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Characterization of Weaner Donkeys in North West Nigeria using Morphometric Traits

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

Abstract

Biometric traits were used to determine the relationship among Red (Auraki), Black (Duni), White (Fari), Brown (Idabari) and Brown-white (Idabari-fari) for weaners donkeys. A total of 210 weaners 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. The weaner body size measures of donkeys in Northwestern Nigeria were body weight (114.3kg), Body length (92.0cm), Heart girth (94.3), Height at withers (92.8cm), Shoulder width (17.5cm), Neck circumference (50.0cm), Neck length (38.6cm), Head length (39.9cm), Head width (12.3cm), Ear length (22.9cm) and Tail length (45.9cm). All the growth measures were positively and significantly correlated (P<0.05, 0.01). The zoometric phenotypic differentiations that exist among strains of donkeys in Northwest Nigeria should be exploited for genetic improvement of the species.

Key words: Morphometric, characterization, Donkey, weaner, body measurement and traits

Description of Problem

The population of donkeys is on the increase in Africa, and the animals are increasingly becoming important in transportation of farm produce (1). Evidence from mitochondrial DNA studies has confirmed that the present day domestic donkey originated in Africa rather than in Asia (2). It is therefore believed that donkey is the only domestic animal of African origin. 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*) (2). Genetic diversity and similarity among and within strains have been determined using morphostructural differences (3, 4). For instance, (5) used body length and chest circumference, to show significant differences between brown and grey Bengal goat breeds. Similarly, (4) 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. (4, 6, 7). Diversity is fully elucidated through characterization. At phenotypic level, using conventional and non-conventional body parameters (8), linear body measurements can be taken and statistically translated into breeding value (9). These breeding values are applied to production traits and use in breeding profitable herd through selection. (10) 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. (11) 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. This was therefore aimed at describing weaner donkeys in North West Nigeria using their morphometric traits.

Materials and Methods

Two hundred and ten (210) weaner 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 range of 6 months to 1 year were classified as weaners. The age of the donkeys were determine using teeth count in combination with the information provided by the donkey owners. A total of 10 weaner donkeys were sampled each from the three senatorial zones, making a total of 30 donkeys in each of the seven State using random sampling technique.

Body measurements of two hundred and ten (210) weaner 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 (8, 10, 12). The body measurements obtained from the weaner donkeys are as follows:

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).

For descriptive statistics, frequency counts and Chi Square test of (13) were used. General Linear Model procedure of (13) was used to analyze the effect of sex, age, 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

The effect of strain, sex, location and certain morphological traits on linear measurement were estimated using the GLM procedure of the statistics analysis software (13) statistical package. These were computed on the basis of interaction with age groups. Statistical significant means were separated using Duncan Multiple Range Test (14).

Results and Discussion

The morphometric characterization of donkeys in Northwestern zone is presented in Table 1. The table expressed 11 measures of growth in weaners donkeys, including 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 at

weaners stage of growth. Body weight (36.9%), shoulder width (15.5%) and tail length (20.1) were highly variable at weaner stage. The variations in some of the measures were generally low, decreasing as the animals matures. Significant differences recorded by weaner donkey was in line with the pattern obtained by (15). This could be viewed from genetics and physiology perspective that the body system is still in its developmental process which had not been fully established and at that time the genetic influence is highly unstable.

Table 1: Within age group morphometric characteristics of weaner donkeys

Characteristics	Weaner (N=210)	CV%
BWT(kg)	114.3±2.92	36.9
HL(cm)	39.9±0.29	10.7
HWD(cm)	12.3±0.11	12.5
EL(cm)	22.9±0.08	4.9
NL(cm)	38.6±0.27	10.3
NC(cm)	50.0±0.35	10.2
SW(cm)	17.5±0.19	15.5
HW(cm)	92.8±0.36	5.7
HG(cm)	94.3±0.53	8.2
BL(cm)	92.0±0.52	8.2
TL(cm)	45.9±0.64	20.1

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.

Wide neck circumference was obtained in black (49.1±2.03), white (49.4±1.16cm) and brown (50.2±0.37cm) donkeys. The shoulder width and height at withers were similar across the strains. The largest heart girth (94.7±0.56cm) was obtained in brown donkeys while the smallest heart girth (83.5±4.5cm) was obtained in brown-white donkeys. The longest body lengths were recorded in black (93.8±1.87cm) and brown (92.3±0.55cm) donkeys. Longest tail length (50.3±2.67cm) was recorded in black strain while the shortest tail length was however, recorded in red (35.7±7.79cm) donkeys. Body weight of 52.30 to 115.70kg in brown through to white strain of donkeys in this study were higher than those published by Hintz *et al*. (16) in the thoroughbred description.

The effect of sex on morphometric traits of weaner donkeys are indicated in Table 3. Sex of weaner donkeys affected (PƐ0.01) body weight (BWT), head length (HL), neck length (NL), neck circumference (NC), shoulder width (SW) and tail length (TL) in weaner donkeys. Other morphometric traits were however not affected by sex (PƐ0.05). Male weaners donkeys were superior for body weight (137.76±6.32kg), head length (38.72±0.88cm), neck length (37.93±0.84cm), shoulder width (17.76±0.45cm) and tail length (46.27±1.99) than the females. Males had a wider skull and head than females, in a similar way to that found by other authors in saddle-house breed (17, 18). The sex differences obtained in the morphometric traits of donkeys could be attributed to sexual dimorphisms (19). (20) reported that most dimorphism developed during post weaning because of faster mass gain by males during the age of 1-2 years. This is in agreement with the result of this study which reported heavier body weight and longer head in males.

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

Age group/Strain	N	Red (N=3)	Black (N=10)	White (N=11)	Brown (N=184)	Brown-white (N=2)	SEM	LOS
Weaner	**210**							
BWT(kg)		89.6±35.29^{ab}	111.4±15.92^{a}	111.9±12.24^{a}	115.7±3.06^{a}	52.3±11.00^{b}	18.79	**
HL(cm)		33.0±3.21^{b}	40.3±1.43^{a}	38.0±1.28^{ab}	40.2±0.31^{a}	36.5±1.50^{ab}	1.87	**
HWD(cm)		11.7±0.33	12.0±1.06	11.8±0.33	12.4±0.10	10.5±0.50	0.64	NS
EL(cm)		22.0±0.58	22.6±0.40	22.5±0.34	22.9±0.08	23.0±1.00	0.51	NS
NL(cm)		32.3±2.67^{b}	39.0±1.32^{a}	36.3±1.26^{ab}	38.9±0.28^{a}	37.0±1.00^{ab}	1.74	**
NC(cm)		44.3±4.81^{b}	49.1±2.03^{a}	49.4±1.16^{a}	50.2±0.37^{a}	45.5±3.50^{b}	2.26	**
SW(cm)		16.3±2.33^{a}	18.7±1.19^{a}	16.7±1.01^{a}	17.5±0.19^{a}	15.0±1.00^{b}	1.20	**
HW(cm)		89.7±3.71^{a}	92.6±2.38^{a}	90.3±2.03^{a}	93.1±0.37a	86.5±2.50^{b}	2.34	**
HG(cm)		93.0±6.08^{ab}	93.0±2.55^{ab}	91.4±2.19^{ab}	94.7±0.56^{a}	83.5±4.50^{b}	3.42	**
BL(cm)		87.3±7.26^{ab}	93.8±1.87^{a}	89.0±2.19^{ab}	92.3±0.55^{a}	80.0±4.00^{b}	3.35	**
TL(cm)		35.7±7.79^{b}	50.3±2.67^{a}	45.0±2.67^{ab}	45.8±0.68^{ab}	45.5±3.50^{ab}	4.09	**

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).

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

Age group/traits	N	Male	Female	Overall	SEM	LOS
Weaners(210)						
BWT (kg)	210	137.7±6.32^{a}	78.0±5.92^{b}	114.33	2.92	**
HL (cm)	210	38.7±0.88^{a}	37.6±0.83^{b}	39.93	0.29	**
HWD (cm)	210	12.0±0.30	11.9±0.28	12.31	0.11	NS
EL (cm)	210	22.5±0.25	22.6±0.23	22.91	0.08	NS
NL (cm)	210	37.9±0.84^{a}	36.6±0.78^{b}	37.28	0.17	**
NC (cm)	210	48.4±1.05^{a}	47.8±0.98^{b}	48.16	0.26	**
SW (cm)	210	17.7±0.45^{a}	17.1±0.42^{b}	17.46	0.19	**
HW (cm)	210	90.4±1.06	90.5±0.99	92.82	0.36	NS
HG (cm)	210	91.1±1.45	91.5±1.36	94.33	0.53	NS
BL (cm)	210	89.4±1.48	88.9±1.39	92.00	0.52	NS
TL (cm)	210	46.2±1.99^{a}	44.3±1.86^{b}	45.88	0.64	**

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 weaner donkeys is expressed in table 4. All the traits (body weight and linear body measurements) of weaner donkeys were significantly (PƐ0.01) affected by location. Kano State recorded the heaviest body weight (125.65±7.52kg) with the least body weight coming from weaner donkeys of Katsina (96.54±7.48kg) and Kaduna (93.28±7.24kg) state. The head length (HL) of weaner donkeys in Zamfara (39.98±1.09cm) and Kebbi (40.88±1.09cm) were the longest while the shortest head length was recorded by weaner donkeys in Katsina state (36.79±1.05cm). Head width (HWD) was widest in weaner donkeys from Kebbi state (13.32±0.37cm) while the least value for HWD was recorded in Kaduna state (10.77±0.35cm). Generally, the weaner donkeys from Kebbi state had the longest neck length (39.22±1.03cm), widest neck circumference (51.09±1.29cm) and shoulder width (20.06±0.51cm), highest

height at withers (92.97±1.31cm) and longest tail length (49.48cm). However, the neck length (NL) of weaner donkeys from Kebbi state was similar to those from Zamfara. Also, Tail length of weaner donkeys from Kebbi state was similar to those from Sokoto (48.28±2.31cm) and Zamfara (47.18±2.47cm) States. There was a relatively high variation in these traits as well. This agreed with the work of (2) that the wither heights, for example, is the most probably influenced by the origin of the given individual, as it can be an adaptation to specific conditions of that place. The cause of these differences can be found in different domestication families of the populations.

Effect of interaction of strain and sex on morphometric traits of weaner donkeys are shown in Table 5. The strain and sex interaction on morphometric traits of weaner donkeys affected (PƐ0.01) body weight (BWT), head length (HL), neck length (NL), neck circumference (NC), shoulder width (SW), and height at wither (HW). Other morphometric traits were however not affected by strain, sex and location interaction (PƐ0.05). Males had higher values for BWT (143.44±0.33kg), HL (47.84±0.15cm), NC (63.48±0.39cm) and SW (17.60±0.19cm) than females. The heaviest BWT (143.44±33kg) was observed in brown male weaner donkeys while small BWT (84.94±3.02kg) was observed in female weaner. Longest HL (47.84±0.15cm) was recorded in male weaner whereas the shortest HL (47.02±0.14cm) was recorded in females. Weaner donkeys with the longest NL (47.05±0.20cm) was observed in females while shortest NL (46.69±0.23cm) was observed in males. Broader NC (63.48±0.39cm) was obtained in male weaner whereas the female weaner recorded the smallest NC (62.26±0.35cm). The male weaner recorded the wider SW (17.60±0.19cm) while smaller SW (17.23±0.20cm) was recorded in females. The longest HW (93.16±0.49cm) was observed in female weaner donkey. However, the shortest HW (92.91±0.47cm) was observed in male weaner. The sex differences obtained in the morphometric traits of donkeys could be attributed to sexual dimorphisms (21).

The effect of interaction of location and strain on morphometric traits of weaner donkeys are presented in Table 6 (a and b). All the traits (body weight and linear body measurements) were significantly affected (PƐ0.01) by location and strains interaction. The biggest BWT was recorded in Duni (164.92±20.06kg) strain from Kebbi State. While the least body weight (BWT) was recorded in Fari (95.25±17.38kg). The longest head length (HL) was observed in Duni (44.50±2.74cm) strain from Zafara state. While the shortest head length (HL) was observed in Fari (34.25±2.37cm) strain from Kaduna State. Widest HWD was observed in Duni strain from Kebbi state (14.50±0.85cm) and Zamfara State (14.50±0.85cm). The smallest HWD was recorded in Duni strain from Kaduna State (8.00±0.85). Weaner donkeys with the longest ear length (EL) were obtained in Duni (24.00±0.75cm) strain from Kaduna state. While the shortest ear length (EL) was observed in

Table 4: Effect of location on morphometric traits of weaner donkeys

Traits	Jigawa	Kaduna	Kano	Katsina	Kebbi	Sokoto	Zamfara	Overall mean	SEM	LOS
BWT(kg)	105.4±7.59^{c}	93.2±7.24^{d}	125.6±7.52^{a}	96.5±7.48^{d}	119.2±7.79^{ab}	103.7±7.35^{cd}	111.3±7.79^{b}	114.33	2.92	**
HL(cm)	37.4±1.06^{c}	37.9±1.01^{c}	37.1±1.05^{c}	36.7±1.05^{d}	40.8±1.09^{a}	39.1±1.03^{b}	39.9±1.09^{a}	39.93	0.29	**
HWD(cm)	11.6±0.36^{c}	10.7±0.35^{d}	11.9±0.36^{c}	12.1±0.36^{b}	13.3±0.37^{a}	11.2±0.35^{c}	12.7±0.37^{b}	12.31	0.11	**
EL(cm)	22.0±0.29^{c}	23.0±0.28^{a}	22.7±0.29^{b}	22.3±0.29^{b}	22.6±0.30^{b}	22.5±0.29^{b}	22.8±0.30^{a}	22.91	0.08	**
NL(cm)	37.1±1.00^{b}	36.8±0.96^{c}	36.3±0.99^{c}	36.0±0.99^{c}	39.2±1.03^{a}	36.4±0.97^{c}	38.9±1.03^{a}	37.27	0.17	**
NC(cm)	44.2±1.26^{e}	48.0±1.20^{c}	47.1±1.25^{d}	49.1±1.24^{b}	51.0±1.29^{a}	47.2±1.22^{d}	50.0±1.29^{b}	48.15	0.26	**
SW(cm)	16.8±0.54^{d}	17.7±0.52^{c}	17.5±0.54^{c}	16.1±0.53^{d}	20.0±0.56^{a}	14.2±0.52^{e}	19.5±0.56^{b}	17.46	0.19	**
HW(cm)	87.0±1.28^{d}	91.5±1.22^{b}	93.9±1.27^{a}	87.7±1.26^{d}	92.9±1.31^{a}	89.2±1.24^{c}	91.0±1.31^{b}	92.82	0.36	**
HG(cm)	88.7±1.74^{cd}	91.0±1.66^{c}	99.5±1.73^{a}	89.9±1.72^{d}	95.3±1.79^{b}	87.2±1.69^{d}	90.5±1.79^{c}	94.33	0.53	**
BL(cm)	88.8±1.78^{c}	86.2±1.69^{d}	96.3±1.76^{a}	86.1±1.75^{d}	92.8±1.82^{b}	84.6±1.72^{e}	89.5±1.82^{c}	92.00	0.52	**
TL(cm)	44.4±2.39^{b}	42.4±2.28^{c}	42.4±2.36^{c}	42.9±2.35^{bc}	49.4±2.45^{a}	48.2±2.31^{a}	47.1±2.47^{ab}	45.86	0.64	**

BWT: Body weight; HL: Head length; HWD: Head width; EL: Ear length; NL: Neck length; NC: Neck cir cumference; 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 significance, abc; Means with dif ferent superscripts along same row show s significant differences (PƐ0. 01).

Table5 : Effect of strain and sex (interaction) on biometric traits of weaner 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	143.4±33[a]	47.8±0.15[a]	12.4±0.12	24.9±0.08	46.6±0.23[b]	63.4±0.39[a]	17.6±0.19[a]	92.9±0.47[b]	94.2±0.66	92.3±0.66	46.51±0.87
	Female	84.9±3.02[b]	47.0±0.14[b]	12.2±0.12	25.0±0.07	47.0±0.20[a]	62.2±0.35[b]	17.2±0.20[b]	93.1±0.49[a]	94.9±0.69	91.8±0.69	45.16±0.90
	Overall mean	114.33	39.93	12.31	22.91	37.27	48.15	17.46	92.82	94.33	92.00	45.86
	SEM	2.92	0.29	0.11	0.08	0.17	0.26	0.19	0.36	0.53	0.52	0.64
	LOS	**	**	NS	NS	**	**	**	**	NS	NS	NS

Keys: BWT: Body weight; HL: Head length; HD: Head width; EL: Ear length; NL: Neck length; NC: Neck circumference; SW: Shoulde r 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 significance, ab; Means with different superscripts along same row shows significant differences (PƐ0.01).

Table5 : Effect of strain and sex (interaction) on biometric traits of weaner 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	143.4±33[a]	47.8±0.15[a]	12.4±0.12	24.9±0.08	46.6±0.23[b]	63.4±0.39[a]	17.6±0.19[a]	92.9±0.47[b]	94.2±0.66	92.3±0.66	46.51±0.87
	Female	84.9±3.02[b]	47.0±0.14[b]	12.2±0.12	25.0±0.07	47.0±0.20[a]	62.2±0.35[b]	17.2±0.20[b]	93.1±0.49[a]	94.9±0.69	91.8±0.69	45.16±0.90
	Overall mean	114.33	39.93	12.31	22.91	37.27	48.15	17.46	92.82	94.33	92.00	45.86
	SEM	2.92	0.29	0.11	0.08	0.17	0.26	0.19	0.36	0.53	0.52	0.64
	LOS	**	**	NS	NS	**	**	**	**	NS	NS	NS

Keys: BWT: Body weight; HL: Head length; HD: Head width; EL: Ear length; NL: Neck length; NC: Neck circumference; SW: Shoulde r 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 significance, ab; Means with different superscripts along same row shows significant differences (PƐ0.01).

Auraki (21.50±0.75) from Kano state. Longest neck length (NL) was recorded in Duni (43.50±2.60cm) strain from Zamfara state whereas the shortest neck length (NL) was recorded in Auraki (31.00±2.60) strain from Kano state. The highest value was recorded for neck circumference (NC) in Duni (55.00±3.21cm) strain from Zamfara state. While least value for NC was recorded in Auraki (43.00±3.21cm). Widest shoulder width (SWD) was observed in Duni (22.50±1.33cm) from Kebbi state whereas the smallest shoulder width (SWD) was observed in Fari (13.16±1.08cm) strain from Sokoto state. The highest height at wither (HW) measured was obtained in Duni (101.00±3.27cm) weaner donkeys from Kebbi state. The shortest HW measured were obtained in Idabari (89.83±0.93cm) from Jigawa and Fari (89.25±2.83cm) from Kaduna state. High value was recorded in Idabari (102.71±1.22cm) from Kano state for heart girth (HG). While the least value for HG was recorded in Fari (88.16±3.74cm) from sokoto state. Longer body length was observed in Idabari (98.96±1.22cm) from Kano and Duni (100.00±4.60cm) strains from Kebbi state. Weaner donkeys with long tail length were observed in Duni (63.00±6.00cm) from Kebbi state and Fari (55.00±4.89cm) strains from Sokoto state. However, the shortest tail length (TL) was observed in Auraki (35.50±6.00cm). Significant differences recorded in the morphometric traits of weaner donkeys in this study were similar with the result obtained by (22) who reported that there was little physical variation in donkeys found throughout Africa.

The age group differentiated correlations between morphometric traits of donkeys are presented in Table 7. At the weaner stage, all the growth measures were positively and significantly correlated ($P<0.05$, 0.01, $r=0.19$-0.80) except for the non-significant correlation between ear length and body weight ($r=0.09$) and ear length and head width ($r=0.06$). Body weight had low to moderate relationship with body dimensions ($r=0.21$-0.56) at this stage; so was head width, ear length, neck length, neck circumference and shoulder width with other body dimension measures ($r=0.19$-0.51) except for the high positive relationships between head length and neck length ($r=0.80$) and circumference ($r=0.75$); height at withers and heart girth ($r=0.80$); height at withers and body length ($r=0.72$;) and heart girth and body length ($r=0.79$). The result obtained in this study were similar with the findings of Pearson and (23) who reported strong relationship between live weight and body dimensions of working donkeys.

Table 6a: Effect of location and strain (interaction) on biometric traits of weaner donkeys

St ate	Strain	BWT(kg)	HL(cm)	HWD(cm)	EL(cm)	NL(cm)	NC(cm)
Jigawa	Fari	125.0±20.06^{d}	40.0±2.74^{e}	12.0±0.85^{f}	22.5±0.75^{fg}	35.0±2.60^{i}	49.0±3.21^{f}
	Idabari	113.0±5.71^{fg}	39.5±0.78^{ef}	12.1±0.24^{ef}	22.4±0.21^{gh}	39.0±0.74^{d}	46.5±0.91^{g}
Kaduna	Duni	115.3±20.06^{f}	40.0±2.74^{e}	8.0±0.85^{i}	24.0±0.75^{a}	36.5±2.60^{h}	51.5±3.21^{cd}
	Fari	95.2±17.38^{j}	34.2±2.37^{h}	12.5±0.73^{d}	21.7±0.65^{i}	34.2±2.26^{j}	51.2±2.78^{cd}
	Idabari	100.2±5.79^{ij}	40.2±0.79^{e}	11.2±0.24^{h}	23.5±0.21^{b}	38.6±0.75^{e}	49.6±0.92^{e}
Kano	Auraki	116.5±20.06^{f}	39.0±0.73^{fg}	11.5±0.24^{g}	21.5±0.75^{j}	31.0±2.60^{k}	43.0±3.21^{i}
	Idabari	131.4±5.36^{c}	39.0±0.73^{fg}	12.3±0.22^{de}	23.1±0.20^{c}	38.0±0.69^{f}	49.2±0.85^{ef}
Katsina	Idabari	104.8±5.56^{hi}	38.8±0.76^{g}	12.5±0.23^{d}	22.6±0.21^{ef}	37.5±0.72^{g}	51.1±0.89^{cd}
Kebbi	Duni	164.9±20.06^{a}	43.5±2.74^{b}	14.5±0.85^{a}	23.5±0.75^{b}	40.5±2.60^{bc}	51.0±3.21^{d}
	Idabari	123.4±5.36^{de}	42.7±0.73^{c}	13.6±0.22^{b}	23.0±0.20^{d}	40.7±0.69^{b}	53.1±0.85^{b}
Sokoto	Fari	138.3±16.38^{b}	38.8±2.24^{g}	11.1±0.69^{h}	22.3±0.61^{h}	36.6±2.13^{h}	46.0±2.62^{h}
	Idabari	107.4±5.71^{gh}	38.8±0.78^{g}	11.7±0.24^{g}	22.7±0.21^{e}	37.7±0.74^{fg}	49.4±0.91^{ef}
Zamfara	Duni	118.3±20.06^{ef}	44.5±2.74^{a}	14.5±0.85^{a}	23.0±0.75^{d}	43.5±2.60^{a}	55.0±3.21^{a}
	Idabari	118.4±5.36^{ef}	41.7±0.73^{d}	12.9±0.22^{c}	23.2±0.24^{c}	40.2±0.69^{c}	51.8±0.85^{c}
	Overall mean	114.33	39.93	12.31	22.91	37.27	48.15
	SEM	2.92	0.29	0.11	0.08	0.17	0.26
	LOS	**	**	**	**	**	**

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, SEM= Standard Error of Mean, LOS= Level of significance, 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 weaner donkeys

State	Strain	SW(cm)	HW(cm)	HG(cm)	BL(cm)	TL(cm)
Jigawa	Fari	20.0±1.33^{c}	94.5±3.27^{e}	95.5±4.58^{e}	95.5±4.60^{b}	40.0±6.00^{g}
	Idabari	16.9±0.37^{g}	89.8±0.93^{h}	92.6±1.30^{g}	92.0±1.31^{d}	46.0±1.70^{e}
Kaduna	Duni	19.5±1.33^{d}	95.5±3.27^{cd}	96.0±4.58^{d}	93.5±4.60^{c}	47.0±6.00^{de}
	Fari	18.7±1.15^{e}	89.2±2.83^{h}	95.7±3.96^{de}	87.5±3.98^{f}	43.2±5.19^{f}
	Idabari	17.5±0.38^{f}	94.5±0.94^{e}	94.2±1.32^{f}	89.2±1.32^{e}	42.9±1.73^{f}
Kano	Auraki	17.5±1.33^{f}	91.0±3.27^{g}	98.0±4.58^{c}	94.0±4.60^{c}	35.5±6.00^{h}
	Idabari	17.4±0.35^{fg}	96.5±0.87^{b}	102.7±1.22^{a}	98.9±1.22^{a}	42.9±1.60^{f}
Katsina	Idabari	16.3±0.36^{h}	90.6±0.90^{g}	90.6±1.27^{h}	89.6±1.27^{e}	43.5±1.66^{f}
Kebbi	Duni	22.5±1.33^{a}	101.0±3.27^{a}	101.0±4.58^{b}	100.0±4.60^{a}	63.0±6.00^{a}
	Idabari	19.8±0.35^{c}	95.1±0.87^{de}	98.3±1.22^{c}	95.5±1.22^{b}	49.3±1.60^{b}
Sokoto	Fari	13.1±1.08^{j}	90.8±2.67^{g}	88.1±3.74^{i}	87.8±3.75^{f}	55.0±4.89^{a}
	Idabari	14.3±0.37^{i}	91.2±0.93^{g}	90.2±1.30^{h}	87.1±1.31^{f}	48.2±1.70^{bc}
Zamfara	Duni	21.5±1.33^{b}	96.0±3.27^{c}	98.0±4.58^{c}	96.0±4.60^{b}	49.0±6.00^{bc}
	Idabari	19.3±0.35^{d}	93.3±0.87^{f}	93.3±1.22^{fg}	92.2±1.22^{d}	47.85±1.60^{cd}
	Overall mean	17.46	92.82	94.33	92.00	45.86
	SEM	0.19	0.36	0.53	0.52	0.64
	LOS	**	**	**	**	**

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,SEM= Standard Error of Mean, LOS= Level of significance, abc; Means with different superscripts along same row shows significant differences (PƐ0.01)

Table 7: Correlations among morphometric traits of donkeys

Traits	BWT(kg)	HL(cm)	HWD(cm)	EL(cm)	NL(cm)	NC(cm)	SW(cm)	HW(cm)	HG(cm)	BL(cm)
HL(cm)	0.32**	-								
HWD(cm)	0.21*	0.25*	-							
EL(cm)	0.09^{NS}	0.40**	0.06^{NS}	-						
NL(cm)	0.33**	0.80**	0.22*	0.31**	-					
NC(cm)	0.28**	0.75**	0.27**	0.39**	0.64**	-				
SW(cm)	0.28**	0.46**	0.35**	0.22*	0.39**	0.46**	-			
HW(cm)	0.29**	0.51**	0.27**	0.46**	0.43**	0.51**	0.44**	-		
HG(cm)	0.28**	0.44**	0.36**	0.35**	0.38**	0.49**	0.47**	0.80**	-	
BL(cm)	0.41**	0.50**	0.31**	0.29**	0.43**	0.49**	0.48**	0.72**	0.79**	-
TL(cm)	0.56**	0.42**	0.19*	0.19*	0.41**	0.42**	0.25*	0.23*	0.21*	0.25*

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, **P£0.01, *P£0.05 NS: Not significance difference at (P£0.05).

Conclusion and applications

1 The morphometric traits of the weaner donkeys were heterogeneous and in Hardy-Weinghberg equilibrium.

2 Sexual dimorphism exist in the body size measures of donkeys with male weaners donkeys which were superior for body weight (137.76±6.32kg), head length (38.72±0.88cm), neck length (37.93±0.84cm), shoulder width (17.76±0.45cm) and tail length (46.27±1.99) than the females counterpart.

3 There were variations in the morphometric traits of the donkeys due to strain, sex and location effects with black donkeys having the heaviest body weight for strains from Kebbi state.

4 Any breed improvement programme(s) to be instituted for donkeys should take advantage of the observed heterogeneous nature of the morphological and biometric traits of these animals in Northwestern Nigeria.

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