

Original Research Paper

Morphological characterization of fantasia horse breed in Algeria

LABBACI M^{1,2}, BOUKRAA D¹, KRIM F¹, BENHAMMADI M¹, GAOUAR SBS¹

¹ *Laboratory of Genetic applied in Agronomy, ecology and public health (GenApAgiE), Faculty SNV/STU, University ABOU BEKR BELKAID, Tlemcen, Algeria*

² *university center SALHI AHMED, NAAMA, Algeria.*

***Corresponding Author:** LABBACI Madani, university center SALHI AHMED, NAAMA; **Email:** labbaci.madani@cuniv-naama.dz

Article history: Received: July 6, 2024; Revised: July 19, 2024; Accepted: August 8, 2024

Abstract

In Algeria, the equine breeds of fantasia constitute an invaluable biological, cultural, and historical heritage that must be preserved and rehabilitated for better conservation and exploitation. In this context, we carried out two studies: a genetic study, in which we took blood and hair from their roots to identify each horse's breed of origin (unfortunately, we could not do laboratory analyses due to a lack of products). In the morphometric study, we took twenty-six measurements (20 body measurements + 6 body indexes developed for horses) on 88 samples of three different breeds (48 Barb, 23 Arabian Barb, and 17 English-Barb) of presumed origins, each exceeding three years. The results obtained allowed us to divide the horses we studied into three classes, of which the Barb breed is the most present. The statistical analysis showed that there were significant differences in HW, HR, SL, LB, LI, LT, LCE, CC, and TB between breeds ($p < 0.05$), with the superiority in favor of English barbe. For the other parameters, there are no differences, and it confirms who is the ideal horse for the fantasia. Still, on the other hand, we notice the notable mixture in the breeds in Algeria, which has largely contributed to genetic pollution.

Keywords: Algeria; Barb horse; fantasia horse; measurements; statistical analyses.

المخلص

في الجزائر، تشكل سلالات الخيول من الفنتازيا تراثاً بيولوجياً وثقافياً وتاريخياً لا يقدر بثمن يجب الحفاظ عليه وإعادة تأهيله من أجل الحفاظ عليه واستغلاله بشكل أفضل. في هذا السياق، أجرينا دراستين: دراسة جينية أخذنا فيها الدم والشعر من جذورهما لتحديد سلالة منشأ كل حصان (لسوء الحظ، لم تتمكن من إجراء تحليلات معملية بسبب نقص المنتجات). في الدراسة المورفومترية، أجرينا ستة وعشرين قياساً (20 قياساً للجسم + 6 مؤشرات للجسم تم تطويرها للخيول) على 88 عينة من ثلاث سلالات مختلفة (48 Barb و 23 Arabian Barb و 17 English-Barb) من الأصول المفترضة، كل منها يتجاوز ثلاث سنوات. سمحت لنا النتائج التي تم الحصول عليها بتقسيم الخيول التي درسناها إلى ثلاث فئات، منها سلالة بارب الأكثر حضوراً. أظهر التحليل الإحصائي أن هناك اختلافات كبيرة في HW و HR و SL و LB و LI و LT و LCE و CC و TB بين السلالات ($p < 0.05$)، مع التفوق لصالح اللغة الإنجليزية barbe. بالنسبة للمعايير الأخرى، لا توجد اختلافات، وهي تؤكد من هو الحصان المثالي للفنتازيا. ومع ذلك، من ناحية أخرى، نلاحظ الخليط الملحوظ في السلالات في الجزائر، والذي ساهم إلى حد كبير في التلوث الجيني.

الكلمات المفتاحية: الجزائر؛ حصان البار؛ حصان الفانتازيا؛ القياسات؛ التحليلات الإحصائية.

Introduction

In Algeria, animal genetic resources show great heterogeneity of breed in terms of their habits and production capacity in their natural biotope. Equines are not excluded from this assessment. As such, they assign a varied affluence with an important place in the economy and socio-cultural.

The world population of horses is estimated at 58 million, 60% of whom are draft horses, mainly in developing countries. A significant proportion of the rest is used for racing, equestrian sports, and recreation, constituting a rapidly expanding sector (Murray G et al., 2013).

The Algerian equine population, estimated at 46356 horses, is made up of 90% Barb and Arabian Barb horses (and Algerian saddles). The remaining 10% is divided between Arabian horses, English Thoroughbreds, and French Trotters (FAO, 2021).

The DAD-IS database lists in 2018 two breeds of horses bred in Algeria: The Arabian Barb and the Barb (DAD-IS consulted in October 2018). "However, the Arab (Élise Rousseau, 2014), the English Thoroughbred, and the French Trotter are also the subject of more or less important breeding (Berber et al., 2016). Both Arabian Barb breeds and Barb come from the coastal regions of North Africa. They are usually used in fantasia (the traditional horse-riding exhibition in the Maghreb at cultural festivals), as well as in equestrian sports. There are about 10,000 heads belonging to the Barb breed and 80,000 Arabian Barb heads (Kadri, 2006; Berber et al., 2016).

For the horse, as for many domestic animals, the breeds have a genealogical register, or "stud-book". The lists of ancestors registered in the register were selected over a period long enough to ensure the production of a strain with constant and well-defined characteristics: size, morphology, actions, and, sometimes, coat color. The "stud-book" can be closed (only animals descended from animals already registered can be part of the breed) or open (the registry accepts crosses with other breeds). The registration of a horse in such a register is subject to rules of reporting and compliance with the breed standard (Haupt and Willis, 2001). This information is taken up by extensive specialized data bases.

Information on genetic diversity is essential to optimizing strategies for the conservation and use of animal genetic resources. For all these reasons, our work falls within the context of this strategy. She is interested in both the morphological and genetic characterization of the equine breed of fantasia in Algeria. This study will be based on the analysis of microsatellite-like DNA markers using innovative molecular biology and bioinformatics techniques. This will make it possible to build a specific database of these breeds and also to better analyze their abilities. This step is very important for the improvement and preservation of our equine genetic heritage of fantasia.

In general, samples of 20–50 individuals of each breed should be selected in order for them to be relevant. However, the number of individuals sampled may vary from case to case, may be lower in highly bred local populations, and may be higher in cases where the population is widely distributed (divided into different ecological types) (Nei and Roychoudhury, 1974; Nei, 1978). Ideally, the sample should be representative of the population being studied, which is why FAO recommends the use of geographical standards, in which each animal is sampled in a different geographical area. Animals or very few animals (unrelated) (YARO M et al, 2017).

Materials and Methods

Animal sample

The equine population of fantasias is found mainly in western Algeria. During our study, we carried out measurements on 48 Barb, 23 Arabian Barb, and 17 English Barb horses belonging to the wilaya of Saida (the region of Sidi Youcef), the wilaya of Naâma (the region of Mechria), the wilaya of Oran (the region of Belkaid), and the wilaya of Tlemcen (the regions of Ghazaouet, Nedroma, Maghnia, Zenata, Henaya, Sabra, Ben Sekrane, and Ain Fezza). A total of 88 horses were studied, of which 13 were female. They are all over the age of 3.



Figure 1: Geographical map of the Algerian wilayas studied.

Morphometric study:

The horse was put on a well-flattened and plumb horizontal plane. As a first step, we made measurements of the heights at the withers and the rump using the hippometric cane. The cursor is raised above the height to be measured. The cane was brought closer to the animal, and the free hand was applied to the horse to warn the subject. The slider lowered gradually until it reached a very exact outcrop on the most prominent part. In a second step, we proceeded to highlight the landmarks on the surface of the body using a marker pencil. Eleven points were then highlighted (Figure 02) (Barone, 1976; Barone, 1980).

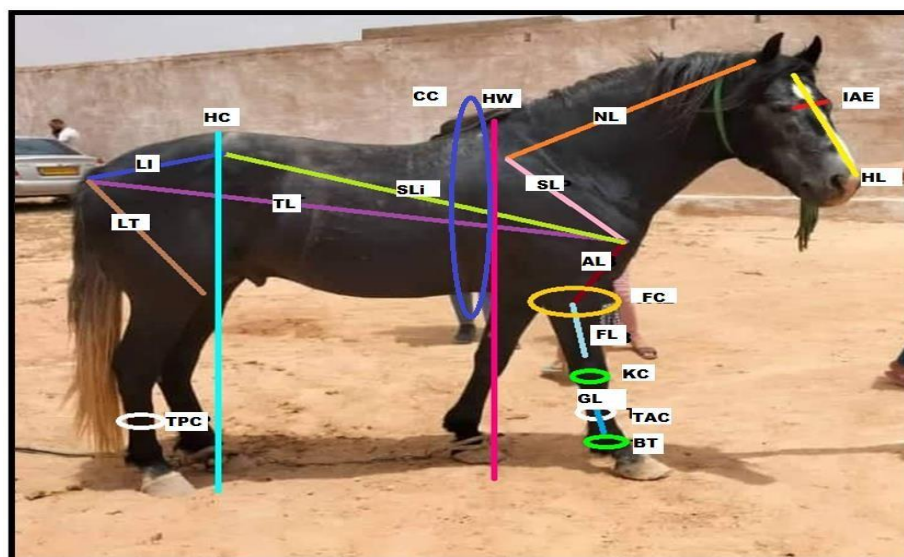


Figure 2: Original photo of the reference points defining the morphological parameters of the length of the horse.

Statistical analysis

The data were analyzed using the R Statistics software (Version 4.0.1) and SPSS statistics v 27. The descriptive analysis of body measurements in the study population was determined after checking the distribution of our variables. The impact of sex on body measurements was determined using the t test. Also, the impact of sex on body measurements was determined for the study of correlation between pairs of measurements, we used principal component analysis (PCA). An ascending hierarchical classification (HAC) was also used to obtain the optimal number of groups in the set of equine samples considered. Finally, we calculated the Shannon morphological diversity index using Excel software for Windows. The Shannon index is defined and given by the following function:

$$H' = - \sum_{i=1}^S p_i \log_2 p_i$$

p_i is the proportion of the total sample present in interval or group i , which means, divide the number of individuals in interval i by the total number of samples. S is the total number of groups of each trait, in this study, S was limited to four for each trait using the following partition: [Minimum; Q1 [, [Q1; Q2 [, [Q2; Q3 [, and [Q3; Maximum], where Q1, Q2, and Q3 represent the first, second, and third quartiles, respectively. $H_{max} = \ln(S)$ = maximum possible diversity, and finally E = uniformity or Pielou index = H'/H_{max} , which provides information on equal distribution or equity. In other words, we used the Shannon Ecological Diversity Index to estimate the morphological diversity of each trait among the population studied (Haddam. Y and all, 2021).

Results and discussion**Morphometric analyze:**

the Mean, the Standard Deviation, the Median, the Standard Error of the Mean, the Variance, the Minima and the Maxima of the 26 parameters measured on the fantasia horses studied are reported in Table 1.

Table 1: descriptive statistics of the 26 parameters measured on the fantasia horses studied.

	Mean	SE	Median	SD	Variance	Minimum	Maximum
WL	453.28	6.32	453.00	59.28	3514.04	335.54	594.13
HW	155.70	0.64	155.00	5.96	35.57	142.00	170.00
HR	154.72	0.65	154.00	6.10	37.24	140.00	170.00
SL	114.91	0.66	115.00	6.20	38.41	101.00	130.00
HL	47.84	0.34	48.00	3.18	10.09	42.00	66.00
AIY	16.47	0.20	16.00	1.91	3.65	13.00	21.00
LE	74.82	0.57	75.00	5.36	28.70	65.00	86.00
SHL	53.20	0.42	53.00	3.89	15.13	45.00	63.00
LB	34.56	0.24	34.50	2.27	5.17	30.00	40.00
FC	31.63	0.43	31.00	3.99	15.89	24.00	40.00
LC	13.49	0.49	11.50	4.62	21.38	7.00	23.00
LI	48.77	0.41	48.00	3.82	14.57	40.00	57.00
LT	161.90	0.93	162.50	8.69	75.43	145.00	180.00
LCE	72.65	0.53	72.00	4.93	24.30	63.00	84.00
CC	181.93	0.95	180.50	8.87	78.59	163.00	198.00
TAB	56.00	0.60	57.00	5.63	31.75	43.00	69.00
TG	32.39	0.23	33.00	2.19	4.82	26.00	37.00
TB	28.00	0.21	28.00	1.92	3.70	23.00	32.00
TCA	23.11	0.63	21.00	5.88	34.56	18.00	38.00
CCC	22.45	0.20	22.00	1.85	3.42	20.00	33.00
(HW/LT)	1.031	0.027	0.913	0.256	0.066	0.667	1.700
(PV/HW)	2.003	0.020	2.033	0.187	0.035	1.344	2.464
(CC/HW)	0.036	0.000	0.036	0.003	0.000	0.031	0.043
(TCA/CC)	0.002	0.000	0.002	0.000	0.000	0.001	0.002
(LT/CC)	0.891	0.005	0.889	0.048	0.002	0.763	1.012
(HW/HR)	1.007	0.002	1.006	0.020	0.000	0.955	1.056

Height at the withers (HW) ; Height at the rump (HR) ; Total Length (LT) ; Scapula iliac Length (SL) ; Length of the head (HL) ; Length between the internal angles of the eyes (AIY) ; Length of the neckline (LE) ; Length of the shoulder (SHL) ; Length of the arm (LB) ; Length of the forearm (FC) ; Length of the canon (LC) ; Length of the ilium (LI) ; Length of the thigh (LCE) ; Circumference from the chest (CC) ; Circumference of the forearm (TAB) ;Circumference of the knee (TG); Circumference of the ball (TB); Circumference of the anterior barrel (TCA); Circumference of the posterior barrel (CCC); Body Profile Index (HW/LT); Compactity Index (PV/HW); Body Ratio: chest circumference (CC)/withers height (HW); Dactyl-Thoracic Index: anterior barrel circumference (TCA)/CC;Relative Body Ratio: LT/CC;Height Front Back: HW/Croup height (HR).

Variation of variables:

By sex:

The table 2 presents the results of comparing the means of each parameter for males and females in our study population using t Student test. This test allows us to see if sexual dimorphism exists in this species.

Of the 26 parameters studied, 10 express significant variations according to sex ($p < 0.05$) (Table 2). We concluded that males were taller and longer than females. The effect of sex on height is well known. It is related to the hormonal effect at the time of the growth of the young (Ronciere A.P. 1998)

Table 2: Average values of the different parameters in males and females and significance tests.

	Females	Males	Sig
Poids	456.1482±70.28656	452.7878±57.69373	0.873
HW	155±7.885	155.83±5.624	0.722
HR	154.69±8.087	154.72±5.76	0.988
SL	115.15±7.841	114.87±5.931	0.901
HL	47.15±3.412	47.96±3.143	0.438
AIY	16.69±2.287	16.43±1.854	0.697
LE	73.54±5.768	75.04±5.293	0.394
SHL	49±2.887	53.93±3.577	0
LB	33.08±1.935	34.81±2.24	0.009
FC	31.69±4.211	31.61±3.976	0.951
LC	14.08±5.139	13.39±4.559	0.656
LI	45.15±2.609	49.4±3.65	0
LT	160±10.058	162.23±8.457	0.463
LCE	69.38±3.254	73.21±4.966	0.002
CC	183.46±10.236	181.67±8.656	0.56
TAB	52.15±4.2	56.67±5.605	0.003
TG	29.62±1.805	32.87±1.884	0
TB	26.31±1.601	28.29±1.829	0.001
TCA	22.46±6.778	23.23±5.753	0.706
CCC	20.92±1.188	22.72±1.82	0
(HW/LT)	1.068336736±0.28906459	1.024941063±0.251822064	0.618
(PV/HW)	1.984436693±0.135172056	2.006777899±0.195020272	0.615
(CC/HW)	0.038142642±0.002333927	0.03549493±0.002379584	0.002
(TCA/CC)	0.00183245±0.000196507	0.001575012±0.000189972	0
(LT/CC)	0.873303357±0.052060831	0.893977014±0.046424739	0.199
(HW/HR)	1.002430887±0.027736285	1.007352861±0.018117886	0.409

Height at the withers (HW) ; Height at the rump (HR) ; Total Length (LT) ; Scapula iliac Length (SL) ; Length of the head (HL) ; Length between the internal angles of the eyes (AIY) ; Length of the neckline (LE) ; Length of the shoulder (SHL) ; Length of the arm (LB) ; Length of the forearm (FC) ; Length of the canon (LC) ; Length of the ilium (LI) ; Length of the thigh (LCE) ; Circumference from the chest (CC) ; Circumference of the forearm (TAB) ;Circumference of the knee (TG); Circumference of the ball (TB); Circumference of the anterior barrel (TCA); Circumference of the posterior barrel (CCC); Body Profile Index (HW/LT); Compacity Index (PV/HW); Body Ratio: chest circumference (CC)/withers height (HW); Dactyl-Thoracic Index: anterior barrel circumference (TCA)/CC;Relative Body Ratio: LT/CC;Height Front Back: HW/ Croup height (HR).

By Breeds:

Table 3: Average values of the different parameters in different horse breeds and significance tests

	English barbe 17	Arabian -barbe 23	Barbe 48	sig
WL	496.2634±61.00654	451.4668±60.71356	438.9333±51.30502	0.002
HW	160.71±4.845	154.09±5.107	154.71±5.856	0
HR	159.12±4.872	153.09±5.526	153.94±6.135	0.003
SL	119.18±5.306	113.83±5.997	113.92±6.042	0.006
HL	48.29±2.616	48.26±4.595	47.48±2.484	0.509
AIY	16.76±2.047	16.48±2.042	16.35±1.828	0.752
LE	77.41±3.858	74.17±5.921	74.21±5.351	0.083
SHL	54.65±5.024	53.22±3.384	52.69±3.609	0.205
LB	35.82±2.215	34.74±1.888	34.02±2.311	0.016
FC	33.53±4.002	31.39±4.629	31.06±3.503	0.084

LC	15.29±5.133	13.04±4.724	13.06±4.324	0.202
LI	49.94±3.544	50.35±3.638	47.6±3.66	0.006
LT	167.35±7.96	160.17±8.021	160.79±8.629	0.013
LCE	76.12±4.635	73.13±5.505	71.19±4.103	0.001
CC	187.29±8.608	182.52±9.853	179.75±7.706	0.009
TAB	55.47±6.691	56.48±7.716	55.96±3.93	0.909
TG	33.12±2.118	32.74±2.094	31.96±2.212	0.115
TB	29±2.179	28.17±1.723	27.56±1.809	0.025
TCA	25.88±7.026	23.22±5.3	22.08±5.492	0.071
CCC	23.18±1.845	22.48±1.275	22.19±2.039	0.167
(HW/LT)	1.124399143±0.321955149	1.038410012±0.262010011	0.99501545±0.222928155	0.306
(PV/HW)	1.918052509±0.224263173	2.002080357±0.226315826	2.034401638±0.141248312	0.149
(CC/HW)	0.034675219±0.002734793	0.035622139±0.00219756	0.03644138±0.002504547	0.039
(TCA/CC)	0.001511099±0.000222813	0.00159407±0.000181923	0.001658239±0.0002095	0.04
(LT/CC)	0.894481238±0.044276311	0.879045308±0.048721681	0.895354096±0.048103586	0.382
(HW/HR)	1.010137772±0.01753535	1.006787909±0.018494456	1.00530421±0.021164092	0.69

Height at the withers (HW) ; Height at the rump (HR) ; Total Length (LT) ; Scapula iliac Length (SL) ; Length of the head (HL) ; Length between the internal angles of the eyes (AIY) ; Length of the neckline (LE) ; Length of the shoulder (SHL) ; Length of the arm (LB) ; Length of the forearm (FC) ; Length of the canon (LC) ; Length of the ilium (LI) ; Length of the thigh (LCE) ; Circumference from the chest (CC) ; Circumference of the forearm (TAB) ;Circumference of the knee (TG); Circumference of the ball (TB); Circumference of the anterior barrel (TCA); Circumference of the posterior barrel (CCC); Body Profile Index (HW/LT); Compacity Index (PV/HW); Body Ratio: chest circumference (CC)/withers height (HW); Dactyl-Thoracic Index: anterior barrel circumference (TCA/CC);Relative Body Ratio: LT/CC;Height Front Back: HW/ Croup height (HR).

Of the 26 parameters studied, we noticed that there are significant differences of HW, HR, SL, LB, LI, LT, LCE, CC and TB between breeds ($p < 0.05$) with the superiority in favor of English barbe, for the other parameters there are no differences. A comparison of these breeds was also made by contribution to English Thoroughbred (legault. J. 1977), Arabian Thoroughbred (El Beji, 1972), and the Barb (Benhamadi, M., Mezouar, K. 2016).

Table 4: comparison of several Average values of the different parameters in different breeds with different horse standards

Parameters (size)	Average values for breed (01)(cm)	Average values for breed (02)(cm)	Average values for breed (03)(cm)	Average values of the barb standard in Algeria	Average values Arabian Thoroughbred (El Beji. 1972)
HW	160.71±4.845	154.09±5.107	154.71±5.856	150.5	147.25
HR	159.12±4.872	153.09±5.526	153.94±6.135	-	-
Parameters (Length)	Average value for breed (01) (cm)	Average values for breed (02)(cm)	Average values for breed (03)(cm)	Mean values (ETB). (Cm). (legault. J.1977)	Average values Barb (cm) (Benhamadi. M. Mezouar. K. 2016)
Total	167.35±7.96	160.17±8.021	160.79±8.629	162.93	160.0
Scapulilelac	119.18±5.306	113.83±5.997	113.92±6.042	109.41	118.2
of the neckline	77.41±3.858	74.17±5.921	74.21±5.351	80.56	62.8
Parameters (Circumference)	Average values for breed(01)(cm)	Average values for breed (02)(cm)	Average values for breed (03)(cm)	Average values of the barb standard in Algeria	Average values Arabian Thoroughbred (El Beji. 1972)

the chest	187.29±8.608	182.52±9.853	179.75±7.706	> 170	-
the canon anterior	25.88±7.026	23.22±5.3	22.08±5.492	> 18	20-21
Live Weight (kg)	496.2634±61.00 654	451.4668±60.71 356	438.9333±51.30 502	-	-
Parameters (Length)	Average value for breed (01)(cm)	Average values for breed (02)(cm)	Average values for breed (03)(cm)	Mean value (ETB) (cm). (Legault J. 1977)	Average value for Barb horses (cm) (Benhamadi. M. Mezouar. K 2016)
the shoulder	54.65±5.024	53.22±3.384	52.69±3.609	46.98	54.40
the arm	35.82±2.215	34.74±1.888	34.02±2.311	33.39	32.62
the forearm	33.53±4.002	31.39±4.629	31.06±3.503	45.36	36.91

According to the questionnaire, that was established with the breeders, we obtained 3 breeds while the breed (01) English-Barb, the breed (02) Arab-Barb, and the breed (03) Barb. A comparison of these classes was also made by contribution to English Thoroughbred (Legault J. 1977), Arabian Thoroughbred (El Beji, 1972), and the Barb (Benhamadi, M., Mezouar, K. 2016).

For the parameters that relate to the size of the horse, there are two characters that are compared: the height at the withers (HW) and the height at the rump (HR). We find that the average HW value of the sample studied in breeds (1) and (2) and (3) is higher than that of the Barb horse standard and that of the Arabian Thoroughbred (ATB). With regard to the average value of height at withers in breed (3), it is higher than that of Barb and Arabian Thoroughbred (ATB), which is the same for HR (Table 4). The HW values are comparable to those obtained for HR, and these two parameters are perfectly correlated. The slight lowering of the front of the horse being disadvantageous for draft animals, on a smaller scale for those of saddle, and a fortiori of race for which a predominance of size of the rump is sometimes sought, especially for horses of the steeplechase, which explains these results (Marcenac L.N. and Aubert H, 1974). According to these results, the horses studied would mainly be horses adapted to racing.

The parameters related to the length of the horse are estimated from the total length (TL), the humeroiliac length (SL), and the length of the neckline (NL). We note that for TL, the average in breeds (1) and (2) is closer to that of the ETB; on the other hand, the value of the NL is much lower than that of the ETB. As for the average value of SL, it is higher than that of ETB. While the average values of TL, SL, and NL in breed (3) are higher than those of ETB, On the other hand, we note that the averages in classes (1) and (2) are almost comparable with the Barb (table 4). TL has an impact on the length of the kidney; the greater it is, the more the horse is entered (Marcenac L.N. and Aubert H., 1974). This provides an important physiological advantage to the Barb studied.

The characters describing the horse weight parameter are live weight (WL), chest circumference (CC), anterior barrel circumference (TAC), and posterior barrel circumference (CCC). For the estimation of live weight, we preferred to use the formula of Carroll and Huntington (Carroll C.L. and Huntington P.J., 1988) for the Crevat method.

(Marcenac L.N. and Aubert H. 1974), which estimates the weight only from the thoracic perimeter, measured at the level of the 9th dimension, raised to the cube, and multiplied by the coefficient 80.

The average PV values of the breeds studied (01), (02), and (3) are 438,933 kg, 456,736 kg, and 496,263 kg, respectively. So, breed (1), (2) and (3) are saddle horses (450 to 600 kg) in comparison with heavy horses (600 to 1000 kg) (Marcenac L.N. and Aubert H. 1974). For chest circumference, the average values of breeds (01), (02), and (03) are consistent with the value of the Barb standard in Algeria (Ben Aissa R. and Tamzali Y., 1989).

Among the means of the previous canon of the 3 studied races, it was noted that they conform to the standard Barb and differ from the pure Arab race. It is noted that our horses have rather thick limbs in relation to their size. Indeed, Marcenac & al. (Marcenac L.N. et Aubert H., 1974) Approximately the TC at the waist as follows: 18 cm for a height less than or equal to 157 cm, 19 cm for a height greater

than 157 cm, and 20 cm for heavy horses. But the horses of races 1, 2 and 3 had a barrel circumference of 23.18 cm, 22.48 cm and 22.19 cm to reach a size of 159.12 cm, 153.09 cm and 153.94 cm. This is in favor of the strength and thickness of the limbs.

The parameters related to bone radius length are represented by (HL), (IAE), (NL), (SHL), (AL), (FL), (GL), (LI) and (LT). We note that there are three parameters whose average values in breeds (1) and (2) are higher than those of ETB and Barb; these parameters are: AL, LI and LT, while for FL and GL, the average values found in the studied breeds are lower than those of PSA and Barbe. For the SHL shoulder length, the average values of these breeds are higher than those of the ETB and lower than those of the Barb. Regarding the breed (3), the average value of SHL is close to that of Barb. Although there are three parameters whose mean values are higher than those of ETB and Barb, these parameters are: AL, LI and LT, while for FL and GL, the average values found in the studied breeds are lower than those of ETB and Barb (Table 4). Marcenac reports that the shoulder is the longest in the racehorse and the shortest in the trotter. The arm is the longest in the draw arm and the shortest in the trotter. The length of the arm must be extended to accommodate the very active muscles that will operate the forearm. However, it must be proportionate to the shoulder and stay short of it in order to avoid that the horse "shaves the carpet" in its strides (Marcenac L.N. et Aubert H., 1974)

The body index is used to assess the proportion of an animal. A horse is said to be brevilineal if the index is less than 1, medioligne if it is equal to 1 and slender for an index greater than 1 (Marcenac L.N. and Aubert H,1974). The average value of HW/TL in three breeds is: 1,124;1,038; 0,995 approximately equal to 1; that is to say, the value required by the O.M.C.B. (Chabchoub A, 1998). This result means that our study was carried out on animals representing the international standard of the Barb horse. This index corrects the errors of visual assessment and proves that a horse called brevilineal is longer than high and that a slender one is higher than long. The equality of these dimensions gives the square horse.

We found at the level of the study population, in breed (1), an average of 1,918 kg/cm, in breed (2), 2,002 kg/cm, and in breed (3), 2,034 kg/cm for the compactness index (PV/HW). For comparison, we give some indexes of compactness calculated from the data reported by Theret (Marcenac L.N. and Aubert H., 1974): (Arabian-Barb: 2.62 kg/cm; Half Saddle Normand: 3.55 kg/cm; Arabian English: 2.79 kg/cm).

Thus, it is noted that the average of ours breeds are lower than that of Arabian-Barb, Arabian English, Demi-Selle Normand. With regard to the corpulence index (CC/HW), the averages of the breeds studied are 0,0346, 0,0356, and 0,0364 in order. Marcenac reports that the best body index ranges from 0.885 to 0.90 (Marcenac L.N. and Aubert H., 1974) and those horses above 0.90 are compact. It can thus be deduced that the breeds studied are among horses with a heavy tendency.

Comparison of the average measurements of the horses studied between the study regions

If we compare the results of all regions (Table 5). Among the 26 parameters studied, we note that there is no difference in PV characters HW HL LE SHL CC TB CCC and body indexes (CC/HW) and (HW/HR) between these populations ($p > 0.05$), the other characters and indexes indicate a significant difference between populations ($p < 0.05$). This may be explained by the effect of the environment, while the climate and type of farming are similar in both regions, and this is due to their proximity to each other in the northwest of Algeria

Table 5: Comparison of the average measurements of the barb horse between the study regions

	Ain fezza	Bensakran	Ghazaouet	Henaya	Maghnia	Naama	Nedroma	Oran	Sabra	Saida	Zenata	sig
	5	8	12	6	8	6	11	5	15	10	2	
WL	410.73±79.81	445.16±59.13	449.71±66.29	513.69±65.37	441.05±24.32	467.78±67.95	452.42±39.82	465.67±29.59	446.58±63.40	434.59±47.50	555.41±54.75	0.061
HW	152.20±6.80	155.38±5.34	156.67±7.92	161.33±6.02	155.63±4.24	153.00±2.53	151.91±5.49	155.60±4.04	156.53±5.25	156.80±5.33	161.00±11.31	0.11
HR	151.60±7.23	154.75±4.98	156.50±8.09	161.67±4.32	155.00±5.18	151.83±2.23	150.64±4.86	153.00±2.24	155.67±5.64	154.30±6.95	160.00±-	0.034
SL	114.80±5.45	116.38±5.10	114.17±6.71	121.00±6.81	114.75±3.77	108.83±6.80	115.82±4.85	115.00±2.12	114.53±5.89	112.00±6.72	126.50±2.12	0.01
HL	45.40±2.19	47.50±2.00	47.42±3.68	48.50±1.38	47.25±1.39	47.67±2.25	47.27±2.45	47.00±1.87	49.67±5.12	47.30±1.89	53.00±2.83	0.12
AIY	17.80±1.30	15.50±1.51	15.00±0.74	18.00±1.27	19.13±0.99	15.33±0.82	18.45±1.57	15.80±1.64	15.33±1.18	15.30±0.68	19.00±-	0
LE	70.60±3.44	77.00±4.47	74.08±5.09	75.00±4.38	74.75±3.92	76.83±6.11	73.91±5.58	77.20±6.38	75.60±6.24	72.30±5.19	80.50±6.36	0.315
SHL	51.60±4.39	54.25±2.71	52.75±5.64	53.33±5.32	52.13±5.06	54.17±1.72	52.45±4.01	53.80±1.79	54.93±2.63	51.60±3.50	54.50±0.71	0.48
LB	34.80±3.96	36.38±2.45	34.42±2.07	33.50±1.64	32.75±2.19	33.50±0.84	33.55±1.75	36.00±1.23	35.87±1.55	34.40±2.63	34.00±-	0.008
FC	29.60±4.34	30.63±2.88	29.50±2.24	38.67±1.75	36.13±2.30	30.50±1.52	33.73±4.47	29.60±1.67	29.53±3.00	30.60±2.32	32.00±7.07	0
LC	14.00±1.58	10.00±1.77	10.08±1.31	22.00±0.63	21.38±1.30	11.00±0.89	16.91±3.67	11.00±1.23	10.20±1.15	11.80±2.04	17.50±2.12	0
LI	46.20±2.05	49.38±2.83	47.08±4.70	52.17±3.06	47.88±3.72	49.17±2.93	49.27±4.38	48.60±0.89	51.07±3.35	46.50±3.72	47.00±1.41	0.049
LT	156.40±9.61	164.50±8.09	159.25±10.15	172.50±4.81	163.88±4.88	158.00±7.64	163.55±7.56	162.20±5.81	160.53±8.76	157.60±7.63	175.00±7.07	0.008
LCE	69.00±4.00	75.38±3.89	71.17±5.36	72.33±5.13	70.13±4.58	73.83±4.71	69.00±2.28	75.60±2.30	75.40±5.88	73.90±4.10	73.00±-	0.009
CC	175.80±11.41	178.88±9.05	182.67±9.93	187.67±9.61	178.75±4.10	187.00±10.20	181.09±4.76	184.60±4.16	181.33±11.10	180.70±7.07	194.00±5.66	0.16
TAB	53.40±2.30	58.75±4.10	55.00±5.75	56.33±6.80	52.50±3.74	59.17±3.97	50.82±5.49	58.00±1.87	57.80±7.44	58.80±2.35	57.00±1.41	0.008
TG	30.00±2.55	33.75±1.17	31.67±2.96	35.00±1.27	31.63±1.60	32.00±2.76	31.55±1.70	32.60±0.89	33.20±1.82	32.70±1.34	30.00±1.41	0.007
TB	26.60±1.67	28.88±1.55	27.67±2.93	29.33±0.82	27.63±2.07	27.33±2.07	27.00±1.95	28.60±0.89	28.67±1.76	28.20±0.92	27.50±0.71	0.083
TCA	19.60±1.14	20.88±0.99	20.08±1.83	36.50±1.38	33.13±1.96	19.67±1.37	24.82±6.78	20.00±0.71	20.73±1.03	20.10±0.74	20.50±0.71	0
CCC	22.20±1.48	22.25±1.39	22.17±2.48	23.67±0.82	22.13±1.25	22.17±1.60	22.64±3.67	22.60±0.55	22.60±1.24	22.30±1.06	22.50±0.71	0.965
(HW/LT)	0.884±0.034	0.939±0.020	0.908±0.031	1.543±0.064	1.499±0.081	0.888±0.022	1.119±0.349	0.885±0.038	0.918±0.033	0.902±0.025	0.911±0.003	0
(PV/HW)	2.013±0.139	2.039±0.165	1.996±0.183	1.922±0.241	1.905±0.125	2.166±0.053	1.886±0.200	2.029±0.076	2.021±0.262	2.086±0.084	2.074±0.105	0
(CC/HW)	0.038±0.002	0.035±0.002	0.037±0.004	0.034±0.001	0.036±0.003	0.037±0.003	0.037±0.003	0.035±0.001	0.035±0.002	0.035±0.001	0.036±0.001	0.12
(TCA/CC)	0.002±0.000	0.002±0.000	0.002±0.000	0.001±0.000	0.002±0.000	0.002±0.000	0.002±0.000	0.002±0.000	0.002±0.000	0.002±0.000	0.002±0.000	0.004
(LT/CC)	0.890±0.026	0.921±0.044	0.873±0.056	0.920±0.027	0.917±0.034	0.846±0.034	0.903±0.034	0.879±0.033	0.888±0.064	0.873±0.039	0.902±0.010	0.05
(HW/HR)	1.004±0.013	1.004±0.019	1.001±0.023	0.998±0.018	1.004±0.019	1.008±0.023	1.008±0.018	1.017±0.013	1.006±0.014	1.017±0.020	1.006±0.071	0.779

Height at the withers (HW) ; Height at the rump (HR) ; Total Length (LT) ; Scapula iliac Length (SL) ; Length of the head (HL) ; Length between the internal angles of the eyes (AIY) ; Length of the neckline (LE) ; Length of the shoulder (SHL) ; Length of the arm (LB) ; Length of the forearm (FC) ; Length of the canon (LC) ; Length of the ilium (LI) ; Length of the thigh (LCE) ; Circumference from the chest (CC) ; Circumference of the forearm (TAB) ; Circumference of the knee (TG) ; Circumference of the ball (TB) ; Circumference of the anterior barrel (TCA) ; Circumference of the posterior barrel (CCC) ; Body Profile Index (HW/LT) ; Compacity Index (PV/HW) ; Body Ratio: chest circumference (CC)/withers height (HW) ; Dactyl-Thoracic Index: anterior barrel circumference (TCA/CC) ; Relative Body Ratio: LT/CC ; Height Front Back: HW/ Croup height (HR)

The Shannon-Weaver and Pielou Diversity Index compares by race and region studied:

Table 6: Comparison of the Shannon-Weaver and Pielou diversity indexes for the three breeds studied.

Parameters (Measurements and indexes)	Shannon Barb Index (n =48)		Shannon Arabian Barb Index (n =23)		Shannon Index English- Barb	
	Average Sdi	Average Pi	Average SDI	Average Pi	Average SDI	Average Pi
Height (cm)						
at the withers	1.43	1.03	1.43	1.03	1.45	1.05
to the rump	1.44	1.04	1.43	1.03	1.43	1.03
Length (cm)						
Total	1.41	1.01	1.44	1.04	1.28	0.93
Scapulo-iliac	1.17	0.84	1.44	1.04	1.45	1.05
of the head	1.47	1.06	1.46	1.06	1.40	1.01
between the internal angles of the eyes	1.46	1.05	1.38	0.99	1.43	1.03
of the neckline	1.45	1.05	1.45	1.04	1.43	1.03
of the shoulder	1.46	1.05	1.45	1.04	1.47	1.06
of the arm	1.47	1.06	1.42	1.02	1.45	1.04
of the forearm	1.46	1.06	1.44	1.04	1.47	1.06
of the cannon ilium	1.44	1.04	1.43	1.03	1.45	1.05
of the thigh	1.45	1.04	1.45	1.05	1.40	1.01
	1.46	1.06	1.45	1.05	1.39	1.00
Circumference (cm)						
of the chest	1.43	1.03	1.44	1.04	1.43	1.03
of the forearm	1.44	1.04	1.45	1.05	1.44	1.04
of the knee	1.38	0.99	1.45	1.05	1.47	1.06
of the ball	1.42	1.03	1.41	1.02	1.46	1.06
of the anterior cannon	1.42	1.02	1.46	1.05	1.46	1.05
of the posterior barrel	1.43	1.03	1.22	0.88	1.42	1.02
Live Weight (kg)	1.42	1.02	1.43	1.03	1.44	1.04
Average	1.43	1.03	1.43	1.03	1.43	1.03

Table 7: Comparison of the Shannon-Weaver and Pielou diversity indexes for the four regions studied.

Parameters (Measurements and indexes)	Shannon index Tlemcen		Shannon index Oran (n =5)		Shannon index Saida		Shannon Naama Index	
	Sdi	Pi	Sdi	Pi	Sdi	Pi	Sdi	Pi
Height (cm)								
at the withers	1.42	1.02	1.47	1.06	1.43	1.03	1.25	0.90
to the rump	1.45	1.04	1.47	1.06	1.46	1.05	1.33	0.96
Length (cm)								

Total	1.43	1.03	1.47	1.06	1.43	1.03	1.33	0.96
Scapulo-iliac	1.45	1.05	1.41	1.01	1.45	1.05	1.38	0.99
of the head	1.47	1.06	1.35	0.97	1.40	1.01	1.43	1.03
between the internal	1.41	1.02	1.35	0.97	1.11	0.80	1.19	0.86
angles of the eyes								
of the neckline	1.44	1.04	1.47	1.06	1.44	1.04	1.46	1.06
of the shoulder	1.45	1.04	1.16	0.84	1.41	1.02	1.43	1.03
of the arm	1.45	1.05	1.22	0.88	1.44	1.04	1.06	0.76
of the forearm	1.45	1.04	1.22	0.88	1.42	1.02	1.41	1.01
of the cannon	1.45	1.04	1.22	0.88	1.34	0.97	1.27	0.92
ilium	1.40	1.04	0.54	0.39	1.40	1.01	1.45	1.04
of the thigh	1.44	1.04	1.41	1.01	1.40	1.01	1.46	1.06
Circumference (cm)								
of the chest	1.43	1.03	1.41	1.01	1.41	1.02	1.46	1.06
of the forearm	1.45	1.04	1.35	0.97	1.42	1.02	1.45	1.04
of the knee	1.45	1.05	0.54	0.39	1.32	0.95	1.33	0.96
of the ball	1.43	1.03	1.16	0.84	1.05	0.76	1.43	1.03
of the anterior cannon	1.45	1.05	0.97	0.70	1.14	0.82	1.35	0.97
of the posterior barrel	1.45	1.04	0.98	0.71	1.17	0.84	1.35	0.97
Live Weight (kg)	1.39	1.00	1.47	1.06	1.37	0.99	1.33	0.96
Average	1.44	1.00	1.23	0.89	1.35	0.97	1.36	0.98

it can be said that these differences could be explained by the effects of the environment and the particular conditions of the environment. Indeed, the size and morphology of the horse are different depending on whether it has been developing for generations in regions of coastal or mountain plains, highlands, or the limit of desert regions of the south. It is obvious that temperature and rainfall affect vegetation and that the development of an animal depends on what its diet will be over generations (Tamzali, 1989; Kadri, 2006).

Table 7 presents the results of the Shannon and Pielou diversity indexes within each breed according to the quantitative characteristics studied. The equal distribution or equity of our SDI is represented by the Pielou Index (PI), which joins the SDI values. Indeed, the equal distribution makes it possible to appreciate the imbalances that the diversity of Shannon's index cannot detect. The closer its value tends to 1, the more it reflects a settlement balance. (Legendre and Legendre, 1979).

The distribution of character data varies from one race to another. At the level of the Barb population, there are 3 parameters that represent a maximum value of diversity (1.06) for the characters: head length (HL), arm length (AL), and forearm length (FL). For the Arabian Barb population, the maximum value (1.06) is represented at the character level related to head length (HL). While the English Barb population scored the maximum value of diversity (1.06) for the characters: shoulder length (SHL), forearm length (FL), knee circumference (KC), and ball circumference (BC), This means that these characteristics are probably controlled by genes that do not have a significant effect on the body (possibility of accumulation of mutation at the gene level over generations) (Benhamadi, M., and Mezouar, K., 2016).

On the other hand, the minimum value is marked in the Barb breed (0.84) for the character scapulilelic length (SL). In the Arabian Barb breed, it is (0.88) for the character: posterior cannon tower (CCC), and for the English Barb breed, it is (0.93) for the character related to the total length (TL). (These traits are likely controlled by genes that have a significant physiological effect on the body and the influence of the environment on the expression of this trait.) (Benhamadi, M., and Mezouar, K., 2016). The other characters have a diversity that varies between 0.99 and 1.05 for the Barb breed, between 0.88 and 1.05 for the Arabian Barb breed, and between 0.93 and 1.05 for the English-Barb breed. The comparison of the mean values of this parameter between the three populations shows that the difference is not very important. It is 1.03 for the breeds Barb, Arabian Barb, and English Barb. This index is relatively high,

which is probably a reflection of significant genetic diversity.

The results expressed in Table 7, presents the indexes of the diversity of Shannon and Pielou; within each region according to the quantitative characteristics studied. The equal distribution or equity of our SDI is represented by the Pielou Index (PI), which joins the values of SDI. Indeed, the equal distribution makes it possible to appreciate the imbalances that the diversity of Shannon the index cannot detect. The closer its value tends to 1, the more it reflects a regulatory balance (Legendre and Legendre, 1979).

Of the 20 parameters studied, the distribution of character data varies from one region to another. At the level of the population of Tlemcen, there is only one parameter: head length: (HL) which represents a diversity that has been estimated at 1.06 (maximum value). For the Population of Oran, the results show us that the maximum value of diversity is (1.06) for the characters: height at withers (HW), height at the rump (HR), total length (TL), length of the neckline (NL) and live weight. For the population of Saida, there is only one character: scapulelic length (SL) which represents a maximum value of (1.05). While the population of Naama scored a maximum diversity of (1.06) for the 3 characters: neckline length (NL), thigh length (LT), and chest circumference (CC). This means that these characteristics are probably controlled by genes that do not have a significant effect on the body (possibility of accumulation of mutation at the gene level over generations) (Benhamadi. M, Mezouar. K, 2016).

On the other hand, the minimum value is marked in the population of Tlemcen (1.00) for a single character: live weight. For the population of Oran, it is (0.39) for the characters: total length (TL) and knee circumference (KC). In the population of Saida, it is (0.76) for the character related to the ball circumference (BC), while the minimum diversity (0.76) is marked in the population of Naâma for a single character: ball length (BC). These traits are likely controlled by genes that have a significant physiological effect on the body and the influence of the environment on the expression of this trait (Benhamadi, M., and Mezouar, K., 2016). The other characters have a diversity that varies between 1.02 and 1.05 in the population of Tlemcen, between 0.70 and 1.01 for the population of Oran, between 0.80 and 1.04 in the population of Saida, and between 0.86 and 1.04 for the population of Naâma. There are some differences for this parameter regarding the populations of Tlemcen, Oran, Saida, and Naâma, which is probably due to the influence of the environment on the expression of these characters.

The comparison of the average values of this parameter between the four regions studied shows that the difference is not very large. It is 1.00 for the population of Tlemcen, followed by the population of Naâma for an average value that is estimated at 0.98, followed by the population of Oran for an average value of 0.97. Finally, we have the population of Saida, which has an average value of 0.89. These differences can be explained by the difference in the number of comparable animals in the different studies or by the effect of the environment, the particular conditions of the environment, and the conditions of farms, thus citing the diet.

Bartlett's sphericity test:

Table 8: The Bartlett sphericity test

Tis of Bartlett sphericity	Khi-square approx	1523 ,662
	Ddl	210
	Meaning	8.03852e -198

This test tests the null hypothesis that all correlations are equal to zero. We must therefore try to reject the null hypothesis, i.e., that the test must be significant (the probability of obtaining the value of the test must be smaller than 0.05). However, the test is very sensitive to the number of cases; it is almost always significant when the number of cases is large. Her results are therefore interesting almost only when there are less than 5 cases per variable (Claire, D., 2005). According to Table 8, the result of the Bartlett sphericity test is significant ($p < 0.05$). We can therefore reject the null hypothesis that our data come from a population for which the matrix would be an identity matrix. The correlations are therefore not all equal to zero.

Kaiser-Meyer-Olkin Index (KMO):

Table 9: Kaiser-Meyer-Olkin Index (KMO) of parameters.

Measurement parameters	KMO Index
Height (cm)	
at the withers at	0.76
the rump	0.77
Length (cm)	
Total scapulo-	0.66
iliac of the	0.81
head	0.80
between the internal angles of the eyes of	0.74
the neckline	0.58
of the shoulder of of	0.86
the arm	0.67
of the forearm of	0.87
the canon of the	0.73
ilium	0.91
of the thigh	0.84
Circumference (cm)	
from the chest of	0.54
the forearm of the	0.88
knee	0.85
of the ball	0.86
of the anterior barrel of	0.76
the posterior barrel	0.82
Live Weight (kg)	0.64
Overall average	0.75

More commonly known as the KMO, the Kaiser-Meyer-Olkin measure is an index of the adequacy of the factorial solution. It indicates the extent to which the selected set of variables is a coherent set and makes it possible to constitute an adequate measure or measures of concepts. A high KMO indicates that there is a statistically acceptable factorial solution that represents the relationships between the variables (Claire. D, 2005).

Table 9 shows the Kaiser-Meyer-Olkin index (KMO) of each measurable parameter. We note that the parameters for which the KMO index has a maximum value (0.9) are those related to the parameters s: shoulder length (SL), ilium (LI), forearm (FL), forearm circumference (FC), knee circumference (KC), and ball circumference (BC). " It indicates that there is a wonderful factorial solution. The KMO index in the parameters of height at withers (HW), height at rump (HR), scapulo-iliac length (SL), head (HL), thigh (LT), anterior and posterior circumference (TAC), and CCC is 0.8, which has a meritorious factorial solution. For the parameters of total length (TL), length between internal angles of the eyes (IAE), barrel length (GL), and arm length (AL), which are 0.7, there is an average factorial solution. Whereas, the value of the KMO index in neckline length (NL) and live weight is estimated at 0.6, which expresses a poor factorial solution. On the other hand, we note that the minimum value of this index (0.5) is represented by a single character: the chest circumference (CC). It can be said that the KMO index of 0.8 can be described as excellent or meritorious. It tells us that the correlations between the items are of good quality. A high KMO indicates that there is a statistically acceptable factorial solution that represents the relationships between the variables. A KMO value of: (less than 0.5 is unacceptable; 0.5 is miserable; 0.6 is poor; 0.7 is average; 0.8 is meritorious; 0.9 is wonderful). The KMO reflects the relationship between the correlations between the variables on the one hand and the partial correlations on the other, reflecting the uniqueness of the contribution of each variable. (Claire. D., 2005).

The principal component analysis of the population studies (PCA):

The principal component analysis (PCA) was carried out on the quantitative variables studied. The result of this analysis showed that these variables showed 52,58% of the total inertia on both axes, which is relatively average (Table 10). The two axes of the analysis express 52,58% of the total inertia of the dataset; this means that 50.51% of the total variability of the cloud of individuals (or variables) is

represented in this plane. This is a fairly large percentage, and so the foreground adequately represents the variability contained in a large part of the active dataset. This value is higher than the reference value of 32.44%, so the variability explained by this plan is significant.

Table 10: Representations of PCA own values.

Component	Total variance explained					
	Initial own values			Sum taken from cargo square		
	Total	% of the variance	% cumulative	Total	% of the variance	% cumulative
1	6,802	34,009	34,009	6,802	34,009	34,009
2	3,716	18,579	52,588	3,716	18,579	52,588

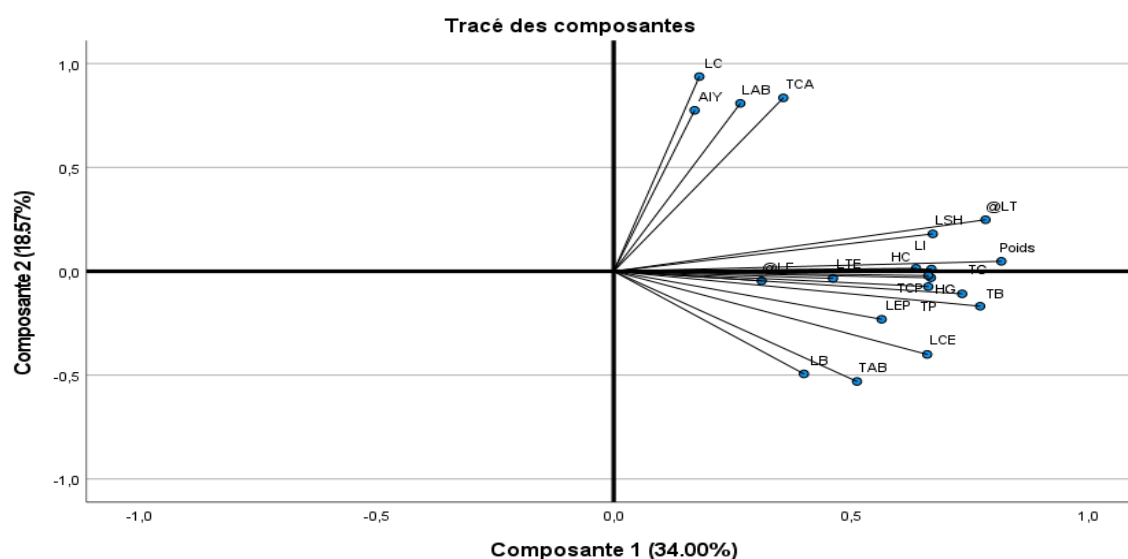


Figure 4: Presentation of body measurements by PCA in the equine population of fantasia studied

According to Table 10 and the analysis of the correlation circle (Figure 4), the parameters of: height at withers (HW), height at the rump (HR), Total length (TL), scapulo-iliac length (SL), head length (HL), neck length (NL), shoulder length (SHL), arm length (AL), ilium length (LI), length of the forearm (FL), thigh length (LT), chest circumference (CC), ball circumference (BC), knee circumference (KC), forearm circumference (FC), anterior barrel circumference (TAC), posterior barrel circumference (CCC) and live weight are most presentable on the first factorial axis (Sun 1) with a positive correlation. In addition, the parameters of: length between the internal angles of the eyes (IAE), total length (TL), barrel length (GL), and anterior barrel circumference (TAC) are positively correlated with the second factorial axis (Sun 2) which is also negatively correlated with the following parameters: shoulder length (SHL), arm length (AL), thigh length (GL), forearm length (FL), forearm circumference (FC).

We note at the PCA level of Figure 4 and 5 that from the characters, we can distinguish the formation of four groups (from top to bottom): The first group includes the parameters: the length of the barrel (GL), which has a negative correlation with the length of the shoulder (SHL), the length of the ball (AL), the length of the thigh (LT), and the circumference of the forearm (FC). The parameter of the length between the internal angles of the eyes (IAE), which is negatively correlated with: the height at the withers (HW), the length of the ball (AL), the length of the thigh (LT), the circumference of the ball (BC), and the circumference of the forearm (FC), Whereas the forearm length parameter (FL) is negatively correlated with shoulder length (SHL), ball length (AL), thigh length (LT), and forearm circumference (FC). The anterior barrel circumference (TAC) parameter has a negative correlation with ball length (AL), thigh length (LT), and forearm circumference (FC). The second group and third group are juxtaposed, but it can be said that the parameters of total length (LT), scapulo-iliac length (SL), length of ilium (LI), height at rump (HR), and live weight (WL) form the second group. All these

A scatter plot showing the relationship between REGR factor score 1 for analysis 1 (X-axis) and REGR factor score 2 for analysis 1 (Y-axis). The X-axis ranges from -3,00000 to 3,00000, and the Y-axis ranges from -1,00000 to 2,00000. The plot displays numerous data points, each labeled with a name, representing the distribution of individuals across the two principal components.

Cluster Dendrogram



The hierarchical bottom-up classification is based on the Euclidean Distance Aggregation Method. The dendrogram of the hierarchical tree (Figure 6) allows us to visualize four major classes. There are 21 individuals in the first and second classes, 29 individuals in the third class, and 17 individuals in the fourth class.

It appears from the PCA (Figure 4) and the HAC (Figure 6) that the breeds studied do not have any population structure; according to the data collected based on the geographical location of the animals, the subdivision of our study taxon into four groups. This is due to the fact that the environment is therefore similar to the breeding practices at the level of the four regions (Tlemcen, Oran, Saida, and Naâma).

Conclusion

In Algeria, this study has compiled the first inventory of the equine population of Algerian fantasia based on field prospecting and the selection of morphometric tools and statistical analyses. The overall results of our study reveal that the Shannon and Weaver index is high in the three breeds studied, which is probably a reflection of significant genetic diversity, and for the four regions studied, the difference is not very large, which can be explained by the difference in the number of comparable animals or by the effect of the environment. It also emerges from this study that we have three classes that are differentiated between them at the level of different morphometric parameters: the classes (01) and (02) are close to the standard of the Barb horse but very different from that of the ETB and ATB. The class (03) is close to the standard of the Barb and ATB horses and different from that of the ETB. As well, the Barb Horse is the most present in all three classes, since it is the ideal horse for the game of fantasia. This morphometric study confirms the presence of mixture and chaos in equine breeds of fantasia in Algeria. Finally, any project of this magnitude would not be complete if it were not completed by a molecular study, an important step of which we want to be the initiators in Algeria.

References:

- BARONE P.** (1976). Anatomie comparée des mammifères domestiques, Tome I, Ostéologie. Vigot Frères Editeurs, Paris, France, 428 p.
- BARONE P.** (1980). Anatomie comparée des mammifères domestiques. Tome II, Arthrologie et myologie, Vigot Frères Editeurs, Paris, France, 984 p.
- BEN AISSA R. et TAMZALI Y.** (1989). La situation actuelle du cheval Barbe en Algérie, *Maghreb Vét.*, 3, 14, 21- 23.
- Benhamadi MA, Kamel M, Gaouar SBS.** (2016). Mémoire master. Caractérisation morphométrique de la race équine Barbe dans le Nord-Ouest de l'Algérie.
- Berber Naima.** (2016). [Thèses Doctorat]. Constitution d'une biothèque d'ADN équin. Caractérisation génétique des Breeds équines en Algérie par l'étude des microsatellites.
- Caroll C.L. et Huntigton P.J.** (1988). Body condition scanning and weight estimation of horses. *Equine Vet. J.*, 20, 1, 41-45.
- Chabchoub A.** (1998). Le standard du cheval barbe tel qu'il est défini par l'OMCB. *Al Baytari*. 24, 6–7.
- Claire D.** (2005). L'analyse factorielle et l'analyse de fidélité notes de cours et exemples.
- DAD-IS.** (2018). Browse by species and country: Algeria, Horse. Accessed in October 2018. Des Haras nationaux, les écuries de bois 61310 LE PIN AU HARAS. Fiche technique.
- El Beji A.** (1972). Le cheval pur-sang arabe en Tunisie et les courses de chevaux en Tunisie. Thèse Méd. Vét, Alfort, France, 62.
- Élise Rousseau.** (2014). Tous les chevaux du monde, Delachaux and Niestlé, Septembre 2014.
- FAO.** (2021) Food and Agriculture Organisation. Caractérisation phénotypique des ressources génétiques animales. Directives FAO sur la production et la santé animales FAO 2021.

- Haddam. Y and all, 2021.** Morphological characterization and the significance of sexual differences in size among Lipochromic Mosaic Canary bird raised in the Wilaya of Tlemcen Northwest of Algeria.
- HOUP, KA, WILLIS, MB.** (2001). Genetics of Behaviour. In : A. Ruvinsky (Ed.) : The Genetics of the Dog. CABIPublishing, Wallingford-New York, pp.371-400.
- Kadri A.** (2006). Le cheval Barbe, cheval du Nord de l'Afrique, son rôle en Algérie. Rev Organismes Mond. Cheval Barbe.7, 9–45
- Legault R.J.** (1977). Contribution à l'étude de la morphologie comparée des chevaux de pursang anglais et trotteurs français. Thèse. Méd.Vét., Alfort, France, 80 p.
- Legendre, L. et Legendre P.** 1979. Ecologie numérique 1. Le traitement multiple des données écologiques, 197 pp. Edition Paris : Masson Presses de l'université du Québec.
- Marcenac L.N. et Aubert H.** (1974). Encyclopédie du cheval. 3ème édition Maloine S.A. Editeur, Paris.
- Murray G, Munstermann S, Lam K.** (2013) Avantages et défis inhérents au développement mondial des événements équestres – nouvelles normes pour la population des chevaux de compétition et pour les zones indemnes de maladies des équidés dans les pays.
- Nei M.** (1987). Molecular evolutionary genetics, Colombia University Press, New York, USA 70 : 3321-3323.
- Nei M., Roychoudhury A.K.** (1974) Sampling variances of heterozygosity and genetic distance. Genetics. 76, 379–390.
- Ronciere A.P.** (1998). Contribution à l'étude du cheval Ariégeois de castillan : Élevage et biométrie. Thèse Méd. Vét., Toulouse, France.
- Tamzali Y.** (1989). La situation du cheval barbe en Algérie. In : Recueil de tous les textes officiels sur le cheval barbe. Organisation mondiale du Cheval Barbe. Caracole Lausanne, 107–11
- Yaro, M., Munyard, K. A., Stear, M. J., & Groth, D. M.** (2017). Molecular identification of livestock breeds : a tool for modern conservation biology. Biological Reviews, 92(2), 993-1010.