Rapeseed oil enriched pig diets - influence on fatty acid composition of backfat and meat

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Background

Due to their beneficial effect in preventing cardiovascular diseases in humans (Schmidt and Dyerberg, 1994), research has focused on manipulation of the fatty acid composition of animal products towards a higher unsaturated fatty acid content, especially the polyunsaturated omega-3 fatty acids. Adipose tissue of monogastric animals (e.g. pigs) is very susceptible to fatty acid alterations through diet modifications, and replacement of saturated fatty acids with unsaturated fatty acids in meat and meat products may therefore be archived by inclusion of high levels of vegetable oils. However, Grundy (1989) suggested that it may be more beneficial to increase the dietary intake of monounsaturated fatty acids (MUFA) rather than polyunsaturated acids (PUFA), as PUFA are highly sensitive to oxidation. Studies have shown that the MUFA content of pig muscle and adipose tissue may be significantly increased by feeding elevated levels of oils high in oleic acid, such as rapeseed oil (Rhee et al., 1988). However, these studies have been performed with dietary rapeseed oil supplements at high levels (10% or 20%) not common to practise.

Objective

It was the objective to study the effect of addition of 6% rapeseed oil to the feed on the fatty acid composition of pig muscle and adipose tissue.

Methods

Landrace x Yorkshire female pigs weighing approximately 25 kg were assigned to one of two dietary treatments and housed individually at the plant of Research Centre Foulum. One diet ("Control") was based on soya bean meal, barley and wheat while the other diet ("Rapeseed") was furthermore supplemented with 6% rapeseed oil. The chemical analysis of the feed showed that the metabolic energy content was 15.9 and 17.2 MJ/kg feed, and the fat content 36.7 and 94.6 g/kg dry matter of the control and rapeseed diets, respectively. The pigs were given *ad libitum* access to feed until slaughter at 100 kg live weight. Samples of backfat and two muscles, *Longissimus Dorsi* (LD) and *Psoas Major* (PM), were obtained immediately after slaughter and stored at -20°C until required. Extraction of lipids and analysis the their fatty acid composition is reported elsewhere (Lauridsen et al., 1998a,b).

Results and discussion

The inclusion of rapeseed oil in the diet changed the fatty acid pattern of the basal diet (18:2>16:0>18:1>18:3) in direction of the same pattern as in rapeseed oil (18:1>18:2>18:3=16:0).

In agreement with other studies (Mortensen et al., 1983), the adipose tissue of pigs was very susceptible to dietary changes as fatty acids are incorporated unchanged into body fat. As can be seen from Table 1, the percentage of total saturated fatty acids in the backfat decreased from 41% in the pigs on the control diet to 30% in the pigs fed 6% rapeseed oil. The ratio of monounsaturated fatty acids to saturated fatty acids in pigs on the control diet was 1.2 and increased to 1.7 in pigs on the rapeseed oil diet. The polyunsaturated to saturated fatty acids ratio ranged from 0.26 in the backfat of the pigs on the control diet to 0.62 in the backfat of pigs fed rapeseed oil. A similar relationship between dietary fat and the backfat composition has been reported previously (St. John et al., 1987; Jørgensen et al., 1996).

Changes in the fatty acid composition by dietary means were less pronounced in muscle than in backfat. This is due to the fact that pigs fed high-energy diets store the non-metabolized fatty acids esterified to glycerol in adipocytes, whereas in muscles most fatty acids are associated with membrane phospholipids. In agreement with Jørgensen et al. (1996), the inclusion of dietary rapeseed oil did not influence the intramuscular fat content. Most of the previously published studies concerning feeding with rapeseed oil have been conducted with levels as high as 10 and 20%, whereby an increase in the relative amount of monounsaturated fatty acids in muscle tissue was obtained (St. John et al., 1987; Rhee et al., 1988). In contrast to those studies, addition of 6% rapeseed oil did not cause any remarkable changes in the composition of all fatty acids extracted from intramuscular fat. However, the triglyceride and the phospholipid fractions of the intramuscular fat were affected differently (Table 2). As with the backfat, the fatty acids of the triglyceride fraction was more unsaturated after addition of rapeseed oil to the feed. The phospholipid fraction was not influenced with regard to the proportion of saturated fatty acids, but the ratio between PUFA and MUFA was altered, i.e. inclusion of 6% rapeseed oil to the diet resulted in an approximately 4% exchange of polyunsaturated with monounsaturated fatty acids (mainly oleic acid). A higher proportion of oleic acid was found in the phospholipids and in the triglycerides of LD compared to PM. As membrane-bound polyunsaturated fatty acids are the sites at which oxidative changes are initiated in meat (Gray and Pearson, 1987), a higher degree of monounsaturated fatty acids in the phospholipids at the expense of polyunsaturated fatty acids as achieved by the dietary rapeseed oil, may improve storage stability of the meat.

Conclusion

Dietary inclusion of rapeseed oil markedly decreased the concentration of saturated fatty acids in backfat of pigs. When the rapeseed oil was included at 6%, the proportion of unsaturated fatty acids increased by 10% at the expense of saturated fatty acids. Due to the health claims recommended by WHO (1990), the perceived nutritional value of the meat products containing a significant proportion of fat, e.g. salami, would be improved if the pigs were fed diets containing rapeseed oil. Thus, from this pint of view addition of rapeseed oil to pig diets could be recommended. However, a high dietary level of unsaturated fatty acids may have a negative impact on the backfat quality (e.g. soft or oily consistency). This study was supported by EU grant project AIR III CT92-1577.

Literature

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Table 1: Profile of selected fatty acids (%) in backfat of pigs (modified after Lauridsen et al., 1998a)

Fatty acids	Control	Rapeseed	P-value
C14:0	0.98	0.79	<0.001
C16:0	25.5	19.4	<0.001
C16:1	2.3	1.5	<0.001
C18:0	14.4	10.1	<0.001
C18:1	45.0	48.0	<0.001
C18:2	9.5	14.5	<0.001
C18:3	0.63	3.4	<0.001
C20:0	0.16	0.17	0.63
C20:1	0.79	1.0	0.011
C20:2	0.32	0.44	0.002
C20:4	0.17	0.39	<0.001
SAT[1]	41.0	30.4	<0.001
MUFA[1]	48.2	50.7	0.007
PUFA[1]	10.7	18.6	<0.001

1) "SAT" refers to saturated fatty acid, "MUFA" to monounsaturated fatty acids and "PUFA" to polyunsaturated fatty acids

Table 2: Profile of selected fatty acid (%) of M. *Long. Dorsi.* (triglycerides and phospholipids) in pigs (modified after Lauridsen et al., 1998b)

	Triglycerides			Phospholipids		
	Control	Rapeseed	P-value	Control	Rapeseed	P-value
C14:0	1.5	1.4	0.37	-	-	-
C16:0	24.8	22.4	<0.001	25.0	27.1	0.10
C16:1*7	4.2	3.4	<0.001	1.8	0.9	<0.001
C18:0	10.1	9.1	0.003	9.5	9.8	0.17
C18:1*9	52.7	52.1	0.12	17.4	21.5	<0.001
C18:2	4.4	7.7	<0.001	34.3	31.0	0.03
C18:3	0.58	1.7	<0.001	1.0	1.5	<0.001
C20:0	0.20	0.19	0.65	-	-	-
C20:1	0.84	0.87	0.13	0.24	0.28	0.05
C20:2*6	0.19	0.35	<0.001	0.77	0.55	0.01
C20:4	0.15	0.12	0.41	7.9	4.8	<0.01
SAT[1]	37	34	<0.001	38	40	0.17
MUFA[1]	58	56	0.02	19	23	0.002
PUFA[1]	5	10	<0.001	43	38	0.04

1) "SAT" refers to saturated fatty acid, "MUFA" to monounsaturated fatty acids and "PUFA" to polyunsaturated fatty acids