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Original Contribution

CANONICAL DISCRIMINANT ANALYSIS OF THREE NIGERIAN MULTIPLE-PURPOSE CHICKENS AND MEAT-TYPE BROILER

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ABSTRACT
PURPOSE: Canonical Discriminant Analysis was conducted on body weight and morphological characteristics of three Nigerian indigenous (normal feathered, naked neck, frizzle feathered) and Ross 308 broiler chickens reared at Maiduguri, Borno State, Nigeria using body weight, shank length, shank circumference, keel length, back length, thigh length and shank diameter. METHODS: Data were subjected to Canonical Discriminant analysis with chicken type as separation criterion using Statistical Packages for Social Sciences (SPSS) version 20.0. RESULTS: The descriptive statistics indicated superiority of Ross 308 over the indigenous types. Naked neck chicken was distinguished from other local types in most morphological traits. The first Canonical function accounted for largest amount between group variability (98.4%), second and third functions accounted for 1.0% and 0.6%. Back length, keel length and thigh length contributed significantly to total variance. The overall percentage of correctly classified cases was 75.8%. The proportion of individual chickens correctly classified in to their original group was 100% in the Ross 308; 76.7% in naked neck, 63.3% in each of normal and frizzle feathered. Overlap observed among indigenous chickens suggests genetic admixture. The Dendrogram distinguished Ross 308, an exotic from the indigenous chickens. Frizzle feathered was most distant among the indigenous strains while normal and naked neck chickens clustered together. CONCLUSIONS: The Ross 308 broiler chicken was superior to the indigenous chickens in body weight and morphological traits while naked neck was superior to other local types. This suggesting naked neck to be crossbred with Ross to develop indigenous broiler-types.

Keywords: Frizzle feathered, Ross broiler, improvement, morphological traits, Dendrogram, cluster, original group, chicken-types

INTRODUCTION

The variations found in indigenous chickens are an indication that these birds are repositories of unique genes that could be harnessed for future improvement and subsequent conservation. The birds have been described to contain a highly conserved genetic reservoir rich in high level of heterozygosity required for the development of genetic stocks with improved adaptability (1). In other words, it is this inherent genetic variation that justifies their future improvement and sustainability of their production systems (2). For a long time, indigenous chickens have been playing uncommon palatable roles in the socio-economy of rural communities thereby alleviating poverty in the rural areas. Among many other credits, indigenous chickens provide the rural communities with animal protein, extra cash incomes and cultural/religious utilities (3). This thus geared the incessant demand for poultry products in form of eggs and meat in the developing nations like Nigeria. The need to expand poultry production was a natural consequence to this end (4). However, to commensurate

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with rapid population growth in Nigeria, the need to improve our indigenous chickens becomes pertinent (5). Poultry production is of great importance to Nigerian households (6) and the country is rich in indigenous chickens. About 80% of the poultry birds in Nigeria are indigenous with more than 80% reared under extensive system of management within the rural households (7).

The first approach to a sustainable use of animal genetic resources is characterization of a group of livestock. Therefore, knowledge of variation of morphological traits in these animals is pertinent (8). For years, morphological measurements have been used to characterize various breeds of animals including domestic fowl and this could provide useful information on the suitability of animals for selection. Additionally, morphological measurements play significant role in judging the quantitative characteristics of meat (9).

Variations measured using univariate analyses consider variable as individual resulting in substantial overlapping results. Thus, univariate statistical techniques may be insufficient to elucidate how population differs when multiple variables are considered (10). Canonical Discriminant analysis technique consideres all variables in differentiation of populations simultaneously. Although, the indigenous chickens have been characterized using morphological traits, however, characterization of these chicken-types with incorporation of exotic meat-type using multivariate-based analysis is rare in this part of the country (northeast Nigeria). The aim of this work is to characterize three Nigerian-owned chickens and one commercial meat-type poultry strain (Ross 308) using multivariate Canonical Discriminant Analysis.

MATERIALS AND METHODS

The work was conducted in Maiduguri, Borno State capital. Adult indigenous chickens were collected from Jere, Maiduguri and Konduga of Maiduguri, Borno State. Out of this, a total of 180 chickens comprising 3 different breeds of normal feathered, frizzle feathered, naked neck, as 60 birds of each breed was randomly selected at the age of between 24 and 30 weeks. Sixty (60) 8 weeks old commercial intensively reared Ross 308 broiler chickens selected from a group of birds were incorporated. This made a total of 240 birds. Collected birds were transported to Department of Animal Science Laboratory, Faculty of Agriculture, University of Maiduguri where they were individually characterized by measurements of body weight and morphological traits. The morphological traits examined were shank length, back length, keel length, thigh length, shank circumference and shank diameter. The measurements of the traits were taken following the methodology of Francesch *et al.* (11).

Data collected were first subjected to Descriptive statistics. Body weight and morphological characteristics were subjected to Canonical Discriminant analysis with the type of chicken as a separation criterion using Statistical Packages for Social Sciences, version 20.0, SPSS (12). The canonical functions were used to classify chickens to their original groups and the use of percentages of the chicken types was an addition used in predictive models of differentiation among samples. Average linkage method was used to construct Dendrogram for the identification of homogenous groups using the same software. Data collected on the seven body measurements of genotype was analyzed using the following statistical model:

$$Y_{ij} = \mu_o + A_i + e_{ij} \quad (1)$$

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

μ_0 = Overall mean

A_i = effect of ith genotype (i =1, 2, 3, 4)

e_{ij} = random error

RESULTS

Ross broiler chicken which is a commercial strain was statistically distinguished by classification models applied from the local strains in body weight and three morphological traits (body weight, keel length, back length and thigh length) out of the total seven traits examined **(Table 1).** Among the seven traits examined, standard deviation for body weight was highest. This is greater (345.39) in the commercial strain compared with the local counterparts (289.67, 179.54, 165.49). The deviation in body weight among the local strains was highest (289.67) in normal feathered chicken. Traits such as shank qualities and keel length were distinguished traits for naked neck from other local strains. Normal feathered chicken had highest values for shank length and thigh length. Frizzle feathered chicken had least values for most of the traits.

Table 1. *Descriptive statistics of three indigenous and one commercial broiler chickens*

	Normal-feathered chicken		Frizzle-feathered chicken		Naked-neck chicken		Ross 308 broiler	
Trait	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Body weight (g)	1543.67	289.67	1271.67	179.54	1613.33	165.49	2377.58	345.39
Shank length (cm)	9.76	1.59	8.87	1.19	9.63	1.16	7.47	0.57
Shank circumference (cm)	5.28	0.76	5.17	0.69	5.23	0.56	5.17	0.53
Keel length (cm)	11.84	0.99	11.43	1.46	13.49	1.57	15.80	0.79
Back length (cm)	21.34	2.29	19.62	1.81	22.38	1.79	43.05	1.84
Thigh length (cm)	13.94	1.77	12.20	1.86	13.34	1.64	18.85	0.86
Shank diameter (cm)	1.69	0.24	1.61	0.134	1.75	0.22	1.63	0.13

SD= Standard Deviation

The first Canonical function **(Table 2)** accounted for the largest amount between group variability (98.4%) while second and third functions accounted for 1.0% and 0.6%, respectively with only the first having Eigen value greater than 1 (33.213). The Structure Matrix clearly explained **(Table 3)** the function loadings with respect to morphological traits as given in **Table 2**. The first function had high positive loading on back length (0.859), second function with high positive loading on keel length (0.888) while the third function had positive loading on thigh length (0.749). In other words, the Structure Matrix defined the traits that contribute significantly to the total variance in order of functions loading superiority. More so, apart from the fact that the Fishers' Linear Discriminant functions as presented in **Table 4** revealed highest values for back length, keel length and thigh length as the distinguishing factors between these chicken types, they remained the best traits to predict body weights in these chickens. The Fishers' Linear Discriminant functions further revealed the function loadings in terms of chicken strains. From the Table, the traits (back length, keel length and thigh length) with high loadings had highest values for Ross broiler chicken. This is followed by that obtained for Naked neck except in thigh length while least values for back length and thigh length were displayed in frizzle feathered chicken.

Table 2. *Summary of Canonical Discriminant Functions*

Function	Eigen value	% Variance	Cumulative %	Canonical correlation
1	33.213	98.4	98.4	0.985
2	0.344	1.0	99.4	0.506
3	0.185	0.6	100.0	0.404

a. First 3 canonical discriminant functions were used in the analysis

Table 3. *Structure Matrix of Function Loadings based on Morphological Traits*

	Functions		
Traits	1	2	3
Back length (cm)	0.859	0.080	0.289
Shank circumference (cm)	0.158	0.127	0.034
Keel length (cm)	0.223	0.888	0.147
Shank diameter (cm)	0.104	0.345	0.158
Thigh length (cm)	0.275	-0.068	0.749
Body weight (g)	0.272	0.379	0.717
Shank length (cm)	-0.121	0.278	0.662

Table 4. *Fisher's Linear Discriminant Function Analysis as based on Chicken Type*

	Chicken Type			
Trait	1	2	3	4
Body weight (g)	-0.014	-0.017	-0.014	-0.028
Shank length (cm)	2.017	1.777	1.449	-3.963
Keel length (cm)	4.709	4.9305	6.073	7.196
Back length (cm)	4.933	4.720	5.205	12.003
Thigh length (g)	3.421	2.929	2.934	5.213
Constant	-104.482	-91.203	-115.442	-317.51

1= normal feathered, 2= frizzle feathered, 3= naked neck, 4= Ross 308

The Discriminant analysis results based on type of chicken as separation criteria are given in Table 5. The overall percentage of correctly classified cases is 75.8%. The proportion of individual chicken-types correctly classified in to their original group was 100% in the Ross 308 broiler strain; this is followed by naked neck (76.7%). However, 25.0% of normal feathered was misclassified as frizzle feathered. Conversely, 23.3% of frizzle feathered chicken was misclassified as normal feathered.

Figure 1 showed that Ross 308 broiler breed was separated from the indigenous strains. This outcome is expected because the bird is exotic which remained distinct from the indigenous. On the other hand, overlap was observed in all the indigenous chickens with naked neck being the most distinct distinguishing it from other indigenous types. This was substantiated by the outcome of classification result **(Table 5).** The overlap signifies the genetic admixture between the indigenous genotypes. The Dendrogram **(Figure 2)** based on average linkage between groups classified the birds into two major clusters; the first cluster has commercial strain, the second has two sub-clusters one having frizzle feathered and the other comprises normal feathered and naked neck chickens. The Dendrogram distinguished Ross 308, a commercial breed from the indigenous chickens.

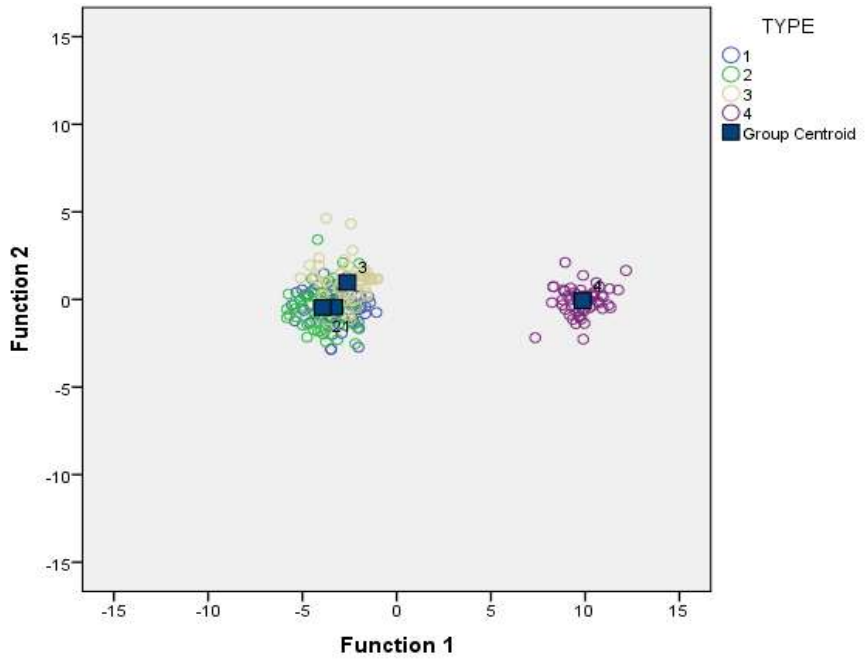

Figure 1. 95% confidence ellipses of Discriminant Analysis scores of morphological characters. Keys:1= normal feathered, 2= frizzle feathered, 3= naked neck, 4= Ross 308

Table 5. *Classification of Three Indigenous and Ross 308 Broiler into their Original Group*

Classification		**Predicted Group Membership**				**Total**
	Type	1	2	3	4	60
Count	1	38	15	7	0	60
	2	14	38	8	0	60
	3	6	8	48	0	60
	4	0	0	0	60	60
Original %	1	63.3	25.0	11.7	0	100
	2	23.3	63.3	13.3	0	100
	3	10.0	13.3	76.7	0	100
	4	0	0	0	100	100

a. 75.8% of original grouped cases correctly classified.
1= normal feathered, 2= frizzle feathered, 3= naked neck, 4= Ross 308

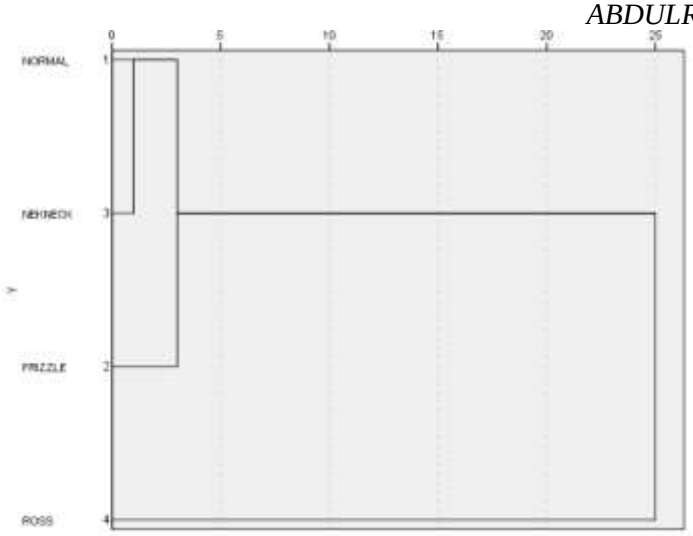

Figure 2. Dendrogram using average linkage (between group)

DISCUSSION

The indigenous strains expressed better shank qualities than their commercial counterpart. Distinguished characteristics of Ross 308 are expected not only because it's a commercial breed but also it is a breed exclusively developed for commercial meat. In other words, keel, back and thigh lengths constitute the major parts of broiler body weight. Additionally, this result suggests the suitability of Ross 308 broiler chicken for cross-breeding programmes for genetic improvement of these indigenous chickens. On the other hand, generally lower body weights and dimensions expressed by the indigenous strains confirm earlier reports that indigenous chicken types are light birds compared with their exotic counterparts (13). Meanwhile, naked neck among the indigenous types was identified with heaviest body weight, longest keel and back as well as best shank diameter. This is in accordance with the work of (14) and (15) who reported that naked neck was more divergent from other local chicken-types by having superior values for most traits. Meanwhile, (16) reported that frizzle feathered chicken was most diverse in term of morphological characteristics. Since these traits are most important for the meat quality of a bird, the result indicates that naked neck would be the best indigenous chicken-type for cross-breeding programme with the Ross 308 to develop indigenous meat-type chickens with appreciable shank qualities. Similar to this report was the work of (17) on five northeastern Nigerian indigenous chicken populations. This is equally in line with the observation of (1) on Southwest Nigerian indigenous chicken ecotypes. The similar corroborations may suggest the superiority of naked neck chickens over other genotypes (normal and frizzle feathered) in both the northern and southern parts of the country.

Additionally, the reason for morphological distinctness of the commercial breed from the indigenous types may suggest that commercial breeds have not been intermingling freely with their indigenous counterparts. On the other hand, introgression between the indigenous strains was observed. The naked neck chicken being most highly classified in to its original group among the local chicken types suggesting that naked neck possesses the potential to respond to genetic improvement than any of its local counterparts. Thus, it remains the best local bird to be used for indigenous chicken improvement with the exotic. This is a further confirmation of descriptive statistics as reported in this study. The first Canonical function **(Table 2)** accounted for the largest amount between group variability (98.4%) while second and third functions accounted for 1.0% and 0.6%, respectively with only the first having Eigen value greater than 1 (33.213); an implication of which is that the traits in the first function contributed significantly to total variance followed by the trait in the second function and the trait in the third function. Although (18) reported that, a high prediction could be obtained for a particular type or population of animals, it is difficult to obtain 100% prediction of group membership in samples belonging to the same group of animals. Contrary to this report, (19) obtained 100% classification for Florida, Andalusia goats. Meanwhile, the variation in

this report and that of the authors could have direct link with species differences.

Classification models applied showed that Ross 308 broiler breed was distinguished from the indigenous strains. This outcome is expected because the bird is a commercial-type which remained distinct from the indigenous. On the other hand, overlap was observed in all the indigenous chickens with naked neck being the most distinct distinguishing it from other indigenous types. This was substantiated by the outcome of classification result **(Table 5).** The overlap signifies the genetic admixture between the indigenous genotypes. This result correlates well with report of (1). Frizzle feathered was most distant among the indigenous strains while normal and naked neck were related. The reason for this may be because both genotypes share recent common ancestors with respect to morphological characters. A deviant report has however been presented by (13) who reported that frizzle feathered is more related to normal feathered than the naked neck. The result of these authors is expected because blood protein was used to characterize the chickens and more importantly the chickens in use were from an environment (southwestern Nigerian) different from that of this study which is equally a factor that could serve as a source of variation in the result.

CONCLUSIONS

The Canonical function indicated that back length, keel length and thigh length were the most important distinguishing traits among the chickens. The results revealed distinctness of commercial breed (Ross 308 broiler) from indigenous types. Naked neck indicated the best potential for genetic improvement. There was genetic admixture among indigenous chickens.

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