

Comparison of Morphological Traits between Barb and Arab-Barb Tunisian Horses and Proposal of an Initial Standard for the Arab-Barb

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Citation: Hamrouni Abir, Gharbi Belki, Mezir Haddad, Djemali MNaouer (2024) Comparison of Morphological Traits between Barb and Arab-Barb Tunisian Horses and Proposal of an Initial Standard for the Arab-Barb, J Vet Sci Ani Husb 12(1): 104

Received Date: January 27, 2024 **Accepted Date:** February 27, 2024 **Published Date:** February 29, 2024

Abstract

The main objectives of this study were to characterize the morphological features of Barb and Arab-Barb horses, develop an assessment grid, and propose a breed standard for the Arab-Barb. A total of 20 measurements were conducted on 33 horses from the Tunisian National Haras at El Battan. Based on these 20 morphological measurements, four distinct body indices commonly used in horse breeding and evaluation were calculated. These indices included the body profile index, the body index, the corpulence index, and the compactness index. In addition to these indices, we also estimated the live weight of each horse. To optimize the morphological characterization of the Barb and Arab-Barb horses while minimizing the number of measurements required, we utilized Principal Component Analysis (PCA). PCA helped reduce the dimensionality of the dataset and identified key variables contributing to the horses' phenotypes. Subsequently, Canonical Discriminant Analysis (CDA) was employed to determine the linear combinations of variables that maximized the separation between the Barb and Arab-Barb groups. This allowed us to develop an appreciation grid that could accurately distinguish between these breeds based on the most influential morphological characteristics. The Barb horses were found to be relatively light in weight, with an average of 490 ± 127 Kg, which is typical for light horse breeds such as the Barb. They also had a medium size (157.7 ± 4.5 cm) and square shape, which means that their body length and height are approximately equal (body index equal to 1). Additionally, the thorax girth measurement for these horses was $196. \pm 22.4$ cm, while the cannon circumference measurement was 18.9 ± 0.7 cm, which is consistent with the breed standards. The Arab-Barb horses have measurements close to those of the Barb, with an intermediate format between Arab and Barb horses. In contrast, the Arab-Barb horses studied had measurements similar to those of the Barb horses but with an intermediate body size and shape between the Arab and Barb breeds. This breed is also characterized by a square and mediolateral type. On average, Arab-Barb horses have a weight of 458 ± 55 Kg. They also have a medium size, with an average height at withers of 158.4 ± 5.1 cm. Arab-Barb horses have somewhat smaller heads and slightly shorter necks. However, their limbs are relatively long and thick, with powerful canons and voluminous articulations. Overall, the proposed standard can be used to evaluate and select Arab-Barb horses. We refined our approach to selecting morphological traits by reducing the number of measured characteristics from 20 to 11. This optimization was achieved through a comprehensive analysis of the dataset, identifying the 11 most informative mor-

phological features. These carefully chosen traits play a pivotal role in characterizing the Barb and Arab-Barb horses, capturing the essence of their phenotypes.

Keywords: Genetic; Horses; Arab Horses; Arab-Barb Horses

Introduction

The Barb or Berber horse is recognized as one of the world's oldest horse breeds, with its origins dating back to ancient North Africa [1]. These horses were highly esteemed by the Berber people for their exceptional attributes, including speed, agility, endurance, docility, and adaptability to changing climates. They served various purposes, such as racing and hunting [2]. Over time, the Barb horse significantly influenced the development of numerous other horse breeds [3]. Presently, the Barb horse is classified as an endangered breed, with only a few thousand purebred individuals remaining worldwide. Efforts are underway to preserve the breed and its unique genetic heritage. The Arab-Barb horse is the result of crossbreeding between Barb horses and Arab horses, which were introduced to North Africa during the Arab conquests in the 7th and 8th centuries [4-5]. The purpose of this crossbreeding was to address certain limitations of Barb horses, including issues related to their size, endurance, temperament, and overall versatility. In June 1987, the World Organization for the Management of Crop Biodiversity (OMCB) established a standard for the Barb horse. This standard defined it as a symmetrical, square-shaped, mediolineal breed with a medium height ranging from 1.45 to 1.60 meters [5-6]. Various types of Barb horses conform to the purity standard, while other types exhibit significant heterogeneity [7-10]. However, in the regions where the Barb breed originated, such as Morocco, Algeria, and Tunisia, purebred Barbs are not found due to the presence of recessive genetic markers inherited from the Arab-Barb breed. The Arab-Barb breed is more diverse than the Barb horse, as it incorporates varying percentages of Arab blood, ranging from 0% to 100%. According to the report from the National Foundation for the Improvement of Horse Breeds, Tunisia's equine population consists of approximately 26,000 horses. This includes 20,000 Barb and Arab-Barb horses, 5,000 Pure Arab horses, and 1,000 English Thoroughbreds. The distribution of this equine population across Tunisian territory is uneven. However, there is currently no established standard for the Arab-Barb breed. To address this gap, the Tunisian Ministry of Agriculture has formed a breed commission. Consequently, the aim of this study is to define and compare the body measurements of Barb and Arab-Barb Horses. The primary objective is to minimize the number of parameters required to distinguish between the two breeds. Additionally, the study proposes a standard for the Arab-Barb breed, which can be utilized to differentiate it from the Barb breed. This standard may also help clarify any confusion or uncertainty that arises in the identification of mixed-breed horses.

Material and Methods

Horse Sample

The equine sample utilized in this study was carefully chosen to conform to our research goals. It comprised a total of 33 horses, including 9 Tunisian Barb females, all aged 3 years and older. These horses were identified and collected from the Tunisian National Haras, a well-established institution in the country, recognized for its commitment to breed improvement and the preservation of their distinct characteristics. However, it's important to note that this study was conducted during the challenging period of the COVID-19 pandemic, which presented logistical and safety constraints that influenced our sample size.

Morphometric Measurements, Body Indices and Estimated Live Weight

To acquire the essential measurements, we employed a metric tape to assess length and circumference parameters, along with a vernier caliper for height measurements. Each horse was positioned on a flat, even surface to guarantee uniform measurement origins. The measurements encompassed a comprehensive set of 20 quantitative parameters, each contributing to a detailed characterization of the horses (Table 1).

Table 1: Morphometric measurements

Eye distance:	The distance between the inner corners of the eyes.
Total length:	The measurement from the tip of the head to the tip of the buttock.
Body length:	The distance between the point of the shoulder and the point of the buttock
Head length:	The measurement from the neck to the tip of the nose
Neck length:	The distance from the middle of the anterior edge of the shoulder to the most prominent part of the first cervical vertebra's edge.
Shoulder length:	The measurement from the highest point to the tip of the shoulder.
Arm length:	The distance from the central area of the scapula-humeral joint to the central area of the humero-radial joint.
Forearm length:	The measurement between the lateral prominence of the radial head and the distal part of the radius.
Thigh length:	The distance between the greater trochanter of the femur and the coxal tuber of the thigh.
	Length of the withers to the base of the tail.
Chamfer length:	The width expanding from under the eyes to the nostrils.
Withers height:	The vertical distance from the highest point of the withers to the floor.
Height at the rump:	The vertical distance from the highest point over the sacral tuberisoty to the floor.
Thorax girth:	A measurement passing vertically behind the withers and at the level of the strap passage.
Cannon circumference:	The circumference of the cannon bone at the midpoint of its length
Knee girth:	The central region of the carpus
Fetlock girth:	The circumference of the middle third of the lateral face of the metacarpo-phalangeal joint
Neck girth1:	The circumference measured at the base of the neck.
Neck girth2:	The circumference measured at the top of the neck.
Pelvis girth:	The measured circumference of the iliac fossa.

Body Indices and Live Weight

Body Profile Index

The body profile index is a metric that offers valuable insights into the overall body shape and proportionality of horses. When a horse has a body profile index value close to 1, it signifies that the horse is medioliner, indicating that its total body length is approximately equal to its height [11-13]. This classification is typical for numerous horse breeds and can influence their physical attributes and performance.

Body profile index (BPI) = withers height /total length

Index or Body Report

The body index is measurements of a horse chest development in proportion its height at the withers, expressed as the ration between the circumference of the chest in centimeters and the height at the withers in centimeters [14]. A horse with a high body index is likely to have a well-developed chest and strong musculature, which can be advantageous in disciplines such a show jumping that require power and agility. On the other hand, a horse with a low body index may have a narrower chest and less muscling, which may make it more suitable for disciplines that require speed and endurance, such a racing or long-distance riding.

Body Index (BI) = Thorax girth/Withers height

Front-Back Height Index

The ratio of the height at the withers to the height at the rump is a commonly used metric to assess a horse's size and balance [14-15]. A well-balanced horse typically exhibits a ratio close to 1.

Front-back height index= withers height/ height at the rump

Compactness and Corpulence Index

The compactness index measures the weight of the horse in relation to its body size [16], while the corpulence index measures the overall body condition of the horse [14-16]

Corpulence index = Thorax girth/Total length

Compactness index= live weight /withers height

Live weight

Furthermore, the estimated live weight was approximated based on the Thorax girth and total length, using the method described by Carroll and Huntington.

$$\text{liveweight (kg)} = \frac{\text{Thoraxgrith}^2 \times \text{totallength}}{y} \quad (y = \text{aconstantequalto}11877.4\text{cm}^3/\text{kg})$$

Principal Component Analysis

Principal Component Analysis (PCA) was employed to reduce the dimensionality of the body measurements dataset while retaining maximum original variation. It aimed to identify parameters contributing significantly to phenotypic variability among the studied parameters in horses. This allowed us to visualize dependency relationships between metric variables and main components.

Canonical Discriminant Analysis

Canonical Discriminant Analysis (CDA) was utilized to assess the effectiveness of variables in distinguishing between groups. CDA identifies the key variables contributing to breed differentiation without going into extensive detail about the methodology."

Results and Discussion

Morphological Characteristics

Figure 1 focuses on coat color. The study categorized the horses into four groups based on their coat colors: Alezan and Berry (each at 36%), Grey (6%), and dark brown berry (2%). These results align with earlier research conducted by Chabchoub. Notably, the grey color was the most dominant among Barb horses, while alezan was the most common among Arab-Barb horses. This trend corresponds with observations in Morocco, where grey is the most prevalent coat color among horse populations [17]. It's important to highlight that the dark brown berry color, which constituted 18.18% of the Barb breed, is relatively rare in the Arab-Barb population.

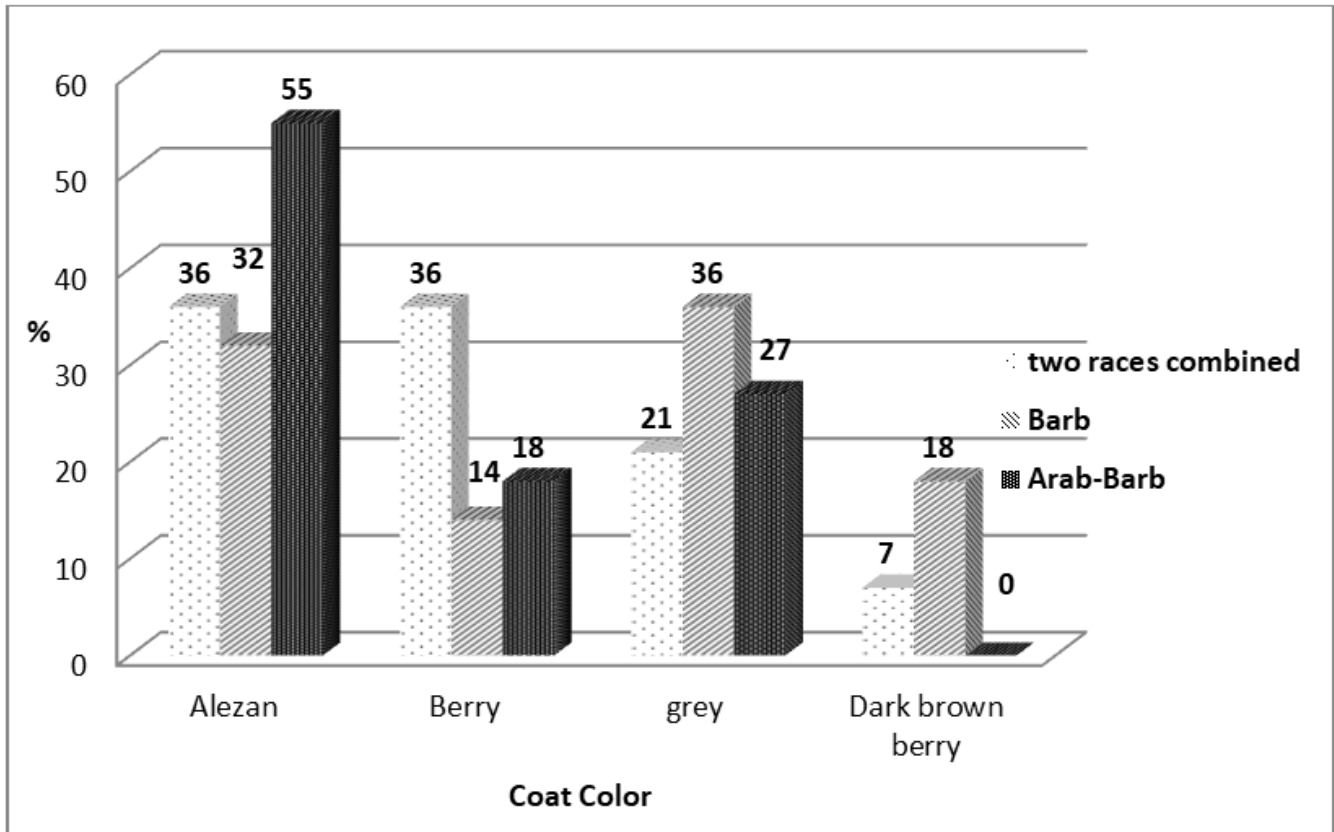


Figure 1: Coat Color distribution in studied horses

Table 2 provides descriptive statistics for the morphometric measurements and body indices of Tunisian horses. The average estimated height at withers for Arab-Barb horses was 158.4 ± 5.1 cm, which surpasses the values reported by Boujenane and Mebariki for Moroccan and Algerian Arab-Barb horses [15, 18]. According to the Commonwealth Agricultural Bureaux International (CAB) in 2016, the typical size range for Barb horses falls between 1.52 m and 1.62 m. The reference measurements for Tunisian Barb horses listed in the DAD-IS database are somewhat lower, with an average height of 1.50 m for females and 1.55 m for males. As indicated in Table 1, the average height at withers for Barbs is similar to that of Arab-Barbs (157.7 ± 4.5 cm). The height at the rump for Barb horses ranges from 152.5 cm to 153.1 cm for Barb and Arab-Barb, respectively. In general, the height measurements of the horses included in this study are consistent with the standard values reported for Arab Thoroughbred Arabian horses.

When considering length measurements, it is observed that the Arab-Barb horses are generally more elongated (152.5 ± 8.8 cm) compared to Barb horses (149.09 ± 3.2 cm). These findings are in line with prior studies of Tunisian Barb and Moroccan Arab-Barb horses, which also reported relatively modest mean values for length measurements [9]. The average total length of Barb horses ex-

ceeds the height at withers, although the breed standard for Barb horses stipulates that these two measurements should be equal (OMCB). In terms of neck length, the Barb horses in this study had an average length of 63.5 ± 7.2 cm, while Arab-Barb horses had a slightly shorter average neck length of 59.5 ± 3.1 cm. The mean values for head length are similar for both breeds and are also akin to the average neck length. The mean value of the distance between the eyes was slightly different between the two breeds, with a measurement of 20.7 cm for Barb horses and 21.8 cm for Arab-Barb horses. These results suggest that both breeds have long and broad heads. In this study, we discovered that the total length of Arab-Barb horses is marginally greater than that of Barb horses, with average values of 228.27 ± 12.99 cm versus 227.09 ± 8.56 cm, respectively.

The thorax girth of Barb and Arab-Barb horses measures 196.3 ± 22.4 cm and 188.5 ± 8.5 cm, respectively. It's important to note that these horses exhibit a larger than average thorax size. This observation is supported by Marcenac and Aubert's research in 1974, which confirmed that Barb and Arab-Barb horses have a disproportionately large thorax relative to their body size. This is likely the result of selective breeding practices that have prioritized traits such as physical endurance. In addition to a larger thorax girth, these horses may also possess other advantageous physical characteristics, such as increased lung capacity and respiratory efficiency.

Furthermore, the average cannon circumference for Barb horses was found to be 18.9 ± 0.7 cm, aligning with the standard set for Barb horses by OMCB in 1987. The cannon bone measurement is vital in assessing horses, as it serves as an indicator of bone strength and is used to evaluate the suitability of the horse for specific activities like racing or jumping. This finding corresponds with previous research conducted by Jary, Chabchoub, and Rahal. Tunisian Arab-Barb horses are similar in this aspect to Algerian horses [14] and Moroccan horses [15]. Interestingly, the measurements of cannon, knee, and fetlock girth for Arab-Barb horses were found to be finer compared to Barb horses.

The body weight of horses is a significant characteristic that can influence their athletic ability and overall health. The average estimated weight of Barb horses is 490 ± 127 Kg, categorizing them as medium-sized animals. This finding is in accordance with previous studies conducted by Mariante, Chabchoub, and Guedaoura. The average estimated weight of Arab-Barb horses was determined to be 458 ± 55 Kg, which is slightly lower than the estimated weight of Barb horses. This variance may be attributed to several factors, including differences in body composition or selective breeding practices. The observed difference in weight between the Barb and Arab-Barb samples implies that Barb horses generally tend to be heavier than Arab-Barb horses. However, it's essential to acknowledge that significant variations in weight may exist within each breed due to factors such as diet, exercise, and genetics. These variations can influence the physical characteristics and performance of individual horses within each breed.

For both breeds, the body profile index was found to be very close to 1. Various studies comparing morphometric measurements between Barb and Arab-Barb horses from Morocco, Algeria, and Tunisia have been conducted by multiple researchers, including Chabchoub, Boujenane, Rahal, and Mebarki. These studies consistently reveal that Barb and Arab-Barb horses from these regions exhibit a similar square format. Notably, this square format is also observed in other breeds, such as Andalusian and Lusitano horses, which are renowned for their athletic ability and versatility. The ideal body index typically falls within the range of 0.885 to 0.90. Horses with a body index above 0.90 are generally considered to have a more compact body size [19]. The body ratio of the Barb and Arab-Barb horses in this study was determined to be 1.24 ± 0.16 for Barb horses and 1.19 ± 0.04 for Arab-Barb horses, respectively. This suggests that both breeds exhibit a relatively good thoracic development concerning their overall body size. The well-developed thorax observed in these Barb and Arab-Barb horses is a characteristic also found in other saddle horse breeds used for fast-paced activities like racing and jumping [20]. The front-to-back height ratio for both breeds was found to be 1, aligning with the results reported by Boujenane and Guedaoura. These findings indicate a balance between the height at withers and the height at the croup for Barb and Arab-Barb horses.

Table 2 shows that the average compactness index for Barb horses was 3.11 ± 0.88 Kg/cm, while for Arab-Barb horses, it was slightly lower at 2.88 ± 0.30 Kg/cm. This implies that Barb horses may have a slightly more compact body size compared to Arab-Barb horses. Regarding the corpulence index, the average value exceeded 1 (1.31 ± 0.15 for Barb and 1.23 ± 0.07 for Arab-Barb), indicat-

ing that both breeds tend to have a slightly more muscular and robust body condition. The Compactness and corpulence index categorize the studied Barb and Arab-Barb horses as compact and relatively heavy-bodied.

Table 2: Mean and Standard deviation of Morphological measurements and body index conformation

	Barb	Arab-Barb
Heights (cm)		
Withers height	157.7±4.5	158.4±5.1
Height at the rump	152.5±5.1	153.1±3.8
Lengths (cm)		
Total length	227.09±8.56	228.27±12.99
body length	149.09±3.2	152.5±8.8
Head length	59.2±4.4	58.4±4.4
Neck length	63.5±7.2	59.5±3.1
Shoulder length	58.6±4	56.1±6.6
Arm length	35.9±3.9	33±3.7
Forearm length	30±3.7	31.2±3.8
Thigh length	42.6±5.1	43±4.7
Eye distance	20.7±3	21.8±1.8
length of the withers to the base of the tail	105.59±5.73	107.27±2.90
Chamfer length	18.14±1.93	17±1.61
Circumferences (cm)		
Thorax girth	196.3±22.4	188.5±8.5
Canon girth	18.9±0.7	18.8±1.6
Knee girth	31.9±3.7	31.1±1.9
Fetlock girth	26.3±1.3	25.9±2
Neck girth1 :	119.8±7.9	122.9±6.6
Neck girth2 :	78.7±7.2	79.6±7
Pelvis girth	65.68±3.63	66±3.61
Live weight (Kg)	490±127	458±55
Index		
Body profile index	1.06±0.03	1.04±0.05
Body index	1.24±0.16	1.19±0.04
corpulence index	1.31±0.15	1.23±0.07
Compactness indexFront-back height	3.11±0.881.03±0.01	2.88±0.301.03±0.02

Proposed Standard for an Arab-Barb Horse

Based on the measurements of physical characteristics, phenotypic characterization, estimated indices, and a comprehensive re-

view of the existing literature [9, 14, 17], [21-23], as well as insights derived from other relevant research, we propose a preliminary breed standard for Arab-Barb horses (Table 4). In terms of size, the two breeds exhibit considerable similarity. However, the Barb horse is known for several distinguishing physical characteristics. It possesses a head with a convex profile, which may be slightly arched or straight, complemented by almond-shaped eyes. The neck of the Barb horse is wide and thick, and its shoulders are inclined. It features a tall and broad chest, a short, taut, and sharp back, as well as a level rump, and a long, well-supplied tail attached low. This proposed standard draws not only from the results of this research but also incorporates insights from various other studies and research sources [9, 14, 17], [21-22].

The Barb horse comes in various colors, including Chestnut (Alezan), Bay (Berry), Grey, and dark brown berry. On the other hand, the Arab-Barb can be found in colors like Chestnut (Alezan), Bay (Berry), and Grey. The Arab-Barb breed is renowned for its distinctive physical characteristics, making it a unique and sought-after breed among horse enthusiasts. It is classified as euo-metric and mediolineal, which means its physical measurements fall within a specific range of proportions considered ideal for the breed. Morphologically, Arab-Barb horses could be seen as an intermediate between the Arabian and Barb breeds, displaying some unique features that set them apart. Notably, they have an elongated and slender neck. Arab-Barb horses are of medium size, giving them a balanced and agile appearance, and they can be described as having a square build. Additionally, they possess a slightly small head with open nostrils, contributing not only to their aesthetic appeal but also facilitating easier breathing during exercise. The horse's cephalic profile is another essential characteristic that can vary from convex to straight. The slightly arched neck further contributes to the horse's overall look, imparting an elegant and refined appearance. Well-developed high withers provide a robust foundation for the saddle, ensuring even weight distribution across the horse's back. The short back enhances the horse's agility and speed. The Arab-Barb horse is characterized by a relatively short and gently elevated rump, lending it an elegant demeanor. A distinctive feature of this breed is the short, tied-up tail. The breed typically possesses a slender body type, accompanied by a flat and open ribcage. This aspect bestows upon the breed its characteristic sleek and streamlined appearance. Overall, the breed's conformation should showcase balance, well-defined musculature, and a sleek and athletic look.

Table 3: Comparison between Barb and Arab Barb horses

Characters	Barb	Arab-Barb
Size	Varied 150 cm from to 165 cm	varied 148 cm from to 164 cm
Head Profile	Convex profile, slightly arched or straight	concave or straight
eyes	Almond shape eyes	wide, expressive and energy
Neck	wide and thick	thin and elongated
Shoulders	tilted	well laid
Chest	Tall and wide.	well developed
Back	Short, tense and sharp	Short
rump	horizontal	gulp
Tail	long and supplied attached low	short tied up
Color	Alezan and Berry, grey and Dark brown berry	Alezan and Berry and grey
Weight	Barb is heavier than Arabic Barb horses	

Table 4: Proposed standard for an Arab-Barb horse

Characters	Description
Ethnic coordinates	

Format	Eumetric
Proportions	mediolinal
Profile	convex to straight
Size	varied 148 cm from to 164 cm
length	Nearly equal to size
Body profile index	Equal to 1 : square horse
Cannon circumference	Minimum : 18 cmMaximum : 21 cm
mophological characters	
Head	slightly small
Eyes	large, expressive and energy
Neck	little wheel
Withers	High
Shoulders	well laid
Chest	well developed
Back	Short
Rump	Gulp
Tail	short tied up
Skin	Thin
Thighs	Flat
Nostrils	Open

Morphological Assessment Grid

Contributing Variables

The Principal Component Analysis (PCA) resulted in the reduction of variables to eight principal components, identified based on eigenvalues greater than 1 (refer to Figures 2 and 3). Among these components, the body measurements strongly correlated with the first and second principal components (PC1 and PC2) are considered most significant in elucidating the dataset's variability. These specific variables play a pivotal role in contributing to the observed variations and are thus crucial for understanding individual or group morphology. In contrast, variables that display little or no correlation with any axis or are weakly correlated with the final few axes are categorized as low-impact variables. Collectively, these components explain approximately 76.16% of the total dataset variability. Notably, the first component, representing 19.44% of the total variability, exhibits strong correlations with several body measurements, such as rump height (0.77), withers height (0.73), arm length (-0.62), thorax girth (-0.59), and pelvis girth (0.56). This initial component primarily pertains to factors influencing a horse's balance, specifically height at the rump and withers height. This is in line with findings by Machmoum. The second component, explaining 17.94% of the variability, is significantly correlated with variables including cannon girth (0.64), thorax girth (0.62), shoulder length (0.58), total length (0.57), forearm length (0.55), chamfer length (0.53), and fetlock length (0.53). To visually represent these correlations, we constructed a diagram that portrays the interdependence between metric variables and the primary components. In this diagram (refer to Figure 2), each variable is depicted as a vector, while the main components are represented as axes. The direction and length of each vector signify the degree of a variable's contribution to a particular component. This plot serves as a tool for identifying variables strongly associated with specific components and exploring the relationships between variables. Upon examining the correlation

plot, we can discern that the most pivotal variables can be categorized into three groups, each related to lengths, heights, and circumferences. For height, the most influential traits are total length and arm length. In terms of height, the two most significant traits are withers height and height at the rump. Lastly, the most influential traits for circumferences are thorax girth, knee girth, cannon girth, and fetlock girth. This reduction in the number of measured variables demonstrates a practical and effective approach to morphological analysis.

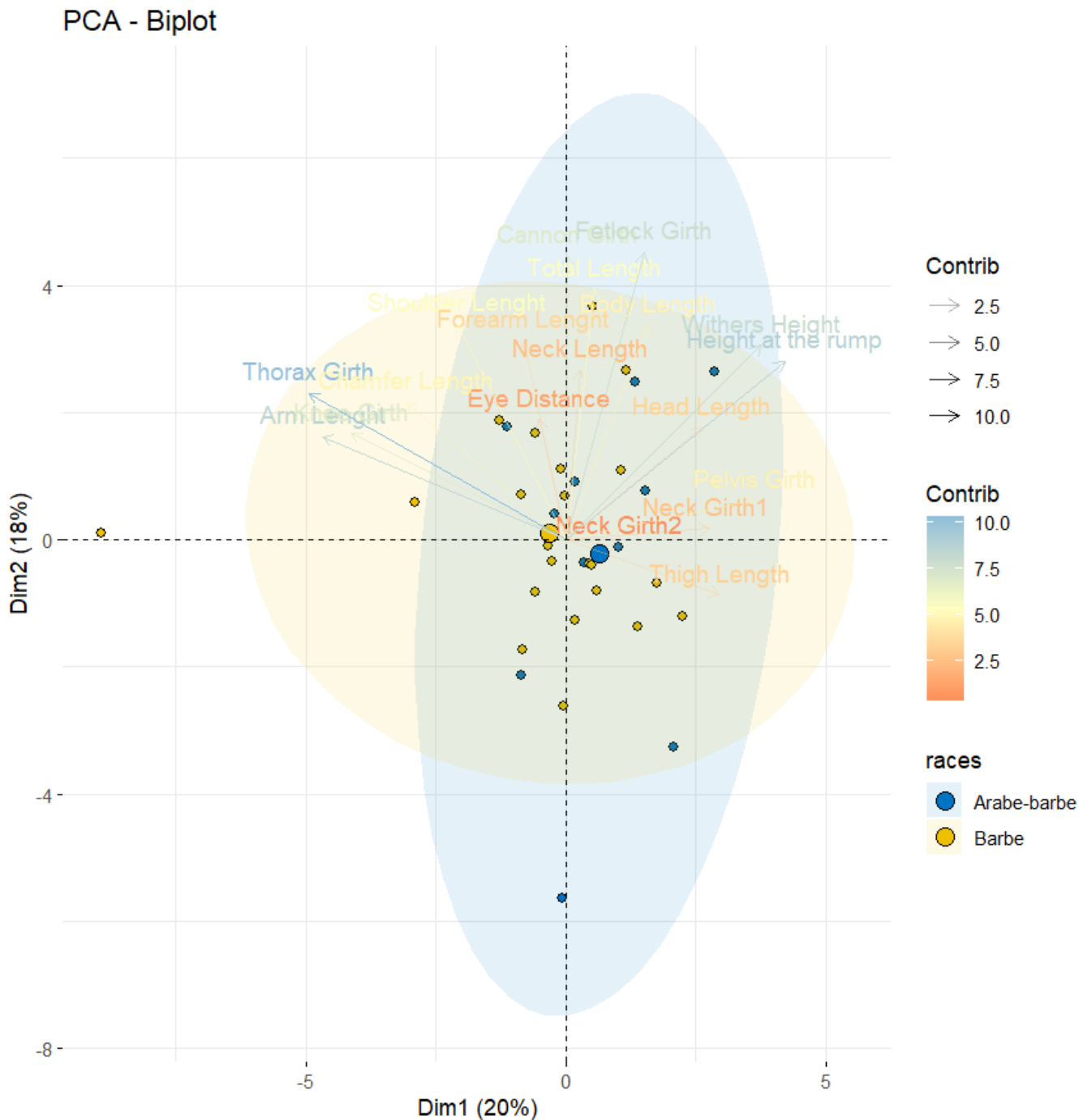


Figure 2: Biplot considering morphological traits for breeds

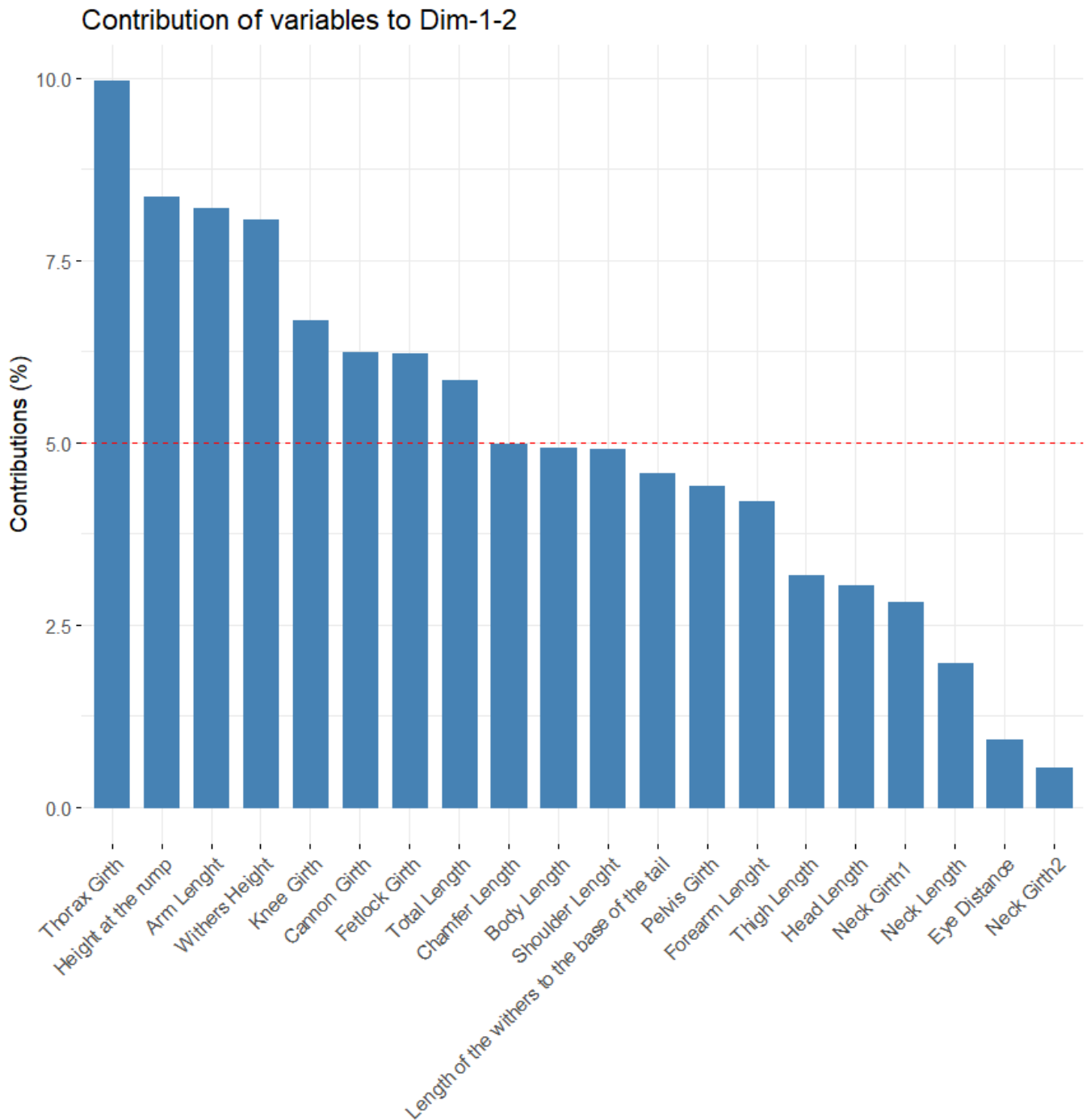


Figure 3: Contribution of variables to Dim 1-2

Canonical Discriminant Analysis

The aim of Canonical Discriminant Analysis is to identify and select the measurements that exhibit the most significant differentiation between the two breeds under investigation. In this specific instance, from the initial set of 20 body measurements, the progressive "Stepwise" method determined that four parameters displayed the highest discriminatory power. These selected parameters are likely to possess distinctive characteristics or variations that are particularly indicative of the differences between the two horse breeds. These outcomes are detailed in Table 5. Two canonical discriminant functions have been isolated, and they enable the differentiation between the breeds under examination (Figure 4). A clear phenotypical separation exists between the two breeds, signifying visible disparities in their physical characteristics. Both the Barb and Arab-Barb breeds exhibit zones of approximation, further validating the findings obtained through Principal Component Analysis

Table 5: Selection of variables by Stepwise method applied to the measurements of Barb and Arab-Barb horses

	Variables	Lambda	sig
Measurements			
1	Arm Length	0.878	*
2	Neck Length	0.792	*
3	Eye Distance	0.763	**
4	Head Length	0.668	**

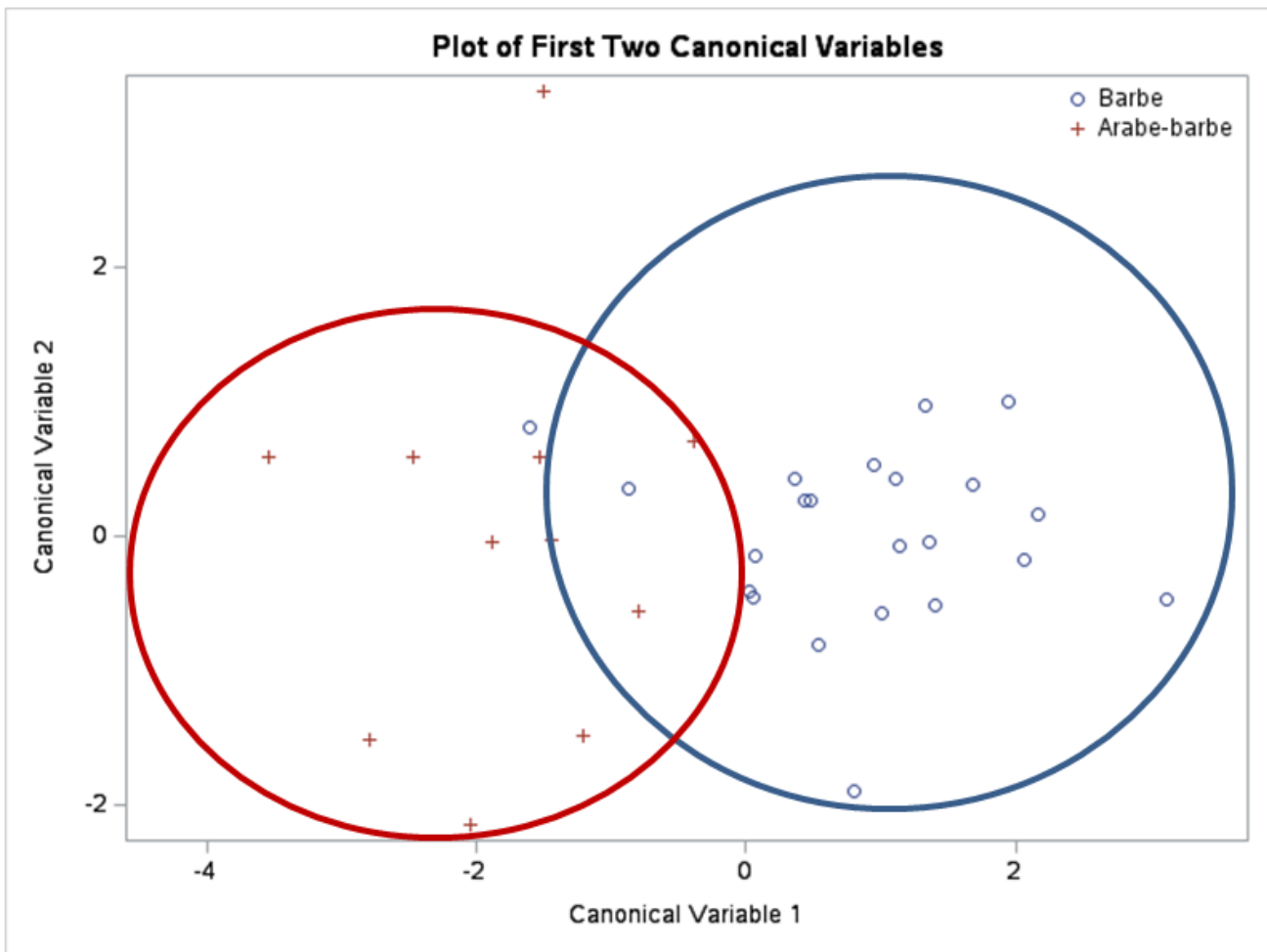


Figure 4: Graphic representation of Barb and Arab-Barb horses according to the first two canonical variables of body measurements

Morphological Appreciation Grid

Based on the analysis of the most influential traits, contributing to over 50% of the variance observed in the first two principal components, and taking into account the discriminatory traits identified, we have developed an evaluation grid encompassing 11 selected morphological characters (Table 6). This assessment grid was formulated by defining the minimum and maximum values for each of the chosen characters, as identified through the optimization process. It serves as a system for evaluating and comparing the phenotypic characteristics of Barb and Arab-Barb horses. A detailed breakdown of this evaluation is provided in Table 5. It's crucial to emphasize that this evaluation represents an initial scientific endeavor aimed at establishing differentiation standards between the two breeds. It serves as a foundational step for future in-depth investigations and advancements in characterizing Barb and Arab-Barb horses. The evaluation of a horse is performed by assessing each trait individually, allowing for an objective com-

parison of horses from different breeds. For instance, the height at the rump is utilized to determine whether a horse belongs to the Barb breed or potentially possesses a crossbreed heritage with Arab blood. Horses with a height at the rump exceeding 1.60 m or falling below 1.49 m are classified as Barb. However, if the measurement falls within the range of 1.49 m to 1.60 m, further consideration of other influential traits is warranted to differentiate between Barb and Arab-Barb horses.

Table 6: Morphological Appreciation grid

	BarbMIN MAX	Arab-BarbMIN MAX
Thorax girth	1.74 2.80	1.74 2.02
Height at the rump	1.37 1.64	1.49 1.60
Arm length	0.29 0.46	0.25 0.37
Withers height	1.48 1.64	1.50 1.65
Knee girth	0.29 0.46	0.28 0.34
Cannon girth	0.18 0.21	0.16 0.22
Fetlock girth	0.24 0.29	0.22 0.29
Total length	2.13 2.50	2.01 2.51
Neck Length	0.53 0.77	0.53 0.63
Eye Distance	0.14 0.25	0.20 0.25
Head Length	0.51 0.68	0.50 0.66

Conclusion

Overall, the morphometric measurements provide valuable information about the physical characteristics of the Tunisian Arab-Barb and Barb horses. The results of the morphometric measurements indicate that both Tunisian Arab-barb and Barb horses have a square body format. The Arab-Barb is a mediolineal horse of medium size and weight, and lighter than Barb horses. Furthermore, the Tunisian Barb horse was found to conform to the breed standard for the Barb breed. This suggests that the Barb breed has a distinct and recognizable set of physical characteristics, which the Tunisian barb horses shares. An optimization of the number of characters measured has been carried out for reducing the time and cost of measurements. We have optimized the selection of morphological characters by reducing the number of characters measured from 20 to 11. Our optimization of the selection of morphological characters has led to the development of an appreciation grid that allows for the accurate and reliable distinction between Arab-Barb and Barb horses. The appreciation grid takes into account various aspects of the horse's morphology. By using this grid, researchers, breeders, and other stakeholders can objectively and consistently assess the morphological differences between Barb and Arab-Barb, which can be crucial for various purposes, such as breed conservation, genetic improvement, and breed standardization.

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