EFFECTS OF LAMB FEEDING WITH SUCKLING FEEDS CONTAINING ω-3 POLYUNSATURATED FATTY ACIDS. 1. PRODUCTIVE PERFORMANCES, SLAUGHTERING DATA AND CARCASS QUALITY TRAITS.

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Background

There has been a growing body of evidence over the past years on the fact that consumption of diets high in ω-3 polyunsaturated fatty acids (PUFAs) is associated with a decrease in the occurrence of cardio-vascular diseases in man (Nordoy et al., 2001). Thus, diets based on foods rich in PUFA are ever more recommended since consumers are becoming more careful for their food choices due to the gain of awareness of the relationship between nutrition and health. Therefore, this stresses the need to identify dietary manipulations of ruminant feeding able to increase the PUFA content in foods such as meat and milk. In ruminants the fatty acid composition of meat does not fully reflect the fatty acid content of the diet, due to the extensive biohydrogenation of unsaturated fatty acids which occurs in the rumen by the microbial activity (Leskanich et al., 1997; Huang et al., 1998; Wachira et al., 1998). As a consequence, ruminant meat contains a higher amount of saturated fatty acids in comparison with monogastrics. However, in suckling lambs, in which the rumen has not gained its function yet, fatty acids are able to by-pass the ruminal barrier and reach directly the intestine where they can be absorbed. This may be achievable by the administration of a suckling feeds containing ω-3 PUFAs, which seem to exert positive effects on the post-natal health and growth of animals (Simopoulos, 1991; Calder, 1996; Leskanich and Noble, 1999; Ragni et al., 2001).

Objectives

The aim of the present study was to examine the effect of replacing the fat of a commercial suckling feed with different amounts of ω-3 PUFAs on the productive performances and carcass quality traits of lambs submitted to artificial suckling.

Methods

The trial was carried out in Southern Italy (Spinazzola, Bari, 41° N) on 30 male lambs of an autochthonous breed (Leccese) born in March. Lambs received colostrum for 48 hours after birth and were afterwards subdivided into 4 groups submitted to the following feeding treatments: natural suckling under mothers (group A, n.=12); commercial suckling feed (group B, n.=6); experimental suckling feed in which either 20 (group C, n.=6) or 40% (group D, n.=6) of the fat present in the feed was substituted with lipids rich in ω-3 fatty acids (Siloil ω-3 plus, Table 1); thus, the suckling feeds administered to Groups C and D contained globally 5% and 10% of ω-3 fatty acids, respectively. Lambs fed by artificial suckling were given *ad libitum* twice daily the suckling feed prepared by dissolving 200 g of feed (% on the DM basis: moisture: 3.0; crude protein: 24.0; ether extract: 25.0; crude cellulose: 0.3; ash: 7.0) in 1 l of water. Throughout the experimental period, lambs were checked daily for food consumption and weekly for their live weight. Lambs were slaughtered at 40 days of age. The carcasses were chilled for 24 hours at 4 °C and sectioned into cuts which were dissected into tissue components (lean, fat and bone) (ASPA, 1991). Samples taken from the *Longissimus lumborum* muscle were used to assess colour and tenderness. Colour was determined by a fotometer (HunterLab) which measures the values of Lightness (L), Redness (a) and Yellowness (b). Tenderness was measured as the cutting force using a Warner Bratzler shear applied to an INSTROM 1140 instrument. Data were processed using the GLM procedure of the SAS system and means were compared using Student's t test (SAS, 1991).

Results and Discussions

Natural suckling lambs showed a slightly lower intake of milk compared to the other groups (Table 2) and a markedly lower feed conversion index compared to the groups receiving suckling feeds, especially if feed contained PUFAs ($P<0.01$). The economic convenience index (ECI) takes into consideration both feed conversion index and feed cost; thus, the fact that natural suckling provides a significantly ($P<0.01$) higher ECI compared to the artificial reared groups suggests that the technique of artificial suckling is quite advantageous for the breeding system, both in economic terms, due to ewes' milk worth, as well as for lamb productive efficiency. As for the slaughtering data (Table 3) replacement of the feed fat with ω-3 fatty acids significantly ($0.05>P<0.01$) enhanced the incidence of the digestive tract in comparison with natural reared lambs, probably due to their higher feed consumption. No relevant differences among groups aroused with regards to the carcass sectioning into cuts (Table 4). Likewise, the dissection of the lumbar region into its tissue components showed that treatments did not differ among each other (Table 5). As far as the physical characteristics of meat are concerned (Table 6), lightness and yellowness of meat obtained from natural suckling lambs were markedly higher in comparison with the groups receiving suckling feeds. Previous studies (Ponnampalam et al., 2001) reported that dietary administration of ω-3 fatty acids may negatively affect some meat quality characteristics such as colour, flavour and odour due to the increased susceptibility to lipid oxidation. In this trial, incorporation of ω-3 PUFAs into the suckling feed did not affect meat redness, regardless the percentage used. Tenderness was significantly ($P<0.01$) worse in natural reared lambs; therefore, feeding with suckling feeds may have somehow influenced the factors which are known to affect meat tenderness (such as collagen, muscle proteinases and fat deposition rate) (Koohmaraie, 1992).

Conclusions

The results of our study show that the technique of artificial rearing by the administration of suckling feeds to lambs may be applied successfully since it determines productive performances completely overlapping to those of natural reared lambs. This may provide remarkable profits to the breeding system since milk yielded by the mothers may be completely used for the dairy industry. Furthermore, lambs fed with suckling feeds showed better tenderness, thus better meat quality. In this study, the integration of ω-3 fatty acids into the suckling feed positively affected the parameters investigated, even though no differences between the percentages tested were found.

Pertinent literature

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Table 1 - Fatty acid composition of Siloil plus ω-3 (% by weight).

$C_{18:3}$ ω-3	$C_{20:5}$ ω-3	$C_{22:6}$ ω-3	Polyunsaturated ω-3	Saturated	Unsaturated	Others
1.50	4.32	3.11	9.85	22.58	70.88	6.54

Table 2 - Productive performances.

			Group A	Group B	Group C	Group D	SED
Lambs (n.)			12	6	6	6	DF = 26
Initial live weight (kg)			5.500	5.036	4.908	4.878	0.933
Final live weight (kg)			11.958	12.100	11.117	11.166	1.938
Daily weight gain (g/d)			182	192	170	171	39.188
Daily feed*:	Intake	(g/d)	1032	1219	1232	1165	229.188
	Cost	(€/d)	0.80^{A}	0.51^{B}	0.57^{B}	0.58^{B}	0.143
Feed conversion index		(kg/kg)	5.72^{Cb}	6.38^{Ba}	7.27^{A}	6.82^{AB}	0.543
Economic convenience index**		(€/kg)	4.45^{A}	2.68^{C}	3.37^{B}	3.42^{B}	0.330

*Calculated on milk supposed to contain 6.5% of fat according to Pulina et al. (1989). **Calculated considering 0.80 €/kg as the current price for milk sale and 1.96, 2.14 and 2.32 €/kg as the purchase prices of the suckling feeds administered to Groups B, C and D, respectively. A, B, C: P<0.01; a, b: P<0.05.

Table 3 - Slaughtering data (% on the empty body weight).

	Group A	Group B	Group C	Group D	SED
Lambs (n.)	6	6	6	6	DF = 20
Empty body weight(1)	10.904	11.798	10.704	10.681	1.886
Carcass weight(2)	7.268	7.781	7.063	6.936	1.281
Pelt + wool	12.04^{b}	12.93	13.34^{a}	12.68	0.980
Gastrointestinal tract	10.66^{Bb}	12.42	13.08^{A}	12.47^{a}	1.491
Omentum	0.47	0.38	0.29	0.33	0.248
Warm dressing percentage	66.61	65.93	65.95	64.97	1.760
Chilling loss(3)	3.33	2.81	3.07	3.20	0.406

(1)Calculated by subtracting the gastrointestinal content weight to live weight. (2)Includes head, shins and pluck. (3)% on warm carcass weight. A, B: P<0.01; a, b: P<0.05.

Table 4 - Sectioning data (% on the reconstituted carcass weight).

	Group A	Group B	Group C	Group D	SED (DF = 20)
Reconstituted carcass weight (kg)	6.916	7.382	6.713	6.606	1.121
Head	10.79^{Aa}	9.38^{B}	9.76^{b}	9.81^{b}	0.767
Pluck	7.70^{B}	8.51	9.36^{B}	9.19^{A}	0.749
Neck	5.11^{b}	5.71	5.40	6.14^{a}	0.831
Steaks + brisket	20.88	20.53	19.97	19.81	1.094
Thoracic limbs	14.70	14.60	14.38	14.72	0.684
Lumbar region	7.21^{A}	7.11^{a}	6.19^{Bb}	6.65	0.601
Abdominal region	2.28	2.10	2.51	2.08	0.422
Pelvic limbs	26.95	27.43	27.75	24.98	1.344
Shins	2.96	2.91	3.07	3.12	0.273
Kidney fat	0.71	0.79	0.56	0.54	0.313
Kidneys	0.70^{B}	0.93^{A}	1.01^{A}	0.95^{A}	0.099

A, B: P<0.01; a, b: P<0.05.

Table 5 – Tissue components of the lumbar region (% on the reconstituted lumbar region weight).

	Group A	Group B	Group C	Group D	SED
Reconstituted lumbar region weight (kg)	0.49	0.51	0.41	0.43	0.095
Lean	55.37	56.26	51.62	52.08	4.482
Fat	13.80	11.40	14.92	12.23	5.516
Bone	30.83	32.34	33.46	35.69	4.251

Table 6 - Meat colour and tenderness assessed on *Longissimus lumborum*.

	Group A	Group B	Group C	Group D	SED
Colour:					
L (Lightness)	43.40^{Aa}	40.49^{b}	40.69^{b}	39.32^{B}	2.175
a (Redness)	7.50	8.47	8.29	8.08	0.861
b (Yellowness)	9.63^{Aa}	8.51^{b}	8.35^{b}	7.83^{B}	0.917
WBS (Warner Bratzler Shear) force (kg/cm²)	4.43^{A}	2.02^{B}	2.00^{B}	2.10^{B}	0.453

A, B: P<0.01; a, b: P<0.05.