Lipid characteristics of commercial lamb cuts

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Abstract— **It is important to know the composition of the food that we consume due to the current awareness about health and its relationship with the diet. The aim of this work was to assess the fatty acid composition and the total fat content of the edible portion of different commercial cuts in lamb. Ten animals, entire males belonging to the Protected Geographical Indication (PGI) 'Ternasco de Aragón', weaned at about 50 days old and intensively fed with concentrate and cereal straw ad libitum until reaching 80 days-old, were used. After slaughtering, and following standard procedures, the left half carcass was divided into seven commercial cuts: leg, shoulder, neck, shoulder-ribs, loin + rack, breast and flank. Each cut was weighed, deboned and the edible part (muscle + visible fat) analyzed. The leaner cut was the leg, with a fat content of 12.5%, although not statistically different from the neck, shoulder and shoulder-ribs. The fatter cut was the breast (40%), although it contributed little to the total fat content of the animal since it represented only 4.3 % of the carcass weight. When all edible tissues were considered together, few differences were found in the percentage of fatty acids among the different cuts, and most of them fell upon minor fatty acids. Nevertheless, the leg showed the lowest percentage of stearic acid and the highest of arachidonic acid, whereas the breast had the highest concentration of palmitoleic acid and the lowest of arachidonic acid. No significant differences were found among groups of fatty acids.**

Keywords— **Fat, fatty acid composition, light lamb.**

I. INTRODUCTION

Recent studies have shown that human overweight is an increasing problem in developed countries. The excess in energy intake and the sedentary style of live have been considered its main contributors [1], although more factors are implicated, such as the amount and composition of the fat in the diet [2]. The consumption of red meats, such as lamb, is associated with diets with high content of fat, especially saturated fat [3]. Therefore, there are recommendations at human level to avoid the intake of meat from ruminants based on those facts, even though other studies have shown that ruminant meat, more specifically lamb, is rich in some micronutrients [4] necessary for a healthy status.

Nevertheless, lamb is an important part of the agriculture in Mediterranean countries [5] with high levels of consumption. Much effort has been done in assessing the composition of specific muscles, especially longissimus dorsi. However, the consumption includes also some subcutaneous and intermuscular adipose tissues that, most of the times, are not included in the analysis but contribute to the total fat intake in the diet. The aim of this work was to assess the lipid composition of the edible portion, including lean and visible fat, of different commercial cuts of light lambs reared in Spain.

II. MATERIAL AND METHODS

Ten entire males of Rasa Aragonesa breed, belonging to the PGI 'Ternasco de Aragón' and with a cold carcass weight of 9.90 ± 0.28kg were selected at a EU-licensed abattoir 24 hours after slaughtering. Following a standardized procedure [6], the left side carcass was divided into seven commercial cuts: leg, shoulder, neck, shoulder-ribs, loin+rack, breast and flank. Each cut was weighed (expressed as percentage of the half carcass weight) and deboned, weighing the lean together with any visible fat tissue, which were considered as the edible part of the cut. These tissues were ground in a cutter SAMMIC-SK3 at 1700 rpm for 30 seconds. Then, a homogeneous sample was taken, vacuum packaged, immediately frozen and kept at -18 ºC until analyzed.

Total fat content was analyzed according to ISO1443:1973. Fatty acids were extracted in chloroform:methanol [7]. Methyl esters were obtained with KOH in methanol and analyzed by gas chromatography in a HP 6890 equipped with a flame

ionization flame and an automatic injection system (HP 7683), and fitted with a SP 2380 column (100m x 0.25 mm x 0.20 μm) with N as a carrier gas and C19:0 as an internal standard. Complete details can be checked elsewhere [8].

A General Lineal Model was applied with commercial cut as a fixed effect using SAS 8.0. When significant, a Duncan test was used to assess different mean values.

III. RESULTS AND DISCUSSION

The leg was the biggest commercial cut, followed by the loin+rack and the shoulder (Table 1). These three cuts accounted for 71.22 % of the half carcass weight. These percentages do not coincide with other findings [9, 10]. Although no diet effect has been described when the percentages are related to the total carcass weight, the different breeds and commercial cuts used in different countries contribute to these differences. The proportion of bone was one of the lowest in the three cuts, with values of edible tissues between 74.64 % in the loin+rack and 78.64% in the shoulder. However, the cut with the highest yield of edible tissue (85.79%) was the flank.

Table 1. Percentage of commercial cuts (in relation to the half carcass), visible muscle + fat and total fat.

	% over ½ carcass	% Visible Muscle + Fat	% Total Fat
Leg	27.17 e	77.75 cd	12.46 a
Shoulder	18.69 c	78.64 d	14.31 ab
Neck	6.89 b	66.26 b	13.31 ab
Shoulder-ribs	8.08 b	66.94 b	14.14 ab
Loin + rack	25.36 d	74.64 c	21.59 c
Breast	4.27 a	62.16 a	40.05 d
Flank	6.90 b	85.79 e	17.90 bc
MSE	2.09	15.43	29.03
	***	***	***

MSE: mean square error; *** = p≤0.001;
a, b, c, d, e: mean values in the same column with different letters differ significantly (p≤0.05);

The cut with the highest content of chemically-analyzed total fat was the breast, with 40.05%. However, it only represents 4.27% of the carcass. Therefore, its contribution to the total fat intake is low. The leanest cut was the leg, although without significant differences from the shoulder, neck or shoulder-ribs. These differences can be respectively attributed to the differential development of tissues in young animals

Table 2 shows the fatty acid composition of the different cuts, considering together the lean (intramuscular fat) and the visible fat tissues (subcutaneous and intermuscular fats). Few fatty acids have shown significant percentage differences among cuts: C16:1, C18:0, C22:0 (p≤0.05); C20:5 (p≤0.01); C20:3 n-6, C20:4 and C22:6 (p≤0.001).

Among the major fatty acids, the leg showed the lowest percentage of stearic acid, whereas the shoulder-ribs had the highest. However, among the polyunsaturated fatty acids, the leg had the highest percentage of arachidonic acid (0.88%), EPA (0.04%) and DHA (0.08). Although not significant differences were found on the groups of fatty acids, these higher percentages on the individual PUFA contributed to a higher total percentage of PUFA, n-3 and n-6 fatty acids in the leg than in the rest of cuts.

Even though with the differences in individual fatty acids, no significant differences were found in the groups of fatty acids and in most of the calculated indexes. Only ATT [(C20:3 *n*-3+C20:5 *n*-3)/C20:4 *n*-6] was significantly higher in the breast than in the rest of cuts, probably due to its considerably higher content of total fat, which makes this particular piece of the animal the least recommended for consumption in terms of fat composition.

IV. CONCLUSIONS

In light lambs, the shoulder and the leg are the cuts with higher content of edible tissues, although the leg accounts for a higher percentage of the total carcass. The flank has substantially higher fat content than the rest of cuts. However, few differences have been found in the fatty acid composition between the different cuts, although the leg showed lower stearic acid and higher arachidonic acid, EPA and DHA percentages than the rest of cuts.

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Table 2. Fatty acid composition (% of total fatty acids) of the edible portion of commercial cuts in light lambs

	Leg	Shoulder	Neck	Shoulder-ribs	Loin + Rack	Breast	Flank	MSE	
C10:0	0.26	0.25	0.24	0.24	0.24	0.26	0.28	0.009	ns
C11:0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.000	ns
C12:0	0.60	0.57	0.58	0.53	0.48	0.64	0.64	0.076	ns
C13:0	0.06	0.05	0.05	0.05	0.05	0.06	0.06	0.000	ns
C14:0	5.54	5.50	5.56	5.21	5.04	6.17	5.92	4.243	ns
C14:1	0.20	0.25	0.20	0.16	0.16	0.26	0.20	0.010	ns
C15:0	0.77	0.75	0.73	0.73	0.81	0.86	0.88	0.041	ns
C16:0	24.50	24.66	24.55	23.92	23.99	24.74	25.54	7.891	ns
C16:1 *n*-9	2.05 a	2.14 ab	2.29 ab	2.03 a	1.77 a	2.64 b	1.95 a	0.305	*
C17:0	2.24	2.37	2.30	2.32	2.58	2.17	2.35	0.979	ns
C17:1	1.18	1.10	1.11	10.2	1.14	1.14	1.13	0.216	ns
C18:0	13.50 a	14.07 ab	14.29 abc	16.20 c	15.81 bc	13.87 ab	13.97 ab	4.480	*
C18:1 *n*-9	34.83	35.04	35.35	34.96	34.50	35.27	34.43	6.874	ns
C18:1 *n*-7	1.29	1.26	1.21	1.21	1.31	1.19	1.23	0.099	ns
tC18:2 *n*-6	0.25	0.26	0.27	0.27	0.20	0.28	0.26	0.013	ns
C18:2 *n*-6	5.41	5.01	4.85	4.92	5.19	4.41	4.75	5.638	ns
Total CLA	0.54	0.49	0.53	0.52	0.49	0.61	0.53	0.022	ns
C18:3 *n*-6	0.06	0.06	0.04	0.05	0.05	0.04	0.04	0.001	ns
C18:3 *n*-3	0.51	0.50	0.49	0.50	0.49	0.49	0.48	0.027	ns
C20:0	0.13	0.14	0.14	0.17	0.16	0.15	0.14	0.001	ns
C20:1	0.15	0.15	0.16	0.16	0.16	0.15	0.15	0.001	ns
C20:2 *n*-6	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.001	ns
C20:2 *n*-3	0.02	0.03	0.01	0.01	0.01	0.01	0.01	0.000	ns
C20:3 *n*-6	0.08 d	0.07 cd	0.05 abc	0.06 bc	0.05 abc	0.04 a	0.05 ab	0.010	***
C20:3 *n*-3	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.000	ns
C20:4 *n*-6	0.88 d	0.58 c	0.52 bc	0.54 bc	0.47 bc	0.23 a	0.36 ab	0.034	***
C22:0	0.14 b	0.12 ab	0.12 ab	0.12 ab	0.11 a	0.09 a	0.10 a	0.000	*
C22:1 *n*-9	0.01	0.01	0.01	0.01	0.01	0.09	0.01	0.000	ns
C22:2 n-6	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.000	ns
C20:5 *n*-3	0.04 c	0.01 a	0.03 bc	0.01 a	0.01 a	0.01 ab	0.01 ab	0.000	**
C22:6 *n*-3	0.08 d	0.05 c	0.05 bc	0.04 abc	0.04 abc	0.02 a	0.04 ab	0.000	***
% SAT	47.81	48.53	48.60	49.54	49.33	49.06	49.94	16.689	ns
% MUFA	39.71	39.95	40.34	39.56	39.05	40.74	39.10	8.001	ns
% PUFA	7.95	7.14	6.92	7.00	7.07	6.21	6.59	6.669	ns
% *n*-6	6.75	6.04	5.80	5.90	6.01	5.05	5.52	6.200	ns
% *n*-3	0.66	0.61	0.59	0.58	0.56	0.55	0.55	0.033	ns
n-6/*n*-3	10.57	10.31	10.25	10.48	10.78	9.49	10.26	10.390	ns
PUFA/SAT	0.17	0.15	0.15	0.14	0.15	0.13	0.13	0.005	ns
ATT	0.07 a	0.05 a	0.08 a	0.05 a	0.05 a	0.13 b	0.07 a	0.002	**
I1	2.00	2.02	2.06	2.18	2.14	2.02	1.93	0.126	ns
AI	0.66	0.67	0.67	0.65	0.66	0.69	0.72	0.026	ns
TI	8.40	9.65	10.04	10.21	10.18	11.22	10.91	6.687	ns

MSE: mean square error; ns= no significant; * = p≤0.05; ** = p≤0.01; *** = p≤0.001;
a, b, c, d: mean values in the same row with different letters differ significantly (p≤0.05); Total CLA: sum of conjugated linoleic acid isomers; SFA: Saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids
ATT = (C20:3 *n*-3+C20:5 *n*-3)/C20:4 *n*-6; I1 =(C18:0 + C18:1 *n*-9)/C16:0;
AI = (C12:0+C14:0+C16:0)/(*n*-3 PUFA + *n*-6 PUFA + MUFA);
TI = (C14:0+C16:0+C18:0)/(3*n*-3 PUFA + 0.5*n*-6 PUFA + *n*-3 PUFA/*n*-6 PUFA);