SUMMARY

This thesis concerns the influence of essential dietary fatty acids on the fatty acid composition of adipose tissue and growth performance of growing pigs. Essential fatty acids cannot be synthesized by the body and have to be ingested with the feed. There are two families of essential polyunsaturated fatty acids (PUFAs) that cannot be metabolically interconverted. Linoleic acid (LA; C18:2 n-6) is the parent compound of the n-6 PUFAs and α-linolenic acid (ALA; C18:3 n-3) that of the n-3 PUFAs. In the body, LA can be converted into the n-6 PUFA arachidonic acid (AA; C20:4 n-6) and ALA can be elongated and desaturated to eicosapentaenoic acid (EPA; C20:5 n-3) and docosahexaenoic acid (DHA; C22:6 n-3). The n-6 and n-3 PUFAs are essential structural components of the cell membranes and are precursors of eicosanoids, compounds affecting functions such as immunity, platelet aggregation and vasoconstriction. It is well-known that the quantitative intakes of n-6 and n-3 PUFAs are reflected in the adipose tissue of non-ruminants. This implies not only that the fatty acid composition of adipose tissue can be modulated by diet, but also that the adipose tissue composition can be used as an index of the qualitative PUFA intake.

The LA requirement of growing pigs has been set at 0.08 g/MJ metabolizable energy (ME), but the requirement of ALA is not known. On the basis of literature data, Chapter 1 indicates that the current recommended intake of LA is too low to sustain maximum growth. Intakes of ALA higher than 0.05 g/MJ may not further enhance growth. Review of the literature did not provide evidence for a positive effect of the intake of extra n-3 PUFAs on disease resistance, at least not under realistic, practical conditions. In one published study, a high intake of EPA and DHA reduced the severity of lung lesions as induced by Mycoplasma hyopneumoniae infection, but the EPA and DHA intakes were unrealistically high and the diet used had a LA level below the requirement for maximum growth.

Chapter 2 describes the mathematical relationships between the fatty acid composition of adipose tissue and PUFA intake by growing pigs. For LA, ALA, EPA and DHA there were strong correlations. The slopes of the regression equations for the relationships between dietary and adipose tissue PUFAs can be considered a measure of the efficiency of incorporation of the dietary fatty acids into adipose tissue. The slope was steepest for LA and most shallow for EPA. The mathematical relationships were used to verify PUFA intake in subsequent studies carried out on small-holder farms in Central Vietnam. On those farms, mixtures of locally available feedstuffs with varying quality are fed which makes it difficult to assess fatty acid intake by the pigs.

An inventory of fatty acid intake and average daily gain (ADG) of pigs was made on 12 small-scale farms on which the pigs were fed according to the farmers’ choice of feedstuff mixtures. The feeding of higher amounts of LA and ALA was associated with higher percentages of these fatty acids in adipose tissue of growing pigs (Chapter 3). There were weak, but statistically significant, positive correlations between either adipose tissue content of LA or that of ALA and ADG.

In an attempt to raise EPA and DHA intake, the farmers were instructed to use either fish meal or specially prepared ruminant meal as constituent of the ration (Chapter 4). The diets without and with 20% (% in total dietary dry matter) fish meal on average contained
0.01 and 0.03 g EPA/MJ ME and 0.00 and 0.25 g DHA/MJ ME. The relative percentages of DHA, ALA and LA in adipose tissue were reflected by the intake of the corresponding fatty acids. EPA was not detectable in adipose tissue. There was no impact of fish meal intake on growth performance of the growing pigs. The intake of EPA or DHA was not related with ADG, and neither was the adipose tissue content of DHA. Adipose tissue content of ALA or that of LA were significantly correlated with ADG. Thus, it was concluded that on the farms ALA and LA intake were limiting growth.

In a further study (Chapter 5) EPA and DHA were fed in the form of shrimp by-product meal, essentially consisting of shrimp heads. The diets without and with 20% shrimp meal on average contained 0.01 and 0.13 g DHA/MJ ME. The relative percentage of ALA in adipose tissue was directly related with the intake of this fatty acid. EPA was not detectable in adipose tissue, but the content of DHA was increased after consumption of shrimp by-product meal. The intake of DHA or its content in adipose tissue was not related with ADG. Inclusion of shrimp by-product meal caused an increase in the ash and crude-fibre content of the ration. Nevertheless, there was a general stimulatory effect of shrimp by-product meal on growth.

The hypothesis tested in Chapter 6 was that feeding of either linseed or fish oil, instead of coconut oil, would enhance growth of growing pigs kept on small holdings. The linseed oil used contained 57% ALA and the fish oil contained 1.5% EPA and 20% DHA. The diet with 5% linseed oil on average contained 2.4 g ALA/MJ and the diet with 5% fish oil on average contained 0.06 and 0.75 g EPA and DHA/MJ ME, respectively. The relative percentages of DHA, EPA, ALA and LA in adipose tissue were found to be determined by the intake of the corresponding fatty acids. Dietary linseed oil versus coconut oil significantly enhanced ADG, and when compared with fish oil, it also stimulated growth, but this effect just failed to reach statistical significance. It was concluded that extra intake of ALA may stimulate growth, this effect being independent of conversion of ALA into EPA and DHA.

In Chapter 7, the question addressed was whether the addition of either spinach or sweet-potato leaves to the diet of growing pigs, kept in small holdings in Central Vietnam, would improve growth performance. The diets contained 15% of each of the vegetables in the total dietary dry matter. The spinach leaves contained 35% ALA in its fat component and for the sweet-potato forage the value was 41%. The diets without and with vegetables on average contained 0.14 and 0.32 g ALA/MJ ME. The relative percentage of ALA in adipose tissue was raised by the intake of the vegetables. There was a significant, stimulatory impact of the intake of either spinach or sweet-potato leaves on growth performance of the growing pigs.

The studies described have yielded knowledge on the relationship between PUFA intake and ADG in growing-finishing pigs kept on small-scale farms in Central Vietnam. It is suggested that supplementary intakes of LA and ALA, up to dietary concentrations of 2 and 0.3 g/MJ ME, respectively, may increase ADG. Such intakes are high when compared to the optimum intakes that were derived from the literature. However, the pigs in the present studies had relatively low weight gain and high body fat. Furthermore, in these studies LA and ALA were not the only dietary variables so that unknown, associated factors may have been responsible, either fully or in part, for the observed direct correlations between the intakes of either LA or ALA and growth.