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INCREASING THE N-3 POLYUNSATURATED FATTY ACID CONTENT OF PIGMEAT AND EFFECTS ON MEAT QUALITY

J.D. Wood[a], P.R. Sheard[a], M. Enser[a], G.R. Nute[a], R.I. Richardson[a] and B.P. Gill[b]

[a] Division of Food Animal Science, Department of Clinical Veterinary Science, University of Bristol, Langford, Bristol, BS40 5DU
[b] Meat and Livestock Commission, PO Box 44, Winterhill House, Snowdon Drive, Milton Keynes, MK6 1AX

Keywords: α-linolenic acid, pigs, oxidative stability, flavour

Background:
Pigmeat products have become progressively leaner in recent years as production technologies have advanced. However, there has also been a marked increase in the content of linoleic acid (18:2) and other n-6 polyunsaturated fatty acids (PUFA) (Enser *et al*, 1996), because 18:2 is a major components of plant oils used in pig feeds. According to medical opinion, modern diets are too high in n-6 PUFA and people are now encouraged to consume more n-3 PUFA for optimum cardiovascular health. Pigmeat is potentially a good source of α-linolenic acid (18:3) and long chain n-3 PUFA, providing a cheap source can be found, because the pig deposits a high proportion of the PUFA it eats, in muscle and other tissues. However, increasing n-3 PUFA levels in meat could reduce shelf life and adversely affect flavour because n-3 PUFA are very susceptible to lipid oxidation.

Objectives:
To manipulate the fatty acid composition of pig muscle and adipose tissue by changing the diet so that the ratio of n-6 to n-3 PUFA in meat is reduced from the current value of 8-10 to a more nutritionally acceptable 4-5. Also to avoid too large modifications in PUFA composition which would adversely affect shelf life and eating quality, especially flavour.

Backfat thickness was similar in the two groups (11mm P2 average) as was the pH fall in *m.longissimus*. On the day following slaughter, the right *longissimus lumborum et thoracis* muscle was removed, one chop taken for fatty acid analysis in muscle and backfat and the rest vacuum packed and conditioned at 1°C for 10 days. Two chops were overwrapped and stored under simulated retail display conditions (1000 lux illumination, on 16h and off 8h) for 10 days at 4°C. Lipid oxidation, assessed as thiobarbituric acid reacting substances (TBA) was measured at days 0, 4, 7 and 10 using the method of Vynke (1975). Chops from the conditioned *longissimus thoracis* were overwrapped, displayed for 5 days at 4°C, then frozen at -20°C to await sensory analysis.

Sensory analysis was performed by 10 trained female assessors (age range 35-55 years). They received samples of pork chops grilled to an internal temperature of 75°C and rated them on 8-point category scales for the attributes described in Table 2.

Results and discussion:
Results for the fatty acid composition of total muscle lipid are in Table 1. There were no effects of diet or sex on intramuscular fat content. 18:2 and its major n-6 product 20:4 (arachidonic acid) were at lower concentrations in pigs fed the test diet and the concentration of 18:3 and most n-3 products were increased. As a result, the n-6:n-3 ratio was reduced to the target level for the human diet when pigs had been fed the test diet. The results for backfat were similar, in fact the concentration of 18:3 was higher than in muscle. Results for lipid oxidation are shown in Figure 1. TBA values increased with days displayed but were not affected by diet or sex. Values at 10 days were much lower than those associated with rancid odours or flavours (about 0.5mg malonaldeyde/kg).

The sensory results for pork chops are shown in Table 2. There were no effects of diet on any aspect of odour or flavour. This is probably because the concentrations of the n-3 PUFA achieved here were intentionally lower than those that have caused stability problems in other studies. For example, Shackelford *et al* (1990) found low flavour scores when dietary canola oil caused 18:3 to increase to 3g/100g fatty acids. The differences seen here between entire males and females have been found before.

At normal UK consumption levels for pork and assuming a ratio of 1:10 fat : lean, we estimate that the test diet could provide about 12g long chain n-3 PUFA per year, about one third of that from oily fish.

Conclusions:
A study with 80 pigs has shown that a relatively small change in the diet by which 18:3 from linseed replaces 18:2 from grain and soya can significantly reduce the n-6:n-3 PUFA ratio in meat from 8-9 to about 5. This posed no problems for oxidative stability of pork chops, even after 10 days conditioning and 10 days retail display. The modified pork could make a positive contribution to the health of the average UK consumer.

References:

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Table 1 Fatty acid composition of *Longissimus lumborum* muscle (g per 100g total fatty acid)

	Control		Test			
	female	male	female	male	sed	signif.
18:0 (stearic)	11.7	12.0	11.9	12.5	0.3	ns
18:1 (oleic)	29.6	30.1	32.2	31.6	1.1	ns
18:2 *n*-6 (linoleic)	17.5^{b}	17.3^{b}	14.1^{a}	14.1^{a}	0.9	***
18:3*n*-3 (α-linolenic)	0.84^{a}	0.91^{a}	1.32^{b}	1.32^{b}	0.06	***
20:4n-6 (arachidonic)	4.1^{b}	3.9^{b}	3.1^{a}	3.1^{a}	0.3	**
20:5*n*-3 (eicosapentaenoic)	0.42^{a}	0.36^{a}	0.73^{b}	0.69^{b}	0.05	***
22:5*n*-3 (docosapentaenoic)	$0.95^{a,b}$	0.85^{a}	1.06^{b}	1.08^{b}	0.08	***
22:6*n*-3 (docosahexaenoic)	$0.43^{a,b}$	0.34^{a}	0.47^{b}	$0.43^{a,b}$	0.05	*
Total (g/100g muscle)	1.09	1.29	1.20	1.31	0.17	ns
n-6:n-3	8.61	9.02	5.06	5.03		

Means in the same row with the same superscript do not differ significantly at the 0.05 level of probability. *p<0.05, **p<0.01, *** P<0.001

Table 2 Effect of diet and sex on the eating quality of grilled pork loin chops (1-8) scales

	Diet		Sex		
	Control	Test	Males	Females	sed
at assessments					
ork odour	3.8	3.7	3.8	3.8	0.07
bnormal odour	3.0	3.0	3.0	3.0	0.08
ean assessments					
exture	4.4	4.3	4.4	4.3	0.07
uiciness	3.7	3.9*	3.9	3.7	0.07
ork flavour	3.3	3.3	3.3	3.3	0.06
bnormal flavour	3.6	3.4	3.7	3.4***	0.08
edonic					
lavour liking	3.4	3.4	3.3	3.5*	0.07
verall liking	3.2	3.2	3.2	3.3	0.06

p<0.05, ***p<0.001

Fig. 1 Lipid oxidation for pork longissimus (means± sd): influence of diet (control and test), sex of pig and display time