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Phenotypic Characterization of Donkey in the Northeastern Sahel Agro Ecological Zone of Nigeria

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Abstract

The phenotypic characterizations of the donkey in the Sahel agro ecological zone of Nigeria were assessed. A total number of 200 matured adult donkeys were sampled through stratified random samplings from donkey owners in some part of Borno and Yobe state and were used for phenotypic studies. The qualitative traits measured include, face profile, ear size, ear orientation, coat color, color pattern, hair type, fur distribution, udder size and teat size. Phenotypic body measurements evaluated include face length (FL), distance between the eyes (DBE), ear length (EL), neck length (NL), chest girth (CG), height at withers (HW), body length (BL), tail length (TL) and body weight. Data and qualitative traits were subjected to descriptive statistics such as means, percentages and frequencies. On the other hand, quantitative phenotypic data were subjected to analysis of variance (ANOVA) using the IBM SPSS (2021). Pearson correlation analysis was carried out on body weight and the phenotypic data to determine the correlation between various body parameters. The phenotypic of the donkey in the Sahel agro – ecological zone of Nigeria presents diversities in body weight and morphometric body measurements. Breed / ecotypes as well as location significantly ($p<0.05$) impacted body weight and body linear measurements of the donkey. The high positive and significant phenotypic correlations observed between body weight and some morphometric body parameters and among some morphometric body parameters may hold some significance for improvements in body weight and morphometric body measurements.

Keywords: Phenotypic, Donkey, Body measurement, Correlation. Qualitative traits

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1. Introduction

Donkeys play major role in the economy of developing countries by being the main source in transport and traction, particularly in areas with difficult reliefs [1]. The capacity and performance of donkeys could be assessed by the description of the morphological characteristics, such as chest girths, body length and height at wither [2]. Donkey, during domestication, some morphological and genetic changes took place in order to survive better in given conditions [3]. According to Fielding and Krause [4], donkeys adapt well to hot-dry desert environment through body temperature control, water metabolism, and special nutritional and anatomic features. Donkeys in the tropics are able to maintain homoeothermic by compensatory mechanisms in order to keep their physiological values within the established normal range [5]. The most limiting factor for survival in semi-arid and arid areas is during drought, that is, when water is not available. The presence of variations within and between different donkey's populations with respect to morphological, productive, adaptive and other characters may provide a basis for selection, for genetic improvement [6]. Thus, identifying unique characteristics, their variations between individual populations and can be used to understand donkey genetic resources and can be used for future genetic improvement and conservation [7]. The objective of the study was to provide the phenotypic characterization of the donkey in the Sahel agro ecological zone of northeastern Nigeria.

2. Materials and Methods

2.1. Location of the Study

This study was conducted in the Sahel agro-ecological zone of Nigeria. The Sahel agro-ecological zone comprises the following states in Northeast and some state in the Northwest of Nigeria: Borno and Yobe. The Sahel ecological zone is characterized by vast grassland and few trees. The temperature ranges from 33 ºC to 40 ºC and humidity percent ranging from 4 - 12% with annual average rainfall of 400 – 600mm [8].

2.2. Experimental Animals

Two hundred (200) mature donkeys were sampled through stratified random samplings from donkey owners in some parts of Borno and Yobe States and were used for phenotypic studies.

2.3. Data Collection

2.3.1. Discrete traits

The discrete/qualitative traits that were measured included: face profile, ear size, ear orientation, body color, color pattern, hair type, horn presence, fur distribution, udder size, and teat size. The donkey of each location was described in line with Food and Agricultural Organization [9] descriptor guidelines.

2.3.2. Body measurements

Body biometrical indices evaluated include Face length (FL), Distance between the ears (DBE), Ear length (EL), Neck length (NL), Height at withers (HW), Body length (BL), Tail length (TL) and Body weight (BW). Donkeys were measured in a standing position. Body weight and body measurements were measured using a specially designed tape (WE-BO MALEBAND®) graduated from 0 meters to 2.26 meters (0 - 226cm). Body weight was estimated by taking readings round the circumference of the chest girth. All morphometric measurements were measured according to FAO [9] phenotypic characterization guidelines.

1. Body length (BL): This was measured as the distance between the anterior part of the shoulder to the junction between the hip and the tail that is, the pin bone (ischium).
2. Height at withers (HW): This was measured from the highest point at the withers to the ground.
3. Heart girth (HG): This was measured as the circumference around the chest, just behind the front leg.
4. Back length (BkL): This was measured from the base of the withers to the base of the tail.
5. Neck length (NL): This was measured as the distance between the cranial edge of the atlas wings and the apex of the scapula.
6. Face length (FH): This was measured from the midline between the top of the occipital region and the tip of the nose.
7. Tail length: This was measured from the base of the tail to the end of the tail.

2.4. Data Analyses

All data on qualitative traits were subjected to descriptive statistics such as means, percentages and frequencies. On the other hand, quantitative phenotypic data were subjected to analysis of variance (ANOVA) SPSS version (21) release 2012. Pearson correlation analysis was conducted on the phenotypic data to determine the correlation between various body parameters.

3. Results and discussion

3.1. Results

3.1.1. Qualitative Traits of the Donkey

The qualitative traits and their distributions in the donkey of the Sahel agro-ecological zone of Nigeria are shown in Table 1. The face profile, ear size, ear orientation, color pattern, hair type, udder size, udder shape, number of teats and fur distribution have various distributions in the two locations of Borno and Yobe state. Among the three categories of the face profile, straight to concave face profile had the highest percent distribution of 59% while straight face had the lowest value of 16%. Medium ear size had the highest frequency (47%) while small ear size recorded the lowest value of 23%. Erect ear orientation recorded the highest frequency distribution (67.5%) while the lateral ear size had the lowest value of 3%. The grey coat color was most abundant (49.5%) while the white colored coat had the lowest distribution of 12%. Among the hair types, straight hair had the highest value of 53.5% while the sheen hair type was the least abundant (5.0%). The small and large udder size appeared to have nearly even distributions being 21% and 23% while the medium udder size had the highest distributions of 56% respectively. The predominant udder shape is the bowl udder with a frequency distribution of 76.03% while the funnel and cylindrical udder shapes are rare, being 12.4% and 11.57%, respectively. The whole-body fur distribution had a frequency distribution of 76.0% as against the 24% of not the whole- body fur distribution.

3.1.2. Ecotype (Breed) Distribution of Donkeys

Table 2 presents the distribution of the different ecotypes based on coat color. The grey ecotype with the total number of 80, representing 40% of the population is the most abundant followed by the red/rust ecotype which is 26% of the population. The white ecotype had the least number, being 26 and represents 13% of the population. The black ecotype had 21% of the population of the donkey in the two States.

3.1.3. Descriptive statistics of body Weight and Morphometric Traits of the Donkeys in Sahel Agro-ecological Zone of northeastern Nigeria

Table 3 presents the summary statistics of body weight and morphometric traits of donkeys in the study area. As expected, body weight had the highest mean value, followed by height at withers, body length, back length and chest girth. In terms of variability, distance between ears was most variable with coefficient of variability (CV) of 55.06%. This is followed by tail length, height at withers, neck length and foreleg length. Other parameters with coefficient of variation of more than 10 % include hind leg length, ear length, body weight and chest girth. The least variable body trait was back length body length and followed by face length in that order.

3.1.4. Relationship between Body Weight and Morphometric Traits of the Donkey

Table 4 presents the Pearson correlation coefficients among body weight and linear body measurements of donkeys in the study area. High and positive significant relationships were observed between foreleg length (FLL) and hind leg length (HLL) (r = 0.69**) and between Chest girth (CG) and height at wither (HW) (r = 0.63*). Moderate significant correlation was observed between ear length (EL) and distance between ear (DBE) (r = 40 **) while low but significant correlations were observed between BW and BL (r = 0.18*), BW and HW (r = 0.19*), BW and EL (r = 0.18 *), BL and BKL (r = 0.16 *), BL and FL (r = 0.20 *), HW and BKL (r = 0.14 *), NKL and TL (r = 0.18 *), NKL and FL (r = 0.18 *), TL and FLL (r = 0.25**), TL and HLL (r = 0.15**), TL and FL (r = 0.22**) and between EL and BKL (r = 0.19 **). Negative low significant ($p < 0.01$) correlation was

recorded between TL and BKL (r = - 0.17*), EL and HLL (r = - 0.14*) and DBE and BKL (r = - 0.23**).

3.2. Discussions

3.2.1. Qualitative Traits of the Donkey

The high distribution of the straight to concave face profile recorded in this study is as also reported by [10-12]. The distribution of the medium ear size as reported in the present study is in consonance with the findings of [11-13]. The erect ear orientation with the highest distribution is as earlier reported by [14]. Variation in qualitative body parameters could be used for breed classification. The highest distribution of the grey observed coat color in all the locations is in line with the findings of Khaleel *et al*. [15] and Mustefa *et al.* [11] who reported variation in donkey coat color distribution. Mustapha *et al.* [11] reported preponderance of the plain color pattern in their studied population similar to what has been reported in the present study. These results agree with those of previous researches [16]. The observation of varied coat colour may be a sign of within population diversity in interbreeding with sub – populations. Generally, the grey coat colour which had the dominant occurrence may relate to the presence of dominant dun allele causing strong dilution of the pigmentation in the population [13].

3.2.2. Ecotype/Breeds Distribution

The grey ecotype/breed donkey in the Sahel agro-ecological zone of Nigeria are the most abundant donkey which is usually referred to as the normal donkey in the both location studied, thus agreeing with the findings of others [10-15-17-18]. Brown plus white strain of donkey however were observed to be predominant among Algeria donkeys [19]. Getachew *et al.* [12] observed Roan coat color as dominating among southern Ethiopia donkeys. The grey (*Idabari)* had the most predominant coat color in Kenya just as in the present study [20]. The reasons for abundance of grey donkey in the study area may be as a result of their ability to carry load to long distance as compared to the other breeds, or their high market price, their greater adaptation to the Sahel as compared to the other ecotypes. Blench *et al.* [21] reported that the grey (*Idabari*) donkey had a stronger body that can carry heavier load than other breed of donkey.

3.2.3. Body Weight and Linear Body Measurements

The mean value of body weight obtained in the present study was higher than the findings of John *et al*. [13] in north western Nigeria. The highest body weight recorded by Ayad *et al*. [19] is similar with the present findings. Hannani *et al*. [22] obtained lower body weight (158.83kg) as compared with the present findings. The variation in body weight may be due to breeds, age, and location and also due to geographical location of the studies. The body weight had the lowest standard deviation and variance which indicated that the traits are clustered tightly around the mean in the study area, or the values were not that extreme in the study area. The mean value of body length obtained in the present study is lower than the results obtained by [12-13-23]. However, it is higher than the values obtained by Khaleel *et al*. [15] and Mustefa *et al*. [11]. The body length obtained in the present study is within the range reported by Getachew *et al*. [12] in comparison of some morphometric measurements of donkeys from central Kenya and different parts of the world. Body length is correlated with body weight therefore variation in body length is expected to be reflected in body weight. The mean value of chest girth obtained in the present study is lower than the results obtained by John et al. [13]: Mustefa et al. [11] and Getachew et al. [12]. This may be as a result of the different geographical distribution and genotypes of donkeys used for the study. The values obtained in the present study is within the range reported by Pearson and Quassart [24] and Aluja *et al*. [25]. The mean value of height at wither obtained in the present study agreed with the findings of Orhan and Mehmet [10], Khaleel *et al* [15] and Mustefa *et al.* [11] although it is slightly higher than the values obtained by previous study [13]. The height at wither obtained in the present study is generally within the range earlier reported by Pearson and Quassart [24], Orhan and Mehmet [10], Aluja *et al*. [25] and Getachew *et al.* [12]. The mean value of neck length obtained in the present study agreed with the findings of Ayad *et al.* [19] in Algerian donkey and Mustefa *et al*. [11]. However, the values obtained in the present study are lower than the values obtained by [12]. The mean value obtained in the present study are higher as compared to the values obtained by John *et al*. [13] for donkeys of north west Nigeria. The value of tail length obtained in the present study were lower as compared to the findings of John *et al*. [13] in some locations while other location the present findings was higher. On the whole, the present findings obtained higher mean value as compared with [15]. The mean value of ear length obtained in the present study agreed with the findings of [11]. However, it is lower than the results obtained by [12]. The present findings are higher as compared with the findings of John *et al*. [13] and Ayad *et al*. [19], Khaleel *et al*. [14] obtained a higher value of ear length as compared with the present findings. The front leg length and the hind leg length obtained in the present study were above the values obtained by [14]. There existed positive and significant relationship between the two. The mean value of back length obtained in the present study was above the values obtained by Ayad *et al.* [18] and Getachew *et al*. [12] in Ethiopia and below the mean value obtained by John *et al.* [13] in Nigeria.

The present study obtained back length higher than the results obtained by [11-26]. The mean value of face length obtained in the present study agreed with the findings of [18]. Lower values were obtained by Khaleel et al. [14] as compared with the present study while Getachew *et al.* [12] obtained values above the present study. This agreed with the findings of the previous studies [14]. On the general note variations obtained in linear body measurements may be because of genotypes of donkey and also as a result of different geographical distribution. The high coefficient of variation recorded for distance between the ears shows that distance between the ears was the most variable attributed among the morphometric traits. Other morphometric traits such as tail length, height wither, neck length and foreleg length with sufficient variations as revealed by their coefficient of variation go to reveal phenotypic diversity in the studied population. Such diversities could be leveraged for selection for improvement. The significant variations ($p< 0.05$) in body weight (BW), ear length (EL), Foreleg length (FLL), hind leg length (HLL) and back length (BKL) among the various ecotypes agreed with the findings of John *et al*. [13] who worked with donkeys in northwestern Nigeria.

Table 1: Distribution (%) of Qualitative Traits in the Donkey Population in the Sahel Region of Nigeria (N = 200)

Qualitative traits	Category	Number of Observation	Percent distribution
Face profile	Straight	36	18.0
	Straight to Concave	117	58.5
	Convex	47	23.5
Ear size	Small	46	23.0
	Medium	94	47.0
	Large	60	30.0
Ear ;2orientation	Erect	135	67.5
	Dropping	59	29.5
	Lateral	05	3.0
Coat colour	Red/rust	41	20.5
	Black	36	18.0
	White	24	12.0
	Grey	99	49.5
Colour pattern	Plain	135	67.5
	Patchy –pied	16	8.0
	Spotted	49	24.5
Hair type	Glossy	54	27.0
	Curly	35	17.5
	Straight	107	53.5
	sheen	04	2.0
Udder size	Small	26	21.48
	Medium	67	55.37
	Large	28	23.15
Udder shape	Funnel	15	12.4
	Bowl	92	76.03
	Cylindrical	14	11.57
Fur distribution	Whole – body	152	76
	Not whole – body	48	24

Table 2: Distribution (%) of Various Ecotypes/Breeds of Donkey in Borno and Yobe States of Nigeria

Ecotype/Breed	No of observations			
		Locations		
		Borno	Yobe	% Distribution
Grey	80	46	34	40
Red/rust	52	27	25	26
Black	42	20	22	21
White	26	06	20	13

Table 3: Descriptive Statistics of Body Weight and Morphometric Traits of Donkey in the Sahel Agro-ecological Zone of Nigeria

Traits	Min	Max	Range	Mean	Variance	Standard deviation	Cv (%)
BW (kg)	109	260	151	176	1.13	1.06	11.41
BL (cm)	82	124	42	99	152.5	31.62	6.19
CG (cm)	52	118	66	85	84.87	9.21	10.20
HW (cm)	82	121	39	102	76.00	8.77	16.02
NKL (cm)	36	56	20	48	65.31	8.08	15.38
TL (cm)	22	69	47	55	72.61	8.52	19.16
EL (cm)	22	35	13	25	151.71	12.31	11.28
DBE (cm)	10	14	04	12	8.81	2.96	55.06
FLL (cm)	43	90	47	67	115.76	6.99	13.28
HLL (cm)	43	92	49	74	92.65	18.75	11.52
BKL (cm)	82	117	35	98	65.72	8.10	4.52
FL (cm)	38	60	22	47	24.31	4.93	7.85

Where: min = minimum values, max = maximum values and CV = coefficient of variation, BW=body weight, BL= body length, CG=chest girth, HW=height at wither, NKL= neck length, TL= tail length, EL= ear length, DBE= distance between ear, FLL= fore leg length, HLL=Hind leg length, BKL= back length and FL= face length.

Table 4: Pearson Correlation Coefficients among Body Weight and Morphometric Body Measurements of Donkey in Sahel Agro-ecological Zone of Nigeria

	BW	BL	CG	HW	NKL	TL	EL	DBE	FLL	HLL	BKL	FL
BW	1											
BL	0.18*	1										
CG	0.17	0.77	1									
HW	0.19*;8	0.18*	0.63*	1								
NKL	0.06	-0.10	0.20*	0.54	1							
TL	-0.08	0.10	0.10	;80.55	0.18*	1						
EL	0.18**	-0.53	0.09	0.;280	0.52	10.70	1					
DBE	0.55	0.85	0.91	0.84	0.57	-0.10	0.40**	1				
FLL	0.09	-0.10	0.32	0.76	0.68	0.25**	-0.13	0.13	1			
HLL	0.29	-0.62	0.10	0.83	0.86	0.15**	-0.14*	0.17*	0.69**	1		
BKL	0.19	0.16*	0.85	0.14*	0.78	-0.17*	0.19**	0.46	-.23**	0.32	1	
FL	0.68	0.20**	0.20*	0.11	0.18*	0.22**	0.52	0.53	0.75	0.10	0.61	1

Where: BW= body weight, BL = body length, CG= chest girth, HW= height at wither, NKL= neck length, TL= tail length, EL= ear length, DBE= disance between ear, FLL= fore leg length, HLL = hind leg length, BKL= back length, FL = face length. * = significant ($p<0.05$) ** highly significant ($p<0.01$).

The white donkey in the study area which had the longest for ear length is not in consonance with the findings of Mustefa *et al.* [11] who obtained lower value for ear length in white donkey. Observed variation may be as a results of different environmental conditions, managements and location. Black donkey had highest fore leg length and hind leg length that significantly differed ($p < 0.05$) from other ecotypes which agreed with reports of [14] also reported ecotype/breed effect on morphometric measurements of donkeys**.** In general, variation in linear body parameters among genotypes could be due to their distribution in different geographical locations in addition to genetic differences.

3.2.4. Phenotypic Relationships

The high positive and significant phenotypic correlations observed between body weight and some morphometric body parameters and among some morphometric body parameters may hold some significance for improvements in body weight and morphometric body measurements. Given the general similarity between genetic and phenotypic correlation, phenotypic correlations may be

substituted for genetic correlation when genetic correlation are unavailable or not precisely estimated [27]. Thus, when reliable genetic estimates are unavailable phenotypic correlation may be substituted for their genetic counterparts in evolutionary models of phenotypic evolution [27]. Following from the foregoing argument, the significant positive and strong phenotypic correlation may imply that as one trait increase, the other which are positively correlated with it also increase. Consequently, improvement in body weight will lead to improvement in chest girth, height at wither and fore/ hind leg length or vice versa. Conversely, the negative phenotypic correlation observed among some body parameters may mean that increase in one may lead to concomitant decrease in the other. This knowledge may be important in deciding the traits that can be combined together in any selection program for improvement in body weight and body parameters of the donkey.

4. Conclusions

The phenotype of the donkey in the Sahel agro-ecological zone of the northeastern Nigeria presents diversities in body weight and morphometric body measurements. Breed/ecotypes as well as location significantly ($p<0.05$) impacted body weight and body linear measurements of the donkey.

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