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Fatty acid composition of meat from typical lamb production systems of Spain, United Kingdom, Germany and Uruguay

M.T. Díaz [a], I. Álvarez [a], J. De la Fuente [a], C. Sañudo [b], M.M. Campo [b], M.A. Oliver [c], M. Font i Furnols [c], F. Montossi [d], R. San Julián [d], G.R. Nute [e], V. Cañeque [a,*]

[a] *Departamento de Tecnología de los Alimentos, Instituto Nacional de Investigacion y Tecnologia Agraria y Alimentaria, Carretera de la Coruña, Madrid 28040, Spain*
[b] *Departamento de Producción Animal y Ciencia de los Alimentos, Facultad de Veterinaria, Zaragoza, Spain*
[c] *Centre de Tecnologia de la Carn, IRTA, Monells (Girona), Spain*
[d] *Programa Ovinos y Caprinos, INIA Tacuarembó, Uruguay*
[e] *Division of Farm Animal Science, University of Bristol, Langford, United Kingdom*

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Abstract

The fatty acid composition of commercial lambs from different production systems of Spain, Germany, United Kingdom and of two types of Uruguayan lambs (heavy and light) was studied. Concentrate fed lambs, as Spanish lambs, displayed the highest proportions of linoleic acid (C18:2), while Uruguayan lambs, reared under extensive grazing conditions, showed the highest proportions of linolenic acid (C18:3), due to the great concentration of this fatty acid in grass. German and British lambs, which were fed grass and concentrate, displayed intermediate proportions of linolenic acid (C18:3). Heavy Uruguayan lambs had higher intramuscular fat content (5.92%) than German (4.25%) and British (4.32%) lambs, and this content was twofold higher than light lambs (Spanish (2.41%) and light Uruguayan (3.05%)). Heavy Uruguayan, German and British lambs had a low polyunsaturated/saturated (P/S) ratio due to their high saturated fatty acid (SFA) content and proportion. Principal component analysis was performed to study the relationship between fatty acids. Spanish lambs were clearly separated from the other types and were situated close to the proportions of short chain and $n-6$ fatty acids and $n-6/n-3$ ratio in the data plot for fatty acid proportions. Light Uruguayan lambs were located close to long chain fatty acids, and heavy Uruguayan and British lambs were placed near the antithrombotic potential (ATT), stearic acid (C18:0), SFA and conjugated linoleic acid (CLA) proportions. German lambs were located between Spanish lambs and the other types.

Keywords: Fatty acids; Lamb; Meat origin; Production system

1. Introduction

World-wide we have to note the emergence of countries in South America as entrants into the European Union market and these countries are able to produce cheap and good quality meat. Lamb production systems are different among countries of South America and Europe. The production system represents the combined effects of breed, weight, feeding, sex, age and husbandry, all of which can contribute to variations in meat fatty acid composition. Results of numerous studies confirm that fatty acid composition can be influenced by individual factors such as diet (Díaz et al., 2002), breed (Robelin, 1986), age/weight (Rhee, 2000) and level of fatness (Nürnberg, Wegner, & Ender, 1998). Thus, grain

* Corresponding author. Tel.: +34 913474038; fax: +34 913572293.
E-mail address: caneque@inia.es (V. Cañeque).

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diets result in high concentrations of $n-6$ polyunsaturated fatty acids (PUFA), while grass diets increase muscle concentrations of $n-3$ PUFA (Enser et al., 1998). The effect of breed may be important but it is difficult to assess the real contribution of genetics to differences in fatty acid composition. Effects attributed to breed are often due to the degree of fatness, live weight, slaughter age or the production system (Sañudo et al., 2000). The fatty acid composition of meat may also be influenced by changes in age and fatness. Thus the proportion of PUFA in muscle decreases while the deposition of intramuscular neutral lipids increases with animal age (Link, Bray, Cassens, & Kauffman, 1970). Variations in fat content have an effect on fatty acid composition, independent of species or breed and dietary factors. The content of SFA and monounsaturated fatty acids (MUFA) increases faster with the fatness level than the content of PUFA (De Smet, Raes, & Demeyer, 2004).

Fatty acid composition influences the nutritive value and the organoleptic characteristics of meat. In relation to the nutritive value, consumption of SFA has been associated with increased plasma cholesterol and plasma low density lipoprotein (LDL) levels, linked to a major risk of coronary heart disease; on the other hand, consumption of $n-3$ PUFA is inversely associated with the incidence of this disease (Grundy, 1987). Conjugated linoleic acid (CLA) has been linked with important beneficial effects such as anticarcinogenic properties, beneficial actions on body composition (reducing body fat) and on the immune function (Williams, 2000). In regard to organoleptic characteristics, Fisher et al. (2000) found that flavour intensity is positively correlated with linolenic acid (C18:3) and negatively with linoleic acid (C18:2). In addition, fatty acid composition can affect meat lipid oxidation (Gatellier, Hamelin, Durand, & Renerre, 2001).

The purpose of this study was to assess the extent of natural dissimilarity in the fatty acid composition of meat from commercial lambs typical of the production systems in several countries of the European Union, such as Spain, Germany and United Kingdom and one country of South America, namely Uruguay.

2. Materials and methods

Five groups of 20 lambs from Spain, United Kingdom, Germany and heavy and light lambs from Uruguay were used in the present study. Lambs were slaughtered at the usual commercial weights, representing the typical production systems of each country. Spanish lambs were entire male of Rasa Aragonesa breed, reared under intensive husbandry conditions, and fed concentrates and cereal straw ad libitum until slaughter at less than 3 months of age. The carcass weight was 10.2 ± 0.6 kg. British lambs were commercial crossbred castrated males, mainly reared on a grass-based system using strategic concentrate supplementation. The carcass weight was 22.8 ± 1.7 kg. German lambs were commercial entire males from crossbreeds between Suffolk or Schwarzköpfe × Merino Landschaf, reared on grass supplemented with concentrate. The carcass weight was 23.2 ± 3.6 kg and animals were slaughtered at 4–6 months of age. Uruguayan lambs were castrated male Corriedales raised under extensive improved-grazing conditions. Light lambs were slaughtered at 3–4 months of age at a carcass weight of 11.1 ± 1.4 kg, whereas heavy lambs were slaughtered at 12–13 months of age at a carcass weight of 19.4 ± 2.2 kg.

The *m. longissimus dorsi* was dissected 24 h after slaughter and samples were obtained in order to determine the composition of fatty acids in the muscle from the level of T1 (first thoracic vertebra) to T6 (sixth thoracic vertebra) of the left side. The muscle samples were vacuum-packed and frozen at −25 °C. Intramuscular fat was extracted from the muscle according to the Hanson and Olley (1963) method. Methyl esters were formed according to the method of Morrison and Smith (1964), using 14% boric trifluoride in methanol. Nonadecanoic acid (19:0) was added prior to saponification as an internal standard. Chromatographic analysis of methyl esters was performed using a Perkin–Elmer gas chromatograph (Perkin–Elmer, USA) equipped with a split-splitness injector and a flame ionisation detector (FID), using a fused silica capillary column (0.32 mm internal diameter and 30 m long). The mobile phase consisted of helium C-50 at a flow of 9 psig. Fatty acids were identified using Sigma reference standards and quantified using the internal standard. Data regarding fatty acid composition were expressed in percentage by weight of total identified fatty acids and data concerning fatty acid content were expressed in mg per 100 grams of muscle.

2.1. Statistical analyses

The data were analysed using one-way analysis of variance with the GLM procedure of the Statistical Analysis System package (SAS, 1996) according to the model:

$$y_{ij} = \mu + X_{i(1\ldots5)} + \varepsilon_{j(i)},$$

where y_{ij} is the fatty acid, μ is the population mean, X_i is the effect of lamb type (Spanish, German, British and heavy and light Uruguayan) and $\varepsilon_{j(i)}$ is the experimental error. Differences between least square means were determined using the Student Newman–Keuls test.

In order to summarise the relative differences amongst samples in relation to their overall fatty acid profiles, and to determine the contribution of individual