

# Effect of breed and diet on subcutaneous beef fat fatty acid indices for enzyme activities and nutritional interest

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**Abstract**— The effects of breed and diet on several indices of fatty acids involved in MUFA metabolism in subcutaneous fat for 54 Hereford (H), Bradford 1/4 (B 1/4), Bradford 3/8 (B3/8) and Bradford 1/2 (B1/2) steers under three production systems, pasture exclusive (P), pasture and 0.7% corn grain (P+0.7%), and feedlot (F) were determined. Samples of subcutaneous fat were taken at the height of the 11-13 rib and stored at -20°C until analysis. Lipids were extracted using the method of Folch *et al.* (1). The fatty acid methyl esters (FAME) were analyzed on a Chrompack 900 gas chromatograph with a 100 m CP-Sil 88 capillary column. The indices for the activities of  $\Delta$ -9 desaturases as well as the elongase activity were estimated by the ratios of the products of the reaction to the substrates of the reaction. Treatments were compared by analysis of variance using the GML procedure (SAS 8.0 SAS Institute, Inc., Cary, NC). Mean values were compared using the Tukey's test. The ratio MUFA/SFA was affected by diet and breed. F had higher MUFA/SFA ratios than P and P+0.7% and was higher in B1/2, B1/4 and B3/8 compared with H. The ratio 16:1/16:0 was only affected by breed. H was lower than the other breeds. The ratio 18:1/18:0 was only affected by diet. H presented the lowest values. 18:2/18:3 ratio was lower in P compared to F and higher in H and B3/8 compared to B1/2 and B3/8. The CLA concentrations were lower in F and in B3/8.

**Keywords**— Beef subcutaneous fat, indices desaturase activity.

## I. INTRODUCTION

Fatty acid (FA) composition of beef fat from a specific production system represents the effects of several factors as breed, genotype, sex, age, nutrition and management. The effects of breed and diet on several indices involved in monounsaturated fatty acids metabolism (MUFA) and polyunsaturated

(PUFA) metabolism in intramuscular fat were presented previously [1].

The key enzymes involved in saturated fatty acid (SFA) production are fatty acid synthase and acetyl-CoA-carboxylase  $\alpha$ . The biosynthesis of MUFA is catalyzed by stearoyl-CoA desaturase (SDC) and the key enzymes in biosynthesis of PUFA are  $\Delta$ 6-desaturase and  $\Delta$ 5-desaturase [2]. These enzymes catalize the synthesis of long chain MUFA and PUFA, which are needed to maintain membrane structures, to participate in cellular communication and differentiation, for eicosanoid signaling and to regulate gene expression. Indices of individual fatty acids have been used as a surrogate measure of desaturase activities in observational studies and have been related to several variables. Feeding ruminants concentrate-based diets increases the oleic content of their tissues, whereas the cis-9,trans-11 conjugated linoleic acid (CLA) content is increased by feeding forage diets [3, 4]. Both these metabolic transformations could be attributable to increased activity of stearoyl-CoA desaturase.

The aim of this study was determine the effects of breed and diet on several indices of fatty acids involved in MUFA metabolism in subcutaneous fat for 54 Hereford (H), Bradford 1/4 (B 1/4), Bradford 3/8 (B3/8) and Bradford 1/2 (B1/2) steers under three production systems, pasture exclusive (P), pasture and 0.7% corn grain (P+0.7%), and feed lot (F).determined. The effects of breed and diet on several ratios of nutritional interest were also considered.

## II. MATERIALS AND METHODS

Samples of subcutaneous fat (SUB) were taken at the height of the 11-13 rib and stored at -20°C until analysis. Lipids were extracted using the method of Folch *et al.* [5]. The FA methyl esters (FAME) were analysed on a Chrompack 900 gas chromatograph with a 100 m CP-Sil 88 capillary column. The indices for the activities of  $\Delta$ -9 desaturases as well as the elongase activity were estimated by the ratios of the products of the reaction to the substrates of the reaction. Treatments were compared by analysis of variance using the GML procedure (SAS 8.0 SAS Institute, Inc., Cary, NC). Mean values were compared using the Tukey's test.

## III. RESULTS AND DISCUSSION

In Tables 1a and 1b are presented the effects of diet and breed on the subcutaneous fat fatty acid percentages of the fatty acids involved in the calculation of the 14:1/14:0, 16:1/16:0, 18:1/18:0 indices for  $\Delta$  9-desaturase activities and 18:1/16:1 for elongase activity.

Diet affected significantly 14:1, 16:0, 18:0 and 18:1 and breed 14:0, 18:0 and 18:1. Feed lot subcutaneous fat presented the higher values for 18:1 and Pasture subcutaneous fat the higher values for 14:1, 16:0 and 18:0.

Table 1a. Effect of diet on the subcutaneous fat fatty acids composition (%) of fatty acids used on the calculation of the different indices.

FA	Pasture	P+0.7%	Feedlot	p<
14:0	4.01	3.96	3.89	NS
14:1	0.50a	0.42a	0.26b	***
16:0	27.04a	26.30ab	25.13b	**
16:1	4.85	5.25	4.94	NS
18:0	15.42a	12.95b	12.33b	***
18:1	32.35b	37.13a	38.47a	***

abc Mean values in rows having different letters are significantly different. Standard error: (14:0 0.72; 14:1 0.34; 16:0 1.76; 16:1 0.97; 18:0 2.61; 18:1 3.52). \* p<0.05, \*\* p<0.01, \*\*\*p<0.01.

Table 1b. Effect of breed on the subcutaneous fat fatty acids composition (%) of fatty acids used on the calculation of the different indices.

	H	B 1/4	B 3/8	B 1/2	p<
14:0	3.97b	4.05b	3.46b	4.34a	**
14:1	0.37	0.38	0.36	0.45	NS
16:0	26.84	25.66	25.74	26.38	NS
16:1	4.36	5.48	5.11	5.11	NS
18:0	15.16a	12.96ab	14.04ab	12.11b	**
18:1	33.76b	36.03ab	38.03a	36.11ab	**

abc Mean values in rows having different letters are significantly different. Standard error (14:0 0.72; 14:1 0.34; 16:0 1.76; 16:1 0.97; 18:0 2.61; 18:1 3.52). \* p<0.05, \*\* p<0.01, \*\*\*p<0.01.

Breed affected significantly the percentages of 14:0, 18:0 and 18:1. B1/2 was higher in 14:0 but lower in 18:0. B1/2 presented the highest proportion of 18:1.

In Tables 2a and 2b are given the effects of diet and breed on the indices 14:1/14:0, 16:1/16:0, 18:1/18:0, 18:1/18:1 and MUFA/SFA.

Diet affected significantly only 18:1/18:0 and MUFA/SFA with and small interaction (p<0.05) diet x breed for MUFA/SFA indice. Feedlot subcutaneous fat presented higher values for both indices. It is well establish that there is a general elevation in MUFA and a concomitant depression in SFA with increasing time on grain-based diets. It seems to be that some portion of the increases in MUFA over time in FA tissues is due to an increase in SCD gene expression and concomitant catalytic activity. Pasture or hay feeding strongly depress SCD gene expression [6] resulting in an elevation in SFA in beef from corn fed steers. This increase was mainly due to increases in 18:1/18:0. Others studies [7] founded also that concentrate-fed lambs had higher ratios compared with pasture lambs, which indicate changes in  $\Delta$ -9 SCD activity or reflect differences in the diet composition.

Breed affected significantly 16:1/16:0 and MUFA/SFA and the lowest values were for H compared with the other breeds. Several studies [8] demonstrated that there are breed-specific and tissue-specific variations in CLA, MUFA, total fat content and SCD expression in beef cattle. The variations in SCD protein expression might contribute to the breed-specific variations in MUFA.

The ratio 18:1/16:1, related to elongase activity involved in MUFA metabolism was not affected by diet or breed.

Table 2a. Effect of diet on the desaturation indices involved in MUFA metabolism in subcutaneous beef fat.

	P	P+0.7%	Feedlot	p <
14:1/14:0	0.12	0.12	0.07	NS
16:1/16:0	0.18	0.20	0.20	NS
18:1/18:0	2.22b	3.55a	3.22a	*
18:1/16:1	6.80	7.78	7.91	NS
MUFA/SFA	0.81b	0.99ab	1.16a	***

abc Mean values in rows having different letters are significantly different. Standard error (14:0 0.72; 14:1 0.34; 16:0 1.76; 16:1 0.97; 18:0 2.61; 18:1 3.52). \* p<0.05, \*\* p<0.01, \*\*\*p<0.01.

Table 2b. Effect of breed on the desaturation indices involved in MUFA metabolism in subcutaneous beef fat.

	H	B 1/4	B 3/8	B 1/2	p<
14:1/14:0	0.09	0.10	0.09	0.10	NS
16:1/16:0	0.16b	0.22a	0.20a	0.19ab	**
18:1/18:0	2.28	2.92	2.95	3.84	NS
18:1/16:1	7.85	6.73	7.47	7.94	NS
MUFA/SFA	0.86b	1.03a	1.06a	1.02a	**

abc Mean values in rows having different letters are significantly different. Standard error (14:0 0.72; 14:1 0.34; 16:0 1.76; 16:1 0.97; 18:0 2.61; 18:1 3.52). \* p<0.05, \*\* p<0.01, \*\*\*p<0.01.

All factors of nutritional interest were affected by diet and breed (Tables 3a and 3b).

The 18:2 n-6/18:3 n-3 ratios increased from P to F with a significant interaction diet x breed (p<0.01). The higher values for the ratio were for H and B1/4.

MUFA proportions were higher in F and SFA proportion in P. Significant interactions diet x breed (p<0.05) for MUFA were detected. The highest proportions of CLA were found in P and P+0.7% and the lowest in F.

Table 3a. Effect of diet on some nutritional aspects of subcutaneous beef fat.

	P	P+0.7%	Feedlot	p<
18:2/18:3	1.41b	1.90b	11.72a	***
MUFA	37.20b	42.38a	43.41a	***
SFA	46.48a	43.21b	37.65c	**
MUFA/SFA	0.81b	0.99ab	1.16a	***
CLA	0.67b	0.79a	0.41c	***

abc Mean values in rows having different letters are significantly different. Standard error (18:2/18:3 2.57; MUFA 3.87; MUFA/SFA 0.16; CLA 0.17). \* p<0.05, \*\* p<0.01, \*\*\*p<0.001.

Table 3b. Effect of breed on some nutritional aspects of subcutaneous beef fat.

	H	B 1/4	B 3/8	B 1/2	p<
18:2/18:3	6.50a	5.75a	4.54b	3.25b	**
MUFA	38.11b	41.51a	43.14a	41.22a	**
SFA	44.72a	41.21b	42.37ab	41.48b	*
MUFA/SFA	0.86b	1.03a	1.06a	1.02a	**
CLA	0.64a	0.74a	0.48b	0.63ab	***

abc Mean values in rows having different letters are significantly different. Standard error (18:2/18:3 2.57; MUFA 3.87; MUFA/SFA 0.16; CLA 0.17). \* p<0.05, \*\* p<0.01, \*\*\*p<0.001.

#### IV. CONCLUSIONS

Breed and diet affected the subcutaneous fat fatty acids proportion of fatty acid related to MUFA metabolism.

Indices related to  $\Delta 9$  desaturase activity as MUFA/SFA were affected by diet and breed. The 16:1/16:0 indice was only affected by breed and 18:1/18:0 was affected only by diet. The 18:1/16:1, related to elongation was not affected for diet or breed.

All ratios of nutritional interest were significantly affected by diet and breed.

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## REFERENCES

1. Garcia PT, Pensel NA, Sancho AM et al. (2008) Beef lipids in relation to animal breed and nutrition in Argentina. *Meat Science* 79:500-508.
2. Ntambi JM (1999) Regulation of stearoyl-CoA desaturase by polyunsaturated fatty acids and cholesterol. *Journal Lipid Research* 40:1549-1558.
3. Enser M, Scollan ND, Choi NJ et al. (1999) Effect of dietary lipids on the content of conjugated linoleic acid (CLA) in beef muscle. *Animal Science* 69:143-146)
4. Mir JM, Rushfeldt MI, Paterson LJ et al. (2000). Effects of dietary supplementation with CLA or linoleic acid rich oil in the lamb content of lam tissues. *Small Ruminant Research* 36:25-31.
5. Folch J, Lees M, Soane-Stanley GHS (1957) A simple method for the isolation and purification of total lipids from animal tissues. *Journal Biological Chem.* 226:497-509
6. Chung KJ, Lunt DK, Kawchi H et al. (2007) Lipogenesis and stearoyl-CoA desaturase gene expression and enzyme activity in adipose tissue of short- and long fed Angus and Wagyu steers fed corn- or hay-based diet. *J. Animal Sci* 85:381-387.
7. Vasta V, Priolo A., Scerra M et al. (2009)  $\Delta 9$  desaturase protein expression and fatty acid composition of longissimus dorsi muscle in lamb fed green herbage or concentrate with or without added tannins. *Meat science* 82:357-364.
8. Dance LJE, Mathews KR, Doran O. (2009) Effect of breed on fatty acid composition and stearoyl-CoA desaturase protein expression in the Semimembranosus muscle and subcutaneous adipose tissue of cattle. *Livestock Science* 125:291-297.