Description of phenotypic traits in indigenous cows in east of Algeria

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Abstract

The aim of this research is the study of the animal genetic resources biodiversity and to list information on the main varieties of indigenous cattle "Brune de l'Atlas". Data collected during 2022, from 51 cows with two stage of lactations. In this context to characterize this population, sixteen body measurements and five qualitative traits were used. The morphometric approach addresses the following measurements: HG, HD, HS, HP, LSI, LE, LH, LB, TP, TCA, Ltro, Lisch, IDT, PV1, PV2, TS) and the phenotypic approach based on coat color, mucous membrane color, head color, leg color and cephalic profile. The barymetric results obtained are respectively 134.33±9.28cm, 131.51±8.50cm, 137.25±9.63cm, 70.55±5.62cm, 151.10±12.76cm, 41.94±5.48cm, 50.35±5.97cm, 9.76±4.40cm, 172.59±10.68cm, 20.25±1.26cm, 47.63±5.77cm, 30.67±4.84cm, 0.115±0.016cm, 415.86±75.06kg, 387.93±13.46kg and 212.63±13.46cm. The fawn color is the dominant color of the studied population; it is 58.8% with the presence of different colors: black, gray and light gray. The majority of the population has dark mucous membranes (64.7%) and a concavilinear cephalic profile (72.5%). In conclusion, the majority of indigenous cattle are short stature and fawn in color.

Keywords

Indigenous cattle, Phenotype, Characterization, Algeria.

Introduction

The cattle herd is concentrated especially in the Eastern region, which predominates with approximately 59% of the national cattle population, followed by the Central and Western regions with 22% and 14%, respectively, and finally the South with only 5% (Houssou et al., 2024). With a total cattle population of approximately 21, 716, 33 head (MADR, 2019), this livestock sector plays an important role in the Algerian agricultural economy. It contributes

30% to meeting national animal protein needs. In Algeria, the composition of the herd has changed significantly with the introduction of the Black and Red Pie breeds and the Tarentaise breed. Often uncontrolled crossbreeding and artificial insemination using imported semen have greatly reduced the preservation of the local breed. In addition, following the dairy programs initiated and in the absence of large-scale programs for management, conservation and improvement of local genetic resources, the local breed is clearly declining but remains dominant (Bekhouche-Guendouz, 2011).

The ndigenous cattle is attributed to a single mother "breed": the Brown Atlas with its varieties, types or sub-breeds, depending on the name each one gives it, which arouses much controversy as to its origin (Bouzebda-Afri, 2007). Its four essential branches are identified by the color of the coat: the Guelmoise (dark gray coat), the Cheurfa, (whitish coat), the Chélifienne, (fawn coat), the Sétifienne, (blackish coat). The other secondary populations which are in danger of disappearing with very small numbers like the Djerba, the Kabylie and Chaoui. The last two derive respectively from the Guelmoise and the Cheurfa following the successive mutations of cattle breeding (FAO, 2013).The approach of the criteria studied, according to the color of the coat; allows to evaluate the differences. Indeed within this region; the bovine population is very heterogeneous in terms of its phenotypic representation. The name "Brown Atlas breed" all the types of native cattle of Tunisia, Algeria and Morocco (Dechambre, 1922).

The indigenous cattle breed is small, hardy, and well-adapted to environmental conditions. It is well-adapted to variations in diets, infectious and parasitic diseases, and resistant to malnutrition (Aissaoui et al. 2003). The local cattle herd is distributed exclusively in the northern part of Algeria. The concentration of the local herd is in the east of the country, where more than half of the population is found (ITEBO, 1997), with a predominance of females (Feliachi, 2003). Our study presents a characterization of the local cattle population in east of Algeria region by studying 51 adult cows of different varieties.

Materials and Methods

Study Area

The province of Souk Ahras is located in northeastern Algeria, near the Tunisian border. It covers an area of 4,541 km² with an average altitude of 1,000 m in the north and 650 m in the south (Houssou et al., 2023b).

The northern part of the region is exposed to Mediterranean climatic influences, while the southern part is characterized by a semi-arid climate. The province is characterized by hot, dry summers with an average temperature of 33°C, peaking at 42°C, and cold, wet winters with an average temperature of 12°C. Rainfall averages 600 mm per year (250 mm in the south and 700 mm in the north), often unevenly distributed. The higher elevations experience significant snowfall during the winter (Souk Ahras Metrological Station 2016). The water potential of the Wilaya of Souk Ahras, estimated at 265 million m3 per year, is significant enough to promote any agricultural development requiring irrigation. It consists of surface water, mainly from two large dams (Ain-Dalia and Foum el Khenga) with a capacity of 243 million m3, and groundwater with 22 million m3.

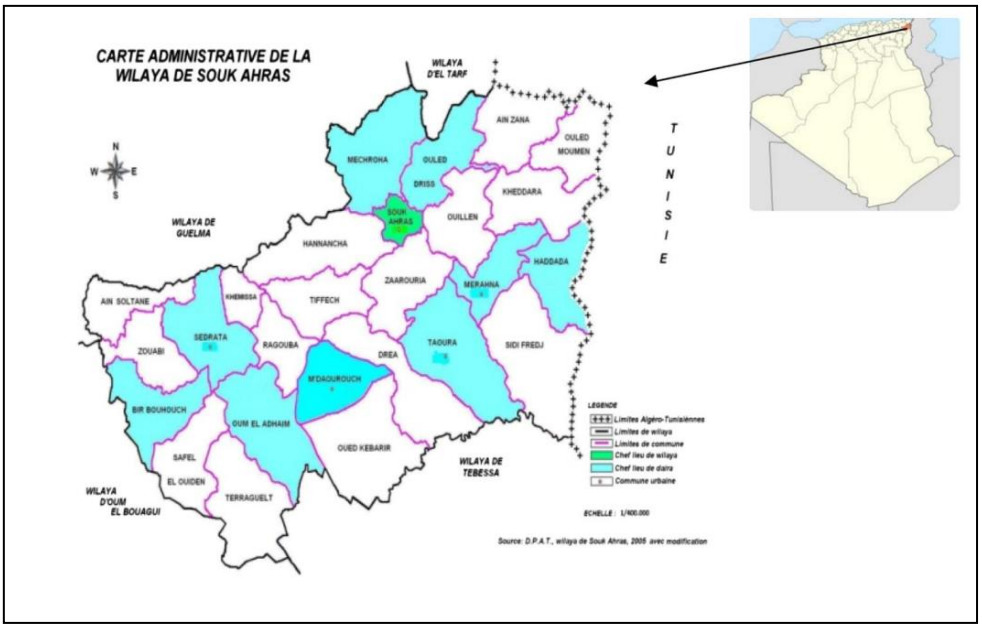

Figure 1. Map of the Wilaya of Souk-Ahras**.**

Animals Studied

With nearly 100,000 head of cattle, more than half of which are dairy cows, including 9,000 imported breeds, mainly Holstein and Montbéliarde, 12,200 hybrid (crossbred) cows, and 29,000 local breeds (Brune Atlas), the Souk-Ahras region is considered the dairy basin of the eastern part of the country, with a production of 50 million liters per year (Sahi et al. 2021; Houssou et al., 2023a).

Efforts were made to limit the sample to ecotypes that meet the standard of the local cattle population and have at least one morphological specificity that distinguishes them. A total of 51 adult cows were measured during the winter period between February and March 2022.

Animal samples were randomly taken from 15 local cattle farms spread across five municipalities in the wilaya. These farms are characterized, on the one hand, by small herds, with no more than 10 animals in 30% of the farms, and on the other hand, by extensive livestock farming practices.

Variables studied

Each animal was characterized following the FAO recommendations on the phenotypic characterization of animal genetic resources (FAO, 2013; Houssou et al., 2024). 19 quantitative variables were retained (scapuloischial length or body length (LSI), height at withers (HG), height at back (HD), height at sacrum (HS), chest height (HP), shoulder width (LE), hip width (LH), trochanter width (Ltro), ischial width (Lisch), pelvic length (LB), anterior cannon circumference (TCA), chest circumference (TP), spiral circumference (TS)) (Figure 2) and 05 zootechnical index (body index: BI, Proportionality index: PI, Relative depth of thorax index: RDTI, Width index: LI, balance: B, Relative thickness of cannon bone index: RTCI, Thoracic dactylo-index: IDT and weight: PV1 and PV2) for barymetric characterization (Table 1)

Figure 2. The indigenous cattle breed

Table 1. Zootechnical indices studied in the local cattle population studied

	Index	**Formula**
Animal format	Body index (BI)	*(LSI/TP)x100*
	Proportionality index (PI)	*(HG/LSI)x100*
Performance	Weight Formula 1 (WF1)	$80x\ PT^3$
	Weight Formula 2 (WF2)	$40x\ TS^3$

Skeleton	Relative thickness of cannon bone index (RTCI)	*(PC/HG)x100*
	Index dactylo- thoracique (IDT)	(Pc/TP)

The five qualitative variables (coat color, mucous membrane color, head color, and cephalic profile) were used for morphological characterization (Table 2). All measurements were recorded by the same operator to avoid inter-operator effects. All features were recorded from the left side of each animal placed on a flat surface and held by two assistants. The various measurements were taken using a tape measure and a height chart. Age was determined based on the number of permanent incisors: 2, 4, 5, 6, 7, and 8; for the oldest animals, based on the breeders' declaration

Table 2. Morphological variables used.

Variable	**Abbreviation**	**Modalities and associated codes**
Coat color	CR	Grey, black, fawn,
Leg color	CP	Fawn, Black, Grey, White
Mucous membrane color	CM	Light, Dark
Head color	CT	Grey, black, fawn
Cephalic profile	PC	Rectilinear, Concavilinear, Convexilinear

Statistical Study

Body measurements, zootechnical indices, and morphological characteristics obtained during this study were analyzed using SPSS v26 software. A principal component analysis (PCA) was performed to group homogeneous individuals to differentiate local cows according to certain barymetric criteria that could be identified to define an animal classification and construct a typology that clearly identifies the local populations studied. A multiple correspondence analysis (MCA) was used for qualitative variables to present the most significant characteristics for identifying each group.

Results and Discussion.

Barymetric description

The means, standard deviations, minimums, maximums, and variances of body measurements and zootechnical indices of the local cows studied are reported in Tables 3 and 4, respectively.

Table 3. Descriptive analysis of body measurements (cm) in the local cattle population studied.

Mensurations	Mean	Err. Std	SD	Var.
LSI(cm)	151,10	1,79	12,76	162,73
HG(cm)	134,33	1,30	9,28	86,07
HD(cm)	131,51	1,19	8,50	72,29
HS(cm)	137,25	1,35	9,63	92,67
HP(cm)	70,55	0,79	5,62	31,57
LE(cm)	41,94	0,77	5,48	30,06
LH(cm)	50,35	0,84	5,97	35,63
Ltro(cm)	47,63	0,81	5,77	33,28
Lisch(cm)	30,67	0,68	4,84	23,43
LB(cm)	49,76	0,62	4,40	19,34
TCA(cm)	20,25	0,18	1,26	1,59
TP(cm)	172,59	1,50	10,68	114,17
TS(cm)	212,63	1,89	13,46	181,24
WF 1 (kg)	415,86	10,51	75,06	5633,61
WF 2 (kg)	387,93	9,57	68,31	4666,24

SCL: Scapulo-ischial length; H: Height at withers; H: Height at back; H: Height at sacrum; H: Chest height; H: Shoulder width; H: Hip width; H: Trochanter width; H: Ischial width; H: Pelvic length; H: Anterior cannon girth; H: Chest girth; H: Spiral girth.

The total cattle population studied had a mean scapulo-ischial length (SCL) of 151.10±12.76 cm and a chest girth (CH) of 172.59±10.68 cm, with very significant variances. The height at sacrum (HS) was 137.25±9.63 cm, and had greater variance than the height at withers (H) and the height at back (HD). While the spiral circumference is the measurement with the greatest variance (181.24), it is 212.63.

The average live weights are 415.86 ± 75.06 kg and 387.93 ± 68.31 kg for the two formulas. Our results are similar to those reported by Bouzebda-Afri (2008). The average live weight of the population is 412.16 kg, and the same author reported that the formula P1 = $80c^3$ yields a superiority of around 40 kg compared to PV2. These results are very different from those of Aisssaoui et al. (2003), whose weights are reported as 295 kg and 274 kg. The dactylothoracic index, as predefined, evolves in the opposite direction to the fineness; in fact, the lower the value of this index, the more the fineness increases; It is 1/10 in thin animals, 1/11 in so-called very thin cattle, whose skeleton may be too fragile (Sahi et al., 2021). Our results indicate a dactylothoracic index of 1/10 for the population studied, which is close to the results found by Bouzebda-Afri, which is 1/10 in females aged 2 to 5 years, which is confirmed by the fineness of the cannon in this category.

Table 4. Analysis of variation in body measurements (cm) according to the races studied.

	Chorfienne	Sétifienne	Chélifienne	Guelmoise
N	**30**	**16**	**3**	**2**
LSI(cm)	150±4,24	149,38±12,79	151,94±9,57	161,67±11,01
HG(cm)	144±2,82	132,97±8,81	133,50±8,05	139,67±4,61
HD(cm)	140±10	130,79±7,42	131,56±6,79	136±7
HS(cm)	145,5±3,53	136,29±9,56	136,06±8,97	142,33±2,51
HP(cm)	69,5±0,70	69,85±5,70	69,69±4,39	75±9,16
LE(cm)	45±8,48	41,59±5,18	40,31±3,77	42,33±1,15
LH(cm)	54,5±2,12	49,50±5,96	50,38±5,94	55,67±6,42
Ltro(cm)	49±4,24	46,82±5,82	46,69±5,58	50±1,73
Lisch(cm)	27,5±0,70	31,15±4,97	28,94±5,05	30,33±3,05
LB(cm)	48±7,07	49,79±4,07	49,38±4,19	52±6,00
TCA(cm)	20±0,70	20,18±1,05	20,81±1,27	21,67±1,15
TP(cm)	173,5±2,80	172,41±10,25	173,37±10,37	179,67±9,45
TS(cm)	215,5±7,77	211,88±14,14	213,31±12,19	220±11,26

LSI: Scapulo-ischial length; HG: Height at withers; HD: Height at back; HS: Height at sacrum; HP: Chest height; LE: Shoulder width; LH: Hip width; Ltro: Trochanter width; Lisch: Ischial width; LB: Pelvic length; TCA: Anterior cannon circumference; TP: Chest circumference; TS: Spiral circumference

Furthermore, the body measurements observed in this study show significant and nearly similar averages for the HG, HD, HS, and Ltro variables for the Guelmoise and Chorfienne populations. These results suggest that the Guelmoise and Chorfienne varieties show the highest averages, characterized by better skeletal and muscular development for the latter two populations. The body measurements observed in the Sétifienne and Chélifienne populations show low and similar averages for almost all the criteria studied. These results suggest that the latter two populations are small-sized cattle compared to the Guelmoise and Chorfienne varieties. The superior measurements observed in Chorfiennes and Guelmoise cattle are related to the terrain, where they are generally found on the plains, while the Sétifienne and Chélifienne populations are generally found in mountainous areas with rugged terrain and near dense scrubland. This situation is a good indication of a considerable genetic difference between the varieties studied.

The Guelmoise population exhibits higher average values across all measurements than the other three populations. Indeed, the average chest circumference in this population, which is around 179.67 ± 9.45 cm, is the largest compared to the other populations. This allows us to assess the good conformation and harmonious development of the internal organs of the Guelmoise variety compared to the other.

A principal component analysis (PCA) was performed on the barymetric variables studied. The first two axes of this PCA account for 67% of the total inertia, which is relatively high.

The two axes represent 52.16% and 14.84%, respectively. Axis 1 (52.16%) includes the following measurements: LSI, HG, HD, HS, HP, LE, LH, Ltro, LB, TCA, TP, PV1, TS, PV2. Axis 2 (14.84%) contains the following measurements: LIsch and IDT

Principal component analysis: PCA (Figure 3) shows three classess.

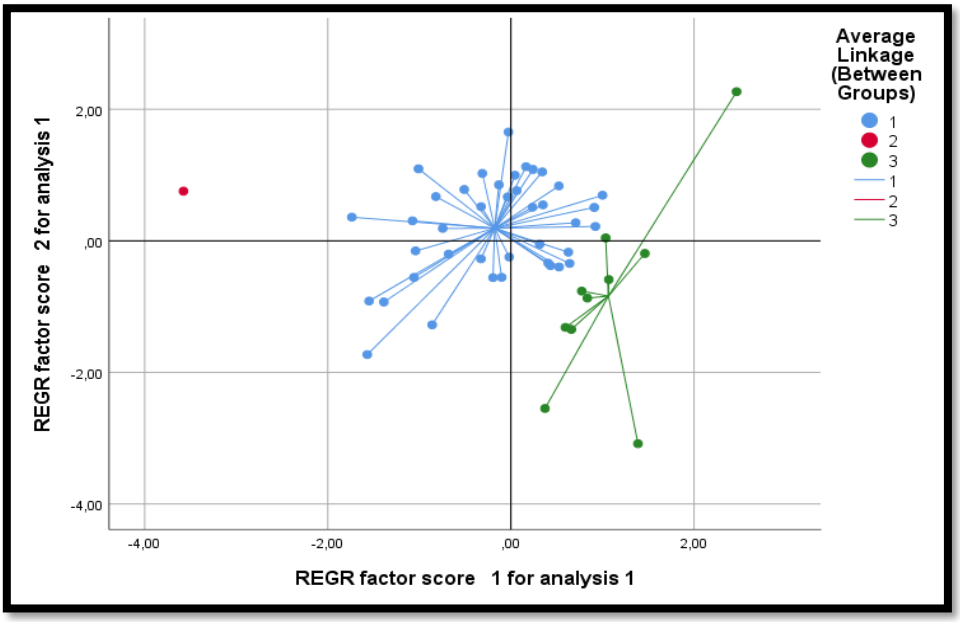

Figure 3. Presentation of individuals from the indigenous cattle population studied.

Class 1: Consists of the majority of the population (40 individuals) (Table 5), it is characterized by a scapulo-ischial length (LSI) of 150 ± 11 cm, a height at the withers (HG) of 13.4 ± 8 cm and a shoulder width (SL) of 41 ± 5 cm, these three measurements being almost equal to the average of the total population. These animals are less developed than the third class; they are less slender and smaller, with a chest circumference of 170 ± 7 cm and a spiral circumference of 210 ± 9 cm, which is less important than the animals in the third class.

Class 2: Consists of a single individual that is very different from the population and is characterized by a shoulder width (SW) of 31 cm and a chest circumference (CC) of 137 cm. They are less slender (SW: 113 cm) and smaller (CC: 116 cm), with a spiral circumference (SC) of 160 cm, smaller than the animals in the first class and below the average of the total population.

Class 3: Consists of 10 individuals. These animals are more developed than the first and second classes. They are characterized by a very developed shoulder width (SW) (46±5 cm), a spiral circumference (SC) of 230±4 cm, and a larger chest circumference than the animals in the first and second classes and above the average of the total population. These animals are more

slender (LSI: 161±8 cm) and taller on the legs (HG: 137±12 cm). They have a wider pelvis (Ltro: 51±5 cm)).

Table 5. Classification of animals in the bovine population studied by PCA.

	Class 1	Class 2	Class 3
N	**40**	**1**	**10**
LSI (cm)	150 ± 11	113	161±8
HG (cm)	134 ± 8	116	137 ± 12
HD (cm)	132 ± 6	110	134 ± 13
HS (cm)	137 ± 9	113	139 ± 11
HP (cm)	70 ± 5	55	75 ± 5
LE (cm)	41 ± 5	31	46 ± 5
LH (cm)	50 ± 5	35	53 ± 7
L tro (cm)	47 ± 6	36	51 ± 5
L isch (cm)	31 ± 4	18	33 ± 6
LB (cm)	49 ± 4	38	53 ± 3
TCA (cm)	20±1	18	21±1
TP (cm)	170±7	137	187±3
TS (cm)	210±9	160	230±4
PV 1 (kg)	393,97±48,99	205,70	524,41±27,75
PV 2 (kg)	370,45±45,36	163,84	480,26±24,43
IDT	0,118±0,006	0,131	0,104±0,034

Morphological Description

Descriptive Analysis of Qualitative Traits

Table 6 reports the distribution of qualitative traits in the cattle population studied**.**

Table 6. Distribution of qualitative traits in the cattle population studied.

Qualitative traits		N	%
Coat color	**Fawn**	30	58,8
	Black	16	31,4
	Grey	3	5,88
	Gris claire	2	3,92
Leg Color	**Light**	18	35,3
	Dark	33	64,7
Mucous membrane color	**Fawn**	27	52,9
	Black	18	35,3
	Grey	3	5,9
	Wight	3	5,9
Head color	**Fawn**	29	56,9
	Black	19	37,3
	Grey	3	5,9
Cephalic Profile	**Rectilinear**	11	21,6

	Concavilinear	37	72,5
	Convexilinear	3	5,9

According to the study and field observations, as well as descriptive analyses of qualitative traits in the cattle population studied, only four local cattle populations were identified. The Chélifienne cattle population constitutes the majority of the cattle population studied (30 animals). The Sétifienne variety, with its black coat color, comes in second (31.4%), followed by the Guelmoise population with a reduced percentage of 5.88%, and finally the Chorfienne variety with a rate of 3.92%. The varieties of the Brown Atlas breed studied have a much more concavilinear cephalic profile. The main color of the limbs and heads of the population studied is fawn (52.9% and 56.9%). Our results are similar to the data published by Feliachi (2003) and Ben Jemaa et al. (2018).

Morphological Variation of Individuals (MCA)

The MCA analysis performed on 51 animals for the 5 qualitative traits in the cattle population in the study regions shows that the first two factorial axes, 1 and 2, express 56.23% and 43.70% of the inertia, respectively, representing 100% of the total inertia, which is statistically significant. Axis 1 (56.23%) is represented by the variables: coat color; mucous membrane color; head color; and cephalic profile.

Axis 2 (44.77%) is represented by leg color. The multiple correspondence analysis (MCA) on individuals (Figure 4) identified three classes.

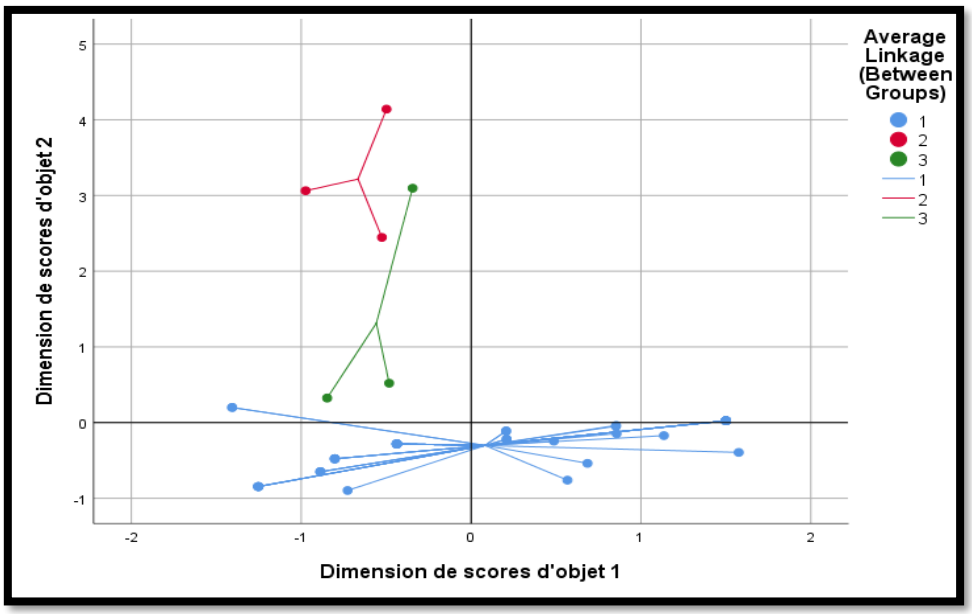

Figure 4. Presentation of individuals from the local bovine population studied by ACM.

Class 1: The animals in this class comprise the majority of the population (45 individuals). They have a coat color that is either 60% fawn (Chélifienne population); 35.6% black (Sétifienne population); fawn (60%) or black (18%) legs, light (35.6%) or dark (64.4%) mucous membranes, and a fawn or black head (57.8%; 42.2%), or a light gray coat color (4.4% of the Chorfienne variety). The animals in this class are much more concaviling (68.9%).

Class 2: Three animals make up this class; all of them are from the Guelmoise population, characterized by a gray coat (100%). The mucosa is either light (66.7%), the legs are either grayor white (66.7%; 33.3%), the head is either fawn (33.3%) or gray (66.7%), the animals in this class have a concavilinear head profile 100%.

Class 3: The animals in this class consist of 3 animals, have a 100% fawn coat (Chelifia population), the mucosa is either light (33.3%) or dark (66.7%), the legs are gray (33.3) or white (66.7%), they have a fawn or gray head (66.7%; 33.3%). The animals in this class have a concavilinear head profile 100%.

Conclusion

The indigenous cattle is often cited as an example for its hardiness which is explained by its resistance to difficult climatic conditions (heat, cold, drought, etc., its ability to enhance mediocre feed. The local cattle has the capacity to consume abundantly and to transform low-quality coarse fodder, its ability to walk in difficult terrain, its resistance to parasites and diseases, especially resistance to biting insects, vectors of diseases. The populations that make up the Brown Atlas differ clearly from the phenotypic point of view. The aim of this work is to list information on the main varieties of indigenous cattle "Brown Atlas", so that breeders throughout the wilaya of Souk-Ahras can benefit from it, it must also be admitted that many important indigenous types are threatened with disappearance or "dilution" by the massive influx of foreign blood. In addition, to determine some morphometric and phenotypic characteristics of the cows of the local population in the east of Algeria.

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