International Journal of Agriculture, Forestry and Fisheries
2014; 2(2): 35-39
Published online March 30, 2014 (http://www.openscienceonline.com/journal/ijaff)

Interrelationships and phenotypic correlations among body dimensions in commercial pullets reared in the derived savannah zone of Nigeria

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To cite this article

Simeon O. Olawumi. Interrelationships and Phenotypic Correlations among Body Dimensions in Commercial Pullets Reared in the Derived Savannah Zone of Nigeria. *International Journal of Agriculture, Forestry and Fisheries.* Vol. 2, No. 2, 2014, pp. 35-39.

Abstract

This research work was conducted to evaluate the relationship between live body weight and linear body measurements in three strains of commercial layers reared under intensive system of management. Traits considered were body weight, body length, thigh length, shank length, breast girth, while the feed variables were feed intake, feed conversion ratio and feed efficiency. There were significant ($P<0.01$) phenotypic correlations between body weight and linear measurements in all the three strains. Feed intake and feed efficiency also have high phenotypic correlations with body weight and linear measurements, whereas the reverse was the case with feed conversion ratio. In general, some traits had very high significant positive phenotypic correlations with body weight, some recorded medium phenotypic correlation values while some had low correlation values with body weight. Traits that recorded high phenotypic correlations with body weight are body length, thigh length, feed intake and feed efficiency, those with medium phenotypic correlations are shank length and breast girth, while trait with low phenotypic correlations was feed conversion ratio. The obtained results indicate pleiotropic effects of genes operating on these traits. The implication is that selection for any of the traits in these strains will lead to improvement of others.

Keywords

Strain, Phenotypic Correlation, Trait, Feed Efficiency, Pleiotropic, Weight

1. Introduction

Production of improved strains of egg type and broiler chickens involves breeding, selection, development and improvement of new strains. In Nigeria, there are different strains of commercial pullets which are produced locally from breeder stock imported from overseas companies. For improvement programmes to be successful, a breeder must take into consideration the interrelationships between body weight and other body conformation traits. Such conformation traits include shank length, thigh length, breast girth and body length. According to Ibe (1989), some of these conformation traits are good indicators of body weight and market value in chickens. Previous study had reported that the relationships between body weight and conformation traits are direct and positive (Okon *et al.*, 1997). In addition, Kabir *et al*. (2008) documented that the exact time to slaughter a mature broiler depends on its body weight and general development. Body weight is a qualitative trait, controlled by few pairs of genes, highly heritable and influenced also by the environment. Previous investigators had reported that differences in growth pattern are under genetic control, and that variations exist within species (Lilja *et al.*, 1985; Carborg *et al*., 2003).

Previous studies made one to understand that researchers and local farmers make use of body weight and body dimensions as parameters for selection in order to improve the productivity of their breeds (Fitzburgh, 1976). In most places, and especially in the villages where manual weighing scales are not readily available, prediction equations according to Ozoge and Herbert (1997) and

Nesamvuni *et al.* (2000) may be derived from body measurements and there after used to predict body weight of animals. There are genetic differences in growth rate between strains, and the changes in weight ranking may be critical in the age range between 8-12weeks (Deeb and Lamont, 2002). Body weight according to Chambers (1990) is the most frequently used indicator of growth.

Early study had indicated positive and significant phenotypic correlations between live weight and body dimensions, that is, body dimensions can be used to predict the body weight of an animal. In cane rat, Kolawole and Salako (2010) found a positive relationship between live weight and body length and heart girth. Similarly, Ige *et al.* (2007) reported positive phenotypic correlation between body weight and linear measurements in local fowls. The findings of the authors are in agreement with Ezzeldin *et al.* (1994) and Ojedapo *et al.* (2006) who found positive significant phenotypic correlations between body weight and linear body measurements in three strains of domestic chickens.

It is imperative to know the association existing between live weight and linear measurements of all egg producing chicken strains in order to be able to predict the body weight from body parts and vice versa. In view of the reason adduced above, this study was carried out to estimate the phenotypic correlations between live weight and body dimensions in Isa Brown, Bovan Nera and Dominant Black pullets raised under intensive management practices. The scope of this study includes evaluating the relationship between growth traits and feed variables such as feed intake, feed conversion ratio and feed efficiency.

2. Materials and Methods

The study was carried out at the Animal Breeding Unit, Teaching and Research Farm, Ekiti State University, Ado-Ekiti, between March, 2007 and August, 2007. Ado-Ekiti is situated along latitude $7^{0}31^{1}$ and $7^{0}49^{1}$ North of the Equator and longitude $5^{0}71^{1}$and $5^{0}27^{1}$East of the Greenwich Meridian. The city falls under Derived Savannah zone. The city enjoys two separate seasonal periods namely, Rainy (May-October) and Dry (November-April) seasons.

2.1. Management and Experimental Birds

A total number of 300 day-old chicks, that is, 100 chicks each of Isa Brown, Bovan Nera and Dominant Black were sourced from local hatcheries and used for this study. The chicks were brooded using coal pot to supply heat for the first three weeks of life. Antibiotics and vitamins were administered as and when due. Also, vaccines against Infectious Bursae and Newcastle diseases were given at specified age intervals. Their beddings are made up of dry wood shavings to prevent coccidiosis outbreak, and high level of hygiene was maintained throughout the experimental period to ensure unhindered conducive environment for growth and to lower death rate. The birds were raised on deep litter under uniform management and environmental conditions. They were of the same age, and were given chicks mash from 1st day-8 weeks containing 21%CP and 3000 Kcal/kg ME. Thereafter, they were switched over to growers mash containing 14%CP and 2400 Kcal/kg ME until 20 weeks of age. Medications and vitamins were given on regular basis to boost the immunity level of the birds.

2.2. Data Collection

The birds were weighed at day-old and subsequently at 4 weeks interval until 20 weeks of age. Fifty (50) birds per strain were taken at random for weighing after being starved overnight from the pens each time the exercise was carried out. Other linear measurements taken are body length, breast girth, shank length and thigh length. In addition, data were taken on feed intake, feed conversion ratio and feed efficiency at four (4) weeks interval beginning from day one. Live body weights were weighed using sensitive scale (gm), while other parts were measured with tailors tape rule in centimetre.

2.3. Statistical Analysis

Both the pooled and individual strain data on body weight, body length, shank length, breast girth, feed intake, feed conversion ratio and feed efficiency of the three strains were analyzed using Pearson Correlation Analysis of SAS (2001).

3. Results and Discussion

Table 1 represented the descriptive statistics (pooled data) for the traits evaluated on the commercial layer strains. The mean values for body weight, body length, thigh length, shank length, breast girth, feed intake, feed conversion ratio and feed efficiency respectively, were 668.39±507.81g, 20.31±7.61cm, 8.50±3.65cm, 5.39±3.04cm, 10.35±6.46cm, 203.33±142.35g, 0.30±0.19 and 2.57±1.39.

Table 1. *Descriptive statistics of body weight and linear measurements in commercial pullet strains.*

Traits	No.	Mean	Sx	Min.	Max.
Body weight (g)	900	668.39	507.81	23.5	1920
Body length (cm)	900	20.31	7.61	7.30	84
Thigh length (cm)	900	8.50	3.65	1.80	14
Shank length (cm)	900	5.39	3.04	1.50	71
Breast girth (cm)	900	10.35	6.46	3.2	145
Feed intake	900	203.33	142.35	00	450
Feed conversion ratio	900	0.30	0.19	00	1.44
Feed efficiency	900	2.57	1.39	00	5.00

Table 2 shows the phenotypic correlation analyzes for body weight and linear measurements (pooled data). There was statistically significant ($P<0.01$) positive phenotypic correlations between body weight and body length (0.881), thigh length (0.955), shank length (0.677) and breast girth (0.700). The result implies that linear body measurements are good indicators of body weight. This was in agreement with the observations of previous researchers (Ojedapo *et al*., 2006; Ige *et al*., 2007). Similarly, body weight has positive phenotypic correlation with feed intake (0.962) and feed efficiency (0.783). This means that feed intake and feed efficiency are good determinants of body weight. On the contrary, an insignificant (P>0.05) phenotypic correlation was indicated between body weight and feed conversion ratio in this study. Furthermore, all the linear body measurements evaluated had high phenotypic correlations with one another, and this suggests a pleiotrophic gene action and gene linkage effects (El-Labban, 1999). The implication is that any selection programme to improve any one of the conformation traits will lead to improvement in body weight. Conversely, any factors such as disease, under nutrition or nutritional imbalance that depresses organ development will have adverse and negative effect on body weight of chickens.

In this study, it was discovered that feed intake and feed efficiency were positively (P<0.01) correlated with growth traits. The correlation values between these feed variables and body weight were very high (r =0.78-0.96). This means in effect that proper and balanced nutrition promotes and enhances rapid development of all organs of the animal. Therefore, it implies that the rate of anatomical and physiological development of all animals including chickens depends on availability of balanced diet since positive association was found in this study between growth traits and the amount of feed taken. However, body weight has no significant (P>0.05) phenotypic correlation with feed conversion ratio. This implies lack of association between the two traits.

Table 2. *Phenotypic Correlations among Production Traits in Pullets (pooled data).*

Traits	Body weight	Body length	Thigh length	Shank length	Breast girth	Feed intake	Feed conversion ratio	Feed efficiency
Body weight	1.00	0.881**	0.955**	0.677**	0.700**	0.962**	0.015	0.783**
Body length		1.00	0.926**	0.660**	0.618**	0.851**	0.129**	0.853**
Thigh length			1.00	0.702**	0.672**	0.931**	0.147**	0.889**
Shank length				1.00	0.483**	0.658**	0.110**	0.641**
Breast girth					1.00	0.689**	0.073**	0.549**
Feed intake						1.00	0.209**	0.717**
Feed conversion ratio							1.00	0.216**
Feed efficiency								1.00

**P<0.001

The combined analyzes (Table 2) also revealed very strong association (r =0.48-0.95) among growth traits, that is, body length, thigh length and breast girth. There appears to be linked-genes controlling these traits. Therefore, it implies that any selection for one trait will lead to improvement of others since they are linked by genes responsible for growth. The result was consistent with the findings of Kolawole and Salako (2010) who reported positive correlations among linear body measurement in cane rat. In this study, significant (<0.01) phenotypic correlation values (r =0.65-0.96) were reported between feed intake and linear body measurements. Similarly, feed efficiency was highly positively correlated (r =0.54-0.88) with linear body measurements. This simply means that feeding animals with quality diet, and in amount sufficient for maintenance and growth, all body dimensions will be positively affected, while under nutrition will cause stunted growth in all organs and eventual death. There was very low positive phenotypic correlations between feed conversion ratio and feed intake (r =0.21) and feed efficiency (r =0.22), whereas, feed intake and feed efficiency were highly correlated (r =0.72). In general feed conversion ratio has very low significant phenotypic correlations (r =0.07-0.14) with all the linear body measurements. On the contrary, feed intake and feed efficiency had very high significant phenotypic correlations (r =0.54-0.96) with those traits connected with animal growth. This implies that in chickens, feed intake and feed efficiency increased in values at a rate greater than feed conversion ratio as the hens grew in size and age. It is important to add that the varying degrees of positive association between body weight and linear measurements will have direct bearing on the level of success or improvement to be recorded in any selection programme.

In the present study (Table 3), strain-basis analysis showed a positive significant (P<0.01) phenotypic correlations between body weight and linear body measurements in Isa Brown pullets. Ojedapo *et al*. (2006) reported similar results in three strains of commercial layers. In addition, feed intake and feed efficiency had very high correlation values with body weight, while there was weak association between the former and feed conversion ratio. Also in this strain, feed conversion ratio has very low but positive phenotypic correlations with linear body measurements, feed intake and feed efficiency, whereas, feed intake and feed efficiency correlation values with growth traits were high. The result indicates that feed variables with the exception of feed conversion ratio increased in mean values as the animals grew in size. Notable findings obtained from this study were that certain traits such as body length, thigh length, feed intake and feed efficiency can be categorized as having high phenotypic correlation values with body weight. Others such as shank length and breast girth have medium phenotypic correlation values, while feed conversion ratio has low phenotypic correlations with body weight. The implication of this is that selection for growth traits with high phenotypic correlations will lead to rapid improvement in body weight of the animal due to linkage gene effects operating on them.

Furthermore, there was statistically significant ($P<0.01$) positive phenotypic correlation between body weight and linear body measurements in Dominant Black pullets (Table 3). In this strain, all the linear measurements had higher phenotypic correlations with body weight when compared with values obtained for Isa Brown. However, contrary to what was recorded for Isa Brown, there was negative significant ($P<0.01$) phenotypic correlations between body weight and feed conversion ratio and an insignificant ($P>0.05$) correlations with other growth traits. This implies that the rate of feed conversion in Dominant Black strain is inversely proportional to live body weight of the pullets, that is, feed conversion ratio has inverse relationship with body weight. This feed variable also has no direct positive association with all the linear body measurements measured. The observed high phenotypic correlation values recorded for feed efficiency in Dominant Black might not be unconnected with negative association between body weight and feed conversion ratio. This singular attribute makes this strain unique, superior and more feed efficient than Isa Brown and Bovan Nera.

In Bovan Nera strain (Table 4), there was statistically significant ($P<0.01$) positive phenotypic correlations between body weight and linear measurements, feed intake and feed efficiency. However, no significant ($P>0.05$) phenotypic correlation between body weight and feed conversion ratio was indicated in this strain. Similar to Isa Brown results, feed conversion ratio in Bovan Nera has very low phenotypic correlation values with all the traits under consideration. In addition, feed intake and feed efficiency in Bovan Nera had high phenotypic correlations with all growth traits except feed conversion ratio. The obtained results in this strain indicate the possibility of linked-genes effects acting on these traits. Therefore, selection for one of the traits will bring about improvement on others.

Table 3. *Phenotypic Correlations among Production Traits in Isa Brown and Dominant Black Pullets.*

Traits	Body weight	Body length	Thigh length	Shank length	Breast girth	Feed intake	Feed conversion ratio	Feed efficiency
Body weight	1.00	0.787**	0.951**	0.482**	0.534**	0.971**	0.266**	0.735**
Body length	0.948**	1.00	0.824**	0.415**	0.425**	0.753**	0.280**	0.729**
Thigh length	0.959**	0.984**	1.00	0.497**	0.506**	0.924**	0.399**	0.872**
Shank length	0.962**	0.987**	0.989**	1.00	0.266**	0.466**	0.203**	0.444**
Breast girth	0.977**	0.941**	0.957**	0.957**	1.00	0.513**	0.183**	0.423**
Feed intake	0.952**	0.914**	0.930**	0.934**	0.972**	1.00	0.386**	0.673**
Feed conversion ratio	-0.149**	-0.012	-0.017	-0.012	-0.017	0.099	1.00	0.527**
Feed efficiency	0.838**	0.936**	0.922**	0.926**	0.829**	0.770**	0.031	1.00

**P<0.01. Above diagonal- Isa Brown
Below diagonal- Dominant Black

Table 4. *Phenotypic Correlations among Production Traits in Bovan Nera Pullets.*

Traits	Body weight	Body length	Thigh length	Shank length	Breast girth	Feed intake	Feed conversion ratio	Feed efficiency
Body weight	1.00	0.916**	0.957**	0.941**	0.889**	0.969**	0.11	0.775**
Body length		1.00	0.981**	0.984**	0.792**	0.906**	0.285**	0.914**
Thigh length			1.00	0.989**	0.839**	0.943**	0.247**	0.885**
Shank length				1.00	0.823**	0.925**	0.270**	0.908**
Breast girth					1.00	0.884**	0.113**	0.634**
Feed intake						1.00	0.259**	0.729**
Feed conversion ratio							1.00	0.375**
Feed efficiency								1.00

**P<0.01

4. Conclusions

It was revealed in this study that body weight has significant (P<0.01) positive phenotypic correlation with linear body measurements in egg laying strains, and that these traits are good determinants of body weight. In certain situations whereby weighing scale is not available, the values of linear parts could be used to predict the value of body weight. Also in this study, feed intake and feed efficiency high phenotypic correlation with body weight and linear measurements, but the reverse was the case for feed conversion ratio, that is, the latter has very low correlation with the former. It is inferred from the findings of this study that linked gene effects operate on these traits, and any selection for one trait will lead to improvement of the others.

Acknowledgements

The authors appreciate the support and cooperation received from staff and management of Teaching and Research farm, Ekiti State University, Ado-Ekiti.

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