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FATTY ACID PROFILE OF VARIOUS ADIPOSE TISSUE DEPOTS IN BULLS OF DIFFERENT BREEDS

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Abstract:

The objective of the present study was to compare the fatty acid (FA) profile of intramuscular, subcutaneous and cod adipose tissue (AT) of Aberdeen Angus (AA), Gascon (GS), Holstein (HO) and Czech Fleckvieh (CF) bulls. The breeds were selected on the basis of their differing propensity to deposit AT. Thirty-six bulls (9 per breed) were reared and finished under identical housing and feeding conditions. Days on feed and slaughter age were similar for breed groups. The AT site was found to be a significant source of variation ($P<0.001$). Whereas intramuscular AT contained the highest proportion of polyunsaturated FA and polyunsaturated FA/saturated FA ratio, cod AT had the highest concentration of saturated FA, and subcutaneous AT contained the highest proportion of monounsaturated FA, regardless of breed. The lowest concentrations ($P<0.001$) of CLA *c9t11* (conjugated linoleic acid) were observed in intramuscular AT compared to the other AT sites. The AA and H bulls exhibited higher ($P<0.001$) intramuscular AT (petroleum ether extract) contents (36.2 and

27.7 g/kg, respectively) than the GS and CF bulls (15.0 and 16.9 g/kg, respectively). These differences give plausible explanation of the tendency towards lower PUFA and PUFA/SFA ($P<0.1$) found in the AA and H bulls. The AA bulls had the highest proportions of C14:1n-5 and C16:1n-7 in most AT. In addition, the AA bulls had the highest concentrations of *c9t11*CLA in subcutaneous ($P<0.001$), cod ($P<0.01$) and intramuscular ($P=0.0528$) AT.

Keywords: beef, bulls, adipose tissue, fatty acid profile;

Introduction:

The fatty acid (FA) composition of beef has been recently raising health concerns particularly due to the high content of saturated fatty acids (SFA), which have relationships with several diseases from cardiovascular disease to cancer (Mapiye et al., 2012). On the other hand, monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids are more associated with beneficial health status (Luciano, 2009). The FA composition of adipose tissue in meat animals is affected by a number of factors including breed, diet, age, genotype and gender (Wood et al., 2008). It also differs among adipose depot sites throughout the bovine carcass (Turk and Smith, 2009).

The objective of the present study was to compare the fatty acid profiles of intramuscular, subcutaneous and cod adipose tissues of Aberdeen Angus, Gascon, Holstein and Czech Fleckvieh bulls.

Material and Methods:

A total of 36 bulls of four breeds (9 per breed) substantially differing in the maturity age and the propensity to deposit fat - Aberdeen Angus (AA), Gascon (GS), Holstein (HO) and Czech Fleckvieh (CF) - were used. The bulls were finished under identical housing and feeding conditions and slaughtered at the age of 17 months and the average weight of 657 kg. Immediately after slaughter, cod (from the scrotal area), subcutaneous (from the brisket) and intramuscular (from *m. longissimus lumborum*) adipose tissue samples were collected.

The FA composition of different AT was determined after extraction of total lipids in accordance with Folch et al. (1957). Alkaline trans-methylation of FA was performed in accordance with ISO 5509 (2001). Gas chromatography of FA methyl esters was performed

using the HP 6890 gas chromatograph with a programmed 60 m DB-23 capillary column (150 to 230°C). The proportions of FA were expressed as percentages of the total area of injected methyl esters.

Samples of *m. longissimus lumborum* were homogenised in a food blender and were dried by the method of oven drying (105°C) to a constant weight. Dried samples were pulverized using a Grindomix 92 GM 200 knife mill (Retsch, Haan, Germany) and analysed for fat by extraction with petroleum ether (Soxtec 94 Avanti 2055, FOSS Tecator AB, Höganäs, Sweden).

Data were analysed using the MIXED procedure of SAS, with the model including breed and adipose tissue type, and their interaction as the fixed effects and animal as the random effect.

Results:

The experiment was designed so that all breed of bulls entered the trial at a similar average age and were fattened under similar conditions, and slaughtered at the same age. The average weight at slaughter for AA, GS, HO and CF were 676.2 ± 35.1 kg, 670.7 ± 22.7 kg, 655.6 ± 16.6 kg, and 626.7 ± 31.4 kg respectively. The results of fatty acid profile of cod, subcutaneous and intramuscular AT are summarised in Table 1, sum of fatty acid and nutritionally important ratios are expressed in Table 2. The muscle samples of AA and HO contained significantly ($P<0.001$) higher amounts of intramuscular fat (36.2 and 27.7 g/kg, respectively) than the GS and CF bulls (15.0 and 16.9 g/kg, respectively).

Conclusion:

In the present study significant differences in composition of various adipose tissues were found. Intramuscular AT contained the highest proportion of PUFA and PUFA/SFA and had the lowest concentration of CLA*c9t11*. Cod AT contained the highest proportion of SFA. Subcutaneous AT had the highest concentration of MUFA and CLA*c9t11*.

The AA and HO bulls exhibited significantly higher intramuscular fat content than the GS and CF bulls. The AA bulls had lowest proportion of PUFA and the highest concentrations of CLA*c9t11* in all types of adipose tissues. The AA bulls had the highest proportions of C14:1n-5 and C16:1n-7 in most AT. In addition, the AA bulls had the highest

concentrations of CLA *c9t11* in all adipose tissue. Based on the results it is suggested that the differences may exist between breeds and between adipose depots in the activity of stearoyl-CoA desaturase, which is the enzyme responsible for the conversion of saturated FA into monounsaturated FA and *trans*-vaccenic acid into *c9t11*CLA, as well as in the activity of other enzymes involved in *de novo* FA synthesis.

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Table 1: Fatty acid profile in cod, subcutaneous and intramuscular adipose tissue (g/100 g FA determined)

		Breed					significance
		AA (n=9)	**GS** (n=9)	**HO** (n=9)	**CF** (n=9)		
	Adipose tissue	***LSM***	***LSM***	***LSM***	***LSM***	***SEM***	***P* -value**
C14:0	**Cod**	**4.30** ^{A}	**4.38** ^{A}	**3.87**	**3.59** ^{B}	0.178	0.0142
	Subcutaneous	**3.43**	**3.77**	**3.45**	**3.59**	0.256	0.8171
	Intramuscular	**3.11**	**2.85**	**3.13**	**2.70**	0.188	0.3345
C16:0	**Cod**	**30.58**	**29.21**	**28.79**	**28.73**	0.599	0.1255
	Subcutaneous	**27.82**	**27.64**	**26.73**	**27.90**	0.938	0.8029
	Intramuscular	**29.49** ^{A}	**26.53** ^{B}	**27.49** ^{B}	**26.59** ^{B}	0.473	0.0003
C18:0	**Cod**	**15.30**	**17.77**	**17.82**	**17.79**	0.899	0.1453
	Subcutaneous	**12.48**	**12.31**	**12.87**	**14.06**	0.894	0.5052
	Intramuscular	**16.23**	**15.29**	**15.40**	**17.14**	0.679	0.2583
C14:1n-5	**Cod**	**0.95** ^{A}	**0.71**	**0.72**	**0.51** ^{B}	0.080	0.0068
	Subcutaneous	**1.51**	**1.20**	**1.09**	**0.95**	0.167	0.1485
	Intramuscular	**0.51**	**0.45**	**0.47**	**0.31**	0.059	0.3317
C16:1n-7	**Cod**	**3.32** ^{A}	**2.72** ^{B}	**2.96**	**2.67** ^{B}	0.154	0.0225
	Subcutaneous	**5.29** ^{A}	**4.29**	**4.12** ^{B}	**4.24**	0.273	0.0176
	Intramuscular	**2.50**	**2.65**	**2.72**	**2.48**	0.139	0.6977
C18:1n-9	**Cod**	**35.23**	**33.62**	**35.42**	**35.46**	0.842	0.3704
	Subcutaneous	**39.00**	**39.26**	**39.68**	**37.47**	1.149	0.5533
	Intramuscular	**34.64**	**34.92**	**35.83**	**33.84**	0.709	0.3116
C18:2n-6	**Cod**	**3.10**	**3.91**	**3.46**	**3.50**	0.530	0.6575
	Subcutaneous	**3.27**	**4.18**	**4.65**	**3.83**	0.686	0.4952
	Intramuscular	**5.20**	**8.08**	**6.14**	**7.61**	0.917	0.0905
C18:3n-3	**Cod**	**0.84**	**0.82**	**0.70**	**0.76**	0.075	0.5062
	Subcutaneous	**0.75**	**0.89**	**0.78**	**0.83**	0.100	0.7295
	Intramuscular	**1.15**	**1.49**	**1.11**	**1.32**	0.139	0.1862
CLA *C9t11*	**Cod**	**0.58** ^{A}	**0.42**	**0.31** ^{B}	**0.34** ^{B}	0.050	0.0024
	Subcutaneous	**0.71** ^{A}	**0.46** ^{B}	**0.36** ^{B}	**0.50** ^{B}	0.047	<0.0001
	Intramuscular	**0.31**	**0.23**	**0.23**	**0.24**	0.024	0.0528

^{A,B,C} means within a row with different superscripts significantly differ at P<0.05).

Table 2: Sum of fatty acid and nutritionally important ratios in cod, subcutaneous and intramuscular adipose tissue (g/100 g FA determined)

		Breed				significance	
		AA (n=9)	**GS** (n=9)	**HO** (n=9)	**CF** (n=9)		
	Adipose tissue	***LSM***	***LSM***	***LSM***	***LSM***	***SEM LSM***	***P* -value**
SFA	**Cod**	**50.18**	**51.33**	**50.47**	**50.15**	0.911	0.7789
	Subcutaneous	**43.73**	**43.69**	**43.10**	**45.58**	0.830	0.5646
	Intramuscular	**48.83** ^{A}	**44.71** ^{B}	**46.03**	**46.39**	0.916	0.0162
MUFA	**Cod**	**39.49**	**37.04**	**39.10**	**38.64**	0.996	0.3382
	Subcutaneous	**45.79**	**44.74**	**44.89**	**42.67**	1.260	0.3662
	Intramuscular	**37.64**	**38.02**	**39.01**	**36.64**	0.797	0.2910
PUFA	**Cod**	**4.26**	**5.04**	**4.47**	**4.75**	0.613	0.7329
	Subcutaneous	**4.34**	**5.49**	**5.83**	**5.06**	0.830	0.5646
	Intramuscular	**8.21**	**11.88**	**9.50**	**11.52**	1.119	0.0708
PUFA/ SFA	**Cod**	**0.09**	**0.10**	**0.09**	**0.10**	0.013	0.8109
	Subcutaneous	**0.10**	**0.13**	**0.14**	**0.11**	0.022	0.5740
	Intramuscular	**0.17**	**0.27**	**0.21**	**0.25**	0.029	0.0608
MUFA/ SFA	**Cod**	**0.79**	**0.73**	**0.78**	**0.77**	0.033	0.5669
	Subcutaneous	**1.06**	**1.04**	**1.06**	**0.94**	0.056	0.4241
	Intramuscular	**0.77**	**0.85**	**0.85**	**0.79**	0.026	0.0719

^{A,B,C} means within a row with different superscripts significantly differ at P<0.05).

Fig. 1: Effect of breed on CLA *c9t11* content in different adipose tissue