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THE USE OF ULTRASONOGRAPHY TO PREDICT CARCASS COMPOSITION IN KIDS

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Original scientific paper

SUMMARY

The objective of this work was to analyse the use of ultrasounds to predict carcass composition in kids. Twenty kids from Serrana Portuguese local breed with a mean live weight of 12.6 ± 2.99 kg were scanned by ultrasonography to determine longissimus muscle depth (LD), subcutaneous fat thickness (SF) between the 12th and 13th vertebrae (D12), 1st and 2nd (L1) and 3rd and 4th (L3) lumbar vertebra and breast bone tissue thickness at 1st (BT1), 2nd (BT2), 3rd (S3) and 4th (BT4) sternebrae. Lambs were slaughtered after 24-h fasting and carcasses were cooled at 4 ºC for 24 hours. Carcass left side was dissected into muscle, subcutaneous fat, intermuscular fat and bone and remainder (major blood vessels, ligaments, tendons, and thick connective tissue sheets) associated with some muscles. Tissues measurements plus hot carcass weight were fitted as independent variables to predict carcass composition by stepwise regression analysis. Models developed 96.7% of muscle, 64.6% of subcutaneous fat, 95.0% of intermuscular fat, and 85.0% of bone weight variation, respectively. Ultrasound measurements were admitted in the models, improving the determination coefficient (R^2) and reducing the residual standard deviation. The HCW and tissues measurements taken by ultrasounds in live kids can be used to develop models to predict carcass composition at slaughter-house level.

Key-words: Carcass, Composition, Kids, Prediction, Ultrasonography

INTRODUCTION

Carcass economic value depends on its tissue composition, and according to Delfa and Teixeira (1998) the tissue composition of each joint are the main criteria for carcass evaluation and classification. The recent creation of meat products with Origin Denomination or Geographic Protection Indication of sheep and goat origin is an incentive to quality product development whose characteristics must correspond to consumer's expectations. Therefore, the development of a low-cost and expeditious method to predict carcass composition will have applicability in carcasses classification at slaughter-houses level (Cadavez et al., 1999), and carcasses classification will present an important role on commercialisation and on prices definition (Cadavez et al., 2002). The objective of this study was to evaluate the accuracy of hot carcass weight (HCW) when associated with ultrasound tissue depth measurements for prediction of carcass tissues weight on kids.

MATERIAL AND METHODS

A total of 20 male kids of the Serrana goat breed from the experimental flock of the Agrarian Superior School of Bragança were used in this study. Twenty-four hours before slaughter ultrasonic measurements of the muscle l*ongissimus* depth (LM), subcutaneous fat thickness (SF) between the 12th and 13th ribs (D12), 1st and 2nd (L1) and 3rd and 4th (L3) lumbar vertebrae and breast bone tissue thickness at 1st (BT1), 2nd (BT2), 3rd (BT3) and 4th sternebrae (BT4) were assessed using an ultrasonic machine ALOKA SSD-500V equipped with a 7.5 MHz probe. Kids were fasted for 24-h, and then slaughtered in the experimental slaughterhouse of the Agrarian Superior School of Bragança. Carcasses were cooled at 4 ºC for 24-h, and halved. Carcasses left side was divided into eight standardised commercial joints: leg, chump, loin, ribs, anterior ribs, shoulder, breast, and neck.

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The jointing procedure (Figure 1) was outlined according to the commercial jointing and cutting system of Estação Zootécnica Nacional (EZN – Portugal; Calheiros and Neves, 1968).
Each joint of carcass left side was dissected into muscle, subcutaneous fat, intermuscular fat, bone, and remainder (major blood vessels, ligaments, tendons, and thick connective tissue sheets associated with some muscles). Carcass evaluation and tissue separation were undertaken by the standard methods for lamb carcasses evaluation suggested by Colomer-Rocher et al. (1988).

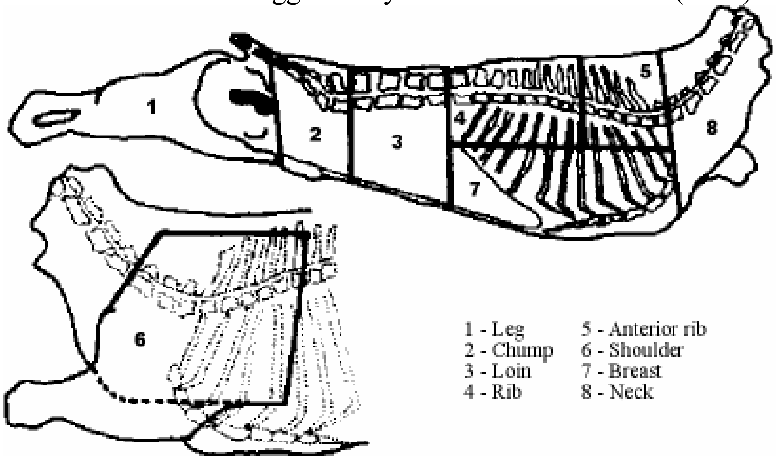

Figure 1. Representation of the EZN carcass cutting system (Calheiros and Neves, 1968)

Models to predict carcass composition were developed by stepwise regression (SAS, 1998). Hot carcass weight, and ultrasonic measurements were used as independent variables. The coefficient of determination (R^2), and the residual standard deviation (RSD) were used to assess the models fitting quality as suggested by Kempster et al. (1982).

RESULTS AND DISCUSSION

Table 1 shows the mean, standard deviation, minimum and maximum for the HCW, tissues thickness, and area measurements, and tissues weight. The HCW presented a CV around 25% and it is expected that the variation on this variable controls the variation observed in the carcass dimension tissues thickness and area measurements. Subcutaneous fat thickness measurements (SFD12, SFL1 and SFL3) were the ones presenting the highest CV (higher than 38%). The adipose tissue presents late maturity (Butterfield et al. 1983) compared to carcass weight and the increase in BW leads to high variations in this tissue and in the associated fat thickness measurements. The adipose tissue is the most susceptible to variations induced by nutritional factors, therefore, tissues measurements that reflect carcass fatness, like subcutaneous fat thickness, are highly affected by the relation between BW at slaughter and potential mature BW, as stated by Taylor et al. (1980). The breast bone tissues (BT1, BT2, BT3 and BT4) measurements presented CV similar to that observed in HCW and lower than those in subcutaneous fat thickness measurements. The CV observed for muscle longissimus depth (B12, B1 and B3) measurements (varying from 12.9 to 17.9%) was similar to that observed in the HCW. These results can be explained by the isometric muscle growth when compared to the BW growth as described by Butterfield et al. (1983). It is then expected that the variation in HCW will be directly reflected in the muscle longissimus depth measurements variation as it can be observed in our results.

Table 1. Mean, coefficient of variation, minimum and maximum of hot carcass weight (HCW), carcass tissues measurements taken by ultrasounds and carcass left side tissue weight

Variable	Mean	Coefficient of variation	Minimum	Maximum
HCW, kg	6.0	24.8	3.7	8.51
Tissues measurements, cm				
SFL1	0.06	38.3	0.02	0.13
SFL3	0.09	51.1	0.03	0.14
SFD12	0.07	54.3	0.02	0.14
BT1	1.37	24.9	0.70	2.1
BT2	1.49	24.7	0.70	2.2
BT3	1.48	20.6	0.75	1.9
BT4	1.37	22.3	0.75	1.8
LML1	1.94	13.0	1.5	2.4
LML3	1.83	13.3	1.5	2.4
LMD12	1.97	17.9	1.5	2.8
Tissues weight, g				
Muscle	1753	28.3	1143	2607
Subcutaneous fat	103	41.3	25	195
Intermuscular fat	179	41.0	32	301
Bone	580	20.6	370	767
Kidney and knob fat	105	43.5	52	193

HCW – hot carcass weight; SFL1 - subcutaneous fat thickness between the 1st and 2nd lumbar vertebrae; SFL3 - subcutaneous fat thickness between the 3rd and 4th lumbar vertebrae; SFD12 - subcutaneous fat thickness between the 12th and 13th ribs lumbar vertebrae; BT1 - breast bone tissue thickness at 1st sternebrae; BT2 - breast bone tissue thickness at 2nd sternebrae; BT3 - breast bone tissue thickness at 3rd sternebrae; BT4 - breast bone tissue thickness at 4th sternebrae; LML1 - muscle l*ongissimus* depth between the 1st and 2nd lumbar vertebrae; LML3 - muscle l*ongissimus* depth between the 3rd and 4th lumbar vertebrae; LMD12 - muscle l*ongissimus* depth between the 12th and 13th ribs lumbar vertebrae

The correlation coefficients between the *in vivo* ultrasound tissue measurements and calliper tissue measurements are presented in Table 2. The correlation coefficients between SFL1, SFL3 and SFD12 *in vivo* ultrasound measurements and the homologous measurements taken on the carcass were low (P> 0.05; from -0.22 to 0.13). The low development of subcutaneous fat in kids is well documented (Delfa et al., 1994; Teixeira et al. 1995), and the low magnitude of subcutaneous fat measurements implies a low precision of measurements taken on the carcass and by ultrasounds. The highest correlation coefficients were obtained for BT2, BT3 and BT4 all of them higher than 0.80, confirming the results attained by Delfa et al. (1995, 1996) and by Cadavez et al. (2002). The highest correlation coefficients were obtained at LMD12 (r = 0.74) for muscle depth measurements. These results are lower than those reported by Delfa et al. (1995, 1996) who found correlation coefficients higher than 0.80. However these results were attained in adult Blanca Celtibérica goats.

Table 2. Correlation coefficients (r) between in vivo ultrasound measurements and the homologous measurements taken on the carcass with a calliper

Carcass	Ultrasounds									
	SFL1	SFL3	SFD12	BT1	BT2	BT3	BT4	LML1	LML3	LMD12
SFL1	-0.23ns									
SFL3		0.1ns								
SFD12			0.13ns							
BT1				0.65ns						
BT2					0.81**					
BT3						0.83**				
BT4							0.81**			
LML1								0.72*		
LML3									0.62ns	
LMD12										0.74*

SFL1 - subcutaneous fat thickness between the 1st and 2nd lumbar vertebrae; SFL3 - subcutaneous fat thickness between the 3rd and 4th lumbar vertebrae; SFD12 - subcutaneous fat thickness between the 12th and 13th ribs lumbar vertebrae; BT1 - breast bone tissue thickness at 1st sternebrae; BT2 - breast bone tissue thickness at 2nd sternebrae; BT3 - breast bone tissue thickness at 3rd sternebrae; BT4 - breast bone tissue thickness at 4th sternebrae; LML1 - muscle l*ongissimus* depth between the 1st and 2nd lumbar vertebrae; LML3 - muscle l*ongissimus* depth between the 3rd and 4th lumbar vertebrae; LMD12 - muscle l*ongissimus* depth between the 12th and 13th ribs lumbar vertebrae

The percentage variation (R^2) of carcass tissue weights accounted for by HCW and ultrasonic measurements are shown in Table 3. All developed models were highly significant ($P<0.001$). The HCW was the first predictor admitted into the models, and accounted for 96.7, 64.6, 95.0, 85.0 and 63.7% of the variation of muscle, subcutaneous fat, inter-muscular fat, bone, and kidney and knob fat, respectively. Ultrasound tissues measurements were not admitted into the models to predict bone and subcutaneous fat, whereas models R^2 were lower than those obtained by Cadavez et al. (2002). The SFL3 and LML1 tissues measurements were admitted into the model to predict muscle; these variables produced an increase of 2.4 percent units in the coefficient of determination and reduced the RSD by 23.5%. These results are contrary to those of Delfa et al. (1999) who observed that ultrasonic measurements don't improve muscle weight prediction in kids of Blanca Celtibérica breed but, corroborate the results of Cadavez et al. (2002). For inter-muscular, the ultrasound measurements admitted into the model were LML1 and BT2; these variables increased units by further 4.8 percent. The percentage of variation explained and reduced the RSD by 27.6%. For kidney and knob fat, the LM1 ultrasound measurement was admitted into the model and increased the percentage of variation explained for a further 7.3 percent units and reduced RSD by 6.7%. These results are lower than those presented by Delfa et al. (1999, 2000), who found coefficients of determination between 0.71 and 0.95 using tissues measurements taken by ultrasounds.

Table 3. Prediction equations of the weight (g) of carcass tissues

Step	Variable	Parameter	Standard error	R^2	RSD
	Muscle				
1	Intercept	-191.7	119.59	0.943	169.6
	HCW	323.2	19.32		
2	Intercept	-160.6	108.91	0.956	149.5
	HCW	338.2	18.74		
	SFL3	-1324.8	601.60		
3	Intercept	-513.2	184.75	0.967	129.8
	HCW	311.2	20.64		
	SFL3	-1607.7	552.10		
	LML1	277.8	123.75		
	Subcutaneous fat				
1	Intercept	-34.3	25.51	0.646	33.4
	HCW	22.9	4.12		
	Intermuscular fat				
1	Intercept	-102.5	23.18	0.902	32.6
	HCW	46.9	3.74		
2	Intercept	-15.6	37.48	0.933	27.2
	HCW	54.2	4.17		
	LML1	-67.2	24.65		
3	Intercept	-45.6	35.9	0.950	23.6
	HCW	49.1	4.34		
	LML1	-60.2	22.19		
	BT2	31.5	13.92		
	Bone				
1	Intercept	134.0	46.70	0.850	64.9
	HCW	74.2	7.5		
	Kidney and knob fat				
1	Intercept	-33.4	30.44	0.564	38.8
	HCW	23.1	4.92		
2	Intercept	-14.4	39.07	0.637	36.2
	HCW	30.6	6.65		
	LMD12	-47.3	26.35		

HCW – hot carcass weight; SFL3 - subcutaneous fat thickness between the 3rd and 4th lumbar vertebrae; BT2 - breast bone tissue thickness at 2nd sternebrae; LML1 - muscle l*ongissimus* depth between the 1st and 2nd lumbar vertebrae; LMD12 - muscle l*ongissimus* depth between the 12th and 13th ribs lumbar vertebrae

CONCLUSION

Under the present experimental conditions we could indicate that HCW is the dominant variable in models to predict tissues weight of kids carcasses. The ultrasound measurements of carcass tissues taken in live kids improve the precision of models to predict muscle, intermuscular fat and kidney and knob fat weight, increasing the coefficient of determination and reducing the RSD. The HCW and tissue measurements taken by ultrasounds in live kids can be used to develop models to predict carcass composition at slaughter-houses level.

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