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In vivo ultrasonic measurements and live weight for predicting carcass quality in Churra Tensina mountain breed lambs

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Abstract

Forty-six single male lambs of Churra Tensina mountain breed with a live-weight ranging from 19.9 to 24.4 kg ('Ternasco' carcass commercial type) were scanned by ultrasound (ALOKA model SSD-900, with a 7.5 MHz probe) to determine M. *longissimus dorsi* depth and subcutaneous fat thickness between the 10th-11th, 12th-13th dorsal vertebrae and 1st-2nd, 3rd-4th lumbar vertebrae. Lambs were slaughtered and carcasses were cooled at 4 °C for 24 h and halved. The left side was divided according to a standardised jointing procedure, based on six anatomical regions: shoulder, long leg, anterior ribs, ribs, flank and neck. Each joint was then dissected into muscle, bone plus remainder and subcutaneous, inter-muscular, kidney and pelvic fat. The *in vivo* ultrasound measurements plus slaughter weight were fitted to predict carcass tissue composition by Stepwise regression analysis. All the developed models were highly significant (P<0.001) and explained 70, 51, 82, 56, 59 and 41% of the muscle, bone plus remainder, subcutaneous, inter-muscular, kidney and pelvic fat variation respectively. The model residual standard deviations were lower than 124.3 g.

Keywords: lamb, fat thickness, M. longissimus dorsi, ultrasound

Introduction

The EU established a model for classification of lamb carcasses highly subjective, using photographic standards (European Union, 1994). That model has not been useful to classify carcasses according to the most important consumer criteria and it becomes important to provide information about carcass composition as saleable meat, or fat, muscle and bone contents. Therefore, it is necessary to develop an accurate method of carcass classification that allows assessing objectively carcass composition.

Nowadays, one of the most promising techniques to assess carcass composition is Real Time Ultrasound Scanner because it presents a high potential for the immediate use (Delfa *et al.*, 2005; Teixeira *et al.*, 2006). This tool can predict with high precision the tissue and anatomical composition of carcasses in measures, which are carried out *in vivo*. It is evident the interest to obtain equations of prediction for the regional lamb genotypes in order to avoid the errors linked to others genotypes and others weight ranges (Delfa, 1992). Churra Tensina sheep is an endangered local course-wooled hardy breed belonging to Churra group, which is raised for lamb production, although it has been milked for years. The main objective of the present study was to determine the precision of slaughter weight (SW) and ultrasound measures as predictors of carcass composition.

Materials and methods

Forty-six male lambs of Churra Tensina breed, from single birth and unshaven, with live-weight of 22.4±0.96 were used. Twenty four hours before slaughter an ALOKA SSD-900 real time Ultrasound

Scanner was used to take16 measures of subcutaneous fat thickness (C*), 16 of subcutaneous fat thickness plus interface (C**), 16 of subcutaneous fat thickness plus interface plus skin (C), 16 measures of *M. longissimus dorsi* depth (B) and 4 of *M. longissimus dorsi* width (A). These measurements were taken with a 7.5 MHz probe at different anatomical positions (10-11 and 12-13 dorsal vertebrae, Dv; and 1-2, 3-4, lumbar vertebrae, Lv). Probe was placed perpendicularly to the backbone at 2 cm, 4 cm and at 1/3 distance and parallel to the backbone at 1/3 of distance (Figure 1).

Lambs were slaughtered and carcasses were cooled at 4 °C for 24 h and halved carefully. On the left side, fat thickness was measured with a 'calliper' at the same anatomical point where it was assessed in the live animal using ultrasounds. The left side was divided into six standardized commercial joints, shoulder, long leg, anterior ribs, ribs, flank and neck, according to Colomer-Rocher *et al.* (1988). Depth and width of *M. longissimus dorsi* were taken in the same anatomical localizations as ultrasounds. Each joint was then dissected into muscle, bone plus remainder and subcutaneous, inter-muscular, kidney and pelvic fat, according to Colomer-Rocher *et al.* (1988).

Data were analysed by stepwise regression (Ott, 1993) using the ultrasonic measurements and the SW as independent variables. The statistics R^2 and residual standard deviation (RSD) were used to assess the accuracy of prediction of ultrasonic measurement and SW (Kempster *et al.*, 1982).

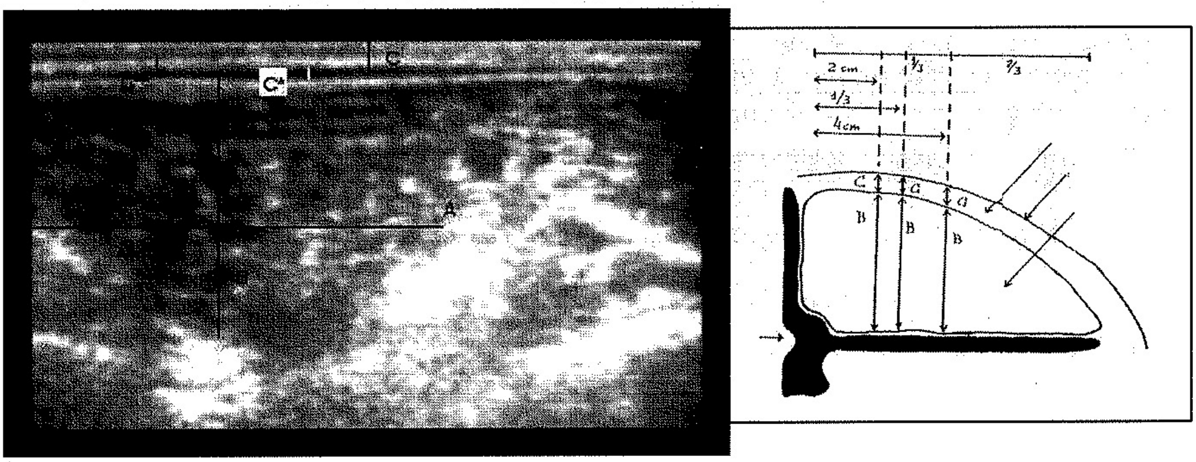

Figure 1. Ultrasounds measurements carried out "in vivo" perpendicularly to the backbone. C= skin+interface+fat; C = fat; C** = interface+fat; B = M. Longissimus dorsi depth; A = M. Longissimus dorsi width. B and C measures were taken at 2cm, 4cm and 1/3 from the backbone.*

Results and discussion

The prediction equations, determination coefficients (R^2) and residual standard deviation (RSD) of the weight of the different carcass tissues are shown in Table 1.

The SW only was admitted as independent variable in the prediction models of muscle, subcutaneous and kidney fat weights. These results agree with those found by Cadavez *et al.* (2000b) and Joy *et al.* (2005), but are not supported by those found by Delfa *et al.* (1995), Teixeira and Delfa (1997), Cadavez *et al.* (2000a) and Teixeira *et al.* (2006) where live-weight was the first variable admitted in the models. These differences can be due to the different type of animal and the range of live-weight and the anatomical points used for ultrasonic measurements.

All prediction equations included different muscle depth (B) measurements and subcutaneous fat thickness, mainly the C measure. The prediction equation of bone weight was the only that include

Table 1. Multiple regression equations live-weight and ultrasound measurements to predict carcass composition. (Linear equation: y=a+bx; Dep. Var. (y) = Dependent variable, Independent Var. (x) = Independent variable a= Intercept, b=slope).

Step	Dep. Var. (y)	Independent Var. (x)	R^2	RSD	b	a
1	Muscle weight ½	B parallel 1/3 1st- 2nd Lv	0.61***	137.48	52.42	247.28
2	carcass	SW	0.66***	130.46	62.18	
3		B 1/3 1st- 2nd Lv	0.70***	124.31	26.71	
1	Bone plus	B parallel 1/3 1st- 2nd Lv	0.20*	72.70	4.33	344.1
2	remainder weight	A 12th- 13th Dv	0.39***	64.28	6.34	
3	½ carcass	B 2 cm 12th- 13th Dv	0.46***	61.40	15.52	
4		C* 4 cm 3rd- 4th Lv	0.51***	59.14	-47.65	
1	Subcutaneous fat	C 1/3 1st- 2nd Lv	0.57***	59.14	64.28	-608.12
2	weight ½ carcass	C 4 cm 10th- 11th Dv	0.69***	51.12	27.97	
3		SW	0.76***	44.98	23.51	
4		B 4 cm 3rd- 4th Lv	0.79***	42.32	9.74	
5		C parallel 1/3 12th- 13th Dv	0.82***	40.57	-20.70	
1	Intermuscular fat	B 4 cm 3rd- 4th Lv	0.28**	99.25	29.85	-47.21
2	weight ½ carcass	C 2 cm 1st- 2nd Lv	0.43***	89.65	99.24	
3		B parallel 1/3 1st- 2nd Lv	0.51***	84.07	-19.08	
4		B parallel 1/3 3rd- 4th Lv	0.56***	80.44	12.06	
1	Kidney fat weight	SW	0.30**	27.01	13.04	-216.69
2	½ carcass	B 2 cm 3rd- 4th LV	0.42***	24.85	7.66	
3		B 2 cm 1st- 2nd Lv	0.49***	23.50	-6.61	
4		C* parallel 1/3 10th- 11th Dv	0.55***	22.27	8.54	
5		B 4 cm 1st- 2nd Lv	0.59***	21.58	2.85	
1	Pelvic fat weight ½	B 4 cm 3rd- 4th Lv	0.12*	10.27	3.89	35.72
2	carcass	B 2 cm 12th- 13th Dv	0.25**	9.56	-3.47	
3		C 4 cm 3rd- 4th Lv	0.36**	8.96	8.67	
4		C parallel 1/3 1st- 2nd Lv	0.41***	8.72	4.69	

A measurement equation with A measurement as independent variable and when associated with a B measurement increase the accuracy of the model in 19%. When the SW was included in the equations of ULTRASOUNDS measures the accuracy of the predicted weight of the different carcass tissues (R^2, RSD) was enhanced between 9 and 31%. All the developed prediction equations were highly significant ($P<0.001$) and explained 70, 51, 82, 56, 59 and 41 % of the muscle, bone plus remainder, subcutaneous, intermuscular, kidney and pelvic fat variation, respectively. All the RSD of the predicting equations were very low and the highest error was only 124.3 g to predict the muscle carcass weight.

The 70% of variation in muscle weight was accounted for by variation in measurements B parallel 1/3, 1^{st}-2^{nd} Lv, SW and B1/3, 1^{st}-2^{nd} Lv, in agreement with Cadavez *et al.* (2000b) and Joy *et al.* (2005). However, Teixeira and Delfa (1997) and Teixeira *et al.* (2006) found greater R^2 values (0.94 and 0.96, respectively).

The B, A and C* measurements together (Table 1) accounted for the 51% of variation in bone weight. These results were very similar to those reported by Delfa *et al.* (1995). In relation to the subcutaneous fat weight, we observed that 57% of the variations were accounted for by variation in C1/3, 1^{st}-2^{nd} Lv. The inclusion of the measurement C, SW and B (Table 1) increased 25% the determination coefficient and decreased 31.4% RSD, which is in agreement with values observed by Teixeira and Delfa (1997), Cadavez *et al.* (2000b), Joy *et al.* (2005), and Teixeira *et al.* (2006).

Nevertheless, only 56% of variation in intermuscular fat weight was accounted for by variation in B and C measurements (Table 1). Nevertheless Joy *et al.* (2005) working with lambs of the same breed and with similar live-weight range, reported that 75% of variation in the weight of these depots were accounted for by variation in three C measurements.

Finally, for kidney and pelvic fat we observed that the B and C measurements and SW explained 59 and 41% respectively of the variation in the weight of this fat depots (Table 1), according with the results found by Joy *et al.* (2005).

Conclusions

From the present animal type it was no advisable to take subcutaneous fat thickness and subcutaneous fat thickness plus interface measures measurements to predict carcass composition. The low residual standard deviation in association with the good determination coefficients indicate that ultrasound measurements in addition to slaughter-weight could be acceptable predictors of some carcass tissue components as muscle weight and subcutaneous fat weight in Churra-Tensina lambs.

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