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MORPHOLOGICAL CHARACTERISTICS OF DONKEYS (*EQUUS ASINUS*) IN KABYLIE AREA, ALGERIA

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ABSTRACT

The survey was to define some morphometric characteristics and body biometric indexes of donkeys sampled in the Kabylie area, Algeria. The study was carried out from February to June 2018 in Bejaia and Tizi-Ouzou province. The study population included 124 males and 2 females. In total, 17 body measures were selected for morphometric characterization including and seven body biometric indexes were calculated. Body weight estimated the two equations was 144.3 ± 23.9 and 171.5 ± 28.8 kg, respectively. Significant higher body weight was recorded in the age group ≤ 5 years and the lower body weight in the age group ≥ 6 - ≤ 10 years and ≥ 11 years. Morphological variables of chest width (CW) and Cannon length (CL) were significant longer ($P < 0.02$) in aged donkeys (25.2 ± 1.3 and 20.5 ± 0.7 cm, respectively) compared to adult donkeys (24.7 ± 2.3 and 20 ± 1.4 cm, respectively). Aged donkeys (114.8 ± 5.8 cm) were also significantly superior ($P < 0.01$) concerning the thoracic circumference (TC) compared to adult donkeys (112.2 ± 9.8 cm). The highest values were found between WH and BH ($r = 0.80$); HR and BH ($r = 0.72$) HR and WH ($r = 0.72$) ($P < 0.05$). Dactyl thoracic Index (DTI), Compact Index (CI), Massive index (MI) and Relative body index (RBI) appeared to be influenced by donkey ages ($P > 0.05$). This is a first report on the phenotypic characterization in donkeys in Kabylie area (Algeria) based on corporal measurements. Our comparative analysis of morphometric parameters; such as back length, body length, neck length; suggests that donkeys of Kabylie area are typically invariant among breeds and it has not been changed through the periods.

Key words: donkeys; morphometric characterization; Kabylie; Algeria

INTRODUCTION

Donkey (*Equus asinus*) is an odd-toed ungulate and the smallest species in the Equidae family (Grinder *et al*., 2006). Donkeys in their nature are very friendly, calm, quite, patient, intelligent, cautious, playful, and eager to learn and enjoy the company of humans. It is characteristically short-legged with exceptionally long ears. Importance of donkeys is also conferred through their use in riding tourism and as eco-friendly means of pack and transportation when compared with horses (GOVS, 2005). Donkeys (*Equus asinus*) represent an important component of Algerian livestock and make a significant contribution to the agricultural economy; serving as draft animals.

According to the year 2001 inventory; the donkeys population is estimated 180160 heads in Algeria (FAO, 2003) found essentially in the northern regions, where they are particularly appropriate to tolerate the hard conditions of works. As draught animals, donkeys play a major role in the economy of developing countries by being the main source in transport and traction, particulary in areas with difficult reliefs. However, despite the donkey's popularity, information regarding various morphological characteristics in this species is limited (Labbaci *et al*., 2018).

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The capacity performance of donkeys could be assessed by the description of the morphological characteristics, such as umbilical girths, body length and height. This has been suggested as donkey draft power is directly proportional to size parameters (Nengomasha, 1999). In donkey, during domestication, some morphological and genetic changes have taken place in order to survive better in given conditions (Rossel *et al*., 2008). In African continent, the typical factors (high daily temperatures, minimal amount of precipitation and lack of nutriment quality) enabled donkeys to develop typical aptitudes, which played a key role to survive in dry areas (Pearson and Ouassat, 2000). The knowledge of morphometric measurements in donkey is of great importance for the genetic diversity preservation and development and taxonomic affiliation. Thus, the general objective of the current study was to contribute to a better knowledge of donkey in Algeria, especially in Kabylie region, known for its typical mountains. The survey was to define some morphometric characteristics and body biometric indexes of donkeys sampled in Bejaia and Tizi-Ouzou province. The correlation coefficients different between body measurements were estimated.

MATERIAL AND METHODS

Area study

The study was carried out from February to June 2018 in the Kabylie area, Algeria. Different localities of Bejaia (36° 43' N, 5° 04' E) and Tizi-Ouzou (36° 42' N, 4° 2' E) province were chosen randomly. The topography of Kabylie area is mostly predominated by mountainous. The vegetation is mainly composed of several species of trees and natural or cultivated herbs. Constitute part of climate is Mediterranean region. The maximum summer temperature are ranged from 30.3 to 36.3 °C (July) and the minimum winter temperature are ranged from 6.6 to 6.7 °C (February).

Animal and measurements

The study population included 124 males and 2 females. The donkeys are divided in 3 age groups namely ≤ 5 (young), ≥ 5 - ≤ 10 (adulte), ≥ 11 (aged). In total, 17 body measures were selected for morphometric characterization including. Linear measures (Figure 1) as head length (HL), ear length (EL), neck length (NL), chest width (CW), back length (BaL), body length (BoL), hips width (HW), umbilical circumference (UC), back height (BH), height at the rump (HR), thoracic circumference (TC), chest depth (CD), withers Height (WH), front leg length (FLL), cannon circumference (CC), cannon length (CL), cannon height (CH) were performed using a specially graduated measuring tape. The ages of donkeys were determined from the donkey owners and controlled by dentition analysis (Daveze and Raveneau, 2002). The identification of robe color was performed by direct observation under natural daylight and the frequency distribution of each phenotype was estimated.

From some measured morphometric donkeys, seven body biometric indexes were calculated according to the following formulas. Body Profile Index (BPI) = WH/BoL (Mariante *et al*., 2002); > 0.90: long and good animal for speed; 0.86 - 0.88: medium conformation animal or < 0.85: small conformation animal, fit for traction. Pectoral height index (PHI) = CD/FLL (Marcenac *et al*., 1980); 0.50 ≤ PHI ≤ 0.55: leggy animal or PHI > 0.56: leg shorted. Dactyl thoracic index (DTI) = CC/TC (Chabchoub *et al*., 2004); this index define three animal types: hypermetric, eumetric and elliptical. Compact index (CI) = BW/WH (Boujenane *et al*., 2008). Front-back height in (FBH) = WH/HR (Marcenac *et al*., 1980); FBH ≤ 1: straight back (no overload) or FBH > 1: the anterior region is higher than the posterior (overload). Massive index (MI) = TC/WH (Mariante *et al*., 2002); MI ≤ 1: support well its weight or MI > 1: massive overload. Relative Body Index (RBI) = BoL/TC (Nicks *et al*., 2006); RBI ≥ 0.90: longilinear, 0.84 ≤ RBI ≤ 0.89: mediolinear or RBI ≤ 0.83: brevilinear.

The body weight (BW) for each animal was calculated according to two validated formulas:
BW-1 = $TC^{2.65}/2188$ (Pearson and Ouassat, 1996) or BW-2= $(WH^{0.24})$ x $(TC^{2.576})$ x 0.000252 (Eley and French, 1993).

Statistical analysis

Data were analyzed using a mixed model for repeated measurements (Statview Software, Version 4.55) taking into account an autocorrelation between data obtained successively on the same animal. The data (± SD) were expressed as values of the donkey body measurements (cm). The animal

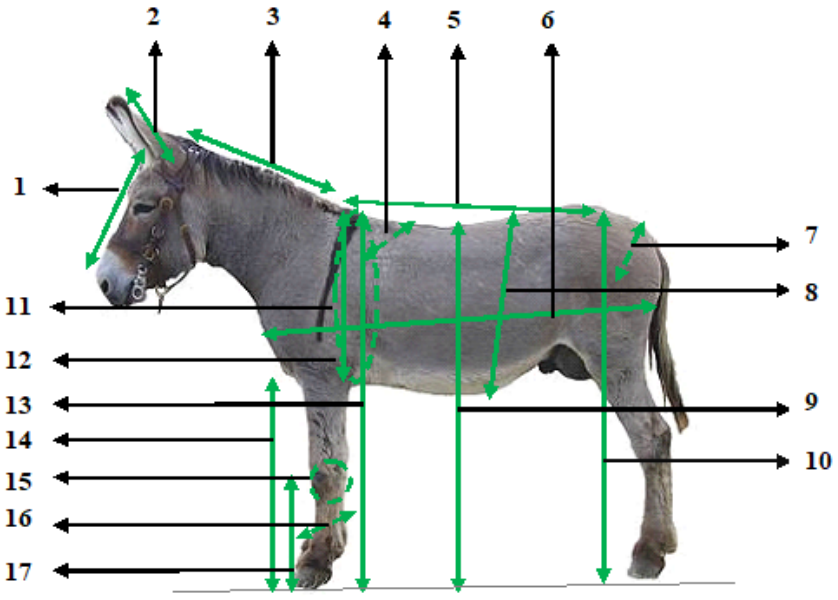
weight and donkey body measurements were analyzed using age (young: ≤ 5 years aged; adult: ≥ 5 - ≤ 10 years aged; aged: ≥ 11 years) as factors of variation. The one way variance analysis (ANOVA) was used to evaluate the obtained data. The values were statistically different when the *P*-value was < 0.05.

RESULTS

The frequency of the coat color (Figure 2) showed that 59.5 % of the donkeys had various shades of brown, 27 % grey and 13.5 % black. The body weight according to the age of donkeys is illustrated in Figure 4. Body weight estimated the two equations was 144.3 ± 23.9 and 171.5 ± 28.8 kg, respectively. The higher body weight was recorded in the age group ≤ 5 years and the lower body weight in the age group ≥ 6 - ≤ 10 years and ≥ 11 years (Figure 3). A significant difference of body weight was observed between the young donkey group and the aged donkey group (P < 0.05).

Descriptive statistics of morphological variables including mean, standard deviation, minimal-maximal and coefficient of variation are depicted in Table 1. Mean values of morphological variables and their standard for each age group are shown in Table 2. Morphological variables of chest width (CW) and Cannon length (CL) were significant longer (P < 0.02) in aged donkeys (25.2 ± 1.3 and 20.5 ± 0.7 cm, respectively) compared to adult donkeys (24.7 ± 2.3 and 20 ± 1.4 cm, respectively). Aged donkeys (114.8 ± 5.8 cm) were also significantly superior (P < 0.01) concerning the thoracic circumference (TC) compared to adult donkeys (112.2 ± 9.8 cm).

Phenotypic correlation coefficients (r) among morphologic variables and body weight are given in Table 3. The highest values were found between WH and BH (r = 0.80); HR and BH (r = 0.72) HR and WH (r = 0.72) (P < 0.05). Other high values were found between CW and BLL (r = 0.60), WH and CH (r = 0.56), WH and HR (r = 0.56) (P < 0.05). The correlation values of TC-CH, WH-CH, WH-HR, HL-TC, BaL-WH, BoL-WH and TC-WH presented values



1 - Head length (HL); 2 - Ear length (EL); 3 - Neck length (NL); 4 - Chest width (CW); 5 - Back length (BaL); 6 - Body length (BoL); 7 - Hips width (HW); 8 - Umbilical circumference (UC); 9 - Back height (BH); 10 - Height at the rump (HR); 11 - Thoracic circumference (TC); 12 - Chest depth (CD); 13 - Withers Height (WH); 14 - Front leg length (FLL) 15 - Cannon circumference (CC); 16 - Cannon length (CL); 17 - Cannon height (CH)

Figure 1. The different body measurements performed in donkey

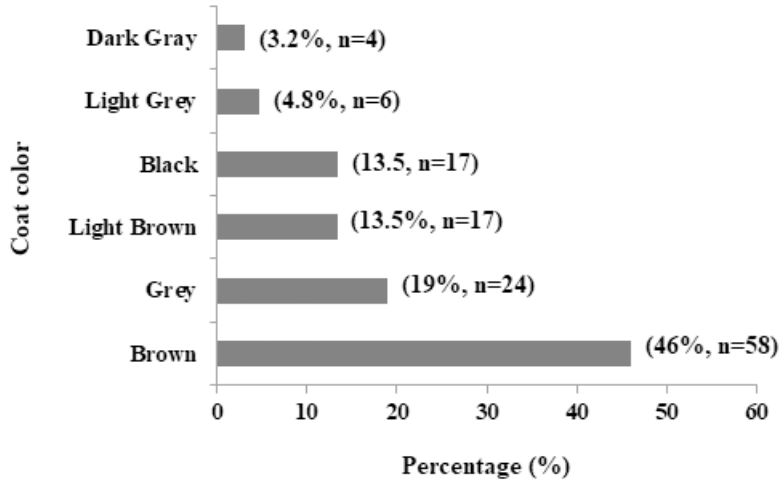
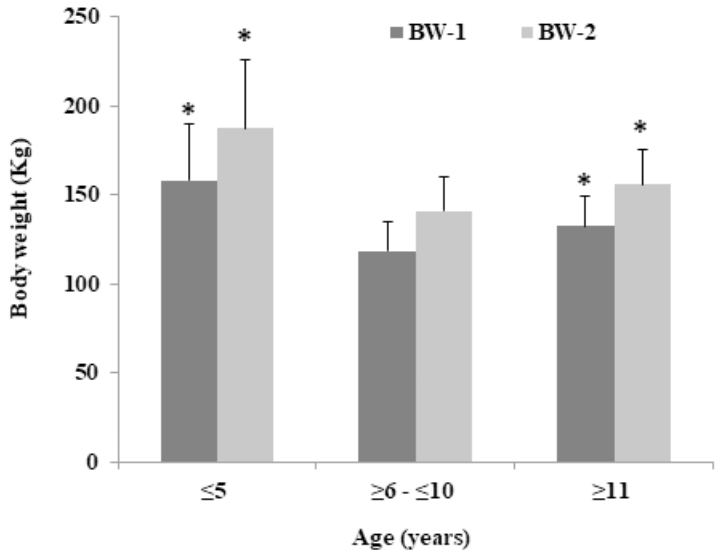


Figure 2. Frequency distribution of coat color of donkey in Kabylie area, Algeria

ranged between 0.51 and 0.58 ($P < 0.05$). Other low or very low correlation values were found between the others morphological parameters. There were also no high negative correlations between all other traits. For the body weight, the correlations were more marked with TC ($r = 0.99$), moderately marked with HL; WH and CH ($0.50 \geq r \leq 0.70$), and weakly marked with the rest of the morphological parameters ($P < 0.05$).

The results of body biometric indexes are summarized in Table 4. Dactyl thoracic Index (DTI), Compact Index (CI), Massive index (MI) and relative body index (RBI) appeared to be influenced by donkey ages ($P > 0.05$). The averages of the DTI, CI, MI and RBI index are 0.18 ± 0.01, 1.34 ± 0.2, 1.11 ± 0.06 and 0.93 ± 0.06, respectively. The BPI, FBH and PHI indexes are 0.97 ± 0.05; 0.66 ± 0.04 and 0.98 ± 0.04 respectively.



Means with the same superscripts in each weight of different ages are significantly different (*$P < 0.05$).

Figure 3. Weight of donkey by age groups (young: ≤ 5 years aged; adulte: ≥ 5 - ≤ 10 years aged; aged: ≥ 11 years)

Table 1. Descriptive analysis of donkey body measurements in Kabylie area, Algeria

	Mean ± SD	Min-Max	Median	CV (%)	95 % CI
BW-1 (kg)	144.3 ± 23.9	91.2 - 107.5	146.2	0.165	473 - 718.1
BW-2 (kg)	171.5 ± 28.8	107.5 - 250.8	172.8	0.168	679.7 - 1031.9
HL (cm)	48.5 ± 3.3	40 - 56	48	0.069	9.1 - 13.8
EL (cm)	24.4 ± 1.8	20 - 28	25	0.074	2.7 - 4.1
NL (cm)	46 ± 4.7	33 - 56	47	0.102	18.1 - 27.4
CW (cm)	25.6 ± 1.9	20 - 29	26	0.073	7.1 - 10.8
BaL (cm)	63.2 ± 2.5	58 - 72	63	0.039	5 - 7.6
BoL (cm)	110.1 ± 5.9	91 - 130	110	0.054	28.6 - 43.4
HW (cm)	32.4 ± 1.6	29 - 40	32	0.051	2.2 - 3.4
UC (cm)	141.1 ± 10.3	108 - 161	142	0.073	86.3 - 131
BH (cm)	107.2 ± 5.3	92 - 120	107.5	0.039	23.2 - 35.2
HR (cm)	109.6 ± 4.8	97 - 118	110	0.044	18.9 - 28.7
TC (cm)	118.5 ± 7.5	100 - 137	119.5	0.063	45.9 - 69.8
CD (cm)	49.2 ± 1.94	44 - 56	49	0.039	3.1 - 4.7
WH (cm)	106.9 ± 5.4	94 - 118	107	0.051	24.3 - 36.9
FLL (cm)	75 ± 3.9	51 - 82	75	0.052	12.6 - 19.2
CC (cm)	14.7 ± 1.1	12 - 23	15	0.078	1.1 - 1.6
CL (cm)	21.07 ± 1.72	14 - 25	21	0.081	2.4 - 3.7
HC (cm)	31.98 ± 2.92	17.5 - 38	32	0.091	7 - 10.6

Min: minimal value; Max: maximal value; CV: coefficient of variation; CI: confidence interval.

Table 2. Morphometric measurements of the donkeys in Kabylie area, Algeria

Body variables (cm)	Young donkeys (≤ 5 years) (n = 13) (Mean ± SD)	Adult donkeys (≥ 6 - ≤ 10 years) (n = 62) (Mean ± SD)	Aged donkeys (≥ 11 years) (n = 51) (Mean ± SD)
HL	47.8 ± 5.3^{a}	46.3 ± 2.3^{a}	47.1 ± 2.1
EL	24.8 ± 1.9	23.6 ± 2.4	23.7 ± 1.6
NL	44.4 ± 5.4	48.9 ± 1	48.2 ± 1.6
CW	25.6 ± 2.1^{a}	24.7 ± 2.3^{a,b}	25.2 ± 1.3^{b}
BaL	63.5 ± 3.8^{a}	61.7 ± 1.5^{b}	62.1 ± 2.2^{a,b}
BoL	107.3 ± 8.7^{a}	109.6 ± 3.5	108.4 ± 6.4^{a}
HW	33.2 ± 2.9^{a,b}	32.5 ± 0.9^{a}	32.1 ± 2^{b}
UC	137.5 ± 14.6	142.8 ± 12.5	143.4 ± 9.3
BH	105.8 ± 6	107.8 ± 5.3^{a}	105.8 ± 4.2^{a}
HR	110.2 ± 5.8	108.7 ± 5.3^{a}	107.2 ± 3.7^{a}
TC	112.2 ± 9.8^{a,b}	110.2 ± 5.9^{a}	114.8 ± 5.8^{b}
CD	48.8 ± 3.2^{a,b}	49.6 ± 1.2^{a}	48.4 ± 2.1^{b}
WH	106 ± 6.3	105.3 ± 4.8	103.2 ± 5.2
FLL	73.5 ± 7.5^{a}	77.2 ± 1.6^{a,b}	73.5 ± 3.2^{b}
CC	14.5 ± 1.3^{a}	14.8 ± 0.6^{a,b}	14.7 ± 0.9^{b}
CL	21.5 ± 1.6	20 ± 1.4	20.5 ± 0.7
CH	32.5 ± 2.1^{a}	30.3 ± 0.6^{a,b}	30.8 ± 1.1^{b}

^{a,b} Means with the same letters superscripts in each row of different ages are significantly different (P < 0.05).

Table 3. Phenotypic correlation coefficients (r) between body measurements in donkeys (*P < 0.05)

	BW-1	BW-2	HL	EL	NL	CW	BaL	BoL	HW	UC	BH	HR	TC	CD	WH	FLL	CC	CL	CH
BW-1																			
BW-2	**0.99***																		
HL	**0.53***	**0.55***																	
EL	033*	0.34*	0.23*																
NL	-0.08	-0.08	-0.35*	0.07															
CW	0.40*	0.40*	-0.01	0.12	0.13														
BaL	0.48*	0.50*	0.43*	0.28*	-0.08	0.34*													
BoL	0.34*	0.37*	0.27*	0.47*	0.14	0.05	0.29*												
HW	0.29*	0.30*	0.15	0.31*	0.02*	0.23	0.32*	0.25*											
UC	0.17	0.19*	0.32*	0.30*	-0.08	-0.13	0.26*	0.33*	0.22*										
BH	0.36*	0.40*	0.36*	0.38*	0.05	0.09	0.41*	0.46*	0.40*	0.46*									
HR	0.49*	**0.52***	0.32*	0.40*	-0.04	0.08	0.41*	0.49*	0.36*	0.44*	**0.72***								
TC	**0.99***	**0.99***	**0.54***	0.33*	-0.07	0.40*	0.45*	0.35*	0.26*	0.17	0.36*	0.47*							
CD	0.37*	0.39*	0.22*	0.16	-0.04	0.39*	0.47*	0.25*	0.27*	0.22*	0.40*	0.31*	0.36*						
WH	**0.51***	**0.56***	0.45	0.41*	-0.09	0.20	**0.53***	**0.51***	0.41*	0.36*	**0.80***	**0.72***	**0.51***	0.45*					
FLL	0.25*	0.26*	0.07	0.21*	0.22*	**0.60***	0.40*	0.28*	0.39*	0.13	0.40*	0.39*	0.24*	0.35*	0.41*				
CC	0.25*	0.25*	0.19*	0.01	0.14	0.12	0.16	0.10	0.16	0.19*	0.08	0.14	0.25	0.17	0.14	0.19*			
CL	0.39*	0.40*	0.39*	0.36*	-0.06	0.17	0.32*	0.35*	0.18	0.18	0.35*	0.42*	0.39*	0.29*	0.41*	0.29	0.16		
CH	**0.58***	**0.60***	0.25*	0.37*	-0.03	0.33*	0.38*	0.32*	0.34*	0.19*	0.43*	**0.56***	**0.58***	0.31*	**0.56***	0.36*	0.16	0.46*	

Head length (HL); Ear length (EL); Neck length (NL); Chest width (CW); Back length (BaL); Body length (BoL); Hips width (HW); Umbilical circumference (UC); Back height (BH); Height at the rump (HR); Thoracic circumference (TC); Chest depth (CD); Withers Height (WH); Front leg length (FLL); Cannon circumference (CC); Cannon length (CL); Cannon height (CH).
* P < 0.05

Table 4. Morphometric index of the donkeys in Kabylie area, Algeria

Index	Young donkeys (≤ 5 years) (n = 13) (Mean ± SD)	Adult donkeys (> 6 - < 10 years) (n = 62) (Mean ± SD)	Aged donkeys (> 11 years) (n = 51) (Mean ± SD)	Donkeys Total (n = 126) (Mean ± SD)
BPI	0.99 ± 0.05	0.97 ± 0.05	0.97 ± 0.05	0.97 ± 0.05
PHI	0.67 ± 0.08	0.66 ± 0.03	0.66 ± 0.04	0.66 ± 0.04
DTI	0.18 ± 0.01[a]	0.17 ± 0.02[b]	0.18 ± 0.01[a,b]	0.18 ± 0.01
CI	1.46 ± 0.26[a]	1.36 ± 0.2	1.3 ± 0.16[a]	1.34 ± 0.2
FBH	0.96 ± 0.03	0.98 ± 0.04	0.98 ± 0.04	0.98 ± 0.04
MI	1.14 ± 0.05[a,b]	1.11 ± 0.06[a]	1.09 ± 0.07[b]	1.11 ± 0.06
RBI	0.89 ± 0.04[a,b]	0.93 ± 0.07[a]	0.95 ± 0.06[b]	0.93 ± 0.06

Body Profile Index (BPI), Pectoral height index (PHI), Dactyl thoracic index (DTI), Compact index (CI), Front-back height (FBH), Massive index (MI), Relative Body Index (RBI).
[a,b] Means with the same letter superscripts in each row of different ages are significantly different (P < 0.05).

The analysis of the correlation coefficients between the biometric indexes (Table 5) shows both negative and positive correlations (P < 0.001). Particularly significant positive correlation (P < 0.001) is recorded between CI and MI (r = 0.816) on one hand with significant negative correlation (P < 0.001) between CI and RBI (r = -0.71) on the other hand.

Table 5. Correlation coefficients (r) between morphometric index in donkeys

	BPI	PHI	DTI	CI	FBH	MI	RBI
BPI	-	-	-	-	-	-	-
PHI	0.038	-	-	-	-	-	-
DTI	-0.095	-0.065	-	-	-	-	-
CI	-0.001	0.034	-0.464*	-	-	-	-
FBH	0.395*	0.045	-0.011	-0.046	-	-	-
MI	0.233*	0.085	-0.469*	**0.816***	-0.329*	-	-
RBI	**-0.536***	-0.104	0.474*	**-0.71**	-0.006	**-0.69***	-

Body Profile Index (BPI), Pectoral height index (PHI), Dactyl thoracic index (DTI), Compact index (CI), Front-back height in (FBH), Massive index (MI), Relative Body Index (RBI). *P < 0.001.

DISCUSSION

Around world, and particularly in Africa, donkey is suitable in difficult regions, especially in mountainous area. They played a major role in the evolution of agriculture until the introduction mechanization that neglected this animal. Traditionally, donkeys are part of the Algerian agricultural systems used as a mean of products transport and animal draft, especially in Kabylie area. The morphobiometric characterization has been proposed as one of the strategies for analyzing and characterization of domestic populations (Bouchel *et al.*, 1997). The general objective of the current study was therefore to evaluate the morphometric variation and some biometric indexes; and to estimate the correlation coefficient between measurements of donkey in Kabylie region.

Out of a total of 126 donkeys, only two females were sampled in the present study. In Kabylie region, as in all of North Africa, donkey is certainly the most used animal in the daily life of people, especially in the village constructions. However, there are no donkey females in Kabylie area. Indeed, possession of a donkey female is not allowed for traditional reasons as breeding are located in the other regions of Algeria.

The results of survey revealed that the coat color was diversified with a predominance of brown color (46 %) following by grey color (19 %). In another survey conducted in the Tlemcen area of the East Northern Algeria, Labbaci *et al.*, (2018) reported a similar observation with the presence of five different classes of color of the studied donkeys. In Bulgaria, the coat color also varies where the more common colors are brown (57 %) and grey (Vleava *et al.*, 2016). The body coat color frequencies the Turkish donkeys are: mouse gray, white, black and brown (31.4 %, 24.7 %, 23.7 % and 20.2 %, respectively) (Yimlez and Ertuğrul, 2012). In Ethiopia, a variability of coat color in donkeys has been reported from some country localities (Kefena *et al.*, 2011). In North African region, there are two fundamental denominations of the donkey "*aγyul*" and "*ayzeḍ*", very widespread in Berber language. The word "aγyul" could be a term related to the brown color and derivative of the verb "*iγwal*" which means to be brown in the Touareg population of Southern Algeria (Camps *et al.*, 1985). Our results show that the donkey population was heterogeneous in Kabylie region. This difference of coat color could be attributed to ecological patterns and altitudinal gradients (Gizaw *et al.*, 2007).

Body weights were compared between young, adult and aged donkeys. Our results corroborate with those reported by Ebangi and Vall (1998) revealing a consistent development in body weight for estimated from 1 to 8 years with a decline thereafter. A similar donkey body weight was found in south-western Zimbabwe (Nengomasha *et al.*, 1996; 1999). In another study, the body weight average was higher than those reported by Nininahazwe *et al.* (2017) in West African and Stanišić *et al.* (2015) in Serbia. Also, this body weight is lower compared to investigation in Morocco (Boudjenane *et al.*, 2008). The differences between the average weight values can be

explained by the condition of the donkeys when taking the measurements, but also by the formulas used to estimate body weight.

Our findings revealed that young animals, adults, and aged animals do not present the same body parameters and this increases concomitantly with age for certain parameters (Table 3). There was a significant difference between the values of some variables measurements (CW, TC and CL) according to the animal age classes. This would be due to the fact that the physiological evolution according to animal age leads to an increase in weight and morphological growth. These findings corroborate with results obtained previously (Roamba, 2014; Kaboré, 2014; Nininahazwe *et al.*, 2017; Labbaci *et al.*, 2018). The size and body dimensions of donkeys in Kabylie region were similar to those reported in other parts of Africa e.g. Morocco (Pearson and Ouassat, 1996), Zimbabwe (Nengomasha *et al.*, 1999). It is reported by Wilson (1981) that there is little physical variation in donkeys found throughout Africa. Algerian donkeys have a less long body length than donkeys of Bulgaria (Barzev, 2004), Cyprus (Barzev, 2004), Turkey (Yilmaz and Ertuğru, 2012) and Martina Franca (Barzev, 2004). In Kabylie region, donkeys are used for pack transport to carry all types of merchandise e.g. during the olive picking period. The results of this study noticed that donkeys are small in size compared to the other mentioned above. This can be explained by the difficulty of living conditions such as food quantity and quality and work intensity.

From the analysis of obtained results, the correlations among 17 morphological variables observed, in general, are positive ($P < 0.05$) and similar to those reported in numerous studies (Folch and Jordana, 1997; Yilmaz and Ertuğru, 2012; Yilmaz *et al.*, 2013; Daloum *et al.*, 2015; Sobotková *et al.*, 2015).

The correlations between BW and some measurements were significant ($p < 0.05$). Regardless of the age of the donkey, the TC was the only measure highly correlated with the both results of BW formulas. Many investigations have reported a correlation coefficient of 0.90 between BW and TC (Pearson and Ouassat, 1996; Nengomasha *et al.*, 1999; Hassan *et al.*, 2013; Nininahazwe *et al.*, 2017). Furthermore, Aluja et al (2005) confirmed that the thoracic circumference was found to be an easier and more reliable measurement compared to the umbilical circumference which could be affected by other factors such as the moment of food ingestion, the food quantity and the physiological state (gestation).

In order to study deeply donkey conformation in Kabylie area, some indexes were assessed from the morphometric measurements. Our results have shown a statistically conclusive difference of biometric indexes (DTI, CI, MI and RBI) between different age groups. It is difficult to compare these results with others reported in literature because of the lack of studies on biometric indexes in donkeys.

The body profile index was 0.97. This value allows to classify the animal population as a longlinear breed ($BPI < 1$), meaning that its total length is substantially equal to its height. These results corroborate with those reported in donkey by Daloum *et al.* (2015) and, Folch and Jordana (1997) but seem to disagree with the results obtained in the Arabian horses Barbe and Barbe (Chabchoub *et al.*, 2004). The dactylo thoracic index shows a relationship between the mass of individuals and the members that sustain it. The DTI of the donkeys studied is defined as animals among to the category of hypermetric donkeys ($DTI < 1$). These results are comparable to those obtained in Spain (Folch and Jordana, 1997), Tchad (Daloum *et al.*, 2015) and Cameroun (Defeu *et al.*, 2015).

The compact index explains that the body mass of the studied donkey is greater than its size, i.e. the animal does not support its weight. In this study, the donkeys sampled have massive overload (1.34 ± 0.2 kg/cm), this corroborate with those reported by Daloum *et al.* (2015) and Defeu *et al.* (2015). The MI confirmed that donkeys studied in Kabylie area have a body overload ($MI > 1$). Similar characteristic is found in domestic donkeys of the Sahelian region, Tchad (Daloum *et al.*, 2015). Moreover, there was a high positive correlation between CI and MI ($r = 0.816$, $P < 0.001$).

The pectoral height index (PHI) indicated that donkeys are short-legged. The front-to-back height (FBH) suggests that donkeys have a posterior region higher than the anterior region. In this current investigation, it is revealed that donkeys are short-legged ($PHI > 0.56$) with a straight back ($FBH \leq 1$). Our finding does not corroborate with those reported by Folch and Jordana (1997), where the height at the withers and the height at the rump are equal in the Catalan race, in other terms well

balanced. The massive index indicates whether the animal supports its weight.

According to the relative body index (RBI), the obtained results (0.93 ± 0.06) confirm that donkeys are elongated in the study area (RBI > 0.90). Recently, Defeu *et al.* (2015) recorded a high RBI in the domestic donkeys of Northwest Cameroon. However, a low of RBI values has been found in different Algerian horse breed (Guedaoura *et al.*, 2011). A negative correlation was found between CI and RBI ($r = -0.71$, $P < 0.001$), i.e. the weight varies with the body length. A considerable genetic variability was observed between our results and cited studies previously. This difference could be attributed to the geographical origin of donkey genetics, which adapts to the warm and humid environment that affects the growth and development of the body.

CONCLUSION

This is a first report on the phenotypic characterization in donkeys in Kabylie area (Algeria) based on corporal measurements. Our comparative analysis of morphometric parameters; such as back length, body length, neck length; suggests that donkeys of Kabylie area are typically invariant among breeds and it has not been changed through the periods. These obtained results constitute a baseline data for a deeper understanding of the genetic diversity in equines and for using in genetic improvement. However, the molecular characterization would better identify donkey breeds in Algeria.

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