EFFECT OF MILK-REPLACER REARING *VS* NATURAL REARING ON FATTY ACID COMPOSITION OF SUCKLING LAMB LIVER

Osorio, M. T.[1], Bermejo, B.[1], López, O. A.[2], Zumalacárregui, J.M.[1], and Mateo, J.[1]

[1] Department of Hygiene and Food Technology. Faculty of Veterinary Sciences. University of León. Campus de Vegazana, s/n. 24071, León, Spain, dhtmoa@unileon.es

[2] Food Technology Area. Technologic University of Tecamachalco. Av. Universidad Tecnológica, 1. El Montecillo Tecamachalco. Puebla, México.

Background

"Castilla y León" is the region of Spain with the largest sheep stock –c.a. 6 millions–, from which approximately 2.5 millions are slaughtered annually for human consumption. The mayor part of these are suckling lambs 'lechales' –c.a. 60-70%– with age between 25-45 days and with a carcass weight of less than 7 kg, coming from milk production systems (Sañudo *et al*., 1998). The importance, value and quality of suckling lamb meat in 'Castilla y León' has been recognized and protected by a geographical indication: 'Lechazo de Castilla y León' (Council Regulation 2081/92/EC).

In general, in this region the suckling lambs are reared exclusively either with ewe's milk or with milk-substitute, although the last is being more widely used, especially in milk breeds. It appears that rearing suckling lambs, with one or the other type of milk has effect on several production aspects: economical –i.e. feed conversion, milk's price, cheese making, etc.–, meat quality –i.e. nutritional and organoleptic characteristics–, animal welfare and health (De la Fuente *et al*., 1998; Pérez *et al*., 2001; Napolitano *et al*., 2002), supporting the one or the other of both possibilities.

No studies on the fatty acids content of suckling lamb's liver have been found in the literature; however, there were found references dealing with the fat composition of older lambs (Enser *et al.*, 1998; Mir *et al.*, 2000; Moibi and Christopherson, 2001).

Objectives

The purpose of this study was to evaluate the effects of the type of rearing on the fatty acid composition of the liver of an autochthonous lamb breed from Spain (Churra). It was expected that fatty acid profile of fat depots from unweaned young lambs would really reflect the composition of the ingested milk (Bas and Morand-Fehr, 2000, Napolitano *et al*., 2002) –due to the fact that rumen metabolic development has not occurred at this early stage (Lane *et al*., 2000).

Materials and methods

Samples

Thirteen livers of 'lechales' from the Churra breed which were hand reared with milk-replacer and seventeen livers of Churra 'lechales' reared with ewe's milk were purchased from a local slaughterhouse. All samples were homogenised and kept frozen at -40 ºC prior to all analysis.

Fatty acid profile of liver

For analysis of fatty acids, the fat from aliquots of 35 g of liver was extracted according to the method described by Bligh and Dyer (1959). The methyl esters of fatty acids (FAME) from the fat were obtained by base-catalyzed transesterification with $NaCH_3O$ (Sehata *et al.* 1970). Gas chromatographic (GC) analysis were carried out using a Hewlett Packard 6890 Series GC System Chromatograph equipped with a automatic injector (HP 7683 Series Injector), and a Hewlett Packard 5973 Mass Selective detector. The column used for the separation was a Supelco 2-4136 Omegawax^{TM} 250 fused silica capillary column (30 m × 0.250 mm, 0.25 µm film thickness). The GC conditions were as follows: Initial oven temperature 50 ºC, held for 1 min, then programmed at 10 ºC min^{-1} to 150 ºC and held for 1 min, then 12 ºC min^{-1} to 180ºC, then 2 ºC min^{-1} to188ºC and held for 6 min, then 2 ºC min^{-1} to 220 ºC and held for 2 min, and finally 20 ºC min^{-1} to 260 and held for 7 min. Injector and detector temperature were 200 ºC and 300 ºC, respectively. The flow rate of the carrier gas (He) was 1 ml min^{-1} and 1 µl of solution was injected in the mode split, ratio 30:1, and the pressure was 16 psi.

The FAMEs were identified by using individual standards and by their mass spectrometry data obtained with a HP Mass Spectral Libraries (Hewlett Packard, revision D 01.00, 1998) as well as by their retention time found in literature. Quantities of FAMEs were calculated from the response factor of standards or, in case of those standards that were not available, from the response factors of their respective isomers. Results were expressed as percentage of weight of the identified peaks.

Statistical analysis
Fatty acid composition were analysed using ANOVA with one factor, rearing system.

Results and discussion

The fatty acid compositions of the liver from both types of feeding are shown in table 1. The most abundant fatty acids were C18:1, C18:0 and C16:0 and compared with other fatty depots of meat, a high percentage of polyunsaturated fatty acid was observed. These results are in agreement with those found in liver of older lambs in other studies (Enser *et al*., 1998; Mir *et al*., 2000; Moibi and Christopherson, 2001).

Liver from artificially reared lambs showed a lower content of saturated fatty acids ($P<0.001$) and a higher content of unsaturated fatty acids ($P<0.001$). The percentage of monounsaturated fatty acids was lower in the liver obtained from ewe-reared lambs ($P<0.001$) whereas no difference were observed for polyunsaturated fatty acids.

Saturated capric (C10:0), pentadecanoic (C15:0), palmitic (C16:0), margaric (C17:0) and stearic (C18:0) fatty acid contents were lower in the liver of lambs reared with milk substitute ($P<0.005$, $P<0.001$, $P<0.05$, $P<0.001$, and $P<0.001$, respectively). The amount of branched fatty acids was ten times greater in the samples of liver of lambs raised with ewe's milk ($P<0.001$) which can be attributed to the presence of these fatty acids only in ewe's milk. On the contrary, the monounsaturated oleic (C18:1) fatty acid contents were lower in the liver of ewe-reared lambs ($P<0.001$) whereas the cis-heptadecenoic fatty acid (C17:1) were higher ($P<0.001$), the same as the entire fatty acids with an odd number of carbon atoms.

The content of linoleic (C18:2), eicosadienoic (C20:2) and eicosatrienoic (C20:3) fatty acids were higher ($P<0.005$, $P<0.001$ and $P<0.05$, respectively) in the liver of lambs reared with milk substitute. On the other hand the content of linolenic (C18:3), arachidonic (C20:4) and eicosapentaenoic (C20:5) ($P<0.001$) polyunsaturated fatty acids were lower.

The P/S ratio was higher in lambs reared with milk substitutes ($P<0.001$) while the percentage of ω-3 polyunsaturated fatty acids was higher in lambs reared with ewe's milk ($P<0.001$).

The fatty acid profile of liver rather reflects the composition of the milk ingested by lambs. The rumen of suckling lambs is not functional yet and so the fatty acid composition of liver is similar to the fatty acid composition of ingested milk. According to Napolitano *et al.* (2002) milk substitutes showed a lower content of saturated fatty acids (60.2 *vs* 66.4%) and a higher content of monounsaturated (30.1 vs 20.1%) and polyunsaturated (9.7 vs 6.2%) fatty acids compared to milk from ewe. Most of the fat components of milk substitutes are derived from vegetables oils, which are characterised by a lower level of saturation compared to animal fats.

Conclusions

Substantial differences in fatty acid composition between liver from suckling lambs reared with ewe's milk and from those reared with milk-replacer were observed in this study. The liver of the lambs reared exclusively with ewe's milk showed a higher content of saturated fatty acids and a lower content of monounsaturated fatty acids than liver from artificially reared lambs. The nutritional characteristics of the livers of suckling lambs are influenced by the type of feeding.

References

- Bas, P. and Morand-Fehr, P. 2000. Effect of nutritional factors on fatty acid composition of lamb fat deposits. Livestock Production Sci. 64:61-79.

- Bligh, E. G., Dyer, W.J. 1959. A rapid method of total lipid extraction and purification. Can. J. Bioch. And Phys. 37:911-917.

- Council Regulation 208/92/EC

- De la Fuente, J., Tejón, D., Rey, A., Thos, J. and López-Bote, C.J. 1998. Effect of rearing system on growth, body composition and development of digestive system in young lambs. J. Anim. Physiol. a. Anim. Nutr. 78:75-83.

- Enser, M., Hallett, K., Hewett, B., Fursey, G. A. J., Wood, J. D., Harrington, G. 1998. Fatty acid content and composition of UK beef and lamb muscle in relation to production system and implications for human nutrition. Meat Science. 49:329-341.

- Lane, M.A., Baldwin VI, R.L. and Jesse, B.W. 2000. Sheep rumen metabolic development in response to age and dietary treatments. J. Anim. Sci. 78:1990-1996.

- Mir Z., Rushfeldt, M. L., Mir, P. S., Paterson, L. J., Weselake, R. J. 2000. Effect of dietary supplementation with either conjugated linoleic acid (CLA) or linoleic acid rich oil on the CLA content of lamb tissues. Small Ruminant Research. 36: 25-31.

- Moibi, J. A. and Christopherson, R. J. 2001. Effect of environmental temperature and a protected lipid supplement on the fatty acid profile of ovine longissimus dorsi muscle, liver and adipose tissues. Livestock Production Science. 69:245-254

- Napolitano, F., Cifuni, G.F., Pacelli, C., Riviezzi, A.M., Girolami, A. 2002. Effect of artificial rearing on lamb welfare and meat quality. Meat Science. 60:307-315.

- Pérez, P., Maino, M., Morales, M.S. y Soto, A. 2001. Effect of goat milk substitutes and sex on productive parameters and carcass composition of Creole kids. Small Ruminant Research. 42:87-93.

- Sañudo, C., Sánchez, A., Alfonso, M. 1998. Small ruminant production systems and factor affecting lamb meat quality. Meat Science. 49:S29-S64.

- Shehata, A.J., De Man, J.M. Alexander, J.C. 1970. A simple and rapid method for the preparation of methyl-esther of fats in milligram amounts for gas chromatography. Can Inst. Food Technol. J. 3:85-89.

Table 1. Fatty acids profile of liver fat of suckled lambs reared with ewes' milk or milk replacer.

Fatty acids	Ewes' milk	Milk replacer	Significance
C10:0 capric	0,04±0,04	0,01±0,01	P<0,005
C12:0 lauric	0,21±0,15	0,33±0,17	NS
C14:0 myristic	1,57±0,63	1,32±0,40	NS
C15:0 br. isomer	0,04±0,04	0,00±0,00	P<0,001
C15:0 br. isomer'	0,13±0,08	0,00±0,00	P<0,001
C15:0 pentadecanoic	0,46±0,12	0,06±0,05	P<0,001
C16:0 br. isomer	0,12±0,08	0,11±0,18	NS
C16:0 palmitic	19,48±3,39	16,82±2,00	P<0,05
C16:1 isomer	0,20±0,11	0,31±0,33	NS
C16:1 palmitoleic	0,5±0,16	0,71±0,44	NS
C16:1 isomer'	0,02±0,06	0,02±0,05	NS
C17:0 br. isomer	0,37±0,08	0,00±0,00	P<0,001
C17:0 br. isomer'	0,39±0,14	0,00±0,00	P<0,001
C17:0 br. isomer''	0,03±0,07	0,00±0,00	NS
C17:0 margaric	1,33±0,30	0,21±0,18	P<0,001
C17:1 cis-heptadecenoic	0,17±0,07	0,01±0,02	P<0,001
C17:1 isomer	0,13±0,07	0,00±0,00	P<0,001
C18:0 stearic	29,56±3,53	18,78±3,49	P<0,001
C18:1 isomer	0,00±0,00	0,03±0,06	P<0,05
C18:1 ω9 oleic	17,67±2,90	26,95±1,84	P<0,001
C18:1 isomer'	0,16±0,44	1,70±1,97	P<0,005
C18:1 isomer''	2,09±0,74	3,97±1,87	P<0,001
C18:1 isomer'''	0,52±0,34	2,83±1,29	P<0,001
C18:1 isomer''''	0,81±0,47	2,90±2,10	P<0,001
C18:1 isomer'''''	0,00±0,00	0,39±0,39	P<0,001
C18:2 isomer	0,08±0,13	0,29±0,26	P<0,01
C18:2 isomer'	0,00±0,00	0,50±0,43	P<0,001
C18:2 ω6 linoleic	8,26±1,04	10,91±2,76	P<0,01
C18:2 isomer''	0,00±0,00	0,05±0,10	P<0,05
C19:0 nonadecanoic	0,20±0,13	0,05±0,09	P<0,01
C18:3 ω3 α-linolenic	0,82±0,32	0,10±0,21	P<0,001
C18:2 CLA	0,38±0,22	0,88±0,89	P<0,05
C20:0 arachidic	0,10±0,07	0,06±0,12	NS
C20:1 gadoleic	0,18±0,14	0,30±0,37	NS
C20:2 isomer	0,00±0,00	0,09±0,08	P<0,001
C20:2 eicosadienoic	0,03±0,04	0,33±0,50	P<0,05
C20:3 ω6 eicosatrienoic	0,51±0,20	1,64±1,82	P<0,05
C20:4 ω6 arachidonic	12,32±1,85	7,30±1,48	P<0,001
C20:5 ω3 eicosapentenoic	1,09±0,48	0,05±0,08	P<0,001
C22:0 behenic	0,02±0,03	0,01±0,02	NS
Saturated	54,05±3,85	37,75±3,79	P<0,001
Monounsaturated	22,45±2,80	40,11±6,08	P<0,001
Polyunsaturated	23,50±3,04	22,14±3,95	NS
Branched	1,08±0,31	0,11±0,18	P<0,001
ω3	1,92±0,76	0,15±0,22	P<0,001
ω6	21,12±2,77	20,17±3,81	NS
P/S	0,44±0,08	0,59±0,11	P<0,001

br.: branched
P: Polyunsaturated
S: Saturated
CLA: conjugated linoleic acid
NS: no significance