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Carcass traits and meat fatty acid composition in Mediterranean light lambs

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Abstract: Lamb meat is an important source of different fatty acids with numerous health benefits for the consumer. The aim of this study was to characterize carcass and meat traits in 14 Lacaune, 77 Ripollesa, and 33 Lacaune × Ripollesa pascual-type lambs (carcass weight, 13–16 kg) by using ultrasound and direct measurements on carcasses and laboratory analyses on meat samples. More specifically, ultrasound images and direct carcass measurements of the *Longissimus dorsi* (LD) were taken between the 12th and 13th ribs and between the first and second lumbar vertebrae, characterizing skin thickness, subcutaneous back-fat thickness, and depth, width, and area of LD. After slaughter, standard commercial joints were weighted (i.e., leg, rack, shoulder/foreshank, and neck), whereas a sample of the LD muscle was analyzed for fatty acid composition. All of this information becomes essential for light lamb producers, a livestock product that has a high market demand in the Mediterranean basin.

Key words: carcass trait, fatty acid, light lamb, meat composition, ultrasound.

Résumé : La viande d'agneau est une source importante des différents acides gras avec de nombreux effets bénéfiques pour la santé des consommateurs. Le but de cette étude était de caractériser les traits de carcasse et de viande chez 14 agneaux Lacaune, 77 Ripollesa et 33 Lacaune × Ripollesa de type pascual (poids de carcasse : 13–16 kg) en utilisant des mesures ultrasons et directes sur les carcasses et des analyses de laboratoire sur des échantillons de viande. Plus particulièrement, des images ultrasons et des mesures directes de la carcasse du muscle *Longissimus dorsi* (LD) ont été effectuées entre les 12e et 13e côtes et entre les première et deuxième vertèbres lombaires, caractérisant l'épaisseur de la peau, l'épaisseur du gras dorsal sous-cutané ainsi que la profondeur, largeur et aire du muscle LD. Après abattage, les joints commerciaux standards ont été pesés (c.-à-d. cuisse, carré, épaule/jarret et cou), tandis qu'un échantillon du muscle LD a été analysé pour la composition en acides gras. Toute cette information devient essentielle pour les producteurs d'agneaux légers, un produit animal très populaire dans le marché du bassin de la Méditerranée. [Traduit par la Rédaction]

Mots-clés : traits de carcasse, acides gras, agneau léger, composition de la viande, ultrasons.

Introduction

Within the context of the sheep industry, consumer preferences towards light and low-fat lambs have been extensively reported in southern Europe (Alfonso et al. 2001; Font I Furnols et al. 2006; Teixeira et al. 2006). Lambs are typically slaughtered after weaning (~10 kg live weight) or after a short fattening period (20–30 kg live weight) in several areas of the Mediterranean basin. Moreover, society's concern about meat composition and its relationship with human health has increased during the last few decades (Bernabéu and Tendero 2005), and is currently a key point for the sheep farming industry (Mortimer et al. 2010). Among other types of meat, lamb meat has been suggested as a relevant source of omega-3 fatty acids [e.g., long-chain polyunsaturated fatty acids (PUFAs) and several conjugated linoleic acid

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isomers], with beneficial effects on attenuating carcinogenesis, atherosclerosis, the onset of diabetes, and obesity (Wong et al. 1997), and it has revealed a lower level of allergenicity than red meat from other domestic species (Nudda et al. 2011). The evidence provided by these studies would be of special relevance to stockbreeders, although not all of it can be directly extrapolated to all lamb production systems given the plethora of factors that influence lamb meat quality (Sañudo et al. 1998). This is of special relevance in light lamb production systems where little is known about the composition of lamb meat at early ages.

Although light lamb production represents the largest share of the lamb market in many Mediterranean countries (Sañudo et al. 1998), little is known about carcass peculiarities and meat composition at early ages of lambs. Moreover, this kind of lamb production involves multiple sheep breeds, including native types such as the Ripollesa breed, with an approximate census of 30 000 ewes in the northeastern region of Spain (Casellas et al. 2007). Within this context, this paper focuses on the characterization of carcass and meat composition traits for light lambs from sheep breeds with a worldwide distribution, i.e., the meat-type Lacaune, and a Spanish-native sheep breed, i.e., the Ripollesa. Carcass traits were evaluated by both ultrasound techniques on live animals and direct measurements on the carcass after slaughter; furthermore, the fatty acid profile of the *Longissimus dorsi* (LD) muscle was also characterized. This study was carried out to provide detailed knowledge about the commercial output from this type of Mediterranean productive system and to highlight candidate targets for further breeding programs in sheep breeds.

Materials and Methods

All animal protocols were approved by the Universitat Autònoma de Barcelona (Bellaterra, Spain) Animal Care and Use Committee (reference CEEAH1260) and were designed and conducted according to the guidelines of Council Directive 86/609/EEC (European Communities 1986) on the protection of animals used for scientific purposes.

Animals and management

This study focused on two meat-type sheep breeds, Ripollesa and Lacaune, as well as their first-generation cross. Among the native sheep breeds in Spain, the Ripollesa is the most abundant breed in Catalonia (i.e., the northeastern region of Spain), producing pascual-type lambs that are slaughtered at ~3 mo of age with a carcass weight of 13–16 kg. It is a rustic meat-type breed with convex profile, characteristic black or dark brown pigmentation on the head and legs, and white entrefino-type wool (Esquivelzeta et al. 2011). The meat-type Lacaune is the most numerous sheep breed in France for producing lambs, with a census exceeding 300 000 ewes (Perret et al. 1995). A total of 124 Ripollesa (n = 77), Lacaune (n = 14), and Ripollesa × Lacaune (n = 33) pascual-type lambs (58 males and 66 females), from the Ramaderia Castosa flock (Bigues i Riells, Barcelona, Spain) were involved in this research.

After weaning at approximately 30 d of age, the lambs were housed indoors (<2 lambs m^{-2}) and fattened with concentrate (15.14% crude protein; 2.80 Mcal kg^{-1} of metabolisable energy) and hay ad libitum; continuous access to fresh water was also guaranteed. The lambs were slaughtered when they reached 24–28 kg of live body weight, which is representative of the pascual-type lambs produced in the Mediterranean region.

Ultrasound measurements and image analysis

Although relevant differences among breeds (and their first-generation cross), if any, must be effectively evaluated on the carcass itself, ultrasound measurements were also included in this study to evaluate its ability to anticipate phenotypic patterns later found in the slaughterhouse. Two different LD ultrasound images were recorded per lamb 48–72 h before slaughter by the same trained technician using Vet180 Plus ultrasound equipment with a C60 convex probe of 2–5 MHz (SonoSite Inc., Bothell, WA, USA). Ultrasound images were taken at thoracic (TV; between the 12th and 13th ribs) and lumbar locations (LV; between the first and second lumbar vertebrae). At each location, transverse (TR; perpendicular to the vertebral column, covering all the LD from the nearest end to the backbone) and longitudinal ultrasound images were recorded (LG; parallel to the vertebral column, in the middle of the total length of the transverse apophysis). Before ultrasound images were taken, fleece was clipped and vegetable oil was directly applied to the skin as coupling medium. A superflab standoff (SonoSite Inc., Bothell, WA, USA) was used for TR ultrasound images to ensure proper fit of the transducer to the animal's body shape, and acoustic gel was applied between the transducer and the superflab standoff. Pressure on the transducer head was kept to a minimum to avoid the compression of both fat and muscle. Ultrasound images were recorded for later viewing and analysis.

All ultrasound measurements were obtained using ImageJ version 1.42q software (NIH 2009) by the same trained technician. Focusing on TR images at both TV and LV locations, skin thickness (ST), subcutaneous back-fat thickness (BFT), and depth (DLD), width (WLD), and area (ALD) of the LD were measured. In a similar way, the ST, BFT, and DLD of the LD were measured in the LD images. Note that DLD and WLD were the maximum height and width of the loin muscle, whereas ST and BFT were evaluated in the midpoint between the 12th and 13th ribs (TV location) or between the first and second lumbar vertebrae.

Slaughter procedure and carcass trait measurements

Lambs were slaughtered 48–72 h after ultrasound measurement in a commercial slaughterhouse (Carns Riu SL, Caldes de Montbui, Barcelona, Spain) by standard commercial practices. Carcasses were individually identified and chilled at 4 °C for 24 h. Following this, carcasses were weighed and halved. Cold carcass weights were measured for the right half of the carcass divided into standard commercial joints, i.e., (a) neck (scrag end), (b) shoulder and foreshank, (c) leg, and (d) trunk. As for the ultrasound images, BFT, DLD, WLD, and ALD were directly measured on the cold carcass between the 12th and 13th ribs and between the first and second lumbar vertebrae. More specifically, BFT, DLD, and WLD were measured with a ruler, whereas ALD was measured by tracing the outer perimeter of the LD on acetate paper. A sample of the LD muscle corresponding to the 12th meat chop on the right-half carcass was taken for further analyses of fatty acid composition.

Intramuscular fatty acid composition analysis

After collecting the LD samples they were labeled and frozen at −18 °C for subsequent analyses in the laboratory of the Departamento de Producción Animal y Ciencia de los Alimentos of the Universidad de Zaragoza (Zaragoza, Spain). The samples were thawed and ground before analysis. To determine intramuscular fat, the first lipid extraction was performed; once the fatty methyl esters were collected, the fatty acid composition was determined by gas chromatography following the method of Carrilho et al. (2009). After determination of individual fatty acids, the proportions of saturated fatty acids (SFA, C10:0 + C11:0 + C12:0 + C13:0 + C14:0 + C15:0 + C16:0 + C17:0 + C18:0 + C20:0 + C22:0 + C23:0 + C24:0), monounsaturated fatty acids (MUFA, C14:1 + C16:1 + C17:1 + C18:1 + C20:1 + C22:1), and polyunsaturated fatty acids (PUFA, C18:2*n*-6 + C18:3*n*-3 + C18:3*n*-6 + C20:2*n*-3 + C20:2*n*-6 + C20:3*n*-3 + C20:3*n*-6 + C20:4*n*-6 + C20:5*n*-3 + C22:2*n*-6 + C22:6*n*-3), as well as the nutritional ratios of PUFA/MUFA, *n*-6/*n*-3 [(C18:2*n*-6 + C18:3*n*-6 + C20:2*n*-6 + C20:3*n*-6 + C20:4*n*-6 + C22:2*n*-6)/(C18:3*n*-3 + C20:2*n*-3 + C20:3*n*-3 + C20:5*n*-3 + C22:6*n*-3)], and C18:2*n*-6/C18:3*n*-3 (linoleic/α-linolenic) were calculated.

Statistical analysis

Carcass traits, direct and ultrasound measurements on the LD area, and meat fatty acid composition were analyzed by the generalized linear model procedure of SAS version 9.1 (SAS Institute Inc., Cary, NC, USA) using the following linear model:

$$y_{ijk} = \mu + B_i + S_j + \varepsilon_{ijk}$$

where y_{ijk} is the phenotypic record, μ is the population mean, B_i is the breed effect with three categories (i.e., Ripollesa, Lacaune, and Ripollesa × Lacaune), S_j is the gender effect with two categories (i.e., male or female), and ε_{ijk} is the residual term. Differences among least square means were determined by using the Student–Newman–Keuls's test.

Results and Discussion

Ultrasound and direct measurements on the LD muscle

Although ultrasounds have been suggested as an appealing way to evaluate carcass traits in vivo (Herring et al. 1998), their usefulness in light lambs remains unclear (Leeds et al. 2008; Emenheiser et al. 2010*a*, 2010*b*; Esquivelzeta et al. 2012). Ultrasounds (Tables 1 and 2) failed to find most of the relevant departures later revealed by the direct measurement of the carcass (Table 3; e.g., WLD and ALD at the thoracic level and WLD at the lumbar level), and even suggested significant differences for DLD at the thoracic level that were never revealed when checking carcasses in the slaughterhouse (Table 3). These inconsistencies may be linked to the moderate correlation coefficients between direct and ultrasound measurements previously reported on the same data set for all traits (0.61–0.88; Esquivelzeta et al. 2012), with the exception of BFT which reached worse correlations (0.32–0.60). Focusing on BFT estimates, they were smaller than those reported for heavier animals by Leeds et al. (2008) and Thériault et al. (2009). Nevertheless, one must be cautious when making this kind of comparisons because Mediterranean and United States sheep industries are markedly different. The delay between ultrasound measurement and lamb slaughter (2–3 d) must explain part of these inconsistencies, although moderate correlations were also reported in other Mediterranean sheep populations with similar production systems (Ripoll et al. 2009, 2010). As a whole, these results must inform the sheep industry about the potential weakness and limitations of the ultrasound technology to evaluate light lambs in vivo.

Focusing on cold carcass measurements, BFT did not show significant differences between the purebred (i.e., Ripollesa and Lacaune) and crossbred individuals, whereas Lacaune lambs revealed wider LD muscles with larger areas. An advantage in DLD was also revealed for Lacaune lambs, although restricted to the lumbar level. When compared with other studies on lambs with similar body weight, ALD was similar to the estimates reported in Manchega and Merina breeds (Fernández et al. 1997), and smaller than the values provided for Suffolk-crossed lambs (Stanford et al. 2001). In contrast, the DLD of the lambs used in this study was larger than in neighboring breeds, such as the Churra Tensina and Rasa Aragonesa (Ripoll et al. 2009), confirming the meat aptitude of the animals used in this study. Focusing on BFT, it is important to highlight that pascual-type lambs used in this study were leaner than similar individuals from neighbor breeds, such as Rasa Aragonesa (Delfa et al. 1995; Ripoll et al. 2009), Churra Tensina (Ripoll et al. 2009, 2010), Manchega, Merina, and Ile de

Table 1. Least square means ± SD of transversal ultrasound measurements at thoracic and lumbar levels for purebred (Ripollesa and Lacaune) and crossbred lambs.

Trait	Ripollesa	Ripollesa × Lacaune	Lacaune
Thoracic level			
ST (cm)	0.16a ± 0.03	0.16a ± 0.03	0.17a ± 0.03
BFT (cm)	0.17a ± 0.05	0.16a ± 0.03	0.17a ± 0.03
DLD (cm)	2.36a ± 0.24	2.48a ± 0.25	2.45a ± 0.27
WLD (cm)	4.44a ± 0.38	4.66a ± 0.79	4.71a ± 0.22
ALD (cm^2)	9.65a ± 1.30	9.94a ± 1.08	10.17a ± 1.28
Lumbar level			
ST (cm)	0.16b ± 0.02	0.16b ± 0.03	0.18a ± 0.03
BFT (cm)	0.17a ± 0.07	0.17a ± 0.04	0.18a ± 0.07
DLD (cm)	2.33b ± 0.22	2.47a ± 0.25	2.51a ± 0.33
WLD (cm)	4.48a ± 0.42	4.75a ± 0.79	4.69a ± 0.39
ALD (cm^2)	9.59b ± 1.32	10.04ab ± 1.09	10.69a ± 1.49

Note: Means with the same lowercase letter across a row did not differ significantly ($P > 0.05$). ST, skin thickness; BFT, subcutaneous back-fat thickness; DLD, depth of *Longissimus dorsi*; WLD, width of *Longissimus dorsi*; ALD, area of *Longissimus dorsi*.

Table 2. Least square means ± SD of longitudinal ultrasound measurements at thoracic and lumbar levels for purebred (Ripollesa and Lacaune) and crossbred lambs.

Trait	Ripollesa	Ripollesa × Lacaune	Lacaune
Thoracic level			
ST (cm)	0.11a ± 0.02	0.12a ± 0.02	0.12a ± 0.02
BFT (cm)	0.12a ± 0.03	0.13a ± 0.03	0.12a ± 0.02
DLD (cm)	2.16b ± 0.24	2.28ab ± 0.26	2.35a ± 0.22
Lumbar level			
ST (cm)	0.12a ± 0.02	0.13a ± 0.02	0.13a ± 0.02
BFT (cm)	0.13a ± 0.05	0.13a ± 0.02	0.12a ± 0.02
DLD (cm)	2.09b ± 0.22	2.24a ± 0.37	2.27a ± 0.28

Note: Means with the same lowercase letter across a row did not differ significantly ($P > 0.05$). ST, skin thickness; BFT, subcutaneous back-fat thickness; DLD, depth of *Longissimus dorsi*.

France × Merina (Fernández et al. 1997; Ripoll et al. 2009). Note that lean carcasses are of special interest for the light lamb production industry, given that leaner animals are typically preferred in the Mediterranean area (Alfonso et al. 2001; Font I Furnols et al. 2006; Teixeira et al. 2006).

Carcass quartering

The light lambs in this study were slaughtered at an average live weight of 26.8 kg, with a carcass weight and carcass yield of ~13 kg and ~49%, respectively. Commercial joints averaged 0.85 kg (neck), 1.08 kg (shoulder and foreshank), 1.46 kg (leg), and 3 kg (trunk), although some variability was shown among the breed types (Table 4). Comparing our results with previous estimates of heavier lambs from other countries like the USA (20.6–30.6 kg carcass weight; Carter et al. 1973; Leeds et al. 2008) and Australia (19–24 kg carcass weight; Hopkins and Fogarty 1998), the carcass yield (53% versus 49%) was very similar despite differences in carcass weight. Focusing on the commercial joints, Hopkins and Fogarty (1998) and Leeds et al. (2008) reported lighter necks, whereas Carter et al. (1973) and Leeds et al. (2008) reported heavier legs in light lambs, although these differences could be partially attributed to differing carcass retail procedures and the corresponding commercial joints.

When comparing slaughter variables and weights of the carcass joints among the breeds, significant differences were only found for carcass weight and the neck cut, which were heavier for the Lacaune breed (Table 4). In general, the breed did not affect the proportions of the slaughter variables or weights of the carcass joints, suggesting that these three meat-type lambs had very similar performances, in contrast with previous studies which suggested that carcass weights could be largely dependent on the breed of the lamb (Barone et al. 2007; Rodríguez et al. 2011).

Table 3. Least square means ± SD of direct carcass measurements at thoracic and lumbar levels for purebred (Ripollesa and Lacaune) and crossbred lambs.

Trait	Ripollesa	Ripollesa × Lacaune	Lacaune
Thoracic level			
BFT (cm)	0.24a ± 0.07	0.21a ± 0.05	0.23a ± 0.07
DLD (cm)	2.42a ± 0.26	2.55a ± 0.28	2.51a ± 0.29
WLD (cm)	4.46b ± 0.33	4.46b ± 0.52	4.82a ± 0.16
ALD (cm^2)	9.66b ± 1.14	10.13b ± 1.24	11.21a ± 1.31
Lumbar level			
BFT (cm)	0.25a ± 0.09	0.22a ± 0.06	0.27a ± 0.09
DLD (cm)	2.40b ± 0.25	2.61a ± 0.29	2.59a ± 0.35
WLD (cm)	4.58b ± 0.39	4.53b ± 0.44	4.93a ± 0.42
ALD (cm^2)	9.97b ± 1.42	10.28b ± 1.32	11.16a ± 0.95

Note: Means with the same lowercase letter across a row did not differ significantly ($P > 0.05$). ST, skin thickness; BFT, subcutaneous back-fat thickness; DLD, depth of *Longissimus dorsi*; WLD, width of *Longissimus dorsi*; ALD, area of *Longissimus dorsi*.

Intramuscular fatty acid composition

The intramuscular fat content of the LD muscle and its fatty acid composition is shown in Table 5. The fatty acids most frequently represented in the LD muscle of light lambs were oleic (C18:1*n*-7, 38.84%), palmitic (C16:0, 21.66%), and stearic (C18:0, 14.29%); only the first

Table 4. Mean ± SD of weight and carcass traits for purebred (Ripollesa and Lacaune) and crossbred lambs.

Trait	Ripollesa	Ripollesa × Lacaune	Lacaune
Slaughter variables			
Slaughter weight (kg)	26.90a ± 1.13	26.76a ± 1.57	27.12a ± 0.89
Carcass weight (kg)	13.21ab ± 0.86	12.86b ± 0.83	13.51a ± 0.46
Carcass yield (%)	49.10a ± 2.68	48.09a ± 2.66	49.87a ± 1.99
Weight of carcass joints			
Neck (kg)	0.81b ± 0.10	0.80b ± 0.10	0.87a ± 0.11
Shoulder and foreshank (kg)	1.09a ± 0.07	1.06a ± 0.07	1.07a ± 0.05
Rack (kg)	3.06a ± 0.29	2.92a ± 0.28	3.01a ± 0.25
Leg (kg)	1.41a ± 0.09	1.42a ± 0.09	1.48a ± 0.08

Note: Means with the same lowercase letter across a row did not differ significantly ($P > 0.05$).

one revealed a significant difference departure among breeds, with higher percentages in Lacaune lambs (Table 5). These percentages were similar to those provided by Sañudo et al. (2000), Velasco et al. (2001), Díaz et al. (2005), and Juarez et al. (2010) in Spanish lambs that were lighter than the ones used in this study (~10 kg of carcass weight), and Velasco et al. (2004) in heavier lambs. Far from impairing the relevance of this research, both the similarities with previously published results and the scarcity of remarkable departures between Ripollesa and Lacaune lambs must be viewed as a relevant contribution for the sheep industry. Crossbreeding have had a deep impact over sheep populations worldwide (Rasali et al. 2006), also in the Mediterranean area where the Ripollesa breed comes from (Dalvit et al. 2009). Within this context, stockbreeders can guarantee the homogeneity of the final product (i.e., meat composition), even under crossbreeding with the Lacaune breed.

Even though the fatty acid composition of meat from ruminants was reported to be barely affected by ruminal modifications (Díaz et al. 2005), we found lower percentages of linoleic fatty acid (4.16%) than the 9.48% and 5.45% reported for Spanish and Uruguayan light lambs, respectively (Díaz et al. 2005). Linoleic fatty acid is the only essential ω6 PUFA [Institute of Medicine (IOM) 2005] and there were no statistical differences among the breeds included in this study. The percentage of linolenic fatty acid was significantly higher in the Lacaune breed, as well as the percentages of eicosapentaenoic (C20:5*n*-3), docosahexaenoic (C22:6*n*-3), and docosadienoic (C22:2*n*-6) fatty acids. Note that the *n*-3 PUFA plays an important role as a structural membrane lipid, particularly in the nerve tissue and in the retina, and it is a precursor to eicosanoids and linolenic fatty acid.

The percentages of SFA were greater for Ripollesa and Ripollesa × Lacaune individuals, and these were comparable with values reported by Sañudo et al. (2000) and Díaz et al. (2005) in other Spanish lambs. Levels of MUFAs were higher compared with those in previous reports (Díaz et al. 2005), although they were lower in the Lacaune breed than in the remaining individuals. On the contrary, PUFAs showed higher percentages in Lacaune lambs although, in general, they were lower than found in previous studies (Díaz et al. 2005), suggesting that the animals fed with concentrate could have had lower levels of PUFAs than grass-fed lambs (Enser et al. 1998; Díaz et al. 2002). All individuals had a PUFA/SFA ratio ranging between 0.15 and 0.19 (Table 5), which was lower than the ratios reported for meat from lighter lambs slaughtered at younger ages (Velasco et al. 2001; Napolitano et al. 2002; Díaz et al. 2005; Oriani et al. 2005), although it was larger than those reported by Enser et al. (1998) for older and grass-fed lambs.

Fatty acids are of special relevance to human health, especially, long-chain PUFAs such as arachidonic and docosahexaenoic fatty acids that are essential for optimal fetal and neonatal growth and development; moreover, inadequate supplies of ω6 and ω3 fatty acids can negatively affect the development of the central nervous system and may result in long-term changes in learning ability and reduced visual functioning (Nudda et al. 2007). Owing to the importance of PUFAs during infancy, experts in the area of infant nutrition recommend a substantial dietary intake of these fatty acids, with a suggested ratio of linoleic:linolenic of 8:1 (IOM 2005). In our study, this ratio varied from 7.85 to 8.57; this fact, along with the evidence that the *n*-6/*n*-3 ratio varied from 6.27 to 6.96, suggested that this type of meat could be beneficial for child nutrition, although for adult nutrition dietary *n*-6/*n*-3 ratios of <4 are indicated as being the most favorable to prevent some cardiovascular diseases (Scollan et al. 2006).

Table 5. Light lambs *Longissimus dorsi* muscle intramuscular fat, fatty acid composition in percentage by weight of total identified fatty acids, and nutritional ratios.

Trait		Ripollesa	Ripollesa × Lacaune	Lacaune
Intramuscular fat		3.60a ± 0.37	3.23a ± 0.45	3.10a ± 0.29
Fatty acid composition				
C10:0	Decanoic (Capric)	0.13a ± 0.01	0.11b ± 0.01	0.11ab ± 0.01
C12:0	Dodecanoic (Lauric)	0.09a ± 0.01	0.08a ± 0.01	0.09a ± 0.01
C13:0	Tridecanoic	0.01a ± 0.00	0.01a ± 0.00	0.01a ± 0.00
C14:0	Tetradecanoic (Myristic)	2.03a ± 0.09	1.81a ± 0.07	1.97a ± 0.14
C14:1	Tetradecenoic (Myristoleic)	0.06ab ± 0.00	0.06b ± 0.00	0.07a ± 0.01
C15:0	Pentadecanoic	0.32a ± 0.02	0.31a ± 0.01	0.31a ± 0.02
C16:0	Hexadecanoic (Palmitic)	22.01a ± 0.36	21.61a ± 0.28	21.36a ± 0.37
C16:1	Hexadecenoic (Palmitoleic)	1.79b ± 0.08	1.95a ± 0.09	2.08ab ± 0.05
C17:0	Heptadecanoic (Margaric)	1.36a ± 0.08	1.41a ± 0.09	1.26a ± 0.04
C17:1	Heptadecenoic	0.80a ± 0.04	0.89a ± 0.05	0.90a ± 0.03
C18:0	Octadecanoic (Estearic)	14.74a ± 0.34	14.85a ± 0.48	13.27b ± 0.27
C18:1	Octadecenoic (Elaidic)	6.17a ± 0.45	5.57a ± 0.57	4.29b ± 0.36
C18:1*n*-7	Octadecenoic (Oleic)	37.34b ± 0.63	39.14ab ± 0.68	40.03a ± 1.09
C18:1*n*-9	Vaccenic	1.72b ± 0.06	1.79a ± 0.07	1.97a ± 0.15
C18:2*n*-6	Linoleic (LN)	4.26a ± 0.28	3.55b ± 0.27	4.37a ± 0.44
tC18:2*n*-6	Linoelaidic	0.23a ± 0.01	0.18b ± 0.02	0.23a ± 0.02
CLA	—	0.42a ± 0.02	0.40a ± 0.02	0.43a ± 0.02
C18:3*n*-3	α-Linolenic (ALA)	0.52ab ± 0.03	0.44b ± 0.03	0.59a ± 0.07
C18:3*n*-6	γ-Linolenic	0.06a ± 0.01	0.05a ± 0.00	0.06a ± 0.01
C20:0	Eicosanoic (Arachidic)	0.09a ± 0.00	0.09a ± 0.00	0.08b ± 0.00
C20:1	Eicosenoic (Gadoleic)	0.19a ± 0.01	0.18a ± 0.01	0.17a ± 0.01
C20:2*n*-3	—	0.04b ± 0.00	0.04b ± 0.00	0.06a ± 0.01
C20:2*n*-6	Eicosadienoic	0.07a ± 0.00	0.06a ± 0.00	0.06a ± 0.01
C20:3*n*-3	—	0.03a ± 0.00	0.02a ± 0.00	0.03a ± 0.01
C20:3*n*-6	Dihomo-γ-linolenic	0.14ab ± 0.01	0.12b ± 0.01	0.16a ± 0.02
C20:4*n*-6	Eicosatetraenoic (Arachidonic ARA)	1.26a ± 0.10	1.29a ± 0.13	1.53a ± 0.15
C20:5*n*-3	Eicosapentaenoic (EPA Timnodonic)	0.18b ± 0.02	0.18b ± 0.02	0.23a ± 0.03
C22:0	Docosanoic (Behenic)	0.25a ± 0.01	0.29a ± 0.03	0.33a ± 0.05
C22:1	Docosenoic (Erucic)	0.01a ± 0.00	0.01a ± 0.00	0.01a ± 0.00
C22:2*n*-6	Docosadienoic (Brassic)	0.01b ± 0.00	0.02ab ± 0.00	0.02a ± 0.00
C22:6*n*-3	Docosahexaenoic acid (DHA)	0.09b ± 0.01	0.09b ± 0.01	0.12a ± 0.01
C23:0	Tricosylic	0.17a ± 0.05	0.13a ± 0.01	0.17a ± 0.03
C24:0	Tetracosanoic (Lignoceric)	0.02a ± 0.00	0.02a ± 0.01	0.02a ± 0.01
SFA	Saturated fatty acid	41.19a	40.70a	38.99b
MUFA	Monounsaturated fatty acid	48.10a	49.59a	49.53b
PUFA	Polyunsaturated fatty acid	6.90ab	6.04b	7.45a
Nutritional ratios				
PUFA/SFA	—	0.16ab	0.15b	0.19a
n-6/*n*-3	—	6.96a	6.84a	6.27a
C18:2*n*-6/C18:3*n*-3	LN/ALA	8.57a	8.54a	7.85a

Note: Means with the same lowercase letter across a row did not differ significantly ($P > 0.05$). CLA, isomer *cis-9*, *trans-11* C18:2; SFA, saturated fatty acids; MUFA, monosaturated fatty acids; PUFA, polyunsaturated fatty acids.

Conclusion

In conclusion, this study provides a detailed characterization of carcass and meat composition traits in light lambs, a livestock product that has high market demand in the Mediterranean basin. Given the current society's concern on healthy and high-quality foods, these results are of special relevance for the sheep industry in which an accurate knowledge about carcass conformation and composition becomes essential. Both Ripollesa and Lacaune breeds provided similar averages for all traits and, although some significant departures were revealed, their aptitudes for the production of light lambs must be considered similar. As a whole, both the degree of leanness and fatty acid composition revealed in this study provide relevant evidences about the adequacy of these lambs to the market demand in Mediterranean areas, lamb meat even being suggested as a functional food of special interest for infant nutrition.

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