



## STRAIN CLASSIFICATION OF DONKEYS IN NORTHWEST NIGERIA USING CANONICAL DISCRIMINANT ANALYSIS ON QUANTITATIVE TRAITS

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### ABSTRACT

Metric traits were used to determine the relationship among Red (Auraki), Black (Duni), White (Fari), Brown (Idabari) and Brown-white (Idabari-fari) donkeys. A total of 700 donkeys were used for the study. Metric measures taken were head length, head width, ear length, neck length, neck circumference, shoulder width, height at withers, heart girth, body length and tail length. Data obtained were subjected to General Linear Model Procedure of SAS to determine the relationship among donkey strains. Canonical discriminant analysis (CANDISC procedure), was used to perform uni-and multivariate analysis to derive canonical variables (CAN), which was used to match the donkey strain groups until reached the satisfactory number of clusters (genetic groups) and to show the clustering groups among these four donkey strains. The canonical coefficients and a scatter diagram for visual interpretation of the different groups were also generated during the canonical discriminant analysis. Among the all the donkey strains, Black (Duni) strain had the highest trait loading in CAN 1 for HL (0.61), HW (0.71), NC (0.91), SW (0.71), HG (0.84) and BL (0.82). The four strains that is, red, black, white and brown donkeys were clustered or separated into a separate group while the brown-white were separated into another distinct group. The results of the study showed that Black donkeys had more canonical weight on the generalized canonical component followed by red and white donkeys. There is need to screen and conserve the four basic donkey strains to arrest further genetic erosion and dilution in these strains.

**Keywords:** *Strain classification, Donkeys, Nigeria, Canonical Discriminant Analysis and Quantitative Traits.*

### INTRODUCTION

The use of donkeys as draught animals in rural areas has improved considerably the involvement of small-scale farmers in the market economy (Fernando and Starkey, 2004). In Nigeria, about 16,000 donkeys are transported yearly from the Northern states to the Southern part of the country for meat (Blench, 2004). They also provide greater mobility with which to face erratic rainfalls and are used for carrying firewood, loads, including water, house-hold structures, goods and children (Marshall and Weissbrod, 2011). Presently, donkeys are used in the production of milk for children, who are allergic to bovine milk (Carcocio *et al.*, 2000). The study of donkey behaviour was first advocated during the

1991 Equine Colloquium in Edinburgh (Fielding and Pearson, 1991) as part of an overall effort to investigate the basic parameters of the donkey in order to efficiently exploit its potentials as a draft animal. Research on the behaviour of equids is of great interest to handlers and trainers in terms of welfare/health, breeding and training. In general, the understanding of animal behaviour is the most basic knowledge required to improve animal welfare, enhance productivity and influence performance. Most of the studies carried out were focused on behavioural pattern in horses (McDonnell and Haviland, 1995; Christensen *et al.*, 2002), while others were on the behaviour in wild asses (Lamoot *et al.*, 2004). There is paucity of information concerning the behavioural activities of donkeys in

Africa (Canacoo and Avorny, 1998). Information on the classification of donkeys is lacking because of the little interest shown in the area of research in Nigeria. The aim of this study is to classify and establish the relationships among donkey strains in Northwest Nigeria using canonical discriminant analysis.

## MATERIALS AND METHODS

### Description of Experimental Sites

The field research was conducted in the semi-arid zone of Nigeria in Sokoto, Jigawa, Kano, Katsina, Kaduna, Zamfara and Kebbi States respectively. The semi-arid zone of Nigeria starts from about 11°N 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 28°C. 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<sup>2</sup> and a population of over 35 million people (NPC, 2006). This part of Nigeria has very low level of infrastructure and roads which render it difficult for the people to have access to both rural and urban markets. The major inhabitants of this area are Hausa and Fulani who are predominantly mixed crop-livestock farmers and livestock herders respectively. These States in North West Nigeria were selected for this study because of existence of high population of donkeys. All the three senatorial zones in each of the seven states were covered in this study using a random sampling technique.

### Sampling Size and Sampling Structure

Seven hundred (700) donkeys were sampled for this study which was carried out in the Northwest of Nigeria. A random sampling method was used to determine or measure donkeys, using their morphological and morphometric traits within a given senatorial zone. The weaners, young and adults donkeys were observed and measured in almost

equal number. Thirty-three (33) weaners, young and adults were used in two (2) senatorial zones. Thirty-four (34) donkeys were however, observed in the third senatorial zone to make a total of 100 donkeys sampled per State. Donkeys were measured 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

### Morphometric traits measured

A flexible tailors measuring tape was used to take the body measurement. During body measurement, animals were made to stand upright and restrained by assistants in such a way that their necks, heads, tails and ears were stretched almost in a straight line. Each measurement was taken for at least two times and recorded in centimeter.

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

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 (HDW): 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 spinous 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

Data obtained were subjected to General Linear Model Procedure of SAS 2004 to determine the relationship among donkey strains. Canonical discriminant analysis (CANDISC procedure), was used to perform uni- and multivariate analysis to derive canonical variables (CAN), which was used to match the donkey strain groups until reached the satisfactory number of clusters (genetic groups) and to show the clustering groups among these four donkey strains. The canonical coefficients and a scatter diagram for visual interpretation of the different groups were also generated during the canonical discriminant analysis.

The statistical model considered was

$$Y_{ij} = \mu + S_i + e_{ij}$$

where  $Y_{ij}$  is the record of observation

$\mu$  = population mean

$S_i$  = Effect of  $i^{\text{th}}$  strain of donkeys (Auraki, Fari, Duni, Idabari and Idabari-Fari)

$e_{ij}$  = Random error particular to the  $ij^{\text{th}}$  observation assumed to be independently randomly distributed with mean zero and variance NIID (0, e)

### Morphometric Characteristics of Donkey Population Studied

The canonical discriminant analysis to match the donkey strains into genetic groups (clusters) are indicated in Tables 1a and b. The result from the canonical discriminant analysis showed that four components were extracted from the original ten morphometric traits of red donkeys. The trait loadings for HWD, NC, SW, HG and BL were obtained in CAN 1, HL, NL, SW, HG and BL in CAN 2, HWD and EL in CAN 3. Black donkeys had high trait loadings in CAN 1 for BWT, HL, HWD, NC, SW, HG and BL, CAN 2 for HL, NL, SW, BL and TL, CAN 3 for HWD, EL and TL. White donkey strains had high trait loadings for HWD, NC, SW, HG and BL in CAN 1. CAN 2 had HL, NL and SW. CAN 3 recorded HWD and EL. Brown donkey strains recorded high values in terms of NC in CAN 1. CAN 2 were HL, NL and SW. EL was obtained in CAN 3. For brown-white donkeys, NC was observed in CAN 1. HL, NL and SW in CAN 2. The trait loadings in CAN 3 were EL and NL. Black donkeys had more canonical weight on the generalized canonical component in CAN 1 for HL (0.61), HW (0.71), NC (0.91), SW (0.71), HG (0.84) and BL (0.82) followed by red in CAN 1 for NC (0.62) and SW (0.62); and white donkeys in CAN 1 for NL (0.61) and SW (0.64). This implies that the red (duni) and white (fari) donkey strains had a close genetic relationship as compared to others that extracted their loadings on a single component. This further buttressed the reports of Carneiro *et al.*, (2010) in sheep, Yakubu and Ibrahim, (2011) in goats and Kefena *et al.*, (2011) in donkeys. This is in conformity with this study which showed that red, black and white had high canonical coefficient and were clustered together into the same genetic group. These might be attributed to a closed genetic origin and relationships among donkey strains which can be selected for genetic improvement.

## RESULTS AND DISCUSSION

Table 1a. Canonical discriminant analysis to match the donkey strains into genetic groups (clusters)

Class means on canonical variables												
Strains	Red				Black				White			
Traits	Can 1	Can 2	Can 3	Can 4	Can 1	Can 2	Can 3	Can 4	Can 1	Can 2	Can 3	Can4
BWT(kg)	0.25	0.12	0.007	-0.13	<b>0.90</b>	0.36	0.02	-0.24	0.25	0.11	0.01	-0.13
HL(cm)	0.40	0.58	0.15	-0.19	<b>0.61</b>	<b>0.77</b>	0.16	-0.15	0.39	0.58	0.15	-0.19
HWD(cm)	0.51	0.38	0.52	0.13	<b>0.71</b>	0.45	0.53	0.09	0.51	0.37	0.52	0.13
EL(cm)	0.29	0.04	<b>0.61</b>	-0.16	0.55	0.07	<b>0.82</b>	-0.15	0.29	0.04	<b>0.61</b>	-0.16
NL(cm)	0.14	<b>0.61</b>	0.42	-0.05	0.22	<b>0.85</b>	0.48	-0.04	0.14	<b>0.61</b>	0.42	-0.05
NC(cm)	<b>0.62</b>	0.18	0.33	-0.09	<b>0.91</b>	0.22	0.35	-0.07	<b>0.62</b>	0.18	0.33	-0.09
SW(cm)	<b>0.62</b>	<b>0.64</b>	0.37	-0.09	<b>0.71</b>	<b>0.63</b>	0.31	-0.05	<b>0.62</b>	<b>0.64</b>	0.37	-0.09
HW(cm)	0.09	0.08	0.08	-0.20	0.59	0.41	0.33	-0.61	0.09	0.08	0.08	-0.20
HG(cm)	0.58	0.31	0.32	-0.17	<b>0.84</b>	0.39	0.34	-0.13	0.57	0.31	0.32	-0.17
BL(cm)	0.59	0.43	0.18	0.21	<b>0.82</b>	0.53	0.18	0.15	0.58	0.43	0.18	0.21
TL(cm)	0.19	0.31	0.43	0.15	0.41	0.59	<b>0.67</b>	<b>0.67</b>	0.19	0.31	0.43	0.15

BWT = Body weight; HL = Head length; HWD = Head width; EL = Ear length; NL = Neck length; NC = Neck circumference; SW = Shoulder width; HW = Height at withers; HG = Heart girth; BL = Body length; TL = Tail length.

**Table 1b. Canonical discriminant analysis to match the donkey strains into genetic groups (clusters)****Class means on canonical variables**

Strains	Brown				Brown/white			
	Can 1	Can 2	Can 3	Can 4	Can 1	Can 2	Can 3	Can 4
BWT(kg)	0.29	-0.01	-0.19	-0.12	0.29	-0.01	-0.19	-0.12
HL(cm)	-0.04	<b>0.70</b>	-1.11	-0.81	-0.04	<b>0.70</b>	-1.11	-0.80
HWD(cm)	0.16	0.06	0.48	0.45	0.15	0.06	0.48	0.45
EL(cm)	-0.17	-0.43	<b>0.80</b>	-0.13	-0.17	-0.43	<b>0.80</b>	-0.13
NL(cm)	-0.04	<b>0.70</b>	-1.11	-0.81	-0.01	<b>0.66</b>	<b>0.67</b>	0.10
NC(cm)	<b>0.89</b>	-0.98	-0.02	0.16	<b>0.89</b>	-0.98	-0.02	0.16
SW(cm)	0.46	0.55	0.33	-0.29	0.46	0.54	0.33	-0.29
HW(cm)	-0.17	0.05	0.12	-0.11	-0.17	0.05	0.12	-0.11
HG(cm)	0.09	-0.15	0.04	-1.61	0.09	-0.15	0.04	-1.61
BL(cm)	0.40	0.14	-0.64	1.87	0.39	0.14	-0.63	1.86
TL(cm)	0.16	0.06	0.48	0.45	-0.25	0.002	0.29	0.36

BWT = Body weight; HL = Head length; HWD = Head width; EL = Ear length; NL = Neck length; NC = Neck circumference; SW = Shoulder width; HW = Height at withers; HG = Heart girth; BL = Body length; TL = Tail length.

Figure 1 showed the canonical discriminant analysis to match the donkey strains into genetic groups (clusters). The three strains that is, red, black, white and brown were clustered or separated into separate groups while brown-white donkeys were also separated into another distinct group. The four strains were joined together by conceptual clustering that is, the points in a cluster shared some general property that derives from the

entire sets of points in the intersection of the circles belonging to each donkey strain. The implication is that, the greater the similarity (or homogeneity) within strain, the greater the differences between groups, the better or more distinct the clustering, and also the better the chances for selection.

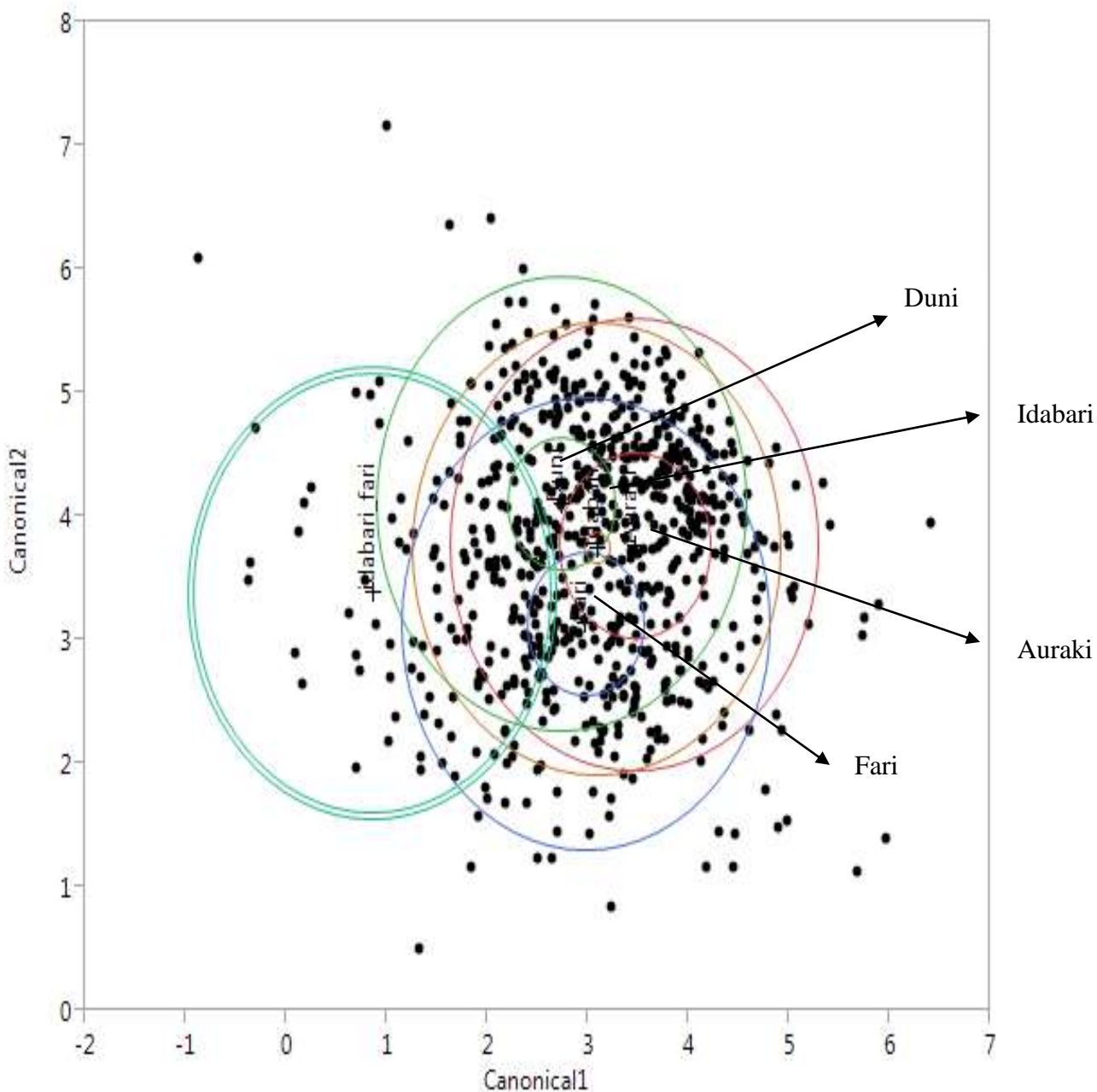


Figure 1: Canonical discriminant analysis to match the donkey strains into genetic groups (clusters).

**CONCLUSION AND RECOMMENDATION**

Black (Duni) donkey strains had more canonical weight on the generalized canonical component followed by Red (Auraki) and White (Fari) donkeys.

Idabari (Brown), Duni (Black), Fari (White) and Auraki (Red) donkeys showed closed genetic relationships among themselves compared to Idabari-fari (Brown-

white), which were distinct and farther away from the other strains.

It is therefore recommended that the neck circumference, shoulder width, head length, height at withers, heart girth and body length should be used as criteria for the classification of donkey strains because of their high canonical weight.

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