EFFECTS OF COMPENSATORY GROWTH FEEDING STRATEGY ON FATTY ACID COMPOSITION OF PORCINE MUSCLE

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Introduction

Compensatory growth may be defined as a physiological process whereby growth is accelerated after a period of restricted development, usually due to reduced energy intake, such that the animal's weight equals or approaches that of animals whose growth was never reduced (Hornick *et al.*, 2000). Increased growth rates and carcass leanness have been demonstrated in pigs using such production strategies.

Foods containing high n-6:n-3 PUFA ratios have been implicated in the onset of certain cancers and heart disease. It is feasible that the ratio of n-6:n-3 PUFA of pork might be improved by feeding grass-based diets high in α-linolenic acid (as in ruminants). Grass is also low in metabolisable energy (restricted energy feed source) compared to conventional pig concentrate diets. Feeding grass-based diets to pigs could, therefore, produce leaner pork whilst improving fatty acid profiles in accordance with contemporary health guidelines. The purpose of this study was to determine the effects of compensatory growth diets on the fatty acid composition of muscle from Landrace and Duroc pigs.

Materials and Methods

Landrace (L) or Duroc (D) × (Large White × L) female pigs (n=72) were assigned to one of six diets: (1) Control – concentrate weaner and finisher diets to slaughter (C), (2) grassmeal diet (GM – included at 100 and 200 g/kg) of weaner and finisher diets respectively) to slaughter (GM105), (3) GM to 50 kg followed by finisher diet (GM50), (4) GM to 80 kg followed by finisher diet (GM80), (5) as (4) except α-tocopheryl acetate (200 mg/kg feed) and 5% rapeseed oil added to finisher diet (α-TOC), and (6) as (5) except green tea catechins (200 mg/kg feed) as antioxidant (GTC). Grass was included in pelleted form. Pigs were slaughtered at 105 kg and stored (24 h at 3°C) prior to removal of *M. longissimus dorsi* for subsequent analysis.

Muscle lipid extract was fractionated (neutral (NL) and polar lipid (PL) fractions) by the solid phase extraction (SPE) procedure of Lauridsen *et al.*, (1999). Lipid fractions were transesterified using 0.05 M sodium methylate solution. Fatty acid methyl esters (FAMEs) were quantified using a Varian CP-3800 gas chromatograph equipped with FID and Varian CP-Sil 88 column (50 m × 0.25 mm i.d.). Helium was used as carrier gas at 30 psi. Oven temperature was programmed at 150°C for 35 min, increased at 4°C/min to 240°C and held for 2 min. Injector and detector temperatures were 270°C and 300°C respectively. FAMEs were identified by comparison with pure standards and expressed as a percentage of total fatty acids. Statistical analysis was carried out by GLM procedure (ANOVA) of SPSS (Chicago, IL, USA).

Results and Discussion

Dietary treatments significantly affected SFA and MUFA contents of NL and MUFA and PUFA contents of PL (Table 1). Inclusion of rapeseed oil during re-alimentation (α-TOH and GTC diets) increased MUFA levels of both NL and PL fractions and improved (lowered) the n-6:n-3 balance of porcine muscle. The higher oleic acid (C18:1 n-9) levels observed in both lipid fractions resulting from dietary rapeseed oil inclusion is supported by the findings of Rhee *et al.* (1988). Animals fed rapeseed oil, however, also had significantly lower PL PUFA content than other dietary treatments (with the exception of GM50). Levels of arachidonic acid (C20:4 n-6) were highest in pigs fed GM105 diets, an effect supported by Bee *et al.*, (2002), who reported an increase in this fatty acid in pigs fed low energy diets. It would appear that the increased levels of α-linolenic acid (C18:3 n-3) in PL fractions of α-TOH and GTC fed pigs were due to addition of rapeseed oil rather than the effects of grassmeal consumption.

With the exception of the palmitoleic acid (C16:1) content of NL, all MUFA contents of NL and PL fractions from Duroc pigs were higher than those from Landrace animals (Table 1). This effect is probably related to the higher IMF content of the former breed (Suzuki *et al.*, 2003). Arachidonic acid (C20:4 n-6) contents were significantly higher in lipids from Landrace pigs. Pig genotype did not affect either SFA content or n-6:n-3 ratios of NL or PL fractions.

Table 1: Fatty acid compositions (%) of neutral and polar lipids of *M. Longissimus dorsi* muscle from pigs fed experimental diets.

	Neutral lipid									
	Dietary treatment							*Breed*		
	C	GM105	GM50	GM80	α-TOH	GTC	*sig*	L	D	*sig*
C14:0	1.36	1.50	1.38	1.26	1.40	1.43	ns	1.45	1.33	**
C16:0	22.16	21.39	21.80	22.31	21.55	21.75	ns	21.56	22.10	ns
C16:1	3.65^{a}	3.49^{ab}	3.38^{ab}	3.25^{b}	3.46^{ab}	3.38^{ab}	*	3.46	3.41	ns
C18:0	12.39^{a}	11.63^{ab}	11.17^{bc}	11.41^{bc}	10.61^{c}	10.76^{c}	***	11.23	11.43	ns
C18:1 (n-9)	42.93^{a}	43.06^{a}	42.34^{a}	42.95^{a}	44.67^{b}	44.94^{b}	***	43.03	43.93	*
C18:2 (n-6)	7.32	7.30	7.68	7.08	7.38	7.37	ns	7.36	7.36	ns
C18:3 (n-3)	0.75	0.76	0.73	0.67	0.73	0.74	ns	0.73	0.74	ns
C20:4 (n-6)	0.35^{a}	0.46^{c}	0.34^{a}	0.42^{bc}	0.37^{ab}	0.38^{ab}	***	0.42	0.35	***
C20:5 (n-3)	0.10	0.10	0.10	0.10	0.10	0.09	ns	0.10	0.10	ns
C22:6 (n-3)	0.24	0.26	0.29	0.28	0.32	0.26	ns	0.25	0.30	**
Σ SFA[1]	36.65^{a}	35.21^{ab}	35.01^{ab}	35.63^{ab}	34.23^{b}	34.64^{b}	**	34.95	35.51	ns
Σ MUFA[1]	47.36^{a}	47.25^{a}	46.67^{a}	46.96^{a}	49.01^{b}	49.25^{b}	***	47.30	48.19	**
Σ PUFA[1]	9.45	9.60	9.78	9.23	9.60	9.54	ns	9.55	9.52	ns
n-6/n-3[1]	7.42	7.28	7.51	7.49	7.07	7.35	ns	7.57	7.14	ns

	Polar lipid									
	Dietary treatment							*Breed*		
	C	GM105	GM50	GM80	α-TOH	GTC	*sig*	L	D	*sig*
C14:0	0.42	0.41	0.42	0.40	0.43	0.44	ns	0.45	0.40	**
C16:0	19.49	19.67	19.90	19.43	19.49	19.71	ns	19.49	19.74	ns
C16:1	0.76^{a}	0.65^{ab}	0.66^{ab}	0.50^{b}	0.58^{ab}	0.60^{ab}	*	0.58	0.67	*
C18:0	8.68	9.99	8.75	9.20	9.27	9.86	*	9.19	9.40	ns
C18:1 (n-9)	12.08^{a}	11.94^{a}	11.30^{a}	11.83^{a}	19.92^{b}	20.55^{b}	***	14.12	15.09	**
C18:2 (n-6)	28.93^{ab}	27.97^{b}	28.50^{ab}	29.49^{a}	25.44^{c}	25.21^{c}	***	28.10	27.08	***
C18:3 (n-3)	0.74^{ab}	0.75^{ab}	0.75^{ab}	0.70^{a}	0.84^{c}	0.84^{c}	*	0.77	0.77	ns
C20:4 (n-6)	11.82^{a}	13.29^{c}	11.16^{a}	12.10^{b}	11.77^{ab}	11.89^{ab}	***	12.35	11.66	***
C20:5 (n-3)	0.92	0.95	1.04	0.95	1.00	0.90	ns	0.99	0.93	ns
C22:6 (n-3)	1.26	0.97	1.07	1.11	1.16	1.25	ns	1.16	1.11	ns
Σ SFA[1]	31.25	32.99	31.96	32.07	31.98	32.88	ns	31.99	32.38	ns
Σ MUFA[1]	13.24^{a}	12.92^{a}	12.43^{a}	12.85^{a}	20.93^{b}	21.59^{b}	***	15.11	16.21	**
Σ PUFA[1]	45.97^{a}	46.07^{a}	44.47^{b}	46.44^{a}	42.40^{c}	42.46^{bc}	***	45.51	43.76	***
n-6/n-3[1]	14.73^{ab}	16.51^{a}	15.56^{ab}	16.10^{ab}	13.05^{c}	13.14^{c}	**	14.95	14.75	ns

[1] Sum of fatty acids: Not all data shown. Means within the same row with different superscripts significantly different, * = P < 0.05, ** = P < 0.01, *** = P < 0.001, ns = non significant, P > 0.05.

Conclusions

Lipid composition of porcine muscle was most affected by inclusion of rapeseed oil to re-alimentation diets. Such treatments enhanced the nutritional quality of pork through augmentation of MUFA content and improvement of the n-6:n-3 balance of PL fractions. Inclusion of grassmeal to pig diets or pig genotype did not affect n-6:n-3 ratios. Overall, diet and breed affected the PL fraction of muscle lipids to an extent greater than NL.

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