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## Use of cold carcass weight and fat depth measurements to predict carcass composition of Rasa Aragonesa lambs

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### Abstract

A total of 22 measurements of fat depth, taken along the 13th rib, 5–6th lumbar vertebra, 3–4th sacrum vertebra, and the 2nd, 2–3rd, 3rd, 3–4th, 4th, 4–5th sternebra of the breast bone, were taken on intact carcasses with a sharpened steel rule, and related to the carcass composition of 18 Rasa Aragonesa lambs. The objective was to study the accuracy of these different measurements for predicting carcass composition and possible value, in the process of carcass grading or classification of 'Ternasco' Aragón lambs. Cold carcass weight (CCW) accounted for 74% and 40% of the total variation of muscle weight and total carcass fat weight, respectively. The addition of 4 cm fat depth over the 13th rib from the left side accounted for a further 13% of muscle weight, and the addition of 4 cm fat depth over the 5–6th lumbar vertebra from the right side accounted for a further 29% of the variation of total carcass fat weight. Regarding different fat depots, CCW accounted for 49% and 31% of the total variation of the intermuscular fat and kidney and pelvic fat, respectively.

However, CCW alone only accounted for 21% (NS) of the total variation of subcutaneous fat weight, but the addition of 4 cm fat depth over the 13th rib from the right side or the addition of 4 cm fat depth over the 5–6th lumbar vertebra from the right side accounted for a further 47% of the subcutaneous fat variation. A comparison of the residual standard deviations (RSD) of the two measurements indicated that the fat depth over the 5–6th lumbar vertebra was more accurate for predicting subcutaneous fat. The highest precision, after CCW, for predicting intermuscular fat, was fat depth over the 13th rib from the left side, which accounted for a further 18% of total variation of this fat depot. Prediction of carcass composition was improved by the addition of fat depth measurements, assisting in the commercial classification of 'Ternasco' Aragón lambs.

### Resume

Un total de 22 mesures d'épaisseur du gras, évaluées sur la 13ème côte, entre la 5ème et la 6ème vertèbre lombaire, 3ème et 4ème vertèbre du sacrum et 2ème, 2ème–3ème, 3ème, 3ème–4ème, 4ème, 4ème–5ème sternèbres du sternum, ont été effectuées par calibrage, sur des carcasses entières et intactes et ont été rapportées à la composition de la carcasse de 18 agneaux de race Rasa Aragonesa, en ayant comme objectif principal l'étude exacte des différentes mesures d'épaisseur du gras comme éléments de prédiction de la composition de la carcasse, ainsi que l'intérêt de l'inclure dans un schéma de classification commerciale du Ternasco de Aragón.

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Le poids de la carcasse froide (PCF) explique 74 et 40% de la variation totale du poids du muscle et du gras total de la carcasse respectivement. L'addition de la mesure de l'épaisseur du gras prise sur le côté gauche de la carcasse à 4 cm de la 13<sup>ème</sup> côte augmente de 13% la précision de l'estimation de poids du muscle et l'addition de la mesure de l'épaisseur du gras prise sur le côté droit de la carcasse entre la 5<sup>ème</sup> et la 6<sup>ème</sup> vertèbre lombaire augmente de 29% la précision de l'estimation du poids du gras total de la carcasse. En ce qui concerne les différents dépôts adipeux de la carcasse, le PCF explique 49 et 31% de la variation du poids du gras intermusculaire et pelvico-rénal respectivement.

Cependant, le PCF n'explique que 21% (NS) de la variation totale du poids du gras sous-cutané, néanmoins l'addition de la mesure de l'épaisseur du gras prise sur le côté droit de la carcasse à 4 cm de la 13<sup>ème</sup> côte ou de celle prise entre la 5<sup>ème</sup> et 6<sup>ème</sup> vertèbre lombaire augmentent de 47% la précision de l'estimation de la variation du gras sous-cutané. RSD a été utilisé pour comparer l'exactitude de ces deux mesures, et on a constaté que des deux mesures, la deuxième s'est avérée plus correcte.

Après le PCF, la plus grande précision pour prédire le gras intermusculaire a été obtenue en mesurant l'épaisseur du gras sur le côté gauche de la carcasse à 4 cm de la 13<sup>ème</sup> côte la précision de la variation totale de ce dépôt gras ayant augmenté de 18%.

La prédiction de la composition des carcasses s'est améliorée avec l'addition des mesures de l'épaisseur du gras, celles-ci pouvant être incluses dans un schéma de classification commerciale du Ternasco de Aragón.

## Resumen

Un total de 22 medidas de espesor de grasa, evaluadas en la 13<sup>a</sup> costilla, entre la 5<sup>a</sup> y 6<sup>a</sup> vértebra lumbar, 3<sup>a</sup> y 4<sup>a</sup> vértebra sacra y 2<sup>a</sup>, 2–3<sup>a</sup>, 3<sup>a</sup>, 3–4<sup>a</sup>, 4<sup>a</sup>, 4–5<sup>a</sup> esternibras del esternón, fueron efectuadas con calibre, en canales enteras e intactas, y relacionadas con la composición de la canal de 18 corderos de raza Rasa Aragonesa, con el principal objetivo de estudiar la exactitud de las diferentes medidas de espesor de grasa como predictoras de la composición de la canal, así como el interés de su inclusión en un esquema de clasificación comercial del Ternasco de Aragón.

El peso de la canal fría (PCF) explica el 74 y 40% de la variación total del peso del músculo y de la grasa total de la canal respectivamente. La adición de la medida de espesor de grasa tomada en el lado izquierdo de la canal a 4 cm de la 13<sup>a</sup> costilla incrementa un 13% la precisión de la estimación del peso del músculo y la adición de la medida de espesor de grasa tomada en el lado derecho de la canal entre la 5<sup>a</sup> y 6<sup>a</sup> vértebra lumbar incrementa un 29% la precisión de la estimación del peso de la grasa total de la canal. Respecto a los diferentes depósitos adiposos de la canal, el PCF explica el 49 y 31% de la variación total del peso de la grasa intermuscular y pélvico-rénal respectivamente.

Sin embargo, el PCF, solamente explica el 21% (NS) de la variación total del peso de la grasa subcutánea, no obstante la adición de la medida de espesor de grasa tomada en el lado derecho de la canal a 4 cm de la 13<sup>a</sup> costilla o de la tomada entre la 5<sup>a</sup> y 6<sup>a</sup> vértebra lumbar incrementan un 47% la precisión de la estimación de la variación de grasa subcutánea. Para comparar la exactitud de estas dos medidas se utilizó el RSD, observándose que de las dos es más correcta la segunda.

La mayor precisión, tras el PCF, para predecir la grasa intermuscular se obtuvo con el espesor de grasa medido en el lado izquierdo de la canal a 4 cm de la 13<sup>a</sup> costilla que incrementó en un 18% la precisión de la estimación de la variación total de este depósito graso.

La predicción de la composición de las canales se incrementó con la adición de medidas de espesor de grasa, pudiendo ser incluidas en un esquema de clasificación comercial del Ternasco de Aragón.

## 1. Introduction

Many authors have studied carcass measurements in order to predict carcass composition. In sheep, Hirzel (1939) used B and C measurements as principal characters in order to classify carcasses. Palsson (1939) showed that *M. longissimus dorsi* depth

(measurement B) was an indicator of total carcass muscle, and fat thickness (measurement C) was highly correlated with subcutaneous fat. Nevertheless, Starke and Joubert (1961) suggested that the B measurement was a better predictor of *M. longissimus dorsi* weight than total carcass muscle and the J measurement (depth of rib fat) was better than C

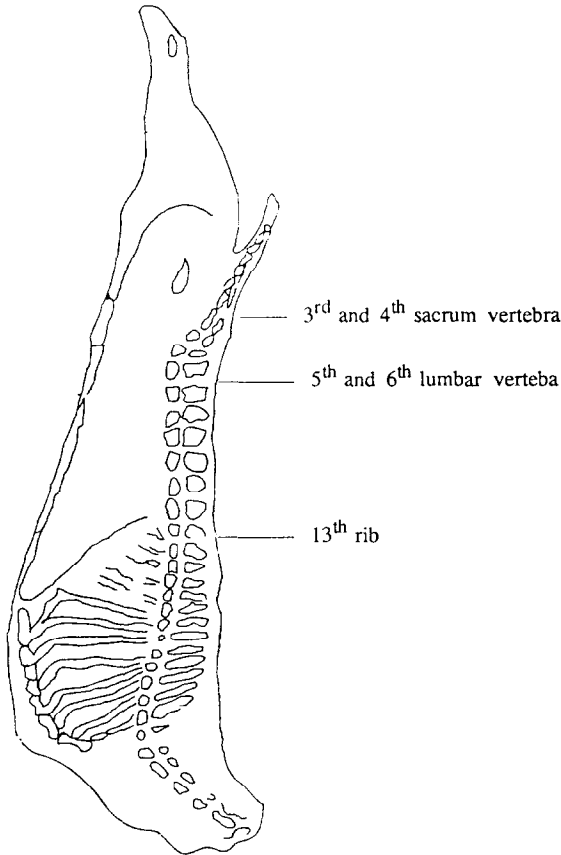


Fig. 1. Fat depths measurements taken in the 13th rib, between the 5th and 6th lumbar vertebra, between the 3rd and 4th sacrum vertebra. All measurements taken at 2 and 4 cm from the spinal column and at both sides, right and left.

measurement to estimate total carcass fat. The results from Kempster et al. (1982) showed that a visual assessment of external fat cover, kidney knob and

channel fat (KKCF) development and fat thickness (measurement C) provided precise carcass composition estimates and that sample joints are the most precise predictors. Bruwer et al. (1987) found that the inclusion of fat thickness measurements as independent variables in a multiple regression with carcass weight improved the precision of carcass composition prediction, in agreement with Timon and Bichard (1965), Kirton and Johnson (1979), Thompson and Atkins (1980) and Wood and McFie (1980).

Unfortunately, the measurements used in these studies require cutting the carcass or making subjective evaluation. The purpose of this study was to evaluate the accuracy of different measurements taken on an intact carcass, in order to predict carcass composition and possible value in the process of carcass grading or classification of the Aragón ‘Ternasco’ lambs.

## 2. Materials and methods

Eighteen Rasa Aragonesa lambs with characteristics defined by the Consejo Regulador of Ternasco (BOA, 1989) were used in this study.

The designation ‘Ternasco de Aragón’ comprises those carcasses from the extra and first categories weighing between 8.5 and 11.5 kg, belonging to male lambs from the Rasa Aragonesa, Ojinegra de Teruel and Roya Bilbilitana breeds, without sex distinction between non-castrated males and females. Sheep farms must be located within the Autonomous

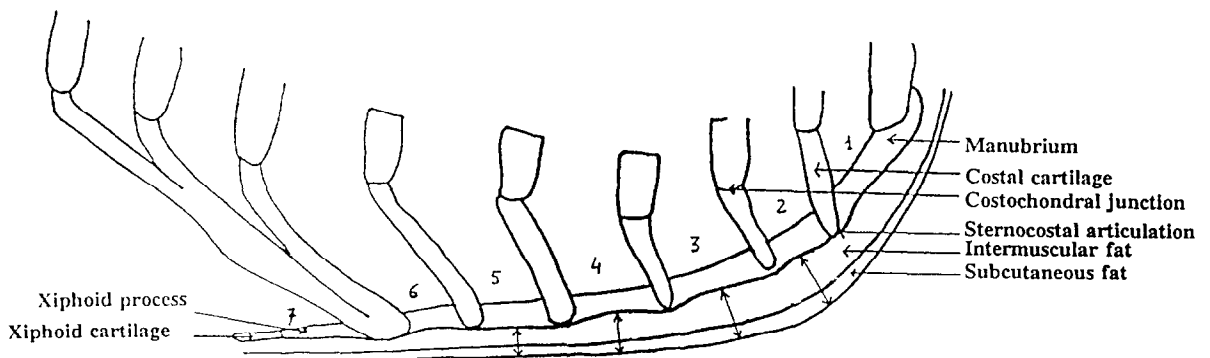


Fig. 2. All breast bone fat depths measurements taken in the middle of the 2nd, 3rd, 4th and 5th sternebra.

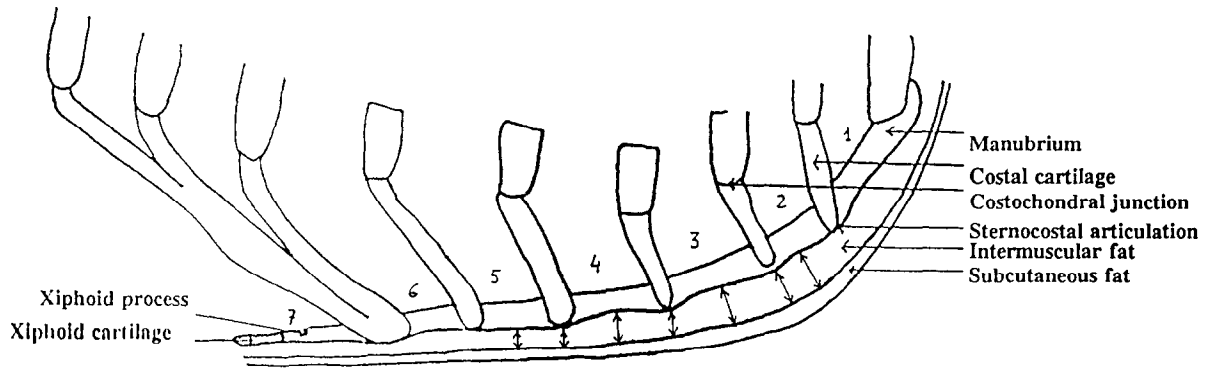


Fig. 3. Breast bone intermuscular fat depths measurements taken in the 2nd, 2–3rd, 3rd, 3–4th, 4th and 4–5th sternebra.

Community of Aragón and the lambs born and bred indoors.

Feeding must be maternal milk complemented with ad libitum white straw and concentrates authorized by the Regulating Council. The minimal period

of natural lactation is 50 days. However, during weaning, ad libitum white straw and concentrate constitute the feeding. The concentrate must have a percentage of milk substitute fixed by the Regulating Council.

Table 1

Means and standard deviations of cold carcass weight and fat depth measurements taken on 18 carcass lambs from Rasa Aragonesa breed

	Mean	Standard deviation
Cold carcass weight (kg)	10.02	0.38
<i>Fat depth measurements (mm)</i>		
13th rib 4 cm left	0.87	0.48
13th rib 4 cm right	0.89	0.51
13th rib 2 cm left	0.85	0.44
13th rib 2 cm right	0.82	0.37
5–6th lumbar 4 cm left	2.28	0.89
5–6th lumbar 4 cm right	2.37	0.98
5–6th lumbar 2 cm left	1.61	0.91
5–6th lumbar 2 cm right	1.75	1.11
3–4th sacrum 4 cm left	1.32	0.57
3–4th sacrum 4 cm right	1.66	0.65
3–4th sacrum 2 cm left	1.46	0.94
3–4th sacrum 2 cm right	1.69	0.86
All breast bone 2nd sternebrae	17.75	2.38
All breast bone 3rd sternebrae	16.91	2.00
All breast bone 4th sternebrae	12.06	2.54
All breast bone 5th sternebrae	14.38	2.74
Breast bone interm. 2nd sternebrae	11.14	2.81
Breast bone interm. 2–3rd sternebrae	9.22	1.91
Breast bone interm. 3rd sternebrae	11.06	1.61
Breast bone interm. 3–4th sternebrae	8.85	2.02
Breast bone interm. 4th sternebrae	9.36	2.08
Breast bone interm. 4–5th sternebrae	6.41	2.24

Slaughtering and carcass dressing must be performed in the Autonomous Community of Aragón. The live weight in the slaughterhouse must be between 18 and 24 kg and the age between 70 and 90 days.

Lambs were slaughtered in the experimental slaughterhouse of the Agricultural Research Service of the Autonomic Government of Aragón after 24 h fasting. Carcasses were cooled at 6°C for 24 h. A total of 22 measurements of fat depths were made taken at the 13th rib, between the 5th and 6th lumbar vertebra, between the 3rd and 4th sacrum vertebra (Fig. 1). All measurements were taken at 2 and 4 cm from the spinal column and at both sides, right and left. Measurements between the 2nd, 3rd, 4th and 5th sternebra of the breast bone (all breast bone) (Fig. 2) and the intermuscular fat depth (breast bone-intermuscular) of the 2nd, 2–3rd, 3rd, 3–4th, 4th, 4–5th

sternebra (Fig. 3) (Delfa, 1992), were taken on the intact carcass with a sharpened steel rule.

Carcasses were halved carefully and the left side was dissected into muscle, bone, subcutaneous, intermuscular and KKCF, according to the standard methods and procedures for lamb carcass evaluation by Colomer-Rocher et al. (1988).

Regression analyses (Steel and Torrie, 1980) were developed for predicting carcass composition, using cold carcass weight and the 22 fat depth carcass measurements as independent variables. The  $R^2$  and RSD (residual standard deviation) assessed the prediction accuracy of the different measurements.

### 3. Results and discussion

Means and standard deviations of cold carcass weight and fat depth measurements on the carcass

Table 2

Percentage of variation ( $R^2$ ) of carcass composition accounted for by cold carcass weight and increase when paired with fat depth measurements

	Muscle		Bone + remainder		Total fat	
	$R^2$	RSD (g)	$R^2$	RSD (g)	$R^2$	RSD (g)
Cold carcass weight	0.74 ****	51.53	0.02 NS	55.59	0.40 **	93.24
Additional variate	Increase	RSD (g)	Increase	RSD (g)	Increase	RSD (g)
(Fat depth measurements)						
13th rib 4 cm left	0.13 **	37.93	0.04 NS	56.07	0.20 **	79.06
13th rib 4 cm right	0.07 *	46.36	0.01 NS	57.11	0.27 **	71.43
13th rib 2 cm left	0.09 **	43.22	0.006 NS	57.28	0.19 *	79.24
13th rib 2 cm right	0.05 NS	48.50	0.01 NS	57.14	0.18 *	80.35
5–6th lumbar 4 cm left	0.11 **	41.21	0.03 NS	56.60	0.25 **	73.65
5–6th lumbar 4 cm right	0.04 NS	49.35	0.004 NS	57.30	0.29 **	69.21
5–6th lumbar 2 cm left	0.03 NS	50.51	0.007 NS	57.23	0.14 *	84.02
5–6th lumbar 2 cm right	0.05 NS	47.95	0.006 NS	57.25	0.27 **	71.05
3–4th sacrum 4 cm left	0.01 NS	51.99	0.07 NS	55.40	0.05 NS	91.89
3–4th sacrum 4 cm right	0.03 NS	50.43	0.13 NS	53.38	0.05 NS	92.02
3–4th sacrum 2 cm left	0.04 NS	49.50	0.28 *	48.45	0.04 NS	93.37
3–4th sacrum 2 cm right	0.02 NS	51.59	0.29 *	48.32	0.04 NS	93.19
All breast bone 2nd sternebrae	–0.04 NS	54.26	0.02 NS	58.78	0.04 NS	95.64
All breast bone 3rd sternebrae	–0.02 NS	52.41	0.13 NS	55.53	0.08 NS	92.23
All breast bone 4th sternebrae	–0.03 NS	54.28	0.15 NS	54.86	0.001 NS	97.90
All breast bone 5th sternebrae	–0.03 NS	53.95	0.02 NS	58.68	0.11 NS	89.89
Breast bone interm. 2nd sternebrae	–0.04 NS	54.26	0.01 NS	58.97	0.05 NS	94.81
Breast bone interm. 2–3rd sternebrae	–0.03 NS	53.98	0.07 NS	57.39	0.001 NS	97.96
Breast bone interm. 3rd sternebrae	0.01 NS	50.27	0.008 NS	59.18	0.02 NS	97.38
Breast bone interm. 3–4th sternebrae	–0.02 NS	53.08	0.05 NS	57.75	0.01 NS	98.07
Breast bone interm. 4th sternebrae	–0.02 NS	52.84	0.06 NS	57.59	0.01 NS	98.30
Breast bone interm. 4–5th sternebrae	–0.03 NS	53.60	0.15 NS	54.65	0.01 NS	97.80

NS, not significant; \*  $P < 0.05$ ; \*\*  $P < 0.01$ ; \*\*\*  $P < 0.001$ ; \*\*\*\*  $P < 0.0001$ . RSD, residual standard deviation.

Table 3

Percentage of variation ( $R^2$ ) of fat carcass depots accounted for by cold carcass weight and increase when paired with fat depth measurements

	Subcutaneous fat		Intermuscular Fat		KKCF	
	$R^2$	RSD (g)	$R^2$	RSD (g)	$R^2$	RSD (g)
Cold carcass weight	0.21 NS	58.06	0.49 ***	32.87	0.31 *	48.45
Additional variate (Fat depth measurements)	Increase	RSD (g)	Increase	RSD (g)	Increase	RSD (g)
13th rib 4 cm left	0.33 **	45.54	0.18 **	27.13	0.06 NS	47.65
13th rib 4 cm right	0.47 ***	38.39	0.14 *	28.97	0.02 NS	49.91
13th rib 2 cm left	0.37 **	43.65	0.10 NS	30.33	0.02 NS	49.30
13th rib 2 cm right	0.36 **	44.25	0.08 NS	31.22	0.01 NS	49.72
5–6th lumbar 4 cm left	0.40 ***	42.06	0.15 *	28.57	0.00 NS	49.99
5–6th lumbar 4 cm right	0.47 ***	37.93	0.17 **	27.58	0.07 NS	49.91
5–6th lumbar 2 cm left	0.29 **	47.72	0.05 NS	31.94	0.01 NS	49.72
5–6th lumbar 2 cm right	0.44 ***	39.83	0.17 **	27.42	0.02 NS	49.85
3–4th sacrum 4 cm left	0.09 NS	56.50	0.11 NS	29.96	0.10 NS	46.31
3–4th sacrum 4 cm right	0.14 NS	54.27	0.05 NS	31.99	0.11 NS	46.15
3–4th sacrum 2 cm left	0.04 NS	58.47	0.11 *	29.86	0.06 NS	47.95
3–4th sacrum 2 cm right	0.08 NS	56.69	0.07 NS	31.50	0.07 NS	47.66
All breast bone 2nd sternebrae	0.04 NS	60.30	0.02 NS	33.49	-0.01 NS	50.95
All breast bone 3rd sternebrae	0.06 NS	59.66	0.09 NS	31.09	0.005 NS	50.38
All breast bone 4th sternebrae	0.03 NS	60.79	-0.01 NS	39.60	0.01 NS	50.21
All breast bone 5th sternebrae	0.08 NS	58.73	0.05 NS	32.71	0.13 NS	45.66
Breast bone interm. 2nd sternebrae	0.07 NS	59.37	0.02 NS	33.73	-0.02 NS	52.21
Breast bone interm. 2–3rd sternebrae	0.03 NS	60.68	0.00 NS	34.30	0.005 NS	50.39
Breast bone interm. 3rd sternebrae	0.03 NS	60.81	0.02 NS	33.56	-0.03 NS	51.60
Breast bone interm. 3–4th sternebrae	0.05 NS	60.09	-0.02 NS	34.90	-0.03 NS	51.54
Breast bone interm. 4th sternebrae	0.05 NS	60.09	-0.02 NS	34.88	0.004 NS	50.41
Breast bone interm. 4–5th sternebrae	0.03 NS	60.80	-0.02 NS	34.91	0.04 NS	48.97

NS, not significant; \*  $P < 0.05$ ; \*\*  $P < 0.01$ ; \*\*\*  $P < 0.001$ ; \*\*\*\*  $P < 0.0001$ . RSD, residual standard deviation.

are presented in Table 1. Percentage of variation ( $R^2$ ) of carcass composition accounted for by cold carcass weight on its own, and the increase when paired with fat depth measurements are shown in Tables 2 and 3.

Cold carcass weight alone accounted for 74% ( $P \leq 0.0001$ ) and 40% ( $P < 0.01$ ) of total variation of muscle weight and total carcass fat weight, respectively. Cold carcass weight alone, only accounted for 2% (NS) of total variation of bone, plus the remainder weight.

As shown by several authors, Judge and Martin (1963); Field et al. (1963); Timon and Bichard (1965); Kempster et al. (1976); Kirton and Johnson (1979); Thompson and Atkins (1980); Wood and McFie (1980); Kirton et al. (1986); Bruwer et al.

(1987) and Delfa et al. (1991), the best carcass composition predictors are fat carcass measurements in multiple regression with carcass weight. Thus in the present study the addition of the 4 cm fat depths over the 13th rib from the left side, accounted for a further 13% ( $P \leq 0.01$ ) of muscle weight, and the addition of the 4 cm fat depth over the 5–6th lumbar vertebra from the right side, accounted for a further 29% ( $P \leq 0.01$ ) of the variation of total carcass fat weight.

Cold carcass weight accounted for only 21% (NS) of the variation in subcutaneous fat weight, but the addition of the fat depth measurement taken 4 cm over the 13th rib, on the right side of the carcass, or the fat depth measurement taken 4 cm over the 5–6th lumbar vertebra on the right side of the car-

cass, accounted for a further 47% ( $P \leq 0.001$ ) of total variation. For comparing the accuracy of these two measurements, we used the RSD which was lower for the measurement taken over the 5–6th lumbar vertebra.

Cold carcass weight accounted for 49% ( $P \leq 0.001$ ) and 31% ( $P \leq 0.05$ ) of the total variation of the intermuscular fat and KKCF, respectively. The addition of 4 cm fat depth over 13th rib from the left side, accounted for a further 18% ( $P \leq 0.01$ ) of the total variation of intermuscular fat. Delfa et al. (1991) working with ewes with different body condition scores, have found that the cold carcass weight alone was the best predictor of intermuscular fat ( $R^2 = 0.94$ ), and accounted for 93% of the variation of total carcass fat 87% of the variation of subcutaneous fat could be explained by cold carcass weight. These differences can be explained because the present study involves 18 lambs with the same live weight, whereas the work mentioned above was carried out on 52 ewes with a greater range of condition score.

In spite of the fact that any measurement increased the accuracy of prediction of KKCF, fat measurement taken over all breast bone 5th sternebra accounted for a further 13% (NS) of the total variations of this fat depot.

There was little improvement in the prediction of carcass composition from the addition of more than one fat depth combined with cold carcass weight in multiple regression.

#### 4. Conclusion

The results suggest that the prediction of carcass composition was improved by the inclusion of one fat depth measurement in multiple regression with cold carcass weight, indicating its usefulness in a more accurate commercial classification of Aragón lambs.

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