INFLUENCE OF STRATEGIC MAIZE GRAIN SUPPLEMENTATION ON CHOLESTEROL AND FATTY ACIDS OF LONGISSIMUS AND SEMITENDINOSUS MUSCLES OF BEEF STEERS AT GRAZING

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Background.

Beef is a high quality food for human consumption, yet its saturated fatty acid and cholesterol content has led to a negative image by some consumers (Chizzolini, 1999). In human beings, fatty acids C14:0 and C16:0 increase blood total LDL (low density lipoproteins) and HDL (high density lipoproteins) cholesterol concentration and the LDL:HDL ratio (Wiseman, 1997). Omega 6 fatty acids tend to decrease LDL, while dietary omega 3 polyunsaturated fatty acids are effective in reducing high blood levels of triacylglycerol (Austin, 1997). Nutrition affects tissue fatty acids in cattle. Forage diets in comparison to high grain diets, as those fed in feedlots for prolonged periods, result in higher levels of unsaturated fatty acids (Miller *et al.*, 1987; García and Casal, 1992). There exists discrepancy about nutritional effects on cholesterol contents in bovine muscles. Some researchers (Eichhorn *et al.*, 1986; Miller *et al.*, 1987; Rule *et al.*, 1997) found no effects, while García and Casal (1992) reported that feedlot diets increased cholesterol in *Longissimus* muscle. Short term supplementation in pasture based beef production systems, which amount to not more than half of the daily food intake, is a common feeding practice to overcome seasonal forage production, particularly in the last stage of the fattening period. Thus, the effect of this feeding strategy on cholesterol and fatty acid composition needs to be established.

Objective.

To assess the effects of limited grain supplementation on cholesterol and fatty acid composition of *Longissimus* and *Semitendinosus* muscles of steers grazing pastures and slaughtered at a similar subcutaneous fat depth.

Methods.

Twenty seven , 22 months old Angus steers of 391±38 kg mean liveweight were used. Steers were alloted at random to either grazing only mixed pastures (OP) (n = 12) or to grazing the same pasture supplemented with cracked maize grain at 1.5% of liveweight per day (PG) (n = 15). Animals grazed 2.5 hectares paddocks of a 15 hectares field. Slaughter point was visually determined by a trained abattoir official and objectively by measuring subcutaneous fat depth between ribs 12 and 13 using an ultrasound unit (Aloka SSD 900, Fujihara Ind. Co. Ltd.). Samples of *Longissimus* at 10-12 ribs and *Semitendinosus* were obtained and kept at -18°C. Intramuscular fat was determined by AOAC (1984) procedures, cholesterol was determined by a colorimetric method using an enzimatic kit (Boerhinger Mannheim GmbH) and fatty acids in meat were extracted according to Folch *et al.* (1957) and analyzed as methyl esters by gas cromatography (Hewlett Packard 5890 Series II) using HP23(cis/trans FAME) semicapillary column (30 m x 0.53 mm x 0.25 µm) and Helium as carrier gas. Data were subjected to analysis of variance using SAS (1998) procedures for general linear models, means were separated using t-tests in the presence of significant F-statistics.

Results and discussion.

Steers in OP were heavier ($P<0.05$), had heavier carcasses ($P<0.05$) and were slaughtered 82 days later than steers in PG (Table 1); subcutaneous fat depth at slaughter was similar in both treatments ($P>0.05$), thus meeting one of the preconditions of this study.

Composition of *Longissimus* and *Semitendinosus* muscles is given in Table 2. Cholesterol concentration of both muscles was not affected by feeding strategy ($P>0.05$), these results agree with the findings of Eichhorn *et al.* (1986), Miller *et al.* (1987) and Rule *et al.* (1997). García and Casal (1992) reported lower cholesterol in *Longissimus* muscle of forage fed steers, in our case animals were slaughtered at a heavier weight, therefore age effects cannot be discarded (Clemens *et al.*, 1973). In coincidence with García and Castro Almeyra (1992), the percentage of intramuscular fat (IMF) of *Semitendinosus* muscle was lower ($P<0.01$) than of *Longissimus* muscle (4.2 % *vs.* 2.1 % respectively). Feeding strategy did not affect IMF ($P>0.05$). Among saturated fatty acids (SAT), palmitic acid (C16:0) concentration as percentage of total fatty acids (FA) was highest (27%), followed by stearic acid (C18:0, 9.7%). Oleic acid (C18:1, 40%) prevailed in the case of monounsaturated fatty acids (MUFA). Most relevant among polyunsaturated fatty acids (PUFA) were linoleic acid (C18:2, 7.9%) and linolenic acid (C18:3, 3.5%); this is coincident with García and Casal (1992). Feeding strategy did not affect SAT (45% *vs.*. 44% for OP and PG respectively, $P>0.05$), however there was a significant ($P<0.01$) feeding strategy x muscle interaction, in OP, as opposed to PG; *Longissimus* had higher SAT while *Semitendinosus* had lower SAT. Muscles of animals in OP had lower levels of C18:1 (38% and 42 % for OP and PG respectively, $P<0.01$) whereas concentrations of C15:1 ($P<0.01$) and C18:0 ($P<0.05$) were higher, which agrees with the data reviewed by Rule *et al.*(1998). A not significant ($P>0.10$) higher concentration of C18:3 in OP was found, probably brought about by high levels of this acid in leaves, which in turn some of it may by-pass rumen hydrogenation and be absorbed as such in the intestines. According to the existing literature, muscles of forage fed cattle typically have more SAT (Rumsey *el al.* 1972) and higher C18:3 (Miller *et al.*, 1987 and García and Casal, 1992) than grain fed cattle; the apparent discrepancy of our results, though the trend is the same, can find its explanation on the relative low levels of supplement used over a short period of time.

Fatty acid profile of muscles show higher C15:1 ($P<0.05$), C18:2 ($P<0.01$) , C20:0 ($P<0.01$) and lower C16:0 ($P<0.05$) and C18:1 ($P<0.05$) in *Semitendinosus* muscle. There was a trend ($P>0.05$) of *Semitendinosus* muscle showing lower levels of SAT (44%) than *Longissimus* muscle (45%), which can be associated with a lower proportion of depot lipids and a higher proportion of functional lipids in lean meat (Rule *et al.*, 1998).

Conclusions.

Differences in cholesterol content and percentage of intramuscular fat in *Longissimus* and *Semitendinosus* muscles due to short term supplementation of grazing cattle were not found. Intrinsic differences between muscles in percentages of intramuscular fat prevailed. Profile of fatty acids was affected to a larger extent by type of muscle rather than by feeding strategy.

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TABLE 1. Effect of feeding strategy (FS) on animal performance

	Initial Liveweight kg	Final Liveweight kg	Daily Gain kg day^{-1}	Subcutaneous Fat Depth mm	Carcass Weight kg	Killing Out Percentage %	Fattening Period days
OP	389±11	499±11	0.81±0.09	7.21±0.50	299±6	61.0±0.4	136
PG	393±10	450±10	0.95±0.08	7.29±0.50	262±6	60.4±0.3	54
P<	ns	*	ns	ns	*	ns	na

OP = only pasture, PG = pasture + cracked maize. ns = P>0.05, * = P<0.05, na = differences statisticaly not analyzed

TABLE 2. Effect of feeding strategy (FS) and muscle (M) on fatty acid composition, intramuscular fat (IMF) and cholesterol contents

Feeding Strategy and Muscle	Fatty Acids (%)													SAT %	Cholesterol mg 100g	IMF %
	<C14	C14-0	C14-1	C15-0	C15-1	C16-0	C17-0	C18-0	C18-1	C18-2	C18-3	C20-0	C20-3			
OP																
LD	0.6	1.9	0.2	0.6	2.9	29.3	1.0	11.7	38.9	6.7	3.6	2.2	0.4	47.4	38.1	4.2
ST	1.0	1.7	0.3	0.7	4.3	24.7	1.1	9.6	37.2	10.0	4.4	4.2	0.7	43.1	37.9	2.6
PG																
LD	0.5	2.3	0.6	0.7	1.6	28.1	1.0	8.3	44.9	6.7	2.6	1.9	0.8	42.8	48.6	4.2
ST	0.9	2.6	0.3	0.8	2.8	26.9	1.0	9.3	39.3	8.2	3.4	3.4	0.8	45.0	33.3	1.6
Probability:																
FS	ns	ns	ns	ns	0.01	ns	ns	0.043	0.009	ns	ns	ns	ns	ns	ns	ns
M	0.018	ns	ns	ns	0.014	0.035	ns	ns	0.019	0.004	ns	0.001	ns	ns	ns	0.001
FS x M	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.003	ns	ns
S.E.	0.4	1.1	0.3	0.3	1.4	3.6	0.0	2.4	4.0	2.1	1.6	0.9	0.8	2.7	14.8	1.0

OP = only pasture, PG = pasture + cracked maize, LD = Longissimus dorsi, ST = Semitendinosus. ns = P>0.05