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RESEARCH ARTICLE

Estimation of Genetic Parameter in Yoruba and Fulani Ecotypes Indigenous Chickens of Nigeria

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ABSTRACT

The study evaluated the estimates of genetic parameters using correlation and regression models in extensively reared Yoruba and Fulani Indigenous chickens. Data collected on body weight and fourteen metric traits from 2041 chickens were analyzed using SAS statistical package. Correlation coefficients were generally significant ($P<0.05$) and positive, It ranged from low to high, the value were between 0.30-0.89 and 0.4-0.99 in male and female Fulani Ecotype respectively while in Yoruba Ecotype, the value were between 0.2-0.88 in female and 0.15-0.85 in male. Highest correlation coefficient estimate was obtained between body weight and chest circumference in both populations. Coefficient of determination R^2 were also generally significant ($P<0.05$), the value were between 0.2-0.91, 0.10-0.76 and 0.22-0.94 for Linear, Quadratic and Cubic functions in Yoruba Ecotype Chicken while 0.55-0.94, 0.64-0.81 and 0.55-0.86 was observed in Fulani Ecotype Chicken for the three functions respectively. The prediction functions do not follow any significant trend. However, linear and cubic functions appeared to be superior to quadratic function.

Strong discriminatory power (98.29%) was obtained between the two populations while low genetic distance measured by Euclidean genetic distance (11.2) was obtained. Conclusively, the relationship that existed within and between the two populations indicated that morphological trait such as chest circumference and body lengths are reliable to estimate bodyweight for improvement, especially in Nigeria where no purposive selection has been made. Also, the two populations are closely related at this level of study, further study should be extended to molecular level.

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INTRODUCTION

Relationships exists between body weight and linear body measurements. This is to organize the breeding programme so as to achieve an optimum combination of body weight and good conformation for efficient production and maximum economic returns. Body weight and body dimensions have been used as parameters for selection by local sellers and for research.

The morphological features, growth and egg potentials of the local chicken have been reported (Nwosu, 1992; Nwosu and Asuquo, 1985; Oluyemi, 1990; Adedokun and Sonaiya, 2001). The correlation of the linear body measurement with body weight depends on species and breeds. Wiener (1994) reported that linear body dimension can be used as a way of estimating body weight. Thus, correlation and regression are of great interest to breeder. The extent and direction of correlated selection response are determined by the genetic correlation or covariance between the concerned traits. Therefore for improving the total economic value of an animal, it is important to know both the effect of the trait actually being selected and its effect on the other traits. Laxmi *et al* 2002 opined that correlation permits prediction of direction and magnitude of change in the dependent traits as a correlated response to direct selection of the principal trait.

Ebangi and Ibe (1994) conducted an experiment on randomly choosing local fowls to estimate the genetic correlation between body weight, shank length, kneel length and chest circumference, it was observed that the results obtained were positively and highly correlated ranging from 0.99-1.51 between body weight and shank length, kneel length and chest circumference. Phenotypic correlations among body weight and body measurement in some pure breeds of chicken and their crosses were estimated by Ezzeldin *et al.* (1994). Ige 2013 reported that high, positive and significant correlation coefficient between body weight and linear body measurement indicates that easily measured body parts can be used as criteria for selection of body weight in crossbred Fulani ecotype. The correlations between live body weight and body linear measurement were studied by Adeniyi and Ayorinde (1990) using Cobb broilers strain. Regression equations revealed that body length, breast girth, kneel length and shank thickness was highly positively correlated with live body weight. Live body weight was best predicted using chest circumference. The objective of this study is to estimate genetic parameters through correlation and regression coefficients in indigenous chicken ecotypes.

MATERIALS AND METHODS

Study Area

The study was conducted in Ogbomoso area of Oyo State Nigeria. Ogbomoso falls within the derived savannah zone of Nigeria. The vegetation and climate of the zone had been previously described (Ige *et al* 2012).

Management of the Animals

The ecotypes focused in this study were managed under extensive system of Animal Husbandry where they were partially housed against predators at night and normally released in the morning to scavenge, with supplementary feed in the morning, kitchen waste and crop residues constituted their major feed resources. The use of ethno veterinary drugs was adopted to combat health challenges of the chickens with occasional interference of Animal scientist and Veterinary personnel.

Data Collection

Body weight and fourteen linear body measurements of 2041 Indigenous chickens were individually taken using a 5kg weighing instrument with sensitivity of 0.01 g and a measuring tape. Reference points for body measurement were according to standard descriptor (FAO, 1986c). Linear body measurement taken were Body Weight (BW), Shank Length (SHLT), Shank Circumference (SHCC), Comb Length (CMBLT), Wattle Length (WALT), Chest Circumference (CHCC), Comb Thickness (CMBTK), Wing Span (WNSP), Spur Length (SPLT), Tail Length (TALT), Beak Length (BKLT), Femur Length (FELT), Crus Length (CRLT), Tarsometatarsus Length (TMTLT), and Body Length (BDLT).

Statistical Analysis

Correlation: The degrees of correlations between all pair wise metric variables were computed within each ecotype. They were generated using the SASCORR procedure of SAS (2006)

Regression Models: The relationships between Body Weight and linear measurements and relationship among linear parameters were investigated and quantified using SASREG procedure of SAS (2006). Linear, Quadratic and Cubic models were used to fit the curves leading to the respective prediction equations.

The regression functions applied were

$Y_{ij} = a + bX + e_{ij}$…………………… (1) (Linear)
$Y_{ij} = a_2 + b_2X + c_2X^2 + e_{ijk}$……….. (2) (Quadratic)
$Y_{ij} = a_3 + b_2X + c_2X^2 + c_3X^3 + e_{ijkl}$….. (3) (Cubic)

Where Y_{ij} represents the dependent variable (Body Weight or Linear Measurement) assumed to be random and normally distributed.

'a' represents the intercept of the regression line on the Y-axis and it is the estimate of Y (dependent variable) when X (the independent variable) is Zero.

'b' and 'c' represents the regression coefficient associated with the independent variable. They represent the amount of change in Y for each unit change in X.

X represents the independent variable (body measurement)

e_{ij}, e_{ijk} or e_{ijkl} represents random error about the regression line.

Discriminant analysis and hotelling T^2

The multifactorial discriminant analysis is a multivariate technique used for studying the extent to which different population overlap one another or diverge from one another as outlined by Snedecor and Cochran (1937). It was used to perform a multivariate generalization of t-test to obtain a single test of null hypothesis that the two populations studied belong to the same population with respect to all phenotypic measurements.

Genetic distance estimation

Genetic (Morphological) distance between the studied ecotypes was estimated using the Cavalli-sforza (1967). The statistics is an extension of Pearson's coefficient of racial likeness to the cases where characters used are not independent.

RESULTS

Phenotypic correlation coefficients that described the degree of association between Body Weight and body measurements studied in Yoruba Ecotype Chicken (YEC) are presented in Table 1. The result indicated that Body weight was positively and significantly ($P<0.05$) correlated with most body parameters in both sexes within the population. Correlation coefficients in the female Yoruba Ecotype Chicken were: Chest Circumference (0.88), Comb Thickness (0.79), Body Length (0.74), Shank Length (0.64), Shank Circumference (0.71), Comb Length (0.63), Wattle Length (0.50), Wing Span (0.52), Spur Length (0.40), Tail Length (0.2), Beak Length (0.3), Femur Length (0.24), Crus Length (0.2), Tarsometartasus Length (0.3) while in the male Yoruba Ecotype Chicken, the correlation coefficiens were: Shank Length (0.79), Shank Circumference (0.59), Comb Length (0.65), Wattle Length (0.45), Chest Circumference (0.85), Comb Thickness (0.77), Wing Span (0.40), Spur Length (0.57), Tail Length (0.63), Beak Length (0.44), Femur Length (0.50), Crus Length (0.25), Tarsometartasus Length (0.15) and Body Length (0.40). It is evident that highest coefficient of correlation were obtained in the chest circumference and comb thickness in both sexes.

Table 1: Correlation coefficients between body weight (BW) and body measurement in Yoruba ecotype Indigenous chickens (Values for female are above the dotted line and those for males below)

	BW	SHLT	SHCC	CMBLT	WALT	CHCC	CMBTK	WNSP	SPLT	TALT	BKLT	FMLT	CRLT	TMTLT	BDLT
BW	-	0.64^{**}	0.71^{***}	0.63^{**}	0.50^{**}	0.88^{***}	0.79^{***}	0.52^{**}	0.40^{*}	0.20^{ns}	0.30^{ns}	0.24^{ns}	0.12^{ns}	0.30^{ns}	0.74^{***}
SHLT	0.79^{***}	-	0.69^{***}	0.52^{**}	0.56^{**}	0.61^{**}	0.54^{**}	0.65^{**}	0.46^{*}	0.30^{ns}	0.35^{ns}	0.56^{**}	0.65^{**}	0.30^{ns}	0.40^{*}
SHCC	0.59^{**}	0.45^{*}	-	0.45^{*}	0.56^{**}	0.73^{***}	0.60^{**}	0.54^{**}	0.32^{NS}	0.41^{*}	0.22^{ns}	0.60^{**}	0.12^{**}	0.36^{ns}	0.62^{**}
CMBLT	0.65^{**}	0.56^{**}	0.44^{*}	-	0.59^{**}	0.77^{***}	0.67^{**}	0.50^{**}	0.40^{*}	0.30^{ns}	0.43^{*}	0.52^{**}	0.20^{ns}	0.27^{ns}	0.70^{***}
WALT	0.45^{*}	0.76^{***}	0.66^{**}	0.46^{*}	-	0.83^{***}	0.48^{*}	0.61^{**}	0.64^{*}	0.30^{ns}	0.54^{**}	0.70^{**}	0.13^{ns}	0.25^{ns}	0.60^{**}
CHCC	0.85^{***}	0.78^{***}	0.72^{***}	0.74^{***}	0.59^{**}	-	0.68^{**}	0.75^{***}	0.52^{**}	0.63^{**}	0.32^{NS}	0.63^{**}	0.24^{ns}	0.14^{ns}	0.74^{***}
CMBTK	0.77^{888}	0.52^{**}	0.62^{**}	0.46^{***}	0.33^{ns}	0.63^{**}	-	0.53^{***}	0.31^{ns}	0.20^{ns}	0.55^{**}	0.63^{**}	0.30^{ns}	0.43*	0.55^{**}
WNSP	0.40^{*}	0.60^{**}	0.56^{**}	0.55^{**}	0.42^{*}	0.40^{*}	0.80^{***}	-	0.30^{ns}	0.42^{*}	0.13^{ns}	0.62^{**}	0.22^{ns}	0.26^{ns}	0.62^{**}
SPLT	0.57^{**}	0.51^{**}	0.37^{ns}	0.73^{***}	0.73^{**}	0.66^{**}	0.40^{*}	0.30^{ns}	-	0.22^{ns}	0.30^{ns}	0.40^{*}	0.10^{ns}	0.30^{ns}	0.70^{***}
TALT	0.63^{**}	0.40^{*}	0.30^{ns}	0.40^{*}	0.40^{*}	0.42^{*}	0.50^{**}	0.20^{ns}	0.43^{*}	-	0.32^{ns}	0.59^{**}	0.65^{**}	0.15^{ns}	0.51^{**}
BKLT	0.44^{*}	0.60**	0.35^{ns}	0.33^{ns}	0.33^{ns}	0.33^{ns}	0.30^{ns}	0.30^{nsp}	0.50 **	0.36^{ns}	-	0.47^{*}	0.51^{**}	0.61***	0.50^{**}
FMLT	0.50^{**}	0.71^{***}	0.51^{**}	0.76^{***}	0.76^{***}	0.40^{*}	0.50^{*}	0.53^{**}	0.62^{***}	0.67^{**}	0.51^{*}	-	0.31^{ns}	0.29	0.71**
CRLT	0.25^{ns}	0.32^{ns}	0.20^{ns}	0.23^{ns}	0.23^{ns}	0.50^{**}	0.30^{ns}	0.31^{ns}	0.20^{ns}	0.24^{ns}	0.34^{ns}	0.71^{***}	-	0.24^{ns}	0.83^{***}
TMTLT	0.15^{ns}	0.25^{ns}	0.16^{ns}	0.73^{***}	0.73^{***}	0.60^{**}	0.40^{8}	0.21^{ns}	0.32^{ns}	0.12^{ns}	0.32^{ns}	0.32^{ns}	0.45^{*}	-	0.54^{**}
BDLT	0.40^{*}	0.64^{**}	0.51^{**}	0.63**	0.63^{***}	0.70^{***}	0.70^{***}	0.72^{***}	0.66^{**}	0.66^{***}	0.73^{***}	0.46^{*}	0.70^{***}	0.60***	-

NS=Not Significant; * = $P<0.05$; ** = $P<0.01$; *** = $P<0.001$

BW=Body Weight, SHLT=Shank Length, SHCC=Shank Circumference, CMBLT=Comb Length, WALT=Wattle Length, CHCC=Chest Circumference, CMBTK=Comb Thickness, WNSP= Wing Span, SPLT=Spur Length, TALT=Tail Length, BKLT=Beak Length, FELT=Femur Length, CRLT=Crus Length, TMTLT=Tarsometatarsus Length, BDLT=Body Length.

The mutual relations between Body Weight and body measurements as described by phenotypic correlation coefficients with respect to sex in Fulani Ecotype Chicken (FEC) are presented in Table 2. The result showed that live weight was positively and significantly ($P<0.05$) correlated with most body parameters in both sexes. The Correlation coefficients in male FEC were as follows; Shank Length (0.73), Shank Circumference (0.51), Comb Length (0.82), Wattle Length (0.77), Chest Circumference (0.89), Comb Thickness (0.71), Wing Span (0.50), Spur Length (0.62), Tail Length (0.51), Beak Length (0.30), Femur Length (0.71), Crus Length (0.30), Tarsometartasus Length (0.22) and Body Length (0.70) While in Female Fulani Ecotype Chicken, the correlation coefficients were as follows; Shank Length (0.76), Shank Circumference (0.53), Comb Length (0.66), Wattle Length (0.76), Chest Circumference (0.99), Comb Thickness (0.57), Wing Span (0.71), Spur Length (0.75), Tail Length (0.78), Beak Length (0.53), Femur Length (0.77), Crus Length (0.61), Tarsometartasus Length (0.41) and Body Length (0.41). Highest Correlation coefficients were obtained for Chest Circumference in the two ecotypes studied.

Coefficient of determinations (R^2) that showed the strength of body measurements in live weight determination based on linear quadratic and cubic functions are presented in Table 3 with respect to ecotype. The equation were positive and highly significant ($P<0.05$) for most parameters. The body parameter that almost predicted Body Weight accurately were the Chest Circumference, Body Length, Comb Thickness, Femur length and Shank Length in both ecotypes for all the functions examined.

Description of the relationships using the linear function gave the following coefficient of determination (R^2) in Yoruba Ecotype Chicken; Shank Length (0.79), Shank Circumference (0.50), Comb Length (0.73), Wattle Length (0.54), Chest Circumference (0.91), Comb Thickness (0.84), Wing Span (0.70), Spur Length (0.40), Tail Length (0.40), Beak Length (0.30), Femur Length (0.80), Crus Length (0.30), Tarsometartasus Length (0.20) and Body Length (0.78). For quadratic function, the coefficient of determination (R^2) were as follows; Shank Length (0.79), Shank Circumference (0.51), Comb Length (0.23) Wattle Length (0.55), Chest Circumference (0.71), Comb Thickness (0.34) Wing Span (0.67), Spur Length (0.70), Tail Length (0.60), Beak Length (0.70), Femur Length (0.76), Crus Length (0.10), Tarsometatarsus Length (0.20) and Body Length (0.80). While for cubic function coefficient of determination associated with each of the metric trait are as follows; Shank Length (0.79), Shank Circumference (0.63), Comb Length (0.66), Wattle Length (0.76), Chest Circumference (0.94), Comb Thickness (0.83), Wing Span (0.78), Spur Length (0.70) Tail Length (0.71), Beak Length (0.80), Femur Length (0.78) Crus Length (0.22), Tarsometatarsus Length (0.56) and Body Length (0.86)

In the Fulani Ecotype Chicken, coefficient of determination for linear, quadratic and cubic functions were as follows; Shank Length (0.94, 0.76,0.86), Shank Circumference (0.72, 0.64, 0.64), Comb Length(0.96, 0.77, 0.87), Comb Thickness (0.84, 0.65, 0.75), Wing Span (0.77, 081, 0.71), Spur Length (0.67, 0.67, 0.73), Tail Length (0.62, 0.76, 0.55), Beak Length (0.67, 0.65, 0.67), Femur Length (0.78, 0.73, 0.66), Crus Length (0.55, 0.78, 0.66), Tarsometatarsus Length (0.55, 0.66, 0.70) and Body Length (0.78, 0.70, 0.81) respectively.The prediction power does not follow any significant trend among the functions used, however linear and cubic functions appeared to be superior to quadratic functions based on their respective R^2 Values.

Hotteling discriminant representation for the two ecotypes is as presented in Fig. 1. The figure revealed that the morphological traits had a strong discriminatory power between the two populations with 98.29% correctly classified. Euclidean genetic distance was 11.2. This value indicated low genetic distance which thus suggests a close relationship between the two ecotypes.

DISCUSSION

The results of phenotypic correlations between body weight and linear body measurement in both Yoruba and Fulani Ecotype chickens in this study are in agreement

Table 2: Correlation coefficients between body weight (BW) and body measurement in Fulani ecotype Indigenous chickens (Values for male are above the dotted line and those for females below)

	BW	SHLT	SHCC	CMBLT	WALT	CHCC	CMBTK	WNSP	SPLT	TALT	BKLT	FMLT	CRLT	TMTLT	BDLT
BW	-	0.73^{***}	0.51^{**}	0.82^{***}	0.77^{***}	0.89^{***}	0.71^{***}	0.50^{**}	0.62^{**}	0.51^{**}	0.30^{ns}	0.71^{***}	0.30^{ns}	0.22^{ns}	0.70^{***}
SHLT	0.76^{***}	-	0.68^{**}	0.70^{***}	0.63^{***}	0.54^{**}	0.69^{***}	0.70^{***}	0.50^{**}	0.62^{**}	0.31^{ns}	0.80^{***}	0.42^{*}	0.18^{ns}	0.20^{ns}
SHCC	0.55^{**}	0.84^{***}	-	0.84^{***}	0.59^{**}	0.99^{***}	0.79^{***}	0.63^{**}	0.62^{**}	0.52^{**}	0.35^{ns}	0.71^{***}	0.30^{ns}	0.30^{ns}	0.73^{***}
CMBLT	0.66^{**}	0.89^{***}	0.61^{**}	-	0.87^{***}	0.91^{***}	0.87^{***}	0.97^{***}	0.75^{***}	0.83^{***}	0.71^{***}	0.80^{***}	0.40^{*}	0.50^{**}	0.73^{***}
WALT	0.76^{***}	0.86^{***}	0.77^{***}	0.77^{***}	-	0.50^{**}	0.74^{***}	0.84^{***}	0.67^{**}	0.90^{***}	0.63^{**}	0.70^{***}	0.52^{**}	0.62^{***}	0.81^{***}
CHCC	0.99^{***}	0.76^{***}	0.78^{***}	0.78^{***}	0.91^{***}	-	0.70^{***}	0.83^{***}	0.54^{**}	0.75^{***}	0.61^{**}	0.70^{***}	0.31^{ns}	0.44^{*}	0.72^{***}
CMBTK	0.57^{**}	0.75^{***}	0.88^{***}	0.61^{**}	0.89^{***}	0.74^{***}	-	0.88^{***}	0.71^{***}	0.61^{**}	0.70^{***}	0.80^{***}	0.22^{ns}	0.42^{*}	0.82^{***}
WNSP	0.71^{***}	0.74^{***}	0.72^{***}	0.52^{**}	0.82^{***}	0.80^{***}	0.74^{***}	-	0.70^{***}	0.80^{***}	0.40^{*}	0.70^{***}	0.54^{**}	0.66^{**}	0.82^{***}
SPLT	0.75^{***}	0.74^{***}	0.63^{**}	0.60^{**}	0.70^{***}	0.54^{**}	0.34^{ns}	0.44^{*}	-	0.71^{***}	0.53^{**}	0.65^{***}	0.52^{**}	0.44^{*}	0.87^{***}
TALT	0.78^{***}	0.52^{**}	0.57^{**}	0.50^{**}	0.33^{ns}	0.60^{**}	0.73^{***}	0.50^{**}	0.72^{***}	-	0.77^{***}	0.53^{**}	0.73^{***}	0.83^{***}	0.80^{***}
BKLT	0.53^{**}	0.74^{***}	0.7^{***}	0.66^{**}	0.57^{**}	0.37^{ns}	0.46^{*}	0.30^{ns}	0.78^{***}	0.50^{**}	-	0.73^{***}	0.50^{**}	0.68^{**}	0.75^{***}
FMLT	0.7^{***}	0.78^{***}	0.68^{**}	0.57^{**}	0.70^{**}	0.81^{***}	0.55^{**}	0.70^{***}	0.60^{**}	0.86^{***}	0.55^{**}	-	0.67^{**}	0.51^{**}	0.90^{***}
CRLT	0.61^{**}	0.33^{ns}	0.7^{***}	0.65^{**}	0.33^{ns}	0.47^{*}	0.37^{ns}	0.35^{ns}	0.31^{ns}	0.30^{ns}	0.51^{**}	0.53^{**}	-	0.56^{**}	0.70^{***}
TMTLT	0.41^{*}	0.51^{**}	0.68^{**}	0.51^{**}	0.46^{*}	0.54^{**}	0.56^{**}	0.41^{*}	0.20^{ns}	0.41^{*}	0.38^{ns}	0.61^{**}	0.70^{***}	-	0.90^{***}
BDLT	0.74^{***}	0.79^{***}	0.65^{**}	0.70^{***}	0.86^{***}	0.93^{***}	0.80^{***}	0.80^{***}	0.70^{***}	0.70^{***}	0.82^{***}	0.70^{***}	0.80^{***}	0.70^{***}	-

NS=Not Significant; * = P<0.05; ** = P<0.01; *** = P<0.001

BW=Body Weight, SHLT=Shank Length, SHCC=Shank Circumference, CMBLT=Comb Length, WALT=Wattle Length, CHCC=Chest Circumference, CMBTK=Comb Thickness, WNSP= Wing Span, SPLT=Spur Length, TALT=Tail Length, BKLT=Beak Length, FELT=Femur Length, CRLT=Crus Length, TMTLT=Tarsometatarsus Length, BDLT=Body Length.

Table 3: Estimate of Parameters in Simple Linear, Quadratic and Cubic Function Fitted For Body Weight-Body Measurements Relationship of Yoruba and Fulani Ecotype Chickens

Linear measurements (Y)	Model	Equations	S.E	R^2	Sign
Shank length	Linear	$Y = 0.5 + 0.08X$	0.16	0.79	***
(yoruba ecotype)	Quadratic	$Y = 0.01 + 0.01X + 0.02X^2$	0.47	0.79	***
	Cubic	$Y = 0.7 – 0.1X + 0.06X^2 – 0.01X^3$	1.06	0.79	***
Shank length	Linear	$Y = 0.75 + 0.1X$	0.10	0.94	***
(fulani ecotype)	Quadratic	$Y = 1.88 – 0.2X + 0.02X^2$	0.19	0.76	***
	Cubic	$Y = -4.42 – 0.1X - 0.1X^2 + 0.02X^3$	0.38	0.86	***
Shank circumference	Linear	$Y = 0.90 + 0.1X$	0.21	0.50	***
(yoruba ecotype)	Quadratic	$Y = 2.96 + 0.1X + 0.9X^2$	0.62	0.51	***
	Cubic	$Y = -0.1 + 0.01X + 0.2X^2 + 0.3X^3$	1.38	0.63	***
Shank length	Linear	$Y = 1.1 + 0.55X$	0.04	0.72	***
(fulani ecotype)	Quadratic	$Y = 2.35 – 3.1X - 2.2X^2$	0.08	0.64	***
	Cubic	$Y = 1.98 + 0.5X - 0.8X^2 + 0.1X^3$	0.16	0.64	***
Comb length	Linear	$Y = 11.5 - 2.5X$	0.27	0.73	***
(yoruba ecotype)	Quadratic	$Y = 3.63 + 0.5X - 0.2X^2$	0.83	0.23	***
	Cubic	$Y = -2.73 + 0.5X – 0.2X^2 –0.05X^3$	1.82	0.66	***
Comb length	Linear	$Y = 0.5 + 0.2X$	0.12	0.74	***
(fulani ecotype)	Quadratic	$Y = 8.1 – 0.1X + 0.2X^2$	0.24	0.74	***
	Cubic	$Y = 13.62 + 0.2X – 0.5X^2 + 0.01X^3$	0.47	0.76	***
Wattle length	Linear	$Y = -1.49 + 3.38X$	0.23	0.54	***
(yoruba ecotype)	Quadratic	$Y = - 3.91 + 7.73X – 1.87X^2$	0.71	0.55	***
	Cubic	$Y = 9.20 – 26.40X +26.56X^2 –7.58X^3$	1.57	0.76	***
Wattle length	Linear	$Y = 1.66 + 0.45X$	0.09	0.73	***
(fulani ecotype)	Quadratic	$Y = 2.58 – 0.67X + 0.31X^2$	0.18	0.64	***
	Cubic	$Y = 8.87 – 12.07X + 6.80X^2 - 1.16X^3$	0.35	0.75	***
Chest circumference	Linear	$Y = 0.92 + 0.01X$	0.16	0.91	***
(yoruba ecotype)	Quadratic	$Y = 2.1 + 0.02X - 0.01X^2$	0.48	0.31	***
	Cubic	$Y = –10.11 – 0.01X – 0.02X^2 + 0.01X^3$	1.05	0.94	***
Chest circumference	Linear	$Y = 1.43 + 0.02X$	0.07	0.96	***
(fulani ecotype)	Quadratic	$Y = 2.66 - 0.2X + 0.01X^2$	0.18	0.77	***
	Cubic	$Y = –21.53 –0.2X -0.01X^2 + 0.02X^3$	0.35	0.87	***
Comb thickness	Linear	$Y = -0.16 + 0.36x$	0.01	0.84	***
(yoruba ecotype)	Quadratic	$Y = -0.09 + 0.24x + 0.05x^2$	0.04	0.34	***
	Cubic	$Y = 2.02 – 5.25x + 4.63x^2 – 1.22x^3$	0.09	0.83	***
Comb thickness	Linear	$Y = 0.13 + 0.06X$	0.01	0.84	***
(fulani ecotype)	Quadratic	$Y = - 0.07 – 0.30X -0.0X^2$	0.02	0.65	***
	Cubic	$Y = 0.33– 0.43X + 0.35X^2 – 0.07X^3$	0.07	0.75	***
Wing span	Linear	$Y = 0.61 + 0.04X$	0.14	0.70	***
(yoruba ecotype)	Quadratic	$Y = 2.05- 0.2X + 0.01X^2$	0.44	0.67	***

	Cubic	$Y = -10.85 - 0.01X - 0.02X^2 + 0.01X^3$	0.98	0.78	***
Wing span (fulani ecotype)	Linear	$Y = -1.8 + 0.3X$	0.12	0.77	***
	Quadratic	$Y = 5.30 - 0.2X - 0.01X^2$	0.24	0.81	***
	Cubic	$Y = -14.62 + 0.2X - 0.01X^2 + 0.01X^3$	0.48	0.71	***
Spur length (yoruba ecotype)	Linear	$Y = 1.06 + 0.02X$	0.03	0.40	**
	Quadratic	$Y = 1.10 - 0.05X + 0.03X^2$	0.08	0.70	***
	Cubic	$Y = 1.15 - 0.18X + 0.14X^2 - 0.03X^3$	0.18	0.70	***
Spur length (fulani ecotype)	Linear	$Y = 1.10 - 0.004X$	0.02	0.67	***
	Quadratic	$Y = 1.11 - 0.03X + 0.01X^3$	0.03	0.67	***
	Cubic	$Y = 1.60 - 0.91X + 0.51X^2 - 1.92X^3$	0.08	0.73	***
Tail length (yoruba ecotype)	Linear	$Y = 1.06 + 0.02X$	0.03	0.40	**
	Quadratic	$Y = 11.55 + 2.83X - 1.28X^2$	0.63	0.60	***
	Cubic	$Y = 14.87 - 5.80X + 5.91X^2 - 1.92X^3$	1.40	0.71	***
Tail length (fulani ecotype)	Linear	$Y = 12.75 - 0.08X$	0.14	0.62	***
	Quadratic	$Y = 13.10 - 0.51X + 0.12X^2$	0.28	0.76	***
	Cubic	$Y = 14.73 - 3.46X + 1.80X^3 - 0.03X^3$	0.56	0.55	***
Beak length (yoruba ecotype)	Linear	$Y = 1.37 + 0.03X$	0.05	0.30	ns
	Quadratic	$Y = 1.13 + 0.46X - 0.19X^2$	0.15	0.70	***
	Cubic	$Y = 2.27 - 2.49X + 2.27X^2 - 0.65X^3$	0.33	0.80	***
Beak length (yoruba ecotype)	Linear	$Y = 1.55 + 0.01X$	0.03	0.67	***
	Quadratic	$Y = 1.46 + 0.12X + 0.03X^2$	0.06	0.65	***
	Cubic	$Y = 8.09 + 5.85X - 3.47X^2 + 0.65X^3$	0.43	0.67	***
Femur length (yoruba ecotype)	Linear	$Y = 2.82 - 0.16X$	0.17	0.80	***
	Quadratic	$Y = 0.20 + 0.3X - 0.02X^2$	0.53	0.76	***
	Cubic	$Y = 1.43 - 0.02X + 0.01X^2 - 0.01X^3$	1.18	0.78	***
Femur length (fulani ecotype)	Linear	$Y = 2.0 - 0.03X$	0.11	0.78	***
	Quadratic	$Y = 10.65 - 0.01X + 0.1X^2$	0.22	0.73	***
	Cubic	$Y = 20.43 - 0.1X - 0.03X^2 - 0.01X^3$	0.13	0.66	***
Crus length (yoruba ecotype)	Linear	$Y = 1.46 - 0.004X$	0.03	0.30	ns
	Quadratic	$Y = 1.54 - 0.14X + 0.06X^2$	0.10	0.10	ns
	Cubic	$Y = 1.28 - 0.53X + 0.50X^2 + 0.15X^3$	0.22	0.22	ns
Crus lenght (fulani ecotype)	Linear	$Y = 1.55 - 0.004X$	0.02	0.55	***
	Quadratic	$Y = 1.54 + 0.12X - 0.003X^2$	0.04	0.78	***
	Cubic	$Y = 0.97 + 1.04X - 0.58X^2 + 0.10X^3$	0.08	0.66	***
Tarsometatarsus length (yoruba ecotype)	Linear	$Y = 1.54 + 0.05X^2$	0.03	0.20	ns
	Quadratic	$Y = 1.66 - 0.27X + 0.10X^2$	0.10	0.20	ns
	Cubic	$Y = 1.13 + 1.11X - 1.06X^2 - 0.31X^3$	0.22	0.56	***
Tarsometatarsus length (fulani ecotype)	Linear	$Y = 2.44 - 0.03X$	0.02	0.55	***
	Quadratic	$Y = 2.47 - 0.003X + 0.008X^2$	0.04	0.66	***
	Cubic	$Y = 2.44 + 0.05X - 0.02X^2 + 0.006X^3$	0.03	0.73	***
Body length (yoruba ecotype)	Linear	$Y = 1.22 - 0.1X$	0.24	0.80	***
	Quadratic	$Y = -4.21 - 0.01X + 0.02X^2$	0.73	0.80	***
	Cubic	$Y = 43.529 - 0.02X + 0.01X^2 - 0.01X^3$	1.63	0.86	***
Body length (fulani ecotype)	Linear	$Y = 1.28 + 0.02X$	0.17	0.78	***
	Quadratic	$Y = 7.15 - 0.1X - 0.01X^2$	0.34	0.70	***
	Cubic	$Y = 68.136 - 0.1X + 0.01X^2 - 0.01X^3$	0.68	0.81	***

with literature report (Gueye *et al.*, 1998; Raji *et al.*, 2009; Badubi *et al.*, 2006; BogaleKilbert, 2008; Ibe and Nwakalor, 1987; Ebangi and Ibe, 1994). Highest correlation coefficients were found between Body Weight and Chest Circumference; 0.88 and 0.77 for YEC and FEC respectively. This was followed by Comb Thickness (0.79) in YEC and Comb Length (0.82) in FEC. All these were positive and significant. Gueye *et al.* 1998 reported positive and significant phenotypic correlation of 0.68, 0.74 and 0.52 between Body Weight and Body Length, Chest Circumference and Tarsometartasus Length respectively in indigenous chicken in Senegal. Badubi *et al.* (2006) opined that highest correlation coefficients were found with Body Length (0.77) and Shank Length (0.49) in Indigenous chickens in Botswana. Hassan and Adamu (1997) observed that Body Length as well as Chest Width was postively and significantly correlated to Body Weight in indigenous pigeons. Raji *et al.*, (2009) also reported highest correlation values between Body Weight and zoometrical measurements such as Chest girth and body Length (0.87 and 0.85 respectively) in local muscovy duck. Equally, Ibe and Nawakalor, (1987) observed high and positive correlation coefficients between linear body measurement and body weights in local chickens. Lilja (1983) reported that Chest Girth was positively correlated with Body Weight which agrees with the present findings. Szabone, (1997) noted that chest measurement are regarded as reliable criteria to evaluate the body weight of most livestock.

The positive and significant correlations between body weight and linear body measurements obtained in this study indicates that possible genetic response could

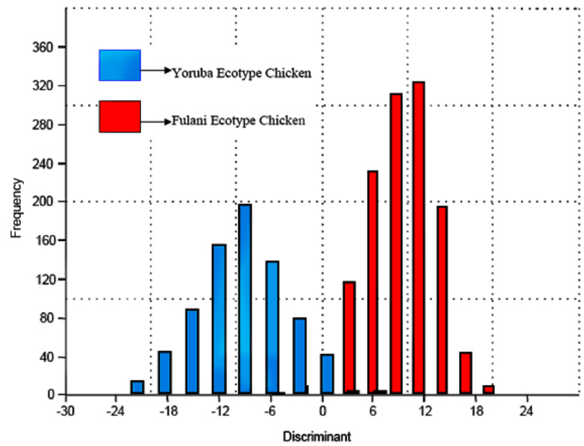

Fig 1: Hotelling Discriminant Representation for Morphological Traits

be achieved with selection for higher body weight in Yoruba ecotype chicken and Fulani ecotype chickens using the linear body measurement such as chest circumference, body length comb thickness and comb length as criteria for selection. High genetic correlation reported between body weight and linear body measurement in this study is not surprising because body weight is a measure of overall body growth which is the sum total of increases in sizes of different structural components (Ibe and Nwakalor, 1987). It further suggests that these traits are under the same gene action (Pleotropism) and by implication selection in one trait would bring about a corresponding improvement in the other trait as a correlated response.

Deeb and Lamout (2002) also observed that improvement in the live weight of some strains of chicken have been possible because of high number of genes affecting the phenotype. The high number of genes affecting body weight also significantly influences the development of other body parameters such as body length, toe and shank length together with kneel length and breast breadth. A consistent selection based on these body measurements can thus be used to improve body weight significantly in the two populations of chicken studied.

Very low genetic correlation coefficient indicates the presence of a stronger interaction like the environment (Lin and Togashi, 2005). The genes contribute very little to the control of traits with low correlations coefficient. Low correlation also indicates that the chickens are more sensitive to environmental influence on the concerned trait (Gondwe, 2004).

The higher coefficient of determination (R^2) value obtained for linear, quadratic and cubic model indicated that Shank Length, Shank Circumference, Comb Length, Chest Circumference, Wing Span, Femur Length and Body Length could be best used to predict body weight in both populations. Raji *et al.* (2009) reported highest coefficient of determination value for Chest Girth, Body Length and Wing Length in a linear regression model. Saatci and Tulku (2007) also reported similar findings in Turkish geese. In their studies, they concluded that regression analyses showed that easily measurable body parts such as Chest Girth and Body Length helped in determination of Body Weight.

The higher association of Body Weight with Chest Circumference in the entire model tested may possibly be due to relatively large contribution to body weight by chest Circumference consisting of bones, muscles and viscera. This is in agreement with the findings of Szabone (1997), and Ngapongara *et al.* (2004). Peters *et al.* (1999) noted that more than one model will be more appropriate to describe different traits in a particular animal or genotype.

The present and future improvement coupled with sustainability of indigenous chickens production systems are dependent upon the availability of genetic variation within and between indigenous breeds. The use of discriminant analysis has been successfully used to differentiate within and between livestock breeds (Jordana *et al.*, 1993 and Herrera *et al.*, 1996). In this study, Chest Circumference appeared to be the most discriminating variable and Euclidean genetic distance indicated close relationship between the two populations. This agrees with literature reports (Eding and Laval, 1999 and Hillel *et al.*, 2003). This study therefore revealed the use of correlation and regression coefficients in estimating genetic parameter of indigenous chicken populations.

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