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DISCRIMINANT ANALYSIS OF MORPHOMETRIC DIFFERENCES IN THE NORMAL FEATHERED AND FRIZZLE FEATHERED CHICKENS OF NORTH CENTRAL NIGERIA

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ABSTRACT
Ten morphometric traits were measured on 1046 extensively managed adult local chickens made up of 610 normal feathered and 436 frizzle feathered chickens in north central Nigeria. Step-wise canonical discriminant analysis generated 8 morphological traits (breast girth, body length, shank length, bird height, head circumference, wing length, neck length, and keel length) with the most discriminating power between the two genotypes. The discriminant function obtained correctly classified 100% of individuals from the chicken population. The classification accuracy of the function was cross- validated using the split- sample method, and indicated 100% success rate. The low mahalanobis distance (11.27) reported suggests non-selection, continuous inbreeding and high rate of intermingling between the two chicken genotypes. The results obtained could be complemented by DNA-based techniques for better preservation and management of the chicken genetic resources.

Key words: local chicken, morphometric traits, discriminant, mahalanobis distance

INTRODUCTION
Nigeria is endowed with many poultry species which are indigenous to the country. These species have lived, adapted and produced for many years in the Nigerian environment (Momoh, 2005). Indigenous chickens constitute 80% of the 185 million chickens found in Nigeria (FAOSTAT, 2011). They contain a highly conserved genetic reservoir with high level of heterozygosity which may provide the biological material for the development of genetic stocks with improved adaptability and productivity.

The Nigerian indigenous chicken can be identified based on morphological characteristics as naked neck, normal and frizzle feathered conditions and dwarfism. The genetic distinctness and performance characteristics of chickens possessing heat tolerance, adaptability and production genes among these indigenous chickens have been described by several workers (Nwosu *et al*., 1985; Peters, 2000; Egahi, 2012). Phenotypic characteristics are important in breed identification and classification. The first step in characterization of local genetic resources is to assess variation of morphological traits (Delgado *et al.,* 2000).

Adapted indigenous animal genetic resources provide sustainable options to smallholder livestock production in developing countries. Conservation and sustainable development of Animal Genetic Resources (AnGR) require a broad focus that includes the many adaptive breeds that survive well in the low external input agriculture typical of developing countries (Drucker *et al*., 2001). Knowledge-based management of animal genetic resources is critical to address current agricultural, socio-economic and environmental challenges facing animal production. Appropriate design of breeding programmes is impossible for breeds that have not been adequately characterized either phenotypically and/or genetically (Mwacharo *et al*., 2006). There is therefore an urgent need to characterize these genetic resources to quantify differentiation and to examine relationships between existing breeds in order to design rational breeding programme for conservation and sustainable utilization (Melesse *et al*., 2013).

Morphological distance between groups or populations is the estimate of morphological differentiation between the populations or groups, and is usually estimated using discriminant analysis. Barbosa (2005) reported that techniques of multivariate analysis have been successfully employed as a means to identify developing genotypes and better utilize the advantages provided by heterosis. Information on the genetic distance between populations based on genetic, quantitative or even attribute data on our indigenous chicken is

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scarce. When determined, the genetic distance between our indigenous chicken populations can also be used to describe breed differences and predict potential gains from their crosses. Morphological distances are capable of providing a sound foundation and reference in the systematic evaluation and characterization of our indigenous species. It will also save cost of experimental materials in terms of number of animals which may be required for crossbreeding experiments to determine heterotic gains.

The objectives of this study were to evaluate the morphological characteristics of normal and frizzle feathered chickens and to estimate the morphological distance between the two genotypes using multivariate statistical analyses for effective classification, conservation and improvement of our local chicken genetic resources.

MATERIALS AND METHODS

Experimental Animals and Their Management

The experimental animals consisted of 610 adult normal feathered and 436 adult frizzle feathered local chicken genotypes of both sexes randomly sampled in Dekina, Kabba-Bunu and Mopa-Amuro Local Government Areas of Kogi state, north central Nigeria. The animals were extensively managed by smallholder rural farmers in villages within the study area.

Traits Measured

Ten morphometric traits were measured on each chicken. The traits were live weight (LW), body length (BDL), head circumference (HDC), breast girth (BRG), body circumference (BDC), bird height (BDH), shank length (SKL), wing length (WGL), neck length (NKL) and keel length (KLL). Live weight was measured in kilogramme (kg) using a weighing scale, while body measurements were estimated in centimetres using a graduated flexible measuring tape.

Statistical Analyses

SPSS (2001) statistical package was used to compute means (±standard error), standard deviations, coefficients of variation and canonical discriminant analysis of the morphometric traits of normal feathered and frizzle feathered chickens. Canonical discriminant analysis is a multivariate technique that describes the relationship between two variable sets by calculating the linear combinations that are maximally correlated (Tabachnick and Fidel, 2001). It evaluates the relative contribution of each independent variable to the derived canonical functions in order to explain the nature of the relationships. In the present study, 10 morphometric variables were stepwise introduced as predictor variables into the discriminant analysis. For genotype identification, the unstandardized discriminant function procedure of the canonical discriminant analysis was utilized. The ability of this function to identify normal feathered and frizzle feathered chickens was indicated as the percentage of individuals correctly classified from the sample that generated the function. Accuracy of the classification was evaluated using split-sample cross-validation.

The CANDISC procedure of SAS (2000) was used to perform the univariate and multivariate one-way analysis of variance (ANOVA) that calculated the Mahalanobis distance between the two chicken genotypes. Mahalanobis distance is the most commonly used distance measure for quantitative characters.

RESULTS AND DISCUSSION

Descriptive statistics of the morphological traits of normal and frizzle feathered local chickens are presented in Table 1. Univariate ANOVA showed significant ($p < 0.05$) differences in all the morphometric traits, except shank length and wing length, with higher values estimated for the frizzle feathered chicken compared to the normal feathered chicken. The significantly higher values recorded for frizzle feathered chickens were consistent with Horst (1989) and Nwachuckwu *et al.* (2005), who reported that the frizzle feathered chicken genes conferred superiority in most morphometric traits than other local chicken genotypes. The live weight for frizzle feathered chicken reported in this study fell within the range of 1.10-1.78kg reported by Ige *et al. (*2012).

Table 2 presents the results of the stepwise discriminant analysis showing Wilk's Lambda, F-values, probability and tolerance statistics. The discriminant analysis based on significant F- values indicated breast girth, body length, shank length, bird height, head circumference, wing length, neck length and keel length as the parameters responsible for the discrimination between the normal feather and frizzle feathered local chickens. When the eight most important morphometric variables for separating the two genotypes were selected, Wilk's Lambda dropped to 0.004 with a significant difference between the two chicken genotypes ($F = 11.637$; $p < 0.001$). Unstandardized stepwise discriminant function was used to classify individual local chickens. The eight discriminating variables earlier extracted were the variables included in the discriminant (D) equation given as:

$$D = -83.267 - 11.869BDL + 8.453HDC + 7.915BRG + 4.095BDH - 15.326SKL + 10.007WGL - 4.131NKL - 0.890KLL$$

Where BDL is body length, HDC is head circumference, BRG is breast girth, BDH is bird height, SKL is shank length, WGL is wing length, NKL is Neck length and KLL is keel length.

The stepwise discriminant procedure permitted the selection of the most discriminating variables that allowed a clear separation between the two

Table 1: Descriptive statistics of morphometric traits of normal and frizzle feathered local chickens

Trait	Normal Feather Chicken			Frizzle Feather Chicken		
	mean±s.e.	SD	CV	mean±s.e.	SD	CV
Live weight	1.32±0.04^{b}	0.42	0.32	1.48±0.05^{a}	0.52	0.35
Body length	27.50±0.18^{b}	1.80	0.07	28.74±0.15^{a}	1.45	0.05
Head circumference	11.40±0.17^{b}	1.66	0.15	12.90±0.17^{a}	1.66	0.13
Breast girth	27.36±0.16^{b}	1.61	0.06	30.90±0.15^{a}	1.50	0.05
Body circumference	35.50±0.20^{b}	1.96	0.06	38.10±0.24^{a}	2.39	0.06
Bird height	25.54±0.19^{b}	1.92	0.08	27.44±0.19^{a}	1.86	0.07
Shank length	9.30±0.11^{a}	1.08	0.12	8.86±0.13^{b}	1.31	0.15
Wing length	17.24±0.11^{a}	1.13	0.07	16.88±0.11^{b}	1.14	0.07
Neck length	10.86±0.16^{b}	1.56	0.14	11.40±0.11^{a}	1.16	0.10
Keel length	10.96±0.19^{b}	1.90	0.17	12.20±0.17^{a}	1.73	0.14

Means in the same row with different superscripts are significantly ($p < 0.05$) different;
s.e. - standard error, SD - standard deviation, CV - coefficient of variation

Table 2: Morphological traits selected by stepwise discriminant analysis to separate normal and frizzle feathered local chicken

Trait	Wilk's Lambda	F-remove	P-level	Tolerance
Breast girth	0.435	2424.501	0.0001	0.006
Body length	0.065	1184.689	0.0001	0.002
Shrank length	0.047	2939.149	0.0001	0.003
Bird height	0.022	288.339	0.0001	0.010
Head circumference	0.018	480.339	0.0001	0.004
Wing length	0.007	691.849	0.0001	0.006
Neck length	0.004	143.407	0.0001	0.013
Keel length	0.004	11.637	0.0001	0.022

genotypes. Some of the discriminating variables (body length, breast height and bird height) of the present study are similar to those reported by Abdelqader *et al*. (2008), who worked on Jordanian local chickens. In a related study, Ajayi *et al*. (2012) reported that breast girth, keel length, shank length and wing length were among some of the discriminating variables used to separate chickens into distinct populations.

The discriminant function was able to correctly classify 100% of the 610 normal and 436 frizzle feathered chickens investigated (Table 3). Cross-validation with the split–sample method indicated a 100% success rate. One hundred percent of normal feather and 100% of frizzle feathered chickens were correctly assigned into their distinct genetic groups. The classification results of this study could directly be used to identify the two genotypes; the eight discriminating variables extracted were sufficiently robust to be used in the field to separate the two chicken genotypes. Yakubu *et al*. (2010) used discriminant analysis to correctly classify West African Dwarf and Red Sokoto goat populations of Nigeria into their source population. The current classification function is a prime tool available to differentiate between normal and frizzle feathered chickens under field conditions, which could aid their effective management and conservation.

Results of the Mahalanobis distance between the two chicken genotypes are presented in Table 4. The pairwise squared distance was small (11.27) and significant ($p < 0.001$). This observation agrees with Egahi (2012), who reported a similar value (11.26) between the normal and frizzle feathered local chickens. It, however, disagrees with Atiyat (2009), who reported higher values of 433.88, 429.87and 38.31, respectively for layers, broilers and indigenous chicken populations of Jordan. The low Mahalanobis distance between the normal and frizzle feathered genotypes reported in this study may result from non-selection, continuous inbreeding and high intermingling rate between these two genotypes in the free range management system of production commonly practised.

Table 3: Classification results for discriminant analysis of local chicken populations

	Genotypes	Predicted group membership		Total
		1	2	
Original	1.00	610	0	610
Count %	2.00	0	436	436
	1.00	100	0	100
	2.00	0	100	100
Cross-validated	1.00	610	0	610
Count %	2.00	0	436	436
	1.00	100	0	100
	2.00	0	100	100

Genotypes 1.00 - Normal feather chicken; 2.00 - Frizzle feather chicken. 100% of the original grouped cases correctly classified. 100% of cross-validated grouped cases correctly classified

Table 4: Mahalanobis distance between normal and frizzle feathered local chicken

Genotype	Normal feather	Frizzle feather
Normal feather	0	11.27***
Frizzle feather	11.27***	0

***= ($p < 0.001$)

CONCLUSION

This work showed that multivariate analysis of morphometric traits provided practical basis for differentiating between normal and frizzle feathered local chickens. The results could facilitate field assessment, management and conservation of the two chicken genotypes for future selection and genetic improvement programmes. However, the morphometric evaluation using multivariate analysis should be complemented by DNA-based techniques to further confirm the present findings.

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