits relating to body morphometric measurements such as body length, shank length and chest girth can serve as good indicators of growth (Ige, 2013; Yunusa and Adeoti, 2014). Searle *et al.* (1989) had earlier reported that skeletal growth and muscular development are interconnected. Thus, body morphometric measurements could be used to - describe body conformation and predict live weight, examine relationship among economic traits, evaluate breed and reproductive performance and to study interactions between heredity and environment (Chineke, 2005). This article describes a study undertaken to evaluate growth traits in two Nigerian local chicken genotypes and using information obtained to predict body weight.

MATERIALS AND METHODS

Site: This study which lasted for 16 weeks was carried out in the Poultry Unit of the Teaching and Research Farm of the Department of Animal Science, Rivers State University of Science and Technology, Port Harcourt, Nigeria.

Animals: A population of 150 mixed sex birds originating from improved Nigerian local chicken (normal feather and naked neck genotypes) developed by the Poultry Breeding Unit of Federal University of Agriculture, Abeokuta were used for the study. The birds were brooded in two replicates pens per genotype for four weeks and thereafter randomly allotted to 5 replicates deep litter pens/genotype with 15 birds per replicate. The chickens received feed for the chick phase (day old to 8 weeks of age) containing 20 % crude protein and 2804 kcal ME per kg and in the growing phase (8 weeks to 16 weeks of age), the feed composed of 18 % crude protein and 2605 kcal ME per kg. Feed and water were provided *ad-libtum* throughout the experimental period. Standard sanitary and routine vaccination practices were maintained.

Growth Traits: Six growth traits were measured on each bird using the methods described by Gueye *et al.* (1998) from 4 – 16 weeks of age. The traits considered include body weight (BW), body length (BL), chest circumference (CC), shank length (SL), shank circumference (SC), leg length (LL) - the distance between the hock joint and the pelvic joint (Adeleke *et al.*, 2011). All measurements except body weight were done using a flexible tape. The body weight was obtained using a sensitive weighing balance. Measurements were done monthly.

Statistical Analysis: Data on the growth traits from the two genotypes at four age periods (4, 8, 12 and 16 weeks) were analysed by applying multivariate analysis of the general linear model procedure using genotype and age as fixed factors. Means were considered significant at $p<0.05$; such means were separated using Duncan. Pearson's correlation coefficients were estimated between body weight and other growth traits studied. Regression of body weight on the independent variables was performed using stepwise multiple linear regression procedure. All statistical analyses were carried out using SPSS (2012).

RESULTS AND DISCUSSION

Analysis of variance exposed some growth differences between the normal feather and naked neck type chickens in Nigeria (Table 1). Much discrepancy ($p<0.05$) in the variation was observed between the two genotypes at the early growing phase (4 – 8 weeks). Normal feather chickens were heavier, with thicker shanks, longer body and leg at 4 weeks of age. The difference between the body weight, body length, leg length and shank circumference of the normal feather and naked neck was 7.99, 2.98, 4.31 and 3.58 % respectively (Table 1).

At 8 weeks, except for body length and shank circumference, there were variations in all the traits - body weight (9.38 %), chest girth (5.80 %), leg length (5.02 %) and shank length (3.13 %) – between the two genotypes, with the normal feather having greater values. Conversely, no significant disparity ($p>0.05$) was observed in the two genotypes for all traits by the 16^{th} week of age (Table 1).

Table 1: Effect of genotype and age on growth traits of two Nigerian local chicken genotypes

Age	Trait	Normal feather (n=75)	Naked neck (n=75)
4 week	BW	312.06 ±7.71^{aw}	287.13 ± 6.17^{bw}
	BL	28.52 ± 0.24^{aw}	27.67 ± 27.67^{bw}
	CG	20.06 ± 0.22^{w}	19.68 ± 0.20^{w}
	LL	13.68 ± 0.14^{aw}	13.09 ± 0.17^{bw}
	SL	5.70 ± 0.06^{w}	5.54 ± 0.07^{w}
	SC	3.63 ± 0.05^{aw}	3.50 ± 0.05^{bw}
8 week	BW	931.72 ± 23.85^{ax}	844.30 ± 21.84^{bx}
	BL	35.17 ± 0.35^{x}	35.23 ± 0.40^{x}
	CG	23.78 ± 0.21^{ax}	22.40 ± 0.42^{bx}
	LL	19.94 ± 0.20^{ax}	18.94 ± 0.23^{bx}
	SL	7.98 ± 0.07^{ax}	7.73 ± 0.08^{bx}
	SC	3.86 ± 0.05^{x}	3.80 ± 0.06^{x}
12 week	BW	1180.59 ± 32.45^{y}	1158.15 ± 25.71^{y}
	BL	41.85 ± 0.37^{y}	40.91 ± 0.35^{y}
	CG	30.37 ± 0.29^{ay}	29.35 ± 0.26^{by}
	LL	20.52 ± 0.20^{y}	20.76 ± 0.21^{y}
	SL	8.94 ± 0.10^{y}	8.84 ± 0.01^{y}
	SC	4.41 ± 0.04^{y}	4.40 ± 0.04^{y}
16 week	BW	1635.08 ± 43.62^{z}	1587.93 ± 40.00^{z}
	BL	44.29 ± 0.48^{z}	44.01 ± 0.36^{z}
	CG	30.99 ± 0.30^{z}	30.75 ± 0.29^{z}
	LL	22.36 ± 0.28^{z}	22.07 ± 0.26^{z}
	SL	9.38 ± 0.13^{z}	9.18 ± 0.14^{z}
	SC	4.53 ± 0.04^{z}	4.50 ± 0.04^{z}

BW = body weight, BL = body length, CC = chest circumference, SL = shank length, SC = shank circumference, LL = leg length. ^{ab}Meafns on the same row not sharing a common superscript are significantly different (p<0.05). ^{wxyz}Means on the same column with different superscript are significantly different (p<0.01)

The present finding is contrary to the report of Islam and Nishibori (2009) who demonstrated that naked neck chickens had improved body weight over their normal feathered contemporary in hot climates. Rajkumar *et al.* (2011) also reported that growth performance was significantly higher in the naked neck chicken. However, the higher body weight and general body size observed in the present study affirmed that the indigenous naked neck had lighter mature weight when compared to the normal feather (Norris *et al.,* 2007; de Almeida and Zuber, 2010; Magothe *et al.,* 2010). Adekoya *et al.* (2013) found significantly heavier body weight in the normal feather chicken when compared to the naked neck counterpart. Yakubu *et al.* (2009a) observed non-significant variations in body weight and body measurements of Nigerian normal feather and naked neck chickens at maturity.

It is obvious that the growth traits studied significantly increased (p<0.01) with age. Ige (2013) recognized that the age of an animal influences its growth pattern. There was rapid increase in body weight gain of both genotypes at the early growth phase (between 4 and 8 weeks) with maximum average daily gain of 22.13 and 19.90 g/day in the normal feather and naked neck respectively. Adeniji and Ayorinde (1990) worked on a population of Cobb broiler strain and observed a more rapid weight gain between three to six weeks of age. Generally, the body weight of the two genotypes compared favourably with those of Shaobo, Huaixiang and Youxi chicken of China at 4 and 8 weeks of age (Zhao *et al.*, 2015).

Anthony *et al.* (1991) posited that selection age in relation to age at point of inflection may contribute to the timing and magnitude of growth response. Iraqi *et al.* (2002) concluded that genetic selection at early ages may give rapid improvement in growth of local strains. The superior performance of the normal feather at the early growth phase suggests that this genotype could be of more genetic importance for selection towards the development of broiler strains from Nigerian local chicken.

Relationship between Growth Traits: The relationships between body weight and all the body morphometric measurements as well as the interrelationship between other traits were positive and very highly significant ($p<0.001$) (Table 2). The correlation ranged from 0.62 – 0.94 and 0.73 – 0.94 in the normal feather and naked neck respectively. In the normal feather, the highest correlation existed between body weight and shank length whereas in the naked neck, it was between body length and body weight (Table 2). A high correlation coefficient (0.709) was obtained between body weight and body length in a population of indigenous Nigerian chickens raised under extensive management system (Egena *et al.,* 2014). Okpeku *et al.* (2003) in a report on phenotypic and genetic variation among local chickens in Edo State, Nigeria noted that body weight had strong and positive correlation with body length and chest girth. In a pairwise correlation among body measurements, Yakubu *et al.* (2009b) also reported significant strong correlation between live weight and body length (0.85), and shank length (0.79) in Arbor broiler chickens. Haunshi *et al.* (2012) stated that strong and positive correlations between body weight and shank length would result in improvement in shank length of native birds which is a desirable trait in free range or semi-intensive system of rearing. This implied that it is a good trait for selection.

The strong positive association between body weight and the growth traits measured is an indication of pleiotropy and provides basis for possible genetic manipulation and improvement of the Nigerian local chicken (Yakubu *et al.,* 2009a). The goodness of fit as explained by the degree of linear correlation at 4 weeks of age indicated weak correlation with between body weight and all other traits with only the leg length, chest girth, shank length and shank circumference exhibiting significant association with body weight.

The strength and direction of linear relationship between traits was, however, strong and positive from 8 weeks of age ($p<0.001$) (Table 3). Although previous studies have indicated positive association between body weight and other growth traits (Gueye *et al.,* 1998; Guni *et al.,* 2013; Fayeye *et al.,* 2014), the strength of the association obtained from this study at four weeks differed from their findings. Similar observations, however, were made at 4 weeks by Ojedapo *et al*. (2012) on two commercial layer strain chickens. Udeh and Ogbu (2011) also found weak correlations between body weight and shank length, and body weight and leg length in Arbor Acre and Marshall broiler chickens.

The variations observed in the present study and some previous ones may be associated with the genetic constitution of the individual population assessed as well as environmental factors.

For instance, Ige (2013) found high positive significant genetic correlation between body weight and shank length at 4 and 8 weeks of age in the crossbred Fulani ecotype chickens in Nigeria. Likewise, Haunshi *et al.* (2012) found high genetic and phenotypic correlations between body weight and shank length in Aseel and Kadaknath native chicken breeds of India at 4 and 6 weeks of age. Yakubu *et al.* (2009b) also reported strong and positive relationship between the two traits in Arbor broiler chickens at 8 weeks.

Body weight: The linear function for predicting body weight included all growth traits studied, except shank circumference (Table 4). The high R^2 (0.89 – 0.90) obtained indicated that these traits could be used to forecast body weight precisely. These various morphometric traits have been earlier described as appropriate predictor variables for body weight (Adeniji and Ayorinde, 1990; Chitra *et al.,* 2012; Musa *et al*., 2011; Dahloum *et al.,* 2016).

Table 2: Correlation coefficient between body morphometric measurements

Morphometric measurements	BW	BL	CG	LL	SL	SC
			Normal feather			
Body weight (BW)	0.00	0.90**	0.90**	0.90**	0.91**	0.73**
Body length (BL)		0.00	0.94**	0.87**	0.91**	0.74**
Chest girth (CG)			0.00	0.84**	0.88**	0.77**
Leg length (LL)				0.00	0.92**	0.62**
Shank length (SL)					0.00	0.73**
Shank circumference (SC)						0.00
			Naked neck			
Body weight (BW)	0.00	0.94***	0.86***	0.89***	0.88***	0.74***
Body length (BL)		0.00	0.87***	0.90***	0.89***	0.76***
Chest girth (CG)			0.00	0.81***	0.81***	0.75***
Leg length (LL)				0.00	0.90***	0.73***
Shank length (SL)					0.00	0.75***
Shank circumference (SC)						0.00

*** = p<0.01, *** = p<0.001*

Table 3: Correlation coefficient between body weight (BW) and other growth traits at different ages

Traits	Age (weeks[a])			
	4	**8**	**12**	**16**
Body length (BL)	0.13 ns	0.58**	0.78**	0.77**
Chest girth (CG)	0.15*	0.58**	0.80**	0.79**
Leg length (LL)	0.20**	0.82**	0.68**	0.72**
Shank length (SL)	0.19*	0.82**	0.80**	0.63**
Shank circumference (SC)	0.15*	0.60**	0.52**	0.56**

*[a]Using pooled data; *p<0.05; **p<0.01; [ns]Not significant*

Table 4: Estimation model for body weight for the two genotypes

Genotype	Model	R^2	P-value
Normal feather[a]	BW = -1726.70 + 57.91SL + 32.99CG + 52.67LL + 10.81BL	0.89	0.001
Naked neck[a]	BW = -1677.77 + 41.59BL + 23.59LL + 13.41CG + 41.39SL	0.90	0.001
Age (Week[b])			
4	BW = 179.63 + 8.88LL	0.04	0.014
8	BW = -1408.69 + 165.44SL + 40.51LL + 74.66SC + 8.62CG + 5.59BL	0.81	0.001
12	BW = -1850.67+85.73SL + 34.88CG + 20.48BL + 17.13LL	0.78	0.001
16	BW = -2990.58 + 58.54CG + 239.06SC + 24.59BL + 28.25LL	0.77	0.001

[a]Models derived using stepwise regression, [b]Using pooled data of the two genotypes, BW = body weight, BL = body length, CG = chest girth, LL = leg length, SL = shank length and SC = shank circumference

In order to improve the prediction power of the equations, data were categorized according to age irrespective of the genotype. The stepwise regression models for body weight on other growth traits at different ages are also presented in Table 4. The result depict that at 4 weeks, the best fitted regression equation had only the leg length included in the model with a coefficient of determination (R^2) of 0.04. This implies that at 4 weeks of age, it would not be reliable to predict body weight with the other growth traits employed in the analysis, since only about 4.0 % of the total variation is attributable to them. Much significant and positive association between body weight and the growth traits studied were observed from 8 weeks of age through the 16th week. At 8 weeks, the shank length, shank circumference, leg length, body girth and body length all had a highly positive and significant relationship with body weight as indicated by a high R^2 (0.81). Furthermore, all the growth traits were included in the prediction model implying that there were all important predictors for body weight at this age. The result in Table 4 revealed that leg length, unlike other growth traits studied, was an essential predictor variable in estimating body weight at all the ages.

Generally, the result shows that the relationship between body weight and the other growth traits varied much with age, indicating that a single weight estimation model should not be adopted across age as suggested by Semakula *et al.* (2011). The disparity in the different models for predicting body weight at various ages maybe attributed to variations in the maturing patterns of the different body parts (Chineke, 2005). This buttresses the assertion of Carlson (1973) that the process of growth involves individual pattern of development of the various body tissues. However, judging from the significant positive regression coefficient associated with the growth traits, there is a clear indication that these traits increased with unit change in body weight and vice versa. Similar observation was made by Ajayi *et al.* (2008) in a population of two commercial meat-type chickens.

Conclusion: There are differences in the growth traits of the normal feather and naked neck chicken. Such differences were more obvious during the early growing phase with the normal feather having greater values, signifying that they could be of more relevance in development of broiler strains from the local chicken. The results of this study also show that the body weight of the chickens may be predicted accurately from other growth traits especially after the 4th week of age.

The leg length was an intrinsic predictor variable for body weight at every age.

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