Slaughter Performances, Body Composition and Carcass Traits of Indigenous Algerian Cattle "Brune de l'Atlas"

Djalel Eddine Gherissi[1], Ramzi Lamraoui[1,2], Moussa Chergui[3], Mohammed Titaouine[3,4], Djamila Chaid[5], Salima Benamara[5], Faicel Chacha[1,6], Semir Bechir Suheil Gaouar[7]

[1]Laboratory of Animal Production, Biotechnology, and Health (PABIOS), Institute of Agricultural and Veterinary Sciences. University of Souk Ahras, Souk Ahras 41000, Algeria
[2]Department of Biology of Living Organisms, faculty of Natural and Life Sciences, University of Batna 2, Batna 05110, Algeria
[3]Laboratory Diversity of Ecosystems and Dynamics of Agricultural Production Systems in Arid Zones (DEDSPAZA), University of Biskra BP 68, Biskra 07000, Algeria
[4]Laboratory of Genetics, Biotechnology and Valorization of Bio resources (LGBVB), University of Biskra PB 68, Biskra07000, Algeria
[5]Faculty of Natural and Life Sciences. University of Chadli Bendjedid, El Tarf, 36000, Algeria
[6]Biotechnology Research Center, PO E73 .NU N° 03 Constantine, Algeria
[7]Applied Genetics in Agriculture, Ecology and Public Health Laboratory, University of Tlemcen, Algeria, 13000

Keywords: *Body weight, Brune de l'Atlas, carcass, fattening, meat, slaughter performance.*

Abstract. *The present study aimed to evaluate the meat production potential of the indigenous Brune de l'Atlas cattle breed as a contribution to improving local meat production in Algeria. It investigated the slaughter performance, body composition, and carcass traits of 51 Brune de l'Atlas bulls from four distinct Algerian ecotypes, aged 16.46 ± 2.94 months, and subjected to a 128.4 ± 97 days fattening period. The assessment focused on key meat production parameters, including live weight, body composition, slaughter yield, conformation, fatness, and carcass fineness. The studied bulls exhibited an average body weight of 366.56 ± 92.56 kg, with interesting true and commercial dressing percentages at 60.11 ± 11.09% and 56.1 ± 10.04%, respectively. The study revealed the production of lean carcasses with a remarkably low proportion of body fat, reflected in a remarkably low fat index of 1.48 ± 0.76 and a body fat weight rate of 5.9 ± 3.86%. While carcass conformation and compactness indices were relatively moderate, the findings highlight the promising slaughter performance of the indigenous Algerian cattle population. These results suggest that targeted genetic, nutritional, and management improvements could further elevate the value of their butchering performance, contributing to local meat supply and potentially reducing dependency on meat imports.*

Introduction

Global meat demand is experiencing significant growth, driven by rising incomes, rapid urbanization, and population expansion (Komarek et al., 2021). This trend is particularly evident in the correlation between meat consumption and gross domestic product (GDP) as reported by Food and Agriculture Organization (FAO, 2018). In Algeria, cattle fresh meat production has shown considerable progress, increasing by 63% between 1990 and 2021, reaching approximately 146 270 tons (FAO 2019). The country's current red meat consumption averages 13.5 kg per capita annually, with domestic production reaching 530 000 tons in 2019, consisting of 60% sheep, 30% cattle, 7% goat, and 3% camel meat. To meet growing demand, Algeria supplements its domestic production with imports of approximately 50 000 tons (1.3 kg/inhabitant/year), either as frozen or refrigerated meat, or as live animals for local slaughter (Ministry of Agriculture and Rural Development: MADR, 2022).

The Algerian cattle sector relies on various breeds for meat production. Dairy breeds, primarily Montbéliard and Prim'Holstein, contribute through their male offspring used for breeding or fattening, and through culled females (Haou et al., 2022). Additionally, imported suckler breeds, such as Limousin, Charolais, Aubrac, and Blonde d'Aquitaine, along with tropical cattle from Mali and Niger, are used for fattening and slaughter (Algerian Red Meat Company: ALVIAR, 2022). However, amid this diversification, the indigenous Brune de l'Atlas cattle population has declined dramatically, dropping from 80% to 34% of the national herd between 1998 and 2015 (MADR, 2015).

This decline threatens a valuable genetic resource that has evolved to thrive in tropical environments. The Brune de l'Atlas demonstrates remarkable productivity when considering its adaptation to lower-quality forage, fertility, calving interval, heat tolerance, and resistance to parasitic and infectious diseases (Hanzen et al., 2024a, b; Ferag, 2024). These adaptive traits make it especially valuable for crossbreeding programs with imported *Bos taurus*

Corresponding author: Dr. Djalel Eddine Gherissi. Laboratory of Animal Production, Biotechnology, and Health. University of Souk Ahras, Souk Ahras, Algeria.
E-mail: d.gherissi@univ-soukahras.dz, Tel: +213 662638204, ORCID: 0000-0003-1615-1658

breeds, aiming to combine improved meat and milk production with environmental adaptation and disease resistance (Mehdid et al., 2017; Leroy et al., 2020; Rahel et al., 2020; Eulmi et al., 2023).

Currently, Algeria's national cattle population stands at 1 734 476 heads (FAO, 2023). Brune de l'Atlas, indigenous to the Atlas Mountains and spread across North Africa (Boujenane and Ouragh, 2010; Ben-Jemaa et al., 2020), comprises four distinct ecotypes: the dark gray Guelmoise adapted to forest zones, the whitish Cheurfa found in pre-forest areas, the fawn-colored Chelifian, and the blackish Sétifienne suited to more rustic conditions (National Institute for Agronomic Research of Algeria: INRAA, 2003; Rahel et al., 2017; Ben-Jemaa et al., 2018, Rahel et al., 2020). Research has revealed that these populations possess a mixed European and African ancestry, with traces of indicine genetics inherited from African ancestors (Ben-Jemaa et al., 2015).

In the modern meat market, commercial success depends on both quantitative and qualitative criteria. Markets demand well-conformed carcasses with high lean meat content, favorable muscle-to-bone ratios, and appropriate fat coverage for optimal storage and sensory qualities (Albertí et al., 2005; Blanco et al., 2020). This has led to the successful establishment of both later-maturing breeds (e.g., Charolaise, Limousine, Brahman) and early-maturing breeds (e.g., Angus, Hereford, Droughtmaster) in specific market segments with recognized quality labels (Quyen et al., 2018; Chi et al., 2023).

Currently, there is no available literature evaluating various aspects of meat production and slaughter performance of local cattle population of Brune de l'Atlas in North Africa. The primary objective of this study is to provide a comprehensive assessment of slaughter and carcass traits of beef cattle from the Algerian local population.

Fig. 1. Geographical location of Algeria and the study region (Ain Assel) within El Tarf Department (Lat: 36.767 and Lon: 8.317)

Materials and methods

Ethical statement

Studied animals were used according to the ethical principles of animal experimentation and international guidelines for animal welfare (Terrestrial Animal Health Code 2018, section 7. Art 7.5.1) and national executive decree No. 95-363 of November 11, 1995 (Algeria).

Study area

The experiment was conducted between October 2020 and December 2021 in the El Tarf department, located in the extreme northeastern region of Algeria (Lat: 36.767, Lon: 8.317) (Fig. 1). El Tarf is characterized by a semi-humid climate, with an average altitude of 287 meters above sea level. The annual rainfall averages 673 mm, ranging from a minimum of 10 mm in July to a maximum of 141 mm in November. The mean annual temperature is 23°C, with the lowest recorded temperature of 15°C in January and the highest of 32°C in August (MADR, 2021). The livestock population in the study region includes 50 408 cattle, 21 375 sheep, and 7 811 goats (MADR, 2019). This region ranks fifth in Algeria in terms of the size of its local cattle population (MADR, 2019).

Experimental animals

This study included 51 clinically normal entire male beef cattle from four ecotypes (Fig. 2 Guelmoise, Setifienne, Cheurfa, and Chélifienne) of the autochthones Atlas Brown population aged between 12 and 24 months (average of 16.46 ± 2.94 years).

The animals belonged to the same beef herd and were reared under similar breeding conditions within a semi-intensive system. They were maintained under consistent experimental conditions, accounting for factors such as age, fattening duration, husbandry conditions, livestock system, management practices, slaughter conditions, and the overall production process. To mitigate potential limitations arising from the relatively low genetic diversity within the sample population, a random sampling approach was employed to ensure the selection of unrelated experimental animals. The feeding regimen was based on the continuous distribution of a mixture consisting of barley flakes (50–65%), crushed corn (20–30%), soybean meal (10–14%), sodium bicarbonate (1.5%), appropriate vitamin supplements (5%), and natural prairie hay, all provided ad libitum, along with unrestricted water intake and preventive medical coverage. The animals belonged to four distinct coat color ecotypes (Fig. 2): black (n = 18), gray (n = 16), brown (n = 14), and white (n = 3), with respective average ages of 16.44 ± 3.38 months, 15.62 ± 2.88 months, 17.00 ± 3.42 months, and 18 ± 1.33 months. The white ecotype was particularly scarce in the region. All animals underwent a long-fed fattening period of 128.4 ± 97 days (4 to 6

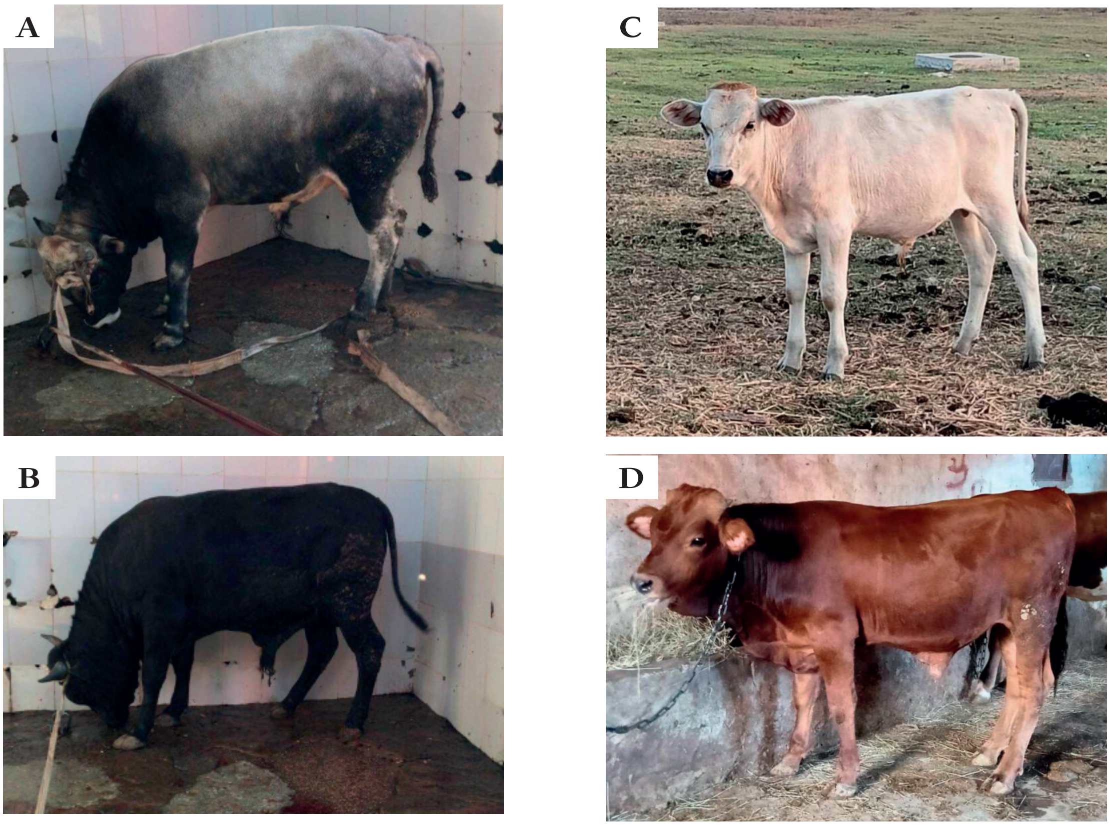

Fig. 2. Male beefs of local cattle population Atlas Brown form the Northeast Algeria (El Tarf). A: Guelmoise ecotype (gray), B: Setifienne ecotype (Black), C: Cheurfa ecotype (White), D: Chélifienne (brown).

months) (Greenwood, 2021) under a semi-intensive system. They were slaughtered for commercial meat production, with no intentional killing conducted specifically for this study. The slaughtering process took place at a licensed slaughterhouse, where the animals were given a limited resting period (1 hour) before slaughter, under the supervision of a veterinary inspector.

Methodological approach

The methodological approach adopted for this study consists of the steps outlined in Fig. 3.

The selection of the study area was based on the high concentration of local cattle, with a total population of 50 408 head, including both local and crossbred cattle (MADR, 2019). The slaughterhouse is situated within the Ain El Assel cattle market and consists of a single-block facility, which facilitated the study of the various animal components. During the identification process, data were collected regarding fattening duration, slaughter age, origin, ecotype, and sex of each animal. Prior to slaughter, the live weight of the beef cattle was recorded using an electronic scale. The animals were then bled and manually skinned. Immediately post-slaughter, the head and feet were skinned and weighed separately. The digestive tract was weighed twice: first, immediately after evisceration, including its entire contents, and second, after being emptied of its digestive contents. The carcasses were then split into two halves, with the tail positioned on the right side, and subsequently chilled at 4 ± 1°C for 24 hours. The weights of the various components of the fifth quarter were recorded. Each carcass was classified based on conformation, fatness, and fineness, following an inspection of the hot carcass and the application of beef cattle evaluation indexes.

Live/Empty Body Weight (BW)

The slaughter weight of each animal was taken within 15 minutes prior to slaughter using an electronic scale. It was considered as the live body weight (BW) with digestive tract content included. The empty body weight (EBW) was calculated by subtracting the weight of stercoral contents from the BW.

Slaughtering and fifth quarter (5^{th} Q) composition

Immediately after bleeding, the animals were skinned, and the slaughterers proceeded with evisceration. At this stage, our focus was on assessing body composition by weighing the various components of the fifth quarter (5^{th} Q). Generally, all parts of the slaughtered animal that are not classified as meat belong to the 5^{th} quarter. The red offal includes liver, lungs, spleen, kidneys, heart, tongue, snout, tail, cheeks, diaphragm, as well as white offal such as brains, sweetbreads, and gonads. These are tripe products sold raw after undergoing essential

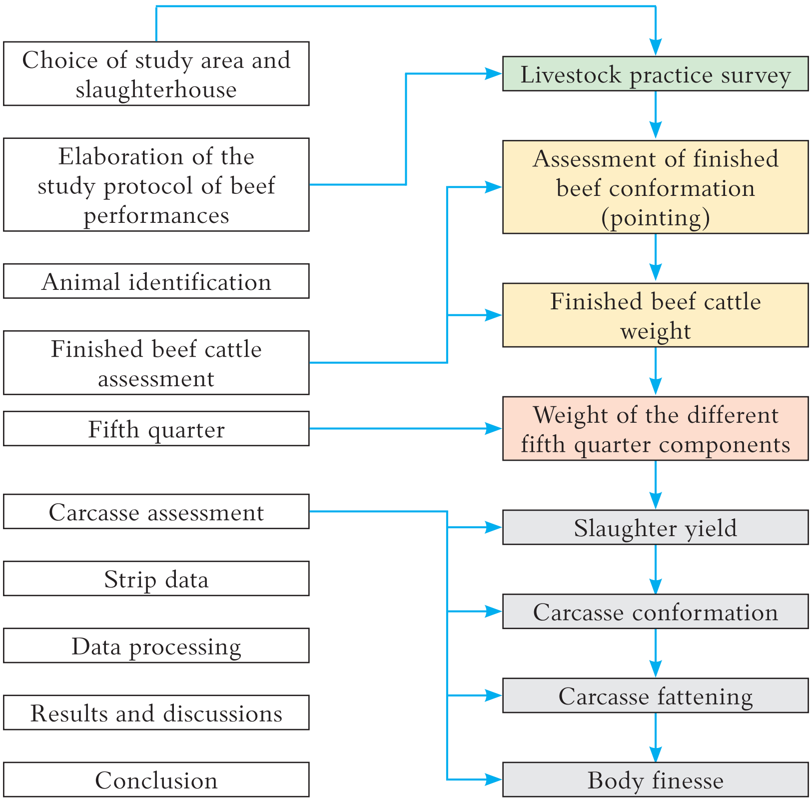

Fig. 3. Diagram showing the methodological approaches to study Atlas Brown beef cattle slaughter traits

trimming. White tripe products, such as the stomach, feet (cannons), ears, and head, require varying degrees of preparation at the slaughterhouse and are sold scalded, blanched, or even half-cooked, which gives them an ivory-white color. Blood is considered a specific co-product. Almost all skins recovered at the slaughterhouse are part of the 5^{th} Q and are processed into leather. The weight of the 5^{th} Q, excluding blood and stercoral contents, was determined as the sum of the weights of the following body parts: hooves, feet, head, leather, intestines, the empty digestive tract (rumen-reticulum-omasum-abomasum), red offal, glands, viscera, and tallow. The proportions of the 5^{th} quarter components were calculated relative to body weight (BW) to allow for standardized comparison.

Carcass weight and dressing percentage

Hot/chilled carcass weight

The weight of hot carcass (HCW) was measured immediately after the end of its preparation. It was measured on scales weight bascule. The weight of chilled carcass (CCW) was obtained after 24 hours of chilling at 4°C.

Dressing percentage

The weight of digestive content was calculated in kg by difference between the full and empty weight of the digestive tract. In fact, the empty body weight (EBW) of each animal was estimated by subtracting the weight of the contents of the digestion tract of BW. The commercial dressing percentage (CDP) and the true dressing percentage (TDP) were calculated using the following formulas (Manafiazar et al., 2016): CDP (%) = (CCW/BW) × 100; TDP (%) = (CCW/EBW) × 100.

Evaluation of carcass conformation

Conformation EUROP classification

The EU system was developed in 1981, and it was called EUROP. The conformation-EUROP grid method of carcass classification represents a visual-based assessment of muscular mass development in different regions of the carcass developed by countries involved in trading in the common European Union (EU) market (EU 1994). Conformation is classified according to a 5-level grid. Each level is represented by a letter: E – excellent; U – very good; R – good; O – fair; P – poor, transformed to ordinal scoring scale from 5 for E to 1 for P for statistical analysis (Monteils and Ellies-Oury, 2018; Nogalski et al., 2019). More comprehensive data on carcass conformation indices were applied according to previous studies (Strydom, 2000; Naves, 2003; Albertí et al., 2005; Conroy et al., 2010).

Indices of carcass conformation

Each chilled half-carcass was divided into forequarters and hindquarters (HQ) by cutting between the fifth and sixth ribs, approximately 22 cm from the spine. The forequarter included the neck, shoulder, forelegs, and five ribs. The six short ribs were removed by separating them about 22 cm from the spine, along with the abdominal muscles (Rezende et al., 2019). The plate remained attached to the forequarter, with the cut passing perpendicular to the ribs at a point below the center of the rib cage. For each animal, the hindquarter mass (HM, kg), hindquarter-to-carcass compactness (HCC, %), forequarter mass (kg), and forequarter-to-carcass compactness (FCC, %) were measured on the right side of the carcass (Rezende et al., 2019). The following carcass measurements and ratios were calculated as indicators of carcass conformation:

Hip thickness index (HTI) = HT / HL, where HT is the horizontal distance between the outermost points on the medial and lateral surfaces of the leg, and HL is the hind leg length, measured as the distance from the center of the ilio-pubic fusion of the pelvis to the distal edge of the pelvic limb (Xavier, 2022).

Carcass compactness index (CCI) = CCW / CL, where CCW is the chilled carcass weight, and CL is the distance from the anterior edge of the symphysis pubis to the middle of the anterior edge of the first visible rib (Swanepoel et al., 1990).

Buttock compactness index (BCI) = HM / HL, calculated as the ratio between hindquarter mass and hind leg length (Santos et al., 2007).

Evaluation of carcass fattening

EUROP-fatness score

The carcass fattening score (CFS) was assigned to each animal through a visual assessment of the left and right chilled half-carcasses, evaluating fat distribution on both the exterior and interior sides of the ribcage. A five-point scale (1 = low, 2 = slight, 3 = average, 4 = high, 5 = very high) was employed, in accordance with European Community regulations (EU, 1994) and the criteria outlined by Monteils and Ellies-Oury (2018). Additionally, a half-point scale was used to provide greater granularity in the ratings.

Body fat weight

This parameter evaluates the proportion of body fat in the animal's carcass. It is expressed as a percentage and calculated by dividing the body fat weight (BFW) by the hot carcass weight (HCW) (Jurie et al., 2007; Bonny et al., 2016). The BFW is determined as the sum of kidney fat (KFW), digestive tract fat (DFW), mediastinal fat (MFW, also known as red tripe fat), and cover fat (CFW). The formula used is:

BFW (kg) = KFW + DFW + MFW + CFW

BFW (%) = (BFW / HCW) × 100

Fat index

The fat index (FI %) represents the ratio KFW to CCW (Naves, 2003).

FI = (KFW / CCW) × 100

Bone slimness (body fitness)

The fitness of the carcass of each studied animal was evaluated by studying the body boniness index (BBI) (Communod et al., 2013) using the following formula:

BBI = CBC / CC

where CBC is cannon bone circumference and CC is chest circumference.

Data analysis

The SPSS software (Version 26.0, IBM Corp., 2019) was used to perform statistical analysis on the data. Descriptive statistics, including mean ± standard deviation, maximum, minimum, and variance, were calculated for the quantitative variables. Ordinal dependent variables were trans-formed into quantitative variables to ensure normality. The normality of the dependent variables was assessed using the Shapiro-Wilk test and the Kolmogorov-Smirnov test ($P > 0.05$). Pearson correlation analysis was conducted to evaluate associations between the different parameters. Furthermore, the independent samples t-test, one-way analysis of variance (ANOVA), and the Duncan post-hoc test were applied to analyze differences in means between the evaluated conformation and fattening parameters, as well as to compare mean values among the four cattle ecotypes. Statistical significance was considered at $P < 0.05$.

Results

Slaughter weight, carcass weight and slaughter yield

The descriptive parameters related to live weight, carcass weight, and slaughter yield of Algerian autochthonous beef cattle are presented in Table 1. The study sample comprised 51 animals, with an average body weight of 366.56 ± 92.68 kg, exhibiting considerable variation in body weight and carcass traits. The hot carcass weight (206.51 ± 51.95 kg) and chilled carcass weight (202.12 ± 50.89 kg) indicated an approximately 2% weight loss during the chilling process. The left and right half-carcass weights (103.51 ± 26.68 kg and 103.55 ± 26.88 kg, respectively) were notably symmetrical, demonstrating uniform carcass splitting. The dressing percentages, both commercial (56.1 ± 10.04%) and true (60.11 ± 11.09%), showed a difference of approximately 4 percentage points, reflecting the impact of empty body weight calculation on yield estimation.

Weight of the fifth quarter

Table 2 presents the weights and proportions of various fifth quarter components in Algerian autochthonous cattle. The total fifth quarter weight, excluding stercoral content, averaged 95.24 ± 41.00 kg, accounting for approximately 26% of body weight. Among the components, skin contributed the highest proportion (7.11% of body weight), followed by the empty digestive tract (6.27%), red offal (5.73%), and head (5.36%). In contrast, legs represented the smallest proportion, comprising 2.92% of body weight. The considerable standard deviations, particularly in the empty digestive tract (11.12 kg) and skin (7.10 kg), highlight substantial variation among animals in these components.

Carcass conformation

Table 3 presents the carcass conformation parameters and classification indices of Algerian Brune de l'Atlas cattle. The EUROP conformation scores (1.86 ± 1.04) indicated modest carcass conformations overall. Among the conformation indices, the carcass compactness index (CCI) and body conformation index (BCI) averaged 1.55 ± 0.37 and 0.69 ± 0.02, respectively, while the hip thickness index (HTI) was 0.34 ± 0.05. The hindquarter-to-forequarter mass ratio (HM/FM) was 1.28 ± 0.11, reflecting a significantly higher hindquarter weight ($P < 0.05$). In terms of commercial cuts, the hindquarter compactness (HCC) accounted for a larger proportion of the carcass compared to the forequarter compactness (FCC), with a difference of approximately 15 percentage points ($P < 0.05$).

Table 1. Descriptive statistics of slaughter weight, carcass weight and dressing percentage

		N	Mean	Min	Max	Variance	Std.Dev.
BW	(kg)	51	366.56	219.52	620.99	8590.91	92.68
EBW	(kg)	51	343.97	202.52	589.99	8697.66	93.26
L(1/2)CW	(kg)	51	103.51	57.00	174.00	712.01	26.68
R(1/2)CW	(kg)	51	103.55	56.00	174.00	722.61	26.88
HCW	(kg)	51	206.51	116.00	348.00	2699.13	51.95
CCW	(kg)	51	202.12	113.68	341.04	2589.71	50.89
CDP	(%)	51	56.1	29.94	72.69	100.70	10.04
TDP	(%)	51	60.11	30.86	77.73	122.88	11.09

BW: Body weight, EBW: Empty body weight, L(1/2)CW: Left chilled 1/2 carcass weight, R(1/2)CW: Right chilled 1/2 carcass weight, HCW: Hot carcass weight, CCW: Chilled carcass weight, CDP: Commercial dressing percentage, TDP: True dressing percentage.

Table 2. Descriptive statistics of the total weight of the fifth quarter and the weight of its components (Red and White tripe products)

		N	MEAN	MIN	MAX	%BW	VARIANCE	STD.DEV.
Red offal	(kg)	51	15.53	4.20	28.00	5.73	4.11	5.10
Head	(kg)	51	19.85	8.00	32.00	5.36	18.74	4.33
Legs	(kg)	51	8.45	4.00	13.00	2.92	5.21	2.28
Skin	(kg)	51	27.76	12.00	45.00	7.11	50.39	7.10
Empty digestive tract	(kg)	51	23.65	13.81	76.00	6.27	123.61	11.12
TOTAL	(kg)	51	95.24	44.00	117.00	26	25.62	41.00

Table 3. Descriptive statistics of carcass classification, carcass conformation indices

		N	MEAN	MIN	MAX	VARIANCE	STD.DEV.
Conformation-EUROP		51	1.86	1	4	1.08	1.04
HTI		51	0.34	0.26	0.48	0.002	0.05
CCI		51	1.55	0.73	2.69	0.13	0.37
BCI		51	0.69	0.62	0.74	9.85	0.02
HM/FM		51	1.28	1.13	1.34	177.65	0.11
FM	(kg)	51	47.43[a]	27	83	180.05	13.42
HM	(kg)	51	62.41[b]	37	98	244.56	15.64
FCC	(%)	51	44.54[1]	39.52	51.72	8.39	5.8
HCC	(%)	51	59.22[2]	52.3	63.16	17.75	8.42

Conformation-EUROP: carcass conformation classification. HTI: Hip thickness index, CCI: Carcass compactness index, BCI: Buttock compactness index, HM/FM: Hind/fore quarter mass ratio, FM: Forehand quarter mass, HM: Hindquarter mass, FCC: Forehand quarter to carcass mass, HCC: Hindquarter to carcass mass. Different letters between FM and HM indicate a statistically significant difference of the mean of these parameters. Different numbers between FCC and HCC indicate a statistically significant difference of the mean of these parameters.

Fattening indicators

Table 4 presents the fattening characteristics and fat distribution in Algerian autochthonous cattle. The carcass fatness score (CFS) averaged 1.85 ± 0.83, indicating a relatively lean carcass composition. This observation is further supported by the fat index (FI) of 1.48 ± 0.76%. The total body fat weight (BFW) accounted for 5.9 ± 3.86% of the chilled carcass weight, with notable variations in fat depot distribution. Among the fat depots, the digestive fat (DFW) showed the highest accumulation, followed by cavity fat (CFW) and kidney fat (KFW), with no significant difference between these three parameters ($P > 0.05$). In contrast, mesenteric fat (MFW) exhibited the lowest deposition, with a significant difference ($P < 0.05$) compared with the other fat depots.

Body fineness

The fineness level of the body and carcass of the studied beef cattle showed an average of body boniness index (BBI) of 1/8 (0.125 ± 0.02). The maximum and minimum values were 1/7 (0.14) and 1/11 (0.09).

Correlations between the different parameters

Table 5 presents the correlations between growth, slaughter, conformation, and fattening parameters in Brune de l'Atlas beef cattle. Body weight (BW) exhibited moderate positive correlations with chilled carcass weight (CCW), fifth quarter weight (5QW), and carcass compactness index (CCI) (r = 0.42–0.62; $P < 0.05$). However, BW was negatively correlated with dressing percentages (DP) and body fineness (BFI) (r = –0.45 to –0.32; $P < 0.05$), indicating that as BW increases, DP and BFI tend to decrease. Chilled carcass weight (CCW) displayed the strongest correlations among the studied parameters, with significant positive relationships observed with live weight (LW), dressing percentages (DP), fifth quarter weight (5QW), compactness index (CCI), and

Table 4. Descriptive statistics of carcass fattening score, body fat weight and fat index

		N	MEAN	MIN	MAX	VARIANCE	STD.DEV.
CFS		51	1.85	0.5	4	0.68	0.83
FI	(%)	51	1.48	0.3	6.88	1.12	0.76
KFW	(kg)	51	3.28[a]	0.5	12	6.12	2.47
DFW	(kg)	51	4.01[a]	1	12	11.94	3.46
MFW	(kg)	51	1.24[b]	0.3	11	2.22	1.49
CFW	(kg)	51	3.67[a]	1	12	9.68	3.11
BFW	(kg)	51	12.2	4	36.3	82.65	9.09
BFW	(%)	51	5.9	1.82	16.85	14.91	3.86

CFS: Carcass fattening score, FI: Fat index, KFW: Kidney fat weight, DFW: Digestive tract fat weight, MFW: Mediastinal fat weight, CFW: Cover fat weight, BFW: Body fat weight. The weights of the different CFW components were compared, and means with different superscripts are statistically different at $P < 0.05$.

Table 5. Correlations between the live weight, slaughter yield, carcass conformation, fattening level, and body fitness of the studied Brune de l'Atlas beef cattle

	CCW	BW	CDP	TDP	5thQ	HTI	CCI	KFI	BBI	CFS	EUROP
CCW	1.00	0.62*	0.47*	0.40*	0.65*	0.27	0.81*	0.19	0.14	0.45*	0.50*
BW		1.00	–0.39*	–0.45*	0.42*	–0.20	0.51*	–0.03	–0.32*	0.19	0.18
CDP			1.00	0.99*	0.25	0.56*	0.38*	0.19	0.54*	0.30	0.34*
TDP				1.00	0.24	0.60*	0.31*	0.21	0.55*	0.31	0.35*
5thQ					1.00	0.42*	0.33*	0.56*	0.12	0.62	0.68*
HTI						1.00	0.08	0.52*	0.37*	0.39	0.51*
CCI							1.00	0.02	0.06	0.32	0.35*
KFI								1.00	0.15	0.51	0.65*
BBI									1.00	–0.00	0.20
CFS										1.00	0.65*
EUROP											1.00

BW: Body weight, CCW: Chilled carcass weight, CDP: Commercial dressing percentage, TDP: True dressing percentage, 5thQ: Weight of the fifth quarter, HTI: Hip thickness indices, CCI: Compactness indices, Conformation-EUROP: carcass conformation classification, FI: Fat index, CFS: Carcass fattening score, BBI: Body boniness index. An asterisk indicates a significant correlation at $P < 0.05$.

fattening parameters (r = 0.45–0.81; $P < 0.05$). This suggests that as CCW increases, these parameters also tend to increase. Conformation parameters and fattening indices exhibited moderate to strong positive correlations (r = 0.32–0.65; $P < 0.05$), indicating parallel development during the fattening period. However, no significant correlation was found between conformation parameters and the body fineness index (BFI). These correlation patterns provide valuable insights for future genetic improvement programs in the Brune de l'Atlas population, particularly in understanding the relationships between growth, carcass characteristics, and body conformation traits.

Comparison between local cattle ecotypes

Table 6 presents a comparative analysis of the studied variables across the four ecotypes of the local cattle population. The average live weight showed no significant differences among the ecotypes ($P > 0.05$), with values ranging between 360.14 kg and 382.32 kg. Similarly, the fifth quarter weight and chilled carcass weight were not significantly influenced by ecotype ($P > 0.05$), although the Setifienne ecotype exhibited slightly higher values for both parameters compared with the others. Commercial and true slaughter yields also remained consistent across ecotypes ($P > 0.05$), with commercial yields ranging from 51.56% to 58.54% and true yields from 55.02% to 62.4%. Notably, the Setifienne ecotype demonstrated higher thigh and carcass compactness indices compared with the other groups, although these differences were not statistically significant ($P > 0.05$). The conformation-EUROP classification revealed overall low carcass conformation levels across all ecotypes, ranging between P and O categories ($P > 0.05$). However, a significant difference in fattening index (FI) was observed between the Setifienne and Cheurfa ecotypes ($P < 0.05$), with the Setifienne group exhibiting a higher fattening score. The Guelmoise and Chelifienne ecotypes showed intermediate fattening levels, whereas the fitness score remained consistently low across all groups ($P > 0.05$). Lastly, carcass fineness level (BBI) was uniform across all four ecotypes, consistently classified as 1/8 ($P > 0.05$).

Discussion

There are few reports on the slaughter and carcass characteristics of Algerian beef cattle. The fattening performance and carcass traits recorded in this study pertain specifically to young bulls of the local bovine population descended from the Algerian Brune de l'Atlas breed.

When comparing the mean slaughter weight of indigenous Brune de l'Atlas cattle (343.97 ± 93.26 kg) with that of Bos indicus indigenous African beef cattle, the weight appears to closely match that of African Zebu and Afrikaner cattle (Teye and Sunkwa, 2010). It is higher than the weights reported for Nguni, Sanga, West African Shorthorn breeds, Curraleiro Pé-Duro and Pantaneiro breeds, indigenous Ethiopian cattle, and Creole cattle, yet it is comparable to the weight of young bulls resulting from crosses with Prim'Holstein (Teye and Sunkwa, 2010; Gudeto et al., 2022; Barbosa et al., 2023; Gelaye et al., 2022), Greek Blonde indigenous cattle (Nikolaou et al., 2023), and Nelore Brazilian cattle (Barbosa et al., 2023). However, the local Algerian cattle in this study exhibit lower slaughter weights than Bonsmara from South Africa, the N'Dama breed from Congo, American Santa Gertrudis, European

Table 6. Comparison of body weight and slaughter performance and carcass traits of the four local cattle Brune de l'Atlas ecotypes

	Setifienne (n = 18)	Guelmoise (n = 16)	Chélifienne (n = 14)	Cheurfa (n = 3)
PV (kg)	370.8 ±22.48	365.09 ± 25.49	360.14 ± 23.85	382.32 ± 55.08
CCW (kg)	214.62 ± 12.08	196.49 ± 13.70	198.33 ± 12.81	173.67 ± 29.60
CDP (%)	58.54 ± 2.40	54.86 ± 2.71	55.29 ± 2.53	51.56 ± 2.85
TDP (%)	62.4 ± 2.65	59.07 ± 3.00	59.41 ± 2.81	55.02 ± 6.49
5thQ (kg)	122.86 ± 6.10	112.96 ± 6.92	118.37 ± 6.46	105.23 ± 14.96
HTI	5.37 ± 0.36	4.82 ± 0.41	4.35 ± 0.39	3.97 ± 0.90
CCI	1.61 ± 0.08	1.52 ± 0.09	1.52 ± 0.09	1.52 ± 0.21
BCI	0.72 ± 0.03	0.67 ± 0.02	0.69 ± 0.05	0.67 ± 0.03
Conformation-EUROP	2 ± 0.24	1 ± 0.27	2 ± 0.25	1 ± 0.58
FI	2.14 ± 0.23[a]	1.16 ± 0.26[a,b]	1.49 ± 0.24[a,b]	0.97 ± 0.57[b.]
CFS	2.13 ± 0.19	1.5 ± 0.21	1.88 ± 0.20	1.67 ± 0.46
BBI	1/8	1/8	1/8	1/8

BW: Body weight, CCW: Chilled carcass weight, CDP: Commercial dressing percentage, TDP: True dressing percentage, 5thQ: Weight of the fifth quarter, HTI: Hip thickness indices, CCI: Compactness indices, BCI: Buttock compactness Index, Conformation-EUROP: carcass conformation classification, FI: Fat index, CFS: Carcass fattening score, BBI: Body boniness index. Values in the same row with different letters are statistically different ($P < 0.05$).

Pinzgauer, and Brown Swiss breeds (Strydom, 2000; Silvere et al., 2023). These differences may arise from various factors, including age, sex, type or breed of cattle used in each study, as well as differences in general management practices and the ecology of the respective regions.

In Algeria, previous studies have reported that live body weight varied between 250 and 350 kg (Aissaoui et al., 2003). However, Bouzebda Afri et al. (2007) recorded relatively higher mean live weights using barymetric formulas. These differences among Algerian studies highlight the direct and indirect effects of factors such as nutrition, age, cattle conformation, and husbandry practices. In particular, our study involved four ecotypes of the native Algerian Brune de l'Atlas cattle, all belonging to the same herd with specific husbandry and management conditions. The high variance observed in live body weight suggests strong potential for production improvement within this population, which has historically never undergone selection. Slaughter weight is a crucial indicator of calf growth, primarily dependent on dam milk production and, secondarily, on forage quality, with intake increasing significantly after three months of age (Handcock et al., 2021; Gherissi et al., 2013). In this study, measuring slaughter weight provided essential data for subsequent post-slaughter estimations, including dressing percentage, fifth-quarter proportion, carcass conformation, fattening level, and the proportion of first-class meat cuts.

The empty live weight recorded in this study ranged from 202.52 kg to 589.99 kg, emphasizing the need for selection based on this quantitative trait as part of a genetic improvement strategy for beef performance. Additionally, environmental factors such as temperature, humidity, rearing conditions, low nutrient availability, and parasitism can contribute to variations in live body weight at slaughter (Yüksel et al., 2019; Soulat et al., 2019).

The mean hot carcass weight (HCW) was 206.51 ± 51.95 kg, which was higher than that reported for indigenous African breeds such as Afrikaner and Nguni but lower than the values recorded for other African and Spanish rustic young-bull breeds (Strydom, 2000; Albertí et al., 2005). Compared with Algerian cattle from the same population and Central African N'Dama and Zebu cattle, the HCW in our study was similar to previously reported values (Bouzebda Afri et al., 2007; Silvere et al., 2023). Low meat production per cow in these systems can be attributed to several factors. Firstly, calves are primarily fed high-fiber, low-quality forages with minimal grain supplementation, leading to inadequate nutrient intake for optimal growth. Secondly, due to economic pressures, farmers often sell animals at a young age, preventing them from reaching their genetic potential in terms of live weight (Ben Salem and Khemiri, 2008). Finally, the absence of systematic selection in autochthonous breeds further contributes to the observed limitations in meat production.

The average true dressing percentage (TDP) recorded in this study was 60.11 ± 11.09%, which is notably high compared with previous findings in the same cattle population (Bouzebda Afri et al., 2007). This discrepancy may be attributed to differences in assessment techniques, such as the determination of live weight using barymetric formulas, the heterogeneity of the studied animals in terms of sex, age, and fattening period, as well as variations in the method of estimating carcass yield (true dressing vs. commercial dressing). Specifically, the commercial dressing percentage in our study was estimated at 56%, a value comparable to those reported by Bouzebda Afri et al. (2007) and Gherissi et al. (2013). When compared with other indigenous tropical cattle populations, the true dressing percentage of the studied animals closely aligns with that of Creole cattle and their crossbreeds with the Prim'Holstein breed (Naves, 1985), as well as indigenous African cattle breeds (48.6–58.7%). However, it is lower than that recorded in African suckler breeds (Strydom, 2000) but higher than values reported for Zebu and N'Dama Taurine cattle (Silvere et al., 2023). The dressing percentage for tropical local cattle breeds typically ranges between 50% and 65%, depending on factors such as breed characteristics and management practices. Some local cattle breeds have a higher bone proportion, lower muscle development, or higher fat deposition compared with specialized beef breeds, which can influence dressing percentage. The observed trend in dressing percentages supports the general pattern that heavier animals tend to exhibit higher dressing percentages.

The mean weight of the fifth quarter, excluding blood and stercoral content, was 95.24 ± 41 kg, representing approximately 26% of live weight. The individual components included red offal (heart, liver, lungs, spleen, and kidneys) at 15.53 ± 5.10 kg, the empty digestive tract at 23.65 ± 6.10 kg, the head at 19.85 ± 4.33 kg, the legs at 8.45 ± 2.28 kg, and the skin at 27.76 ± 7.10 kg. Notably, the weight of red offal in our study exceeded the values reported for tropical beef cattle breeds (4.47 to 6.49 kg), as did the weights of the skin (4.84 to 7.93 kg) and the digestive tract (4.56 to 7.41 kg) (Teye and Sunkwa, 2010). Similar weight distributions were observed for the remaining fifth quarter components. Additionally, comparable fifth quarter proportions have been reported for Bonsmara beef cattle, though they tend to be slightly lower in other African indigenous breeds (Strydom, 2000). At present, no studies have specifically examined the variability of these parameters within the indigenous North African Brune de l'Atlas cattle population, highlighting the need for further research in this area.

Carcass conformation refers to the physical shape, size, and muscling of a beef carcass, making it a key trait in determining meat quality and market value.

In this study, conformation was assessed using a combination of calculated indices and visual muscle evaluations. The mean values for hip thickness index (HTI), carcass compactness index (CCI), and buttock compactness index were 0.34 ± 0.05, 1.55 ± 0.37, and 0.69 ± 0.08, respectively. These parameters indicate the relationship between muscle mass and skeletal size. The CCI observed in the studied animals closely resembles that of male Creole indigenous cattle (1.51) as reported by Naves (1985). However, it is higher than the values recorded in indigenous African cattle breeds, which range between 0.74 and 1.02 (Strydom, 2000). A higher CCI suggests a more compact and muscular carcass, while a lower value indicates a less compact carcass with relatively more skeletal structure. The HTI of the animals studied was found to be higher than that reported for the Creole breed (0.283) by Naves (1985).

Despite these moderate values, the carcass conformation of the studied animals remains relatively underdeveloped, with an average conformation score of 1.86, corresponding to class O on the EUROP conformation grid. This conformation level is comparable to that observed in Buffalo species (Nikolaou et al., 2023) and reflects a moderate muscle development with straight to concave profiles. In contrast, higher conformation levels were reported by Alberti et al. (2010) in Spanish beef breeds, which were classified as R on the EUROP grid. Given that high-priced cuts in beef cattle are primarily derived from the hindquarters, the proportion of hindquarters in the studied carcasses was 59.22 ± 8.42% of total carcass weight, leading to a hindquarter-to-forequarter ratio of 1.28 ± 0.11. This ratio is superior to the values reported by Naves (1985) and Teye and Sunkwa (2010), which were 47.7% and 46.3%, respectively, but lower than those obtained in African Bonsmara-crossbred cattle (Slabbert et al., 1992). Naves (1985) observed that in male Creole cattle and other tropical beef breeds, the forequarter tends to be more developed than the hindquarter, leading to an imbalance in carcass distribution. This phenomenon is often linked to anatomical traits, such as an excessively developed hump on the forequarters of certain tropical breeds, affecting overall carcass balance.

The Brune de l'Atlas cattle are recognized as a rustic North African breed, primarily valued for their resilience, adaptability to harsh environmental conditions, and ability to thrive with limited nutritional resources. They have not been subjected to intensive selection for meat production or specific carcass traits, which contributes to the variability observed in carcass conformation. The differences in conformation indices and overall carcass traits can be attributed to genetic factors, breed characteristics, age, nutrition, management practices, and environmental influences. Farmers and breeders often refer to breed-specific standards when selecting animals with desirable hip thickness indices for breeding or marketing purposes, highlighting the importance of targeted selection strategies to improve carcass traits in this local cattle population.

On the other hand, the studied cattle exhibited an average low fattening status score of 1.85 ± 0.83, i.e., carcasses with a light cover of fat and muscles that were visible almost everywhere. Within the thoracic cavity, muscle tissue was clearly visible between the ribs. Compared with other cattle populations, a similar fattening state was observed in Spanish beef breeds, particularly in young bulls with low commercial weight (Alberti et al., 2010). These results were supported by the mean body fat weight, which was 12.20 ± 9.09 kg, and an average fat index (FI) of 1.48 ± 0.76. Similar results were reported for the Creole breed. In the samples studied by Guillaume (2006) on the Prim'Holstein and Charolais breeds, 22% of the carcasses were considered too fat (classified as 4) in the first breed, and only 4.3% in the second. These carcasses came from animals slaughtered at 387.5 kg for young Prim'Holstein cattle and 437 kg for Charolais bulls. Our results showed a low ability to store energy reserves, which was dependent on low slaughter and carcass weights. Moreover, the early development of body fat, which generally increases at low carcass weight, necessitates slaughter at low body weight to avoid excessive fat deposition on the carcass.

Regarding carcass quality, this low-fat deposit could be an advantage, as it is possible to seek higher slaughter weights without risking excessive and early fattening, since the local market demands light to medium carcasses. However, consideration must also be given to the complex interaction of multiple factors affecting carcass fattening variability, and their relative importance varies depending on the specific production system, breed, and environmental conditions (Yüksel et al., 2019; Soulat et al., 2019). Producers and feedlot operators often strive to manage these factors to optimize carcass quality, consistency, and marketability (Soulat et al., 2019). It is important to note that while there are breed standards and guidelines for desirable carcass conformation and fattening levels, there is inherent variability within any beef cattle population. This variation allows for genetic diversity and the potential for improvement through selective breeding programs (Barro et al., 2023; Mamede et al., 2023). Additionally, consumer preferences and market demands may influence the perceived value of different carcass conformations and fattening levels, resulting in variations in desirability depending on the specific market or final use of the meat.

The muscular development of beef cattle refers to the growth and distribution of muscle throughout the animal's body. Cattle with adequate muscling typically have a higher muscle-to-bone ratio and exhibit strong muscle definition in areas such as the hindquarters and loin. Low overall body and carcass fitness, with high variance in these parameters, was observed in the studied cattle population. Achieving optimal carcass fitness requires genetic selection, appropriate nutrition, proper management practices, and adherence to industry standards and grading systems. The specific criteria for carcass fitness may vary depending on regional preferences, breed characteristics, and market demands. Producers and processors aim to raise and select cattle that consistently yield carcasses meeting the desired fitness criteria for their target markets. Frame size is another important parameter for evaluating conformation and the fitness of beef cattle, and it has the potential to be used as a criterion in the selection of precocious beef cattle (Barro et al., 2023).

The carcass characteristics, particularly carcass weight and conformation, exhibited rather modest meat traits in the local Algerian cattle population, which has never been subjected to a structured selection program for the genetic improvement of meat production performance. Recent studies have shown that yearling weight, visual scores of body structure, muscularity, precocity, fattening, and carcass conformation traits have moderate to high heritability (Barro et al., 2023; Mamede et al., 2023), with significant genetic correlations between body weight (BW) at slaughter and carcass quality and meat traits (Albertí et al., 2005). Thus, the high variance observed in most of the studied parameters explains the heterogeneity of individuals in the local cattle population, which suggests that a selection program could be implemented to improve the economic value of bulls. It is also important to point out the established positive linear correlations between body weight and carcass weight, fifth quarter weight, and carcass conformation, as well as the negative correlation with slaughter yield and body fitness.

Conclusion

The Brune de l'Atlas cattle demonstrated heterogeneous yet promising meat production traits at a mean slaughter age of 16 months, characterized by satisfactory carcass weights, good conformation, high slaughter yields, and notably lean carcasses with low fat deposition. These findings support the potential of this local breed as a valuable source of red meat production in its pure form. To optimize the breed's meat production potential, we recommend implementing a systematic performance monitoring system for finished animals, including both pre-slaughter evaluations and detailed carcass assessments. This data-driven approach would facilitate targeted genetic improvement programs aimed at enhancing meat production traits. Additionally, strategic cross-breeding programs utilizing these local cattle could leverage heterosis effects to further improve carcass weights and conformation scores while maintaining the breed's valuable adaptation traits.

Acknowledgement

The authors would like to express their gratitude to the personnel of Cereals and Pulses Cooperative for the technical assistance in animals' live weighting using agreed electronic scale.

References

1. Aissaoui C., Benakhla A., Aouadi H. Caractérisation du bovin race locale dans l'Est algérien : Etude biométrique et structurale du troupeau. Rencontres Recherches Ruminants. 2003. 10: 111. http://www.journees3r.fr/IMG/pdf/systemes_21_Aissaoui.pdf
2. Albertí P., Ripoll G., Goyache F., Lahoz F., Olleta J.L., Panea B., Sañudo C. Carcass characterisation of seven Spanish beef breeds slaughtered at two commercial weights. Meat Science. 2005. 71: 514–521. https://doi.org/10.1016/j.meatsci.2005.04.033
3. ALVIAR. Algérienne des viandes rouges (ALVIAR): Viande rouge: l'importation pour casser les prix, by Lynda Louifi. Jeune Indépendant. 2022. https://www.jeune-independant.net/viande-rouge-limportation-pour-casser-les-prix/
4. Barbosa M.D.C.P., Fioravanti M.C.S., Peripolli V., do Egito A.A., Juliano R.S., Ramos A.F., Cardoso D., Laudares K.M., Feijó G.L.D., Prado C.S., Júnior R.G.V., de Oliveira N.A., de Paula Rezende P.L., Restle J., Costa G.L., Costa M.F.O.E., McManus C. Performance, carcass, and meat traits of locally adapted Brazilian cattle breeds under feedlot conditions. Tropical Animal Health and Production. 2023. 55(4): 243. DOI: 10.1007/s11250-023-03656-7
5. Barro A.G., Marestone B.S., dos Santos E.R., Ferreira G.A., Vero J.G., Terto D.K., de Sousa Muniz C.A., Bridi A.M. Genetic parameters for frame size and carcass traits in Nellore cattle. Tropical Animal Health and Production. 2023. 55: 71. https://doi.org/10.1007/s11250-023-03464-z
6. Ben Salem M., Khemiri H. The impact of agricultural projects on cows' productivity, farmers' revenue, and rural development in Tunisia. Livestock Research for Rural Development. 2008. 20(5). https://www.lrrd.cipav.org.co/lrrd20/5/cont2005.htm
7. Ben-Jemaa S., Boussaha M., Ben Mehdi M., Lee J.H., Lee S.H. Genome-wide insights into population structure and genetic history of Tunisian local cattle using the illumina bovines np50 beadchip. BMC Genomics. 2015. 16(1): 677. DOI: 10.1186/s12864-015-1638-6
8. Ben-Jemaa S., Mastrangelo S., Lee S.-H., Lee J.H., Boussaha M. Genome-wide scan for selection signatures reveals novel insights into the adaptive capacity in local North African cattle. Scientific Reports. 2020. 10(1): 1–14. DOI: 10.1038/s41598-020-76576-3
9. Blanco M., Ripoll G., Delavaud C., Casasús I. Performance, carcass, and meat quality of young bulls, steers, and heifers slaughtered at a common body weight. Livestock Science. 2020. 240: 104156. https://doi.org/10.1016/j.livsci.2020.104156
10. Bonny S.P.F., Pethick D.W., Legrand I., Wierzbicki J., Allen P., Farmer L.J., Polkinghorne R.J., Hocquette J.F., Gardner G.E. European conformation and fat scores have no relationship with eating quality. Animal. 2016. 10: 996–1006. https://doi.org/10.1017/S1751731115002839
11. Boujenane I., Ouragh L Genetic analysis of native Moroccan cattle.. Livestock Research for Rural Development. 2010. 22(8). http://www.lrrd.org/lrrd22/8/bouj22154.htm
12. Bouzebda-Afri F., Bouzebda Z., Bairi A., Franck M. Etude des performances bouchères dans la population bovine locale dans l'est algérien. Journal of Chemical Technology and Biotechnology. 2007. 26: 89-97.
13. Chi N.T.K., Hue P.T., Hanh T.Q., Ngoan L.D. Carcass characteristics and meat quality of crossbred (Brahman × Lai Sind) and (Red Angus × Lai Sind) bulls kept in small-scale farms. Online Journal of Animal Feed Research. 2023. 13(3): 153-161. DOI: https://dx.doi.org/10.51227/ojafr.2023.24

14. Communod R., Guida S., Vigo D., Beretti V., Munari E., Colombani C., Superchi P., Sabbioni A. Body measures and milk production, milk fat globules granulometry, and milk fatty acid content in Cabannina cattle breed. Italian Journal of Animal Science. 2013. 12(1): e18. DOI: 10.4081/ijas.2013.e18
15. Conroy S.B., Drennan M.J., Kenny D.A., McGee M. The relationship of various muscular and skeletal scores and ultrasound measurements in the live animal, and carcass classification scores with carcass composition and value of bulls. Livestock Science. 2010. 127: 11-21. https://doi.org/10.1016/j.livsci.2009.06.007
16. EU. Grille communautaire de classement des carcasses de gros bovins. European Union Publications. 1994. CM-84-94-711-FR-D. Released on October 26, 1994.
17. Eulmi H., Deghnouche K., Gherissi D.E. Dairy cattle breeding practices, production, and constraints in arid and semi-arid Algerian bioclimatic environments. International Journal of Environmental Studies. 2023. https://doi.org/10.1080/00207233.2023.2228616
18. FAO. Food and Agriculture Organizations of the United Nations Statistics (FAOSTAT). 2023. http://www.fao.org/faostat/en/#data/QL
19. FAO. Food and Agriculture Organizations of the United Nations Statistics (FAOSTAT). Regional FAO data list. 2019. http://www.fao.org/faostat/en/#data/QL
20. FAO. The future of food and agriculture: Alternative pathways to 2050. Summary Version. Rome. 2018. 60 pp.
21. Ferag, A., Gherissi, D.E., Khenenou, T., Boughanem, A., Moussa, H.H., Maamour, A. 2024. Reproduction efficiency of native and imported Algerian cattle under challenging climatic conditions. Biology and Life Sciences Forum. 2024, 36, 13. https://doi.org/10.3390/blsf2024036013
22. Gelaye G., Baye M., Masho W., Begna R., Admasu Z. Morphometric traits and structural indices of indigenous cattle reared in Bench Sheko zone, southwestern Ethiopia. Heliyon. 2022. 8(8): e10188. DOI: https://doi.org/10.1016/j.heliyon.2022.e10188
23. Gherissi D.E., Bouzebda Z., Afri-Bouzebda F. Comparison of performance in slaughtering fattening calves from the local population and the Prim'Holstein breed. 11th international seminar on veterinary science: Animal genetic resources in Algeria. 2013. National Veterinary School of Algiers, P36. https://www.ensv.dz/wp-content/uploads/2016/01/recueil_resume_JISV11.pdf
24. Greenwood P.L. Review: An overview of beef production from pasture and feedlot globally, as demand for beef and the need for sustainable practices increase. Animal. 2021. 15, Supp1. https://doi.org/10.1016/j.animal.2021.100295
25. Gudeto A., Aredo T.A., Mirkena T., Banerjee S. Structural traits, structural indices, and body weight prediction of Arsi cows. NASS Journal of Agricultural Sciences. 2022. 4(1): 33-40. http://www.gjasr.com/index.php/GJASR/article/view/81/74
26. Hanzen C., Delhez P., Knapp E., Hornick J.-L., Gherissi D.E. Le stress thermique environnemental dans l'espèce bovine : 1. Caractéristiques générales et méthodes d'évaluation. Revue d'élevage et de médecine vétérinaire des Pays Tropicaux. 2024. 77. 1–8. https://doi.org/10.19182/remvt.37379
27. Hanzen C., Delhez P., Hornick J.-L., Lessire F., Gherissi D.E. Le stress thermique environnemental dans l'espèce bovine : 2. effets physiologiques, pathologiques, comportementaux, alimentaires, immunitaires et sur la production laitière. Revue d'élevage et de médecine vétérinaire des Pays Tropicaux. 2024b. 77. 1-13. https://doi.org/10.19182/remvt.37380
28. Haou A., Miroud K., Gherissi D.E. Impact des caractéristiques du troupeau et des pratiques d'élevage sur les performances de reproduction des vaches laitières au nord-est algérien. Revue d'élevage et de médecine vétérinaire des pays tropicaux. 2021. 74. 4. 183-191. DOI: https://doi.org/10.19182/remvt.36798
29. Handcock R.C., Lopez-Villalobos N., Back P.J., Hickson R.E., McNaughton L.R. Growth, milk production, reproductive performance, and stayability of dairy heifers born from 2-year-old or mixed-age dams. Journal of Dairy Science. 2021. 104(11): 11738-11746. https://doi.org/10.3168/jds.2021-20354
30. INRAA. Rapport National sur les Ressources Génétiques Animales: Algérie. Institut National de la Recherche Agronomique d'Algérie, Alger. 2003. 45 p.
31. Jurie C., Picard B., Hocquette J.-F., Dransfield E., Micol D., Listrat A. Muscle and meat quality characteristics of Holstein and Salers cull cows. Meat Science. 2007. 77(4): 459-466. https://doi.org/10.1016/j.meatsci.2007.04.014
32. Leroy F., Cofnas N. Should dietary guidelines recommend low red meat intake? Critical Reviews in Food Science and Nutrition. 202
33. MADR. Mise en place d'un plan d'action du gouvernement 2022-2024. Ministère de l'Agriculture et du Développement Rural. 2022. https://agri-info.inva.dz/wp-content/uploads/2022/01/FEUILLE-DE-ROUTE-2020-2024.pdf
34. MADR. Statistique Agricole: Superficies et Productions. Serie B 2016. Ministère de l'Agriculture et du Développement Rural. 2019.
35. Mamede M.M.S., Rosa G.J.M., Eifert E.C., Lopes F.B., Baldi F., Costa M.F., Sainz R.D., Carmo A.S., Mascioli A.S., Magnabosco C.U. Estimating genetic parameters of reproductive, carcass, and meat quality traits in Polled Nellore cattle. Tropical Animal Health and Production. 2023. 55. 119. https://doi.org/10.1007/s11250-023-03541-3
36. Manafiazar G., Mohsenourazary A., Afsharihamidi B., Mahmoodi B. Comparison carcass traits of Azeri buffalo, native and crossbred (native × Holstein) male calves in west Azerbaijan-Iran. Italian Journal of Animal Science. 2007. 6. 1167-1170. DOI: 10.4081/ijas.2007.s2.1167
37. Mehdid B., Benyarou M., AmeurAmeur A., Gaouar S.B.S. Contribution to the study of two local bovine breeds in wilaya of Tlemcen: morphometric characterization and DNA Biobank. Genetics and Biodiversity Journal. 2018. 2. 48-59. https://journals.univ-tlemcen.dz/GABJ/index.php/GABJ/article/view/114/79
38. Monteils V., Ellies-Oury M.P. La chaîne de la viande bovine: production, transformation, valorization et consommation. "Critères de qualité recherchés: classement des carcasses et évolution". Sciences & Techniques Agroalimentaires. Lavoisier, Paris. 2018. 10. 165-175.
39. Naves M. Caractérisation et gestion d'une population bovine locale de la zone tropicale: le bovin Créole de Guadeloupe. PhD thesis. INA Paris Grignon. 2003.
40. Nikolaou K., Koutsouli P., Laliotis G.P., Papachristou D., Bizelis I. Comparative analysis of buffalo, local and continental cattle carcasses with the European Union classification system in Greece. Meat Science. 2023. 195. 109018. DOI: https://doi.org/10.1016/j.meatsci.2022.109018
41. Nogalski Z., Pogorzelska-Przybyłek P., Sobczuk-Szul M., Purwin C. The effect of carcase conformation and fat cover scores (EUROP system) on the quality of meat from young bulls. Italian Journal of Animal Science. 2019. 18. 615-620. DOI: https://doi.org/10.1080/1828051X.2018.1549513
42. Quyen P.V., Cam T.T., Hieu L.T.M., Sal G.V., Hung B.N. Performance of F1 (Red Angus × Lai Sind) and F1 (Brahman × Lai Sind) crossbred beef cattle in Tay Ninh province. Journal of Animal Science and Technology. 2018. 86. 19-34.
43. Rahal O., Aissaoui C., Ata N., Yilmaz O., Cemal I., AmeurAmeur A., Gaouar S.B.S. Genetic characterization of four Algerian cattle breeds using microsatellite markers. Animal Biotechnology. 2020. 32. 699-707. DOI: https://doi.org/10.1080/10495398.2020.1746321
44. Rahal O., Aissaoui C., Elmokhefi M., Sahraoui H., Ciani E., Gaouar S.B.S. A comprehensive characterization of Guelmoise, a native cattle breed from eastern Algeria. Genetics and Biodiversity Journal. 2021. 1. 30-42. https://journals.univ-tlemcen.dz/GABJ/index.php/GABJ/article/view/83
45. Rezende P.L.D.P., Restle J., Bilego U.O., Fernandes J.J.D.R., Missio R.L., Guimarães T.P. Carcass characteristics of feedlot-finished Nellore heifers slaughtered at different weights. Acta Scientiarum Animal Sciences. 2019. 41. e44826. DOI: https://doi.org/10.4025/actascianimsci.v41i1.44826
46. Santos V.A.C., Silva A.O., Cardoso J.V.F., Silvestre A.J.D., Silva S.R., Martins C., Azevedo J.M.T. Genotype and sex effects on carcass and meat quality of suckling kids protected by the PGI "Cabrito de Barrosa". Meat Science. 2007. 75. 725-736. DOI: https://doi.org/10.1016/j.meatsci.2006.10.003

47. Silvere D.N., Lucien M., Gaël Stève A., Paul M., Parisse A. Evaluation of cattle slaughtering efficiency at the M'pila slaughterhouse in Brazzaville (Republic of Congo). Scholars Academic Journal of Biosciences. 2023. 11. 171-180. DOI: 10.36347/sajb.2023.v11i05.002
48. Slabbert N., Campher J.P., Shelby T., Leeuw K.-J., Kohn G.P., Meissner H.H. The influence of dietary energy concentration and feed intake level on feedlot steers. South African Journal of Animal Science. 1992. 22. 107-114. https://www.ajol.info/index.php/sajas/article/view/138631/128260
49. Soulat J., Monteils V., Léger S., Picard B. Identification of key rearing factors to manage cattle carcass fatness and conformation scores during the fattening period. Italian Journal of Animal Science. 2019. 18. 1192-1204. DOI: 10.1080/1828051X.2019.1632750
50. Strydom P.E., Naude R.T., Smith M.F., Scholtz M.M., Van Wyk J.B. Characterisation of indigenous African cattle breeds in relation to meat quality traits. Meat Science. 2000. 55. 79-88. DOI: https://doi.org/10.1016/s0309-1740(99)00128-x
51. Swanepoel J., Casey N.H., de Bruyn F.J., Naude R.T. Meat studies of indigenous southern African cattle. I. Growth performance and carcass characteristics of Afrikaner, Nguni and Pedi bulls fed intensively. South African Journal of Animal Science. 1990. 20. 180-187. https://www.ajol.info/index.php/sajas/article/view/138894
52. Teye G.A., Sunkwa W.K. Carcass characteristics of tropical beef cattle breeds (West African Shorthorn, Sanga and Zebu) in Ghana. African Journal of Food, Agriculture, Nutrition and Development. 2010. 10. 2866-2883. DOI: https://doi.org/10.4314/ajfand.v10i7.59041
53. Xavier C. Estimation fine des compositions du corps vide et de la carcasse du bovin par imagerie en trois dimensions (3D) et absorptiométrie bi-photonique à rayons X (DXA). Unité de recherche : UMR Physiologie, Environnement et Génétique pour l'Animal et les Systèmes d'Élevage (PEGASE). L'institut Agro Rennes-Angers, Campus de Rennes. 2022.
54. Yüksel S., Karaçuhalılar A., Yüksel F., Balta B. Effects of housing condition, feeding style and age on meat color, and some carcass characteristics in eastern Anatolian red bulls. Turkish Journal of Agriculture - Food Science and Technology. 2019. 7. 750-756. DOI: https://doi.org/10.24925/turjaf.v7i5.750-756.2401