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Original Research Paper

Morphobiometric characterization of donkey resources in the extreme west of Algeria

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Abstract

The goal of this study is to characterize the diversity of the Algerian south donkey population, characterize its biometric variability, and determine the evolutionary relationships of this animal with its congeners at various latitudes. A total of sixty-six adult asses, distributed on the level of three wilayas from where eleven body measurements, six body indexes developed in horses and adapted to donkeys were calculated, and seven phenotypical characters were retained for this study. Measurements Lsi, HG, TP, LH, LE, Pc, LT, LO, LQ, LaT, Tm, Pv1, Pv2 are respectively: 98.05±10.46; 105.31±6.59; 188.88 ±8.61; 32.62±4.61; 27,17±4.41; 15.52±2.42; 50.92±3.82; 24.07±3.59; 39.24±14.30; 23.174±3.09; 41.82±3.52; 171.83±32.76; 145.83±27.62.Those information are used to compute 6 body indexes. According to body and profile indexes we deduce that our animals were medial linear and small (PI ≈ 1,08 and BI ≈ 0,82), they could not even bear their own weight loads (CI > 1), their heads were long (HI ≈ 0,45< 1) with a square body shape (LI ≈ 0,93< 1,10). Donkeys' thoracic development was average according to (CD≈ 1,13). All parameters except the LE, PC, TM for the regions showed a significant difference on examined body measurements (p>0,05). On the phenotypical characteristics, a factorial analysis of the multiple correspondences revealed two main components that account for 48,90 and 44,26 % of total inertia, or 93,2 %. These percentages are related to the dress color, the head, the members, the hairs, the muzzle, and the belly. This research revealed significant phenotypic differences that should be included in the specie's characterization and conservation efforts.

Keywor ds: population, Algerian south donkey, phenotypical characteristics, characterization, conservation.

الملخص

الهدف من هذه الدراسة هو توصيف تنوع مجموعات الحمير الجزائرية الجنوبية، والتباين البيومتري، وتحديد العلاقات التطورية لهذا الحيوان مع نظائره على مختلف المستويات. إجمالي ستة وستين حمارًا بالغًا، موزعة على مستوى ثلاث ولايات أخذ منها أحد عشر قياسًا للجسم، وستة مؤشرات للجسم تم تطويرها في الخيول وتكييفها مع الحمير، وتم الأخذ بسبعة سمات ظاهرية لهذه الدراسة. القياسات Lsi, HG, TP, LH, LE, PC, LT, LO, LQ, LT, Tm, Pv1, Pv2هي على التوالي: 98,05 ± 10,46؛ 105.31±6.59؛ 188.88 ±8.61؛ 32.62±4.61؛ 27,17±4.41؛ 15.52±2.42؛ 50.92±3.82؛ 24.07±3.59؛ 39.24±14.30؛ 23.17±3.09؛ 41.82±3.52؛ 171.83±32.76؛ 145.83±27.62. تستخدم هذه المعلومات لحساب 6 مؤشرات للجسم. وفقًا لمؤشرات الجسم والمظهر، نستنتج أن حيواناتنا كانت خطية وسطية وصغيرة (PI 1،08) و(BI 0،82)، لم يكن بإمكانهم حتى تحمل أحمال وزنهم (CI > 1)، وقد امتلكت رؤوسا طويلة (1<) HI ≈ 0،45) مع شكل جسم مربع (1،10<) LI ≈ 0،93). متوسط نمو صدر الحمير كان (CD≈ 1،13). أظهرت جميع الصفات باستثناءTM ، PC، LEللمناطق فرقًا معنويًا في قياسات الجسم التي تم فحصها. (0،05 <p) فيما يتعلق بالخصائص المظهرية، كشف تحليل متعدد المكونات مكونين رئيسيين يمثلان 48،90 و44،26٪ من إجمالي القصور الذاتي، أو 93،2٪. ترتبط هذه النسب بلون الفرو، والرأس، والأرجل، والشعر، وكمامة الفم، والبطن. كشف هذا البحث عن اختلافات نمطية كبيرة يجب تضمينها في توصيف النوع وجهود الحفظ.

الكلمات الرئيسية: مجموعات، الحمار الجنوبي الجزائري، الخصائص الظاهرية، التوصيف، الحفظ.

Introduction

Biodiversity in agriculture is the result of thousands of years of human activity in which he sought to suit his requirements in a variety of climatic and ecological settings. The domestication of the African wild ass changed ancient African and Asian transportation routes, as well as the organization of early cities and pastoral cultures. Donkeys are scarce in the archaeological record, and indicators for early stages of animal domestication are difficult to determine. Genetic research suggests that the donkey originated in Africa, but defining the period and site of domestication has been difficult (Rossel et al. 2008).

Farm animals have always been an important part of agricultural production systems, particularly in harsh climates where growing crops is difficult, if not impossible. Zoo genetic variety serves as a resource for breeders looking to choose animals and produce new breeds. More broadly, genetically diverse farm animal populations provide society with a broader range of options for addressing future difficulties.

In rural areas, this animal has a much higher traction force than beef and horses because of its hardiness and resistance (Kaggwa EK et al., 1988): it transports people, water, and aids transhumant movement. These activities have also been reported in Burkina Faso (Blench RM., 2000), Senegal (Blench RM., 2004), and Cameroon (Doutressoulle G., 1947; Roamba CR., 1990; Tafaro A et al., 2007). The rugged terrain of the country's mountainous west, as well as the scarcity of water points, justifies the use of a donkey with an artisanal saddle and/or a basket box for transporting jars and water cans. The donkey is used to transport goods (fruits, food inputs, building materials, etc.) as well as collect garbage and household waste in urban alleys where vehicles cannot access. Other African countries, such as Senegal and Burkina Faso, are experiencing the same phenomenon (Ouedraogo T et al.,1996; Tapsoba M., 2012).

Characterization of animal genetic resources includes the identification, qualitative and quantitative description, and documentation of animal populations. The goal is to learn more about animal genetic resources, such as their current and potential applications for food and agriculture in specific areas, as well as their current status as diverse racial communities (FAO, 1984; Rege, 1992).

Unfortunately, the population of this species has been drastically declining in recent years. Indeed, the population has decreased from 166380 in 2003 to 86987 in 2019. (FAO, 2019). Only a few studies on this species have been conducted in Algeria (Labbaci et al. 2018; Ayad et al. 2019; Hannani et al. 2020), so our understanding of its zoological potential is limited. In this context, this study aimed to provide some aspects of a solution by addressing the problem at the scale of a large region of Algeria using a morphological characterization technique (West and South). This stage is required before beginning a program to manage and improve this resource.

Materials and methods

Study areas and morpho-biometric measurements

Measurements were taken on a sample of sixty-six adult hens (35 males and 31 females) raised in three wilayas (Elbayadh, Adrar and, Naâma) in accordance with the FAO (2013) survey file in order to standardize their morphological characteristics. These measurements are: Scapulo-ischial length (Lsi) or body length, Height at withers (HG), chest circumference (TP), Hip width (LH), Shoulder Width (LE), Barrel Perimeter (PC), head length (LoT), Length of ears (LoO), tail length (LQ), head width (LaT), Muzzle circumference (TM).

Body measurements were used not only for characterization of animals but also for determination of body weight (Pearson, and Ouassat., 2000; Vall et al.,2002). Five body indexes developed in horses and adapted to donkeys were calculated:

The profile index (PI) = HG/Lsi and the body index (BI) = LSI/TP made it possible to distinguish the brevi-linear, medial-linear and longitudinal conformations. The animals were small (<1) or medium (=1); adapted to traction. They could also have a long conformation (>1); fast animals. HI= head index

= head width/head length, the closer the HI is to 1, the head width and head length have equivalent values, resulting in a square head phenotype. The Compactness Index (CI) = PV/HG (Boujenane et Machmoum, 2008). Length index (LI)= LSI/HG; If 0,90>LI<1,10: the body shape is square. If LI>1,10: the body shape is oblong (long). Thoracic development (CD) = TP/HG If DT > 1,2 the animal has significant thoracic development.

The coat color of animals was also documented to these dimensions. Data on each animal (sex, age, locality, and so forth) was gathered. The breeders generally give the donkey's age, but the dentition confirms it. The nomogram assessed the life weight of the animals using four equations given by Svendsen, (1997); Boujenane et Machmoum, (2008); Pearson and Ouassat., (2000).

Statistical analysis

The body measurements were analyzed using the SPSS v 26 software. The effect of sex and region was compared by the Student Newman-Keuls multiple comparison test. A Principal Component Analysis (PCA) was carried out in order to group homogeneous individuals to differentiate donkeys according to certain criteria that could be identified for the definition of a classification of animals and build a typology that consists in clearly identifying the studied populations. A Multiple Correspondence Factor Analysis (MCA) was used for the qualitative variables to present the most significant characters for each group identification.

Ascending Hierarchical Classification (AHC) was used to obtain the optimal number of groups that exist at the level of our sample; These tests were processed by the SPSS software (version 26).

Shannon and weaner Diversity Index was calculated using Excel software for Windows (Version.2021), Shannon Index is defined and given by the following function:

$$H' = - \sum_{i=1}^{s} pi * ln\,(pi)$$

Where pi is the proportion of the total sample represented by species i. Divide the number of individuals of species i by the total number of samples. S is the total number of species. H.max = ln(S) = maximum possible diversity, and finally E = regularity = H'/Hmax.

Results and discussion

Morpho-biometric characteristics

Descriptive analysis of quantitative characteristics

Body measurements

The different body measurements of donkeys are reported in Table 1

The height at the withers and the circumference of the chest allow to determine the weight of the donkey; using the nomogram (Pearson and Ouassat., 2000; Vall et al.,2002).

Results showed that the estimate of the average live weight by the two formulas is different. It is (171,83±32,76) kg and (145,83±27,62) according to Svendsen; Pearson and Ouassat (1996; 2000) formulas. Comparing our population with populations studied in other countries, we note a lower live weight of those of Tunisia (AROUA et al., 2020), Egypt (Mostafa et al., 2020), Serbia (174,5±36,92) cm (Stanisic et al. 2020), and (208,7 ±28,0) cm (Djokovic et al. 2020), and the donkey of Tlemcen (196,45±31,15) (labbaci et al. 2018). However, there is a superiority of that of concerning the Senegalese donkey (Roamba., 2014), the Sahel donkey of Burkina Faso (Kabore., 2014), the Algerian east (151,30 ± 25,45 /158,83 ± 26,77) (Hannani et al. 2020), Kabylia (144,3±23,9/171,5±28,8) (Ayad et al. 2019). Our population has a higher body weight.

According to Nicks et al. (2006), size at withers (HG) is the most frequently cited parameter for the size of animals. The majority of the population has an average HG lower to those of Serbia(Djokovic

et al. 2020), the Ethiopian donkey Sinnar (Kefena., 2011), the eastern Algeria population (Hannani et al. 2020), Kabylia (Ayad et al. 2019), the Tunisian donkey (Aroua et al., 2020), Egyptian donkey (Mostafa et al., 2020).and Tlemcen population (labbaci et al ,2018), higher to that of Nigeria (Khaleel et al. 2020) and Senegal (Roamba., 2014) and the Sahel of Burkina Faso (Kabore., 2014).

Cephalic measurements were used to identify the breed, origin and relationship between species (Jewel, 1963). These cephalic measurements showed a head width lower to the donkey of Serbia (Stanisic et al. 2020). The length of the head is superior to that of the Ethiopian donkey Sinnar (Kefena., 2011) and that of the Kabylie (Ayad et al. 2019), also, higher than the results reported on the Tunisian donkey (Aroua et al., 2020), Eastern Algeria (Hannani et al. 2020) and Nigeria (Khaleel et al. 2020). And the same as Tlemcen's population (Labbaci et al, 2018)

Measurement of the chest circumference taken behind the forelimbs and passing through the shoulder straps, the measurement behind the withers is more subject to variations due to the respiratory activity of the animals (inspiration/expiration) than the measurement at the height of the withers. This measure reflects the development of the chest and the muscles that cover it (Nicks et al., 2006). The donkey population studied has a thoracic development (TP) similar to that of the donkey of Kabylia (Ayad et al. 2019) and to that of the donkey population of Serbia (Djokovic et al. 2020), lower than that of the donkey of Egypt (Mostafa et al., 2020), and to that reported for the Tunisian population of Donkey (AROUA et al., 2020) and Serbia (Stanisic et al. 2020) and to Tlemcen's population (Labbaci et al ,2018). The TP values (118,88±8,61) cm at the level of our population are higher than those encountered in the donkey of Sinnar of Ethiopia (Kefena.,2011), the donkey of Eastern Algeria (Hannani et al. 2020) and those reported at the level of the population of Nigeria (Khaleel et al. 2020). It is noted that the donkey population studied has a larger thoracic cavity than that of the donkey of Senegal and the Sahel of Burkina Faso (Roamba.,2014; Kabore., 2014).

The perimeter of the barrel is used for the calculation of skeletal finesse (Cerqueira et al., 2011; Boujenane and Machmoum, 2008; Nicks et al., 2006). The values of this parameter (15,52±2,42) cm at the level of our population are higher than those reported in Tunisia (Ayad et al. 2019) and higher than those reported in Serbia population (Djokovic et al. 2020), Kabylia population (Ayad et al. 2019) and Tlemcen's population (Labbaci et al ,2018).

The length measured between the tip of the shoulder and the tip of the rump. our population has a body length (98,05±10,46) cm lower than that of eastern Algeria (Hannani et al. 2020) and Kabylia (Ayad et al. 2019) Serbia (Djokovic et al. 2020; Stanisic et al. 2020) higher than reported in Nigeria (Khaleel et al. 2020a) and Northwest Nigeria (John, Akpa, and Iyiola-Tunji 2017).

The ear length is the Distance from the base to the tip of the right ear throughout the dorsal surface. The population studied, expresses lower ear length (24,07±3,59) cm in compared to the populations of the Nigeria (Khaleel et al. 2020), Eastern Algeria (Hannani et al. 2020) Serbia (Djokovic et al. 2020; Stanisic et al. 2020) and Tlemcen population reported in the study of (labbaci et al ,2018). However, our results showed a higher ear length than northwest Nigeria (John, Akpa, Iyiola-Tunji 2017) and similar ear length compared to that of Kabylia area (Ayad et al. 2019) .

The shoulder width is the distance between the two shoulder points, it can be said that our population (LE= 27,17±4,41) cm is superior to the results obtained for northwest Nigeria (John, Akpa, and Iyiola-Tunji 2017) and inferior to that of the (Kefena.,2011) and equal to the donkeys reported in the morphometric study of (Labbaci et al ,2018).

Table 1. Descriptive analysis of body measurements in the surveyed population

	N	**Minimum**	**Maximum**	**Mean**	**Std. Error**	**Std. Deviation**	**Variance**
Lsi	66	80.00	116.00	98.05	1.29	10.46	109.41
HG	66	89.00	119.00	105.31	0.81	6.59	43.49
TP	66	100.00	136.00	118.88	1.06	8.61	74.13
LH	66	19.50	44.00	32.62	0.57	4.61	21.25
LE	66	18.00	36.00	27.17	0.54	4.41	19.42
Pc	66	12.00	28.00	15.52	0.30	2.42	5.85
LT	66	41.00	59.00	50.92	0.47	3.82	14.62
LO	66	18.00	39.00	24.07	0.44	3.59	12.88
LQ	66	21.00	79.00	39.24	1.76	14.30	204.39
LaT	66	18.50	32.00	23.17	0.38	3.09	9.53
Tm	66	32.00	49.00	41.82	0.43	3.52	12.42
Pv1	66	107.25	243.84	171.83	4.03	32.76	1072.96
Pv2	66	91.19	205.98	145.83	3.40	27.62	762.65
Pi	66	0.90	1.34	1.08	0.01	0.10	0.01
Bi	66	0.63	1.13	0.83	0.01	0.10	0.01
Ci	66	0.99	2.29	1.63	0.03	0.28	0.08
Hi	66	0.35	0.61	0.46	0.01	0.06	0.00
Li	66	0.75	1.11	0.93	0.01	0.08	0.01
Cd	66	0.89	1.35	1.13	0.01	0.08	0.01

Ischial scapulo length (Lsi), Height at withers (HG), Chest circumference (TP), Hip width (LH), Shoulder width (LE), Barrel circumference (PC), Head length (LoT), Ear length (Lo O), Tail length (LQ), Head width (LaT), Snout circumference (TM),Live Weight 1(pv1), Live Weight 2 (pv2),Profile Index (hg/lsi) (Pi),Body Index (lsi/tp) (Bi),Compactness Index (pv/hg) (Ci), Head Index lat/lot (Hi), Length Index lsi/hg (Li),Chest development (CD)

The profile and body indexes (PI≈ 1 and BI ≈ 0,80) showed that animals are medial linear and small. Also, according to the body index (CI > 1) the animals studied could not even bear their own weight loads. The results indicated that the donkeys were heavier than their size; therefore, they were overweight, their heads were long (0,45) (Table 1.

Based on the Head Index (HI) (0,45< 1) we can say that our population includes animals that have a long head and a square shape according to the Length Index (LI) (LI 0,93< 1,10). The value of the CD index is 1,13 which means that our animals have an average thoracic development.

Variation in measurements by gender

Body measurements for both sexes in the study population are presented in Table 2. Analysis of the data showed significant differences (p <0,05) between the two sexes for Barrel's circumference (PC). For the other characters the statistical analysis showed that there are no significant differences (p>0,05).

Taking sex as a factor (Table 2), we note a significant difference (p<0,05) in the zootechnical indexes related to chest development between males and Females but for the other indexes (PI, BI, HI, LI, CI) there was no significant difference between the two sexes (P>0,05).

Table 2. Variations in variables by gender

	gender	N	mean	Std. Deviation	P
Lsi	Female	31	96.94	10.46	ns
	Male	35	99.04	10.51	
HG	Female	31	105.00	6.33	ns
	Male	35	105.59	6.90	
TP	Female	31	120.57	8.86	ns
	Male	35	117.39	8.22	
LH	Female	31	34.32	3.89	ns
	Male	35	31.11	4.72	
LE	Female	31	28.63	3.98	ns
	Male	35	25.87	4.41	
Pc	Female	31	15.94	3.03	*
	Male	35	15.14	1.67	
LT	Female	31	51.34	3.75	ns
	Male	35	50.54	3.90	
LO	Female	31	24.53	3.71	ns
	Male	35	23.66	3.48	
LQ	Female	31	44.77	15.23	**
	Male	35	34.33	11.55	
LaT	Female	31	23.02	2.95	ns
	Male	35	23.31	3.24	
Tm	Female	31	42.98	3.03	ns
	Male	35	40.79	3.65	
Pv1	Female	31	177.99	33.88	ns
	Male	35	166.37	31.20	
Pv2	Female	31	151.39	28.82	ns
	Male	35	140.90	25.92	
Pi	female	31	1.09	0.10	ns
	male	35	1.07	0.09	
Bi	female	31	0.81	0.10	ns
	male	35	0.85	0.09	
Ci	female	31	1.69	0.30	ns
	male	35	1.57	0.24	
Hi	female	31	0.45	0.05	ns
	male	35	0.46	0.06	
Li	female	31	0.92	0.09	ns
	male	35	0.94	0.08	
Cd	female	31	1.15	0.09	*
	male	35	1.11	0.06	

Ischial scapulo length (Lsi), Height at withers (HG), Chest circumference (TP), Hip width (LH), Shoulder width (LE), Barrel circumference (PC), Head length (LoT), Ear length (Lo O), Tail length (LQ), Head width (LaT), Snout circumference (TM), Live Weight 1(pv1), Live Weight 2 (pv2), Profile Index (hg/lsi) (Pi), Body Index (lsi/tp) (Bi), Compactness Index (pv/hg) (Ci), Head Index lat/lot (Hi), Length Index lsi/hg (Li), Chest development (CD)

Variation in measurements by region:

The body measurements in the populations studied in different regions are present in Table 3. Statistical analysis showed that there are highly significant differences (p<0,0001) between the animals of the two wilayas studied for all the characters studied except for the characters (LE), (PC), (Tm) where there were no significant differences (p>0,05).

Table 3. Variations in variables by region

	Regions	N	Mean	Std. Deviation	P
Lsi	Adrar	21	93.95	6.80	
	naâma	16	92.78	7.29	***
	Elbayadh	29	103.93	11.33	
HG	Adrar	21	103.00	5.34	
	naâma	16	100.41	2.40	***
	Elbayadh	29	109.69	6.32	
TP	Adrar	21	120.67	7.67	
	naâma	16	110.91	5.07	***
	Elbayadh	29	121.98	8.22	
LH	Adrar	21	34.10	3.90	
	naâma	16	35.38	3.53	***
	Elbayadh	29	30.03	4.35	
LE	Adrar	21	27.14	3.55	
	naâma	16	25.44	3.48	ns
	Elbayadh	29	28.14	5.18	
Pc	Adrar	21	14.95	3.44	
	naâma	16	15.00	1.18	ns
	Elbayadh	29	16.21	1.86	
LT	Adrar	21	50.19	3.57	
	naâma	16	48.53	2.60	***
	Elbayadh	29	52.76	3.75	
LO	Adrar	21	26.38	4.33	
	naâma	16	23.66	3.22	***
	Elbayadh	29	22.62	2.16	
LQ	Adrar	21	57.14	9.07	
	naâma	16	37.25	5.00	***
	Elbayadh	29	27.36	3.69	
LaT	Adrar	21	23.19	2.62	
	naâma	16	20.34	1.22	***
	Elbayadh	29	24.72	3.06	
Tm	Adrar	21	42.57	4.12	
	naâma	16	41.56	4.10	ns
	Elbayadh	29	41.41	2.66	
Pv1	Adrar	21	177.08	30.05	
	naâma	16	141.06	17.17	***
	Elbayadh	29	185.00	30.77	
Pv2	Adrar	21	151.29	25.65	
	naâma	16	120.49	14.88	***
	Elbayadh	29	155.86	26.24	
Pi	Adrar	21	1.10	0.11	
	naâma	16	1.09	0.08	ns
	Elbayadh	29	1.06	0.10	
Bi	Adrar	21	0.78	0.07	
	naâma	16	0.84	0.05	**
	Elbayadh	29	0.86	0.12	
Ci	Adrar	21	1.72	0.27	
	naâma	16	1.40	0.16	***
	Elbayadh	29	1.69	0.27	
Hi	Adrar	21	0.46	0.04	
	naâma	16	0.42	0.04	**
	Elbayadh	29	0.47	0.07	
Li	Adrar	21	0.92	0.09	
	naâma	16	0.92	0.07	ns
	Elbayadh	29	0.95	0.09	
Cd	Adrar	21	1.17	0.08	
	naâma	16	1.10	0.05	**
	Elbayadh	29	1.11	0.09	

Ischial scapulo length (Lsi), Height at withers (HG), Chest circumference (TP), Hip width (LH), Shoulder width (LE), Barrel circumference (PC), Head length (LoT), Ear length (Lo O), Tail length (LQ), Head width (LaT), Snout circumference (TM), Live Weight 1(pv1), Live Weight 2 (pv2), Profile Index (hg/lsi) (Pi), Body Index (lsi/tp) (Bi), Compactness Index (pv/hg) (Ci), Head Index lat/lot (Hi), Length Index lsi/hg (Li), Chest development (CD)

Also, results showed a significant difference (p<0,05) in Body Index (BI), Compactness Index (CI), Head Index (HI), and Chest development (CD) on donkey populations at the level of the two wilayas of study. Regarding, the other characters (PI, LI) there are no significant differences between the individuals of the three regions (p>0,05).

Variation In Individuals

Analysis Of Variables

A Main Component Analysis (PCA) was performed on the variables studied. The first two axes of this PCA account for 56,80% of total inertia, which is relatively average statistically. The two axes have respectively 38,14% and 18,65% of the total inertia. (Table 4)

Table 4. Representation of PCA Eigen Values

Total variance explained					
component	Initial own values			Sums extracted from the load square		
	Total	% of variance	% cumulative	Total	% of variance	% cumulative
1	4.96	38.15	38.15	4.96	38.15	38.15
2	2.43	18.66	56.80	2.43	18.66	56.80
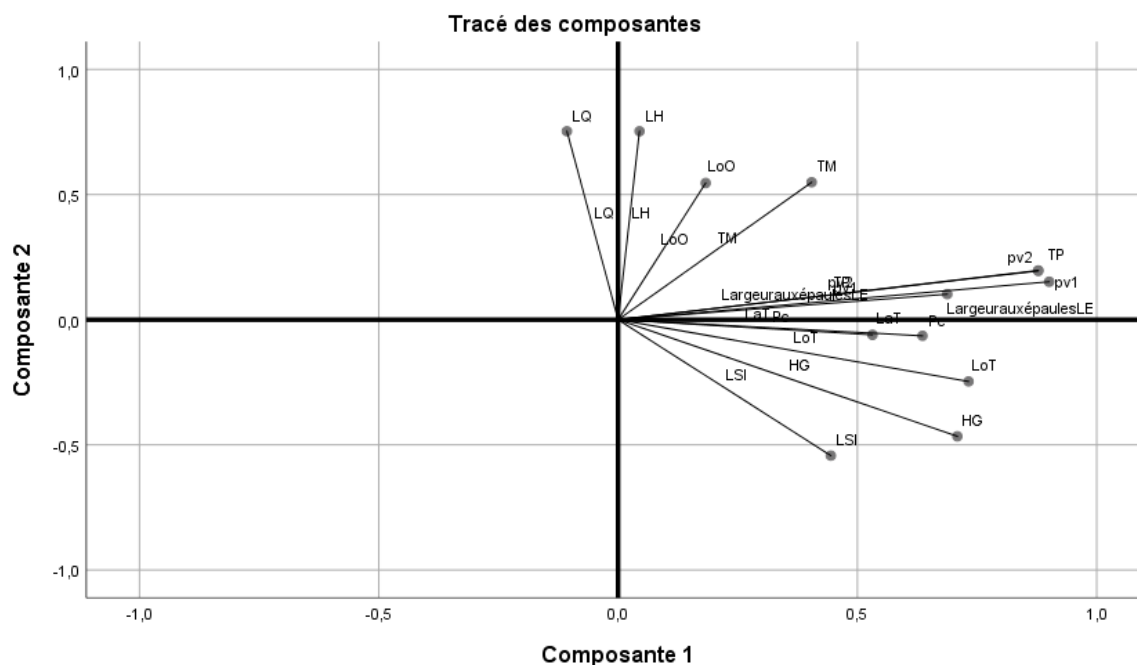
Figure 1: Presentation of body measurements by CPA in the donkey population

The graph shown in Figure 1 shows the formation of three groups of positively correlated variables, the first group contains (LH, LQ,LoO, TM) the second contains (PV1, PV2, TP, PC, LE, TM, LaT), the third contains (LSI,HG, LOT). There is a weak positive correlation between group 1 and 2, a strong positive correlation between groups 2and 3. LQ and LH from Group 1 forms a right angle with group 2 suggesting that there is no correlation between them.
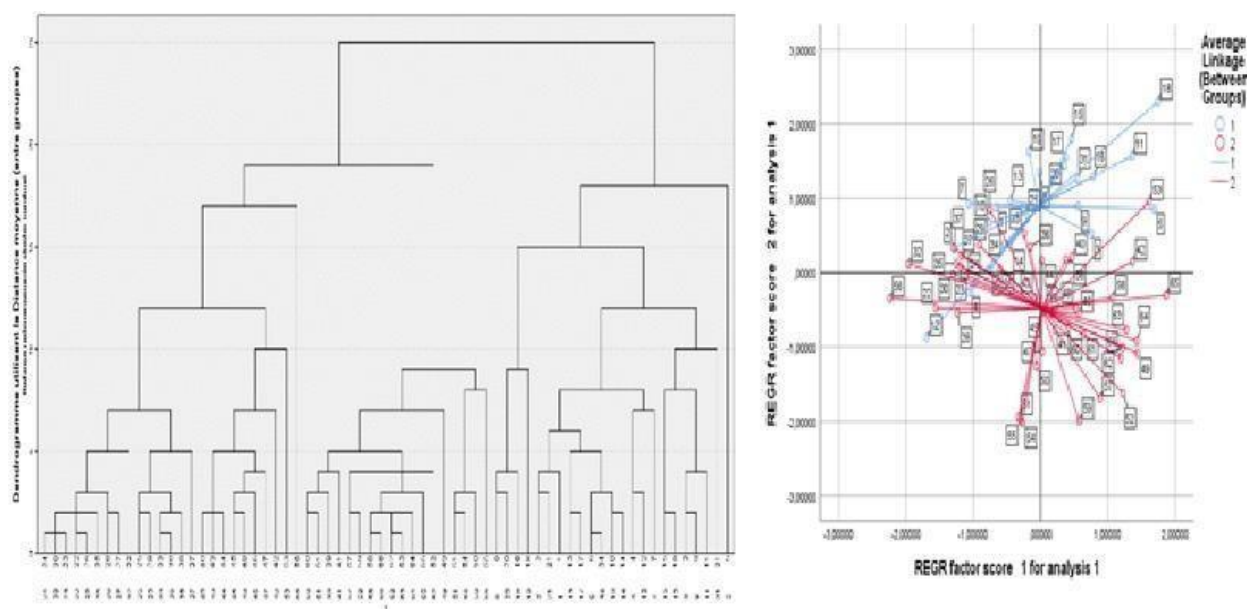
Figure 2. Hierarchicaltree using mean distance (between classes) in the donkey population

Class01: The twenty-three animals of this class are shorter (94,6±7,1) cm, smaller (102,9±5,1) cm and wider (34,4±4,3) cm than the animals of the second class. They have a more developed thoracic cavity (120,3±7,6) cm, very long ears (26,3±4,3) cm, a long head (50,3±3,4) cm and wide (23,0±2,6) cm, a significant muzzle circumference (42,9±4,1) cm. The live weight of animals of this class is very important (pv1 = 175,76kg / pv2 = 150, 16 kg)

Class 02: Animals in this class (43 individuals) make up the majority of the study population, they are longer (99,9±11,5) cm, taller (106,6±7,0) cm and less wide (31,7±4,5) cm than animals in the first class. They have a less developed thoracic cavity (118,1±9,1) cm, shorter ears (22,9±2,5) cm, a long and wide head (51,2±4,0) cm (21,1 1,7) cm respectively, a significant muzzle circumference (41,3 ±3,0) cm, the animals of this class are a little less heavy (PV1 =169,73 kg /PV2 = 143,51 kg) (Table 5).

Table 5. Classification of donkeys by CPA

	Class 01		Class 02	
N	**23**		**43**	
	Mean	S.D	Mean	S.D
LSI	94.6	7.1	99.9	11.5
HG	102.9	5.1	106.6	7.0
TP	120.3	7.6	118.1	9.1
LH	34.4	4.3	31.7	4.5
LE	27.5	3.6	27.0	4.8
PC	15.0	3.3	15.8	1.8
LT	50.3	3.4	51.2	4.0
LO	26.3	4.3	22.9	2.5
LQ	56.2	9.2	30.2	5.5
LAT	23.0	2.6	23.3	3.3
TM	42.9	4.1	41.3	3.0
Pv1	175.76	29.69	169.73	34.43
Pv2	150.16	25.43	143.51	28.74

Ischial Scapulo Length (LSI), Height at withers (HG), Chest Circumference (TP), Hip Width (LH), Shoulder Width (LE), Barrel Circumference (PC), Head Length (LoT), Ear Length (LoO), Tail Length (LQ), Head Width (LaT), Snout Circumference (TM), Live Weight 1(Pv1), Live Weight 2(Pv2)

Indice de Shannon pour les traits quantitatifs

Table 6. Shannon Diversity Index for the sample under consideration.

X	SI
LSI	1.038
HG	1.025
TP	1.035
LH	1.037
LE	1.032
PC	1.020
LT	1.035
LO	1.034
LQ	1.023
LAT	1.022
TM	1.038
PV1	1.038
PV2	1.035
Mean	1.032

(SI): *Shannon Index*.

The eleven traits studied showed similar levels of diversity (between 1,02 and 1,03) (Table 6), which may be explained by the fact that these traits are probably controlled by genes that have no significant effect on the body (possibility of cumulative mutations in genes over generations). It is also noted that this index is relatively average, probably reflecting average genetic diversity.

Phenotypic traits

Descriptive analysis

Table 7 represents the distribution of qualitative traits in our donkey population. There is a predominance of the brown color of the coat in almost half of our sample (51,5%), the head can be either grey (39,4%) or brown (33,3%), there is a predominance of white (51,5%) and grey (31,8%) color at the snout level. The horsehair is either black (43,9%) or brown (40,9%), the belly color is either white (33,3%), or brown (33,3%) the mucous membranes are mostly clear (53%).

The most commonly used measure of summarizing structure within and between populations are the F statistics developed by Wright (Wright, 1951; 1978). F statistics partition genetic variability as measured by levels of heterozygosity into components of within population and between population variations (McVean, 2001). The negative values of F_{IS} in all the loci is an indication of excess heterozygosity, though small effective population size could also contribute to this (Allendorf *et al*., 2013). The fixation index (F_{ST}) between both species at all loci are closer to zero than 1, as such both species in this study have allele frequencies that are not too divergent from each other. This rules out inbreeding within each species.

Phenotypic characterization

The Multiple Correspondence Analysis (MCA) showed phenotypic diversity within the surveyed population.it was carried out on 65 animals for the 7 qualitative traits studied on the donkey population in the study areas, it shows that the first two factor axes 1 and 2 express respectively 48,908% and 44,262% of total inertia, this represents 93,2 % of total inertia, which is very important statistically (Table 8). Axis 1 (48,90%) is represented by the following variables: Color of the coat, Color of the head, belly color, Color of the limbs, Color of the hair, Color of the mucous membranes. Axis 2 (44,26%) is presented by the variable: Color of muzzle (Figure 3).

**Table 7.** Distribution of Qualitative Traits in the Surveyed Population

Qualitative characters		Effective	Percentage
coat color	Grey	19	28.8%
	Black	8	12.1%
	Red	5	7.6%
	Brown	34	**51.5%**
color of the head	Grey	26	**39.4%**
	noire	17	25.8%
	White	1	1.5%
	marron	22	33.3%
Color of muzzle	Grey	21	31.8%
	Black	10	15.2%
	White	34	**51.5%**
Color of members	Grey	17	25.8%
	Black	22	**33.3%**
	White	12	18.2%
	Brown	15	22.7%
Color of the horsehair	Grey	10	15.2%
	Black	29	**43.9%**
	Brown	27	40.9%
Belly color	Grey	20	30.3%
	Brown	22	**33.3%**
	White	22	**33.3%**
color of the mucous membranes	Clear	35	**53.0%**
	Dark	31	47.0%

Table 8: Representation of ACM Eigen value

Summary of the models				
dimension	Cronbach's alpha	Variance represented		
		Total (own value)	inertia	% of variance
1	0.83	3.42	1	0.83
2	0.79	3.10	2	0.79
Total		6.52	Total	
mean	0.81a	3.26	mean	0.81a
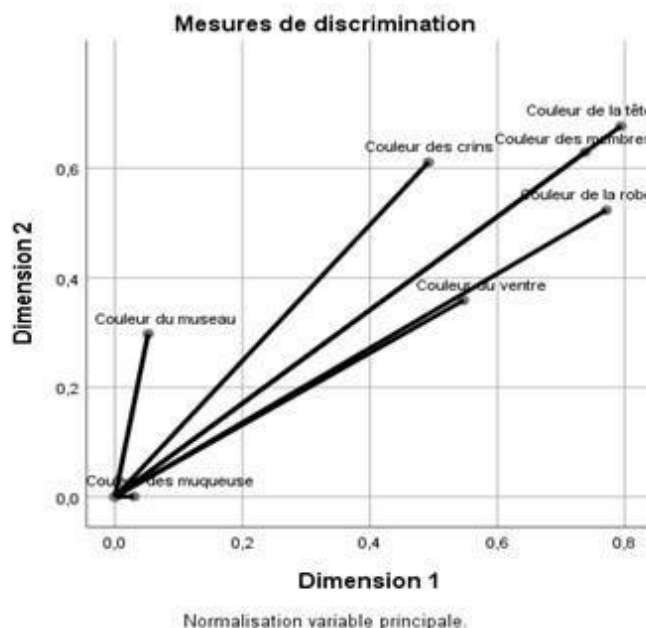
Figure 3. Graphical representation of variables by ACM
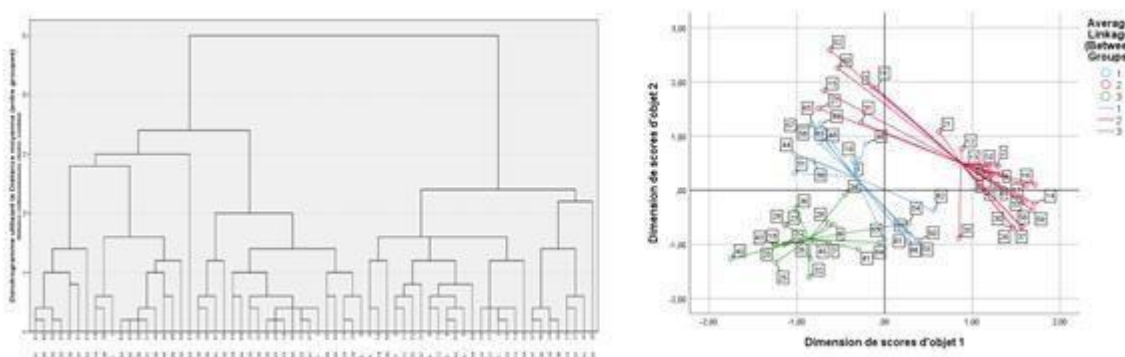
Figure 4. Hierarchicaltree using mean distance (between classes) in the study population (left) and Presentation of the individuals of the donkey population by CPA (right).

These graphs below (figure 4) represent ascending hierarchical classifications (ACH) at the level of the three wilayas studied based on phenotypic (qualitative) characteristics. We notice that there are three classes, this shows that there is a great phenotypic diversity.

Class 01: according to the obtained results on phenotypic characters analysis, the nineteen donkeys here are generally brown with dark mucous membranes and a blackhead, limbs and horsehair are black, the belly is brown.

Class 02: it is the major class with 27 individuals, their coat color is grey, the mucous membranes are clear, the head of the animal is grey also, snout and limbs are either grey or white, the hair is black and the belly is white

Class 03:it contains 21 donkeys and they are generally brown with clear mucous membranes and a brown head, limbs and horsehair and belly color arebrown.

Table 9. Class Characteristics Determined by ACM Analysis

Qualitative characters		Class 1	Class 2	Class 3
		19	27	21
coat color	Grey	-	**70.4%**	-
	Black	-	29.6%	-
	Red	5.3%	-	20.0%
	Brown	**94.7%**	-	**80.0%**
color of the mucous membranes	Clear	47.4%	**55.6%**	**55.0%**
	Dark	**52.6%**	44.4%	45.0%
color of the head	Grey	36.8%	**70.4%**	-
	Black	**47.4%**	29.6%	-
	Brown	15.8%	-	**95.0%**
	White	-	-	5.0%
Color of muzzle	Grey	42.1%	37.0%	15.0%
	Black	10.5%	22.2%	10.0%
	White	**47.4%**	**40.7%**	**70.0%**
	Brown	-	-	5.0%
Color of members	Grey	26.3%	**40.7%**	5.0%
	Black	**57.9%**	29.6%	15.0%
	White	10.5%	29.6%	10.0%
	Brown	5.3%	-	**70.0%**
Color of the horsehair	Grey	-	37.0%	-
	Black	**63.2%**	**59.3%**	5.0%
	White	-	-	-
	Brown	36.8%	3.7%	**95.0%**
Belly color	Grey	36.8%	25.9%	30.0%
	Brown	**52.6%**	7.4%	**50.0%**
	White	10.5%	**59.3%**	20.0%
	Black	-	7.4%	-

Conclusion

According to our findings, the studied population exhibits morphological (size, format, weight, etc.) and phenotypic (color of coat, head limbs, etc.) heterogeneity; we can say that the donkey population in these areas is medium in size and brown or grey in color in most animals, with the presence of other colors such as white and black; identifying these races or populations requires a genotypic study.

Considering our findings and the significance of the donkey in our society, particularly in mountain agriculture it is important to develop suggestions that would allow for an increase in the productivity of asinian breeding, which is now underutilized, putting this species at risk of extinction. The genetic resources of this species must next be assessed by phenotypic characterization of the donkey population in our territory in order to determine the races or populations existing, and then a genotypic characterization study utilizing microsatellite markers must be launched. These findings will help us learn more about the genetic diversity of donkeys in Algeria.

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