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Morphometric Study of Local Algerian Cattle Breeds and Prediction of Carcass Weight from Linear Body Measurements: Case of Setifien and Guelmoise Breeds

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ABSTRACT

Background: In zootechnics, the utilization of local breeds adapted to harsh environmental conditions is a practical strategy for improving performance, particularly in breeding and animal improvement projects. This morphometric study of local Algerian cattle breeds highlights the main characteristics of the two breeds studied.

Methods: The study focused on 60 male cattle, including 30 Setifien and 30 Guelmoise breeds, aged between 24 and 36 months. For each subject, nine biometric measurements were taken prior to slaughter: wither height (WH), thoracic circumference (TC), abdominal circumference (AC), scapulo-Ischial length (SIL), head length (HL), bizygomatic width (BIW), hip width (HIW), cannon circumference (CC) and cannon length (CL). Post-slaughter, the carcass weight (CW) of each animal was also recorded. Data analysis included univariate, bivariate and multivariate statistical methods.

Result: The morpho-biometric comparison between the two studied breeds revealed that the Setifien breed has higher average values for all parameters compared to the Guelmoise breed. The Guelmoise breed is smaller in size (WH=113 cm), while the Setifien breed is larger (WH=121 cm), exhibiting values higher than those of African rustic breeds. Strong correlations were observed between carcass weight and most parameters, supporting the use of linear regression equations to estimate carcass weight from biometric measurements.

Key words: Biometry, Body measurements, Brown of the atlas, Cattle, Guelmoise breed, Setifien breed.

INTRODUCTION

In Algeria, the cattle herd is primarily composed of two types: imported and autochthonous breeds. The imported cattle population, representing 16% of the national herd, is intended to improve milk production and contributes 60% of the country's milk supply. The autochthonous cattle population, consisting of local breeds maintained through internal crossbreeding or crossbreeding with imported breeds, focuses mainly on meat production. This group accounts for 80% of the national beef production and 40% of the milk production (MADR, 2021).

The Brune de l'Atlas is the predominant local cattle breed in Algeria, found exclusively in the northern region of the country (Itebo, 1997), with a higher proportion of females (Feliachi, 2003). Known for its resilience in harsh environments and mixed production capabilities, this breed constitutes the majority of autochthonous cattle in North Africa (Ben djamaa *et al.,* 2020).

Breed description

According to (Ben djamaa *et al.,* 2020) and (Rahal *et al.*, 2021). The Brune de l'Atlas is a distinct brachycephalic breed characterized by a straight or sub-concave profile and an elongated or triangular face. The average height at the withers is around 1.20 meters, although it can be as low as 1 meter. The horns are thin, very pointed and grayish

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or blackish in color. The Brune de l'Atlas is a short-statured breed, featuring a strong neck, thick dewlap, well-developed trunk, deep chest, short legs and a narrow croup. It has moderately thick muscular mass, particularly in the crural region. The breed also possesses thick, rough skin, short hair and black hooves with extremely hard and solid horns. The Brune de l'Atlas is subdivided into four main branches, each shaped by the specific environment of its region (Nadjraoui, 2001). These branches exhibit significant phenotypic differences: the Guelmoise, with its dark gray coat; the Cheurfa, with a whitish coat; the Chelifien, with a fawn coat; and the Setifien, with a blackish coat. However, our study will focus exclusively on two local breeds: the Guelmoise and the Setifien (Rahmani *et al*., 2020).

Study objectives

Morpho-biometric measurements are used to assess the characteristics of different animal breeds and can provide useful information on the suitability of animals for selection (Nesamvuni *et al*., 2000; Rastija *et al*., 2004; Araujo *et al*., 2006; Mwacharo *et al*., 2006; Martins *et al*., 2009; Yakubu *et al*., 2010; Bhinchhar *et al*., 2017; Hamadani *et al*., 2024; Oudini *et al*., 2024). The main objective of this work is to analyze the morpho-biometric characteristics and the relationship between different body measurements, as well as to predict carcass weight from these measurements in the two cattle populations.

This study aims to analyze the morpho-biometric characteristics and interrelationships of body measurements in two local cattle breeds, the Guelmoise and the Setifien and to estimate carcass weight from these measurements.

MATERIALS AND METHODS

Animals

The guelmoise breed

The Guelmoise population is found in the forested areas of Guelma and Jijel. Adults range in color from light to dark gray, with darker extremities on the head, neck and tail. The nasal epithelium is black with a light ring surrounding it. This breed constitutes the majority of the Algerian cattle herd (Rahal *et al*., 2021).

The Setifien breed

The Setifien breed is located in the Babor Mountains. It is characterized by a uniform black coat, good conformation and significant variability in size and weight depending on the specific region. The tail is black and long, sometimes dragging on the ground and a distinctive brown line runs along the back of this breed (Rahal *et al*., 2021).

Method

Study population

The study was conducted in slaughterhouses located in the northeastern region of Algeria between April 2022 and September 2023 and involved a sample of 60 male cattle, evenly distributed between two breeds (30 individuals per breed), mostly aged between 24 and 36 months. The animals were selected based on phenotypic characteristics corresponding to the breed standards (I.T.E.B.O) and any crossbred or suspected crossbred animal was systematically excluded. Information about the animals (breed, age) was carefully collected from the breeders prior to slaughter.

Biometric measurements

Before slaughter, nine biometric measurements were taken for each individual:

- Withers height (WH).
- Thoracic circumference (TC).
- Abdominal circumference (AC).
- Scapulo-Ischial Length (SIL).
- Head length (HL).
- Bizygomatic width (BIW).
- Hip width (HIW).
- Cannon circumference (CC).
- Cannon length (CL).

Live weight (BW) was estimated using the barymetric formula from Crevat (Delage *et al*., 1995): $BW = 80\ TC^3$. Additionally, the Dactylo-Thoracic Index (DTI) was calculated for each animal:

$$DTI = \frac{CC}{TC}$$ (Pagot, 1952).

Measurement tools and precision

Biometric parameters were measured as follows:

- Measuring stick: For WH and SIL.
- Caliper: For HIW, HL, BIW, CL.
- Tape measure: For TC, AC, CC.

Measurements were precise to the centimeter. Live weight (BW) and carcass weight (CW) were measured with a precision of one kilogram.

Post-slaughter measurements

After slaughter, carcass weight for each animal was recorded and the average slaughter yield (CW/BW) was calculated for each breed.

Statistical analyses

Univariate analysis

Data were analyzed using Excel. Statistical parameters such as mean, minimum and maximum were computed for each measured variable for both breeds and the total population. Variability was assessed using the standard deviation (σ) and coefficient of variation (CV).
Where:

$$CV\ (\%) = \frac{\sigma}{mean} \times 100$$

Bivariate analysis

Pearson correlation coefficients were calculated to examine relationships between variables. Linear regression models were developed to predict carcass weight from the most strongly correlated biometric parameters for each breed.

Multivariate analysis

Principal component Analysis (PCA) was performed using R version 4.2.1. PCA produced three key visualizations:

Correlation circle

Illustrates the construction of the first factorial plane.

Scatter plot

Displays the dispersion of individuals from both breeds (Setifien and Guelmoise) in the first factorial plane.

Gravity centers plot

Shows the positions of the centers of gravity for each breed in the first factorial plane, including 95% confidence ellipses.

All statistical tests were performed with a significance level set at 0.05.

RESULTS AND DISCUSSION

Biometric measurements

The biometric measurement values are summarized in Table 1. The average values fall within the breed standards. Guelmoise cattle, mostly aged between 22 and 36 months, have an average live weight of approximately 356 kg and a withers height of just above 113 cm. In contrast, Setifien males are heavier, with an average weight of about 434 kg and a withers height exceeding 121 cm.

For body length and width traits, Guelmoise cattle have an average scapulo-ischial length of 127.35 cm and an average hip width of approximately 39 cm. Conversely, Setifien cattle exhibit a greater average scapulo-ischial length (137.14 cm) and a wider pelvis (42.29 cm) compared to Guelmoise cattle. Regarding head dimensions, Setifien cattle have significantly larger heads than Guelmoise cattle ($P<0.05$).

Slaughter yield

The average slaughter yields are satisfactory for rustic breeds, with approximately 50% yield: 49.9% for Guelmoise and 51.2% for Setifien. These values align closely with those reported by Déchambre E. (1948); Bneder (1978); Boulahbel (1999) and MA (1999-2001) for similar populations (40% to 50%).

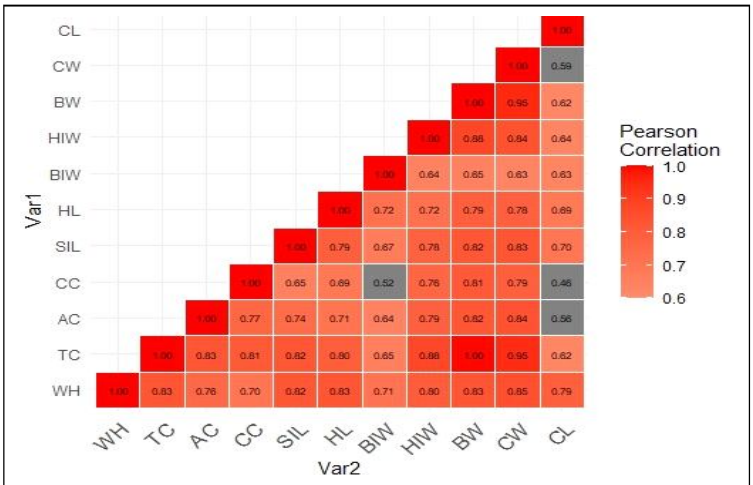
In comparison, yields for suckler meat-producing breeds are 67.5% to 69% for Charolais and Blonde d'Aquitaine and 69% to 75% for Limousin (Dudouet, 1999). Rustic breeds such as Salers, Aubrac and Gasconne show yields of 58.6%, 60.1% and 61.4%, respectively (Renand *et al*., 2002).

The coefficient of variation (CV%) indicates notable variability, particularly for weight variables. For Setifien cattle, the CV is 19.3% for carcass weight and 16.2% for live weight, whereas for Guelmoise cattle, it is 19.5% and 18.3%, respectively. For linear measurements, the CV is lower, ranging from 5.3% to 8.7% across both populations. These observations are consistent with the findings of Haddad and Kiboub (2019), Bouzebda (2007) and Boujenane (2015), who noted similar homogeneity in local breeds adapted to their environment.

Comparative analysis

The data reveal systematically significant differences between the two breeds, with Setifien cattle generally showing higher values across all measured variables compared to Guelmoise cattle. This trend aligns with findings from Haddad and Kiboub (2019) and Bouzebda (2007), though those studies used larger sample sizes.

Compared to local African cattle, the body measurements of Setifien cattle surpass those reported in Togo (Boma *et al*., 2018), Congo Brazzaville (Akouango *et al*., 2014) and Morocco (Boujenane, 2015). However, the Kouri taurines of Niger (Grema *et al*., 2018) exhibit higher measurements, especially for withers height (129 cm) and scapulo-ischial length (155 cm). For Guelmoise cattle, all compared studies indicate higher values except for the Togo cattle population (Boma *et al*., 2018), which is smaller in size, with a withers height not exceeding 110 cm.



(Total population correlation matrix: Pearson correlation coefficient values for the 11 biometric variables).

Fig 1: Pearson correlation coefficient values for the 11 biometric variables of the two cattle breeds.

Table 1: Descriptive statistics of biometric parameters.

Morphotype	Statistical parameters	- BW - Body weight (kg)	- CW- Carcass weight (kg)	- WH- Withers hight (cm)	- TC - thoracic Circonference (cm)	- AC - Abdominal Circonference (cm)	- SIL - Scapulo-ischial length (cm)	-HIW- Hip width (cm)	- HL - Head length (cm)	- BIW - Bizygomatic width (cm)	- CC - Cannon circumference (cm)
	n	30	30	30	30	30	30	30	30	30	30
	m	434.07	222.46	121.8	175.21	192.43	137.14	42.29	49.21	22.83	17.9
Setifien	min	289.34	130	107	153.5	167	122	35	44	20	16
	max	575.12	303	139	193	224	160	51.5	55	26.5	20
	a	70.23	42.84	7.27	9.6	12.1	8.29	3.39	2.63	1.73	1.2
	CV %	16.18	19.25	5.97	5.48	6.29	6.05	8.02	5.35	7.59	6.74
	σ	30	30	30	30	30	30	30	30	30	30
	m	356.11	177.7	113.07	163.87	180.78	127.35	39.03	47.01	21.75	16.76
Guelmoise	min	231.49	114	100	142.5	158	108	32.5	41.5	18	15
	max	466.56	251	126.4	180	205	141	43.5	51.5	27	18.5
	σ	65.2	34.73	7.01	10.35	11.64	8.47	2.67	2.62	1.88	1
	CV %	18.3	19.54	6.2	6.32	6.44	6.65	6.86	5.58	8.65	6.02
P value		3.88E-02	4.23E-02	1.49E-02	4.74E-02	0,00034	3,09e-05	0,0001	0,00198	0,024	0,0002171
	n	60	60	60	60	60	60	60	60	60	60
Total	m	395.09	200.24	117.43	169.54	186.6	132.24	40,64	48,11	22.29	17.33
population	min	231.49	114	100	142,5	158	108	32.5	41.5	18	15
	max	575.12	303	139	193	224	160	51.5	55	27	20
	σ	77.84	45.14	8.34	11.43	13.16	9.67	3.44	2.83	1.87	1.24

n = Sample size, m = Mean, min = Minimum values, max = Maximum values, σ = Standard deviation, CV = Coefficient of variation (S: Setifien breed; G: Guelmoise breed).

When comparing local cattle breeds to modern improved breeds, as studied by Bene *et al*. (2007), it's evident that local breeds like the Guelmoise (113 cm) and Seifien (121.8 cm) are smaller in stature. In contrast, improved breeds such as Blonde d'Aquitaine (142.5 cm), Limousin (138 cm), Charolais (137.4 cm), Aberdeen Angus (132 cm) and Hereford (130 cm) show significantly greater heights at the withers.

In terms of body length (SIL), all the improved cattle breeds mentioned surpass the recorded length for the Guelmoise breed (127.3 cm). However, the Setifien, measuring 137 cm, is relatively long and even exceeds the Aberdeen Angus (132 cm). Meat breeds like Blonde d'Aquitaine (151 cm), Limousin (148 cm) and Charolais (142 cm) have notably longer bodies, which is often advantageous for meat production.

These differences can be attributed to several factors. Firstly, improved breeds have been selectively bred for traits related to meat production, such as size, conformation and rapid growth, resulting in increased body size over generations. In contrast, local breeds, naturally selected by their specific environmental conditions, have developed characteristics like hardiness and feed efficiency, rather than large size.

Breeding practices, nutrition and management methods also play a crucial role in the physical development of animals. Improved breeds often benefit from intensive breeding techniques, whereas local breeds are typically raised in more traditional systems, which can limit their growth potential.

Dactylo-thoracic index (DTI)

The Dactylo-Thoracic Index (DTI), which is inversely related to fineness, was found to be 1/10 for both populations. This index indicates a high level of fineness in these animals, consistent with the findings of Tekkouk and Guintard (2007), who described them as hardy, walker-type breeds with slender limbs.

Correlation coefficients and linear regressions

Correlation coefficients between biometric variables are summarized in Fig 1. Strong significant correlations ($r>0.8$) were observed between most variables. Particularly strong correlations ($r>0.9$) were noted between cannon circumference and carcass weight, live weight and hip width and thoracic circumference and hip width. Moderate correlations ($0.5<r<0.7$) were observed between bizygomatic width and other biometric parameters.

The study of the relationship between live weight and various body measurements produced results consistent with those reported by several authors (Tõzsér *et al*., 2001; Bouzebda, 2007; Rahal *et al*., 2017). A positive correlation was established between carcass weight and most body measurements (AC, SIL, CC, TC, HL, HIW). This finding highlights the importance of taking body measurements in cattle, allowing carcass parameters to be estimated based on these measurements (Table 2).

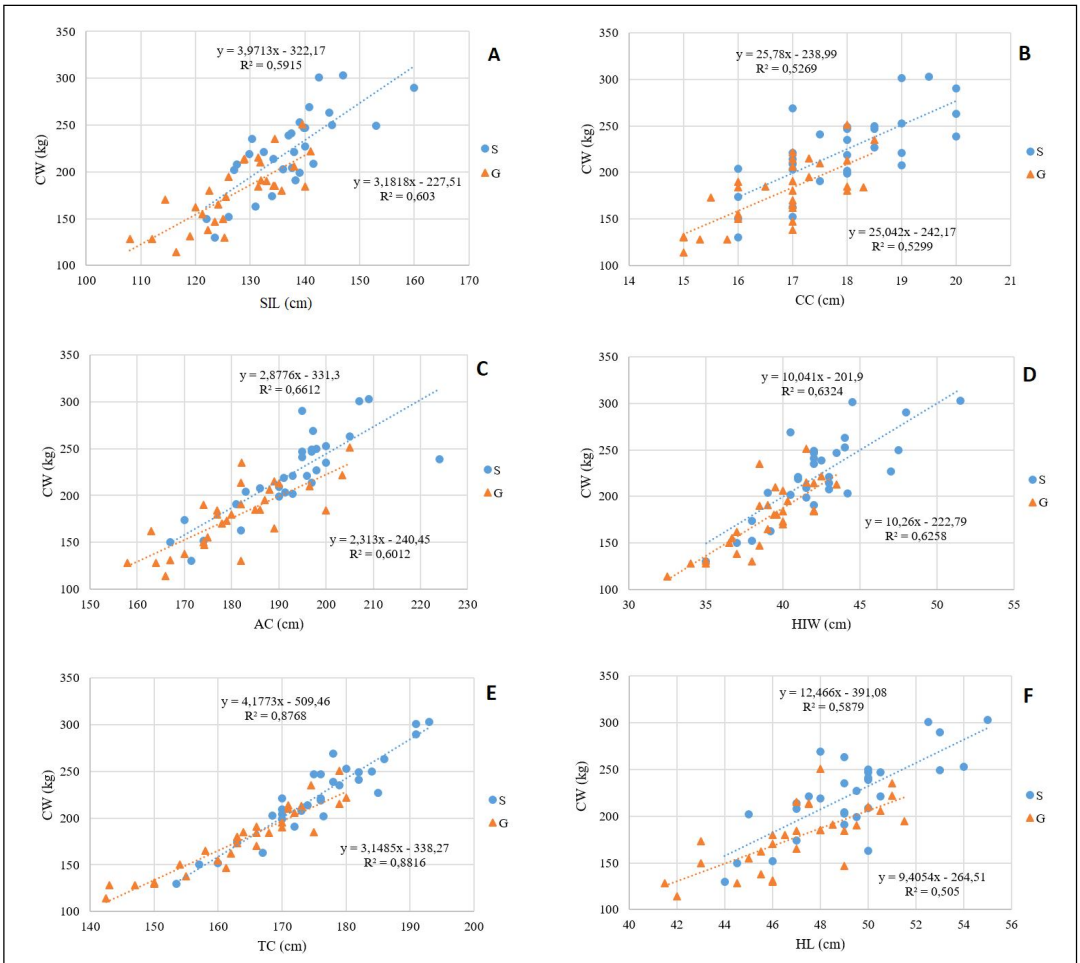
Measurements such as body length, hip width, canon circumference and other morphometric traits were used to assess skeletal development. Thus, body measurements remain a key focus in beef cattle breeding and selection programs, contributing to improved performance and carcass quality.

Linear regression equations for estimating carcass weight (CW) from live animal measurements are presented in Table 2. Carcass weight, measured directly, is a reliable

Table 2: Coefficient values of the linear regression equation (Y=aX+b) between biometric parameters (denoted as X) and carcass weight (denoted as Y).

Breed	x	a	b	r^2
Setifien	AC	2.8776	331.3	0.6612
	SIL	3.9713	322.17	0.5915
	TC	4.1773	509.46	0.8768
	HL	12.466	391.08	0.5879
	CC	25.78	238.99	0.5269
	HIW	10.041	201.9	0.6324
Guelmoise	AC	2.313	240.45	0.6012
	SIL	3.1818	227.51	0.603
	TC	3.1485	338.27	0.8816
	HL	9.4054	264.51	0.505
	CC	25.04	242.17	0.5299
	HIW	10.26	222.79	0.6258
Total Population	AC	2.8524	332.21	0.7031
	SIL	3.8298	306.41	0.6843
	TC	3.705	428.08	0.8954
	HL	12.384	395.78	0.6142
	CC	28.444	292.94	0.6227
	HIW	10.962	245.51	0.7095

Only the best-correlated variables have been retained (Fig 1).



A: CW = f (SIL), B: CW = f (CC), C: CW = f(AC), D: CW = f (HIW), E: CW = f (TC), F: CW = f (HL).

Fig 2: Covariation between variables according to breed. Regression lines obtained according to the following equations:

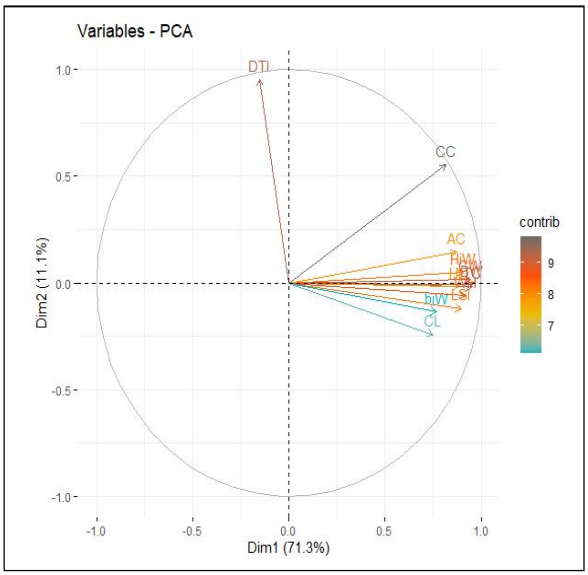


Fig 3: Principal component analysis (PCA) (60 individuals, 11 variables).

indicator of meat production. The regression equations developed for each breed and the combined population provide valuable tools for estimating carcass weight (Fig 2).

Multivariate analysis

The principal component Analysis (PCA) results are presented in Fig 3. The analysis, with an inertia level of 82.4% on the first factorial plane, shows a clear "size" effect, as all linear measurements are positively correlated with each other and with the first factorial axis. Most measurements contribute significantly to this axis (correlation coefficient> 0.75), except for the Dactylo-Thoracic Index (DTI), which is negatively correlated (-0.16). On axis II, the DTI shows a strong correlation (0.95), while other measurements have weak correlations (generally<0.3), indicating that axis II represents general shape.

The scatter plots (Fig 4) distinguish Guelmoise and Setifien breeds mainly on axis I. Guelmoise males are clustered in the left half-plane with negative abscissas, while Setifien males are predominantly in the right half-plane with positive abscissas.

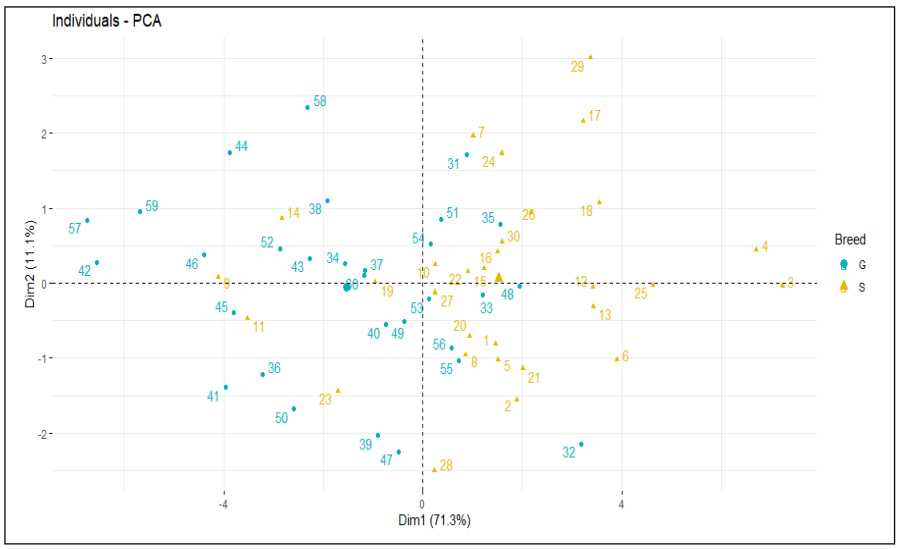


Fig 4: Principal component analysis (PCA): Scatterplot of individuals.

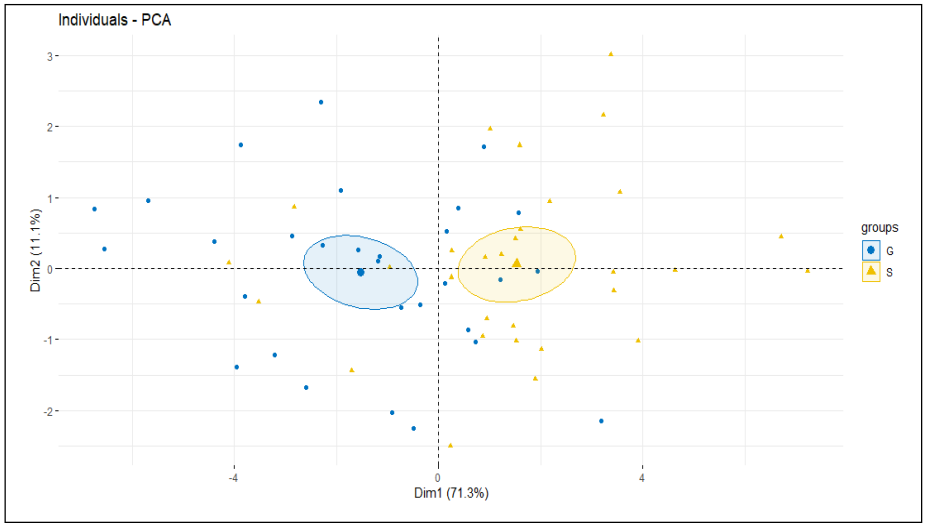


Fig 5: Principal component analysis (PCA): 95% confidence ellipsis for each breed.

Fig 5 shows disjoint confidence ellipses for the two breeds, indicating clear segregation based on biometric measurements. The average points for each breed are in significantly different positions on the first factorial plane. The center of gravity for Setifien males is significantly greater than 0, whereas that for Guelmoise males is significantly less than 0. The ordinates of the centers of gravity for both breeds are close to 0, with the abscissa axis intersecting both ellipses.

This sample offers an interesting extension of previous research. However, it would have been valuable to include both sexes in the study, allowing for an analysis of sexual dimorphism within the population and the inclusion of females, which are highly relevant in zootechnical improvement programs. Studying both sexes would provide a deeper understanding of morphological and physiological differences, helping to refine selection strategies based on specific production goals. Furthermore, females play a critical role in reproduction and sustainable breeding and their inclusion could provide important insights into managing genetic diversity and improving breed adaptability to environmental challenges.

CONCLUSION

This morphometric study of local Algerian cattle breeds has successfully highlighted the key characteristics of the Guelmoise and Setifien breeds. The comparison between these two breeds reveals significant differences, with the Guelmoise breed being smaller in size compared to the larger Setifien breed. The Setifien breed not only surpasses the Guelmoise breed but also shows values that exceed those observed in other African rustic breeds.

The study has established a strong correlation between biometric parameters and carcass weights,

enabling accurate estimation of carcass weight from live animal measurements. The developed prediction equations are valuable tools for researchers, technicians and the meat industry, facilitating the estimation of carcass weights prior to slaughter. These tools can improve the efficiency and accuracy of meat production and supply chain management.

Moreover, this research plays a crucial role in breeding and animal improvement programs by providing insights into the morphometric characteristics of local breeds adapted to harsh environments. Leveraging these local breeds for their resilience and adaptability can significantly enhance performance in breeding projects and meat production systems.

In summary, the findings of this study not only contribute to the understanding of the morphometric traits of Algerian cattle breeds but also offer practical applications for predicting carcass weights. The integration of these insights into breeding strategies can support the development of more efficient and sustainable livestock management practices.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

All animal procedures for experiments were approved by the Committee of Experimental Animal care and handling techniques were approved by the University of Animal Care Committee.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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