NUTRITIONAL EFFECTS OF RAPESEED OILS IN PIGS. 2. COMPOSITION AND CHANGES OF TISSUE LIPIDS

By M. Arens, Elfriede Homberg and A. Seher
Bundesanstalt für Fettforschung
D-4400 Münster, Germany

1. INTRODUCTION

These studies are part of a larger collaborative trial (1, 2). Research was undertaken to investigate the influence of type, level and erucic acid content of dietary fat in the composition and changes of tissue lipids in growing pigs. In the preceding paper the feeding conditions and the carcass characteristics have been described. This contribution shall report on the results of chemical analyses of the lipids, and the next paper will present the histomorphometry of the heart muscles of the test animals.

The total lipids and lipid classes derived from inner and outer back fat, leaf fat, heart muscles, livers, adrenal glands, and blood serum were analysed qualitatively and quantitatively.

2. STEROLS AND STEROL ESTERS

The composition of the sterol mixture derived from the different tissues was found to be qualitatively similar. Besides about 97 to 98 % cholesterol, other sterols identified were: desmosterol, cholestanol, Δ^7-cholestenol, $\Delta^{5,7}$-cholestadienol-(3β) and $\Delta^{5,7,24}$-cholestatrienol. Furthermore, some other intermediates of the metabolic pathway of sterols were observed in the mixture. Thus, 4-methyl-cholesterol, 4-methyl-$\Delta^{8(9)}$-cholestenol, 4,4-dimethyl-$\Delta^{8(9)}$-cholestenol, lanosterol and dihydrolanosterol were detected in small amounts. Traces of 7-hydroxy-cholesterol, $\Delta^{3,5}$-cholestadien-7-on and 7-keto-cholesterol were present in all extracts. But it cannot be excluded that the latter compounds may be artefacts causes by oxidation during the numerous steps of isolation and purification processes.

It is well known that there are differences in the content of total sterols in back fat and leaf fat. These differences were now found to be due to the fact that the back fat contains about 0.7 % of Δ^7-cholestenol and $\Delta^{5,7}$-cholestadienol, whereas the leaf fat contains only 0.3 % of these sterols. The other sterols were found in similar concentration in both depot fats.

No significant influence could be observed on the total sterol content or the composition of the sterol mixtures either by the dietary fat composition or by the content of erucic acid in the diet.

3. FATTY ACID PATTERN

It is well known, that pigs - in comparison with other mammals do not show deposition of excess lipid in the heart muscle when fed with a diet high in erucic acid. However, in the present experimental conditions a cumulative deposition of erucic acid in the heart muscle lipids took place, whereas, the total lipid content was unchanged. The deposition was found to be in good correlation with the total amount of erucic acid fed during the whole lifespan of the animals. Even 0.17 % erucic acid in a diet fed for one hundred days - that is a quantity of 340 g equally

divided into 200 kg of feed - produces a small deposition of this acid in the heart lipids. When a thirteen-fold intake is given, the pigs, only a 6,7-fold deposition of erucic acid occurred in the heart muscle lipids.

Erucic acid is rapidly metabolised in the liver. Therefore, no erucic acid is observed in liver lipids. The essential linoleic acid becomes highly enriched in the sterol ester fraction of the liver lipids. This acid is converted in the microsomes into arachidonic acid, which constitutes about 20 % of the total fatty acids of the phospholipids of the liver. The concentration of arachidonic acid was found to be influenced strongly by the simultaneous intake of linolenic acid, perhaps also by other unsaturated fatty acids. These unsaturated acids hinder obviously the formation of arachidonic acid. In low erucic acid rapeseed oil, the ratio of linoleic acid to linolenic acid is low. Consequently, pigs administered with a diet containing low erucic acid rapeseed oil showed the lowest level of arachidonic acid in livers and in heart muscles. Beare-Rogers and Nera (3) reported similar observations in rats. The latter animals had a high rate of lesions in the heart muscles, whereas Bijster and Vles (2) found in pigs no increase of lesions compared with the controls.

With respect to a hypothesis of Vles (4) the content of ω3-docosapetaenoic and -hexaenoic acids was compared. In experiments with rats, high levels of these acids were reported (3). In pigs less than one per cent was determined. These findings may be of help in further investigations. They possibly explain the quite different susceptibility of rats and pigs for erucic acid and linolenic acid, respectively.

4. CONCLUSIONS

No unfavourable effect was observed in growing pigs after feeding a diet consisting of 4 or 8 % rapeseed oils containing up to 22.5 % erucic acid. The erucic acid did not cause excess lipid deposition in heart muscles or significant enrichment of sterols in the livers. A cumulative deposition of this long-chain monoenoic acid caused obviously no pathological alteration in the heart muscle. A negative influence of linolenic acid intake on the transformation of linoleic acid into arachidonic acid takes place in pigs as well as in rats. But in contrast to rats the biological consequence in pigs is insignificant. Specific differences were found in the formation of docosepentaenoic and docosahexaenoic acids from dietary linolenic acid in rats and in pigs.

5. REFERENCES

1. Petersen, U. and A. Seher, 1978. Nutritional effects of rapeseed oils in pigs. 1. Performance and carcass characteristics (preceding paper).
2. Bijster, G. and R. Vles, 1978. Nutritional effects of rapeseed oils in pigs. 3. Histometry of myocardial changes (next paper).
3. Beare-Rogers, J.L. and E.A. Nera, 1977. Nutritional effects of partially hydrogenated low erucic rapeseed oils. Lipids 12, 769.
4. Vles, R. Private communication.