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Characterization of Young Donkeys in North West Nigeria using Morphometric Traits

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Target Audience: Animal conservationists; Animal Breeders; Geneticists; Extension Agencies

Abstract

Morphometric traits were used to determine the relationship among Red (Auraki), Black (Duni), White (Fari), Brown (Idabari) and Brown-white (Idabari-fari) for young donkeys. A total of 210 young donkeys were used for the study. Morphometric 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 statistical analysis to determine the distribution of phenotypic traits across classes based on morphometric traits. The effect of strain, sex, location and interaction on certain linear body measurements were estimated using the GLM procedure of the statistics analysis software SAS statistical package. There were variations in the morphometric traits of the donkeys due to strain, sex and location effects with white donkeys exhibited the heaviest body weight (126.78kg) for young donkeys from Kaduna state while the least body weight (98.89±6.68cm) was recorded in Fari strain of donkey from Katsina state. The coefficient of variation was fairly uniform at the young stage except shoulder width (13.0%) and tail length (14.8%) which were moderate. Sexual dimorphism exist in the body size measures of donkeys with females having heavier body weight (120.7kg) and larger heart girth (106.2cm). Zoometric phenotypic differentiations exist among the observed strains of donkeys in the Northwestern Nigeria. Further studies should be carried out on molecular studies for determination of diversity that exists among young donkey strains.

Key words: Donkey, morphometric, characterization, traits, young and body measurement

Description of problem

Characterization of livestock genetic resources is the first step to sustainable use (1). According to the (2), the global strategy involves identifying and understanding the unique genetic resources in a particular region and developing the proper use of the

diversity (3). Diversity is fully elucidated through characterization. At phenotypic level, using conventional and non-conventional body parameters (4), linear body measurements can be taken and statistically translated into breeding value (5). These breeding values are applied to production traits and use in breeding profitable herd through selection. (6) also stated that morphometric measurements are applied to evaluate the characteristics of various breeds of animals and thus provide information on their suitability for selection. (7) further asserted that body measurements could objectively improve selection for growth by enabling breeders to recognize early and late maturing animals of different sizes. Characterization of donkeys would therefore provide information that would be useful in decision making on development and breeding programmes for these strains and, their effective utilization. It would also enable the design of suitable production equipment for the strains. Furthermore, characterization would provide inventory for research institutes, academics, breeders and traditional donkey owners. The objective of this study was to determine the relationships that exist amongst traits of young donkeys in North West Nigeria using morphometric traits.

Materials and Methods

Two hundred and ten (210) young donkeys were sampled from Sokoto, Jigawa, Kano, Katsina, Kaduna, Zamfara and Kebbi State. 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. Donkeys within the age group of 1 to 3 years were classified as young. The age of the donkeys were determine using teeth count in combination with the information provided by the donkey owners. A total of 10 young donkeys were sampled each from the three senatorial zones, making a total of 30 donkeys in each of the seven (7) State using random sampling technique.

Body measurements of two hundred and ten (210) young donkeys of various strains were taken for phenotypic characterization. The morphometric traits were determined using body measurement.

Reference marks for body measurement according to the method of Searle *et al*., (8) and Salako (6).

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 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

For descriptive statistics, frequency counts and Chi Square test of SAS (9) were used. General Linear Model procedure of (9) was used to analyze the effect of sex, location, strain and interactions as shown in the model below:

$$Y_{ijkl}=\mu+S_i+L_k+V_l+(V\times S)_{li}+(L\times V)_{kl}+\varepsilon_{ijkl}$$

Where Y_{ijkl}=observation of each trait of the ij^{th} Animal.

μ= population mean

S_i=fixed effect of the i^{th} sex (males and females)

L_k=effect of k^{th} location (Kaduna, Kano, Kebbi, Katsina, Sokoto, Jigawa and Zamfara State)

V_l= fixed effect of l^{th} strain (Auraki, Fari, Duni and Idabari)

$V\times S_{(li)}$= The effect of interaction of l^{th} level of strain, with i^{th} level of sex

$L\times V_{(kl)}$= The effect of interaction of k^{th} location, with l^{th} level of strain.

ε_{ijkl}= residual error

Anova analysis of morphometric traits

The effect of strain, sex, location and certain morphological traits on linear measurement were estimated using the GLM procedure of the statistics analysis software SAS (9) statistical package. These were computed on the basis of interaction with age groups. Statistical significant means were separated using Duncan Multiple Range Test (10).

Results and Discussion

The morphometric characterization of donkeys in Northwestern zone is presented in table 1. The table defined 11 measures of growth in young donkeys encompassing body weight, head length, head width, ear length, neck length, neck circumference, shoulder width, height at withers, heart girth, body length and tail length. Generally, there were inconsistencies in the variations within the measures of growth. Body weight was low at the young (9.4%) stage. The variations in some of the measures were generally low, decreasing as the animals matures with the exception of shoulder width (13%) and tail length (14.8%). Patterns of growth of body parts based on age

have been highlighted by (11); they stated that body parts developed at a different rate at different age groups. Some morphometric parameters were early maturing and stopped growing before others.

Table 1: Within age group morphometric characteristics of donkeys

Characteristics	Young (N=210)	CV%
BWT(kg)	115.0±0.75	9.4
HL(cm)	45.3±0.19	5.9
HWD(cm)	13.9±0.09	9.1
EL(cm)	24.2±0.08[b]	4.7
NL(cm)	44.1±0.20	6.7
NC(cm)	57.8±0.30	7.6
SW(cm)	20.8±0.19	13.0
HW(cm)	100.1±0.19	2.8
HG(cm)	105.1±0.29	3.9
BL(cm)	101.9±0.28	4.0
TL(cm)	52.8±0.54	14.8

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, CV; Coefficient of variation, %; percent, N; Number.

The effect of strain on morphometric characteristics of young donkeys are presented in Table 2. The effect of strain on morphometric traits of young donkeys was significant (PƐ0.01). The effect of Strain on morphometric traits of young donkeys showed that the body weight and linear body measurements were not significantly affected by strain(PƐ0.05) except for neck length and tail lengths (PƐ0.01). Young donkeys with longer neck length were observed in red (46.5±1.50cm) and black (46.4±0.84cm) donkeys. The shorter neck length was observed in white (42.8±1.22cm) donkeys. Longer tail length (63.0±2.00cm) was observed in red donkeys while shorter tail length was observed in white (49.9±2.77cm) donkeys and brown (52.7±0.58) young donkeys. Values of 111-132 Kg reported by (12) were higher to the values obtained in this study in young donkeys. Where differences in age is not so large, morphometric traits were quite similar especially for length wise traits in this study for young.

Table 2: Effect of strain on morphometric characteristics of young donkeys

Young	210	Red (N=2)	Black (N=13)	White (N=9)	Brown (N=186)	Brown-white	SEM	LOS
BWT(kg)		118.8±0.84	115.7±1.85	112.3±5.49	115.1±0.79	-	4.88	NS
HL(cm)		46.0±1.00	46.3±0.47	44.0±1.29	45.2±0.19	-	1.19	NS
HWD(cm)		14.5±0.50	14.1±0.18	13.6±0.44	13.8±0.09	-	0.57	NS
EL(cm)		24.5±0.50	24.1±0.24	23.9±0.51	24.2±0.08	-	0.51	NS
NL(cm)		46.5±1.50[a]	46.4±0.84[a]	42.8±1.22[b]	43.9±0.21[ab]	-	1.30	**
NC(cm)		58.0±2.00	58.4±1.11	58.1±1.24	57.7±0.33	-	1.98	NS
SW(cm)		21.5±1.50	20.7±0.72	19.6±1.11	20.8±0.19	-	1.21	NS
HW(cm)		101.5±0.50	100.8±0.80	99.2±1.49	100.1±0.20	-	1.27	NS
HG(cm)		105.5±0.50	105.5±0.90	104.3±1.74	105.1±0.31	-	1.89	NS
BL(cm)		103.5±0.50	102.8±0.69	101.1±2.38	101.9±0.29	-	1.84	NS
TL(cm)		63.0±2.00[a]	55.2±1.61[ab]	49.9±2.77[b]	52.7±0.58[b]	-	3.47	**

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, **PƐ0.01, NS: Not significant, SEM= Standard Error Mean, LOS= Level of significance, ab; Means with different superscripts along same row shows significant differences (PƐ0.01).

The effect of sex on morphometric traits of young donkeys are indicated in Table 3. Sex of young donkeys affected (pƐ0.01) Body length (BWT), head length (HL), ear length (EL) neck circumference (NC), height at wither (HW), heart girth (HG) and tail length (TL). Other morphometric traits were however not affected by sex (pƐ0.05). The female young donkeys were superior for BWT (120.19±2.24kg), HW (100.83±0.60cm), HG (106.26±0.89cm) while the male young donkey were superior for HL (45.99±0.55cm), EL (24.24±0.23cm), NC (58.73±0.94cm) and TL (55.34±1.49cm). The sex differences obtained in the morphometric traits of donkeys could be attributed to sexual dimorphisms (13). (14) reported that Males had a longer head than females, in a similar way to that found by other authers in saddle-house breed (15).

Table 3: Effect of sex on morphometric traits of young donkeys

Age group/traits	N	Male	Female	Overall	SEM	LOS
Young (N=210)						
BWT (kg)	210	113.0±2.24^{b}	120.1±2.24^{a}	115.02	0.75	**
HL (cm)	210	45.9±0.55^{a}	45.4±0.56^{b}	45.26	0.19	**
HWD (cm)	210	14.2±0.25	14.1±0.26	13.85	0.09	NS
EL (cm)	210	24.2±0.23^{a}	23.8±0.23^{b}	24.15	0.08	**
NL (cm)	210	44.8±0.64	45.1±0.65	44.98	0.20	NS
NC (cm)	210	58.7±0.94^{a}	57.0±0.95^{b}	57.90	0.30	**
SW (cm)	210	21.3±0.49	21.4±0.49	20.75	0.19	NS
HW (cm)	210	100.3±0.59^{b}	100.8±0.60^{a}	100.14	0.19	**
HG (cm)	210	105.0±0.88^{b}	106.2±0.89^{a}	105.06	0.29	**
BL (cm)	210	102.7±0.88	103.1±0.89	101.92	0.28	NS
TL (cm)	210	55.3±1.49^{a}	53.8±1.52^{b}	52.81	0.54	**

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, **PƐ0.01, NS: Not significant at P>0.05, SEM= Standard Error of Mean, LOS= Level of significance, ab; Means with different superscripts along same row shows significant differences (PƐ0.01).

The effect of location on morphometric traits of young donkeys is shown in table 4. For young donkeys, all the biometric traits were significantly affected (PƐ0.01) by location. The heaviest body weight was recorded on young donkeys sampled from Kano (118.68±2.77kg), Kebbi (119.03±2.81kg), Sokoto (115.17±2.50kg) and Zamfara (118.40±2.81kg) states.Whereas, the least body weight was recorded for young donkeys in Kaduna (102.44±2.74kg). The head length (HL) of young donkeys in Kaduna (47.27±0.69cm) was the longest while the shortest head length was recorded by young donkeys in Kano (44.46±0.69) and Sokoto (44.48±0.63) states. The widest head width (HWD) in young donkeys was recorded from Kebbi (15.27±0.32cm) state while the least value for HWD was recorded in Jigawa (13.66±0.32cm), Kano (13.49±0.32cm) and Sokoto (13.67±0.29cm) states. Ear length (EL) was longest in young donkeys sampled from Kaduna (24.86±0.28cm) state whereas the shortest EL were recorded from Jigawa (23.64±0.28cm) and Kano (23.34±0.29cm) states. The longest neck length (NL) for young donkeys sampled were observed in Jigawa

Table 4. Effect of location on morphometric traits of young donkeys

Traits	Jigawa	Kaduna	Kano	Katsina	Kebbi	Sokoto	Zamfara	Overall mean	SEM	LOS
BWT(kg)	109.6±2.73^{b}	102.4±2.74^{c}	118.6±2.77^{a}	114.7±2.59^{ab}	119.0±2.81^{a}	115.1±2.50^{a}	118.4±2.81^{a}	115.02	0.75	**
HL(cm)	45.3±0.69^{bc}	47.2±0.69^{a}	44.4±0.69^{c}	45.2±0.65^{bc}	46.7±0.71^{b}	44.4±0.63^{c}	46.4±0.71^{b}	45.26	0.19	**
HWD(cm)	13.6±0.32^{d}	14.3±0.32^{c}	13.4±0.32^{d}	14.1±0.29^{c}	15.2±0.32^{a}	13.6±0.29^{d}	14.6±0.32^{b}	13.85	0.09	**
EL(cm)	23.6±0.28^{e}	24.8±0.28^{a}	23.3±0.29^{e}	23.7±0.27^{e}	24.2±0.29^{bc}	24.6±0.26^{b}	23.9±0.29^{d}	24.15	0.08	**
NL(cm)	45.3±0.79^{a}	45.2±0.80^{a}	44.4±0.81^{b}	43.9±0.76^{c}	45.2±0.82^{a}	45.3±0.73^{a}	45.2±0.82^{a}	44.98	0.20	**
NC(cm)	55.5±1.16^{b}	59.4±1.17^{a}	57.0±0.18^{ab}	57.4±1.10^{ab}	57.7±1.19^{ab}	58.9±1.07^{a}	59.20±1.19^{a}	57.90	0.30	**
SW(cm)	22.2±0.61^{c}	21.2±0.61^{c}	20.7±0.61^{d}	21.8±0.57^{c}	23.4±0.62^{a}	17.8±0.56^{e}	22.52±0.62^{b}	20.75	0.19	**
HW(cm)	98.4±0.74^{c}	101.9±0.74^{a}	101.0±0.75^{a}	99.7±0.69^{c}	101.6±0.76^{a}	100.6±0.68^{b}	100.5±0.76^{b}	100.14	0.19	**
HG(cm)	103.3±1.09^{d}	106.8±1.09^{b}	107.2±1.10^{a}	104.5±1.03^{c}	106.0±1.12^{ab}	104.5±0.99^{c}	106.8±1.12^{b}	105.06	0.29	**
BL(cm)	101.4±1.09^{b}	104.8±1.09^{a}	103.5±1.10^{a}	101.8±1.03^{b}	104.6±1.12^{a}	101.0±0.99^{b}	103.3±1.12^{ab}	101.92	0.28	**
TL(cm)	51.9±1.86^{c}	47.8±1.87^{d}	51.2±1.89^{c}	55.9±1.76^{b}	57.9±1.91^{b}	58.6±1.70^{a}	58.5±1.91^{a}	52.81	0.54	**

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, **PЄ0.01, SEM= Standard Error Mean, LOS= Level of significance, abc; Means with different superscripts along same row shows significant differences (PЄ0.01).

Table 5: Effect of strain and sex (interaction) on biometric traits of young donkeys

Strain	Sex	BWT(kg)	HL(cm)	HWD(cm)	EL(cm)	NL(cm)	NC(cm)	SW(cm)	HW(cm)	HG(cm)	BL(cm)	TL(cm)
Idabari	Male	111.3 ± 0.99^{b}	45.6 ± 0.25^{a}	13.8±0.11	24.3 ± 0.11^{a}	43.7±0.29	58.6 ± 0.43^{a}	20.7±0.21	99.9 ± 0.26^{b}	104.3 ± 0.40^{b}	101.6±0.38	53.5 ± 0.65^{a}
	Female	118.2 ± 0.97^{a}	44.8 ± 0.24^{b}	13.7±0.11	24.0 ± 0.10^{b}	44.1±0.29	56.7 ± 0.42^{b}	20.7±0.21	100.2 ± 0.26^{a}	105.5 ± 0.39^{a}	101.8±0.37	52.0 ± 0.64^{b}
	Overal l mean	115.02	45.26	13.85	24.15	44.98	57.90	20.75	100.14	105.06	101.92	52.81
	SEM	0.75	0.19	0.09	0.08	0.20	0.30	0.19	0.19	0.29	0.28	0.54
	LOS	**	**	NS	**	NS	**	NS	**	**	NS	**

BWT: Body weight; HL: Head length; HD: Head width; EL: Ear length; NL: Neck length; NC: Neck circ umference; SW: Shoulder width; HW: Height at withers; HG: Heart girth; BL: Body length; TL: Tail length, **PƐ0.01, NS: Not significant difference at P>0.05, SEM= Standard Error of Mean, LOS= Level of significant, ab; Means with different superscripts along same row shows significant differences (PƐ0.01).

(45.36±0.79cm), Kaduna (45.26±0.80cn), Kebbi (45.29±0.82cm), Sokoto (45.36±0.73cm) and Zamfara (45.28±0.82cm) states. Neck circumference (NC) was wider in young donkeys from Kaduna (59.41±1.17cm), Sokoto (58.92±1.07cm) and Zamfara (59.20±1.19) states while the least was recorded in Jigawa (55.58±1.16cm) state. Generally, the young donkeys from Kebbi state had the highest values for shoulder width (23.42±0.62cm), height at wither (101.9±0.76cm) and body length (104.61±1.12cm). However, the height at wither of young donkeys from Kaduna state was similar (PƐ0.05) to those from Kebbi. Body length of young donkeys from Kebbi state was also similar (PƐ0.05) to those from Kaduna (104.89±1.09cm). The longest Tail length (TL) were recorded in Sokoto (58.65±1.70cm) and Zamfara (58.56±1.91cm) states while the shortest TL was observed in Jigawa (51.99±1.86cm) and Kano (51.20±1.89cm) states. The result of this study showed significant differences among donkeys across the seven (7) locations in Northwest Nigeria. This is not in agreement with the report of (16) who reported that the frame size of donkeys in Western Zimbabwe resembles donkeys elsewhere in Africa.

The effect of strain and sex interaction on morphometric traits of young donkeys are revealed in Table 5. The body weight (BWT), head length (HL), ear length (EL), neck circumference (NC), height at wither (HW), heart girth (HG) and tail length (TL) were significantly affected (PƐ0.01) by strain and sex interaction. Other morphometric traits were however not affected (PƐ0.05). Male Idabari had the highest values for HL (45.60±0.25cm), EL (24.30±0.11cm), NC (58.63±0.43cm) and TL (53.58±0.65cm) than females. The report of this study is not similar to the findings of (17) who reported that there were no significant differences in body sizes between male and female donkeys, although males tended to be taller than their female counterparts. The heavier body weight and larger heart girth in female brown (Idabari) donkeys could be attributed to pregnancy.

The effect of location and strain interaction on morphometric traits of young donkeys are shown in Table 6 (a and b). The results showed that all the traits (body weight and body linear measurements) were significantly affected (PƐ0.01) by location and strain interaction. Fari strain of young donkey from Kaduna state recorded the biggest body weight (126.78±5.79kg) while the least body weight (98.89±6.68cm) was recorded in Fari strain of donkey from Katsina state. The longest head length (46.82±0.45cm) was observed in Idabari strain from Kaduna state. However, the shortest HL (42.00±1.68cm) was observed. Wider HWD were recorded in Fari (15.00±0.68cm) strain from Kaduna and Idabari (14.94±0.24cm) strain from Kebbi State. Smallest HWD was recorded in Fari (13.00±0.79cm) from Katsina State. Longest EL was obtained in Idabari (24.93±0.20cm) strain from Kaduna State while the shortest was obtained in Duni (23.25±0.58cm) from Jigawa State. The young donkey with the longest NL was observed in Duni (47.12±1.58cm) from Jigawa State. Shortest NL was observed in Fari (42.00±2.00cm) strain of young

donkeys from Katsina State. Young donkeys with the widest NC was recorded in Idabari (59.52±0.79cm) from Jigawa State while the smallest was also recorded in Idabari (55.02±0.83cm) from Jigawa State. Wider SW was recorded in Duni (22.50±1.15cm) from Jigawa and Idabari (22.72±0.38cm) from Kebbi State. However, smaller SW was observed in Duni (17.25±1.15cm) and Idabari (17.08±0.44cm) strains from Sokoto State. Higher HW wererecorded in Idabari (101.39±0.49cm) from Kaduna and Idabari (101.13±0.47cm) from Kebbi State while the shortest was recorded in Fari (94.50±1.80cm) from Katsina State. Young donkey strain with the largest HG was observed in Fari (109.25±2.32cm) from Kaduna State. However, the smallest HG was obtained in Fari (99.50±2.68cm) strain from Katsina State. Longest BL was observed in Fari (106.75±2.23cm) from Kaduna State while the shortest BL was obtained in Fari (93.00±2.58cm) from Katsina State. The young donkey strain with the longest TL was recorded in Duni (57.87±3.49cm) from Sokoto State. However, the shortest TL was recorded in Idabari (45.89±1.20cm) strain from Kaduna State. The significant effect of location on morphometric traits of these donkeys may be attributed to differences in the climatic conditions of these locations as well as management practices in the various herds at the seven locations. (12) indicated that large variations among donkey populations are due to differences in geographical distribution and management.

Table 6a: Effect of location and strain (interaction) on biometric traits of young donkey

State	Strain	BWT(kg)	HL(cm)	HWD(cm)	EL(cm)	NL(cm)	NC(cm)
Jigawa	Duni	109.8±5.28^{e}	45.8±1.33^{b}	14.0±0.62^{c}	23.2±0.58^{g}	47.1±1.58^{a}	56.1±2.30^{g}
	Idabari	107.9±1.90^{f}	44.7±0.48^{c}	13.2±0.22^{e}	23.7±0.21^{e}	44.3±0.57^{c}	55.0±0.83^{h}
Kaduna	Fari	126.7±5.79^{a}	46.0±1.46^{b}	15.0±0.68^{a}	24.5±0.63^{bc}	42.5±1.73^{e}	58.2±2.52^{c}
	Idabari	118.1±1.82^{b}	46.8±0.45^{a}	13.9±0.21^{c}	24.9±0.20^{a}	44.4±0.54^{c}	59.5±0.79^{a}
Kano	Idabari	116.8±1.79^{bc}	43.9±0.45^{d}	13.2±0.21^{e}	23.5±0.19^{f}	43.2±0.53^{d}	56.7±0.78^{ef}
Katsina	Fari	98.9±6.68^{g}	42.0±1.68^{e}	13.0±0.79^{f}	23.0±0.73^{g}	42.0±2.00^{f}	56.5±2.91^{fg}
	Idabari	113.6±1.85^{d}	44.8±0.46^{c}	13.7±0.21^{d}	23.9±0.20^{de}	42.9±0.55^{d}	57.2±0.80^{de}
Kebbi	Idabari	117.2±1.75^{bc}	46.2±0.44^{b}	14.9±0.20^{a}	24.3±0.19^{c}	44.2±0.52^{c}	57.5±0.76^{d}
Sokoto	Duni	112.1±5.28^{d}	46.1±1.33^{b}	13.8±0.62^{cd}	24.5±0.58^{bc}	45.3±1.58^{b}	57.2±2.30^{de}
	Idabari	113.1±2.02^{d}	43.9±0.51^{d}	13.3±0.23^{e}	24.6±0.22^{b}	44.1±0.60^{c}	58.8±0.88^{bc}
Zamfara	Idabari	116.6±1.75^{c}	45.9±0.44^{b}	14.2±0.20^{b}	24.0±0.19^{d}	44.2±0.52^{c}	58.9±0.76^{ab}
	Overall mean	115.02	45.26	13.85	24.15	44.98	57.90
	SEM	0.75	0.19	0.09	0.08	0.20	0.30
	LOS	**	**	**	**	**	**

BWT: Body weight; HL: Head length; HD: 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, **PƐ0.01, SEM= Standard Error of Mean, LOS= Level of significant, abc; Means with different superscripts along same row shows significant differences (PƐ0.01).

Table 6b: Effect of location and strain (interaction) on biometric traits of young donkey

State	Strain	SW(cm)	HW(cm)	HG(cm)	BL(cm)	TL(cm)
Jigawa	Duni	22.5±1.15^{a}	97.1±1.42^{g}	102.5±2.12^{g}	102.7±2.04^{c}	51.5±3.49^{d}
	Idabari	21.5±0.41^{c}	98.1±0.51^{f}	102.8±0.76^{g}	100.2±0.73^{f}	50.3±1.25^{e}
Kaduna	Fari	22.0±1.26^{b}	100.7±1.56^{ab}	109.2±2.32^{a}	106.7±2.23^{a}	48.5±3.82^{g}
	Idabari	20.3±0.39^{d}	101.3±0.49^{a}	105.9±0.73^{cd}	103.4±0.70^{b}	45.8±1.20^{h}
Kano	Idabari	20.0±0.39^{d}	100.4±0.48^{bc}	106.7±0.72^{b}	102.3±0.69^{cd}	49.3±1.18^{f}
Katsina	Fari	18.0±1.45^{e}	94.5±1.80^{h}	99.5±2.68^{h}	93.0±2.58^{h}	49.0±4.42^{fg}
	Idabari	21.4±0.40^{c}	99.4±0.49^{e}	104.1±0.74^{e}	101.1±0.71^{e}	54.4±1.22^{c}
Kebbi	Idabari	22.7±0.38^{a}	101.1±0.47^{a}	105.4±0.70^{d}	103.4±0.67^{b}	56.3±1.16^{b}
Sokoto	Duni	17.2±1.15^{f}	100.1±1.42^{cd}	104.6±2.12^{e}	102.1±2.04^{d}	57.8±3.49^{a}
	Idabari	17.0±0.44^{f}	100.0±0.54^{d}	103.4±0.81^{f}	99.6±0.78^{g}	56.6±1.33^{b}
Zamfara	Idabari	21.7±0.38^{bc}	100.0±0.47^{cd}	106.1±0.70^{bc}	102.2±0.67^{cd}	56.6±1.16^{b}
	Overall mean	20.75	100.14	105.06	101.92	52.81
	SEM	0.19	0.19	0.29	0.28	0.54
	LOS	**	**	**	**	**

BWT: Body weight; HL: Head length; HD: 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, **P£0.01, NS: Not significant, SEM= Standard Error of Mean, LOS= Level of significance, abc; Means with different superscripts along same row shows significant differences (P£0.01).

The differentiated correlations between morphometric traits of young donkeys are presented in Table 7. At young stage, except the non-significant (p>0.05) negative relationship between ear length and shoulder width (r=-0.01), all relationships between the growth measures were positively low to moderate (r=0.13-0.59) with the following non-significant (p>0.05) relationships between tail length and body length (r=0.10); neck length and head width (r=0.10) and tail length and ear length (r=0.08). All the same, high positive correlations were recorded for body weight with height at withers, heart girth and body length (r=0.66-0.84); height at withers and heart girth (r=0.63); and heart girth and body length (r=0.67).The result of this study similar with the findings of (18) who reported that the correlation estimations between live weight and other response variables indicated positive and highly significant (P<0.001) values of 0.81, 0.74, 0.52, 0.81, 0.89 and 0.42 between live weight and heart girth; live weight and tail length; live weight and height at withers; live weight and body length; height at withers and tail length; trunk length and high at withers respectively.

Table 7: Correlations among morphometric traits of young donkeys

Traits	BWT (kg)	HL (cm)	HWD (cm)	EL (cm)	NL (cm)	NC (cm)	SW (cm)	HW (cm)	HG (cm)	BL (cm)	TL (cm)
HL(cm)	0.30**	-									
HWD(cm)	0.25*	0.38**	-								
EL(cm)	0.21*	0.39**	0.28**	-							
NL(cm)	0.28**	0.46**	0.10^{NS}	0.13*	-						
NC(cm)	0.47**	0.47**	0.18*	0.27**	0.39**	-					
SW(cm)	0.19*	0.39**	0.31**	-0.01^{NS}	0.26*	0.22*	-				
HW(cm)	0.66**	0.34**	0.19*	0.35**	0.21*	0.36**	0.18*	-			
HG(cm)	0.84**	0.32**	0.20*	0.18*	0.28**	0.45**	0.24*	0.63**	-		
BL(cm)	0.64**	0.47**	0.28**	0.22*	0.33**	0.39**	0.40**	0.59**	0.67**	-	
TL(cm)	0.10^{NS}	0.28**	0.18*	0.08^{NS}	0.34**	0.31**	0.38**	0.17*	0.16*	0.17*	-

BWT: Body weight; HL: Head length; HWD: Head width; EL: Ear length; NL: Neck length; NC: Neck circumference; SW: Shoulder width; H W: Height at withers; HG: Heart girth; BL: Body length; TL: Tail length, **P£0.01, *P£0.05 NS: Not significance difference at (P£0.05).

Conclusion And Applications

1 Sexual dimorphism exist in the body size measures of donkeys with females having heavier body weight, wider heart girth and taller height while the males have longer head, ear, tail and wider neck circumference.

2 The zoometric phenotypic differentiations that exist among strains of donkeys in Northwest Nigeria should be exploited for genetic improvement of the species.

3 Low, moderate to high correlation coefficient were observed between the body weight and body linear measurements.

4. It is therefore recommended that the length related measures should be employed in young males donkeys in order to exploit their genetic potentials.

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