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# VARIABILITY IN BODY SHAPE CHARACTERS IN AN INDIGENOUS GUINEA FOWL (*NUMIDA MELEAGRIS* L.)

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## ABSTRACT

Morphometric traits (body length, wing length, neck length, shank length, thigh length, keel length, chest circumference) and body weight obtained from 82 adult (both sexes) Nigerian indigenous guinea fowl, domesticated by rural farmers in three communities of Lafia local government area of Nasarawa State, were determined in the study. The study was aimed at obtaining the sources of shared variability among the body shape characteristics in adult guinea fowl and predicting live weight using both original and orthogonal traits. Sex effect on the traits was not significant (P>0.05). Correlations between traits were ranging from 0.07 to 0.98. Body conformation "shape" was controlled by both common and unique factors, communalities ranges between 0.371 to 0.996 for wing length and keel length, respectively. Common sources of variability in body dimensions of the bird were accounted for by factors representing general size and chest circumference. Original body dimensions were better predictors of body weight than the orthogonal traits derived from factor analysis.

**Key words:** guinea fowl; body dimensions; variability; factor analysis; communality

## INTRODUCTION

There are two main guinea fowl subspecies found in Nigeria. The helmeted guinea fowl, *Numida meleagris galeata* Pallas, occur freely throughout the grassland areas spreading from the derived savanna near the forest zone in the south to the true savanna into northern guinea savanna vegetation zones. The second, the crested guinea fowl, *Guttera edouardi edouardi*, is restricted in distribution to the forest and derived savanna forest edges (Ayeni, 1979). The number of free ranging semi-wild guinea fowl kept in captivity in Nigeria alone is said to be about 45 million (Akinwumi *et al*., 1979) with more millions still in the wild. It is second to the domestic fowl in terms of number and supply of poultry protein in Nigeria. Thus a huge number exists for various studies and from which to select for improvement (Ayorinde, 1991; Smith 2000 ). They are described as a poor man's "pheasant" (Bond 1997). In north- central Nigeria, few farmers tend to domesticate the bird through collection of the egggs from the wild and hatching them at home, thereby growing them with the local chicken. This practice is gaining wide acceptance among rural people. Some farmers keep the bird out of curiosity and as watch animal around home stead because they have an excellent eye sight, a hash cry and shrick at the slightest provocation.

Because of the ever increasing interest in consumption and domestication of this bird, deliberate efforts are required to promote the development of this species. This can be achieved through adoption of breeding programmes that are common to other livestock, there by evolving the know-how on the performance of the various traits and providing a blue print that will lead to improvement in performance and other economic traits in the bird.

Body measurement and its relationship to size and shape have been extensively studied in both large animals and poultry (Mendes *et al*., 2005; Ogah *et al*., 2011; Shahin and Hassan 2000). Its use in predicting weight and other characteristics was also elucidated.

The objective of the study was to obtain the sources of shared variability among the body shape characters of adult guinea fowl and predict live weight

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using both original traits and orthogonal traits.

## MATERIAL AND METHODS

The data used for the study were generated from 82 adult indigenous guinea fowl domesticated by rural farmers as described by Smith (2000), in three villages of Adogi, Ashige and Abu of Lafia local government area of Nasarawa State, Nigeria, located between latitude 08.30ºN and longitude 08.32ºE with annual rainfall ranging from 952 to1988 mm, and a mean monthly precipitation of 150 mm. Its minimum and maximum daily temperatures are in the range of 20-37ºC. Lafia has a mean relative humidity at noon varying between 14 and 74 %. It has two distinct seasons: the wet season covering late April to October and dry season covering November to early April.

The birds were managed under semi-intensive system, housing was provided, water was supplied *ad libitum*, and fed on brewer dried grain and whole corn seed and kitchen waste. They were also allowed to scavenge around at noon. The birds considered for measurement were adult birds of about a year and above.

**Parameter measured (Body traits measurements)**

Live body measurements included body weight (BW), body length (BL), wing length (WL), thigh length (TL), keel length (KL), neck length (NL), shank length (SL) and chest circumference (CC), as outlined by Gueye *et al.* (1998). Kitchen scale and graduated measurement tape were used to obtain the data. To ensure accuracy, each measurement was taken twice, the same person throughout took all measurements and weighing, thus eliminating error due to personal difference. The data from males and females are pooled since there was no significant difference between the sexes in the above mentioned traits, using multivariate Hotellings $T^2$ -test as described earlier (Ogah, 2012).

**Statistical analysis**

The data were subjected to a factor analysis procedure (SAS, 1999) after the descriptive statistics was initially obtained using same package. The main source of shared variation among the interdependence of body measurements (*p*) was expressed in terms of fewer mutually uncorrelated common factors F1, F2...., F*q* (where $q$ < p), than the original measurements (Darton, 1980). The first factor contained the greatest portion of the original variation and in a morphometric application of factor analysis it was designated as a general size factor. Subsequent factors were mutually orthogonal to those preceding and to one another and contained less variation. The model used is as follows:

**X = L F + U**, where

**X** = $a\ p\ ´\ 1$ is a vector observational variables;
**L** = $a\ p\ ´\ q$ a matrix of factor loading 'factor – variate correlations, the degree of correlation of the variable with factor' (the pattern matrix);
**F** = $a\ q\ ´\ 1$ a vector of factors (non-observable) and
**U** = $a\ p\ ´\ 1$ a vector of the specific 'unique' factor.

The total variance of a variable was equal to unity and can be written as the sum of common variance 'communalities' and unique variance 'uniqueness'. The communality represented the portion of the variable variance accounted for by all common factors and the uniqueness represented the portion of the variable variance not ascribable to its correlation with other variables. A build up stepwise multiple regression was used to predict body weight from the live measurements. Attaining the 5 % level of significance was the predetermined criterion for entering the independent variables. Their sequence of retention followed a descending order for the amount of variance explained. The programme terminated when the last independent variable entering the equation had an insignificant regression coefficient.

## RESULTS AND DISCUSSION

The descriptive statistics of the morphometric traits of the indigenous guinea fowl is presented in Table 1. Most of the traits are similar to what was reported earlier by Ogah (2012). However, the body weight of the current work is higher. The reason for the differences in weight and other traits might be genetic and environmental, as variation in management could account for that. The result is similar to those of Saina *et al.* (2005), recorded from Zimbabwe, and higher than reported by Galor (1985) and Ayorinde (1991). The effect of sex using multivariate Hotellings $T^2$ test was not significant (P>0.05), which leads to pooling of the data for general analysis, thus agreeing to the submission of Ayorinde (1991).

Table 2 presents the correlation matrix between the morphometric traits. All traits were positively correlated with body weight, chest circumference had the highest phenotypic correlation (P<0.001) with body weight, while wing length had the least (0.17). Ogah *et al.* (2011) reported similar trend to male Muscovy duck. The positive and significant correlation of body weight and the other morphological traits (body length, keel length, chest circumference) suggests that the traits are under same gene action (pleitropism) and by implication selection for improvement of one result in improvement of the other trait as correlated response. Similar relationship between body weight and chest

**Table 1: Descriptive statistics of morphometric traits of adult indigenous guinea fowl**

| Trait | mean ± se | min | max | cv |
|---|---|---|---|---|
| Body weight (kg) | 1.42 ± 0.09 | 0.90 | 3.00 | 35.90 |
| Body length (cm) | 22.42 ± 0.17 | 20.00 | 24.00 | 4.46 |
| Wing length (cm) | 19.34 ± 0.21 | 15.00 | 22.00 | 6.62 |
| Neck length (cm) | 17.03 ± 0.10 | 16.00 | 17.60 | 3.58 |
| Shank length (cm) | 7.73 ± 0.08 | 7.10 | 8.10 | 5.90 |
| Thigh length (cm) | 11.87 ± 0.10 | 11.10 | 12.50 | 4.95 |
| Keel length (cm) | 2.80 ± 0.06 | 2.30 | 3.10 | 12.89 |
| Chest circumference (cm) | 35.37 ± 0.35 | 33.50 | 38.00 | 5.88 |

**Table 2: Correlation matrix between morphometric traits of the indigenous guinea fowl**

| | BW | BL | WL | NL | SL | TL | KL | CC |
|---|---|---|---|---|---|---|---|---|
| BL | 0.23 | | | | | | | |
| WL | 0.17 | 0.12 | | | | | | |
| NL | 0.44** | 0.16 | - 0.09 | | | | | |
| SL | 0.67*** | 0.23 | - 0.09 | 0.96*** | | | | |
| TL | 0.31 | 0.12 | - 0.12 | 0.98*** | 0.90 | | | |
| KL | 0.52** | 0.18 | - 0.07 | 0.96*** | 0.98 | 0.97 | | |
| CC | 0.78*** | 0.24 | 0.23 | - 0.11 | 0.18 | - 0.27 | - 0.12 | |

BW = body weight, BL = body length, WL = wing length, NL = neck length, SL = shank length,TL = thigh length, KL = keel length, CC = chest circumference, ** = P<0.01, *** = P<0.001

**Table 3: Explained variation associated with rotated factor analysis along with their common and unique factors**

| Trait | Common factors | | | |
|---|---|---|---|---|
| | FC1 | FC2 | communalities | unique factor |
| BL | 0.214 | 0.618 | 0.428 | 0.577 |
| WL | - 0.101 | 0.601 | 0.371 | 0.629 |
| NL | 0.998 | - 0.042 | 0.997 | 0.003 |
| SL | 0.996 | 0.195 | 0.972 | 0.028 |
| TL | 0.980 | - 0.166 | 0.987 | 0.013 |
| KL | 0.997 | 0.031 | 0.996 | 0.004 |
| CC | - 0.072 | 0.806 | 0.655 | 0.345 |
| % var | 56.342 | 20.874 | | |

BW = body weight, BL = body length, WL = wing length, NL = neck length, SL = shank length,TL= thigh length, KL = keel length, CC = chest circumference, FC1 = first common factor, FC2 = second common factor circumference was reported by Ogah *et al.* (2011) for Muscovy duck, Mendes *et al.* (2005) for America bronze turkey under different lightening programmes.

Table 3 outlines the communalities and unique factors for various variables. The result shows that 37 to 99 % of the variation in body measurement traits were brought about by the common factors, whereas 63 to 1 % of these variations were contributed by unique factors specific for each variable; keel length, neck length, shank length and thigh length had the highest common factors (0.993, 0.917, 0.972, and 0.987) with lowest variation contributed by the unique factors. While wing length had the least common factor (0.371) and the highest contribution of the unique factor.

The two common factors were obtained from varimax rotation, accounted for 77.22 % of the total variability of the original variables. The first factor (F1) general size was characterized by high positive loading (factor-variate correlaton) on all body dimensions other than wing length and chest circumference. Shank lenght, thigh length and neck length coefficients dominated the first factor and represent good estimator of general size (Shahin and Hassan, 2000). This first factor "general size" accounted for 56.34 % of the total variance, similar to those of Ricard and Rouvier (1968), obtained from principal component analysis of cockreal among body shape characters (Ogah *et al*., 2009) 57 % for male muscovy duck.

The second factor which was mutually orthogonal to the first show pattern of variation independent of general size, it account for 20.87 % of the total variation and had high loading for chest circumference, body length and wing length. The most common variability here are general size and chest circumference similar to that reported for New Zealand White rabbit (Shahin and Hassan, 2000).

Table 4 presents the results of stepwise multiple regression of body weight on both morphometric and orthogonal traits. Chest circumference alone accounted for 61 % of the variability in the body weight. These traits have been used as an indicator of animal size in number of studies (Shahin 1999; Ogah *et al*., 2011). In addition of thigh length the $R^2$ increases to 86 %, this indicates that live weight can be predicted with fair degree of accuracy and reliability from chest circumference and thigh length. The result of the stepwise multiple regression of body weight could be outlined as following:

BW = -5.344 + 0.481TL + 0.27CC.

That of the orthogonal traits derived from factor analysis scores also show a progression from 41 % to 63 % $R^2$ . BW= 0.327 + 0.054FC1 + 0.054 FC2.

It shows that the regression coefficient in a stepwise multiple regression of body weight on the original traits was unstable and changed with the addition of variables into the equation. The instability could lead to probability to estimate the unique effect of individual variable in the regression equation and thus could lead to false inference.

Corresponding regression coefficient obtained from regression of the body weight on orthogonal traits obtained from factor analysis were stable with addition of factor scores in the equation (order of entry did not affect the result). The scenario was similar to what was reported by Shahin (1996) on analysis of muscles and bone weight variation of egyptian strain of Pekin duckling.

**Table 4: Step-wise multiple regression of body weight on morphometric traits and their orthogonal variable from factor analysis scores**

| Step | indep. Var | | | | | |
|---|---|---|---|---|---|---|
| | Predictor | | | | | |
| A | Original body measurement | intercept | reg.coeff | se | $R^2$ | VIF |
| 1 | Chest circumference | -5.344 | 0.191 | 0.026 | 0.61 | 01.000 |
| 2 | Chest circumf. | -12.321 | 0.227 | 0.015 | 0.89 | 1.075 |
| | Thigh length | | 0.481 | 0.052 | | 1.075 |
| B | Their orthogonal traits | | | | | |
| 1 | FC 2 | 1.421 | 0.327 | 0.067 | 0.41 | 1.000 |
| 2 | FC 2 | 1.421 | 0.327 | 0.054 | 0.63 | 1.000 |
| | FC 1 | | 0.241 | 0.054 | | 1.000 |

FC1 = first common factor, FC2 = second common factor, VIF = variance inflation factor

## CONCLUSION

From the results it can be concluded that chest circumference and thigh length are good predictors of body weight in the bird, similarly the use of original interrelated traits was more appropraite than the orthogonal body shape characters derived from factor analysis for predicting body weight in guinea fowl.

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