FIRST PHENOTYPIC CHARACTERISATION OF LOCAL DROMEDARY CAMEL ECOTYPE IN EL OUED REGION, SOUTHEAST ALGERIA

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ABSTRACT

Understanding morphological variation among regional camel ecotypes is essential for documenting genetic resources and supporting effective conservation and breeding efforts. This study was aimed to phenotypically characterise dromedary camels in El Oued Province, southeastern Algeria, to understand the diversity and distribution of qualitative traits within the local camel ecotype. A total of 63 camels were randomly selected for phenotypic assessment. The qualitative traits evaluated included the ecotype of the animal; the colour of the coat, eyes, and muzzle; pigmentation of the eyelid, ear, and foot; the orientation of the ear and hump; the shape and position of the hump; and the facial and back-line profiles. Statistical analyses were conducted to determine the frequency distribution of each trait. The Arbia breed predominated, representing 65.08% of the ecotype, followed by Tergui and Zegria breeds. Nine distinct coat colours were identified, with Ahdjel being the most prevalent (23.81%). Brown eyes were the most common (85.71%), while blue eyes were rare (1.59%). Muzzle pigmentation was nearly evenly split between pigmented (52.38%) and non-pigmented (47.62%). Hump size varied, with small humps being the most frequent (65.08%), and all camels exhibited upright hump orientations. Additionally, all individuals had straight facial profiles and straight back-line profiles, with centrally positioned humps. This study provides valuable insights into the phenotypic diversity of dromedaries in the El Oued region, highlighting the significant roles of environmental adaptation and herder preferences in shaping the characteristics of local camel ecotypes, thereby informing future conservation and breeding programs.

Key words: Adaptation, camel, colour, ecotype, pigmentation

In Algeria, camels play a pivotal socio-economic role, particularly within El Oued Province in the southeast, where they adapt to the challenging desert environment characterised by extensive dunes and sparse vegetation (Harek *et al*, 2022). According to the latest FAOSTAT data, Algeria's camel population was estimated at 459,616 heads in 2022. The distribution of dromedary camels in Algeria is primarily concentrated in three regions: the central Sahara, which accounts for 56% of the national livestock, followed by the Northern Sahara (37%) and the Steppe (7%). The main camel breeds first identified in Algeria include Chaambi, Ouled Sidi Cheikh, Ait Khebbach, Steppe camel, Saharaoui (Arbia), Targui, Ajjer, Reguibi, and Ftouh (Aissa, 1989).

Phenotypic characterisation involves the assessment of observable traits such as coat colour, eye colour, hump shape, and other morphological features, providing insights into genetic diversity, adaptability, and breed differentiation (Ibtissam *et al*, 2023; Meghelli *et al*, 2020). The extent of phenotypic variation is valuable for selecting and utilising different camel ecotypes based on their specific characteristics and body conformation in breeding programs (Yosef *et al*, 2014). Despite their importance, limited research has focused on the phenotypic diversity of local camel ecotypes in Algeria, which is crucial for sustainable breeding programs and conservation efforts. There remains a notable gap in the literature regarding the phenotypic characterisation of Algerian dromedary camels, particularly in the El Oued region.

This study aims to provide the first comprehensive phenotypic characterisation of the

local dromedary camel ecotype in El Oued Province. By examining qualitative traits, this research seeks to elucidate the diversity and distribution of phenotypic characteristics among camels in this region. The findings will contribute to a better understanding of how environmental adaptation and herder preferences shape the phenotypic landscape of Algerian camels, thereby informing future conservation and breeding programmes.

Materials and Methods

Study Area

The research took place in the province of El Oued, situated in southeastern Algeria at an altitude of 88 meters. It is located at 33°21′ N latitude and 6°51′ E longitude (Fig 1). The region's southern area is characterised by dunes, while the northern section features a sandy desert with sparse vegetation and a Salt Lake, known as a chott, to the west (Ramdani *et al*, 2022). The cold season lasts from November to April, with January temperatures falling to a minimum of 11.3°C. Conversely, the hot season runs from May to September, with August temperatures reaching a maximum of 33.91°C. The yearly average temperature in the area is approximately 22.47°C. The El Oued region's vegetation typifies Saharan flora, including xerophytic plants, perennials, woody species, and annuals with brief vegetative phases and well-developed root systems (Chergui *et al*, 2023).

Studied Animals

This study was conducted across 21 farms located in various regions of the Wilaya of El Oued, involving 19 distinct breeders. A total of 63 camels representing the local ecotype were examined, distributed among the five selected study areas: Mih Ouenssa, Oued Alenda, Douar Elma, El Oued, and Robbah. Although camels were initially sampled randomly, the final selection of specific animals was determined by the breeders. The primary inclusion criterion was age, with only dromedaries older than 5 years for females and 7 years for males being measured. This age threshold was established to ensure that all camels had reached full maturity, thereby providing more reliable and consistent phenotypic data for analysis.

Phenotypic Characterisation

Phenotypic characterisation was conducted through systematic visual assessments and photographic documentation. The qualitative traits evaluated included:

- Coat Colour: Variations in the overall colour of the camel's coat.
- Eye Colour: Differences in the colour of the eyes.
- Eyelid Pigmentation: Patterns and colours present on the eyelids.
- Ear Orientation: The angle and direction in which the ears are set.
- Hump Shape: The form and structure of the camel's hump.
- Hump Orientation: The positioning of the hump relative to the body.
- Hump Position: The vertical placement of the hump on the back.
- Facial Profile: The outline of the camel's face when viewed from the side.
- Muzzle Colour: The colouration of the muzzle area.
- Hair Length: The length of hair in specific regions of the body.
- Back Line Profile: The outline of the camel's back when viewed from the side.
- Ear Pigmentation: Colour patterns present on the ears.
- Foot Pigmentation: Colouration patterns on the camel's feet.

These traits were meticulously recorded to facilitate an in-depth analysis of phenotypic diversity, adaptability, and potential breed differentiation within the local camel ecotypes.

Statistical Analysis

The data collected from phenotypic assessments were processed to generate descriptive statistics, focusing on the frequency distribution of each phenotypic variable. Specifically, frequencies and percentages were calculated to quantify the prevalence of each trait category among the studied camels. All statistical analyses were performed using R software (R x64 3.1.0)

Result and Discussion

Understanding the phenotypic diversity and distribution of camel ecotypes is essential for optimising breeding strategies and enhancing livestock productivity in arid regions. This study focuses on El Oued region, a significant area for camel rearing, to analyse the prevalence of different camel breeds and their qualitative variations.

The data represents dromedary camel ecotypes distributed in the El Oued region (Table

1). Arbia ecotype is clearly dominant at 65.08%. This finding is particularly intriguing when compared to Aouachria's (2020) report, which indicated an even higher prevalence of the Arbia breed at 92.8%. The substantial representation of the Arbia ecotype in this recent study may be attributed to several factors. One significant aspect to consider is the role of high milk production attributed to the Arbia breed, which is often a key driver for farmers' preferences in livestock selection. The superior lactation performance of Arbia camels likely enhances their desirability among pastoralists and agricultural stakeholders in the region, leading to increased herd sizes and a higher concentration of this breed. In contrast, Tergui ecotype, which makes up 30.16%, and the Zegria ecotype at 4.76% demonstrate a much lower prevalence. This variation suggests potential shifts in breeding practices, regional environmental adaptations, and dairy production that may favour the Arbia breed's genetic characteristics in El Oued.

Table 1. Dromedary camel ecotypes distributed in the El Oued region.

| Parameter	Modality	Percentage (%)
Ecotype	Arbia	65.08
	Tergui	30.16
	Zegria	4.76

Fig 2 articulate the diverse coat colour distribution among dromedaries in El Oued region, revealing a total of nine distinct coat colours, with dominance in Ahdjel (23.81%), Ahmer (19.05%), Asfer (14.29%), and Abyad (12.70%) identified as the most dominant (Table 2). One interesting finding is the seasonal change in camel coat colour, with dromedaries becoming lighter in warm months and darker in cold ones. This suggests they adapt to different climates for survival. Additionally, herders use the stable head colour to identify camels, since head colour does not change with the seasons. This highlights the importance of consistent traits for easier identification and breeding. The predominance of Ahdjel as the most frequent coat colour in this study contrasts sharply with Oulad Belkhir's (2018) findings from the northern Sahara, where Ahmer dominated at 60.28%. According to Bouregba and Lounis (1992), the majority of the ecotypes of the northern Sahara are red (brown Ouber), whereas Arif and Regab (1995) show that the dromedaries of the northern Sahara are of several natural colours such as Ahmar (red), Asfar (yellow), Abayd (white), and Azrek (blue). This discrepancy may stem from regional environmental factors, localised breeding practices,

or differing management strategies that affect camel ecotype structures. The relative decrease in Ahmer in the El Oued region, despite maintaining a significant presence at 19.05%, suggests that herders here may be adapting their breeding selections based on factors beyond aesthetics, including practical benefits such as milk production efficiency. The economic implications are significant, as the Ahmer coat colour's association with superior milk production capabilities likely influences herders' mating choices and herd compositions. The preference for camels with certain coat colours, particularly those believed to yield better milk, is indicative of a broader trend in pastoral economies where genetic traits are selected based on direct economic benefits.

Table 2. Colour traits of dromedary camels (coat, eye, muzzle, eyelid, ear, and foot) in the El Oued region.

Parameter	Modality	Percentage (%)
Coat Colour	Abyad	12.70
	Achgher	9.52
	Adkhan	7.94
	Ahdjel	23.81
	Ahmer	19.05
	Asfer	14.29
	Azram	1.59
	Azreg	9.52
	Zelraf	1.59
Eye Colour	Blue	1.59
	Brown	85.71
	Black	12.70
Muzzle Colour	Non-pigmented	47.62
	Pigmented	52.38
Eyelid Pigmentation	Not Pigmented	92.06
	Pigmented	7.94
Ear Pigmentation	Not Pigmented	76.19
	Pigmented	23.81
Foot Pigmentation	Not Pigmented	61.90
	Pigmented	7.94
	Partially Pigmented	30.16

Four eye colours of camels have been identified in El Oued province (Fig 3). The predominance was seen with brown eyes (85.71%) in camels of present study (Table 2). In contrast, Meghelli *et al* (2020) presented differing results in their study of camel ecotypes, observing that 100% of the Sahraoui ecotype possessed brown eyes, while the Steppe camel ecotype (Naili) exhibited a combination of black (58%) and brown eyes (41.82%). Notably, blue eyes
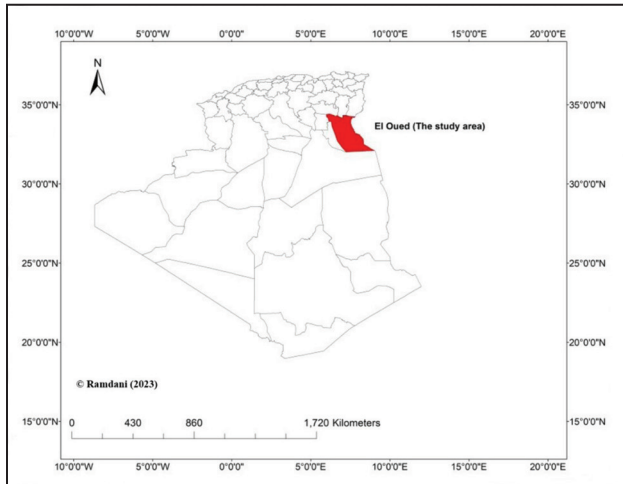
Fig 1. Localisation of the El Oued region (Ramdani, 2021).

were absent in both ecotypes studied by Meghelli *et al* (2020). This discrepancy highlights regional variations in eye colour distribution, potentially influenced by differing genetic backgrounds, environmental pressures, and breeding practices. Furthermore, the presence of blue eyes in the Tergui ecotype with the Zelraf coat pattern corroborates observations by Volpato *et al* (2017), who identified a genetic linkage between coat patterns and eye colour variations in camels. This association suggests that specific genetic markers responsible for the Zelraf (piebald) coat may also influence eye pigmentation, resulting in the rare occurrence of blue eyes within this subgroup.

This study examined three types of pigmentation in dromedary camels, i.e. muzzle (Fig 4), eyelid (Fig 5) and foot (Fig 6) pigmentation. Regarding muzzle pigmentation, there is a notable distribution between pigmented (52.38%) and non-pigmented muzzles (47.62%). These observations suggest that the allele responsible for Abyad Colouration may be linked to non-pigmentation at the muzzle, indicating a possible trait association that could be useful in predicting phenotypic characteristics based on coat colour alone. Conversely, the presence of pigmented muzzles in a substantial proportion (63.6%) of individuals with the Adkhan and Azreg coat colours highlights an important distinction in the genetic traits associated with these Colourations (Table 2).

In contrast, non-pigmented eyelids were observed in the majority of animals (92.06%), while only 7.94% displayed pigmented eyelids (Table 2). These findings differ significantly from the study of Bouzid's (2018), which reported that 94.27% of camels had pigmented eyelids compared to 6.08% with non-pigmented eyelids. The study also identified three types of foot pigmentation. The results indicated that

61.90% of the animals have non-pigmented feet, 7.94% have pigmented feet, and 30.16% possess pigmented front feet. Additionally, pigmentation patterns were found to be related to coat colours. Notably, camels with the Abyad coat colour exhibited no pigmentation, exclusively featuring non-pigmented muzzles. Most camels with pigmented eyelids belong to the Adkhan and Achgher coat colours. Furthermore, a significant majority (86.6%) of animals with the Ahdjel coat colour have pigmented front feet. All camels with Adkhan, Abyad, and Achger coat colours have feet that match their coat colour, while the majority of animals with Azreg, Asfer, and Ahmer coat colours (74%) also exhibit feet that correspond to their coat colour.

In examining camel characteristics, the findings regarding hump size, posture, and position provide significant insights into their health and nutritional status. According to Table 3, small hump size is the most prevalent, accounting for 65.08% of the ecotype, while medium and large sizes were 17.46% each. This distribution indicates a clear correlation between hump size and the fattening condition of the animals; larger humps generally correlate with improved nutritional health. As camels' conditions enhance, their hump size tends to increase, suggesting that hump size serves as a reliable indicator of overall health and fat reserves. Supporting the observations of Bengoumi *et al* (2005), this relationship underscores the critical role of nutrition in camel husbandry. Additionally, the results indicate that all studied animals possess an upright or erect hump, a finding corroborated by Tandoh *et al* (2018). In terms of hump position, data from Table 3 reveal that all animals exhibited a central hump position. However, this finding contrasts with Bouzid's (2018) report, which noted that only 59.56% of the animals had a centrally placed hump, with 14.71% presenting an anterior position and 25.74% a posterior position. Furthermore, all animals in the study exhibited lateral ear orientation. Notably, Tandoh *et al* (2018) also found that all camels have erect humps, aligning with the current study's observations.

Table 3. Distribution of dromedary camels based on hump characteristics in El Oued region.

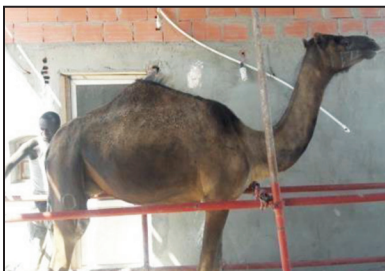| Parameter	Modality	Percentage (%)
Hump Size	Big	17.46
	Medium	17.46
	Small	65.08
Hump Orientation	Upright	100
Hump Position	Medium	100

Ahmer   Abyad   Zelraf
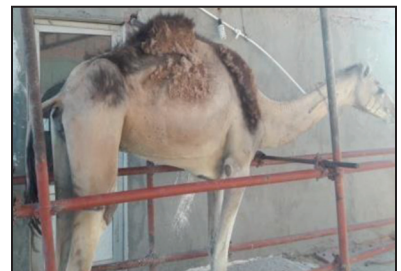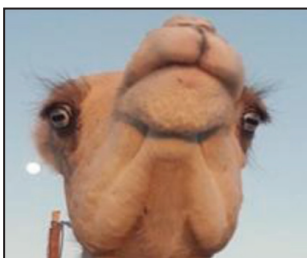
Ahdjel   Azreg   Asfer
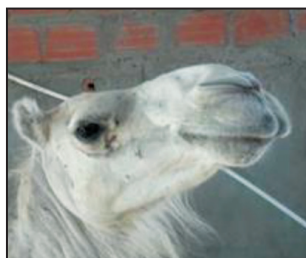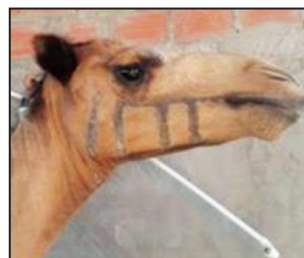
Adkhan   Azram   Achgher

Fig 2. The different coat colours of camels in El Oued region resulting in the rare occurrence of blue eyes within this subgroup.
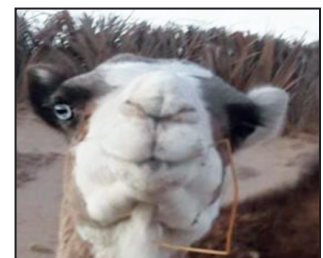

A: Blue Eyes   B: Black Eyes   C: Brown Eyes   D: Eyes of Different Colours (Heterochromia)

Fig 3. Eye colour of camel in El Oued region and Ahmer coat colours (74%) also exhibit feet that correspond to their coat colour.

The analysis of the facial profiles of dromedaries reveals intriguing discrepancies compared to previous studies (Table 4). According to Bouzid (2018), the three most common facial profile types are concave, convex, and straight. However, the results presented in Table 4 indicate that all the animals studied possess a straight facial profile (Fig 10), sharply contrasting Bouzid's findings, where only 49.06% had a straight profile, while 28.30% exhibited a concave profile and 22.64% a convex profile. Additionally, the data in Table 4 highlight

Table 4. Facial, backline and ear Profile Observed in Dromedary Camels in El Oued Region.

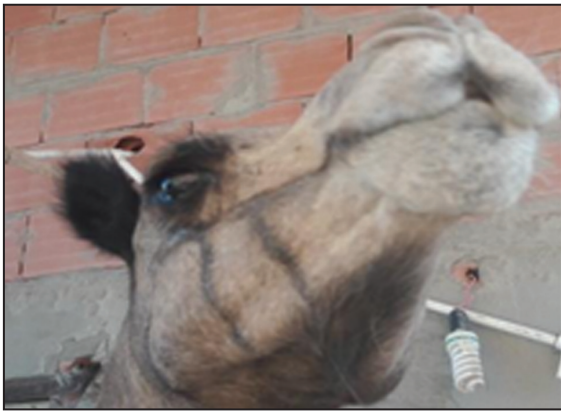| Parameter	Modality	Percentage (%)
Facial Profile	Straight	100
Backline Profile	Straight	100
Ear Orientation	Lateral	100

Non-Pigmented Muzzle

Pigmented Muzzle

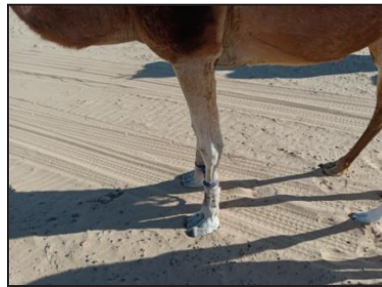**Fig 4.** Muzzle Pigmentation in camel.

Pigmented Eyelid

Non-Pigmented Eyelid

Fig 5. Eyelid pigmentation of camel.

Pigmented Feet
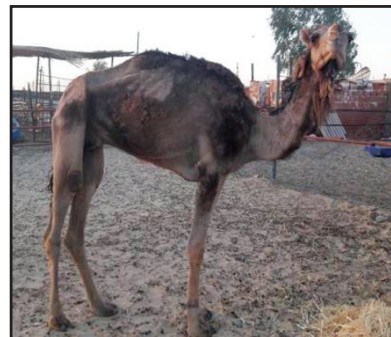
Pigmented Front Feet

Non-Pigmented Feet

Fig 6. Foot Pigmentation of camel.
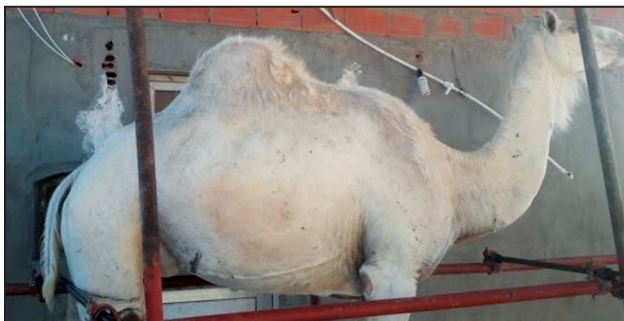

Bosse de taille moyenne → Medium-sized hump

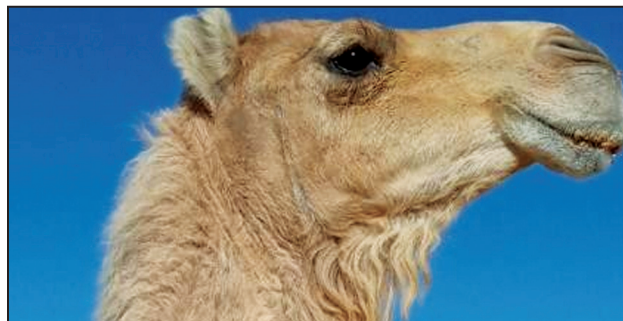Bosse de grande taille → Large-sized hump
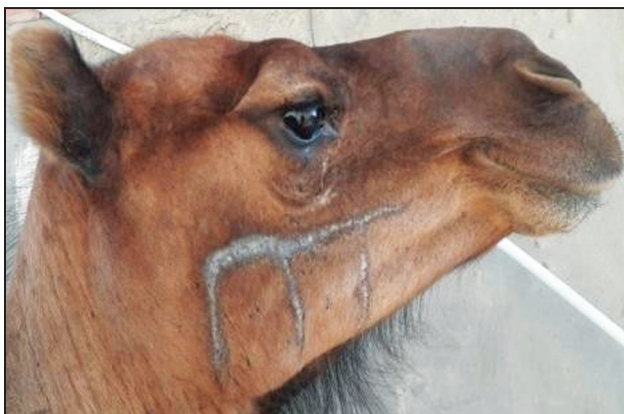
Bosse de petite taille → Small-sized hump

Fig 7. Different hump size of camel in El Oued region.

Fig 8. Hump in a central position of a camel.

Fig 9. Lateral orientation of the ear.

Fig 10. Straight facial profile of a camel's head.

Fig 11. Straight back line of camel.

that all animals also feature a straight back line profile, as illustrated in Fig 11.

This foundational characterisation not only contributes to the understanding of local genetic diversity but also emphasises the importance of preserving and promoting these traits in breeding practices. The results underscore the potential for future research focused on camel breeding strategies and conservation efforts in Saharan Algeria, which are essential for maintaining the genetic integrity and viability of this vital livestock resource. Overall, this study serves as a crucial step towards improving the management and sustainability of dromedary camel ecotypes in the region.

Authors' Contributions:

Maria Chikha contributed to the conception, design, and writing of the manuscript. Safia Tennah supervised the work and provided overall guidance. Aicha Mouane and Nacira Ramdani approved the manuscript for submission. Fahima Neffar contributed to the validation of the study. Safia BEN AMOR: contributed to the validation of the study.

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