Fatty acid composition of lamb's meat from two different genotypes

G.M. Vacca[1], M.L. Dettori[1], L. Cengarle[2], G. Tilloca[2], V. Carcangiu[1]

[1]Dipartimento di Biologia Animale,
[2]Dipartimento di Scienze Fisiologiche Biochimiche e Cellulari,
Università degli Studi di Sassari, via Vienna, 2 07100 Sassari, Italia

ABSTRACT - Milk lamb is the most appreciated meat product of Italian ovine breeding. It is naturally fed and slaughtered at the age of about one month; lamb's meat value is recognized for its excellent organoleptic characteristics. It is obtained from dairy breeds and, sometimes, by crossbreeding with meat breed rams, in order to improve productivity and quality of its meat. The present work, carried out on 10 Sarda breed lambs and 10 Sarda x Mouflon (*Ovis g. musimon)* crossbred lambs, slaughtered at 40 days of age, has the aim of verifying fatty acid composition of *longissimus dorsi* muscle and pelvic adipose tissue. Fatty acid composition was determined by capillary gas chromatography of fatty acid methyl esters. The data were submitted to Student's t test. As concerns *longissimus dorsi* muscle, crossbreds showed higher percent values ($P<0.05$) of C12:0, C14:0 and lower ones of C20:5 and C22:4 and ($P<0.01$) of C18:1 and C22:5. Sarda lambs showed higher levels of MUFA ($P<0.01$), lower SFA ($P<0.05$) and a better n-6/n-3 ratio. The fatty acid profile of adipose tissue was similar in the two groups, with the exception of C18:1, which was higher in Sarda lambs. The values found indicate, on the whole, a good meat's nutritional quality for the two compared genotypes.

KEY WORDS: lamb, meat, fatty acids, composition

INTRODUCTION - Sheep meat production in Sardinia, as in many countries of the Mediterranean area, is based on lambs slaughtered at few weeks of age (5). Milk fed lamb is very appreciated for its tenderness and sapidity. Considering the growing demand for alternative meats, different strategies can be tried to improve this product. A possibility may be represented by crossing dairy sheep and meat rams, which generates crossbred lambs whose meat have very good quality characteristics. This product, combined with the link to traditions and territory, could become a strong attraction for exigent consumers, who are also prepared to accept the higher costs involved in this kind of food production. From this perspective, we wanted to propose a sardinian ovine crossbred, obtained from mating sardinian wild mouflon (*Ovis g. musimon*) with Sarda sheep (*Ovis aries*). This crossbred used to be quite widespread in the Mediterranean Basin since the first century A.D. (Plinius Major in: *Naturalis Historia).* This crossbred has been already analyzed for productive performances (6), carcass characteristics (13) and meat chemical composition (8). Hence, it turns out to be interesting the description of the fatty acid profile. Indeed, among the parameters that define the quality of a meat product, lipids are important for their functional properties (3, 8). Moreover, some fatty acids are believed to be linked with the incidence of coronary heart disease (CHD) (12). Ulbricht and Southgate (12) indicate polyunsaturated fatty acids (PUFA) of the n-6 (linoleic) and n-3 (linolenic) series, and monounsaturated fatty acids (MUFA) as dietary factors protective against CHD and suggest an index of atherogenicity (IA) and thrombogenicity (IT) as a measure for nutritional evaluation of fat. The Department of Health (1994) (7) consider more appropriate the poliunsaturated/saturated FA ratio (P/S) and n-6/n-3 PUFA ratio. The aim of the research is to assess the fatty acid composition of *longissimus dorsi* (LD) muscle and pelvic (PL) adipose tissue in crossbred lambs compared with milk fed lambs of Sarda breed.

MATERIAL AND METHODS - Twenty animals were used in the trial: ten Sarda breed lambs (SxS) and ten crossbred Mouflon x Sarda lambs (MxS). The subjects were milk fed by their mothers, until slaughter at 40 days of age. The fatty acid composition of *longissimus dorsi* (LD) muscle and pelvic (PL) adipose tissue was determined after extraction of total lipids (4) and methylation with trimethylclorosilane (TMCS: Macherey-Nagel). Fatty acids methyl esters (FAME) were analyzed on a Perkin Elmer Gas Chromatograph Mod. 8500, equipped with a flame ionization detector (FID). Separations were performed using a Varian SP 2430 capillary column (50 m x 0.25 mm i.d.) and the following conditions: carrier gas, helium at 10 ml/min flow; injector temperature, 220°C; detector temperature 270°C; the temperature program employed was: 120°C for 5 min., 5°C/min for 20 min., 229°C for 5 min., 5°C/min. for 5 min., 245°C for 3 min. FAME standards Supelco and Matreya for determining retention times, Human Plasma Lipid FAME mix (Matreya) for response factors. The data were submitted to Student t test, after angular conversion.

RESULTS - The results for fatty acid (FA) composition of *longissimus dorsi* (LD) and pelvic adipose tissue (PL) are presented in table 1.

Table 1 - Mean percentage values (±s.d.) of fatty acids analysed

	Longissimus dorsi muscle				Pelvic adipose tissue			
	SxS		MxS		SxS		MxS	
	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
C12:0	0.42^{a}	0.15	0.99^{b}	0.67	0.86	0.54	1.70	0.42
C14:0	5.03^{a}	1.22	8.10^{b}	3.20	9.76	2.46	11.90	3.19
C14:1	0.22	0.24	0.24	0.18	0.09	0.09	0.16	0.16
C15:0	0.35	0.13	0.36	0.20	0.73	0.30	0.45	0.23
C15:1	0.16	0.18	0.40	1.00	0.11	0.10	0.12	0.12
C16:0	22.64	3.88	27.65	5.83	24.77	8.14	30.86	5.18
C16:1	2.54	0.71	3.01	0.89	2.01	0.52	2.30	0.78
C16:2	0.54	0.37	0.54	0.53	0.59	0.41	0.65	0.29
C17:0	0.79	0.20	0.67	0.46	1.05	0.21	0.80	0.38
C17:1	0.62	0.51	0.45	0.46	0.62	0.17	0.49	0.26
C18:0	10.08	2.86	9.94	2.68	13.70	6.22	10.61	2.35
C18:1	37.82^{B}	4.57	31.58^{A}	2.05	40.84^{b}	7.29	34.41^{a}	2.90
C18:2	6.80	2.45	7.56	1.63	2.74	0.74	3.33	1.53
C18:3 n-3	1.91	0.41	1.48	2.26	0.46	0.42	0.67	1.24
C18:3 n-6	0.14	0.17	0.03	0.07	0.11	0.14	0.06	0.11
C20:0	1.34	0.63	1.16	1.00	0.55	0.51	0.70	0.99
C20:1	0.54	1.15	0.15	0.28	0.77	0.67	0.81	0.66
C20:2	0.48	0.22	0.39	0.42	0.03	0.05	0.00	0.00
C20:3	0.51	0.50	0.46	0.47	0.14	0.03	0.00	0.00
C20:4	3.36	0.83	2.65	1.40	0.20	0.21	0.00	0.00
C20:5	1.24^{b}	0.65	0.61^{a}	0.53	0.00	0.00	0.00	0.00
C22:3	0.02	0.06	0.34	0.13	0.00	0.00	0.00	0.00
C22:4	0.66^{b}	0.28	0.37^{a}	0.24	0.00	0.00	0.00	0.00
C22:5	1.08^{B}	0.22	0.66^{A}	0.14	0.00	0.00	0.00	0.00
C22:6	0.75	0.40	0.56	0.24	0.00	0.00	0.00	0.00
SFA	40.65^{a}	6.56	48.88^{b}	6.73	51.41	8.62	57.02	6.15
MUFA	41.89^{B}	4.39	35.83^{A}	2.30	44.43	7.86	38.28	3.75
PUFA	17.46	4.46	15.30	4.71	4.14	1.65	4.70	2.85
n-6	11.95	3.28	11.46	2.42	0.11	0.14	0.06	0.11
n-3	4.97	1.26	3.30	2.99	0.46	0.42	0.67	1.24
n-6/n-3	2.41^{A}	0.40	4.67^{B}	1.61	0.24^{b}	0.02	0.09^{a}	0.01

Capital letters indicate significant differences for $P<0.01$; lower case letters for $P<0.05$.

The results show that the two groups have a quite similar fatty acid profile as regards PL adipose tissue, except for C18:1 which is significantly higher ($P<0.05$) in the group of Sarda lambs. On the other hand, for LD muscle tissue several fatty acids with significantly different percentages were found in the two compared genotypes. In detail, lauric and miristic acid were higher ($P<0.05$) in MxS group, while oleic acid and C22:5 ($P<0.01$), C20:5 and C22:4 ($P<0.05$) had higher percentage values in SxS group. On the whole, MxS lambs showed a higher ($P<0.01$) SFA content and a lower MUFA content ($P<0.01$). In MxS subjects, also the n-6/n-3 ratio resulted higher ($P<0.01$) than purebred lambs.

DISCUSSION - For both genotypes, the results are similar to those reported, for milk fed lambs, by Beriain et al. (2000) (2) and Bas et al. (2000) (1). It can be observed that the fatty acid profile of LD muscle shows a slightly higher nutritional value in Sarda lambs compared to crossbreds. Indeed, Sarda lambs contain a higher amount of beneficial fatty acids, like C18:1, C20:5 and MUFA. Those fatty acids considered risk factors for CHD, such as C12:0, C14:0 and C16:0 and the n-6/n-3 FA ratio are higher in MxS group. The n-6/n-3 FA ratio is in Sarda lamb within the values recommended by nutritional advisers (7). P/S ratio (0.43 SxS and 0.31 MxS) in the LD muscle, is slightly below the recommended value for the diet, that is 0.45 according to Department of Health (c.l.). In both genotypes these values are better than what has been reported for lambs from different Spanish breeds (11). Anyway such an index may not be an adequate way to assess the nutritional value of fat because it considers that all saturated FA induce an increase in cholesterol and ignore the effects of monounsaturated FA (10). A better evaluation of the functional effects of FA on CHD may be given by the indices of atherogenicity (IA) and thrombogenicity (IT) (12). IA in Sarda lamb LD muscle was 0.73, in crossbred 1.21; IT was 0.89 in the SxS group and 1.35 in MxS group. These data also evidence the good quality of meat from milk fed Sarda lambs. Furthermore, C20:5 n-3 (EPA) and C22:6 n-3 (DHA) content is better in purebred lambs, but also the values found in crossbred are very good compared with those found in heavier lambs by Santos-Silva et al. (2002) (10). The importance of this datum is especially due to the evidence for biologic actions of long-chain omega-3 PUFA (14).

CONCLUSION - These results show the good nutritional quality of meats of milk fed lambs and justify the value given to this product in the Mediterranean areas. Although meat of Sarda lambs had a better fatty acid profile, nutritional values resulted good enough also for meats of the crossbred MxS, whose value is increased by the observation that its carcasses are leaner (13) and have a lower cholesterol content (8). Furthermore, general features of the crossbred's meat such as the product typicity and the marked taste (data not published), can lead to meet consumers' concern with health and nutritional values of food, as well as with chacterizing flavours. It is thought to be essential to propose this product in particular eco-gastronomic journeys, where it may become an important asset for less-favoured areas and enhance naturalistic interest and contribute to get nearer two economic areas of great importance for Sardinia, such as zootechnics and tourism.

REFERENCES

1. Bas P., Morand-Fehr P., 2000. Effect of nutritional factors on fatty acid composition of lamb fat deposits". Liv. Prod. Sci., 64, 61-79
2. Beriain M.J., Horcada A., Purroy A., Lizaso G., Chasco J., and Mendizabal J.A., 2000. Characteristics of Lacha and Rasa Aragonesa lambs slaughtered at three live weights. J. Anim. Sci., 78, 3070-3077

3. Berra B. and Rapelli S., 1987. Utilizzazione dei grassi alimentari con particolare riferimento all'olio di oliva: aspetti biochimici e nutrizionali. Rivista Italiana delle Sostanze Grasse, LXIV, 317-324
4. Blygh E.G., Dyer W.J., 1959. A rapid method of total lipid extraction and purification. Can. J. Biochem. Physiol., 37, 911-917
5. Boyazoglu J., Morand-Fehr P. (2001) Mediterranean dairy sheep and goat products and their quality: A critical review. Small Rum. Res. 40, 1-11
6. Carcangiu V., Vacca G.M., Longu G., Bini P.P., 2004. Rilievi alla macellazione di agnelli muflone x Sarda. Atti LVIII Congresso S.I.S.Vet. Grado, 23-25 settembre 2004, pag. 260 htm
7. Department of Health, 1994. Nutritional Aspects of Cardiovascular Disease. Report on Health and Social Subjects, No. 46. HMSO, London
8. Dettori M.L., Vacca G.M., Cengarle L., Carcangiu V., Longu G., Bini P.P., 2004. Composizione chimica dei muscoli semitendinosus e longissimus dorsi e dei lipidi di deposito di agnelli muflone x Sarda.. Atti XII Congresso Fe.Me.S.P.Rum., Istambul (Turchia) 16-19 sept. 2004, in press
9. Hornstra G, Barth C.A., Galli C., Mensink R.P., Mutanen M., Riemersma R.A., Roberfroid M., Salminen K., Vansant G., Verschuren P.M., 1998. Functional food science and the cardiovascular system. Br. J. Nutr., 80:1, 13-46
10. Santos-Silva J., Bessa R.J.B., Santos-Silva F., 2002. Effect of genotype, feeding system and slaughter weight on the quality of light lambs. II. Fatty acid composition of meat. Liv. Prod. Sci., 77, 187-194
11. Sanudo C., Enser M.E., Campo M.M., Nute G.R., Marìa G., Sierra I., Wood J.D., 2000. Fatty acid composition and sensory characteristic of lamb carcasses from Britain and Spain. Meat Sci., 54, 339-346
12. Ulbricht T.L.V., Southgate D.A.T., 1991. Coronary heart disease: seven dietary factors. The Lancet, 338, 985-992
13. Vacca G.M., Carcangiu V., Dettori M.L., Bini.P.P. (2005). Carcass characteristics of Mouflon x Sarda lambs. Veterinary Research Comunications, in. c.d.s.
14. Williams C.M., 2000. Dietary fatty acids and human health. Ann. Zootech., 49, 165-180

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