Effect of crossbreeding on intramuscular fat content and fatty acid composition in pork meat

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Abstract

The effect of crossbreeding (Large White (LW), Duroc (D) and Pietrain (P) as sire lines and Landrace (LR) x LW as dam line: LWx(LRxLW), Dx(LRxLW) and Px(LRxLW)) on intramuscular fat content and fatty acid composition were studied in *Semimembranosus* (SM) muscle and subcutaneous fat (SCF). Animals were fed the same commercial feed, raised under similar conditions and transported from the farm to the slaughter-house at the same live weight (106-116 kg). Dx(LRxLW) had the highest percentage of intramuscular fat. The Large White and Duroc sire lines obtained a higher percentage of saturated fatty acids (SFA) in SM, whereas the sire line Pietrain was significantly higher than sire line Duroc in the concentration of polyunsaturated fatty acids (PUFA), PUFA/SFA (P/S) and *n*-6/*n*-3 ratio. The concentrations of SFA and monounsaturated fatty acids (MUFA) in SCF were significantly higher in LWx(LRxLW) and Px(LRxLW), respectively. No differences were found in the percentage of PUFA, P/S and *n*-6/*n*-3 ratio between Dx(LRxLW) and Px(LRxLW) in SCF. Results show that nowadays the differences among sires are not very important in relation with fatty acid composition.

Introduction

Fat and fatty acids are important because of their effects on human health. It is important to select production options which maximise both meat quality and healthiness in meat production (Kouba *et al.*, 2003). In developed countries, fatty acid composition and the total amount of saturated fatty acids (SFA) have been identified as dietary risk factors (Pascual *et al.*, 2007), related to various cancers and especially coronary heart disease. The terminal sire can strongly influence fat quality such as fatty acid composition, though it seems that a three-way crossbred pig has intermediate values of parents for carcass and meat quality traits (Suzuki *et al.*, 2003). Currently, productive and carcass traits of Duroc lines are similar or even better than traits of white lines without any loss of meat quality (Latorre *et al.*, 2003). Therefore, the introduction of Duroc in pig breeding programmes may help to improve the meat and eating quality of pork (Cameron, *et al.*, 1990).

The objective of this study was to compare the pork intramuscular fat content and fatty acid profile of intramuscular and subcutaneous fat among three crossbreeding pigs.

Materials and methods

This study was undertaken with carcasses of 90 females pigs and 90 castrated males pigs from three different crossbreeding schemes which included Large White (LW), Duroc (D) and Pietrain (P) as sire lines and Landrace (LR) x LW dam line; with 60 animals in each scheme: LWx(LRxLW), Dx(LRxLW), and Px(LRxLW). Animals were fed the same commercial feed, raised under similar conditions and transported from the farm to the slaughter-house at the same live weight (106-116 kg). The samples were removed from *Semimembranosus* (SM) and subcutaneous fat (SCF) at the level of thoracic ribs 24h after slaughter. All samples were placed in vacuum bags and frozen for meat quality analysis.

Intramuscular fat (IMF) was chemically quantified in *Semimembranosus* muscle following the ISO, 1443-1973. The samples were extracted according to Bligh & Dyer (1959) to determinate composition in fatty acids from intramuscular and subcutaneous fat and the methyl esters from fatty acids (FAMES) were analysed in a gas chromatograph HP-6890 II, with a capillary column SP-2380 (100 m x 0.25 mm x 0.20 µm), using nitrogen as the carrier gas. All data were statistically analyzed by the GLM procedure of SPSS, version 14.0 (SPSS, 2005). Duncan test was applied to compare the mean values of the crossbreeding.

Results and discussion

Meat from Dx(LRxLW) had more intramuscular fat (2.24 %) than LWx(LRxLW) (1.69 %) and Px(LRxLW) (1.60) ($p \leq 0.05$) in agreement with the results of other authors (Latorre *et al.*, 2003; Olivier *et al.*, 1994) due to the higher fatness of Duroc in relation with other lean breeds.

Differences between sire lines were significant (Table 1) when comparing concentrations of most individual fatty acids in the intramuscular fat. There were significant differences in the concentration of stearic acid (C18:0) and saturated fatty acids (SFA) between Pietrain sire line and Duroc and Large White sire lines, with a lower percentage in Pietrain. No significant differences were observed in oleic acid (C18:1 *n-9*) and monounsaturated fatty acids (MUFA). The proportion of polyunsaturated fatty acids (PUFA), linoleic acid (C18:2 *n*-6) and arachidonic acid (C20:4 *n*-6) were significantly higher in the intramuscular fat of Px(LRxLW) compared with Dx(LRxLW). However, no differences were obtained for α-linolenic acid (C18:3 *n*-3). We have obtained similar results for the Duroc sire line that Cameron & Enser (1991) found that intramuscular fat of Duroc contained more saturated and less polyunsaturated fatty acids than halothane negative British Landrace pigs.

Table 1. Fatty acid composition (total fatty acids) of intramuscular fat (%) in the *semimembranosus* muscle and the subcutaneous fat (%) of three crossbreeding pigs

	Intramuscular fat							**Subcutaneous fat**						
	LWx(LRxLW)		**Dx(LRxLW)**		**Px(LRxLW)**		**Sign.**	**LWx(LRxLW)**		**Dx(LRxLW)**		**Px(LRxLW)**		**Sign.**
N	**19**		**19**		**19**			**18**		**18**		**18**		
	x	**se**	**x**	**se**	**x**	**se**		**x**	**se**	**x**	**se**	**x**	**se**	
C12:0	0.06^{a}	0.01	0.07^{b}	0.01	0.06^{a}	0.01	**	0.06	0.00	0.06	0.01	0.06	0.01	ns
C14:0	1.07^{a}	0.11	1.22^{b}	0.10	1.06^{a}	0.14	***	1.09	0.06	1.14	0.09	1.14	0.11	ns
C16:0	22.34^{ab}	0.68	22.86^{b}	0.83	21.77^{a}	1.27	**	22.80	0.81	22.43	0.87	22.48	1.09	ns
C16:1	2.88^{a}	0.35	3.19^{b}	0.52	3.23^{b}	0.45	*	1.88^{a}	0.21	2.00^{ab}	0.25	2.08^{b}	0.21	*
C18:0	10.54^{b}	0.63	10.52^{b}	1.28	9.30^{a}	0.61	***	13.98^{b}	1.20	12.90^{a}	1.21	12.48^{a}	0.73	***
C18:1 *n*-9	40.13	3.05	40.85	2.85	39.75	3.69	ns	39.26^{a}	0.98	39.01^{a}	1.09	40.49^{b}	1.36	***
C18:1 *n*-7	4.03^{a}	0.21	4.29^{b}	0.42	4.47^{b}	0.37	***	2.69^{a}	0.13	2.80^{ab}	0.28	2.90^{b}	0.15	**
C18:2 *n*-6	10.70^{ab}	2.55	9.39^{a}	1.76	11.52^{b}	2.75	*	11.74^{a}	1.68	12.67^{b}	1.20	12.03^{ab}	1.21	t
C18:3 *n*-6	0.07^{a}	0.03	0.06^{a}	0.02	0.09^{b}	0.04	***	0.03^{a}	0.01	0.03^{b}	0.01	0.03^{ab}	0.01	t
C18:3 *n*-3	0.61	0.07	0.57	0.05	0.58	0.08	ns	1.04	0.13	1.10	0.11	1.04	0.01	ns
C20:1 *n*-9	0.72	0.09	0.75	0.20	0.66	0.10	ns	1.02	0.13	1.01	0.13	0.98	0.17	ns
C20:2 *n*-6	0.38^{b}	0.05	0.36^{ab}	0.03	0.35^{a}	0.06	T	0.58^{a}	0.07	0.63^{b}	0.06	0.57^{a}	0.09	*
C20:2 *n*-3	0.12^{b}	0.04	0.09^{a}	0.03	0.12^{b}	0.04	*	0.02^{b}	0.00	0.02^{a}	0.00	0.02^{a}	0.00	*
C20:3 *n*-6	0.30^{ab}	0.10	0.26^{a}	0.09	0.35^{b}	0.12	*	0.09^{a}	0.01	0.10^{b}	0.01	0.09^{a}	0.01	***
C20:3 *n*-3	0.10	0.01	0.11	0.01	0.10	0.03	ns	0.17^{a}	0.02	0.19^{b}	0.02	0.16^{a}	0.03	***
C20:4 *n*-6	2.09^{ab}	1.03	1.65^{a}	0.75	2.51^{b}	1.07	*	0.20	0.03	0.20	0.03	0.19	0.03	ns
C20:5 *n*-3	0.13^{a}	0.05	0.11^{a}	0.05	0.17^{b}	0.06	**	0.01	0.01	0.01	0.00	0.01	0.01	ns
C22:5 *n*-3	0.34^{ab}	0.12	0.32^{a}	0.12	0.42^{b}	0.15	*	0.10^{ab}	0.01	0.10^{b}	0.01	0.09^{a}	0.02	t
C22:6 *n*-3	0.15^{ab}	0.07	0.12^{a}	0.04	0.18^{b}	0.06	*	0.04	0.01	0.03	0.01	0.04	0.01	ns
SFA	34.73^{b}	1.13	35.41^{b}	1.92	32.91^{a}	1.88	***	38.82^{b}	1.60	37.51^{a}	1.74	37.03^{a}	1.66	**
MUFA	48.37	3.48	49.72	3.11	48.70	4.26	ns	45.67^{a}	1.00	45.74^{a}	1.23	47.26^{b}	1.37	***
PUFA	15.00^{ab}	3.99	13.04^{a}	2.83	16.40^{b}	4.30	*	14.03^{a}	1.94	15.12^{b}	1.38	14.27^{ab}	1.38	t
***n*-6**	13.55^{ab}	3.68	11.73^{a}	2.58	14.83^{b}	3.96	*	12.64^{a}	1.77	13.65^{b}	1.25	12.91^{ab}	1.28	t
***n*-3**	1.44^{ab}	0.31	1.30^{a}	0.25	1.56^{b}	0.36	*	1.38^{ab}	0.17	1.46^{b}	0.13	1.36^{a}	0.11	*
P/S	0.43^{ab}	0.13	0.37^{a}	0.09	0.50^{b}	0.14	**	0.36^{a}	0.06	0.41^{b}	0.05	0.39^{ab}	0.05	*
***n*-6/*n*-3**	9.34^{ab}	0.72	8.97^{a}	0.39	9.44^{b}	0.59	*	9.16^{a}	0.32	9.35^{ab}	0.24	9.53^{b}	0.43	**

Different letters in the same row indicate significant differences among mean values; ns = p>0.1; t = p≤0.1; * = p≤0.05; ** = p≤0.01; *** = p≤0.001.

The fatty acid composition of the subcutaneous fat (SCF) is shown for the three studied sire lines in Table 1. The concentrations of C18:0 and SFA were significantly higher in LWx(LRxLW) than in Px(LRxLW) and Dx(LRxLW). There were significant differences in the concentration of C18:1 *n-9* and MUFA between Pietrain sire line and Duroc and Large White sire lines, being the first which had the highest percentage. There was only a slight tendency for the proportions of *n*-6 PUFA and linoleic acid to be higher in Dx(LRxLW) than in LWx(LRxLW), but both were similar to Px(LRxLW). No differences were obtained for arachidonic acid, α-linolenic acid, EPA (C20:5 *n*-3) and DHA (C22:6 *n*-3). However, Duroc sire line had more concentration of *n*-3 PUFA than Pietrain and Large White sire lines. PUFA had a tendency to have higher proportion in subcutaneous fat of Dx(LRxLW) than LWx(LRxLW). Recently, Ramírez & Cava (2007) have reported that in SCF from ♂ Duroc (fresh meat production) x ♀ Iberian had higher percentages of polyunsaturated fatty acids than ♂ Duroc (pigs selected for the manufacture of dry-cured meat products) x ♀ Iberian, while this last crossbreeding had higher saturated fatty acids levels. Our Duroc sire line was more similar to Pietrain sire line than Large White sire line for subcutaneous fat. This was probably due to the fact that the sire-line Duroc used in our trial may have been intensively selected for food efficiency and lean

carcasses, which might have resulted in higher polyunsaturation than expected on the basis of results obtained with other Duroc lines.

The P/S (PUFA/SFA) ratio decreased in the following order: Px(LRxLW) > LWx(LRxLW) > Dx(LRxLW) and the *n*-6/*n*-3 ratio was significantly higher in Px(LRxLW) than in Dx(LRxLW) in SM. The UK Department of Health (1994) recommended that the PUFA/SFA ratio remained near 0.4 and the *n*-6/*n*-3 ratio had a maximum value of 4.0. The P/S ratio was higher in Dx(LRxLW) than in LWx(LRxLW) and the ratio of *n*-6/*n*-3 PUFA was significantly lower in the Duroc and Large White sire lines than in Pietrain sire line in SCF.

Conclusions

We could conclude that nowadays the differences among sires are not very important in relation with fatty acid composition. However, crossbreeding with Duroc as sire line is adequate either for fresh meat or for improving dry meat products quality probably due for the higher percentage of intramuscular fat of this crossbreeding.

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