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# Characterization of the fineness of she-camel's wool in the Wilaya of Nâama and El Bayadh

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## Abstract

To further understand productive characteristics and explore economically valuable signs of the wool's camels in Algeria, we studied the wool's fineness of a population of 27 adults female camels. The studied breeds are Ouled sidi cheikh, Targui and Reguibi at the level of the Wilaya of El Bayadh in El Keither commune and the Wilaya of Naama in Naama commune. We took wool samples from different parts of the she-camel's body: the head, the hump and the tail. The measurement of each wool fiber have been done with a binocular loupe glass equipped with an acquisition software, the collected data have been then analyzed using Rstudio software. The results showed how the diameter of the studied she-camels can vary according to different breeds going from super fine for Ouled sidi cheikh and Reguibi she-camels (9.03-11.7 µm and 9.5-10.2 µm, respectively) to fine for Targui she-camels (21-22.8 µm). This study can suggest the application of Ouled sidi cheikh and Reguibi's wool in the te xt ile industries for the production of sweaters and baby clothes, and the application oh Targui's wool in shawls and rugs.

**Keywords:** breed, fineness, she-camel, wool.

## Introduction

As an important class of specialty natural fiber, camel hair has distinctive characteristics, such as luster, softness, warmth, and natural color (Sharma, 2013; Cheng and *al.*, 2016; Wang and *al.*, 2018). Due to its excellent temperature regulation properties, camel hair is an ideal material for clothing applications. Therefore, the demand for this rare animal fiber may increase because their use in some consumer products, such as high-end fabrics, makes them more attractive (Ke and *al.*, 2008). Although the quantitative contribution is small, the importance of camel hair in the clothing and textile industries should not be underestimated.

The most common color of camel hair is reddish brown, with brown to gray variants (Chérifi and *al.*, 2013). White wool is very rare, but is the most valued (Watkins and Buxton, 1992). Camel hair and cashmere have many things in common, except that camel hair is a bit coarser. Camel hair has two basic characteristics, coarse outer hair and inner down fiber. The fine down fibers range from 19 to 24 microns in diameter and about 2.5 to 12.5 cm in length. The coarse fibers have a diameter of 20 to 120 microns and a length of up to 37.5 cm (Watkins and Buxton, 1992). The scales of camel hair have irregular mosaic patterns and they are also very smooth. Some reports claim that camel hair has a regular diameter and a smooth surface. The cuticle of the fiber is somewhat less dense compared to the rest of the length of the fiber (Appleyard, 1978). Near the medulla, in the finer fibers, the pigment distribution is sparse, while in the coarser fibers, the pigment distribution is denser. Other characteristics of camel hair are its strength of 1.79 grams/denier, luster, smoothness, water resistance, warmth rapellency, fineness (9.55 denier) and lightweight (Humphries, 1996). According to reports, the presence or absence of medulla can be used as a criterion to distinguish different types of smooth hair fibers, but most types of coarse hair contain a high percentage of Medulla (Merhi and Abdulsalam, 1971).

Even though camel breeding plays a key role in the food security of Saharan and steppe communities in Algeria, and that camel hair belongs to specialty fiber which is often more expensive due to its scarcity and luxurious texture, it still remains a very little valued wealth. To enhance and develop an economy around the utilization of camel hair in Algeria, we studied in this article the finess of she-camel wool in different parts of the she-camels body aiming the fineness characteristics in relation to the breed and the region.

## Materials and methods

### *Study area*

Our study was carried out at the level of two wilaya, the wilaya of El Bayah in El Kheiter commune and the wilaya of Naama in Naama commune, during 2019 to 2020.
The territory of El Kheiter is located northwest of the wilaya of El Bayadh. It is a border commune with Naama, with an area of 1 023,1 km². The climate in El Kheiter is semi-arid dry cold, with an average temperature of 14.2 °C. The average annual precipitation does not exceed 300 mm³. It often snows in winter in El Kheiter, due to altitude of 984 m.

Naama is a commune in the Wilaya of Naama. It is a small town in the hight plateaux, which was promoted to the capital of a new Wilaya in 1984. It is located 220 km in south of Oran, 180 km in north of Béchar, 40 km in north of Ain Sefra and 18 km from Mécheria. The terrotory of the commune covers an area of 2482.5 km². The climate in Naama is cold, whith an average temperatue of 16.2 °C, the average annual precipitation does not exceed 250 mm³.

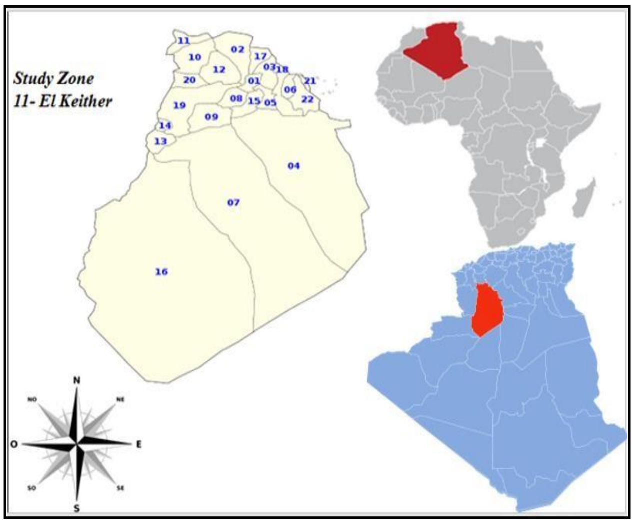


**Figure 1.** Representation of the study zone in El Bayadh.

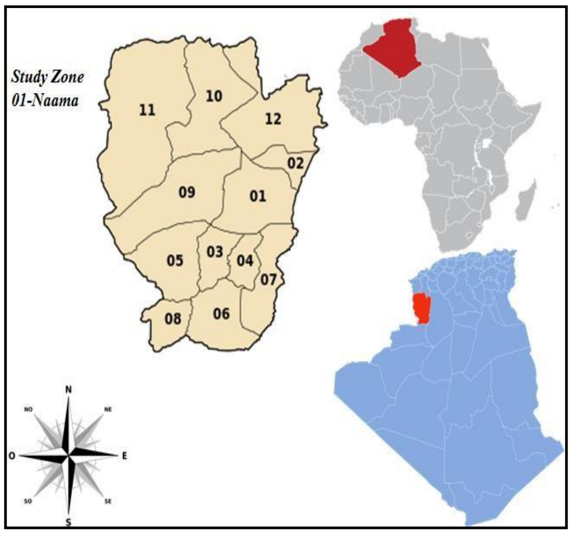


**Figure 2.** Representation of the study zones in Naama.

### *Choice of animals*

We worked on a population of 27 adult animals of the same sex (females), because the breeders of these herds did not allow us to take wool samples of males due to their aggressive behavior during the fertilization season. We worked on different breeds: Ouled Sidi Cheikh, Targui and Reguibi. We made sure that all the animals chosen and studied were in perfect health and showed no signs of any disease. Before doing any manipulation on the animals, the breeders and owners of the she-camels were totally agreeing. The number of samples is presented in the following table according to the breed and the study area.

**Table 1.** Distribution of the studied samples set by the zone and the breed.

| Breed | Wilaya of Naâma | Wilaya of El Bayadh |
|---|---|---|
| **Ouled sidi cheikh** | - | 7 |
| **Targui** | - | 4 |
| **Reguibi** | 15 | 1 |
| **Total** | 15 | 12 |

***Collection of samples***

In this study we took wool samples from different parts of the she-camel's body. The first sampling has been done from the head, the second one from the hump and the third one from the tail. Sampling points are shown in Figure 3.

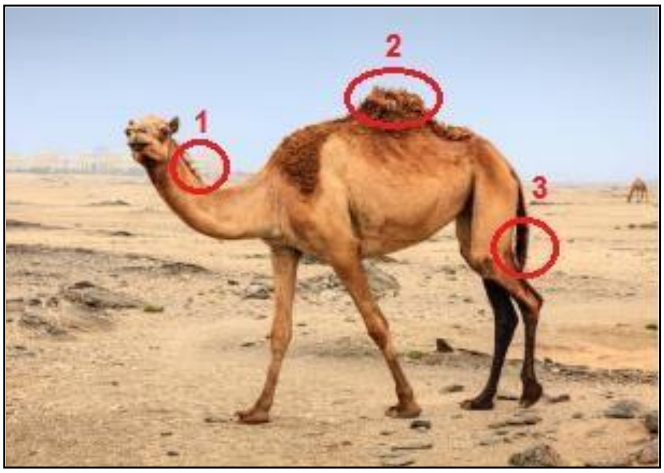

**Figure 3**. Overview of the sampling points in the she-camel’s body.

The measurements of each wool fiber have been done with a binocular loupe glass equipped with an acquisition software. It concerned the areas of wool where the filaments are well flattened and in parallel to the superposition of the slide.

The samples have been conditioned by being placed in a standard air. Then, we used the loupe to measure the fineness in (µm). We took 3 wools from each sample and repeated the experiment six times (six reads) on the same wool (Figure 4). For each sample, the mean in µm has been taken, and the results were registered.

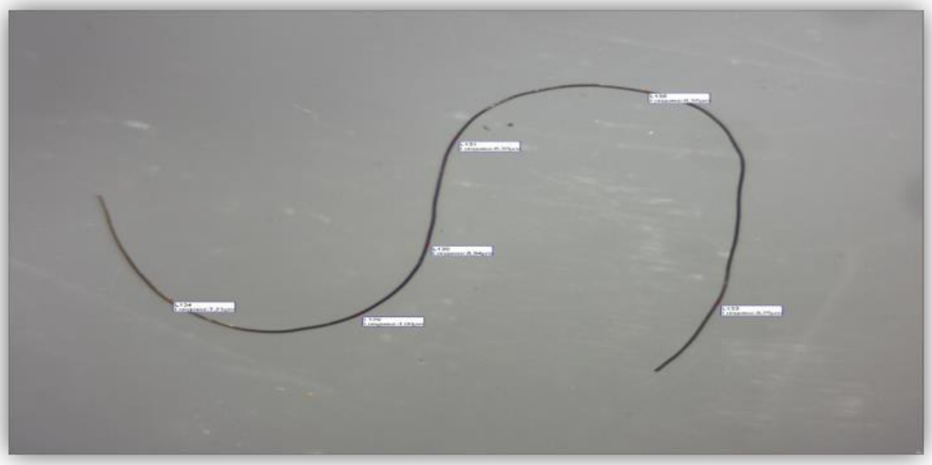

**Figure 4.** The six measures taken on the wool.

***Characters description***

In this research three quantitative characters have been studied, the first is the Head Wool Diameter (HWD), the second is the Hump Wool Diameter (HuWD) and the third is the Tail Wool Diameter (TWD). We also used three qualitative characters which are the color of the wool of the head (CWH), the color of the wool of the hump (CWHu) and the color of the wool of the tail (CWT).

***Statistical analysis***

The collected data have been analyzed using Rstudio software (version 4.0.2), which is an integrated environment for data manipulation, calculation and graph preparation. However, it is not just another statistical environment (such as SPSS or SAS, for example), but also a complete and self-contained programming language **(**Vincent Goulet, 2016). The impact of the zones, breeds and different body parts on wool measurements has been assessed using ANOVA.

A Principal Components Analysis (PCA) has been performed in order to identify clusters of she-camels with similar wool measurements. A Hierarchical Ascending Classification (HAC) has been also used to obtain the optimal number of groups of Algerian she-camels considered from their wool measurements.

A Multiple Components Analysis (MCA) has been performed in order to identify clusters of she-camels with similar wool color. A Hierarchical Ascending Classification (HAC) has been also used to obtain the optimal number of groups of the Algerian she-camels considered from their wool color. Niveau

## Results and discussion

***1. Normality test***

The normal distribution test has been performed before any statistical test using the Shapiro Wilk test in Rstudio. The p-value is equal to 0.81 which suggest that our data set follows the normal distribution.

***2. Descriptive analysis***

**Table 2.** Means, standard deviation, maximum, minimum and median of the 3 studied quantitative characteristics of she-camel wool.

| Characters (µm) | Means | Standard deviation | Maximum | Minimum | Median |
|---|---|---|---|---|---|
| **Head wool diameter** | 9.94 | 2.87 | 16.39 | 6.2 | 9.44 |

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| | | | | | |
|---|---|---|---|---|---|
| **Hump wool diameter** | 9.98 | 5.42 | 34.82 | 6.030 | 8.53 |
| **Tail wool diameter** | 23.2 | 3.62 | 30.9 | 17.39 | 22.5 |
| **Mean wool diameter** | 14.37 | - | - | - | - |

We can observe that the mean of the character Wool diameter varies according to the she camel's body. The mean of the wool diameter in the studied population in the head is 9.94µm, 9.98µm in the hump, and 23.2µm in the tail.

We can also notice that the overall mean of wool diameter of the studied she-camels is 14.37 µm. Compared to the results of the study of Harizi and al in Tunisia, the overall mean of the wool of our studied population is lower (19.5 µm for Harizi) (Harizi and *al.,* 2006).

These results are also lower than the ones of the camel and coet wool, (27.50 µm and 54.50 µm respectively) shown in the study of Kirti Nagal in India (Kirti Nagal, 2006).

Comparing to the Yak of the Qinghai-Tibet Plateau, our results are relatively similar from 15 to 17µm of diameter, but lower than the Alpaca hair (20-34 µm) (Petrie O.J, 1995).

### *3. Principal component analysis (PCA)*

Our data set contains 27 individuals and 5 variables. 2 qualitative variables are illustrative and 3 quantitative variables are normal.

- *Observation of extreme individuals*

The graph analysis does not reveal any out-group in our study.

- *Distribution of inertia*

The inertia of the factorial axes indicates on one hand if the variables are structured and on the other hand suggests the judicious number of principal components to study.

The first two axes of the analysis express 83.53% of the total inertia of the data set, which means that 83.53% of the total variability of the cloud of individuals (or variables) is represented in this design. This is quite a large percentage, and the first design therefore adequately represents the variability contained in a large part of the active dataset, so the variability explained by this design is significant. Because of these observations, it would still probably be preferable to also cons ider in the analysis the dimensions greater than or equal to the third (Figure 5).

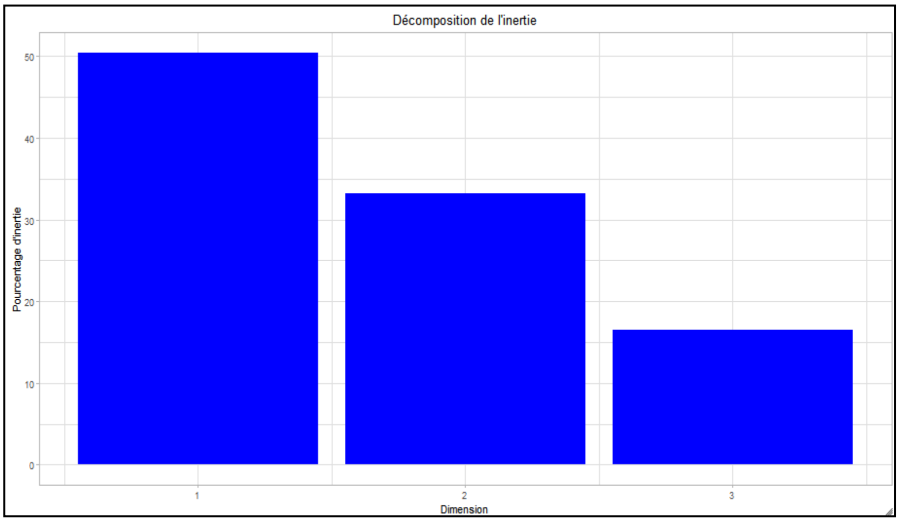



**Figure 5**. Decomposition of the total inertia.

An estimation of the relevant number of axes to be interpreted suggests restricting the analysis to the description of the first two axes. This observation suggests that these two axes contain real information (table 3).

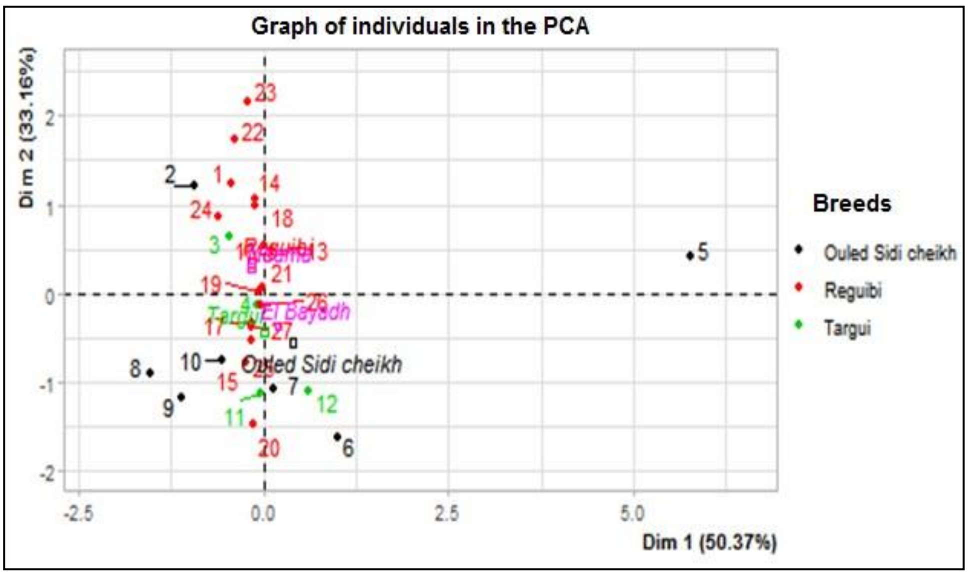
**Table 3.** Percentage of variance for each dimension.

| Dimension | Dim1 | Dim2 | Dim3 |
|---|---|---|---|
| **% of Var** | **50.37** | **33.16** | **16.47** |

- *Description of PCA*

The figure 6 informs us that the labeled individuals are those with the greatest contribution to the design construction. These individuals are colored according to their belonging to the modalities of the category breed. We notice that the breed of individuals 2, 6, 9 and 10 is Ouled Sidi Cheikh. We can also notice that individuals 11 and 12 belong to the Targui breed. Finally, the breed of individuals 19 and 23 is Reguibi.

It also emerges from figure 6 that the animals of the Ouled Sidi Cheikh breed are very heterogeneous, followed by the animals of the Reguibi breed. The animals of the Targui breed present more




homogeneity with respect to these characters compared to the two other breeds.

**Figure 6.** Distribution plan of individuals by breeds.

From the PCA of the studied variables (figure 7), we can notice that the variables in a continuous line are the active variables. The labeled variables are the best represented on the plan and they are colored in red. The variable TWD represents Tail Wool Diameter, HuWD represents Hump Wool Diameter and HWD represents Head Wool Diameter (table 4).

**Table 4.** Contribution of the variables studied on the three dimensions (%).

| Contribution | Dim.1 | Dim.2 | Dim.3 |
|---|---|---|---|
| **HWD** | 87% | 6% | 7% |
| **HuWD** | 86% | 11% | 3% |
| **TWD** | 0.7% | 99% | 0.3% |

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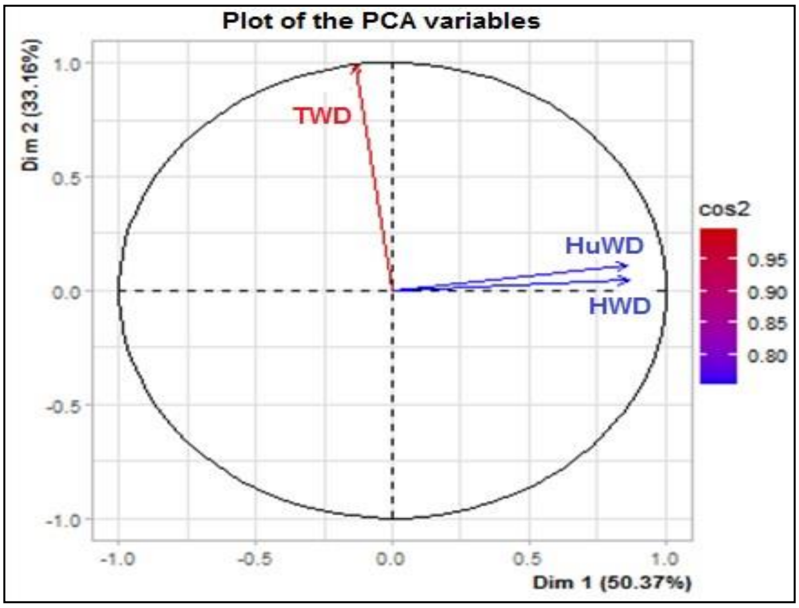
We also notice in the PCA of figure 7 that the studied variables in this population are close in their majority to the circle, which can suggest a significant level of importance on the statistical level.

The formation of two groups of variables can be distinguished. This reflects a positive correlation between these parameters in each group. The first group contains the Head Wool Diameter (HWD) and the Hump Wool Diameter (HuWD). The second group contains the Tail Wool Diameter (TWD).

We can explain the correlation of these variables either by the influence of genes, (that is to say that these variables are controlled by a certain number of genes in common) or that these variables react in the same way with the environmental conditions. To exclude one or the other probability we need to have more information about the situation where the same population evolves in two different biotopes and see if the correlations change, if not, it would mean that these correlated variables are controlled by a number of genes in common.

## Hierarchical Ascending Classification of PCA

This hierarchical classification of individuals in two dimensions shows how the individuals are colored according to their class membership. This hierarchical tree informs us about the proximity




between the individuals (figure 8 and 9).

**Figure 7.** PCA of the studied variables.

We notice from figure 9 that the classification realized on the individuals makes appear 3 classes: class 1 appears in black, the 2nd one in red and the 3rd one in green.

We can notice that only the variables that have a significant relationship with the classes are reported in Table 5. The intensity of the link (eta²) is measured by the correlation ratio between the quantitative variable and the class variable. We have to check if this correlation ratio is significantly different from 0 (table 5).

**Table 5.** Association of the studied variables with the partition.

| | Eta² | P-value |
|---|---|---|
| **HuWD** | 0.845 | 0.0000839 |
| **TWD** | 0.696 | 0.00567 |
| **HWD** | 0.478 | 0.000413 |

The table 5 shows us the variables that separate the best the classes, in other words that allow us to characterize the partition. In this case of study, the variable Diameter of wool of the hump (HuWD) allows to differentiate at best the obtained classes, with a P-value equal to 0.0000839.

We can notice that the critical probability of our study is 0.05. In the table 6, we can observe how the studied variables contribute to each class by their discriminating forces. When the v-test value of a quantitative parameter in a class is lower than (-2), it means that this class obtains a low value (Mean in category) for this parameter compared to a normal individual (Overallmean), and the opposite is true. We have summarized this as follows (Table 6):

- Class 1 is composed of the following individuals: 1, 2, 14, 22 and 23. This group is

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characterized by high values for the variable TWD. These animals are from Targui, Reguibi and Ouled sidi cheikh breeds.

- Class 2 is composed of the following individuals: 6, 7, 8, 9, 11, 12 and 20. This group is characterized by low values for the variable TWD. These animals are from Targui, Reguibi and Ouled sidi cheikh breeds.

- Class 3 is composed of the individual 5. This group is characterized by high values for the variables HuWD and HWD (from most extreme to least extreme). This animal is from Ouled sidi cheikh breed.

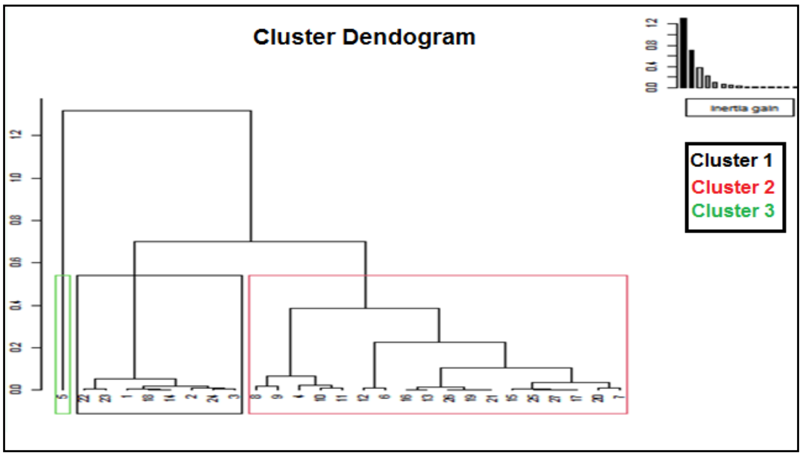


**Figure 8.** Hierarchicaltree of individuals on the two-dimensional plane.

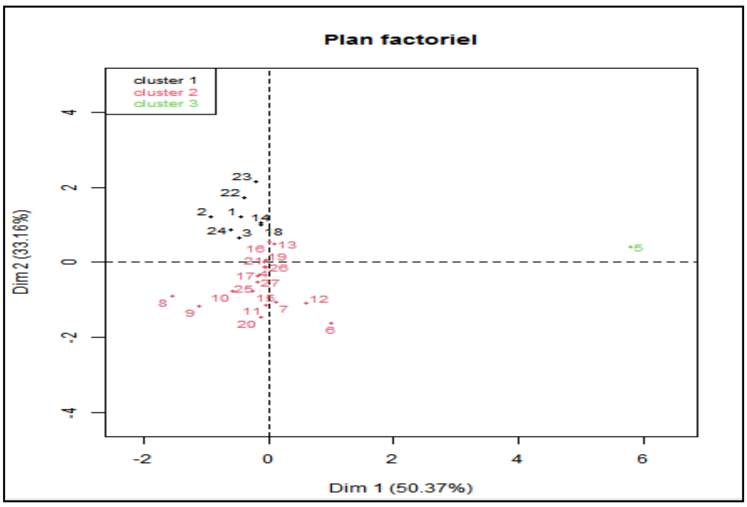


**Figure 9.** Hierarchicalascending classification of individuals.

**Table 6.** Description of clusters by quantitative variables.

| Classes | Variables | V.test | Mean in category | Overall mean | Sd in category | Overall sd | P.value |
|---|---|---|---|---|---|---|---|
| **Class 1** | **TWD** | 4.24 | 27.77 | 23.20 | 1.58 | 3.56 | 0.0147 |
| **Class 2** | **TWD** | -4 | 21.23 | 23.20 | 2.16 | 3.56 | 0.041 |
| **Class3** | **HuWD** | 4.67 | 34.82 | 9.98 | 0 | 5.32 | 0.0074 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **HWD** | 3.52 | 16.39 | 9.94 | 0 | 1.83 | 0.029 |

### 1. *ANOVA of the studied population*

Statistical analysis by ANOVA showed that there was no significant difference between breeds with relation to all measured quantitative variables of the she-camelwool (Table 7).

**Table 7.** ANOVA of the studied quantitative variables of wool according to the breeds.

| | | Number | Sum Squared | Mean squared | F-value | Probability of F |
|---|---|---|---|---|---|---|
| **HWD** | **Breed** | 3 | 1.18 | 0.59 | 0.059 | 0.943 |
| | **Individuals** | 12 | 89.6 | 9.956 | | |
| **HuWD** | **Breed** | 3 | 37.6 | 18.78 | 0.621 | 0.546 |
| | **Individuals** | 27 | 725.8 | 30.24 | | |
| **TWD** | **Breed** | 3 | 69.52 | 34.76 | 3.066 | 0.0652 |
| | **Individuals** | 27 | 272.11 | 11.34 | | |

Statistical analysis by ANOVA showed that there was no significant difference between Wilayas according to all quantitative variables measured in she-camel wool (Table 8).

**Table 8.** ANOVA of the studied quantitative variables of wool according to the Wilayas.

| | | Number | Sum Squared | Mean squared | F-value | Probability of F |
|---|---|---|---|---|---|---|
| **HuWD** | **Wilaya** | 2 | 28.3 | 28.3 | 0.962 | 0.336 |
| | **Individuals** | 27 | 735.1 | 29.4 | | |
| **TWD** | **Wilaya** | 2 | 41.48 | 41.48 | 3.455 | 0.0749 |
| | **Individuals** | 27 | 300.14 | 12.01 | | |

**Table 9.** ANOVA of the studied quantitative variables of wool according to the differents body parts.

| | Number | Sum Squared | Mean squared | F-value | Probability of F |
|---|---|---|---|---|---|
| **Body parts** | 3 | 2795 | 1397 | 73.62 | 0.00001 |
| **Residuals** | 63 | 1196 | 19 | | |

Statistical analysis by ANOVA showed that there was a significant difference between the different body parts (head, hump and tail), according to the diameter of she-camel's wool (Table 9).

***Tests Post Hoc ANOVA with 1 facteur***

**Table 10.** Tests of Post Hoc with 1 facteur ANOVA (Body parts).

| | Diff | Lwr | Upr | P adj |
|---|---|---|---|---|
| Tail-Hump | 13.2203 | 10.3742 | 16.0665 | 0.0000001 |
| Head-Hump | -0.0471 | -3.6752 | 3.581 | 0.9994641 |
| Head-Tail | -13.2675 | -16.8956 | -9.6393 | 0.0000001 |

Tukey multiple comparisons of means showed that the thickness of the wool of the tail is high in relation to the thickness of the wool of the rest of the body, whit a p-value of 0.0000001 (Table 10).

### *Multiple Component Analysis (MCA)*

Our dataset contains 27 individuals and 5 modalities. 2 modalities are illustrative (wilaya and breed) and 3 modalities are essential(Head wool color, Hump wool color, and Tail wool color).

### *Observation of extreme individuals*

The graph analysis does not reveal any out-group in our study.

### *Distribution of inertia*

The inertia of the factorial axes indicates on one hand whether the modalities are structured and on the other hand suggests the judicious number of multiple components to study.

The first two axes of the analysis express 42.03% of the total inertia of the data set (figure 10), which means that 42.03% of the total variability of the cloud of individuals (or of the modalities) is represented in this design. This is a fairly large percentage, and the first plane therefore adequately represents the variability contained in a large portion of the active dataset.

Considering these observations, we can say that it would probably be better to consider dimensions greater than or equal to the third one in the analysis.

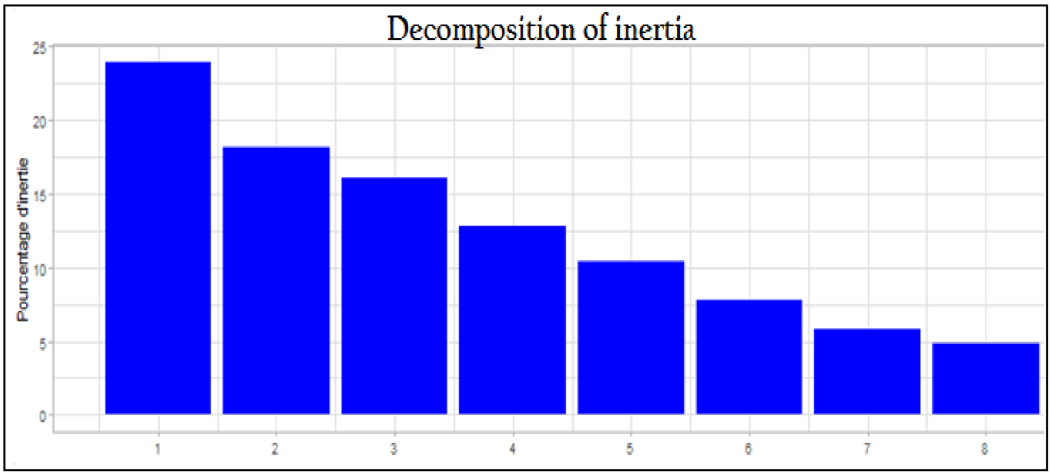


**Figure 10.** Decomposition of the total inertia.

An estimation of the relevant number of axes to be interpreted suggests restricting the analysis to the description of the first and second axe. This observation suggests that these two axes carry real information (Table 11).

**Table 11.** Percentage of variance for each dimension

| Dimension | Dim1 | Dim2 | Dim3 | Dim4 | Dim5 | Dim6 | Dim7 | Dim8 |
|---|---|---|---|---|---|---|---|---|
| % of Var | 23.90 | 18.13 | 16.11 | 12.81 | 10.36 | 7.79 | 5.84 | 5.07 |

## Description of MCA

The figure 11 shows the labialization of the individuals with the highest contribution to the construction of the plan. These individuals are colored according to their belonging to the modalities: wool color, Wilaya and breed.

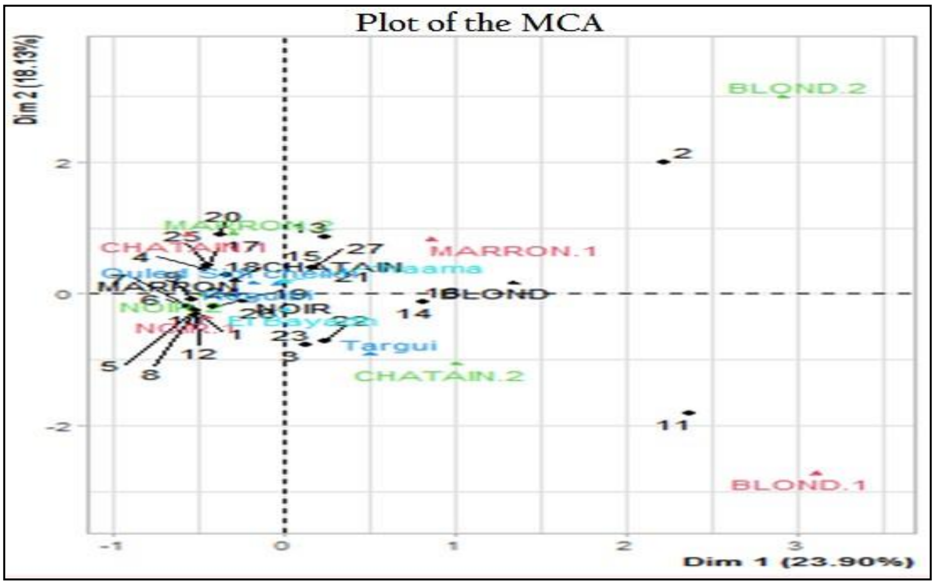


**Figure 11.** Distribution of individuals according to the modalities studied.

The MCA of the studied modalities (figure 12) is demonstrated as follows: the modalities in red are the color of the wool of the head (CWH), the color of the wool of the hump (CWHu) and the color of the wool of the tail (CWT). These latters represent the active modalities. Those in green are the additional modalities (Wilaya and breed) (Figure 12).

We could explain the closeness of modality CWT and CWHu by the common influence of genes that controls these two modalities. The color of the wool of the tail (CWT) is affected by the breed and the environment.

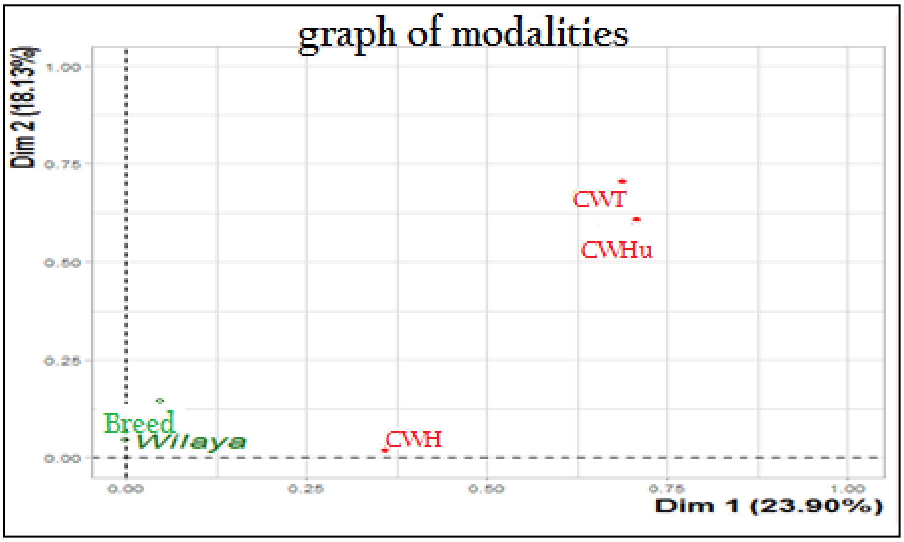


**Figure 12.** MCA of the studied modalities.

***Hierarchical Ascending Classification of MCA***

We notice from figure 13 that the classification carried out on the individuals makes appear 3 classes: class 1 appears in black, the second one in red and the third one in green.

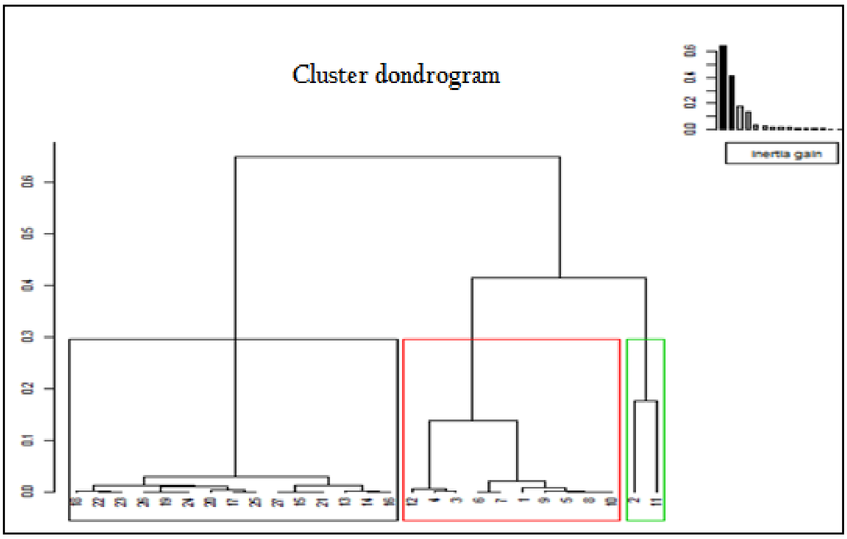


**Figure 13.** Hierarchicaltree of individuals on the 2D plane according to the MCA.

We notice that:

Cluster 1 is composed of the following individuals: 13, 14, 16, 17, 20 and 25. This cluster is characterized by a black wool color of the tail. These animals are from Reguibi breed.

Cluster 2 is composed of the following individuals: 3, 5, 6, 7, 8, 9, 10 and 12. This group is characterized by a color of the wool of the hump in black. These animals are from Targui, Ouled sidi cheikh and Reguibi breeds.

Cluster 3 is composed of the two following individuals: 2 and 11. This group is characterized by a blond color of the wool of the head. These animals are from Ouled sidi cheikh breed.

The table 12 shows us the modalities that allow the best separation of the classes. In this case of study of the color of wool of she-camels, the color of wool of the head (CWH) allows to distinguish the best the classes obtained, with a P-value equal to 0.000313.

**Table 12.** Association of the studied modalities with the partition.

| Modalities | P-value |
|---|---|
| **CWH** | 0.000313 |
| **Wilaya** | 0.00000137 |
| **Breeds** | 0.0000898 |
| **CWHu** | 0.00052 |
| **CWT** | 0.0103 |

***Classification of fineness and determination of the shape, color and the uses of she-camel's wool***

Camel wool, like cashmere, comprises two qualities: relatively coarse outer wool and inner down fibre. The underdown produced by animals living in the hottest desert climates tends to be coarser and sparser than from those living in a more temperate climate (Petrie O.J, 1995).

Varying from reddish to light brown, the wool is sorted according to shade and age of the animal. Baby camel wool, which has an average diameter of about 19 microns and a length of 2.5-12.5 cm, is the finest and softest. It holds greater cachet but it is not currently in greater demand than adult wool as its high premium is beyond its economic value (Petrie O.J, 1995).

Wool can be determined as super fine, fine, medium, common or braided according to the U.S. classification system (AATCC TECHNICAL MANUAL, 2006).

We have observed that the wool's coloration varies from dark blond, brown to black according to the different parts of the she-camels body and the breed. Concerning the shape of the she-camel's wools, we have observed that it varies mainly according to the different parts of the she-camel's body going from mainly strait in the head to slightly wavy in the hump and the tail.

The table 13 show classification of the fineness, shape and color of the wool of each part of the she-camel's and breed belonging.

**Table 13.** Classification of the fineness, shape and color of the wool of each part of the she-camel's body.

| | Breed | Diameters (µm) | mean interval | Numeric system | Fineness system | Shape | Color |
|---|---|---|---|---|---|---|---|
| The wool of the Head | Reguibi | 9.64 | <13 | Super 210's | Super fine | Straight | Dark blond |
| | Ouled sidi cheikh | 9.03 | <13 | Super 210's | Super fine | Straight | Brown |
| | Targui | 22.8 | 22.1-23.4 | 62s | ½ Fine | Straight | Brown |
| The wool of the hump | Reguibi | 10.2 | <13 | Super 210's | Super fine | Slightly wavy | Brown |
| | Ouled sidi cheikh | 11.7 | <13 | Super 210's | Super fine | Slightly wavy | Black |
| | Targui | 21.07 | 20.6-22 | 64s | Fine | Undulated | Black |
| The wool of the Tail | Reguibi | 9.5 | <13 | Super 210's | Super fine | Slightly wavy | Black |
| | Ouled sidi cheikh | 10.8 | <13 | Super 210's | Super fine | Slightly wavy | Black |
| | Targui | 21.65 | 20.6-22 | 64s | Fine | Slightly wavy | Black |

### *8.1 The uses of the she-camel's wool*

The wool of the Alpaca is fine and silky, between 20 and 34 microns in diameter. The fleece from the alpaca is now the only fibre from the South American camelid used in any quantity for spinning yarns for fashion applications. The primary end use for alpaca is knitwear but it also goes into woven cloth for clothing, accessories such as shawls and stoles and rugs **(Petrie O.J, 1995)**. The diameter of the wool of Targui she-camels in our study (21-22.8 µm) which looks similar to Alpaca wool diameter. We could suggest then that the wool of Targui she-camels has the same uses in industries, for example for the production of shawls and rugs.

The angora fibre has a smooth, silky texture with a diameter of 11 to 13 microns which makes it difficult to spin, and the fibres tend to slip out of the yarn and shed from the fabric, nevertheless, the fibre is desired for its texture and warmth. Angora rabbit hair is used primarily for items such as sweaters, mittens, baby clothes, and millinery **(Petrie O.J, 1995)**. The diameter of the wool of Ouled sidi cheikh (9.03-11.7 µm) and Reguibi (9.5-10.2 µm) seems to be similar to the diameter of Angora fibre. We could suggest then that the wool of Ouled sidi cheikh and Reguibi have the same uses in industries, for example for the production of sweaters and baby clothes.

## Conclusion

Camel breeding systems remain important in desert areas not only from cultural and identity perspectives but also as an important economic asset. Algerian Sahara provinces have to develop these systems since this activity is likely to supply local products with a high products value. In this study, as a first step, we focused on the valorization of camel's wool. We showed how the diameter of the studied she-camels can be determined for a morphological characterization and how this latter can vary according to different breeds going from super fine for Ouled sidi cheikh and Reguibi she-camels (9.03-11.7 µm and 9.5-10.2 µm, respectively) to fine for Targui she-camels (21-22.8 µm). These results can suggest the application of Ouled sidi cheikh and Reguibi's wool in the textile industries for the production of sweaters and baby clothes, and the application of Targui's wool in shawls and rugs.

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