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Feeding dehydrated alfalfa increases polyunsaturated fatty acids concentration in Marchigiana beef muscle

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RIASSUNTO – L'alimentazione con erba medica disidratata eleva il contenuto di acidi grassi polinsaturi delle carni di vitelloni di razza Marchigiana. *La ricerca è stata eseguita su 20 vitelloni di razza Marchigiana dai 18 ai 21 mesi. Gli animali sono stati distinti in 2 gruppi sperimentali (controllo e trattato) di 10 capi ciascuno ed alimentati con paglia, fieno e mangime fornito a volontà. I vitelloni del gruppo trattato hanno ricevuto un mangime contenente il 20% di medica disidratata mentre quelli del controllo hanno assunto un mangime di analoghe caratteristiche analitiche ma sprovvisto di foraggi disidratati. I risultati mostrano come l'alimentazione con erba medica disidratata innalzi significativamente il contenuto di acidi grassi polinsaturi (P<0,05) ed in particolare di acido linoleico (C18:3n-3; P<0,001) ed arachidonico (C20:4n-6; P<0,01).*

Key words: beef steers, alfalfa dehydrated, polyunsaturated fatty acids, Marchigiana.

INTRODUCTION – Beef meat is a low fat food (<5% fat). However, the fatty acid composition of beef is relatively saturated (approximately 45-50%). The polyunsaturated/saturated fatty acids (P/S) ratio in beef is approximately 0.1, the ideal being about 0.4 (Department of Health, 1994). This can cause critical comments to beef meat related to human health. Set against this, the ratio of n-6:n-3 fatty acids is beneficially low, approximately 2.0, reflecting the considerable amounts of n-3 polyunsaturated fatty acids (PUFA) in beef, particularly alpha-linolenic acid (C18:3n-3) and the long chain PUFA, eicosapentaenoic acid (C20:5n-3) and docosahexaenoic acid (C22:6n-3). Also American consumers have been advised to reduce consumption of saturated fat and total energy from fat in order to lower plasma cholesterol (NRC, 1989). Meat (and milk) from ruminants also represents the major dietary sources of conjugated linoleic (CLAs). The 9-cis, 11-trans-octadecadienoic acid, accounts for 75-90% of total CLAs in meat. To improve the healthiness of beef, strategies for raising the P/S ratio whilst keeping n-6:n-3 low and boosting CLA are required. The P/S ratio in the total human diet should be >0.4 with an n-6:n-3 ratio <4. Several opportunities exist to change the fatty acid composition of beef by feeding diets rich in long chain PUFA such as C18:3n-3 (alpha-linolenic acid) which are present at high concentrations in grass and in mixed feed containing for example linseed (La Borde *et al.*, 1999; Mills *et al.*, 1992; Pezzi *et al.*, 2004; Scollan *et al.*, 2001; Scollan *et al.*, 2002). Green plants are the primary source of n-3 fatty acids. Forages such as grass or legume hay contain a high proportion (50-75%) of total fatty acids as the alpha-linolenic acid. Since fish consumption, a major source of dietary long-chain n-3 PUFA, is relatively low in Italy, research has focused on improving the fatty acid composition of meats. The aim of this work is to evaluate the opportunity of enhancing the concentration of n-3 fatty acids in beef muscle by feeding dehydrated alfalfa.

MATERIAL AND METHODS – A total of 20 male Marchigiana steers were selected at a mean of 18 months of age. The animals were kept indoor for three months and fed intensively with concentrates *ad libitum* and wheat straw and mixed hay until slaughter. The steers were divided into two homogeneous groups (control and treated) of 10 head each one. Treated group received a concentrate containing grain cereals (corn and barley), wheat middlings, 20% pelletted dehydrated alfalfa, soybean meal, mineral and vitamin complement while control group received a concentrate containing wheat bran, beet pulp, corn gluten feed and sunflower meal in place of pelleted dehydrated alfalfa and wheat middlings. The concentrate was sampled 3 times (monthly) and analyzed for moisture (oven drying), crude fibre, and protein (Kjeldahl nitrogen) using AOAC (1984) procedures. Determination of lipids and extraction for fatty acid analysis was completed using chloroform/methanol (2/1, vol/vol) as described by Folch *et al.* (1957). Analysis of fatty acid composition was performed with Gas Chromatography technique: HRGC Mega 2 (Fisons) equipped with a flame ionization detector. Steers were slaughtered at a mean of 21 months. All carcasses were evaluated for conformation and fatness. *Longissimus dorsi* muscle sample were removed at the 8-12th rib 24 h after slaughtering and stored at -18°C until analysis. Moisture (oven drying), fat (ether extraction), protein (Kjeldahl nitrogen) and fatty acids analysis were performed with the same technique utilized for concentrate feed samples. The statistical analysis was performed using analysis of variance with the statistical package SPSS/PC+. The statistical model included feeding treatment as variable.

RESULTS AND CONCLUSIONS – In Table 1 is shown the analysis of composition of the two concentrate feed. All chemical constituents were present in similar amounts except for fatty acids. These data confirm that alfalfa dehydrated is a good source of PUFA and particularly of Omega-3 fatty acids like alpha-linolenic acid.
The Table 2 shows the performance of beef steers which are very similar. These results, according with previous results of Pezzi *et al.* (2004) suggest that feeding alfalfa dehydrated do not depress the productivity of the animals.

Table 1. Analytical composition of concentrates (mean±std. dev.).

		Control	Treated	P
Moisture	%	10.10±1.18	9.48±1.01	n.s.
Crude protein	%	15.54±0.20	15.33±0.38	n.s.
Total lipids	%	3.99±0.16	4.31±0.48	n.s.
Crude fibre	%	8.59±0.20	8.10±0.25	n.s.
Ash	%	7.40±0.44	7.49±0.33	n.s.
Fatty acids*				
C 16:0	%	27.90±2.36	25.37±1.81	n.s.
C 18:0	%	2.96±0.14	3.35±0.42	n.s.
C 18:1	%	25.74±0.66	26.46±2.75	n.s.
C 18:2n-6	%	36.44±1.61	32.56±5.92	n.s.
C 18:3n-3	%	1.99±0.10	5.82±2.06	P<0.05
Others	%	4.98±4.28	6.43±3.60	n.s.

(*) Reported as normalized percentages (g / 100 g of total fatty acids).

Table 2. Steers carcass weight and quality.

		Control	Treated	P
Slaughter weight	kg	750.80±41.03	746.00±75.56	n.s.
Dressing percentage	%	65.91±1.44	65.39±1.56	n.s.
Carcass conformation score*	P.ts	4.00±0.00	3.90±0.32	n.s.
Carcass fatness	P.ts	2.60±0.52	2.60±0.52	n.s.

(*) The EUROP evaluation system has been transformed in score from 5 (E letter) to 1 (P letter).

The results shown in Table 3, in agreement with other Authors (Pezzi *et al.*, 2004, Scollan *et al.*, 2002) suggest that dehydrated alfalfa, which contain lipids rich in PUFA, allow to limit the hydrogenating action of rumen micro-organisms. In fact beef muscle is enriched in PUFA (P<0.05) and particularly in Omega-3 fatty acids (P<0.01) and alpha-linolenic acid (C18:3n-3; P<0,001); also Omega-6 fatty acids (P<0.05) and particularly arachidonic acid (C20:4n-6; P<0.01) were more concentrated in beef muscle of steers fed alphalpha dehydrated. The net result was a shift in P:S value toward the guidelines of Department of Health (1994). Moreover, as described by Pezzi *et al.* (2004) the lipid content of meat was tendentially low in steers fed dehydrated alfalfa.

Table 3. Effect of dehydrated alfalfa supplementation on the composition of *longissimus dorsi* muscle from 8-12th rib section (mean ± std. dev.).

		Control	Treated	P
Moisture	%	76.31± 2.86	76.00± 0.72	n.s.
Crude protein	%	21.75± 1.00	21.94± 0.87	n.s.
Lipids	%	1.50± 0.42	1.27± 0.20	n.s.
Ash	%	1.13± 0.14	1.11± 0.04	n.s.
Fatty acids*				
Saturated	%	47.16± 4.05	44.76± 2.51	n.s.
Monounsatured	%	36.25± 3.82	34.10± 4.29	n.s.
C18:2n-6	%	11.77± 3.74	14.49± 2.75	n.s.
C20:3n-6	%	0.62± 0.24	0.82± 0.19	n.s.
C20:4n-6	%	2.98± 1.04	4.29± 0.66	P<0.01
C18:3n-3	%	0.41± 0.06	0.61± 0.08	P<0.001
CLA	%	0.34± 0.04	0.36± 0.11	n.s.
Polyunsatured	%	16.59± 5.08	21.14± 3.61	P<0.05
Omega-6	%	15.37± 4.94	19.59± 3.50	P<0.05
Omega-3	%	0.88± 0.20	1.19± 0.24	P<0.01

(*) Reported as normalized percentages (g / 100 g of total fatty acids).

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