

# Discriminant analysis of sexual dimorphism in zoometrical characters of normal feathered Yoruba ecotype adult local chicken in the Tropical Forest Zone of Nigeria

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**ABSTRACT:** Measurement of some zoometrical traits and calculated indices in male and female local chickens were undertaken as means of differentiation between the sexes out of numerous measurements that could be taken and indices that could be calculated. Data on body weight (BW), breast circumference (BC), wing span (WS), Ornithological measurement (OM), total leg length (TLL), stockiness (STK), massiveness (MAS), long-leggedness (LLG) and condition index (CI) were collected on 161 adult local chickens comprising of 86 cocks and 75 hens reared under village scavenging conditions in a cross-sectional survey. The hens showed significantly ( $p < 0.05$ ) higher OM and STK (72 versus 67%) while cocks were higher ( $p < 0.05$ ) in BW, WS, BC, TLK, MAS, LLG and CI. Low, moderate and high positive and negative coefficients of correlation ( $r$ ) were observed among the body parameters in both sexes. Highest  $r$  was observed between WS and TLL ( $r = -0.920$ ;  $p < 0.01$ ) in hens and between TLL and BC ( $r = 0.362$ ;  $p < 0.01$ ) in cocks. When the calculated indices were correlated with body BW, highest  $r$  was obtained between BW and CI in both sexes. The discriminating power of the variables was highest in TLL, chronologically followed by BW, WL and BL. The reduction in the number of measurements saves time and energy required to distinguish between the sexes.

**Key words:** Cocks, cross-sectional survey, hens, zoometrical traits.

## INTRODUCTION

Local chickens (Plates 1 and 2) had not been accorded pronounced recognition in economic empowerment of Africans until lately. These chickens possess distinctive characteristics as a gene pool for traits of importance to adaptation, hardiness and resistance to common diseases of exotic chickens (Byarugaba, 2007). The meat is lean, relatively low priced (Le Behan–Dual, 2004) and tastier compared to their exotic counterparts (Kolawole, 2010). Additionally, there is lack of religious restriction against its consumption (Jaturasitha, 2004) and the production system is sustainable. Consequently, there is now a great number of researches in different aspects of production in native chickens domicile in Africa. Adetayo and Babafunso (2001) studied the age at first egg drop, egg production, egg weight, percent hen-day egg production and percent laying mortality in indigenous

chicken (NIC) from three agro-ecological zones (Rain Forest, RF; Derived Savanna, DS; and Guinea Savanna, GS) in Nigeria. Naidoo (2003) worked on Indigenous poultry production systems in northern Kwazulu-Natal, South Africa. Demeke (2004) studied the comparative egg production performance of local and white leghorn hens under intensive and rural household conditions in Ethiopia. Grobbelaar et al. (2010) worked on egg production potentials of four different indigenous chicken breeds in South Africa while Egena et al. (2012) studied the effect of Spurred and Spurless Male and Female Indigenous chicken in the three administrative zones of Niger State on body parameters - body weight, body length, body girth, wing length, shank length and shank thickness.

However, the incessant decimation of these local



**Plate 1.** Male indigenous chicken.



**Plate 2.** Female indigenous chicken.

germplasms as a result of spread of exotic chickens, through hawking, to every nook and cranny of the country requires frequent evaluation to determine the level of genetic variation as a result of interbreed between/among them. Sexual dimorphism of quantitative traits must be established for accurate information of their characteristics and in cases where they have been established, there is the need for verification and validation.

Sexual dimorphism represents phenotypic differences between male and female of the same animal species in size, form and structure. Generally, birds show plumage dimorphism and characteristically, males are the more brightly coloured sex (McGraw et al., 2002). This has been ascribed to the asymmetrical reproductive contributions of the sexes (Owens and Hartley, 1998) and reproductive fitness such as body condition (Lindsay et al., 2009) or survival (Petrie, 1994). Dimorphism may also influence differences in parental investment during times of food scarcity (Velando, 2002). Sexual dimorphism in form and behavior can lead to sex differences in space and resource use (Main, 2008). Most sexual segregation research has been done on ungulates (Main, 2008) but such research had been extended to bats (Safi et al., (2007), and birds (González-Solís et al., 2000).

In Nigeria, numerous attempts have been made to characterize the local chickens using univariate and multivariate analyses of live weight and zoometrical measurements. However, there is dearth of published information using morphological indices and discriminant analysis. The aim of this study therefore is to measure some zoometric traits and corporal indices in male and female local chickens and use discriminant analysis as a mean of differentiation.

## **MATERIALS AND METHODS**

### **Location and description of study area**

The study was carried out in Ekiti State. There are 16 Local Government Areas (LGAs) in the state which is

divided into South, Central and North (Figure 1). Ekiti State is situated entirely within the tropics and covers an area of 8,557 km<sup>2</sup> with a population of 2,384,212 based on 2006 population census. It is located between longitudes 40°51' and 50°451' east of the Greenwich meridian and latitudes 70°151' and 80°51' north of the Equator. Temperature ranges between 21° and 28 °C with high humidity. In the South, the vegetation is primarily Tropical hardwood forest, while a mixed / derived type savannah can be observed in the northern peripheries ([https://en.wikipedia.org/wiki/Ekiti\\_people](https://en.wikipedia.org/wiki/Ekiti_people)).

### **Biological specimens and sampling technique**

The data were collected on one hundred and sixty one (161) randomly selected normal feathered Yoruba ecotype adult local chickens comprising of 86 cocks and 75 hens reared under village scavenging conditions between November 2011 and March 2012. The local government areas in each district were arranged alphabetically and thereafter numbered serially. All the local government areas that are even-numbered were selected as experimental sites. In all, a total of seven local government areas were selected for the study. The LGAs were Ekiti East, Emure and Ise-Orun in District A; Efon-Alaaye and Ijero in District B and Ikole and Moba in District C.

### **Parameters examined**

The parameters examined on each adult indigenous chicken were body weight (BWT) and four zoometrical measurements (breast circumference, wing span, Ornithological measurement and total leg length). To ensure accuracy, each measurement was taken twice, early in the morning before the chickens were released for scavenging only on apparently healthy birds. From the parameters above, four zoometrical indices: massiveness, stockiness, long-leggedness and condition index were calculated.



Figure 1. Map of Ekiti State (Source: Nigeria Muse, 2010).

### Body weight and anatomical points of reference for each zoometrical measurement

1. The body weight (BWT) of the birds was taken using a weighing scale.
2. Breast circumference (BC) was measured as the circumference at the edge of the sternum under the wings.
3. Wingspan (WS): Distance between the ends of the longest primaries with wings stretched on the work table, maintain the joints of the wings as stretched as possible.
4. Ornithological/body length (BL) measurement: Measured from the tip of the beak to the end of the tail when the bird was laid down on its back.
5. Total leg length (TLL) was measured as the total of the lengths of femur, shank and metatarsal.

### Zoometrical indices estimation

$$\text{Massiveness (MAS)} = \frac{\text{Live weight} \times 100}{\text{Body length}}$$

$$\text{Stockiness (STK)} = \frac{\text{Breast circumference} \times 100}{\text{Body length}}$$

$$\text{Long leggedness (LLN)} = \frac{\text{Total leg length} \times 100}{\text{Body length}}$$

$$\text{Condition index (CND)} = \frac{\text{Live weight} \times 100}{\text{Wing span}}$$

### Statistical analysis

All the data were subjected to ANOVA to determine the effect of sex using the General Linear Model of SPSS Version 19 (1989) after adjustment for age differences. The same statistical package was used to separate the means of both sexes using the two-tailed, two-sample t-test and to compute the Pearson's coefficients of correlation among the various body parameters. Canonical discriminant analysis on body weight and zoometrical measurements of the adult chickens were examined using the same SPSS package. The standardized discriminant function was used to monitor for the most discriminating variables between the sexes. Wilks' lambda (U statistic) was used to test the significance of the discriminant function and the Bartlett's V transformation of lambda (chi-square statistic) was later used to compute the significance of lambda.

### RESULTS AND DISCUSSION

The means, standard deviations and coefficients of variation of the body parameters of indigenous hens and cocks are presented in Table 1. The hens showed significantly ( $p < 0.05$ ) higher body length and stockiness while cocks were higher in body weight, wing span, breast circumference, total leg length, massiveness, long-leggedness and condition index. This is consistent with Yakubu and Salako (2009) who observed that sex influenced body weight and body linear measurements in

**Table 1.** Descriptive statistics of the body weight (kg), linear body measurements (cm) and morphological indices (%) of adult indigenous hens and cocks.

| Traits               | Cocks              |                    |                          | Hens               |                    |                          |
|----------------------|--------------------|--------------------|--------------------------|--------------------|--------------------|--------------------------|
|                      | Mean               | Standard Deviation | Coefficient of variation | Mean               | Standard Deviation | Coefficient of variation |
| Body weight          | 1.25 <sup>a</sup>  | 0.13               | 0.11                     | 0.98 <sup>b</sup>  | 0.09               | 0.09                     |
| Body length          | 16.43 <sup>b</sup> | 0.26               | 0.02                     | 17.47 <sup>a</sup> | 0.16               | 0.01                     |
| Wing span            | 11.45 <sup>a</sup> | 0.17               | 0.02                     | 11.30 <sup>b</sup> | 0.12               | 0.01                     |
| Breast circumference | 11.87 <sup>a</sup> | 0.58               | 0.05                     | 10.96 <sup>b</sup> | 0.62               | 0.06                     |
| Total leg length     | 14.13 <sup>a</sup> | 0.10               | 0.01                     | 11.12 <sup>b</sup> | 0.28               | 0.02                     |
| Stockiness           | 0.67 <sup>b</sup>  | 0.04               | 0.05                     | 0.72 <sup>a</sup>  | 0.04               | 0.06                     |
| Condition index      | 0.11 <sup>a</sup>  | 0.01               | 0.13                     | 0.09 <sup>b</sup>  | 0.01               | 0.08                     |
| Massiveness          | 0.14 <sup>a</sup>  | 0.01               | 0.13                     | 0.08 <sup>b</sup>  | 0.69               | 4.99                     |
| Long leggedness      | 0.86 <sup>a</sup>  | 0.01               | 0.02                     | 0.68 <sup>b</sup>  | 0.01               | 0.02                     |

Means with different superscripts along the same row are significantly ( $p < 0.05$ ) different.

**Table 2.** Correlation matrices of body weight and morphometric traits of hens and cocks.

| Traits | BDW     | BTC     | WGS     | BDL     | TLL     | MAS    | STK     | LLN     | CND     |
|--------|---------|---------|---------|---------|---------|--------|---------|---------|---------|
| BDW    | -       | -.437** | .320**  | .567**  | -.093   | -.038  | -.527** | -.548** | .865**  |
| BTC    | .279**  | -       | .216    | -.158   | -.405** | -.114  | .980**  | -.388** | -.408** |
| WGS    | -.248*  | -.188   | -       | -.440** | -.920** | -.185  | .299**  | -.817** | -.112   |
| BDL    | .306**  | .036    | .311**  | -       | .604**  | .081   | -.350** | -.004   | .790**  |
| TLL    | .148    | -.362** | -.119   | -.054   | -       | .199   | -.506** | .795**  | .254*   |
| MAS    | .303**  | .020    | -.117   | .016    | .062    | -      | -.152   | .188    | .025    |
| STK    | -.337** | .962**  | -.275*  | -.230*  | -.333** | .042   | -       | -.368** | -.549** |
| LLN    | .070    | -.344** | -.234*  | -.492** | .859**  | .081   | -.203   | -       | -.285*  |
| CND    | .989**  | -.216*  | -.353** | .337**  | .175    | .302** | -.284** | .071    | -       |

\*\* $p < 0.01$ , \* $p < 0.05$ ; **Upper matrix:** hens. **Lower matrix:** cocks. **BWT:** body weight; **BTC:** breast circumference; **WNS:** wing length; **BDL:** body length; **TLL:** total leg length; **MAS:** massiveness index; **STK:** stockiness index; **LLN:** long-leggedness index; **CND:** condition index.

local chickens of Nigeria to the favour of cocks. This sexual dimorphism could be attributed to the usual between-sex differential hormonal action (Baeza et al., 2001) resulting in differential growth rates or/and the selection intensity for high quality males for mating which led to fixation of larger body size in male birds (McCracken et al., 2000).

Conformation, type and meatiness of birds could be assessed using massiveness, stockiness, long-leggedness and condition index (Yakubu, 2011). These indices state the ratio of measurements that characterizes the proportionality of bird's body (Oblakova, 2007). In both sexes, meatiness trait was best illustrated using long leggedness at 86% in cocks and 68% in hens;  $p < 0.05$ ). The hens showed a narrower body, which is suitable for egg production while the cocks showed a broader appearance characteristic of meatiness. Low coefficients of variation were however obtained for both sexes indicating sensitivity of the traits to the genotype rather than the environment.

Phenotypic correlations among body weight, morpholo-

gical traits and indices are presented in Table 2. Low, moderate and high positive and negative correlation coefficients were observed among the various body parameters in both sexes. In hens, the coefficients of correlation ( $r$ ) ranged from 0.025 to 0.989 while in cocks it ranged from 0.036 to 0.989. Among the morphometric traits in hens, the highest value was observed between wing span and total leg length ( $r = -0.920$ ;  $p < 0.01$ ) followed by body length and total leg length ( $r = 0.604$ ;  $p < 0.01$ ) and between body weight and body length ( $r = 0.567$ ;  $p < 0.01$ ). However in cocks, the highest value was observed between total leg length and breast circumference ( $r = 0.362$ ;  $p < 0.01$ ) followed by body length and wing span ( $r = 0.311$ ;  $p < 0.01$ ) and between body weight and body length ( $r = 0.306$ ;  $p < 0.01$ ).

Among the morphological indices in hens, the highest correlation was obtained between body weight and condition index, followed by long-leggedness and stockiness ( $r = 0.865$ ,  $-0.548$  and  $-0.527$  respectively;  $p < 0.01$ ) with no significant correlation with massiveness. In cocks, highest correlation was observed between body

**Table 3.** Standardized canonical discriminant function coefficients of the body parameters of adult indigenous chickens.

| Body parameters  | Coefficient |
|------------------|-------------|
| Total leg length | 0.972       |
| Body weight      | 0.499       |
| Wing length      | -0.450      |
| Body length      | -0.340      |

Eigenvalue: 2.345; variance explained (%):100%; Wilks' Lambda: 0.284; Bartlett's Test ( $\chi^2$ : 259.888;  $p < 0.01$ ).

weight and condition index, followed by stockiness and massiveness ( $r = 0.989$ ,  $-0.337$  and  $0.303$  respectively;  $p < 0.01$ ) with no significant correlations with long-leggedness.

Other single variables highly related to body indices in hens were breast circumference and stockiness ( $r = 0.980$ ;  $p < 0.01$ ), wing span and long-leggedness ( $r = -0.817$ ;  $p < 0.01$ ), total leg length and long-leggedness ( $0.795$ ;  $p < 0.01$ ), body length and condition index ( $0.790$ ;  $p < 0.01$ ). In cocks, they are breast circumference and stockiness ( $r = 0.962$ ;  $p < 0.01$ ), total leg length and long-leggedness ( $r = 0.859$ ;  $p < 0.01$ ) and body length and long-leggedness ( $-0.492$ ;  $p < 0.01$ ). High positive relationships among traits suggest that they are under the same gene action and therefore the improvement of any of the traits guarantee the improvement of the other (Ngapongora et al., 2001; Ogah et al., 2009). The differing phenotypic correlation coefficients in both sexes suggest sexual differences in the genetic design of the birds which agrees with the observation that additive genetic variance-covariance structure of the morphological traits is sex-influenced (Jensen et al., 2003).

Although the univariate analysis revealed differences in the body weight and linear body measurements the multivariate analysis could provide better resolution, thereby limiting the number of variables contributing to sexual dimorphism in chickens. Only a single standardized canonical discriminant function was extracted. The significance of the discriminant function tested with the minimization of Wilks' lambda ( $\lambda = 0.290$ ) and Bartlett's test ( $\chi^2 = 262.875$ ;  $p < 0.01$ ) provided validity for the analysis. The discriminating power of the variables as shown by the standardized canonical coefficients was highest in total leg-length, chronologically followed by body weight, wing length and body length with respective values of  $0.972$ ,  $0.499$ ,  $-0.450$ , and  $-0.340$  (Table 3). Three other variables (breast circumference and body length) not qualified to enter the model were deleted. The reduction in the number of measurements saves time and energy required to distinguish between the sexes.

The present findings disagree with the observation of Martinez-Gomez and Curry (1998) that wing chord and tarsus length were the two most important traits for sex

separation in Socorro mocking birds.

## Conclusion

The study showed that there were marked sexual differences in the morphological measurements of hens and cocks with higher values in most cases recorded for cocks. Low, moderate and high positive and negative phenotypic correlations were observed among the muscular and skeletal proportions. Total leg length was the most discriminating variable between the sexes, followed by body weight and wing length. Breast circumference and body length were not included in the canonical discriminant model. This means that the three variables were sufficiently robust to be used in the field to determine the gender of live birds. The use of biometrics and discriminant analysis therefore, may considerably increase the reliability of separating the sexes of indigenous birds.

## CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

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