BREED AND SLAUGHTER LIVE WEIGHT EFFECTS ON INTRAMUSCULAR COLLAGEN CHARACTERISTICS OF SEVERAL OVINE MUSCLES.

Panea, B., Martínez-Cerezo, S., Olleta, J.L., Medel, I. and Sañudo, C.
Department of Animal Production and Food Science. University of Zaragoza. C/ Miguel Servet 177; 50013. Zaragoza. Spain

BACKGROUND

Tenderness seems to be the most important meat quality characteristic for consumers (Monin, 1991; Zamora *et al.,* 1996). It is well established that the amount and properties of collagen, such as solubility, are important in determining meat tenderness (Burson and Hunt, 1986; Horgan *et al.,* 1991). Differences in collagen thermal stability are mainly related to the stable crosslink content (Berge *et al.,* 1997) which in turn depends on other factors such as breed, sex, age, diet, husbandry practices, slaughter live weight, carcass handling, muscle type and conditioning (Judge and Aberle, 1982; Kamoun *et al.,* 1989). Little information is available on the effect of these factors, especially breed and weight, on the collagen characteristics of sheep.

OBJECTIVES

To study the content and the solubility of intramuscular collagen of several muscles from three ovine breeds at three different slaughter weights.

MATERIAL AND METHODS

Forty-five male lambs were used, 15 each from the following Spanish breeds: Rasa Aragonesa (rustic type meat breed, RT), Churra (dairy breed, DB) and Merino Español (ME). Three different slaughter weight lots were considered in each breed: suckling lambs (10-12 kg live weight), light lambs (20-22 kg live weight) and early fattening lambs (30-32 kg live weight). Samples were obtained from four muscles per animal: *Semimembranosus* (SM), *Semitendinosus* (ST), *Gluteo biceps* (GB) and *Longissimus dorsi* (LD).

Animals were reared at the farm of origin until 10-12 kg live weight. Suckling lambs were slaughtered in an abattoir at the place of origin to avoid transport stress. All the other animals were shipped to a fattening plant, fed with concentrate and cereal straw "ad libitum" and slaughtered at the appropriate weight. Muscles were dissected from carcasses 24 hours after slaughter. Each muscle was divided into two parts: one half to calculate the total collagen content (vacuum packed and frozen at –18ºC until analysis) and another half to estimate the insoluble collagen content. Total and insoluble collagen contents were calculated using the method described by Bonnet and Kopp (1984). Results were expressed as µg of collagen/grams of fresh muscle. Solubility percentages were calculated from these results. Data were analysed using SPSS 8.0 statistical software. Means and standard deviations were calculated for every breed, weight and muscle. A GLM procedure was used where breed, slaughter weight and muscle were the fixed effects and the differences were compared with Scheffé test.

RESULTS AND DISCUSSION

General significance of the three fixed effects and interactions are shown in Table 1. Means and standard deviations for each breed, slaughter weight and muscle are shown in Table 2. As seen in Table 1, total collagen content was mainly affected by breed and muscle, without an effect of slaughter live weight. The muscle effect was the most important on insoluble collagen content while breed was the most important effect affecting solubility percentage. Nearly all interactions were significant, indicating that collagen characteristics differ in terms of live weight, breed or muscle.

Breed

Most of the differences between breeds were related to percentage solubility, which was quite variable in suckling lambs. Differences among breeds depended on the muscle considered. ME had the highest solubility percentage (in light and in early fattening lambs), possibly because in Spain, Merino is mainly a meat breed with a fast growth rate. As the animal builds up its muscle tissue, new collagen synthesis is promoted which is less crosslinked and more soluble (Kopp, 1971; Berge *et al.,* 1997, Damergi *et al,* 1998). Thus, in leg muscles, rustic and dairy breeds had lower solubility percentages. At the same chronological age, rustic breeds have a higher physiological age and consequently, thermally stable collagen forms also increase (Judge and Aberle, 1982; Bosselman *et al.,* 1995) and its solubility decreases (Kopp, 1971). Similarly, in this study, total collagen content was generally higher in ME than in other breeds but there were no significant differences in suckling lambs.

Live weight

According to Table 1, live weight did not have an important effect on the collagen characteristics and varied among breeds. High total collagen and lower insoluble collagen were observed in heavier slaughter weights (e.g., in ME, which has a high daily rate breed).

Muscle

In general, GB had the highest total and insoluble collagen contents and LD or ST muscles had the lowest values. The amount of collagen in a specific muscle depends on several factors, including fibre diameter and exercise. As a result, muscles involved in animal movement, such as in the forequarter, have more connective tissue and with a thicker perimysium (which is the basis of muscle classification in commercial categories) in order to transmit the movement throughout the tendons (Boccard and Bordes, 1986). On the other hand, the differences in collagen solubility among muscles were quite variables and depended on breed and weight.

CONCLUSIONS

Breed was the most important effect determining total collagen content and collagen solubility percentage, while the amount of insoluble collagen was mainly affected by muscle type. By comparison, the slaughter weight effect was much less important.

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Table 1. Significance (F value) of the three effects studied: breed, weight and muscle.

Effect	Total collagen	Insoluble collagen	Solubility percentage
Breed	28.63***	5.28**	31.31***
Weight	0.09	4.40*	2.26
Muscle	15.45***	12.70***	2.23
Breed*weight	7.41***	3.24*	5.53***
Breed* muscle	2.47*	5.62***	2.82*
Weight* muscle	6.32***	1.79	4.65***
Breed*weight*muscle	5.09***	2.96***	6.12***

$^{*}p\leq 0.05$; $^{**}p\leq 0.01$; $^{***}p\leq 0.001$

Table 2. Means and standard deviations for several breeds, live weights and muscles in lambs

Sample			Total collagen (μg/g)	Insoluble collagen (μg/g)	Solubility percentage (%)
Rasa Aragonesa (rustic type-RT)	Suckling (10-12 kg)	SM	533.6 (131.1) x	226.2 (63.8) AB	55.3 (17.1) A
		ST	395.7 (103.9)	291.9 (56.1) aA	23.4 (18.0) byB
		GB	445.4 (116.8)	241.5 (62.4)AB	44.8 (10.4) aAB
		LD	368.4 (70.8)	157.0 (32.0) B	54.9 (17.1) axA
	Light (20-22 kg)	SM	321.9 (58.1) byBC	222.9 (23.9)	29.1 (13.7) bAB
		ST	446.2 (79.9) bAB	205.6 (71.5)	54.1 (11.6) abx A
		GB	490.0 (69.8) bA	255.1 (60.2)	48.3 (6.0) ab A
		LD	260.3 (95.7) C	191.6 (33.3) b	21.5 (17.4) by B
	Early fattening (30-32 kg)	SM	390.5 (77.6) xy	187.6 (34.7)	49.3 (19.0)
		ST	346.3 (58.4)	213.2 (34.4) a	36.5 (17.2) xy
		GB	338.4 (80.1) b	194.0 (22.6) b	40.7 (10.7) c
		LD	313.8 (67.2) b	201.4 (34.3) b	34.0 (13.4) bxy
Churra (dairy breed-DB)	Suckling (10-12 kg)	SM	418.5 (108.1)	233.6 (67.7) AB	44.5 (2.1) xy AB
		ST	476.5 (171.3)	168.1 (28.3) bB	62.5 (9.9) a A
		GB	411.0 (129.1) y	292.9 (18.0) A	23.9 (19.3) by B
		LD	421.4 (75.3)	190.1 (46.7) B	55.2 (6.6) a A
	Light (20-22 kg)	SM	328.7 (84.2) b	210.2 (48.7)	34.7 (11.1) by
		ST	353.3 (87.5) b	205.4 (62.3)	41.4 (11.9) b
		GB	409.2 (113.3) by	272.1 (47.2)	30.6 (15.3) by
		LD	436.0 (168.7)	247.3 (33.4) a	37.8 (20.9) ab
	Early fattening (30-32 kg)	SM	439.7 (85.1) B	214.1 (10.2) BC	50.2 (7.30) x AB
		ST	415.1 (149.2) B	181.0 (8.2) ab C	52.4 (14.1) AB
		GB	704.3 (64.5) ax A	297.0 (49.3) a A	57.6 (7.7) bx A
		LD	387.9 (92.2) b B	251.3 (32.6) a AB	32.3 (16.3) b B
Merino Español (meat breed-ME)	Suckling (10-12 kg)	SM	434.5 (32.0) BC	232.9 (59.7)	46.8 (11.3) B
		ST	574.5 (41.8) x A	186.5 (40.7) b	67.4 (7.3) ax A
		GB	497.4 (40.8) z AB	263.3 (35.6) x	46.8 (8.5) ay B
		LD	385.2 (77.0) y C	241.7 (63.6) x	37.2 (12.4) by B
	Light (20-22 kg)	SM	503.0 (123.8) a BC	184.2 (27.6) B	61.5 (10.5) a AB
		ST	625.5 (76.6) ax AB	196.1 (29.9) B	68.4 (5.0) ax A
		GB	767.5 (67.4) ax A	263.7 (41.9) x A	65.2 (7.4) ax AB
		LD	377.6 (46.8) y C	178.3 (18.6) bxy B	52.0 (9.2) ay B
	Early fattening (30-32 kg)	SM	518.7 (216.0) AB	233.5 (53.1) A	51.2 (13.4) B
		ST	311.3 (37.3) y B	150.9 (26.2) b B	50.8 (11.5) y B
		GB	673.9 (14.9) ay A	165.1 (24.9) by B	75.5 (3.4) ax A
		LD	568.3 (34.0) ax A	162.3 (11.9) by B	71.3 (3.4) ax A

a, b, c.- Different letters in the same column reflect significant differences between breeds within live weight and muscle ($p\leq 0.05$).
x, y, z.- Different letters in the same column reflect significant differences between live weights within breed and muscle ($p\leq 0.05$).
A, B, C - Different letters in the same column reflect significant differences between muscles within breed and live weight ($p\leq 0.05$).

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