Genetic Characterization of Local Chickens Population based on their Quantitative Traits in the Tropics

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Abstract: This study was conducted to explore the genetic characterization of local chickens based on their quantitative traits in the Ilisha-Remo, Operu-Remo and Ikenne communities. The total flock number recorded in this survey was 192 chickens, 98 female, 46 male and 48 chicks from 58 household. The parameters recorded were body length, shank length, neck length, wing span from udder, wing span from top, chest circumference, head length and beck. Repeatability estimates were also carried between the male and female local chickens and on the whole, female birds were more repeatable compared to male birds. Principal component analysis with variance maximizing orthogonal rotation was used to extract the components. Three principal components were extracted in male which explained 83.3% of the total variation in the original variables. Similarly three principal components extracted in female accounted for 74.3% of the total variance respectively. Generally, PC1 had the largest share of the total variance and correlated highly with breast width, wing length, thigh length, shank length and body length. PC1 could be used to describe the generalized form of male and female local chickens. PC2 was orthogonal to PC1 and loaded heavily on neck length and body length. The subsequent component, PC3, was highly correlated with body length, shank length, wing span from udder, and beck. The three principal components could be used to define body size of local chickens. These components could be used as selection criteria for improving body size of local chickens.

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1 Introduction

Local chickens are kept by the majority of households in rural areas as a source of protein and income. Findings from different studies in Nigeria revealed the existence of considerable variation among and within local chicken populations. Ajayi (2010) reported that the heritability estimates for body weight in the Nigerian local chicken populations indicates that it has the dual potential for development into a meat or egg breed.

During the past ten to sixteen years studies on Nigeria local chickens have been conducted with the aim of identifying and improving the performance of local chickens Ajayi (2010). Results from these studies have shown the existence of many genotypes, phenotypes and varied productivity potential within local chicken populations, indicating the possibility of improving the genetic potential through selective breeding within and between local chicken populations.

To date, local chickens appear to be the most prospective ecotypes under the traditional production systems. The performance of these ecotypes have been evaluated and documented albeit scanty. However considering the vast land expanse of Nigeria, coupled by the existence of diverse climatic and ecological zones there is a reason to expect that there might be many other chicken populations in the country with valuable attributes which need to be identified. The present study, therefore, was conducted to explore the genetic characterization of local chickens population based on their quantitative traits in the Ilisha-Remo, Operu-Remo and Ikenne communities.

2. Materials and Methods

2.1 Study area

The survey site, Ilisha-Remo is located in Ikenne Local Government Area of Ogun State is situated between Latitude 6.867 °N and Longitude 3.717 °E with an altitude of 235.2 meters above sea level in tropical rainforest belt of Nigeria. It has an annual rainfall of 1200 mm, 65% mean relative humidity and 21.40 °C mean temperature as shown in Figure 1. The research lasted for 2 weeks.

Figure 2: Map of Ogun state showing Ikenne local Government Area (Study Site)

2.2 Data collection

The ward and village for data collection were purposely selected based on the information given by district livestock officer because of its nearness to school environment. Households were randomly selected from a list of households that had been keeping more than ten chickens for the last five years in Illisha-Remo, Operu-Remo and Ikenne communities.

Physical measurements were taken on 144 mature laying chickens (male and female). The measurements taken included body length, circumference of the chest, shank length, neck length, wing span from udder, wing span from top, head length and beck. A normal tailor's measuring tape was used to take the linear measurements as described by FAO (2012). Below is a list of definitions for some of variables measured;

Body length: distance between the tip of the *rostrum maxillare* (beak) and that of the *cauda* (tail, exclusive of feathers) when chicken is fully stretched through its body length.

Chest circumference: circumference of the chest at the tip of the *pectus* (hind breast).

Shank length: length from the hock joint to the spur of any leg.

Wingspan: length between tips of right and left wings after both were fully stretched out.

2.3 Statistical Data Analysis

The descriptive statistics of SPSS IBM was used to analyses the quantitative data. For comparisons of phenotypic values between the male and female local chickens, the researcher performed one-way analysis of variance (ANOVA) with SPSS IBM version 21. The repeatability estimates (*R*) for male and female body measurement of the chickens were calculated using the following formula based on variance component derived from one-way ANOVA given by Becker (1984) as:

$$R = \frac{\hat{\sigma}_B^2}{\hat{\sigma}_B^2 + \hat{\sigma}_E^2}$$

$$\hat{\sigma}_E^2 = MS_E$$

$$\hat{\sigma}_B^2 = \frac{MS_B - MS_E}{K}$$

R = Repeatability

K = Number of record per bird

MS_E = Mean square between individuals

MS_B = Mean square within individuals

$\hat{\sigma}_B^2$ = Variance component of the bird = estimates all the genetic variance and the portion of the environmental variance peculiar to the individual bird.

$\hat{\sigma}_E^2$ = Variance component (error) = the difference among measurements within the individual bird.

The standard error (S.E) of the estimation in this study is given by Becker (1984) expressed as:

$$S.E.(R) = \sqrt{\frac{2(1-R)^2\,[1+(K-1)R]^2}{K(K-1)(N-1)}}$$

Where:

N = Number of eggs

SPSS IBM version 21 was equally used to perform the principal component analysis (PCA). All statistical analyses were set at statistical significance of $P < 0.05$.

3. Results

3.1 Flock Number

The total flock number recorded in this survey was 192 chickens, 98 female, 46 male and 48 chicks from 59 household. It could be observed that the flock number varies from one respondent to another as well as the number of male and female chickens. This could be attributed to value, management practices and uses a respondent has for rearing poultry birds. From the survey result, the aggregate of the flock number indicates that majority of the occupants of Ilisha-Remo, Operu-Remo and Ikenne communities did not have much poultry farmers which is also due to low performance of breed, size of egg, body weight, general egg quality traits of the birds and the low demand of local chickens compared to exotic ones.

3.2 Body Measurements

The descriptive statistics in relation to the body linear measurement of the local chickens for male and female are presented in Table 1. The body length (BL) varied from 24.20-30.10 cm with the mean value of 26.87 cm; shank length (SL) obtained were of the range of 3.90 -5.60 cm with a corresponding mean value of 4.81 cm while neck length (NL) values were 3.70-4.20 cm with 4.04 cm average value. Range of values recorded for wing span from udder (WSU) were 24.20-30.20 cm with responsive mean value of 27.64 cm while values of 25.10-30.40 cm were registered for wing span from top (WST) with a corresponding mean value of 27.72 cm. The chest circumference (CC) spanned from 12.30-17.20 cm with 14.53 cm mean value while values of 2.70-3.20 cm mean value while values of 2.70-3.20 cm were reported for head length with a responsive mean value of 3.00 cm. The beck ranged from 0.90-1.20 cm with a mean value of 1.28 cm.

However, these values were higher than the values recorded from the body measurement of female local chickens except chest circumference which registered higher values as a result of expansion during egg laying periods (Table 1).

Table 1: Descriptive Statistics for Linear Body Measurement of Local Chickens for Male and Female

Body Measurement	Male				Female				
	Minimum	Maximum	Mean	Std. Deviation	Minimum	Maximum	Mean	Std. Deviation	N
BL	24.20	30.10	26.8700	1.92068	21.90	27.40	24.8550	1.72956	29
SL	3.90	5.60	4.8100	.61725	2.90	4.80	3.8200	.56676	29
NL	3.70	4.20	4.0400	.15776	2.50	4.80	3.6090	.65501	29
WSU	24.20	30.20	27.6400	1.91961	24.90	26.80	25.9400	.52536	29
WST	25.10	30.40	27.7200	1.57042	23.50	28.20	25.2700	1.47275	29
CC	9.20	13.60	12.1100	1.39400	10.90	15.00	13.6100	1.28448	29
HL	2.70	3.20	3.0000	.16330	2.30	3.40	2.7600	.35024	29
BK	.90	1.70	1.2800	.27809	.70	1.50	1.0700	.28694	29

Where BL=body length, SL=shank length, NL = neck length, WSU= wing span from udder, WST= wing span from top, CC= chest circumference, HL= head length and BK= beck ($p<0.05$), N = 29 for male and N = 29 for female

As presented in Table 2, one-way ANOVA revealed that the female local chickens showed a significantly higher value for traits such as BL, NL, WSU, CC and BK than the male counterpart, while male local chickens revealed a significantly higher value for variables such as SL, WST and HL compared to the female birds.

3.3 Repeatability Estimates

Repeatability of the eight (8) body linear measurement was estimated in male and female (Table 2). Repeatability estimates were calculated to be -0.2817 – 0.500 and -0.3066 – 0.5856 for male and female local chickens respectively. Although repeatabilities of male and female local chickens are comparable to each other, there are some differences between the two variables. In particular, repeatability of SL, WSU, HL and BL in the female local chickens were 0.0042, 0.5856, -0.0681 and 0.4819 respectively, whereas, those of those of the male chickens were 0.3936, -0.2817, 0.500 and -0.0330, respectively.

Table 2: Linear Body Measurement Analysis of Variance Results and Repeatability Estimates for Male and Female Local Chickens

Body Measurement	Male					Female				
	MS_B	MS_E	*F*-value	*R*	Significance	MS_B	MS_E	*F*-value	*R*	Significance
BL	3.639	3.863	0.942	-0.058±0.19	0.604	3.654	0.674	5.424	-0.3066±0.05	0.164
SH	0.472	0.063	7.449	0.394±0.09	0.123	0.324	0.311	1.043	0.0042± 0.31	0.571
NL	0.029	0.010	2.914	0.159 ±0.14	0.279	0.509	0.148	3.449	0.196± 0.23	0.243
WSU	4.478	0.910	4.921	-0.282± 0.28	0.179	0.348	0.023	14.92	0.586±0.02	0.064
WST	2.838	1.163	2.440	0.126 ±0.12	0.321	1.845	3.303	0.558	-0.046± 0.28	0.764
CC	1.491	2.563	0.582	-0.159±0.14	0.753	2.040	1.603	1.273	0.109± 0.31	0.508
HL	0.033	0.003	10.00	0.500±0.02	0.094	0.088	0.243	0.362	-0.068±0.36	0.869
BK	0.070	0.103	0.676	-0.0330.18	0.709	0.103	0.010	10.30	0.482± 0.06	0.091

Where MS_B = mean square between individuals, MS_E = mean square within individuals, *F*-value = F-statitics, *R* = repeatability, BL=body length, SL=shank length, NL= neck length, WSU= wing span from udder, WST= wing span from top, CC= chest circumference, HL= head length and BK= beck (p<0.05)

3.4 Principal Component Analysis

Principal component analysis with eight (8) body linear measurements of the local chickens for male and female revealed three principal components (PC1, PC2 and PC3) as showed in Table 3.

The PC1, PC2 and PC3 were estimated 2.970, 1.945 and 1.752 respectively for eigen value and 37.130, 24.315 and 21.898, respectively, for variance % in male local chickens while the PC1, PC2, and PC3 were calculated 2.748, 2.074 and 1.122, respectively, for eigen value and 34.349, 25.921 and 14.026 respectively, for eigen value and 34.349, 25.921 and 14.026 respectively, for variance % in female local chickens. These three components explained 83.34% of the total phenotypic variance for the male local chickens, and 74.296% of the total phenotypic variance for the female local chickens. This indicates that the total phenotypic variance for the male local chickens is higher compared to the female ones. PC1, PC2 and PC3 for both male and female local chickens consist of both positive and negative coefficients which indicate contrasts in the various linear measurements.

The correlation between the three PCs with the most body linear measurement were positive, expect for NL and WST for male local chickens and BL and SL for female ones for PC1. PC2 recorded negative values for male BL, WST and HL, whereas, the female ones registered negative values for SL, NL, CC and HL, While PC3 reported negative values for male CC only compare to the female counterpart that recorded negative for BL, WST and CC. The correlation between PC1 and variables of WSU, NL, WST, CC, HL, and BK were high whereas SL, NL, CC, and BK were high for PC2, variables such as BL, SL, and BK were high for PC3. While, quantitative variables were low for PC1, PC2 and PC3 for male chickens. The correlation between PC1 and variables such as BL, SL, and Bk were high for PC2, whereas only Bl, WSU and BK were high for PC3.

Linear combinations of PCL, PC2 and PC3 are as follows:

For Male Chickens

$$PC1 = 0.324(BL) + 0.439(SL) - 0.518(NL) + 0.831(WSU) - 0.648(WST) + 0.621(CC) + 0.814(HL) + 0.497(BK)$$

$$PC2 = -0.460(BL) + 0.607(SL) + 0.733(NL) + 0.020(WSU) - 0.391(WST) + 0.578(CC) - 0.099(HL) + 0.575(BK)$$

$$PC3 = 0.691(BL) + 0.537(SL) - 0.198(NL) + 0.139(WSU) + 0.471(WST) - 0.428(CC) + 0.461(HL) + 0.557(BK)$$

For Female Chickens

$$PC1 = -0.482(BL) - 0.290(SL) + 0.762(NL) + 0.388(WSU) + 0.745(WST) + 0.760(CC) + 0.743(HL) + 0.128(BK)$$

$$PC2 = 0.613(BL) - 0.868(SL) - 0.151(NL) + 0.354(WSU) + 0.417(WST) - 0.295(CC) - 0.209(HL) + 0.701(BK)$$

$$PC3 = -0.469(BL) + 0.307(SL) + 0.002(NL) + 0.618(WSU) - 0.253(WST) - 0.352(CC) + 0.020(HL) + 0.487(BK)$$

Radar charts with these three components is presented in Figure 2. One-way ANOVA revealed that the male PC1 showed significantly higher for WST, BK, and NL, while female PC1 shown significantly higher for SL, WST, CC, and HL whereas, male PC2 shown significantly higher for NL, SL, and CC. Female PC2 shown higher significant for BK only whereas, female PC3 shown higher significant for WST only where female PC3 exhibited higher significant for SL, WSU and BK.

Table 4: Eigenvectors and Eigenvalues from Principal Component Analysis for Male and Female Linear Body Measurement of Local Chickens

Body Measurement	Male			Female		
	Components			Components		
	1	**2**	**3**	**1**	**2**	**3**
BL	0.324	-0.460	0.691	- 0.482	0.613	-0.469
SH	0.439	0.607	0.537	- 0.290	-0.868	0.307
NL	-0.518	0.733	0.198	0.762	-0.151	0.002
WSU	0.831	0.020	0.139	0.388	0.354	0.618
WST	-0.648	-0.391	0.471	0.745	0.417	-0.253
CC	0.621	0.578	-0.428	0.760	-0.295	-0.352
HL	0.814	-0.099	0.461	0.743	-0.209	0.020
BK	0.497	0.575	0.557	0.128	0.701	0.487
Eigenvalue	2.970	1.945	1.752	2.748	2.074	1.122
Variance %	37.130	24.315	21.898	34.349	25.921	14.026

Where BL=body length, SL=shank length, NL= neck length, WSU= wing span from udder, WST= wing span from top, CC= chest circumference, HL= head length and BK= beck ($p<0.05$)

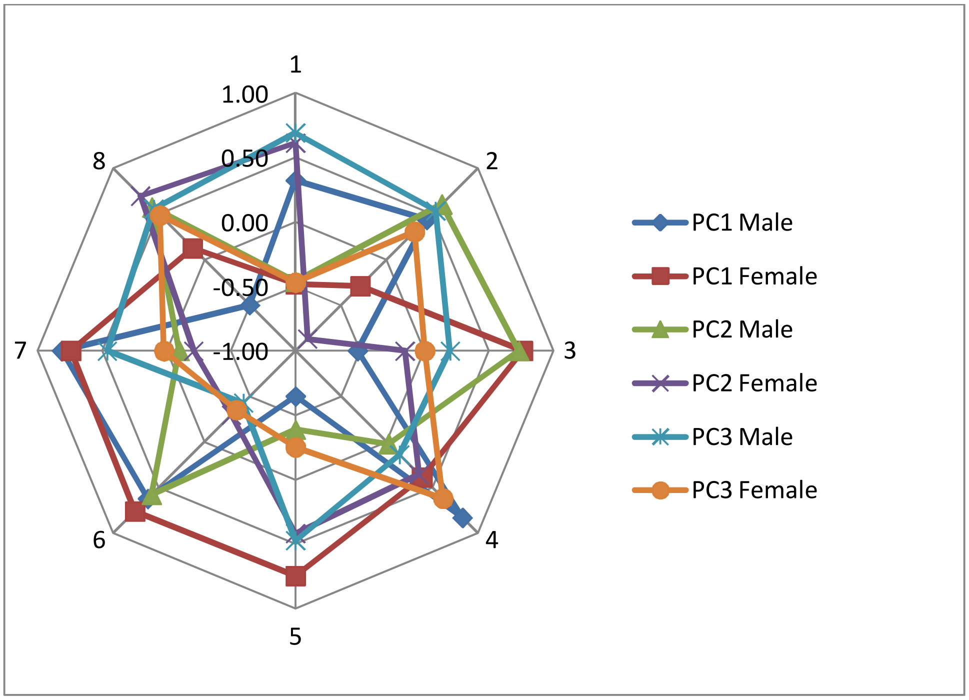

Figure 2: Radar Chart representing the characters of the body measurement (1 =body length, 2 = shank length, 3 = neck length, 4 = wing span from udder, 5 = wing span from top, 6 = chest circumference, 7 = head length and 8 = beck) of local chickens for male and female

4. Discussions

Results of the current study confirmed that the linear body measurement of male chickens is higher than the female chickens are consistent with the findings from other studies suggesting that sexual dimorphism in chickens manifested with respect to a large number of body attributes in most breed (Fayeye et al., 2006; Dana et al., 2010; Ibe, 1989, 1995). This may be attributed to the sex hormones which may promote large muscle development in males than in females expect chest circumference which enlarges during laying periods in female birds compared to male bird.

However, the mean BL observed in this present study were much higher than those reported by Badubi et al. (2006) which were 20.2 and 18.1 cm for male and female chickens respectively in Botswana; and 20.31 cm registered by Olawumi (2014) in Ado-Ekiti, Nigeria. This variation may be attributed to breed difference, age of the bird and management system employed.

In general, repeatability estimates were low corresponding to what is expected for local chickens in Nigeria environment (Ibe, 1989, 1995; Udeh et al., 2011). Quantitative variables such HL and SL reported higher values for male chickens and BK, WSU, and BL registered higher values for female chickens. This is in line with the observation some researchers (Olawumi, 2014; Badubi, 2006) whereas, other workers reported low estimates of repeatability for all linear body measurement. This could be attributed to age of the breed, management system and type of breed as recommended by (FAO, 2010). From the result analysis, although both male and female local chickens reported low estimates of repeatability except WSU for female birds and HL for male variables, female chickens were more repeatable compared to male counterpart.

In the light of principal component analysis, there are strong correlations between some recorded linear body measurements. This report compares favourably with the record of several researchers (Pinto et al., 2006).

Generally in the male and female chickens considered in this researcher, PC1 had the largest share of the total variance and correlated highly with WSU, CC, and HL for male chickens and NL, WST, CC, and HL for female counterpart. On the whole the total variance % in male chickens was higher compared to female variables for PC1 and PC3, while that female counterpart was higher than male birds for PC2. PC1 could be described as the generalized form of broilers (Salako, 2006). In a principal component analysis of body measurements of broilers, Yakubu et al., (2009b) reported that PC1 had high positive loadings on body weight, breast circumference and thigh length of Arbor Acre and termed PC1 “form factor”. Mendes (2011) reported that PC1 had the highest correlation with shank length, breast circumference and bodyweight of Ross 308 broilers. Yakubu et al. (2009a) reported that the first principal component accounted for the largest variance in the morphological traits of three Nigerian chicken genotypes. Ogah et al. (2009) presented data that showed PC1 accounting for the largest variance in the body measurements of ducks with high positive loadings on body width, bill width, shank length, body length, head length and neck length. Pinto et al., (2006) used PCA to analyze performance and carcass traits measured in a population of Gallus gallus. The authors reported that the five first principal components explained 93.30% of the total variation and the first component explained 66.00%. They called the first component generalized weight because the largest eigen vectors were associated with bodyweight at 35 and 42 days of age, liver, breast, wing and thigh weights. According to Mendes (2009), the first principal component provides an adequate summary of the data in most cases.

5. Conclusion and Recommendation

Results of this research confirmed that the linear body measurement of male chickens is higher than the female chickens except chest circumference suggesting that sexual dimorphism in chickens manifested with respect to a large number of body attributes in most breed. The linear body measurement generally reported low repeatability estimates for both male and female as what is expected for local chickens in Nigeria environment.

In the male and female linear body measurement of local chicken considered in this study, PC1 had the largest share of the total variance and correlated highly with breast width, wing length, thigh length and shank length for among local chickens. PC1 could be used to describe the generalized form of male and female local chickens. PC2 was orthogonal to PC1 and loaded heavily on neck length and body length. The subsequent component, PC3, was highly correlated with body length, shank length, wing span from udder, and beck. The three principal components could be used to define body size of local chickens.

These components could be used as selection criteria for improving meatiness in local chickens. The components could also be used as factor scores for predicting the live linear body measurement local chickens.

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