FREE RANGE REARING OF PIGS WITH ACCESS TO PASTURE GRAZING - EFFECT ON FATTY ACID COMPOSITION AND LIPID OXIDATION PRODUCTS

V. Nilzén, A-C. Enfält., K. Lundström, P.C. Dutta, J. Babol and N. Lundeheim*
Department of Food Science, Swedish University of Agricultural Sciences, Box 7051, S-750 07 Uppsala, Sweden
* Department of Animal Breeding and Genetics, Swedish University of Agricultural Sciences, Box 7051, S-750 07 Uppsala, Sweden

Background

There is, in Sweden, a growing demand for meat that is produced in an alternative way to the conventional, intensive rearing of slaughter animals. A new generation of consumers choose meat products not only according to eating quality and price but also consider the ethical quality of the meat, including animal welfare issues and the degree of impact on the environment caused by the production system. Another reason for choosing ecologically or non-intensively produced meat is the belief that the taste and nutritional value of this type of meat is superior to that of conventionally produced meat.

Objectives

In the light of these facts it is very important to investigate how free range rearing influences the quality of pig meat. This investigation was primarily designed to elucidate the effect of outdoor rearing and pasture grazing (growing barley, oats and peas) on pig meat quality, and especially, on the intramuscular lipid fraction of the meat. As both the experimental and the control group had better opportunities than conventional slaughter pigs to exercise, the level of exercise has not been a factor of major importance when comparing the meat quality of these two groups.

Methods

The animals. The animal material in this study consisted of 120 Hampshire cross breeds (castrates and gilts). The sires were pure Hampshire and the sows were cross breeds between Swedish Landrace and Yorkshire. The pigs were reared at Funbo-Lövsta research station, SLU, Sweden. All litters were divided in two and 60 pigs were raised indoors as a control group, in a 120 m^2 pen lined with straw. The other 60 pigs were kept outdoors on an total area of 30 000 m^2 where peas, oats and barley had been sown, in a so called "strip grazing" fashion. The experimental group was given access to a new section of land with fresh pasture at regular time intervals. The animals were kept outdoors during July and August. The pigs in both groups were fed a conventional slaughter pig feeding mixture that was distributed *ad libitum* until the animals reached weight of 60 kg and thereafter in a more restricted diet of 2.8 kg per pig per day.

Analytical procedures. Assessment of technological meat quality was performed in *M. Biceps femoris* (BF) and when specifically stated in *M Longissimus dorsi* (LD). Ultimate pH (pHu), internal reflectance (FOP), marbling score, water-holding capacity (as filter paper wetness, drip- and cooking loss) and shear force values as well as crude protein content, dry matter, ash and water content were analysed according to Enfält *et al.* (1996). The RN genotype was determined in meat juice from LD as described by Lundström and Enfält (1997). The intramuscular fat (IMF) content was determined using the extraction method of Hara and Radin (1978) and the fatty acid composition of the total intramuscular lipids was analysed according to Dutta *et al.* (1994). Lipid oxidation was quantified by measuring peroxide value (IDF method, 1991) and malondialdehyd levels (Draper *et al.*, 1993). The α-tocopherol content was analysed by high performance liquid chromatography (HPLC) (Dutta *et al.*, 1994). Data were analysed using the Statistical Analysis System (SAS Institute, 1995) using a model with type of rearing, RN genotype and sex as fixed effects. Two-way interactions were included when significant ($p < 0.05$).

Results and discussion

Technological properties. No significant differences between the two types of rearing could be detected regarding the technological meat quality parameters measured which could be due to the relatively large area also for the indoor pigs.

Fatty acid composition of IMF. The addition of green feed to the diet of slaughter pigs resulted in significantly higher levels of the essential linoleic C18:2 and linolenic C18:3 acids and a subsequent decrease in the level of the fatty acids C16:1 and C17:1 (Table 1). Consequently, the free range reared pigs produced meat that possessed higher levels of total polyunsaturated fatty acids, (PUFA) ($p=0.027$) and that was richer in healthy omega-3 fatty acids ($p=0.010$) than did the indoor reared pigs. The level of saturated fatty acids (SAFA) was also lower ($p=0.004$) than in the meat from the indoor reared pigs. These results correspond to other investigations where the effect of green feed on the fatty acid composition of IMF have been evaluated (Dufey 1995; Johansson *et al.* 1996). The increased intake of PUFA, omega-3 and omega-6 in food is claimed to be beneficial in human diet, among others by means of reducing plasma cholesterol levels and thereby lowering the risk of cardiovascular diseases. In our investigation the individual fatty acids C18:0 and C24:0 (Figure 1) were both subject to significant two-way interactions between the variables rearing conditions and RN genotype or sex and are therefore not shown in Table 1.

Lipid oxidation products and α-tocopherol. The alterations of the fatty acid pattern did not affect the oxidative stability of the meat. Neither peroxide nor malondialdehyde values in the meat stored in -20°C for three months differ significantly between free range or indoor reared pigs (Table 2). A higher degree of unsaturation in muscle lipids is in other circumstances known to augment the development of lipid oxidation products and thereby the risk of rancid flavour in the meat after storage (Allen and Foegeding, 1981). The lack of such an effect in this study might be explained by the higher level of the natural antioxidant α-tocopherol in the meat of free range reared slaughter pigs (Table 2). Vitamin E, mainly in the form of α-tocopherol, is a powerful lipid-soluble antioxidant in biological systems. It is capable of breaking the chain of lipid oxidation in the cell membranes and thereby prevent the formation of rancid flavour during storage (Buckley *et al.*, 1995). α-Tocopherol can be supplemented in the feed of the pigs as well as be obtained

in a more natural way through grazing green feed, for example growing grain. Further investigation is needed to elucidate the fatty acid pattern and level of natural antioxidants in different types of green feed.

Table 1. *Fatty acid composition (%) of intramuscular fat in slaughter pigs from different rearing conditions, indoors (n=22) and free range (n=22)*

	Rearing condition		
Fatty acid	Indoors	Free range	p-value
14:0 Myristic acid	1.17	1.06	0.095
16:0 Palmitic acid	24.91	23.96	0.087
16:1 Palmitoleic acid	3.14	2.81	0.021
17:0 Margaric acid	0.22	0.20	0.540
17:1	0.24	0.21	0.042
18:1 Oleic acid	44.41	44.26	0.810
18:2 Linoleic acid	9.69	11.12	0.017
18:3 Linolenic acid	0.40	0.50	0.001
20:1	0.36	0.38	0.444
20:2	0.19	0.21	0.133
20:4 Arachidonic acid	1.46	1.61	0.335
22:5	0.28	0.32	0.115
22:6	0.24	0.27	0.181
ω-3	0.93	1.09	0.010
ω-6	11.34	12.94	0.031
Ratio ω-3/ω-6	0.082	0.085	0.525
SAFA	36.86	35.02	0.004
MUFA	48.16	47.66	0.470
PUFA	12.44	14.21	0.027

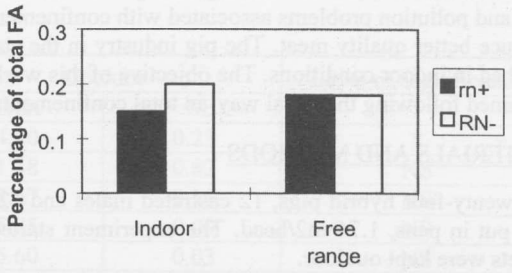

Figure 1. *Illustration of the interaction between the two variables rearing conditions and RN genotype regarding the fatty acid C24:0.*

Table 2. *Lipid oxidation products and α-tocopherol concentrations in pigs reared indoors or free range* [1)]

		Rearing condition		
Variable	*n*	Indoors	Free range	p-value
Peroxide value, meq O_2/kg IMF	34	0.95	1.15	0.525
Malondialdehyde (Spectrophotometer) ng/g muscle	52	71.16	71.18	0.998
Malondialdehyde (HPLC) ng/g muscle	52	43.08	44.13	0.859
α-tocopherol, μg/g muscle	23	2.5	3.4	0.029

1) In meat stored at -20°C for three months

Conclusions

This investigation showed that outdoor rearing of pigs does not affect basic technological meat quality traits. The access to green feed in the form of growing barley, peas and oats resulted in pig meat with elevated levels of omega-3 PUFA compared to that from a control group that had not been fed green feed. The higher levels of PUFA did not affect the oxidative stability of the meat possibly because of the higher levels of the natural antioxidant α-tocopherol (vitamin E) in the meat. It can thus be concluded that free range reared pigs may produce meat that is better suited for the nutritional needs of humans without negative effects on storage stability during at least three months.

References

Allen, C.E. and Foegeding, E.A. 1981. *Food Technology* 35, 253.

Buckley, D.J., Morrissey, P.A. and Gray, J.I. 1995. *Journal of Animal Science* 73, 3122-3130.

Draper, H.H., Squires, E.J., Mahmoodi, J., Wu, S., Agarwai, S. and Hadley, M. 1993. *Free Radical Biology & Medicine* 15, 353-363.

Dufey, P-A. 1995. *Agrarforschung* 2, 453-456

Dutta, P.C., Helmersson, S., Kebedu, E., Alemaw, G. and Appelqvist, L-Å. 1994. JAOCS 71, 839-843.

Enfält, A-C., Lundström, K., Hansson, I., Lundeheim, N. and Nyström, P-E. 1996. *Meat Science* 45, 1-15.

Hara, A. and Radin, N.S. 1978. *Analytical Biochemistry* 90, 420-426.

IDF standard, 1991. 74A:1991.

Lundström, K. and Enfält A-C. 1997. *Meat Science* 45, 127-131.

SAS Institute, 1995. *System for windows*, release 6.11, SAS Inc. Cary, NC.