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CLASSIFICATION OF DONKEY STRAINS IN NORTHWEST NIGERIA USING SIMPLE DISCRIMINANT ANALYSIS OF MORPHOMETRIC TRAITS

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ABSTRACT

Study was conducted to determine the relationship among the biometric measurements of Red (Auraki), Black (Duni), White (Fari), Brown (Idabari) and Brown-White (Idabari-fari) donkeys at different ages. A total of 700 donkeys were used for the study. The biometric traits measured were body weight, head length, head width, ear length, neck length, neck circumference, shoulder width, height at withers, heart girth, body length and tail length. Discriminant analysis was used to classify donkeys into different genetic groups. The result showed that ear length was the most discriminating character followed by body length. The discriminant for ear length was (14.06) Red, (13.59) Black, (13.74) White, (13.80) brown and (14.85) Brown-white and for body length, (1.20) Red, (1.19) Black, (1.18) White, and (1.13) Brown. Two centroids were formed based on their phenotypic characteristics coat colours with Auraki (Red), Idabari (Brown) and Duni (Black) donkeys, clustered together, while the Idabari-fari (Brown-white) form another cluster. The two length measurements: ear and body length could be an indication for biometric traits differentiation in strains of donkeys while the differences observed from the two centroids can be used as criteria for selection based on the strain characteristic.

Keywords: Discriminant analysis; Classification; Donkey strains; Nigeria

INTRODUCTION

Phenotypic variability in metric measurements as much as performance traits in livestock production are affected by both genetic and environmental factors (Semakula *et al*., 2011). Metric measurements related to body lengths, heights and girths of live animals were measured to assess the relationship between these variables and the live weight for breed characterization in different animal species: in cattle (Mekonnen and Biruk, 2004), in sheep (Oke and Ogbonnaya, 2011) or goat (Adeyinka and Mohammed, 2006; Fajemilehin and Salako, 2008) and in donkeys (John *et al*., 2017). Genetic diversity and similarity among and within strains have been determined using morphometric differences (Rey *et al*., 1995; Herrera *et al*., 1996). For instance, Mukeherjee *et al* (1997) used body length and chest circumference, to show significant differences between brown and grey Bengal goat breeds. Similarly, Herrera *et al*., (1996) successfully used, shin circumference, heart girth, chest depth, rump length, and width and shoulder height to determine differences between five goat breeds in Spain. Since variation in mature body weight is considerable even among breeds with similar withers height, it was used to estimate phylogenetic relationships between some Spanish goat breeds. Therefore, the relationships between the body measurements are needful for the prediction of other performance traits in animal (Cecchinato *et al*., 2009). The domestication events of donkey

were based on two mitochondrial lineages. The first lineage was closely linked to the Nubian wild ass (*Equus asinus africanus)*. The second lineage showed some similarities to the Somali wild ass (*Equus casinos somaliensis*) (Beja-Pereira *et al*., 2004). Therefore, there is a need to establish simple and practical methods of classifying donkeys in North West Nigeria using discriminant analysis. This study is aimed at classifying donkey strains into different genetic groups using simple discriminant analysis.

MATERIALS AND METHODS

Study location

The study was carried out in the semi-arid zone of Nigeria in the seven States of North West Nigeria (Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto and Zamfara States). The semi-arid zone of Nigeria starts from about 11ºN latitude and ends at the Nigeria-Niger frontier. It encompasses the Sudan and Sahel Savanna and part of the Northern Guinea Savanna. The mean annual temperature runs between 26 and 28ºC. There is a single rainy season from May to October, with mean annual rainfall ranging from 1016mm in the wettest parts to less than 508mm in the driest parts. The length of growing period is about 100-150 days which makes it possible to cultivate a wide variety of crops (Ogungbile *et al*., 1998). The semi-arid zone has a land mass of 113,530km^2 and a population of over 35 million people (NPC, 2006). The major inhabitants of this area are Hausa and Fulani who are predominantly mixed crop-livestock farmers and livestock herders.

Sampling Structure

A random sampling method was used to determine or measure donkeys, using their metric traits within a given senatorial zone. A total of seven hundred (700) donkeys were used for this study. The weaners, young and adults, males and females were sampled and measured in almost equal number. Thirty-three (33) weaners, young and adults, males and females were used in two (2) senatorial zones. Thirty-four (34) donkeys were however sampled in the third senatorial zone to make a total of 100 donkeys that were sampled per State. Donkeys were classed into three age groups (weaners 6 months- 1year, young above 1- 3years and adults 3 years and above). The age of the donkeys was determined using teeth count (FAO, 2003) in combination with the information provided by the donkey owners.

Data Collection

A flexible measuring tape was used to take the body measurement. During body measurement, animals were made to stand upright and restrained by research assistants in such a way that their necks, heads and ears were stretched almost in a straight line. Each measurement was taken for at least two times and recorded to the nearest centimeter. Morphometric traits measures taken were body weight, head length, head width, ear length, neck length, neck circumference, shoulder width, height at withers, heart girth, Body length and Tail length using random sampling technique.

Reference marks for body measurement according to the method of Searle et al., (1989a and b), and Salako (2006).

Body weight (BWT): This was determine using prediction equation (kg)

Head length (HL): Measured as the distance from between the ears to the upper lip (cm).

Head width (HWD): Measured as the distance between the outer ends of both eyes (cm).

Ear length (EL): Measured as the distance from the base to the zygomatic arch of the ear (cm).

Neck length (NL): Measured as the distance from the base of the cervical vertebra to the base of the top shoulder (cm).

Neck circumference (NC): Taken as the circumference of the neck at the midpoint (cm).

Shoulder width (SW): Measured as the horizontal distance between the two shoulders or distance between the lateral tuberisities of

the humeri which is also described as the widest point over the intraspinus muscle (cm).

Height at wither (HW): Vertical distance from ground to the point of withers measured vertically from the ridge between the shoulder bones to the fore hoof (cm).

Heart girth (HG): Measured as the circumference of the body at the narrowest point just behind the shoulder perpendicular to the circumference of the body, just in front of the hind leg perpendicular to the body axis (cm).

Body length (BL): Distance between points of shoulder to point of hip i.e the distance from the first thoracic vertebrae to base of tail. This is also described as the distance between the most cranial palpable spinosus process of thoracic vertebrae and either sciatic tubers or distance between the tops of the pelvic bone (cm).

Tail length (TL): Measured from the base of the tail to the tip (cm).

Statistical Analysis

Discriminant analysis carried out in this study involved the *determination of a regression-like linear equation. The form of the equation or function that were used is:*

$$D= v_1 X_1+ v_2 X_2+ v_3 X_3 .....v_iX_i+ a$$

Where D = discriminate function
v = the discriminant coefficient or weight for that variable
X = respondent's score for that variable
a = constant
i = the number of predictor variables

The simple discriminant analysis procedure was used to classify the strains using the R 2.13.0 (R Development Core Team, 2015) package. DISCRIM procedure was used to calculate the probabilities of including an animal in determining the strain, taking into account the error made in classification of the strain. Stepwise discriminant procedure (STEPDISC) was applied to determine which performance traits were used in the final clustering analysis, this procedure was used to determine the variables that had more discriminating power than the others.

RESULT AND DISCUSSION

The simple discriminant analysis for strain classification is shown in Table 1. Simple discriminant analysis for strain classification of donkeys in Northwest Nigeria showed no differences in body weight, neck circumference and tail length across strains and therefore cannot be used to distinguish them. Ear length (EL) and body length (BL) were the only biometric measures with high discriminant powers to differentiate the donkey strains. The discriminant for ear length was (14.06) red, (13.59) black, (13.74) white, (13.80) brown and (14.85) brown-white and for body length, (1.20) Red, (1.19) Black, (1.18) White, and (1.13) Brown. The two length measurements; ear length and body length could be an indication for phenotypic differentiation in strains of donkeys. The result of this study showed that ear length was found to be the most discriminating character followed by the body length. This result was not in harmony with Salako and Ngere (2002) where tail length was obtained to be the best discriminating variable between Yankasa and WAD sheep but partly in agreement with the findings of Agievezor *et al*. (2012) who reported tail length, rump height, chest girth, ear length and chest depth as the best discriminating variable to separate WAD, Uda, Yakasa and Balami sheep. The result of this study is similar to the findings of John and Iyiola-Tunji (2018) who reported close genetic relationships amongst the three solid strains, Auraki (Red), Idabari (Brown) and Duni (Black) donkeys compares to the ones that has patched colour Idabari-fari (Brown-white) donkeys.

Table 1: Simple discriminant analysis for Strain classification

Traits/traits	Red	Black	White	Brown	Brown-white
Body weight (kg)	-0.04	-0.04	-0.03	-0.03	-0.04
Head length (cm)	-0.09	0.20	0.12	0.14	-0.18
Head width (cm)	0.03	-0.23	-0.33	-0.24	-0.23
Ear length (cm)	14.06	13.59	13.74	13.80	14.85
Neck length (cm)	0.13	0.29	0.07	0.17	0.69
Neck circumference (cm)	-1.19	-1.37	-1.21	-1.27	-1.46
Shoulder width (cm)	-0.99	-1.04	-1.18	-1.02	-1.34
Height at withers (cm)	0.03	0.03	0.02	0.03	0.04
Heart girth (cm)	0.04	0.05	0.08	0.11	0.11
Body length (cm)	1.20	1.19	1.18	1.13	1.02
Tail length (cm)	-0.03	-0.04	-0.06	-0.05	0.03

Figure 1 shows the discriminant function of the donkey strains. Two functions were generated by discriminant analysis. The first grouped centroid function is made up of Auraki (Red), Idabari (Brown) and Duni (Black) donkey which were clustered together while the second ungrouped cases function is Idabari-fari (Brown-white), which formed another cluster. Generally, there are two centroids which were grouped together based on the strain characteristics. The three solid strains, Auraki (Red), Idabari (Brown) and Duni (Black) donkeys were clustered together from the ones that has patched colour Idabari-fari (Brown-white) donkeys. The implication of the centroid in selection implies that the differences manifested between the two group of strains can be used as a criterion for selection based on the strain characteristic.

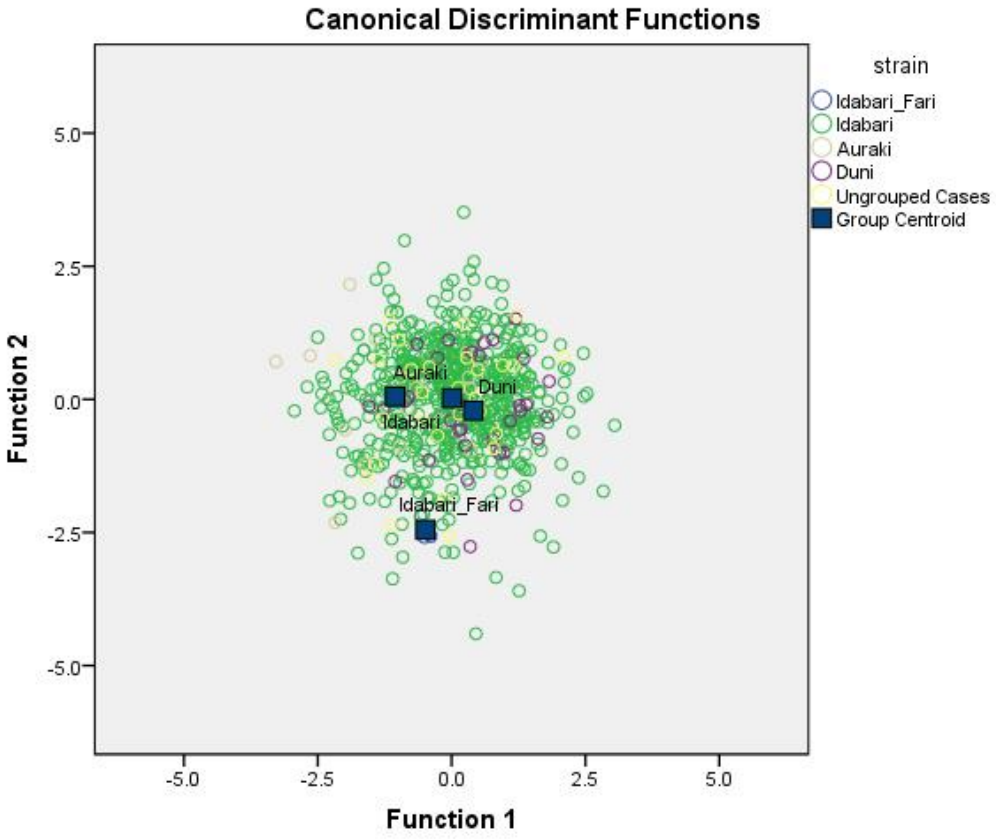


Figure 1: Discriminant function of the donkey strains

The discriminant analysis to determine the variables with more discriminating power than others in the final cluster analysis among age categories is represented in Table 2. Low and negative discriminating power were observed among weaner, young and adults groups for BWT, HWD, NC, SW and TL. Low and positive discriminating power were observed among majority of the biometric traits. EL and BL had high discriminant power among all the biometric traits across the age groups for weaner (14.35), young (14.17) and adults (13.89) and weaner (1.203), young (1.225) and adults (1.208). The differences observed amongst donkey strains in this study might be as a result of genetic constitution of the animals. The result of this study is similar to the findings of (Yakubu and Ibrahim, 2011) who reported that the differences between breeds may have genetic underpinning.

Table 2: Stepwise discriminant analysis to determine the variables with more discriminated power than others in the final cluster analysis among age categories

Traits/age group	Weaner	Young	Adult
Body weight (kg)	-0.067	-0.0625	-0.068
Head length (cm)	0.389	0.332	0.299
Head width (cm)	-0.675	-0.7275	-0.346
Ear length (cm)	14.35	14.17	13.89
Neck length (cm)	0.208	0.367	0.122
Neck circumference (cm)	-1.243	-1.316	-1.264
Shoulder width (cm)	-1.559	-1.579	-1.284
Height at withers (cm)	0.058	0.052	0.059
Heart girth (cm)	0.115	0.081	0.123
Body length (cm)	1.20	1.23	1.21
Tail length (cm)	-0.078	-0.038	-0.037

The stepwise discriminant analysis to determine the variables with more discriminated power than others in the final cluster analysis between sexes are shown in Table 3. Negative, low to high discriminating power were observed between the morphometric traits of donkey with EL (13.75) and BL (1.23) in male and EL (13.77) and BL (1.25) in female. The two length measurements, ear length and body length could be an indication for phenotypic differentiation in strains, sex and across the age categories of donkeys. The result of this study showed that ear length was found to be the most discriminating character followed by the body length. Mammalian body measurements are used to make taxonomic, behavioral and ecological comparisons within and among species. Another application of these comparisons is the promulgation of several rules to explain intraspecific variation in morphology over broad environmental gradient (Brown *et al*., 2006). The pattern of biometric differences among donkey strains for ear length and body length suggests a direct relationship among the extent of biometric divergence and geographical differences. A study carried out by (Yakubu *et al*., 2010) revealed that rump height, body length, horn length, face length, chest girth, neck circumference and head width were the most discriminating variables to separate WAD and Red Sokoto goats. This is similar with the results of this study which showed that ear length and body length as the most discriminating variables. The superiority of the ear length and body length as the best discriminators might be because of the length related traits of donkeys.

Table 3: Stepwise discriminant analysis to determine the variables with more discriminated power than others in the final cluster analysis by sex

Traits	Male	Female
Body weight (kg)	-0.07	-0.08
Head length (cm)	0.20	0.08
Head width (cm)	-0.29	-0.28
Ear length (cm)	13.75	13.77
Neck length (cm)	0.21	0.27
Neck circumference (cm)	-1.34	-1.42
Shoulder width (cm)	-1.25	-1.27
Height at withers (cm)	0.06	0.67
Heart girth (cm)	0.15	0.24
Body length (cm)	1.23	1.25
Tail length (cm)	-0.01	-0.04

CONCLUSION AND RECOMMENDATION

Simple discriminant analysis for strain classification of donkeys of Northwestern Nigeria revealed negative values in body weight, head width, shoulder width, neck circumference, head length and tail length across the strains and therefore cannot be used to classify the donkey strains into genetic groups.

Ear length and body length were the only biometric measures with high discriminant powers to differentiate the donkeys across the strains, age categories and sex.

Closed genetic relationships were observed between Idabari (Brown), Duni (Black) and Auraki (Black) donkeys compared to Idabari-fari (Brown-white), which were distant and farther away from the other strains.

It is therefore recommended that ear length and body length should be used in classifying donkeys into strains because of their high genetic distance estimate.

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