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Prediction of Sheep Carcass Yield using Combinations of Ante-mortem and Post-mortem Measurements

Hind Houssou[1], Samia Djeffal[2], Douai Djebbari[1]

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ABSTRACT

Background: Various factors affect meat production of the sheep, such as feed, live weight at slaughter and genotype. The aim of this research was to provide information on relationship between ante-mortem and post-mortem measurements of sheep as a selection criterion in two breeds.

Methods: This study was carried out on 151 male sheep (rams) belonged to Ouled Djellal breed (n=118) and Hamra breed (n=33) between March and June of 2023 at the municipal slaughterhouse in the wilaya of Tebessa. The animals were older than 12 months (adult individuals).

Result: The data revealed that before slaughter of the Ouled Djellal rams had significantly higher body weight (68.31±11.14 versus 61.83±5.04 kg), compared to Hamra breed. There were significant differences in the following ante-mortem traits between two breeds: heart girth, scapular-ischial length and dactyl-thoracic index among the breed (P<0.05). After slaughter, the carcass weight (34.96±7.82 kg versus 30.53±4.33 kg) and the carcass yield (51.51 versus 49.15) were significantly higher (P<0.05) in Djellal than in Hamra breed. Therefore, the sheep of the Ouled Djellal breed were the heaviest; they had wider chest and longer carcass. However, the carcass conformation was better in Hamra breed (P<0.05). In conclusion, this study confirmed that sheep breed affects carcass conformation and suggested the ways of improving these breeds whose qualities of adaptability are no longer to be demonstrated.

Key words: Breeds, Carcass, Meat, Sheep.

INTRODUCTION

The Algerian sheep herd, increased from 5 million heads at the dawn of Independence (in 1962) to more than 31 million in 2021 (MADR, 2022), of which 61% (19 million heads) are breeding ewes. Indeed, the sheep is one of the few animal species able to survive and produce in the environments of our country such as the steppe, the highlands and the desert (Hadbaoui *et al.,* 2020). The Algerian sheep population is characterized by the presence of several breeds including, the Ouled Djellal (OD) breed (also called "White") remains the dominant sheep breed in Algeria (60% of total sheep) with its particular specificities; it is an autochthonous breed (Dehimi *et al.,* 2014). The consumption of sheep meat which greatly exceeds beef and knowing that quality is the main objective of fattening livestock. Therefore, the value of a carcass is determined from its conformation which constitutes, with other factors such as live weight and fattening, one of the main elements of the commercial value of sheep, considered as a very important criterion.

The assessment of carcass quality by utilizing carcass classification systems might have an important contribution to ensure consumers that the meat is in accordance with the official standards (Dlamini *et al.,* 2020). The EUROP classification system is based on visual assessment of carcass conformation and fatness (Johansen *et al.,* 2006). Ovine carcasses are classified by using EUROP carcass classification system according to the Commission regulation No 461/93 (Commission Regulation, 1993). Two different schemes are used for lamb classification in the EUROP system, one for carcasses above 13 kg and the other for carcasses under this weight (Sañudo *et al.,* 2000; Ekiz *et al.,* 2021).

The ability to estimate the live weight and carcass weight of an animal during its growth, its productive life and then its fattening is of great help to the breeder and the zootechnician. It makes it possible, to measure the effectiveness of breeding but can also guide the farmer in his choice of breeding stock according to his production objectives. Improving the productivity of sheep breeds or maintaining genetic diversity can allow farmers to select animals or create new breeds to cope with environmental changes. Traditionally, it is believed that the meat of Hamra

[1]Laboratory of Science and Techniques of the Living, Department of the Veterinary Sciences, Institute of Agronomy and Veterinary Sciences, University of Souk-Ahras, 41000, Algeria.
[2]Laboratory of Management of Animal Health and Productions, Institute of Veterinary Sciences, University Constantine-1 25000, Algeria.

Corresponding Author: Hind Houssou, Laboratory of Science and Techniques of the Living, Department of the Veterinary Sciences, Institute of Agronomy and Veterinary Sciences, University of Souk-Ahras, 41000, Algeria. Email: houssouhind@yahoo.fr

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lambs is better tasting than the meat of the other breeds. The present study aims to describe the potential of use of body measurements to predict carcass weight and provided a new insight into the effect of breed meat traits of Ouled Djellal and Hamra sheep breeds.

MATERIALS AND METHODS

Description of the study area

The test was conducted in the wilaya Tebessa located in the northeast of Algeria (35°20′ N, 8°6′E, Altitude: 960 m). Its area is about 13878 km^2, near the Tunisian border. The wilaya of Tebessa is distinguished by four bioclimatic stages: The sub-humid, the semi-arid, the sub-arid and the arid or mild Saharan (Houssou *et al.,* 2023). The dominant plant species in this wilaya are Artemisia cereals and derivatives, *Herba alba*, *Stipa tenacissima*, *Rosmarinus tournefortii* and *Retama sphaerocarpa*.

Ethical statement

The animals used in this study had their origin on semi-arid farms with a traditional management system. They were intended for the production of milk and meat for human consumption. These animals were submitted to practices standardized and regulated by international guidelines for animal welfare (Terrestrial Animal Health Code 2018, section 7. Art 7.1) and national executive decree No. 95-363 of November 11, 1995 (Algeria).

Data collection

The study was carried out between March and June 2023 at the municipal slaughterhouse in the wilaya of Tebessa on a total of 151 sheep′s belonged to Ouled Djellal breed (n=118) and Hamra breed (n=33). Age was determined according to the number of permanent incisors counted prior to dressing the carcass. The animals were adult ≥12 months. Linear body measurements were taken on each animal before slaughter and Fig 1 schematically shows the locations of measuring. Dactylo-Thoracic Index (DTI) was calculated according to Sotillo and Serrano (1985) and Houssou and Brik (2021). This remaining index is functional, providing information about the type, aptitude and production performance of the animal as described by (Sotillo and Serrano, 1985; Houssou and Brik, 2021).

Immediately after slaughter and after dressing, two photographs of all carcasses, one of the left lateral side and one of the dorsal view, were taken with a digital camera from a distance of 2 meter. These photographs were then used to classify the carcasses. The offal weight was weighted. Mutton carcasses were visually classified for conformation and fatness by the methodology specified according to E.U.R.O.P. classification: five classes, from E = "excellent", to P = "poor conformation") and fatness score (five classes from 1=lean to 5=fat) (Commission Regulation, 1993). After the carcass classification processes, we measured carcass weight after bleeding and skinning and removing the head, hooves, tail and viscera. The following measurements were taken on the entire carcasses: carcass length, carcass width, leg length and backfat thickness (measured between 13th thoracic and first lumbar vertebrae using caliper); (carcass yield) were calculated as described by Belhaj *et al.* (2021); Ekiz *et al.* (2021) and Kumar *et al.* (2022).

Statistical analyzes

All data were coded and recorded in to excel sheet. The descriptive analysis of the data was established using the SPSS version 20 tool focused on the determination of the mean values, standard deviations, minima and maxima of the studied parameters. In order to study the effect of breed on body measurements and carcass characteristics, difference with value of ($P<0.05$) was considered to be statistically significant. The Pearson's correlation coefficients

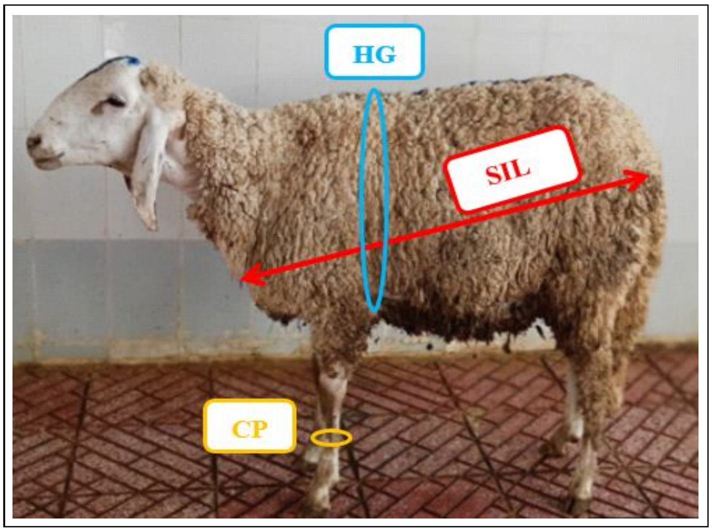

Fig 1: Body measurements taken on sheep. HG: Heart girth, SIL: Scapular-ischial length, CP: Cannon perimeter.

were performed to assess the association between the parameters studied.

RESULTS AND DISCUSSION

Body and carcass measurements

Table 1 and 2 shows the effects of animal′s breed at slaughter on carcass traits using different criteria like body measurements, weight, carcass conformation, fatness (thickness of back fat), thoracic typing index and the carcass yield of the both breeds. In general, there were significant differences (P<0.05) for the body measurements before slaughter: HG; CP; SIL and DTI. The Ouled Djellal breed was significantly longer SIL; developed chest perimeter; more developed canon perimeter CP, the DTI was higher compared to the Hamra breed (P<0.05). There is heterogeneity between the two breeds for these traits: The Ouled Djellal breed was significantly longer; chest perimeter was developed; more developed canon perimeter and the dactyl thoracic index was higher. Consequently, Ouled Djellal have fairly developed bone structure. Our findings are close to those reported by Afri-Bouzebda *et al*. (2018) and Houssou and Brik (2021) for the same breed in the east of Algeria. The dactylo-thoracic index (DTI) indicates the degree of skeletal thinness; it allows us to establish a correlation between the individual mass of the animal and its limbs, so as to determine whether the body volume corresponds to the bone development (Cerqueira *et al.,* 2011). These parameters show that the Ouled Djellal breed (IDT: 0.103±0.012) has a developed bone structure than the Hamra breed (IDT: 0.099±0.011) (P<0.05).

After slaughter, in one hand, we observed significant differences between the two sheep breeds studied at (P<0.05) on the carcass characteristics: K, CW, BW and carcass yield. On the other hand, we recorded no significant differences (P>0.05) on the carcass characteristics: F, G, SW and the offal weight. Regarding yield carcass, we recorded percentage of 51.51% for Ouled Djellal breed and 49.15% for Hamra breed (P<0.05). The findings in the present study were close to results found by other authors Benyounes *et al.* (2015) in Ouled Djellal (OD) breed in Algeria and Belhaj *et al.* (2021) in the both breeds Ouled Djellal and Hamra in Morocco. Moreover, the breed had a significant effect on these parameters, where the higher values were recorded for OD breed. However, Teixeira *et al.* (2005) and Yousefi *et al.* (2012) have noted no significant effect of breed on carcass yield respectively of Portuguese

Table 1: Descriptive statistics of body measurements and carcass traits.

	Variables	TotalN= 151	Breed	Number	Mean ±SD	P
Body measurements « Before slaughter »	HG (cm)	104±6.20	Ouled Djellal	N= 118	109±7.25	0.02
			Hamra	N= 33	99±3.18	
	CP (cm)	10.09±3.22	Ouled Djellal	N= 118	10.54±2.20	0.03
			Hamra	N= 33	9.09±1.28	
	SIL (cm)	82.23±5.77	Ouled Djellal	N= 118	87.20±7.13	0.04
			Hamra	N= 33	75.24±6.25	
	DTI	0.101±0.010	Ouled Djellal	N= 118	0.103±0.012	0.04
			Hamra	N= 33	0.099±0.011	
Carcass characteristics « After slaughter »	K (cm)	71.98±6.54	Ouled Djellal	N= 118	76.50±3.21	0.04
			Hamra	N= 33	68.20±2.03	
	F (cm)	43.45±3.12	Ouled Djellal	N= 118	45.19±3.20	0.23
			Hamra	N= 33	42.93±4.11	
	G (cm)	40.10±2.98	Ouled Djellal	N= 118	40.82±2.73	0.12
			Hamra	N= 33	39.10±4.91	
	SW (cm)	39.09±4.25	Ouled Djellal	N= 118	40.99±4.33	0.08
			Hamra	N= 33	37.95±3.24	
	FT (mm)	1.54±0.56	Ouled Djellal	N= 118	1.59±0.97	0.19
			Hamra	N= 33	1.48±1.01	
	CW (kg)	32.96±5.02	Ouled Djellal	N= 118	34.96±7.82	0.03
			Hamra	N= 33	30.53±4.33	
	The offal weight (kg)	12.14±1.62	Ouled Djellal	N= 118	12.28±2.51	0.43
			Hamra	N= 33	12.02±1.28	
	BW (kg)	64.79±82	Ouled Djellal	N= 118	68.31±11.14	0.03
			Hamra	N= 33	61.83±5.04	
	Carcass yield (%)	49.83±4.77	Ouled Djellal	N= 118	51.51±4.02	0.04
			Hamra	N= 33	49.15±2.25	

N: Number; HG: Heart girth; CP: Cannon perimeter CW: Carcass weight; SIL: Scapular-ischial length; DTI: Dactyl-thoracic index; K: Carcass length; F: Leg length. G: Pelvis width; SW: Chest width; FT: Fatness thick; CW: Carcass weight; BW: Body weight.

breeds and Iranian lambs. The last author determined greater significantly of breed on back fat thickness. The recorded carcass weight values varying between 34.96±7.82 kg and 30.53±4.33 kg respectively for Ouled Djellal and Hamra breeds studied, which appears that these last to be lower than 37.6±1.73 kg of the Ouled Djellal breed in intensive mode in the region of Guelma (East of Algeria) The results in the study showed that overall the Ouled Djellal carcasses were leaner than the Hamra carcasses (Table 2). This found translate into significant differences in yield carcass. Kempster (2003) reported that the proportion of lean meat in the carcass is of major importance since this is the principal determinant of meat yield and commercial value. The results showed that the Ouled Djellal in this research had higher carcass percentage (51.51%) that their Hamra counterpart (49.15%). These results however were closer that the report from Benyounes *et al.* (2015) which mentioned that the carcass percentage of Ouled Djellal was 51.7% and in agreement with the findings from Belhaj *et al.* (2021) and Djenontin *et al.* (2017) which mentioned that the carcass yield of Djallonke and Sahel sheeps breeds were 50.87% and 52.59 % in Benin.

The results showed that the conformity of Ouled Djellal and Hamra sheep carcass were affected positively (P<0.05). Nevertheless, fatness score was unaffected in both breeds (Table 1 and 2). This result showed that the breed had an impact on the subjective classification of carcasses. The higher values of conformity were recorded for Hamra sheep carcasses. Consequently, Hamra sheep carcasses showed better subjective characteristics in terms of conformity; therefore, carcasses required by consumers. Moreover, Exploring the variation in meat quality between muscles is a pivotal step to design strategies for better utilization (Gangadhar *et al.,* 2021).

The weight of offal was 12.28±2.51 kg in the Ouled Djellal against 12.02±1.28 kg among the Hamra (P>0.05) which appears higher than 10.33 kg in the Sahelian against 6.20 kg among the Djallonké reported by Djenontin *et al.* (2017), these variations can be explained by the effect of the genetic potential.

Mutton in the present study were not fully grain-fed inside. This may have meant that some sheep did not reach their full genetic potential for fat deposition it is an important parameter; it provides valuable information on the relevance of feeding, particularly with lactogenic plants present on the pastures, according El-Amaiem and Abd El Kareem (2022), the sheep are able to produce meat without consuming large quantities of feed concentrates. Several factors influenced Lamb meat quality, such as breed (Fogarty *et al.,* 2000; Safari *et al.,* 2001; Aksoy *et al.,* 2019; Pelmuş *et al.,* 2020), age (Belhaj *et al.,* 2021), slaughter weight (Arsenos *et al.,* 2002) and sex (Hoffman *et al.,* 2020). Moreover, other factors could influence meat quality such as pre-slaughter stress, system of production and feed ration (De Araújo *et al.,* 2017; Hoffman *et al.,* 2020; Shibeshi *et al.,* 2022).

Table 2: Subjective carcass characteristics according to EUROP classification.

	Ouled Djellal					Hamra					P
Conformation	E	U	R	O	P	E	U	R	O	P	0.02
Percentage (%)	9	35	45	7	4	22	23	45	3	2	
Fatness	1	2	3	4	5	1	2	3	4	5	0.31
Percentage (%)	0	5	56	35	4	0	4	57	36	3	

E: Excellent; U: Very good; R: Good; O: Fair; P: Poor; 1: Low, 2: Slight, 3: Average, 4: High, 5: High; ns: No significant; *significant at P<0.05.

Table 3: Effect of breed and their interaction on carcass traits and body measurements of Ouled Djellal and Hamra sheep breed.

Variables	HG (cm)	SIL (cm)	K (cm)	F (cm)	G (cm)	SW (cm)	CW (kg)	BW (kg)	CY (%)	DTI
HG (cm)	1									
SIL (cm)	0.043	1								
K (cm)	0.213*	0.673**	1							
F (cm)	-0.024	0.413**	0.393**	1						
G (cm)	0.423**	0.520**	0.668**	0.438**	1					
SW (cm)	0.355**	0.553**	0.700**	0.429**	0.903**	1				
CW (kg)	0.774**	0.380**	0.455**	0.349**	0.828**	0.782**	1			
BW (kg)	0.378**	0.385**	0.477**	0.376**	0.544**	0.573**	0.550**	1		
CY (%)	0.110**	0.002	0.013	-0.004	0.346**	0.247**	0.435**	0.476**	1	
DTI	0.717**	-0.248**	-0.285	-0.303**	0.041	-0.049	-0.346**	0.08	-0.458**	1

ns: Non-significant, *: Significant at P<0.05. **: Significant at 0.01; ns: Non-significant; HG: Heart girth; SIL: Scapular-ischial length; K: Carcass length; F: Leg length; G: Pelvis width; SW: Chest width; CW: Carcass weight; BW: Body weight; CY: Carcass yield; DTI: Dactyl-thoracic index.

Correlation coefficients of carcass and measurements traits

A summary of the correlations among traits is shown in Table 3. Results showed a positive correlation between carcass yield and pelvis width, chest width, carcass weight and body weight (r=0.346, r=0.247, r=0.435 and r=0.476; p<0.01) respectively and there was also a positive correlation between dactyl-thoracic index and heart girth (r=717; p<0.01) in the both lambs. There were negative correlations between dactyl-thoracic index Scapular-ischial length, leg length, carcass weight and carcass yield for both breeds (r= -0.248, r= -0.303, r= -0.346; r=-0.46 and r= -0.458) (P<0.01).

The correlation between carcass weight and heart girth, appear to be the most important traits of sheep live affecting yields (Table 3). The importance of carcass length, chest width and pelvis width and their greater participation in the variance than the other conformational criteria corroborate the work of Flamant and Boccard (1966). These authors sorted the measures in the same order according to the degree of correlation, which can explain with accuracy the choice of these three factors, additionally to the length of the legs, in most works dealing with the characteristics of the carcass. However, professionals were not content to define carcasses of good conformation by a short leg. They want a wide and short carcass. In addition, other “conformation” measures were used quite frequently and relate to the length and width of the carcasses.

CONCLUSION

The results showed that carcass yield was variable, probably reflecting the wide range of sheep destined for slaughter. In general, these results showed the interaction effects of breed on objective and subjective carcass characteristics. Furthermore, we have demonstrated the multiple zootechnical tools by which the ovine product can be qualified and classified, in a general context of characterization of the sheep implying the choice of the breed and the type of food in response to the specific requirements of the Algerian consumer. Likewise, these results could contribute to the development of automated carcass grading systems.

Conflict of interest

All authors declare that they have no conflict of interest.

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