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Prediction of carcass weight based on carcass measurements of four breeds slaughtered in Algeria

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Abstract

The objective of the current study was to predict the quantity of marketable meat and developed predictive models from carcass measurements of 130 bovine heads of four breeds (41 Montbéliarde heads, 26 Aubrac heads, 42 Holstein heads, and 21 Atlas brunette breed heads).Body Length; Thoracic Perimeter; Chest Depth; Thigh Width were individually recorded at the slaughterhouse. Correlation was used to estimate the relationship between carcass weight and all carcass measurements. Linear regression with the "stepwise" type method was also used to building prediction models, and identifying predictors for each race. Results showed a positive correlation between the carcass weight, the body length of all the breeds studied and strong correlation coefficients of the Montbéliarde (r = 0.83) and Aubrac (r = 0.88) breeds with the thoracic perimeter.The coefficients of determination varied from 40% in Holstein cattle to 76% in Aubrac animals and the predictors were Thoracic Perimeter (TP) in the Aubrac, Holstein, Montbéliarde breeds and Chest Depth (CD), Thigh Width (TW) in local breed. In conclusion, Thoracic perimeter can be used to develop predictive models of the quantity of marketable meat of the four breeds.

Keywords: Carcass measurements; meat quantity; model; cattle.

Introduction

In Algeria, cattle breeding ensure, on one hand, a good part of the population's needs for animal proteins through dairy production and the production of red meat and, on the other hand, it is a good indicator in the

national economy (Hirondel., 2012). However, beef production is growing more quickly than livestock production. This growth is the result of improved carcass weight due to a more satisfactory feed supply.

In fact, improved dairy cattle tend to move towards mixed meat-milk production. Most of the beef produced comes from calves of dairy origin from small farms which represent 80% of beef farms. Slaughter barely covers two thirds of Algeria's beef needs. The original herd, made up of imported and local dairy breeds, only accounts for 55% (Sadoud., 2017).

The quality of the carcass is assessed on the basis of criteria which determine the beefing abilities. These are carcass weight and length, back weight, thigh weight and thickness, shoulder weight, meat yield and co-product contents (Renand *et al*., 2002).

Carcass weight is the criterion that primarily interests the breeder, because it serves as the basis for determining his remuneration. (Salifou *et al*., 2013). In developing countries, almost all killings do not have a scale. The slaughter weight is estimated based on the conformation of the animal and constitutes the fundamental element in determining the selling price of the live animal. The higher the estimated weight, the more expensive the animal is sold.

The yield of marketable meat in a bovine carcass is a determining criterion in the commercial value of a bovine intended for slaughter. The assessment of the proportion of meat in a carcass is determined using prediction equations integrating measurements on the carcass and the living animal (Slimane *et al.,* 2018). Carcass weight can be used to assess the muscle yield of cattle and to develop a classification system to assign a value to carcasses (Addis *et al*., 2020).

The objective of our experiment was to predict the quantity of marketable meat from hot carcass measurements and developed predictive models that could be used for carcass classification.

Materials and methods

Animals

The information was collected in collaboration with the veterinarian and the staff of the communal slaughterhouse of Sétif during the period from February 15, 2022 to March 15, 2022, we assist at the different stages of slaughter. The study relates to 130 bovine heads of four breeds (41 Montbéliarde heads, 26 Aubrac heads, 42 Holstein heads, and 21 Atlas brunette breed heads).The cattle were obtained randomly in the slaughterhouse at an age between 14 and 24 months, however the average live weights recorded were respectively 650 kg, 484.5 kg, 466.75 kg, 338.85 kg for Aubrac, Holstein, Montbeliarde, Atlas brunette.

In general, the two dairy breeds (Montbéliarde or Holstein) and the meat breed (Aubrac) either imported or born locally could come from large dairy farms using a basic diet (hay or silage) and a compliment with compound concentrate. However, local breed cattle (Atlas brunette) come from small livestock systems.

Carcass measurement

We carried out four measurements on the carcass of animals which is already numbered for their identification at the level of the slaughter chain. The cattle were slaughtered according to Muslim rites, and a post-mortem inspection of the carcass was carried out according to Algerian regulations by a veterinary surgeon from the slaughterhouse.

- **Body Length (BL):** The length between the point of the shoulder and the points of buttocks.
- **Thoracic perimeter (TP):** Was measured by taking the chest circumference directly behind the shoulders.
- **Chest Depth (CD):** Height of the trunk measured behind the shoulder.
- **Thigh Width (TW):** Measured horizontally between the widest points rounding of the medial and lateral surface of the leg.

Statistical analysis

Mean, standard deviations are calculated to describe age and weight of animals at slaughter as well as the different measurements made on the carcass.

Correlation was used to estimate the relationship between carcass weight and all carcass measurements taken (BL, TP, CD, and TW) of all the breeds studied using Pearson correlation and Spearman's correlation rank when variables were not normally distributed.

We used linear regression with the "stepwise" type method to building prediction models, and identifying a useful subset of predictors for each race. At each step, a variable is considered to be added or subtracted from the set of explanatory variables on the basis of predicting the quantity of meat from measurements on carcasses. The regression model used to predict the amount of meat after slaughter involving a number of explanatory variables which are: BL: Body Length; TP: Thoracic Perimeter; CD: Chest Depth; TW: Thigh Width (carcass measurement). All analysis were performed using SPSS 21 software. (Statistical Program for Social Science).

Result

Carcass characteristics by breed

The results of the different measurements carried out on the carcasses by breed are represented in table 1. It appears from Table 1 that the animals monitored recorded an average carcass weight of around 273.27 ± 69.20 kg for an average age at slaughter of 19.57 ± 3.24 months.

Table1. Average carcass measurements by breed.

	Aubrac (26)	**Holstein (**42)	**Montbéliard (**41)	**Local (**21)	**Total (130)**	**CV (%)**
Age (month)	19,85±3,25	19,45±2,88	19,37±3,48	19,86±3,61	19,57±3,24	16.56
CW(kg)	356,58±57,69	272,24±33,27	261,90±54,46	194,38±51,98	273,27±69,20	25.32
BL	151,65±9,52	147,95±7,28	146,83±8,28	133,81±9,95	146,05±10,15	6.95
TP	190,81±7,48	181,00±9,89	176,46±11,78	167,86±15,01	179,41±13,09	7.30
CD	75,23±4,75	72,52±4,52	72,49±5,86	66,52±5,96	72,08±5,85	8.12
TW	49,00±3,86	46,50±3,94	46,73±4,70	40,86±3,00	46,1615±4,73	10.25

CW: carcass weight**; BL:** Body Length**; TP:** Thoracic Perimeter; **CD:** Chest Depth; **TW:** Thigh Width; **CV:** coefficient of variance.

From this table we see that Aubrac breed carcasses recorded the highest values with regard to carcass weight and all measurements taken (BL, TP, CD, TW). On the other hand, local breed animals presented the lowest values for Body Length; Thoracic Perimeter; Chest Depth; and Thigh Width.

The coefficient of variation was less than 10% for certain variables such as Body Length (BL); Thoracic Perimeter (TP); Chest Depth (CD) while carcass weight was greater than 20%

Relationship between Independent and Dependent Variables

Carcass weight presented a positive correlation with Body Length and Thoracic Perimeter of all the breeds studied with strong correlation coefficients of the Montbeliarde and Aubrac breed (r = 0.83; r = 0.88 respectively) for this last independent variable.

In addition, carcass weight was correlated with thigh width only in Montbéliarde breed cattle (table 2). However, the Chest Depth variable was not correlated only with the variables studied on Aubrak cattle.

Table2. Correlation coefficient of independent and dependent variables

Dependent Variable CW	**Independent Variables**			
	BL	**TP**	**CD**	**TW**
Aubrac	0,40*	0,88**	0,34	0,11

Holstein	0,50**	0,63**	0,52**	0,21
Montbéliard	0,58**	0,83**	0,35*	0,51**
Local	0,55*	0,61**	0,71**	-0,03
Total	0,68**	0,78**	0,55**	0,52**

CW: carcass weight**; BL:** Body Length**; TP:** Thoracic Perimeter; **CD:** Chest Depth; **TW:** Thigh Width

Predictive equations for carcass weights of different breeds

The assessment of the quantity of marketable meat in a carcass was determined using prediction equations integrating measurements on the carcass.

For the data of all breeds combined, Thoracic Perimeter, Chest Depth and Thigh Width were significant predictors of carcass weight and 83% is explained by this model (Table 3). When using data from each breed separately at slaughter, the accuracy of the predictions was improved compared to using data from all breeds combined. Thoracic Perimeter explained 76% of the variability in the carcass weight of Aubrac breed cattle, and 70% of Montbeliarde breed cattle while Thoracic Perimeter explained only 40% of this variation in the Holstein breed (Table 3).Multivariate analysis indicated that 61% of the variation in carcass weight of local breed cattle was explained using Chest Depth and Thigh Width

Table 3. Carcass weight prediction model using carcass measurements in four cattle breeds

Different breeds	**prediction equations**	**R^2**
Aubrac	CW = -930.44 + 6.75 TP	0,76
Holstein	CW= -112.16+2.12 TP	0.40
Montbéliard	CW= - 422.1+ 3.88 TP	0.70
Local	CW= - 47.01+ 7.36 CD - 6.07 TW	0.61
Total breeds	CW= - 565.79 + 3.43TP +1.82 CD+1.99 TW	0.83

CW: carcass weight**; BL:** Body Length**; TP:** Thoracic Perimeter; **CD:** Chest Depth; **TW:** Thigh Width

Discussion

Our study was initiated with the main objective to predict the quantity of meat from hot carcass measurements to assess saleable meat quantity, and to identify those variables that could be implemented in a classification system.

The results of our study performed on 130 bovine heads of four breeds which indicates a coefficient of variation was less than 10% for certain variables such as Body Length (BL); Thoracic Perimeter (TP); Chest Depth (CD) but it was greater than 20% for carcass weight

The variation coefficient values were quite similar to those observed by several authors (Laville *et al*., 1996; Alberti *et al*., 2005 and Slimene *et al*., 2022) for measurement recorded for carcass length. However, our results were weaker compared to the results of the latter, in particular for the weight of the carcass but remain better than those reported by Dernnan *et al*., (2008) for carcass weight (25.32% against 13.9% for bulls and 9.3% for Heifers)

A positive correlation was observed between the carcass weight, body length and thoracic perimeter of all the breeds studied with strong correlation coefficients of the Montbéliarde (r = 0.83) and Aubrac (r = 0.88) breeds for this last variable, and this was also evident for the mixed breed (Montbeliarde) and the other breastfeeding (Aubrac).

Abraham et al. (1968) observed a correlation coefficient between the weight of the carcass and the length of the carcass (r = 0.80) higher than those found in our study with a high coefficient of Montbéliarde cattle followed (r = 0.58) of local cattle (r = 0.55). In Tunisia, Slimane *et al.,* 2022 recorded a lower coefficient (0.44) with other races.

Laville *et al*., 1996 reported lower correlation coefficients between carcasses weight, leg length and carcass length, While Slimane *et al.*, 2022 reported similar results for the correlation between carcass weight and fat cover (r = 0.83).

Addis *et al*., 2020 observed a positive correlation with the weight of the muscles of the hind legs throughout the slaughter age groups 8, 10, or 12 months of age (correlation coefficient of 0.79 to 0.91). In our study, carcass weight was correlated with thigh width only in Montbéliarde breed cattle. However, the Chest Depth variable was not correlated only with the variables studied on Aubrak cattle. Berry *et al*., 1973 found negative correlation coefficient between different carcasses varying in carcass length. Results reported by these authors are not in concordance with those found in the present study.

The stepwise regression analysis shows that we can make a prediction of the quantity of meat with different coefficients of determination (R^2) depending on the breed. The measures adopted in the stepwise prediction analysis were Thoracic Perimeter (TP) in the Aubrac, Holstein, Montbéliarde breeds and Chest Depth (CD), Thigh Width (TW) in local breed animals. The coefficients of determination recorded for the measurements taken on the carcasses varied from 40% in Holstein cattle to 76% in Aubrac animals.

Chen *et al*., 2007 reported that carcass weight would explain 63 to 90% of the variation in meat weight of native and crossbred Chinese animals aged 18 to 52 months.

The values of determination coefficients recorded in our study for the prediction equations of the quantity of meat based on the measurements on the carcass were significantly higher than those reported by Slimene *et al* in 2018, these authors recorded coefficients of 19% for the Holstein breed to 73% for the meat cross breeds. Whereas, Oliver *et al*., 2010 recorded better prediction with an R^2 = 0.93 with bull calves of Spanish breeds with morphological measurements taken by image analysis. Carcass weight was recorded as the best indicator of beef yields for several researches (Epley *et al*., 1970; Berry *et al*., 1973; Lee *et al*., 2016; Addis *et al*., 2020)

Conclusion

Using carcass measurements to develop predictive meat models of beef in Algeria could offer producers and butchers a simple system that makes transactions more transparent and reflects carcass values in red meat slaughterhouses, in order to establish a carcass grading system.

We observed a strong positive correlation between carcass weight and body length and thoracic circumference of all breeds studied. Thoracic Perimeter appears to be the most important trait in explaining variation between the four breeds, as well as Body Length.

However, the variable Thoracic depth was not correlated only with the carcass weight of Aubrak cattle. Thigh width was negatively correlated with measurements taken on local cattle.

The measurements used in the present study do not make it possible to predict the quantity of meat obtained from the animals of the breeds studied. Other additional measurements can be introduced into the equations to better predict net meat weight. The use of new, simpler and faster methods to predict the quantity of marketable meat could replace the traditional method and make the carcass payment system more objective.

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