SUCKLING LAMB FATTY ACIDS AS AFFECTED BY EWES FEEDING SYSTEM

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Background

Milk produced by ewes grazing grass has a different fatty acid composition than milk from ewes given concentrates (Banni *et al*. 1996). In particular, milk from grazing ewes has lower levels of saturated fatty acids (SFA) and higher levels of fatty acids thought to be more beneficial to human health such as polyunsaturated fatty acids (PUFA) and conjugated linoleic acid (CLA) (Banni *et al*. 1996). In suckling ruminants, milk bypasses reticulorumen and is digested directly in the abomasum. Therefore, also milk fat escapes ruminal biohydrogenation. The effect of production system, and in particular of grass feeding, on the intramuscular fatty acids of suckling lamb (raised with their dams at pasture) has been studied (Velasco *et al*., 2001; 2004). However, literature lacks reports on the effect of the production system of ewes (pasture *vs*. stall feeding) on the intramuscular fatty acids of lambs fed exclusively maternal milk.

Objectives

The objective of this trial was to study the fatty acid composition of intramuscular fat in lambs fed exclusively milk from ewes consuming pasture or concentrates.

Materials and methods

Twenty pregnant Comisana ewes were selected about 30 days before lambing and divided into two groups of ten animals. One group of ewes was allowed to graze a vetch pasture (grass) from 07:00 to 18:00 every day. The second group of animals was penned and given hay and concentrate (stall). After lambing, all ewes were allowed to stay with the respective lambs between 18:00 and 07:00 of the following day in two different group pens. The lambs were kept in these pens for the whole trial, and fed exclusively maternal milk. Every ewe gave milk to only one lamb. In case of twin lambing, one was removed.

The lambs were slaughtered at 38 days of age. Twenty-four hours after slaughter samples of *longissimus thoracis* muscle were taken at the level of the 13th thoracic rib, minced, vacuum-packed (50 g for each animal), and stored at –25°C until analysed (10 days on average). Intramuscular fat was extracted, from a 4 g ground meat sample, according to Folch *et al*. (1957) as described by French *et al*. (2000). Fatty acids were quantified as fatty acid methyl esters prepared by acid-catalysed methanolysis (French *et al*. 2000). Separation of fatty acid methyl esters was performed with a capillary column SP-2380 in fused silica (60 m x 0.25 mm i.d.; 0.20 µm film thickness) using He as a carrier gas. The gas-chromatograph used was a Thermo Finnigan, TRACE with the software ChromQuest (Thermo Finnigan, San Jose, CA, USA). The conditions were the following: initial temperature 140°C; initial isotherm 1 min; temperature increasing, 1°C per min up to 165°C with an isotherm of 1 min, then increasing 6°C per min to the final temperature of 225°C; final isotherm 8 min; carrier He, injector temperature 230°C; detector (F.I.D.) temperature, 250°C; injector mode split, flow carrier on column constant (1.2 ml/min). The different fatty acids were identified by the retention time with reference to fatty acid standards. The fatty acid standards were purchased from Larodan Fine Chemicals AB (Malmö, Sweden). Standard mix was prepared in our laboratory, and palmitic acid was used as the reference fatty acid (response factor = 1.00). Fatty acids are expressed as percentage (w/w). Data were analysed by t-test to compare the two maternal feeding regimes (grass *vs*. stall).

Results and discussion

Mean carcass weight of the lambs was unaffected by the feeding treatment of the ewes, and was on average 9.3 kg. Intramuscular fatty acid proportions are reported in Table 1. Palmitic acid (16:0) was more abundant ($P < 0.05$) in the fat from lambs raised by ewes consuming concentrates. At the moment of writing this report, total fatty acid composition of ewe milk has not been finished. However, in a recent trial Scinardo

Tenghi (2003) found that ewes allowed to graze a natural pasture exclusively, showed lower ($P < 0.001$) levels of palmitic acid in their milk compared to ewes given hay and concentrate. Our result on the meat is in accordance with the report of Velasco *et al*. (2001). Trans-vaccenic acid (18:1 11trans) was more abundant ($P = 0.01$) in the fat of the grass-fed lambs. It is well known that milk from cows fed pasture has higher levels of this fatty acid compared to milk from animals given concentrates (Jahreis *et al*., 1997). Linoleic acid (18:2 cis *n*-6) was more abundant ($P < 0.0005$) in the intramuscular fat from lambs raised by ewes given concentrates. In milk, Scinardo Tenghi (2003) reports a concentration of linoleic acid in concentrate-fed ewes being thrice the amount of that in milk of grazing ewes. Linolenic acid (18:3 *n*-3), however, was three times more abundant ($P < 0.0005$) in the fat of the lambs of the grazing ewes compared to the offspring of the stall group. It is well known that grass contains high proportions of linolenic acid (Aurousseau *et al*., 2004). However, in the lambs of the grass group, we found a proportion of this fatty acid much higher than that reported so far in the literature for light lambs (Velasco *et al*. 2001, 2004). On the other hand, compared to lambs of the stalled ewes, conjugated linoleic acid (9cis, 11trans isomer; CLA) was present at about double concentration in the fat of the offspring of the grazing ewes ($P < 0.0005$). This isomer of conjugated linoleic acid in the ruminant tissue may be derived mot only from milk CLA but also from trans-vaccenic acid through the action of Δ^9 desaturase (Barber *et al*., 2000). Indeed, in milk from ewes grazing pasture, both CLA and trans-vaccenic seem to be at higher concentration compared to milk from ewes given concentrates (Jahreis *et al*., 1999). Two long chain *n*-3 fatty acids (EPA; 20:5 and DHA; 22:6) were more abundant (respectively $P < 0.0005$ and $P = 0.01$) in the intramuscular fat of lambs from grass group compared to stall group. These fatty acids are derivates of linolenic acid, and diets rich in this fatty acid result in an increased level of EPA and DHA in meat (Raes *et al*., 2004). Since the *n*-3 fatty acids were more abundant ($P < 0.0005$) and the *n*-6 fatty acids less abundant ($P < 0.01$) in lambs of the grass group compared to the stall group, the former produced a lower ($P < 0.0005$), and therefore more favourable (Wood and Enser, 1997) *n*-6/*n*-3 ratio in their meat than the latter. In both groups of lambs, however, this ratio was below 4.0, which is the recommended minimum for a human diet as a whole (Enser *et al*., 1998).

Conclusions

Intramuscular fatty acid composition of lamb fed exclusively maternal milk was highly affected by the feeding regime of the ewes. In particular, meat from lambs fed by ewes grazing grass showed higher levels of trans-vaccenic acid (18:1 *trans*11), CLA, linolenic acid and its derivates (EPA and DHA). Meat of lambs of the concentrate-fed ewes was higher in linoleic as well as other *n*-6 fatty acids. The *n*-6 to *n*-3 ratio was lower, and therefore more favourable in the meat of lambs of the grazing ewes.

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Table 1. The intramuscular fatty acid composition of lambs as affected by the diet of the ewe.

	Treatment			
Fatty acid	Grass	Stall	SEM	*P*-value
12:0	0.26	0.33	0.030	0.260
14:0	2.32	2.96	0.247	0.199
14:1	0.17	0.25	0.023	0.078
16:0	12.71	15.50	0.659	**0.030**
16:1	0.76	0.87	0.068	0.434
18:0	8.15	9.52	0.292	**0.014**
18:1 9tr	0.10	0.02	0.026	0.137
18:1 11tr	1.71	1.15	0.119	**0.014**
18:1 cis *n*-9	16.54	16.89	0.556	0.762
18:2 tr	1.67	0.79	0.182	**0.011**
18:2 *n*-6	8.28	12.88	0.632	**<0.0005**
18:3 *n*-6 (γ-linolenic)	0.57	0.89	0.045	**<0.0005**
18:3 cis *n*-3	13.23	4.24	1.080	**<0.0005**
18:2 cis-9, trans-11(CLA)	1.35	0.62	0.103	**<0.0005**
18:2 trans-10, cis-12	0.04	0.03	0.006	0.463
20:2 *n*-6	0.22	0.34	0.024	**0.010**
20:3 *n*-3	0.13	0.15	0.027	0.830
20:4 *n*-6	11.89	19.90	2.010	**0.042**
20:5 *n*-3	7.36	3.39	0.510	**<0.0005**
22:5 *n*-3	6.86	5.11	0.318	**0.003**
22:6 *n*-3	5.67	4.17	0.308	**0.010**
n-3 Fatty acids	26.26	11.81	1.790	**<0.0005**
n-6 Fatty acids	22.06	33.91	2.130	**0.003**
n-6:*n*-3 ratio	0.85	3.07	0.305	**<0.0005**