



MORPHOMETRIC CHARACTERIZATION OF DONKEYS IN SELECTED LOCAL GOVERNMENT AREAS OF BAUCHI STATE

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ABSTRACT

The study was conducted to examine morphometric and genetic characterization of donkeys (*Equus asinus*) in Bauchi State, Nigeria. A total of 498 donkeys were randomly sampled from five Local Government Areas in the State. Structured questionnaires were distributed to the owners to obtain information on location, gender, donkey types, specie and morphometric characteristics. Eleven morphometric parameters were analyzed; heart girth (HG), height at withers (HW), height at back (HB), height at croup (HC), body length (BL), cannon length front (LCF), cannon length hind (LCH), cannon circumference front (CCF), cannon circumference hind (CCH), Body weight (BW). The data generated were analyzed using descriptive statistic and analysis of variance (ANOVA). Result revealed that donkeys in the study area were categorized into eight different types based on colour pattern with Adabari (53.20 %) being the dominant, where high number was found in Gamawa (15.1 %) while Soro (6.0 %) had low of Adabari. Based on gender, males were 51.8 % while females 48.2 %, respectively. Danda donkeys was lower (0.8 %) in terms of population. Parameters observed in Adabari, Aura and others were age, HG, HW, HB, HC and BW were significantly ($P < 0.05$) higher. In conclusion, Addabari donkeys were found dominant in the study area while Danda is a rare type (0.8 %). The data for morphological features analyzed in this study can be regarded as a preliminary that was useful for genetic enhancement and would stimulate further studies on donkey species in the region.

Keywords: Body, length, colour, morphometric, conservation,

INTRODUCTION

Genetic variability is a major concern to define any livestock breed and to preserve the maximum amount of genetic diversity (Hassan *et al.*, 2013). It is important to characterize different breeds so that we can know how unique or different a breed is from other native populations. Phenotypic characterization is to answer questions on taxonomy, evolution, domestication processes, management of genetic resources and setting conservation plans for their effective utilization (FAO, 2007). In Nigeria, most of the conservation activities are restricted to a few breeds of livestock (Sanusi *et al.*, 2010). In comparison to other species, phenotypic characterization in cattle, sheep and goats is well documented in the literature. For donkeys, there is lack of information on their phenotypic as well as genetic characteristics (FAO, 2011). Donkeys have played an important role in the development of Nigerian livestock industry. They are used in transportation of people, carrying water from deep wells and rivers, and serve Fulani herdsman during seasonal migration (Hassan *et al.*, 2013). They were and still very important to the Northern part of the country. Donkeys



contribute considerably to the agricultural economy of the rural people mainly through their transport role; carrying loads and other forms of aid to man (Blench, 1999). In some places, donkeys are also used for farming and thus have become a necessity without which life would be very difficult (Sanusi *et al.*, 2010). Despite the great role being played hitherto, breed characterization of donkeys in Nigeria is absent. Their numbers are very small or totally absent in the tsetse dominated South-Western and South-Eastern zones of the country (RIM, 1992). In recent years; there is increasing interest in the use of donkeys in ceremonies, and as draft animals in Nigeria. In rural areas, donkeys are generally highly appreciated, but many people living in towns and cities seem to have a poor view of the donkey. Scholars have not given the attention the donkey deserves in terms of research and development; despite the very important role it plays in the socio-economic life of the Nigerian farming population. Breed characterization of donkeys in Nigeria is virtually absent. The present work intends to categorized our donkeys into various types (breeds) based on their phenotypic and basic genotypic characteristics. A set of 12 linear measurements for phenotypic characterization and microsatellite markers recommended by the International Society for Animal Genetics (ISAG) and FAO will be used (FAO, 2007). The result obtained will help to show the relationship between morphometric traits within a breed and between breeds. The result is needed for future genetic and molecular characterization for conservation of animal genetic resources (AnGR) in Nigeria. This study is therefore, aimed at categorizing donkeys into various breeds based on their phenotypic and genetic characteristics in Bauchi State, Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted at some selected Local Government Areas (Alkaleri, Bauchi, Ningi, Ganjuwa and Gamawa) in Bauchi State. The State is located in the North-East geopolitical zone of Nigeria and was created in 1976. It occupies a total land area of 49,119 km² (18,965 sq mi) representing about 5.3 % of Nigeria's total land mass and ranked 5th out of 36 states in terms of land size. The State is located between latitudes 9° 30' and 12° 30' North of the equator and between the longitudes 8° 50' and 11° 0' East of the Greenwich meridian. The State is bordered by seven States namely: Kano and Jigawa to the North, Taraba and Plateau to the South, Gombe and Yobe to the East and Kaduna to the West with a population of 4,653,066 according to 2006 census. Bauchi state span two distinctive vegetation zones namely Sudan and Sahel Savannah which covers the southern and northern part of the state. The Sudan vegetation gets richer and richer towards the south, especially along water sources and rivers, but generally the vegetation is less uniform and grasses are shorter than what grows even farther south. The rainfall in Bauchi ranges between 700 to 1,300 millimetres (28 to 51 inches) per annum. Consequently, rains start in April/May in the southern part of the state, where it is high and lasts longer. While it is hot and humid during the early part of the rainy season in Bauchi south, the hot, dry and dusty weather lingers up north. The range average daily temperature is 17 to 38 °C and average relative humidity ranges from 16.5 to 75 %, respectively (ATBIA, 2022)

Experimental Design

The study undertaken was exploratory since there is no reliable background information on the existence of breeds in the study areas.

Structured Questionnaire

The structured questionnaire administered had given us information about the site, location, dominant ecology, presence or absence of particular breeds and management practices.



Breed Productivity Information

The parameters were obtained by means of inspection of individuals within herd and flocks, and by the direct questioning and recall of the owner or herdsman.

Phenotypic Traits

The traits studied were those that can easily be measured as presented below:

Table 1: Phenotypic traits measured in donkeys

S/N	Measurement	Measuring device (cm)	Anatomical description
1.	Height at withers (HW)	Measuring stick	Distance from the highest point of the spinous process of the second to the sixth thoracic vertebrae to the floor
2.	Heart girth	Measuring tape	The circumference of the chest
3.	Height of back	Measuring stick	Distance from the deepest point of the back to the floor
4.	Height of croup	Measuring stick	Distance from rump (ilium) to the floor
5.	Body length	Metal measuring tape	Distance from most cranial point of the sternum to the most caudal point of the pin bone
6.	Body weight	Flexible Weighing tape (Kg)	Placed round the girth behind the forelimbs
7.	Age (year)	By dentition	
8.	Coat colour,	Colour guide	
9.	Sex	Physical assessment	Assessment of male and female reproductive organs

Live weight estimation of the West African donkeys was carried out using the monogram as per the procedures of (Pearson and Quassat, 1996; Svendsen, 2000).

Data collection

All animals were subjected to physical examination before biometrical evaluation. However, only apparently healthy animals were used for the research.

Statistical analysis

The data collected was analyzed using descriptive statistic and ANOVA.

The Generalized Correlation Equation Model

$$Y = C_0 + C_1x_1 + C_2x_2 + C_3x_3 + C_4x_4 + C_5x_5 + C_6x_6 + C_7x_7 + C_8x_8 + C_9x_9 + C_{10}x_{10} + C_{11}x_{11}$$

Or

$$Y = C_0 + C_1x_1 + C_2x_2 + \dots + C_{11}x_{11}$$

Or

$$Y = C_0 + \sum_{i=1}^{11} C_i x_i$$

Where Y= is the dependent variable (BW)

C_0 =is a constant

C_1, C_2, \dots, C_{11} = are the coefficients of the regression model

x_1, x_2, \dots, x_{11} = are the independent variables (sex, age, . . . , BL) of the regression model

RESULTS AND DISCUSSIONS

Distribution of Donkey Species by Location in Bauchi

Table 2, shows distribution of donkey type by location in Bauchi state, Nigeria. Adabari also called Idabari or Chilo species of donkeys has the higher number of 265 (53.2%)



mostly found in Gamawa and Alkalari, then followed by Aura species with 144 (28.9 %) commonly found in Maraba. The species of Danda, Fari, Kiyara and Akaza are having lower in numbers of single digit of 4, 5, 6 and 9 (0.8%, 1%, 1.2% and 1.8%) and rarely spread in all the locations.

Distribution of Donkeys Species by Sex in Bauchi State

Table 3, shows the distribution of donkey species by Sex in Bauchi State, Nigeria. Adabari also known as Idabari or Chilo and Aura species of donkeys has the higher in number of 265 (53.2 %) and 144 (28.9 %). The female donkeys are dominants (51.8 %) followed by male (48.2 %), respectively. The species of Danda, Fari, Kiyara and Akaza are lower with single digit of 4, 5, 6 and 9 (0.8%, 1%, 1.2% and 1.8%) in both Sex. The current study corroborates Nininahazwe *et al.* (2017) that there were more males (74%) than females. In addition, farmers buy donkeys which are ready to support traction.

Morphometric Characteristics of Donkeys

Table 4, presents three different species (Adabari, Aura and Others) of donkeys based on some common morphometric characteristics (Age, heart girth (HG), height at withers (HW), height at back (HB), height at croup (HC), body length (BL), cannon length front (LCF), cannon length hind (LCH), cannon circumference front (CCF), cannon circumference hind (CCH), Body weight (BW) along with their corresponding mean, standard error of mean (SEM), F-statistic and p-value. At 0.05 level of significance. There is no significant difference between/among the donkey species based on all the eleven (11) common morphometric characteristics with ($P > 0.05$). This may be due to unavailability of other species of donkeys in the study coverage, particularly the other species which comprise Duna (28), Fari (5), Jaba (18), Jangora (9), Kiyawa (6), Akaza (19) and Danda (4).

Inferential Statistics on Donkey Species and Gender with Morphometric Characteristics

Table 5, shows three different results of donkey species, gender and interaction of species and gender (species*gender). At 0.05 level of significance for species. There is no significant difference between/among the donkey species with all morphometric characteristics ($P > 0.05$). For gender, there is significant difference between male and female donkeys in Age with other species having the higher mean, HG with Aura species having the higher mean, HW with Aura species having the higher mean, HC with other species having the highest mean and BW with Aura species having the higher mean ($P < 0.05$). There is no significant difference in the remaining morphometric characteristics ($P > 0.05$). For interaction/association between donkey species and gender. There is significant association between donkey species and gender in LCH ($P < 0.05$). There is no significant interaction in the other morphometric characteristics ($P > 0.05$).

Table 2: Distribution of Donkey Species by Study Location in some Local Government Areas of Bauchi State

Species	Locations					Total
	Alkalari	Maraba	Gada	Soro	Gamawa	
Adabari	71 (14.3)	47(9.4)	42(8.4)	30(6.0)	75(15.1)	265(53.2)
Aura	27(5.4)	42(8.4)	32(6.4)	12(2.4)	31(6.2)	144(28.9)
Duna	0	6(1.2)	5(1.0)	1(0.2)	16(3.2)	28(5.6)
Fari	0	3(0.6)	0	1(0.2)	1(0.2)	5(1.0)
Jaba	0	2(0.4)	2(0.4)	1(0.2)	13(2.6)	18(3.6)
Jangora	1(0.2)	3(0.6)	4(0.8)	0	1(0.2)	9(1.9)
Kiyara	0	2(0.4)	0	4(0.8)	0	6(1.2)
Danda	1(0.2)	0	2(0.4)	0	1(0.2)	4(0.8)
Total	101(20.3)	108(21.7)	89(17.9)	52(10.4)	148(29.7)	498(100)



Table 3: Donkey Type with Morphometric Characteristics

Variables	Adabari	Aura	Others	df ₁ =2, df ₂ =495	
	Mean ± SEM	Mean ± SEM	Mean ± SEM	F-st	P-value
Age	2.96 ± 0.090	3.10 ± 0.130	3.37 ± 0.193	2.303	0.101
HG	104.37 ± 0.690	104.90 ± 0.783	102.10 ± 1.790	1.623	0.198
HW	95.51 ± 0.520	96.07 ± 0.589	96.07 ± 0.624	0.329	0.720
HB	103.71 ± 4.343	97.07 ± 0.837	97.54 ± 0.672	0.960	0.384
HC	100.25 ± 0.423	98.72 ± 1.046	100.40 ± 0.656	1.637	0.196
BL	109.84 ± 0.632	113.18 ± 4.294	111.31 ± 1.142	0.620	0.538
LCF	19.06 ± 0.459	18.51 ± 0.121	19.83 ± 1.654	0.649	0.523
LCH	22.54 ± 0.101	22.49 ± 0.156	22.81 ± 0.155	1.121	0.327
CCF	13.46 ± 0.083	13.53 ± 0.157	13.70 ± 0.111	0.880	0.415
CCH	14.44 ± 0.073	14.42 ± 0.122	14.62 ± 0.115	0.810	0.445
BW	113.81 ± 1.713	114.61 ± 2.192	110.17 ± 3.307	0.753	0.472

HG- heart girth, HW- height at withers, HB – height at back, HC – height at croup, BL- body length, LCF – cannon length front, LCH - cannon length hind, CCF - cannon circumference front, CCH - cannon circumference hind, BW- body weight, F st – F statistic, SEM – standard error of mean

Table 4: Inferential statistics on donkey species and gender with morphometric characteristics

Morphometric Characteristics	Species (df ₁ =2, df ₂ =492)		Gender (df ₁ =1, df ₂ =492)		Species* (df ₁ =2, df ₂ =492)	
	F-st	P-value	F-st	P-value	F-st	P-value
Age	2.272	0.104	26.472	0.0001	0.439	0.645
HG	1.688	0.186	13.710	0.0001	1.304	0.272
HW	0.358	0.699	14.674	0.0001	0.277	0.758
HB	1.036	0.356	0.137	0.712	0.977	0.377
HC	1.554	0.213	5.981	0.015	0.200	0.819
BL	0.660	0.518	1.012	0.315	1.380	0.253
LCF	0.561	0.571	2.051	0.153	1.335	0.264
LCH	0.941	0.391	0.205	0.651	3.969	0.020
CCF	0.839	0.433	0.171	0.679	0.984	0.375
CCH	0.845	0.430	1.573	0.210	0.843	0.431
BW	0.894	0.409	31.328	0.0001	1.046	0.352

HG- heart girth, HW- height at withers, HB – height at back, HC – height at croup, BL- body length, LCF – cannon length front, LCH - cannon length hind, CCF - cannon circumference front, CCH - cannon circumference hind, BW- body weight, F st – F statistic, SEM – standard error of mean



Table 5: Overall morphometric characteristics of various species of donkeys in Bauchi State, Nigeria (N=498)

Species	Adabari (284)		Aura (144)		Duna (4)		Danda (28)		Fari (5)	Jaba (18)		Jangora (9)		Kiyara (6)	
Sex Variable	M (132)	F (152)	M (71)	F (73)	M (2)	F (2)	M (16)	F (12)	M (5)	M (7)	F (11)	M (4)	F (5)	M (3)	F (3)
Age	2.7	3.4	2.7	3.5	1.5	3.0	2.7	3.3	3.8	2.6	4.4	3.0	3.4	2.7	3.0
(Mean±SEM)	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.5	0.4	0.4	0.5	0.5	0.5	0.2	0.3
HG	102.4	104.7	101.4	108.3	97.0	102.5	99.3	105.0	108.8	97.4	111.3	104.8	107.0	101.7	116.0
(Mean±SEM)	0.1	0.2	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.0
HW	94.2	96.8	94.2	97.9	90.0	92.5	94.2	96.3	97.2	92.0	98.7	97.8	98.8	100.0	98.3
(Mean±SEM)	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.0
HB	108.7	98.6	95.9	98.2	93.0	91.5	95.7	98.3	98.8	93.4	100.5	98.5	100.6	100.7	98.0
(Mean±SEM)	0.9	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.0
HC	99.0	101.3	98.0	99.4	95.5	95.5	98.8	101.1	101.6	96.0	103.5	100.5	102.0	103.7	103.3
(Mean±SEM)	0.1	0.1	0.1	0.2	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.0
BL	107.9	112.2	115.1	111.3	98.0	114.5	105.9	111.9	108.4	103.1	120.5	107.0	111.0	113.3	113.7
(Mean±SEM)	0.1	0.1	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0
LCF	18.9	19.1	18.6	18.5	17.0	19.5	18.1	18.0	17.6	18.1	32.4	18.5	18.8	18.3	16.3
(Mean±SEM)	0.3	0.4	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	1.4	0.0	0.1	0.0	0.1
LCH	22.7	22.4	22.6	22.3	23.0	23.0	22.4	23.3	21.6	22.6	23.9	21.8	22.8	22.7	22.3
(Mean±SEM)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.1
CCF	13.5	13.4	13.4	13.7	13.0	13.5	13.7	13.3	13.6	13.4	14.3	14.5	14.0	13.7	14.3
(Mean±SEM)	0.1	0.1	0.1	0.2	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1
CCH	14.4	14.5	14.2	14.6	14.5	14.5	14.4	14.2	15.2	14.3	14.9	15.5	15.6	15.0	13.7
(Mean±SEM)	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1
BW	107.8	117.4	104.8	124.2	91.4	106.5	98.2	116.4	125.3	93.0	132.6	112.4	119.2	104.0	147.7
(Mean±SEM)	0.2	0.3	0.2	0.2	0.1	0.2	0.2	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.1

HG- heart girth, HW- height at withers, HB – height at back, HC – height at croup, BL- body length, LCF – cannon length front, LCH - cannon length hind, CCF - cannon circumference front, CCH - cannon circumference hind, BW- body weight, F st – F statistic, SEM – standard error of mean

Table 6: Relationship among morphometric parameters of donkeys in Bauhi

Variables	BW	Sex	Age	HG	HW	HB	HC	BL
BW	1.000							
Sex	-0.252	1.000						
Age	0.626	-0.230	1.000					
HW	0.586	-0.187	0.533	0.483	1.000			
HB	0.141	0.043	0.040	0.120	0.187	1.000		
HC	0.552	-0.120	0.499	0.456	0.545	0.166	1.000	
BL	0.184	-0.044	0.194	0.152	0.148	0.034	0.149	1.000
P-value								
BW								
Sex	0.001							
Age	0.001	0.001						
HW	0.001	0.001	0.001	0.001				
HB	0.002	0.169	0.188	0.004	0.001			
HC	0.001	0.004	0.001	0.001	0.001	0.001		
BL	0.001	0.162	0.001	0.001	0.001	0.225	0.001	

HG- heart girth, HW- height at withers, HB – height at back, HC – height at croup, BL- body length, LCF – cannon length front, LCH - cannon length hind, CCF - cannon circumference front, CCH - cannon circumference hind, BW- body weight

CONCLUSION AND RECOMMENDATION

This is a first study focused on corporal observations of the phenotypic and morphometric characterization of donkeys in some selected Local Government Areas in Bauhi State- Nigeria. Adabari/Idabari donkey type is the dominant (53. 2 %) in term of population in the study area while Danda is the rare type (0.8 %), respectively. Our findings suggested that donkeys in these areas are of different Age, HG, HW, HB, HC, BL, LCF, LCH, CCH and BW and were found to be suitable and useful parameters to detect changes in certain morphological characteristics of donkeys.

These findings are preliminary data for a better understanding of the genetic variability of *Equus asinus* which would be useful for genetic enhancement. Meanwhile, further studies on the molecular genetic characterization would help in better understanding and identification of donkey breeds in Bauhi State- Nigeria.

REFERENCES

- Blench, R. M. (1999). Traditional livestock breeds: Geographical distribution and dynamics in relation to the ecology of West Africa. Working Paper 122, Overseas Development Institute Portland House Stag Place London, SW1E 5DP.
- Egwu, O. K. (2017). Assessment of trade donkeys and prevalence of Leptospirosis in slaughtered donkeys in some Southern states of Nigeria.
- FAO (2007). Global Plan of Action for Animal Genetic Resources and the Interlaken Declaration. Rome (available at <http://www.fao.org/docrep/010/a1404e/a1404e00.htm>).
- FAO (2011). Molecular genetic characterization of animal genetic resources. FAO Animal Production and Health Guidelines. No. 9. Rome. ISSN 1810-0708
- Hassan, M. R., Steenstra, F. A. and Udo, H. M. J. (2013). Paper Benefits of donkeys in rural and urban areas in Northwest Nigeria: *African Journal of Agricultural Research*: 8(48): 6202- 6212. Retrieved 29/09/2019 <http://www.academicjournals.org/>



- Hassan, W. A. and Bode, A. (1990). Camels and donkeys as pack and transport animals in Semi – Arid North – Western Nigeria. Presented at a conference in Bagauda Lake hotel, Kano, Nigeria.
- Nininahazwe, P. C., Sow, A., Roamba, R. C., Kalandi, M., Ahmed, H. D., Ouédraogo, G. A. and Sawadogo, G. J. (2017). West-African donkey's liveweight estimation using body measurements. *World Veterinary Journal*, **10**(12): 1-6.
- Pearson, R. A. and Quassat, M., (1996). Estimation of live weight and body condition of working donkeys in Morocco. *Vet. Record*, **138**: 229 – 233.
- RIM, (1992). Nigerian National Livestock Resource Survey (6 vol.). Report by Resource Inventory and Management Limited (RIM) to FDLPCS, Abuja, Nigeria.
- Sanusi M., Kalla, D. J. U., Zahraddeen, D., Mai, H. M., Abubakar, M. and Shuaibu, I. (2010). Survey of Donkeys in Nigeria: A case study of Ningi Local Government Area of Bauchi State. *Proceeding of the 6th International Colloquium on Working equids* organized by the Brooke at the India Habitat Centre, New Delhi, India 29th November – 2nd December, 2010. 100-106p.
- Svendsen, D. E., (2000). Donkeys abroad. In: Svendsen, D. E.(ed): The professional handbook of the donkeys (3rd ed). Whittet Books Limited, London 400p.