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Socio-economic and Morpho-biometric Characteristics of the Aftout Camel (*Camelus dromedarius*) in the Trarza Region of Mauritania

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Abstract

Camels are critically important in Mauritanian culture and traditions. The study was conducted in May and June 2017 in fifteen localities of two departments of Trarza in Mauritania. The objective was to characterize the Aftout camel population from socio-economic and morpho-metric characteristics. A questionnaire was administered to 25 breeders in the study area. Nine morpho-metric measurements were recorded on 104 females aged 6 years or above. The study showed that camel keeping is a typical male activity. All the investigated breeders were men, among whom 68% are aged more than 45 years, and 84 % have never attended formal education. 80% of the breeders have been practicing camel rearing for more than 20 years. Camel breeding was considered a major activity, as it contributes more than 75% of the family income for 76% of the breeders. The average zootechnic performances were 5.28±1.64 l/d, 3.48±1.15 years, 5.04±0.84 years, 1.38±0.58 years and 1.6±0.40 years, respectively, for milk production, age at reproduction of females, age at reproduction of males, age at weaning, and duration of lactation. The studied biometric measurements highlighted a marked variability. Four morpho-zoometric indices were estimated, and the average estimated body weight was 352.41±55.12 kg. Based on the obtained results, the Aftout camel was characterized by a large diversity of practices, which may be an asset for identifying and orienting the productive potential of various camel types in Mauritania.

Keywords: Aftout Dromedary, Breeding practice, Socio-economic, Morpho-biometry, Mauritania

الملخص

تحتل الإبل وتربيتها مكانة بارزة في الموروث الموريتاني الثقافي والحضاري. أجريت هذه الدراسة في الفترة ما بين مايو ويونيو 2017 في خمس عشرة بلدة محلية في مقاطعتين من ولاية اترارزة في موريتانيا. وكان الهدف الرئيسي هو توصيف جمل أفطوط على أساس الخصائص الاجتماعية - الاقتصادية والمورفولوجية. قمنا بتقديم استبيان إلى 25 مربي إبل في مناطق الدراسة. وإجراء تسع قياسات مظهرية على 104 ناقة تتراوح أعمارها من 6 سنوات الى ما فوق. بينت الدراسة أن تربية الإبل نشاط حيوي اقتصادي يمارس بشكل منفرد تحت مسؤولية الرجال. جميع المربين الذين شملهم الاستبيان هم من فئة الرجال، 68% منهم تجاوز سن الخامسة والأربعين ولم يزاول 84% منهم تعليما مدرسيا نظاميا قط. 80% من المربين يربون الإبل منذ أكثر من 20 سنة. وتعتبر تربية الإبل نشاطاً رئيسياً يساهم بأكثر من 75% في دخل الأسرة لدى 76% من المربين. ويبلغ متوسط نتائج مؤشرات الإنتاج والتناسل5.28±1.64 لتر/يوم، و3.48±1.15 سنة، و5.04±0.84 سنة، و1.38±0.58 سنة، و1.6±0.40 سنة على التوالي لإنتاج الحليب، وعمر التناسل عند الإناث، وعمر التناسل عند الفحول، وسن الفطام، ومدة الحلابة. كما أظهرت قياسات الجسم المدروسة تباينا كبيرا. كما حُسبت أربعة مؤشرات جسمية وقُدر الوزن الحي المتوسط أيضا بـ 352.41 ±55.12 كيلوغرام. واستنادا إلى هذه النتائج، يمكن القول ان جمل أفطوط يتميز بتنوع واسع من حيث ممارسات التربية بالإضافة إلى تميزه بالتنوع المورفولوجي لكل الصفات التي تمت دراستها. ويمكن استخدام هذا المستوى من التنوع لتحديد وتوجيه الإمكانات الإنتاجية لمختلف الأنواع والسلالات الإبلية في موريتانيا.

الكلمات المفتاحية: جمل أفطوط، ممارسات التربية، اقتصادي-اجتماعي، قياسات مورفولوجية، موريتانيا

Introduction

Animal resources are among the most valuable and strategically important assets available to developing countries. In most of these countries, animal resources contribute significantly to food production and thus to meeting human needs (Faye, 1997).

The number of camelids in the world in 2014 is estimated at 35,525,270 heads (FAOSTAT 2020), of which 85% are in Africa (FAO, 2017). In Mauritania, the species *Camelus dromedarius*, considered to be a producer of milk, meat, work, skin, and wool, etc. is an integral part of these animal resources. According to the statistics declared by the Ministry of Livestock, the camel population is estimated to be 1,418,448 heads (Ministry of Livestock, 2016). Numerically, the Trarza region occupies fourth place among the thirteen regions of Mauritania, with a camel population that represents 11.3% of the national population (Correra, 2006).

The need for a good knowledge of this species is necessary to expand the possibilities of its management and use (FAO, 2008). To study the camel species in Mauritania, several aspects need to be explored, namely the socio-economic and morphological characterization (FAO, 2008). The latter has been proposed as one of the strategies for analyzing domestic populations (Bouchel et al., 1997). The overall objective of the present work is to contribute to a better knowledge of dromedaries in Mauritania for their conservation and genetic improvement. More specifically, the study aims to (i) describe the socio-economic and zootechnical characteristics of the Aftout camel in its production environment and (ii) characterize the morpho-biometric diversity of the Aftout camel.

Materials and Methods

Study Area. A survey was conducted in May and June 2017, in the two departments most populated by camels and belonging to the Trarza region namely Mederdra (16°55′ 22″ N, 15° 39′ 22″ W) and Ouad Naga (17° 57′ 59″ N, 15° 31′ 05″ W) (Figure 1). Fifteen localities in these two departments, where there is camel density, were visited and studied. The different localities were selected based on their accessibility.

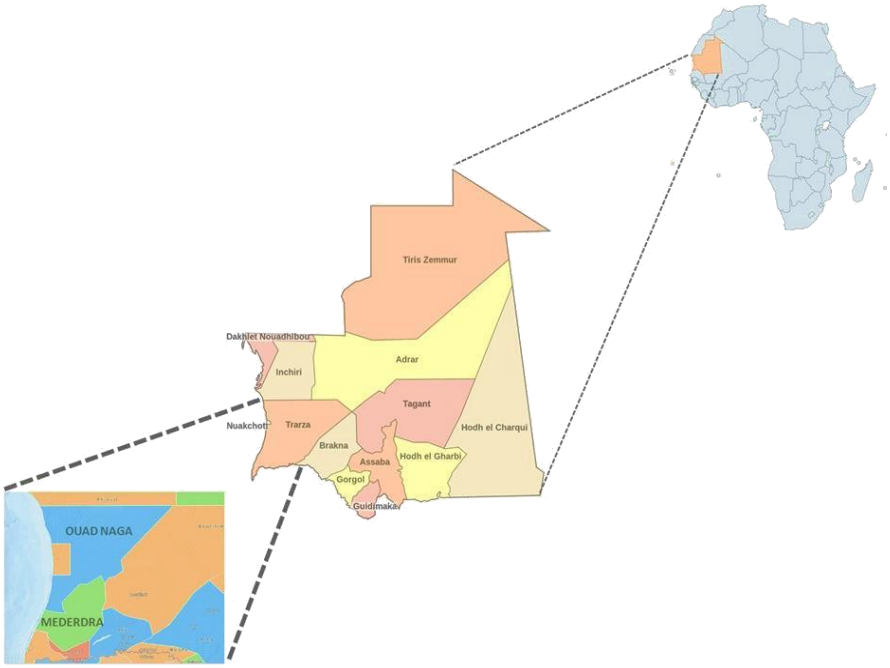

Figure 1. Location of the study area

Data Collection. Using a survey form developed for this purpose, information was collected from camel farmers and their animals. A total of 25 breeders were surveyed, and 104 females were measured for nine body measurements. Direct observations were made on the farms. The objective of the interview with the breeders is to better understand the breeding practices and identify the major constraints that handicap the development of camel breeding.

The questionnaire covered socio-economic aspects related to livestock characteristics and body measurements to establish morpho-biometric descriptors of the Aftout camel reared in the study area. The knowledge of these aspects will help to orient the elaboration of scenarios, for the improvement and rational use of camel resources in Mauritania.

Socio-economic and Technical Data. Socio-economic and technical data were collected by interviewing the herders and included the following parameters

- Sex, age, and education level of the herder,
- Activities of the breeder and the objective of his breeding,
- Experience and seniority of the breeder and mode of acquisition of dromedaries
- Contribution of camels to the farmer's income,
- Feeding and reproduction management.

Morpho-biometric Data. The animals used for the morpho-biometric characterization were adult camels (having given birth and aged over 6 years). The ages of the animals were determined by the breeders. Quantitative traits were measured with a tape measure. For each camel, we measured the different individual body measurements such as head length, head width, neck length, neck circumference, height at withers, barrel circumference, chest circumference, body length, and abdominal circumference. All body measurements were done according to the FAO (2013) guidelines.

Estimation of Body Weight and Zoomometric Indices. The barymetry corresponds to the determination of the body weight of the animals without weighing them, but by measuring them and applying the formula of Boué (1949). These measurements will allow us to estimate the body weight of dromedaries using the formula of Boué (1949) expressed in the equation:

BW = 53 *CC*AC*HW with BW: Body weight (kg), CC: Chest circumference (m), AC : Abdominal circumference(m) and HW: Height at withers (m).
Thus, these measurements help to calculate zoomometric indices that give an idea on the productive abilities of the Aftout camels.

Zoometric indices according to formulas described by several authors (Fuentes et al., 2001; Guedaoura et al., 2011; Boujenane et al., 2008; Claude and Isabelle, 2015; Djomtchaigue et al., 2015) were calculated in order to determine and analyze the relationship between height, length, compactness, estimate and determine the proportions and general size of animals and classify the breeds ethnologically.

These indices are generally classified into two categories, namely racial or ethnological indices, equations (1) and (2), and functional indices, equations (3) and (4).

a. *Racial or Ethnological Indices*

$$1a.\,Cephalic\ index\ (CI) = \frac{Head\ width}{Head\ length} * 100 \quad ''Eq.1''$$

$$2a.\,Body\ index\ (BI) = \frac{Body\ length}{Chest\ circumference} * 100 \quad ''Eq.2''$$

b. Functional Indices

$$1b.\,Dactyl - thoracic\ index\ (DTI) = \frac{Barrel\ circumference}{Chest\ circumference} * 100 \quad ''Eq\ .3''$$

$$2b.\,Proportionality\ index\ (PI) = \frac{Height\ at\ withers}{Body\ length} * 100 \quad ''Eq.4''$$

Statistical Analysis. The data were analyzed using SPSS version 22.0 software. Parameters such as frequency distribution, arithmetic means, standard deviations, and coefficient of variation were calculated for the different variables.

Results

Socio-economic and Technical Characteristics of Camel Breeders. The socio-economic characteristics of camel farming in the study area, revealed by the survey, are summarized in the figures and tables below.

Sex of the Breeders. All the dromedary breeders surveyed are 100% male. The contribution of women in camel breeding is devoted to milk fermentation, extraction of animal oils and meat transformation and conservation.

Distribution of Breeders by Age. The majority of farmers surveyed (68%) are over 45 years old, 20% are between 35 and 45 years old, and 12% are between 25 and 35 years old. Figure 2 shows the distribution of farmers by age.

Education Level of Camel Breeders. As shown in figure 3, most camel herders (56%) have no education at all, while 28% have attended quoranic studies of an undetermined level, so 84% of the herders have never been to school. But there are 8% who have secondary education and 8% who have a university education.

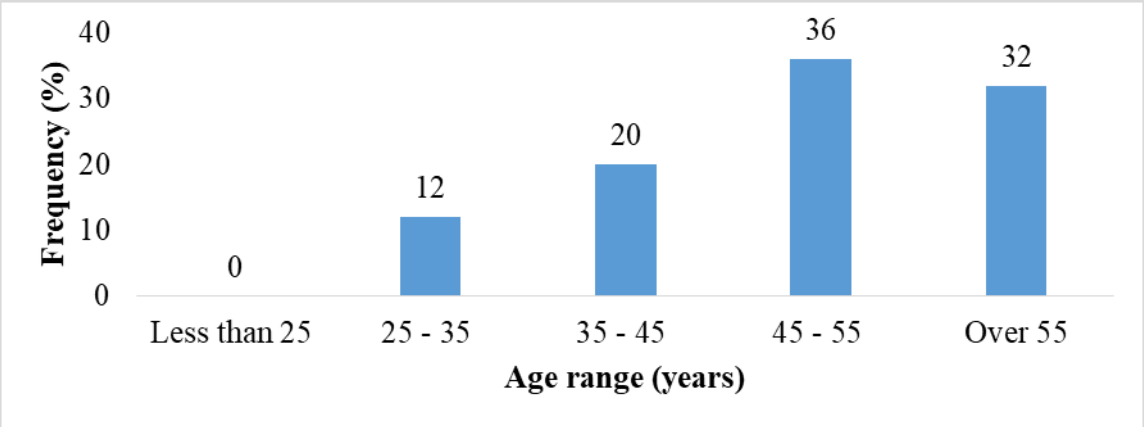

Figure 2. Distribution of the breeders according to the age range

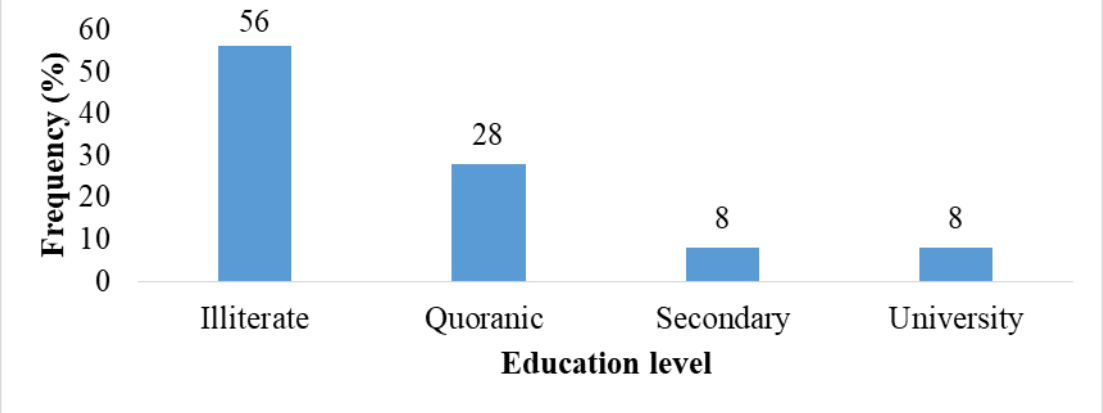

Figure 3. Educational level of the breeders of dromedary

*Species that Were Raised in Association with Dromedaries***.** In our study area, camel breeding is not always mono-specific (32%) but is most often (68%) associated with cattle, small ruminants (sheep and goats) and sometimes with family poultry farming. Figure 5 shows the degree of association of other livestock with camel breeding.

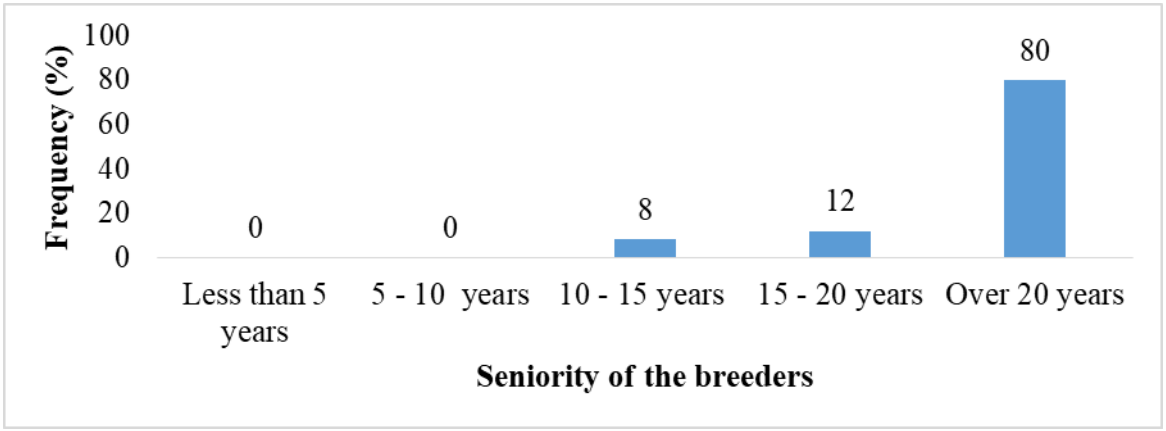

Figure 4. Experience and seniority of the breeders

Objectives of Camel Breeding. The most common objective is the sale of milk or young camels. The sale of milk constitutes a real opportunity for development for breeders living near the road. In the case of transhumant breeders living in remote areas, milk is used for self-consumption, and they focus on selling young camels after weaning.

*Mode of Acquisition of Camels***.** The majority of breeders (60%) acquired their herd through a combination of heritage and buying. While only 28% of breeders acquired camels by heritage. Other origins, such as donation, are very rare with a frequency of less than 4%. Figure 6 shows the different forms of acquisition of camel herds.

Contribution to Household Life. The fact that camel breeding contributes in 76% of cases up to 75% of the family income and that 20% of the breeders surveyed rely on herding from 50 up to 75% testifies to its economic importance in the breeders' life. Only 4% of the farmers surveyed consider camel breeding as a secondary activity, and it contributes less than 50% of their family income (Figure 7).

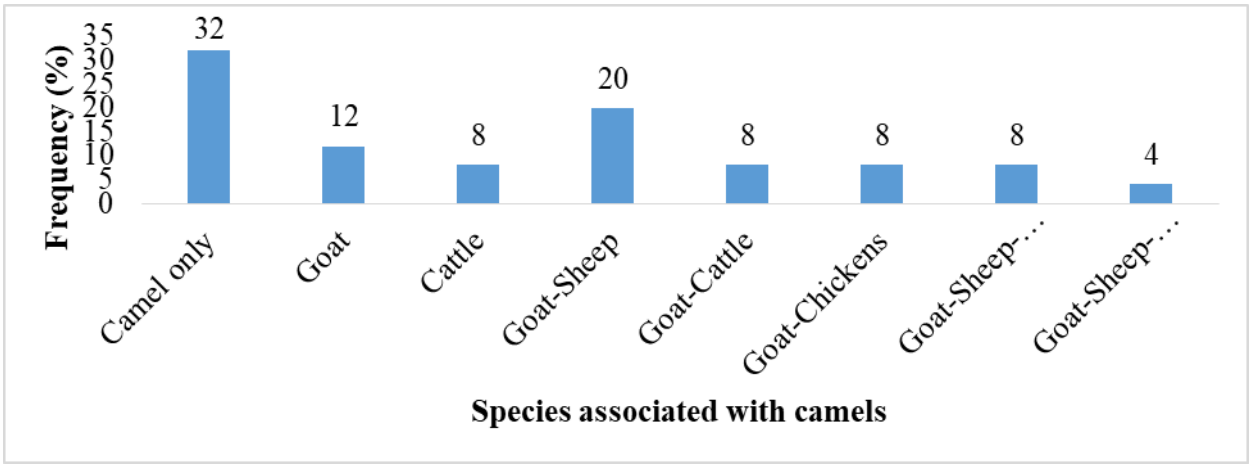

Figure 5. Association of the camel breeding with other species

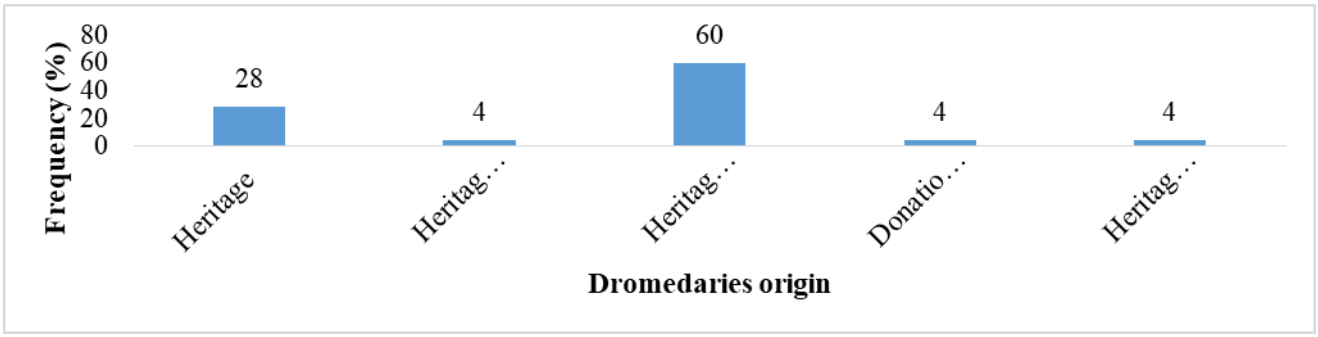

Figure 6. Origin of breeding of dromedaries

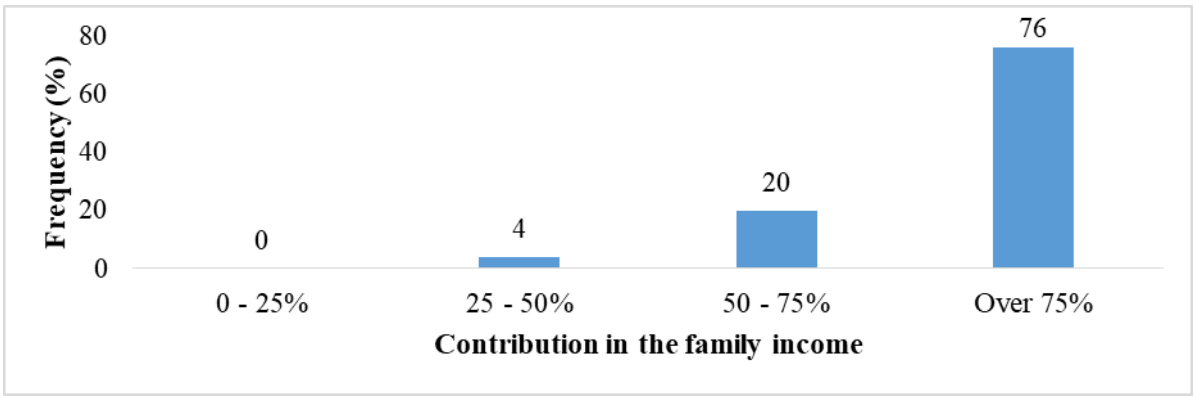

Figure 7. Contribution of the breeding in the family income

*Animal Husbandry Systems and Techniques for Animal Feeding***.** 48% of the farmers surveyed practice an extensive feeding system without any feed supplements. This system is based on natural grazing of indigenous plants (Figure 8). The distance covered daily between the grazing area and the animal camp varies from 2 to 15 km, with an average of 6.76±2.63 km. 52% of the breeders use supplementary feeding (peanut meal, wheat, wheat bran, rice bran), with a preference for wheat and peanut meal.

Animal Abreuvement. The wells known to transhumant herders are the main watering points for their animals (Figure 9). However, sedentary dairy farmers use tap water as their main source of water.

Zootechnical Performance Parameters. Some of the performances related to the reproduction and production of the Aftout camel are reported in Table 1. According to all the investigated breeders, the average age at reproduction of males is 5.04±0.84 years. However, the females are more precocious than the males, with an average age of 3.48±1.15 years. In our study area, the interval between two successive births varies from 1 to 4 years with an average value of 2.12±0.52 years.

Almost all the farmers (88%) do not orientate the mating, it happens in a random way in the pasture. Statistical analysis shows that the average milk production in the study area is 5.28±1.64 liters per day with a wide variation from 3 to 9 liters/day. 96% of the farmers practice two milkings per day (morning and evening) versus 4% who practice milking 3 times per day. The average duration of lactation is 1.6±0.40 years.

Figure 8. Herd in pasture at Hsey-Sidi

Camel calves are weaned at an average age of 1.36±0.58 years but tend to stay with their mothers for more than 2 years. Especially if the mothers are not pregnant. The age range for weaning camels differs between camel farmers. ranging from 6 to 36 months depending on the pastoral and forage availability of the grazing areas and the herder's needs for milk and money. The sale of young camels sometimes begins at a very young age of about 6 months. but on average it is done at the age of 18 months.

Figure 9. Herd in the water source to Hsey-Brahim for the abreuvement

Table 1. Reproductive and productive performance of Aftout camels

Variables	N	Min.	Max.	Aver.	ET	CV (%)
Age at reproduction of females (years)	25	2	6	3.48	1.15	39
Age at reproduction of males (years)	25	2	7	5.04	0.84	17
Lactation duration (years)	25	1	2	1.60	0.40	24
Calving/calving interval (years)	25	1	4	2.12	0.52	26
Average milk production (l/d)	25	3	9	5.28	1.64	35
Longevity (years**)**	25	18	35	23.44	4.25	20
Age at weaning (years)	25	0.5	3	1.36	0.58	42
Age of young at sale(years)	25	0.5	2	1.52	0.52	37
Age at reforme of camels (years)	25	10	20	16.72	2.73	18

N: Number of breeders. Min: Minimal value. Max. : Maximal value. Aver. : Average value. SD : Standard deviation. CV : Coefficient of variation

Tableau 2. Characteristics of biometric measurements of Aftout camel

Variables	N	Min.	Max.	Aver.	SD	CV (%)
Head length (cm)	104	42	60	52.91	2.68	5.10
Head width (cm)	104	20	31	27.98	1.72	6.11
Neck Length (cm)	104	70	200	110.57	16.66	15.14
Neck circumference (cm)	104	60	82	70.59	4.92	7.00
Height at withers (cm)	104	155	198	174.18	10.14	5.84
Barrel circumference (cm)	104	15	22	19.29	1.28	6.39
Chest circumference (cm)	104	148	202	173.36	9.46	6.11
Body length (cm)	104	135	198	159.30	10.89	6.87
Abdominal circumference (cm)	104	136	243	204.02	21.08	11.15
Body weight (kg)	104	242.25	492.04	352.41	55.12	16.92

N: Number of breeders. Min: Minimal value. Max.: Maximal value. Aver.: Average value. SD: Standard deviation. CV : Coefficient of variation

*Morpho-biometric Characteristics of Aftout Camels***.** The arithmetic means. standard deviations. minimum and maximum values of body measurements of camels are recorded in Table 2. The camel

has an estimated average body weight of 352.41±5.12 kg. The average body weight is between 242.25 and 492.04 kg. which is considered an average camel.

Discussion

The majority of the herders interviewed are illiterate (84%). However. It should be noted that a high illiteracy rate can influence the acceptance of new pastoral techniques. This sometimes requires the adoption of a particular and slow communication system to convince herders to accept a particular scenario or technique. But this illiteracy is rewarded by the knowledge and experience accumulated over time. Which allows the sustainability and existence of this breeding. Breeders with low and medium camel numbers raise small ruminants in order to increase their income to meet the needs of their households and renew or increase the size of their camel herd. Sedentary camel breeding is often associated with the breeding of other species. Unlike transhumant breeding. Which is often unique. It is important to note the development of a peri-urban system in recent decades. Allowing the development of the camel species and its integration into the economic circuit. This so-called semi-intensive system is often practiced for dairy camels raised in villages and peri-urban areas to increase milk production with food supplementation. Whatever the system practiced. Pastoral or peri-urban. Natural grazing remains based on the rangeland. The floristic composition of the rangeland is characterized by the predominance of *Acacia radiana*. *Acacia seyal*. *Acacia tortilis*. *Acacia nolitica*. *Leptadenia pyrotechnica*. *Balanites aegyptiaca* and *Panicum turgidum*.

The study allowed us to evaluate the age at reproduction for female camels (3.48±1.15 years) and for males (5.04±0.84 years). These results corroborate those reported in Tunisia by Moslah and Megdiche (1989). The mode of reproduction used is natural mating. The vast majority of breeders (75%) manage the reproduction system by choosing the sire according to precise criteria such as color. morphology. genetic aptitude of the parents and gentleness. They quote as morphological characteristics of a good sire the reduced size of the sheath. The important size of the legs. The important width of the neck. The curved back and the important depth of the chest. Also, almost all (96%) of the farmers surveyed use the sire for a period of more than 6 years. which may increase the risk of inbreeding. This same tendency to use the sire as much as possible was reported by Ould Ahmed et al. (2007) in the majority of camel breeders in Tunisia.

Concerning the obtained average milk yield. it was 5.28±1.64 liters per day. The presence of the camel calves at the time of milking the camel is mandatory for the stimulation of milk flow. The results obtained by Mamoudou in 1995 confirm that the Aftout camel is considered as a good milk producer compared to other species. It can produce up to 5 liters of milk per day. Its milk is highly valued and it has the reputation of being purgative and even curative for certain dermatosis. This camel is a good meat animal with a carcass yield of about 55%. Its meat is very well appreciated in the regions where it is raised.

The estimated average weight is 352.41±5.12 kg. This weight is lower than that reported by Babelhadj et al. (2016) in two Algerian camel populations Sahraoui and Targui (431.1 and 425.6 kg. respectively). Moreover. This live weight is comparable to the average weight (359.76 kg) obtained by Djomtchaigue et al. (2015) in Chad. For body measurements. The height at the withers is on average 174.18±10.14 cm. while Mamoudou (1995) reports for the Camel population of Aftout a height at the withers ranging from 185 to 190 cm. However. This result is lower than that found by Babelhadjet al. (2016) for Sahraoui and Targui camels in Algeria (177.9 and 181.9 cm; respectively). The mean chest circumference (173.36±10.46 cm) is slightly lower than that (177.58 cm) reported by Djomtchaigue et al. (2015) in Chad. The abdominal circumference averaged 204.02±21.08 cm. This is slightly lower than the value (207.28 cm) obtained by Djomtchaigue et al. (2015) in Chad.
Beyond the mean values. the overall variability expressed by the coefficient of variation (CV%) is relatively large for the following variables: body weight. neck length. abdominal circumference with a CV of 16.92%. 15.14% and 11.15%. respectively. but it is less variable for the other linear biometric measures in that the coefficient of variation varies from 5.1% for head width to 7% for neck circumference.

The cephalic index (CI) averages 52.9%. This value allows us to say that the Aftout camel is brachy-cephalic. which means that the head has a length and a width approximately equal. The body index (BI) is on average 92.08%. allowing us to classify the Aftout camel as a long-lined animal. that is to say. it

is a dromedary with a high waist. and long and thin limbs. This result is in agreement with the result obtained by Mamoudou (1995). The dactyl-thoracic index (DTI) is on average11.14% which allows us to classify the dromedary of Aftout as an intermediate animal and tends to heavy animal. The height proportionality index (PI) is on average 109.63% allowing us to classify the Aftout camel as a long and slender breed.

All these indices highlight the distinctive characteristics of a dairy breed. therefore. the Aftout camel is a population with potential dairy abilities. Genetic improvement programs will be useful and necessary for the genetic purification of this population for dairy production. It is important to note that maintaining the existing genetic variation within the species will be an important step in the conservation of camel genetic resources. as reported by Ould Ahmed et al. (2010).

Conclusion

The objective of this work was to carry out the socio-economic and morphological characterization of the Aftout camel raised in the Trarza region. The socio-economic results show that camel breeding plays an inescapable socio-economic role. Although it still retains its extensive aspect. It is important to note the timid evolution towards the development of camel products among some breeders (sale of milk. early weaning. etc.).

The organization and the supervision of the breeders would certainly make it possible to improve the productivity of the camel breeding and the level of living of the breeders. The observed variability of the studied traits within the camel population of Aftout allows us to conclude the existence of selection possibilities as a means of genetic improvement in this population.
The study of the phenotypic diversity of other populations in the country. including Rguibi. should be undertaken to complete the information on the overall diversity of the camel species at national level.
Thus. the implementation of management scenarios and improvement of breeding conditions could allow the improvement of camel productivity. Subsequently. genetic analysis by molecular markers should be carried out in order to appreciate the camel's genetic diversity at the genome level.

Acknowledgements

We would like to thank the camel breeders for their collaboration and for their willingness to answer the questionnaire without any financial motivation. We hope that this modest work contributes to improve the productivity of their farms and specially to improve their level of living by a better valorization and knowledge of camel resources in Mauritania.

Author's contributions

Mohamed Ould Ahmed's contribution consists in the design of the survey. data collection. statistical analysis and drafting of the first version; all authors contributed to the interpretation of the results and the critical revision of the manuscript. which they approved in its current form.

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