APPLICATION OF CANONICAL DISCRIMINANT AND HIERARCHICAL CLUSTER ANALYSES IN MORPHOLOGICAL TRAITS OF FIVE NIGERIAN INDIGENOUS CHICKEN TYPES

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ABSTRACT
Morphological characterization of five Borno state indigenous chicken types (normal feathered, frizzle feathered, naked neck, rose comb and crested chickens) was carried out using Canonical Discriminant and hierarchical cluster analyses. The eleven morphological measurements examined were body weight, ornithological measurement, wingspan, neck length, back length, keel length, tail length, thigh length, shank length, skull length and skull width. Tests of homogenous group means revealed that genotype was source of variation in all the variables and showed that naked neck was most superior while frizzle was least. Rose comb had the longest wing span. Longest tail was expressed by the crested. The first canonical function accounted for largest amount of between-group variability (49.7%), second, third and fourth accounted for 40.6%, 8.1% and 1.6%, respectively. The Dendrogram discriminated the chickens into two main clusters; the first cluster had naked neck on one hand, normal and rose comb on the other. The second cluster consisted frizzle and crested as sub-clusters, suggesting close relationship between the clustered birds. Confirmation of these detected morphological differentiations could be done using molecular-based techniques.
Key words: Frizzle feathered, Crested chicken, Dendrogram, Canonical function, Clusters

INTRODUCTION
The livestock populations were identified with unique adaptation to their agricultural production system and agro-ecological environments (Padmakumar, 2008). Their genetic resources have provided the material for the successful breeding/improvement programmes of the developed countries in the turn of last century (Adekoya *et al.*, 2013). On a global level however, FAO (2007) indicated that about 20% of all recorded farm animal breeds were at risk of extinction. Chicken genetic resources considered the most endangered with about 33% at risk, 4% being extinct, status of 40% was unknown, while only 23% was saved from extinction. The decision making in conservation requires specification of model parameters such as diversity, breed values, extinction probabilities and conservation potential (Simianer, 2005). Therefore, assessment of genetic resource characterization of indigenous breeds is a prerequisite for this purpose (Wollny, 2003). The methods of statistical multifactorial-discriminant analyses do not limit the amount of monitored variables; these also confirm discriminatory capacity of each variable (Herrera *et al.*, 1996) which makes these techniques vital tools of characterization. Data on morphological characterization of Nigerian indigenous chickens especially those conducted using multifactorial-discriminant analyses such as canonical and hierarchical cluster are limited. The intent of this study therefore was to characterize the Nigerian indigenous chickens of Borno state based on morphological characteristics using canonical discriminant and hierarchical cluster analyses.

MATERIALS AND METHODS
Study Area
This study was carried out in Borno State. The state lies between Latitudes 10^0-13^0 N and Longitudes 12^0 – 15^0 E. It is divided into broad relief regions; hilly/mountainous area of generally over 600 m above sea level, which cover the south and southeastern parts of the state; and plains of generally less than 600 m above sea level which dominate the central and northern parts. The annual rainfall varies from 700 to 1000 mm in the southern part and 300 to 500 mm in the north (Ayuba *et al.*, 2003) while the range in the central lies in between. Three seasons were identified, namely: dry cold (October to

March); hot dry (April - June); and wet season (July - September). The temperatures are high all year round, with hot season mean ambient temperatures ranging between 39^0 and 40^0 C. Two vegetation zones identified: are Sudan and Sahel savanna. Agriculture of both crops and animals is the mainstay of the economy (Mohammad and Ahmed, 2014).

Data collection

A total of 600 adult indigenous chickens (normal feathered, 206; frizzle feathered,113; naked neck, 94; rose comb, 90; and crested chicken, 97) of mixed sex (male and female) and of similar ages were randomly collected from Borno State (covering the central and southern parts) and were characterized for morphological traits. Data were collected on eleven morphological measurements which were body weight, ornithological measurement, wingspan, neck length, back length, keel length, tail length, thigh length, shank length, skull length and skull width. All the measurements were taken following the methodology of Francesch *et al.* (2011).

Statistical analysis

Data collected were subjected to post hoc test and significant means were separated using Duncan's Multiple Range Test. Morphological measurements were subjected to Canonical discriminant analysis with the type of chicken as a separation criterion using Statistical Package for Social Sciences (SPSS) Statistics version 20.0 (SPSS, 2011). Average linkage method was used to construct Dendrogram for the identification of homogenous groups using the same software. Data collected on eleven Morphological measurements of each sex and ecotype was analyzed using the following fixed model:

$Y_{ijk} = \mu_o + A_i + B_j + e_{ijk}$

Where Y_{ijk} = observation belonging to $_{ijk}$ classification

μ_o = overall mean

A_i= effect of i_{th} sex (1, 2)

B_j= effect of j_{th} genotype (1,2,3,4,5)

e_{ijk}= random error

RESULTS AND DISCUSSION

Genotype formed the source of variation in all the morphological traits studied (Table 1). In general, naked neck was most divergent from other chicken types by having superior values for most traits while the frizzle feathered had the least values. Rose comb chicken had the longest wing span which is followed by normal feathered chicken. Longest tail was expressed by crested bird, though not significantly different from those of other birds except the frizzle. Rose comb had similar values for neck length with normal feathered and naked neck chickens. Skull length and width were longest in naked neck and longer in crested chicken compared with other chicken types.

The superiority of naked neck in body weight and dimensions over other genotypes studied could be associated with the fact that naked neck reared in hot climates possesses greater ability to dissipate heat which has direct link with good appetite, consequently leading to improved body weight (Islam and Nishibori, 2009). This thus suggests that naked neck could be used to develop indigenous broiler. Contrary to this finding is the work of Norris *et al.* (2007) who observed a lighter mature weight of indigenous Venda naked neck chickens as well as Adekoya *et al.* (2013) who reported lower body weight for southwest Nigerian indigenous naked neck chickens while compared with their normal feathered counterparts. The variation in the reports could be associated with variation in the traits examined and geographical locations. Rose comb that expressed longest wing span is a demonstration of better flight capability possessed by these birds.

Table 1: Morphological characteristics of five Nigerian indigenous chicken types

Trait	Normal feathered N=206	Frizzle feathered N= 113	Naked neck N=94	Rose comb N=90	Crested chicken N=97
Male (Female)	129(77)	57(56)	68(26)	52(38)	20(77)
Body weight	1498.35±21.85^{b}	1266.55±17.33^{d}	1651.06±18.71^{a}	1522.44±31.71^{b}	1332.06±30.21^{c}
Ornithological measurement	64.42±0.73^{b}	60.16±0.60^{c}	67.23±0.67^{a}	64.77±1.03^{b}	62.84±0.82^{b}
Wingspan	66.93±0.62^{ab}	56.65±0.57^{d}	65.53±0.56^{b}	68.12±0.89^{a}	63.53±0.78^{c}
Neck length	13.59±0.13^{a}	12.59±0.15^{b}	13.92±0.14^{a}	13.63±0.17^{a}	12.76±0.11^{b}
Back length	21.97±0.15^{bc}	20.65±0.17^{d}	22.95±0.18^{a}	22.36±0.20^{b}	21.72±0.17^{c}
Keel length	11.74±0.13^{b}	11.05±0.10^{c}	13.14±0.14^{a}	11.93±0.15^{b}	10.94±0.11^{c}
Tail length	22.19±0.30^{a}	18.85±0.28^{b}	21.82±0.27^{a}	22.12±0.41^{a}	22.28±0.29^{a}
Thigh length	13.02±0.13^{b}	12.26±0.13^{c}	13.52±0.14^{a}	13.34±0.15^{ab}	12.58±0.14^{c}
Shank length	9.13±0.09^{b}	8.54±0.09^{c}	9.48±0.10^{a}	9.29±0.15^{ab}	8.36±0.12^{c}
Skull length	5.13±0.07^{b}	4.72±0.08^{b}	5.93±0.50^{a}	5.18±0.10^{b}	5.18±0.09^{b}
Skull width	2.17±0.04^{ab}	2.05±0.04^{b}	2.23±0.03^{a}	2.11±0.04^{ab}	2.13±0.02^{ab}

The first canonical function (Table **2**) accounted for the largest amount of between-group variability (49.7%), second, third and fourth accounted for 40.6%, 8.1% and 1.6%, respectively. The Dendrogram (Figure 1) discriminates the chickens into two main clusters. The first cluster divided into two, naked neck on one hand and the other cluster has two sub-clusters comprising normal feathered and rose comb chickens. The second cluster has two sub-clusters consisting of frizzle feathered and crested chickens. The Dendrogram shows that naked neck share recent common ancestor with both normal feathered and rose comb while frizzle and crested chickens are more closely related on the evolutionary scale. Meanwhile, naked neck was first to diverge, frizzle and crested diverged earlier before normal and rose comb. The cluster of frizzle and crested chickens observed in this study is in line with the work of Romanov *et al.* (2004) who reported that crest belongs to linkage group II which also contains the classical phenotype *Fray*, *Dominant White* and *Frizzle*. The result of this study is similar to the work of Abou-emera *et al.* (2018) who used microsatellite markers and distinguished frizzle genotypes from naked neck genotypes and normal feathered chicken. It is however contrary to the report of Adekoya *et al.* (2013) who characterized five Nigerian indigenous chicken types (wild-type, frizzle, naked neck, wingless and rose comb) based on morphological characters and reported the wild-type to be most divergent from other chicken types.

Table 2: Summary of canonical discriminant functions

Function	Eigen value	% of Variance	Cumulative %	Canonical Correlation
1	.402^{a}	49.7	49.7	.536
2	.329^{a}	40.6	90.3	.497
3	.066^{a}	8.1	98.4	.248
4	.013^{a}	1.6	100.0	.115

a. First 4 canonical discriminant functions were used in the analysis.

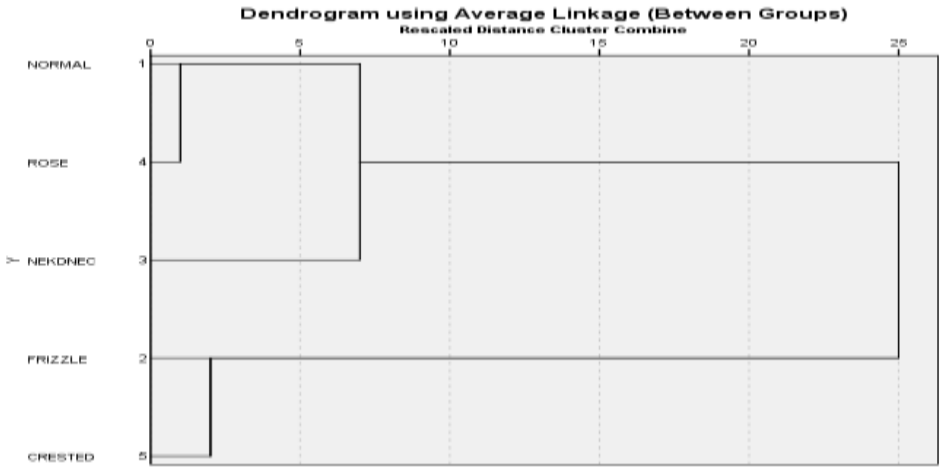

Figure 1: Dendrogram of hierarchical cluster analysis for the chicken types

CONCLUSION

Naked neck chicken was most superior for morphological characters. The first canonical function accounted for the largest amount of between-group variability. Naked neck shared common ancestor with normal feathered and rose comb chickens while frizzle and crested were more closely related on the evolutionary scale based on morphological characteristics.

Recommendation

Confirmation of these phenotypic differentiations should be carried out using molecular-based techniques.

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