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Conjugated linoleic acid (CLA) and polyunsaturated fatty acids in muscle lipids of lambs from the Patagonian area of Argentina

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Abstract

The concentrations of fatty acids were measured in total lipids, triacyglycerol and phospholipid fractions of intramuscular fat (IMF) from the *Longissimus dorsi* (LD) muscle of 10 lambs reared to approximately 30 kg live weight on natural pasture with their dams. Fatty acid composition was also measured in 25 (five of each) *Semitendinosus* (ST), *Semimembranosus* (SM), *Rectus femoris* (RF), *Gluteus* (GLU) and *Tensor fascia latea* (TFL) muscles. Intramuscular fat percentages were similar for all muscles. Aspects of the fatty-acid patterns of relevance to human nutrition tended to favor the leg muscles with lower saturated fatty acids (SFA %), $n-6/n-3$ fatty acid ratios ($p < 0.01$) and higher concentrations of the conjugated linoleic acid (CLA) ($p < 0.05$). The estimated fatty acid concentrations (mg/100 g of meat) showed higher contribution of arachidonic (C20:4 $n-6$), eicosapentanoic (C20:5 $n-3$), docosapentanoic (C22:5 $n-3$) and docosahexanoic (C22:6 $n-3$) acids in leg compared to LD lipids.
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Keywords: Lamb; Muscle lipids; Fatty acids; Conjugated linoleic acid (CLA); $n-3$ PUFA

1. Introduction

Lamb meat is a typical product of Patagonia where production is highly dependent on environmental conditions. Local breeds are used because of their adaptation to difficult weather conditions. In lamb production, each country or region has its own specific weight or age at slaughter depending on its own production system and market demands. A characterization of the Patagonian lamb intramuscular lipids in 1994, 1995 and 1996 allowed us to define Patagonian lamb meat as a lean and tasteful product. The average intramuscular fat content was 2.5%, 56 mg/100 g of total cholesterol and with high levels of polyunsaturated fatty acids (PECOP, 1997). Other studies (García, Pensel, & Margaría, 1995) have shown that Patagonian lamb lipids are an important sources of dietary $n-3$ and $n-6$ highly polyunsaturated fatty acids (HPUFA) with values higher than the ones found in other ruminant meats. Mir, Rushfeldt, Mir, Paterson, and Weselake (2000) found that lamb meat lipids have a significantly higher content of conjugated fatty acids isomers (CLA) compared with other ruminant meat lipids. This may indicate that the process of transesterification taking place in the rumen leads to the formation of conjugated form of PUFA (principally CLA) which is much more efficient in lamb than in other ruminants. CLA refers to a mixture of positional and geometric isomers of conjugated dienoic derivatives of linoleic acid. The major dietary sources of CLA for humans are beef and dairy products. There is a great interest in CLA because of its anticarcinogenic and antiatherogenic properties and its ability to reduce body fat while enhancing lean

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body mass (Azain, Hausman, Sisk, Flatt, & Jewell, 2000; Park, Allen, & Cook, 2000). Pasture lipids have a positive impact on lamb lipid fatty acid profile, namely due to an increase in the proportion of $n-3$ fatty acids (Enser et al., 1999).

There is a concern about animal lipid due to its relatively high concentrations of saturated fatty acids (SFA) and low concentration of polyunsaturated fatty acids (PUFA). Consumption of saturated fatty acids (SFA) and cholesterol has been associated with increased serum low-density lipoprotein, a risk factor for coronary heart disease (Key, 1970; Ulbricht & Southgate, 1991). Recommendations for $n-6$ and $n-3$ classes of PUFA are also important because scientists recognize differences in metabolism and physiological function between these fatty acids families (Scientific Review Committee, 1990). Meats from ruminants feed intensively with grains rich in $n-6$ fatty acids but poor in $n-3$ fatty acids shows lipids with a higher than the recommended ratio $n-6/n-3$ fatty acids (Enser, 2000; Enser et al., 1998). Several studies have demonstrated in cattle that decreasing the proportion of concentrate in the diet and increasing grass intake, caused a decrease in the concentrations of intramuscular fat and the $n-6/n-3$ fatty acid ratio (French et al., 2000; García et al., 2005; García, Pensel, Margaría, Rosso, & Machado, 1999).

The aim of this study was to evaluate the fatty acid composition of intramuscular lipids of lambs produced under extensive natural grasses in the Argentine Patagonian with special emphasis on the contribution of CLA and $n-6$ and $n-3$ polyunsaturaded fatty acids.

2. Materials and methods

2.1. Animals and management

Three hundred Merino lambs born during the spring and reared on pasture with their dams in a typical area of Patagonian lamb production, Alto Rio Senguer, southwest of Chubut province, Argentina, until they reached approximately 30 kg live-weight. They were kept on natural shrub grass steppes and the pasture management was standardized in order to maintain an acceptable growth performance, carcass composition and meat quality. The pasture was evaluated every three years to control the sustainability of the natural resources. Lambs were conventionally slaughtered in a commercial abattoir and 10 *Longissimus dorsi* (LD) and 25 (five of each) *Semitendinosus* (ST), *Semimembranosus* (SM), *Rectus femoris* (RF), *Gluteus* (GLU) and *Tensor fascia latea* (TFL) muscles were taken from 10 lambs after 24 h at 4 °C for total intramuscular fat (IMF%) and lipid fatty acid analysis.

2.2. Analytical measurements

The muscles were stored at −20 °C until chemical analysis were performed. Aliquot samples of 10 g each, trimmed of external fat, were minced carefully, dried and extracted in a Tekator apparatus using hexane as the extraction solvent according to official methods (AOAC, 1992). Aliquot samples of 5 g each were extracted using the Folch, Lees, and Sloane-Stanley (1957) method. The chloroform extract was used for the fatty acid analyses. Total lipids were separated using thin layer chromatography (TLC) (hexane–ether ethylic 80:20 v/v) and triacylglycerols and phospholipids were scraped and converted to methyl esters. Fatty acid methyl esters (FAME) were prepared according to the method of Pariza, Park, and Cook (2001) and measured using a Chrompack CP 900 equipment fitted with a flame ionization detector. Separation of FAME was performed on a WCOT fused silica capillary column (CP-Sil 88 100 m × 0.25 mm i.d. coating), using nitrogen as a carrier gas. The oven temperature was programmed at 70 °C for 4 min, increased from 70 to 170 °C at a rate of 13 °C/min and then increased from to 170 to 200 °C at 1 °C/min. Individual fatty acids were identified by comparing relative retention times with individual fatty acids standard (PUFA-2 Animal Source. Supelco). Mathematical indices for calculating the activities of stearoyl-CoA desaturase were determined according to Malau-Aduli, Siebert, Bottema, and Pitchford (1997). Analytic results were expressed as percentages of total fatty acids. On the basis of the content of fat in the muscle and the fatty acid profile, the content of fatty acid was calculated as mg/100 g of meat.

2.3. Statistical analysis

Statistical analysis were performed by means of the statistical software SAS 6.1 1996. If there was a significant treatment effect by F-test, the Tukey'studentized range (HSD) was used for follow-up comparisons of treatment means. The data is shown as mean ± standard deviation. In order to determine which variables discriminate between the two muscle groups a discriminant analysis using the SPSS 10:0 program was applied to the fatty acid composition data. Since it was expected that some of the fatty acid might not be very useful in discriminating between the two muscle groups a forward stepwise procedure was used to determine the variables that would be included in the discriminant functions.

3. Results and discussion

3.1. Intramuscular fat

The IMF% of LD, ST, SM, RF, GLU and TFL muscles were 2.73 ± 0.97, 2.28 ± 0.68, 2.33 ± 0.79, 3.01 ± 0.44, 2.13 ± 0.65 and 2.63 ± 0.62 respectively. No statistical (>0.05) differences among the different muscles were found. The values were similar to the detected previously for Patagonian lambs (PECOP, 1997). No important changes in lamb production in this area were expected. Similar results were found by Oriani et al. (2005) in LD and SM muscles

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