SHORT COMMUNICATION

Fatty acid composition and conjugated linoleic acid content of intramuscular fat in crossbred cattle with and without Wagyu genetics fed a barley-based diet

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Mir, Z., Paterson, L. J. and Mir, P. S 2000. **Fatty acid composition and conjugated linoleic acid content of intramuscular fat in crossbred beef cattle with and without Wagyu genetics fed a barley-based diet.** Can. J. Anim. Sci. **80**: 195–197. Fatty acid composition and conjugated linoleic acid (CLA) content in pars costalis diaphragmatis (PCD) muscle from European and British crossbred (EBC; no Wagyu genetics) and Wagyu crossbred (WC; 75% Wagyu genetics) beef cattle were determined. Conjugated linoleic acid contents of PCD muscle from EBC (1.7 mg CLA g^{-1} lipid) and WC (1.8 mg CLA g^{-1} lipid) cattle were similar ($P > 0.05$), while WC cattle had higher ($P < 0.05$) CLA content 100 g^{-1} of beef on a DM basis because the lipid content of meat from WC cattle was greater ($P < 0.05$) than that from EBC cattle

Key words: Conjugated linoleic acid, Wagyu, fatty acids, barley, beef cattle

Mir, Z., Paterson, L. J. et Mir, P. S. 2000. **Composition acidolipidique et teneur en acide linoléique conjugué (ALC) de la graisse intramusculaire chez les bovins croisés ayant ou non du sang Wagyu, recevant une alimentation à base d'orge.** Can. J. Anim. Sci. **80**: 195–197. Nous avons déterminé la composition en acide, gras et le contenu en ALC du muscle pars costalis diaphragmatis (pcd) chez des bovins croisés de races européennes et britanniques (ceb) et chez des croisés à 75% d'ascendance Wagyu (cw). La teneur en acide linoléique du pcd des deux types de croisés était la même ($P > 0{,}05$) soit, respectivement, 1,7 et 1,8 mg g^{-1} lipide. Toutefois, les sujets cw contenaient davantage ($P < 0{,}05$) d'ALC par 100 g de viande, calculé sur la matière sèche, du fait que leur viande était plus grass ($P < 0{,}05$) que celle des croisés eb.

Mots clés: Acide linoléique conjugué, Wagyu, acide gras, orge, bovin à viande

Conjugated linoleic acids are produced by bioconversion of linoleic acid ($C_{18:2}$) by the bacterium *Butyrivibrio fibrosolvens* in the rumen (Shantha et al. 1997) and are an intermediary product in the biohydrogenation of linoleic acid to stearic acid ($C_{18:0}$). Currently, CLA are defined as a combination of several positional and geometric isomers with double bonds predominantly at 9 and 11, 10 and 12, or 11 and 13 carbon atoms with various combinations of *cis* and *trans* configuration at each double bond (Stanton et al. 1997). Although CLA are a relatively minor component of the total fatty acid composition of foods, CLA exhibit chemoprotective properties against cancer when included in the diet at very low levels (<1% in the diet; Ip 1997). Meat and dairy products from ruminants (beef, lamb, milk) contain more CLA than meat from non-ruminants [poultry, pork, fish (Chin et al. 1992)]. The CLA content in meat from the semimembranosus (SM) muscle of cattle fed grass was 7.7 mg CLA g^{-1} lipid while the CLA content from those fed corn with grass was 5.2 mg CLA g^{-1} lipid (Shantha et al. 1997). Although the lipid content and fatty acid composition in beef muscle has been extensively studied (Gulati et al. 1996), there is no published information on CLA content of beef from cattle of different breed types raised under identical management practices and fed a barley-based feedlot diet. The objective of this study was to determine the CLA content and fatty acid composition of meat obtained from EBC and WC beef cattle fed a barley-based finishing diet.

Cattle weighing greater than 380 ± 24.4 kg for the WC cattle and 410 ± 33.9 kg for EBC cattle were finished on a 21% barley silage, 78% rolled barley grain and 1% beef mineral and vitamin mix diet (DM basis) until the backfat thickness, as determined by ultrasonography, was greater than 10 mm at the grading site. Cattle were maintained according to the guidelines set by the Canadian Council on Animal Care. Details of breed combination, feeding protocol and diet composition have been described earlier (Mir et al. 1997). Animals were slaughtered in a commercial abattoir and within 20 min, samples were obtained from a subset of the animals whose carcasses were used for meat quality analysis in the study by Mir et al (1997). The samples were obtained from the PCD for determination of lipid

Abbreviations: CLA, conjugated linoleic acid; **DM**, dry matter; **EBC**, European and British crossbred; **LD**, longissimus dorsi; **MUFA**, monounsaturated fatty acid; **PCD**, pars costalis diaphragmatis; **SM**, semimembranosus; **TMG**, tetramethylguanidine; **WC**, Wagyu crossbred

Table 1 Lipid content, fatty acid composition, CLA concentration of muscle lipids from EBC and WC (75%) crossbred cattle

	Cattle breed type	
Parameter	EBC	WC
n	22	16
Lipid (% Dry matter)	29.3 ± 5.25*b*	41.4 ± 5.50*a*
Fatty acids (mg g^{-1} lipid)		
C 16:0	165.1± 4.38	168.2 ± 4.99
C 18:0	117.7 ± 3.22	115.3 ± 0.67
C 18:1	242.1 ± 7.62*b*	323.4 ± 8.68*a*
C 18:2	16.5 ± 1.01	15.6 ± 1.15
C 18:3	1.4 ± 0.06	1.3 ± 0.07
CLA	1.7 ± 0.12	1.8 ± 0.11
CLA (mg $100g^{-1}$ muscle DM)	51.0 ± 1.5*b*	74.5 ± 3.3*a*
Unsat/ total FA	0.48 ± 0.05*b*	0.55 ± 0.06*a*
Unsat/Sat	0.94 ± 0.02*b*	1.21 ± 0.02*a*
Monounsat/Sat	0.87 ± 0.02*b*	1.14 ± 0.02*a*
CLA/18:2	0.12 ± 0.02	0.11 ± 0.02

a,b Means within different letters within rows differ significantly ($P < 0.05$)

content and fatty acid composition from a total of 38 cattle comprising 22 EBC and 16 WC animals with 75% Wagyu influence. Samples were taken from the PCD muscle because this sampling site can be accessed with minimum HACCP (Hazard Analysis Critical Control Point) concerns. Samples were stored on ice, then quick-frozen in liquid nitrogen before being stored at –20°C until further analysis.

Lipid for fatty acid and CLA analysis was extracted from 500 mg of PCD using chloroform-methanol 2:1 (vol vol^{-1}) (Folch et al. 1957). A total of 10 to 20 mg of extracted lipid was derivatized using tetramethylguanidine (TMG) and methanol 1:4 (vol vol^{-1}) (Shantha et al. 1993) after including 17:0 (heptadecanoic acid) as an internal standard. Fatty acid profiles were determined by gas chromatography on a Supelcowax-10, 30 m × 0.25 mm × 0.25 µm column (Sigma Aldrich Canada, Oakville, ON) installed in a HP5830 gas chromatograph with a 18835B capillary inlet system and a 18850A integrator (Hewlett-Packard (Canada) Ltd., Mississauga, ON) by flame ionization detection and splitless injection. Initial oven temperature was 50°C, which was increased to 200°C at a rate of 25°C min^{-1}, then 200–220°C at 1°C min^{-1} and from 220 to 240°C at 15°C min^{-1}. Helium was used as the carrier gas at a flow rate of 1.7 mL min^{-1}. Fatty acids from the muscle samples were identified by comparison of retention times of known standards (Sigma Aldrich Canada, Oakville, ON). Amounts of fatty acids present in the samples were determined by a calculation based on the ratios of the peak area for a fatty acid in the sample to the area of the internal standard times a factor representing the ratio of concentrations of the fatty acid in a standard to the internal standard. Isomers of CLA were identified by comparison to the standard. Isomers of CLA corresponding to peaks identified as c-9,t-11/t-9,c-11 and c-10,c-12 were included in the analysis. The values for c-9,t-11 and t-9,c-11 were identified as CLA peaks and were combined to obtain total CLA, which was used in the statistical analysis. The 38 cattle used in the study were a random subsample of a larger group of cattle raised under the same management system. A simple one-way analysis of variance (F-test) to test differences due to breed type was conducted.

Total extractable lipid and proportion of five fatty acids along with CLA were determined and are shown in Table 1. Total lipid content of the muscle (PCD) was 41.3% lower for samples from EBC cattle relative to those from WC cattle ($P < 0.05$). Similar differences in lipid content of ribeye muscle have been observed in other studies with WC and Angus cattle (Lunt et al. 1993). The relative abundance of the identified fatty acids in the PCD muscle of EBC cattle are comparable to published values for the longissimus dorsi (LD) muscle (May et al. 1993). Studies comparing fatty acid composition of bovine PCD and LD muscles indicated no significant differences for C18:2, while differences among other fatty acids were significantly different (Kazala et al. 1999).

The content of CLA in PCD muscle was similar ($P > 0.05$) for EBC and WC cattle (Table 1) and was approximately 1.7 and 1.8 mg CLA g^{-1} lipid, respectively. These values are lower than those reported (5.2 and 7.7 mg CLA g^{-1} lipid) by Shantha et al. (1997) for the SM muscle, but are higher than those reported (0.23 to 1.25 mg CLA g^{-1} lipid) by Fogerty et al. (1988). In the study by Fogerty et al. (1988), the diets of the animals from which the meat samples were obtained for analyses are not known because they were commercially purchased. The animals in the study by Shantha et al (1997) were on grass pasture with or without daily intake of 8 kg of cracked corn per animal, unlike cattle in the present study, where a complete barley-based diet was utilized during the finishing phase. Although barley and corn have a similar content of linoleic acid, 43.3 and 47.8% of lipid, respectively, the lipid content of corn is double that of barley; the oleic acid content of corn is also higher than that of barley, 30.9 vs. 20.5%, respectively (Palmquist 1988). As dietary lipids enter the biohydrogenation pathway in the rumen and are converted to less saturated fatty acids, the presence of excess oleic acid may lead to increased competition within the pathway. The CLA isomers are intermediates in the conversion of linoleic to oleic acid and, depending on the overall unsaturation of fatty acids in the rumen, they may pass from the rumen prior to being converted to oleic acid isomers. This could increase the passage of CLA from the rumen and ultimately increase deposition of CLA in the tissues. When CLA concentrations were expressed on the basis of PCD muscle DM, the WC cattle had greater ($P < 0.05$) amounts of CLA (74.5 mg 100 g^{-1} DM) than the EBC cattle (51.0 mg 100 g^{-1} DM), because of the higher ($P < 0.05$) lipid content (Table 1) in the of muscle of WC cattle than that of EBC cattle. On the assumption that the C18:2 contents of PCD and LD are similar (Kazala et al. 1999), and given that the lipid content of the LD is 18.9 and 24.6% for EBC and WC cattle, respectively (Mir et al 1997), then the CLA contents of the LD would be 32.1 and 44.3 mg 100 g^{-1} DM for the EBC and WC cattle, respectively. This differential in values would result in 38% more CLA from WC than from EBC cattle.

Oleic ($C_{18:1}$) acid content in the PCD from WC cattle (323.4 mg g^{-1} lipid or 51.7 weight percent) exceeded ($P < 0.05$) those in EBC cattle (242.1 mg g^{-1} lipid or 44.5

weight percent). This observation is in agreement with the oleic acid values of 50.25 and 44.81 weight percent in intramuscular lipid from the LD muscle from Japanese Wagyu and Angus steers, respectively (May et al. 1993). High oleic acid is desirable for human health and some studies have observed a positive association between desirable flavour scores and the percent of oleic acid in beef (Melton et al. 1982). Differences between the cattle types were not observed for palmitic ($C_{16:0}$) stearic ($C_{18:0}$), linoleic ($C_{18:2}$) and linolenic ($C_{18:3}$) acids ($P > 0.05$; Table 1). As a result, the proportions of unsaturated fatty acids to total lipid or saturated fatty acids were greater ($P < 0.05$) for muscle from WC cattle than for samples from EBC cattle. The monounsaturated to saturated fatty acid ratio (MUFA/SFA) was greater ($P < 0.05$) for samples from the WC cattle (1.14) than for those from EBC cattle (0.87). These values are comparable to reported values for the LD from Wagyu and Angus steers of 1.17 and 1.08, respectively for LD (May et al. 1993). A higher level of the MUFA, oleic ($C_{18:1}$) acid, is desirable, as it appears to be beneficial in lowering both plasma total cholesterol and low-density lipoprotein cholesterol in humans. In addition, taste panels tend to give better evaluations of cooked beef that contain higher amounts of oleic acid. No significant difference was observed between the two cattle types for the ratio of CLA to linoleic acid content.

Comparisons of CLA content in lipid extracted from the PCD muscle of EBC and WC cattle fed the same diet indicated no differences between breed types when expressed per unit lipid. However, due to the greater lipid content, meat from animals with Wagyu genetic influence contained greater quantities of CLA and oleic acid than that from cattle with no Wagyu genetic influence. Since a large portion of the lipid in the muscle of Wagyu cattle is present as marbling fat, the likelihood of the fat being trimmed away is small, thus enabling the consumer to benefit from the CLA present in the meat. These results, concerning the CLA content in PCD muscle, indicate the need to further investigate CLA content and availability from cuts more often available to consumers than the PCD.

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