EFFECT OF FINISHING SYSTEM, GENDER AND BREED ON *trans* - VACCENIC AND CONJUGATED LINOLEIC ACIDS IN BEEF

Rymer R. Tullio[1*], Jennifer L. Aalhus[2], Renata T. Nassu[1], Manuel Juárez[2], Alexandre Berndt[1], Maria L. P. da Silva[3], David C. Rolland[2], Mauricio M. de Alencar[1,4], and Mike E. R. Dugan[2]

[1] Embrapa Southeast Livestock, São Carlos, São Paulo, Brazil
[2] Agriculture and Agri-Food Canada, Lacombe Research Centre, Lacombe, Alberta, Canada
[3] São Paulo State University, FCAV, Jaboticabal, SP, Brazil
[4] CNPq Researcher
* rymer.tullio@embrapa.br

Abstract – Studies comparing the effects of different finishing systems on beef quality characteristics suggest that finishing systems produce mixed findings on beef chemical composition. This study analyzed the fatty acid composition of steaks from one-hundred and seventy six crossbred young bulls and heifers finished on pasture or in the feedlot. Feedlot finishing increased steak fat content (29.7%) compared to pasture (23.9%) and heifers had more fat content than bulls. There were no differences in saturated fatty acids (SFA) when production system or sire breed were considered. However SFA was higher for bulls than heifers (48.7% *vs*. 47.2%). Both finishing systems resulted in a greater percentage of *trans (t)* 11-18:1 than *t*10-18:1, and pasture finished had more of both isomers than feedlot. The main natural isomer of CLA (*cis* (*c*)9, *t*11-18:2) was affected by a finishing system*gender interaction and the highest percentage was found in heifers finished on pasture (0.53%). Overall, breed and gender had little influence on beef fatty acid composition, which was more influenced by diet. Both feedlot and pasture finished beef had 'healthy' *trans* fatty acid profiles, and percentages of *trans* isomers and the main natural isomer of CLA were highest on pasture, with preferential accumulation of CLA in pastured heifers.

I. INTRODUCTION

Brazil is one of the largest exporters of beef in the world and to maintain and achieve new markets it is necessary to produce high quality meat. In Brazil, beef cattle are normally pasture-finished, but feedlot-finishing is becoming popular. Results of the studies comparing the influences of the different finishing systems on beef quality characteristics suggest that forage versus feedlot finishing of beef produces mixed findings on beef textural characteristics, chemical composition, and palatability attributes [1]. There is also some controversy regarding the *trans* (*t*) fatty acid profile of forage versus feedlot finishing [2]. Concentrate finishing can at times yield increased *t*10-18:1 which may be grouped with industrially produced *trans* fats that carry a greater cardiovascular disease (CVD) risk. Forage finishing, however, generally yields more *cis* (*c*)9,*t*11-CLA and it's precursor *t*11-18:1 which both may have positive health effects on a number of disease from CVD to cancer [3]. The aim of the present study was to determine to what extent beef fatty acid profiles might be influenced by production systems used in Brazil in a comprehensive study taking into consideration sire breed, gender, and finishing system (i.e. pasture versus feedlot).

II. MATERIALS AND METHODS

Beef from one hundred and seventy six young bulls and heifers, produced in two consecutive years, offspring of Angus or Limousin bulls and ½ Angus + ½ Nellore or ½ Simmental + ½ Nellore cows from Embrapa Southeast Livestock, Sao Carlos, SP, Brazil were evaluated. These animals were arranged in production systems described by Tullio *et al.* [4]. After weaning at 8 months, half of the animals were finished in the feedlot (4.5 months), receiving the diets as a total mixed rations (Table 1), and slaughtered with 419 kg. The other half grazed pasture for 10 months and slaughtered at 450 kg. Animals were shipped the day before slaughter to a commercial abattoir and held overnight with access to water. Carcasses were chilled overnight at 2°C. At 24 h post mortem, carcass were knife ribbed between the 12 and 13th ribs, and a 1 cm loin steak was removed for fatty acid analyses.

From the loin steaks, the *longissimus thoracis* were cut in small pieces and lyophilized (Liotop, model L108 Liobras, São Carlos, Brazil).

Table 1. Diet composition (% dry matter)

	Diet 1	Diet 2	S1	S2
Corn silage	68.0	50.0		
Ground corn grain	12.0	32.8	48.0	65.0
Wheat meal	3.5	8.0	20.0	
Soybean meal	15.0	7.0	20.0	13.0
Limestone	0.5	0.7	4.0	
Mineral supplement	1.0	1.0	5.0	2.0
Urea		0.5	3.0	
Corn gluten				10.0
Protected fat				10.0

S1 = supplement in dry period; S2 = supplement in wet period.

After lyophilization, samples were ground with liquid nitrogen in an analytical mill (model IKA A11 basic, Jank & Kunke GmbH & CO. KG, Staufen, Germany), labelled, individually vacuum packaged and placed in a cooler at -20°C until fat extraction. Intramuscular lipids were extracted from the lyophilized meat samples with chloroform:methanol mixture [5] Extracts were methylated using 5% methanolic HCl, and to correct for conjugated linoleic acid (CLA) isomerization, separate methylations with 0.5 N sodium methoxide were conducted [6]. Fatty acid methyl esters (FAME) were analyzed using GC (acid and basic methylations) [7]. Data were analyzed using the Mixed procedure of SAS and the model included production system, gender, sire and dam breed, and their interactions with total fat as a covariate, and year*system interaction as random factor. As the effect of dam breed was not significant, it was taken out the model. Significance was reported at $P<0.05$.

III. RESULTS AND DISCUSSION

Fat content was higher in supplement (S2) (98.4%) than on forage (10.1%) in the wet season. In the forage, α-linolenic acid (C18:3n-3) was the most abundant fatty acid with 56.9% of total fatty acids, followed by linoleic acid (C18:2n-6) and palmitic acid (C16:0). In diet 1, diet 2, supplement (S2) in the wet season, and corn silage, linoleic acid was the most abundant fatty acid with 49.8%, 49.8%, 47.2%, and 43.2% of total fatty acids, respectively, followed by *c*9-18:1 and C16:0.

Intramuscular fat content was higher in feedlot (29.70%) *vs.* pasture (23.86%) finished beef. A gender by sire breed interaction was also found for intramuscular fat with heifer offspring of Angus bulls having greater fat content (3.82%) than heifer offspring of Limousin bulls (2.66%) whereas fat content for bull offspring was not different ($p>0.05$) with 2.13% and 1.90%, for Angus and Limousin, respectively.

The results of effects of finishing system, gender and sire breed on *longissimus thoracis* muscle total fatty acid methyl esters are shown in Table 2. There were no differences in saturated fatty acids (SFA) when finishing system or sire breed were considered. However the percentage of SFA were higher for bulls *vs.* heifers (48.7% *vs.* 47.2%) and this was mainly due to a higher proportion of 18:0 in bulls. These results are consistent with a previous report [8], nevertheless they found a significant difference between animals finished on pasture (4.91%) and in the feedlot (4.67%). The total *trans* 18:1 content was higher for animals finished on pasture (5.59%) than animals finished in the feedlot (1.70%). Likewise, bulls showed higher *trans* 18:1 than heifers (3.85% *vs.* 3.45%, respectively). No effects of sire breed were found for *trans* 18:1 Laheska et al. [9], found similar total *trans* 18:1 for grass fed animals (6.62%) but feedlot finished animals had more than the present study (5.32%).

Table 2. Effects of Production System, Gender and Bull on *longissimus thoracis* muscle total fatty acid methyl esters (%).

	Effects						s
	System		Gender		Bull		e
	Feed	Past	F	M	AN	LI	
SFA	47.6	48.3	47.2[b]	48.7[a]	48.2	47.7	0.298
c-MUFA[1]	44.4	33.9	41.0	37.3	39.0	39.2	0.296
*t*10-18:1	0.19[b]	0.87[a]	0.50	0.56	0.53	0.53	0.020
*t*11-18:1	0.73[b]	2.87[a]	1.71[b]	1.89[a]	1.75	1.85	0.039
t-18:1	1.70[b]	5.59[a]	3.45[b]	3.85[a]	3.59	3.70	0.079
c9,t11-CLA[1]	0.22	0.48	0.37	0.32	0.34	0.36	0.008
PUFA[1]	6.14	11.71	8.00	9.85	8.87	8.98	0.259
PUFA/SFA[1]	0.13	0.24	0.17	0.20	0.19	0.19	0.006

[1]Production System*Gender interaction significant ($p<0.05$); [a,b]Means in the same row, inside of the effect, with different superscripts are significantly different ($P<0.05$); Feed = feedlot; Past = pasture; se = standard error; F = female; M = male; AN = Angus; LI = Limousin; SFA = saturated fatty acid; *c*-MUFA = *cis* monounsaturated fatty acids; *c,t*-CLA =conjugated linoleic acid; PUFA = polyunsaturated fatty acid.

Looking at the *trans*-18:1 isomers, we were particularly interested in the *t*10-18:1 and *t*11-18:1 contents. Results from experiments in the USA and Canada have shown high *t*10-18:1 to *t*11-18:1 ratios in feedlot finished beef [9, 11]. Feedlot finishing in the present experiment,

however, resulted in lower *t*10-18:1 content than *t*11-18:1 when finished on pasture or in the feedlot. This difference is probably due to different types of feed, with Brazilian diets having a lower proportion of concentrate, and lower rates of fermentation which can positively affect the *trans* 18:1 profile. In the present experiment, a gender effect was also detected with bulls having a higher percentage of *trans* 11-18:1 (1.89%) than females (1.71%), but contents of *t*10-18:1 were similar (0.56 vs. 0.50%, respectively). No effect of sire breed was, however, found ($p>0.05$).

The percentages of *cis* monounsaturated fatty acids (*c*-MUFA), *c9,t11*-CLA, polyunsaturated fatty acid (PUFA) and the PUFA/SFA ratio were affected by production system*gender interactions (Table 3). The percentage *c*-MUFA was higher for animals finished in the feedlot than animals on pasture and heifers had higher *c*-MUFA than bulls in both systems (45.2 vs. 43.6%, and 38.3 vs. 31.0%, for feedlot and pasture, respectively). Aldai *et al*. [1010], found higher contents of *c*-MUFA in animals finished in the feedlot (28.4%) than those finished on pasture (22.4%). However these results were lower than in the present study.

The main natural isomer of CLA (*cis*(*c*)9,*t*11-18:2) was affected by a finishing system*gender interaction and the highest percentage was found in heifers finished on pasture (0.53%).

The percentage of *c*9,*t*11-CLA was not different between genders in the feedlot (0.22%) but on pasture, heifers had a higher percentage (0.53%) than bulls (0.43%). This is in contrast to another report [10] where *c/t*-CLA when finishing on pasture were the same as when finishing in the feedlot.

Table 3. Result of Production System*Gender interaction for different fatty acids (%).

System	Feedlot		Pasture		se
Gender	F	M	F	M	
c-MUFA	45.16[a]	43.57[b]	36.83[c]	30.97[d]	0.46
c9,t11-CLA2	0.22[c]	0.22[c]	0.53[a]	0.43[b]	0.012
PUFA	6.03[c]	6.26[c]	9.97[b]	13.44[a]	0.39
PUFA/SFA	0.13[c]	0.13[c]	0.21[b]	0.28[a]	0.010

[a,b]Means in the same row with different superscripts are significantly different ($p<0.05$); F = female; M= male; se = standard error; c-MUFA = *cis* monounsaturated fatty acids; *c*,*t*-CLA = conjugated linoleic acid; PUFA = polyunsaturated fatty acid; SFA = saturated fatty acid.

Animals finished on pasture *vs.* feedlot had higher percentages of PUFA, and with pasture finished animals bulls had a greater PUFA percentage (13.4%) than heifers (9.97%), whereas during feedlot finishing there was no gender effect. Overall, percentages of PUFA were also higher than other reports [8, 11].

The PUFA/SFA ratio was not different for bulls vs. heifers finished in the feedlot (0.13); however, ratios were lower than those of animals finished on pasture, where bulls had a higher (0.28) PUFA/SFA ratio than heifers (0.21). Nevertheless the results were still lower than the minimum (0.4) recommended for human consumption [12].

IV. CONCLUSION

Sire and dam breeds had only limited effects on fatty acid profiles. The type of finishing systems used in the present experiment had no detrimental effects on the *trans* fatty acid profile of beef, with both pasture and feedlot finishing resulting in more *t*11-18:1 than *t*10-18:1. Meat from animals finished on pasture vs. feedlot did, however, have a greater percentage of *t*11-18:1, and heifers and bulls finished on pasture had the greatest c9,t11-CLA, and PUFA respectively. Brazilian beef produced using both finishing systems may, therefore, have potential to meet market demands for healthy *trans* fatty acid profiles, with healthier overall fatty acid profiles achieved when pasture finishing.

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