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From the Department of Medicin I, Royal Veterinary College, Stockholm, Sweden.

THE RELATION BETWEEN BODY GROWTH AND LINOLEIC ACID CONTENT OF SOME TISSUE FATS IN PIGS*)

By
Eero Tanhuanpää

The influence of dietary fat on the composition of body fat in non-ruminants was demonstrated already at the end of the last century by *Munk* (1884) and *Henriques & Hansen* (1899). The pig is probably the most thoroughly examined animal in this respect. In a recent investigation on the association between polyunsaturated dietary fat and muscular dystrophy in pigs, the composition of tissue and depot fats was examined and related to the dietary fat (*Tanhuanpää* 1965). The present paper deals with the correlation between body growth and the relative content of linoleic acid in depot fat and in some organ fats.

MATERIAL AND METHODS

The experimental animals and the diets have been published (*Tanhuanpää* 1965). In three experiments (V 74, V 76, V 77), comprising 46 pigs divided in 10 groups fed on different diets, pigs of varying body weight were killed at about 2 weeks' intervals. The fatty acid composition of subcutaneous, perirenal, and coronary depot fat, and of the fat of the liver and skeletal muscle tissue was examined by gas-liquid chromatography. At the beginning of the experiments the pigs weighed between 15 and 30 kg. When they were killed the body weight varied from 40 to 90 kg. In experiments V 74 and V 77 the basic diet consisted of

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barley supplemented with skim milk powder and casein, respectively. In experiment V 76 the diet was composed of oats and skim milk powder. In all experiments the methyl ester of linoleic acid was added at the 0.5 % and 1.5 % levels. The preparation of the methyl ester of linoleic acid has been described (*Tanhuanpää* 1965).

Linoleic acid is an essential fatty acid, which the pigs can not synthesize. The quantity which is found in the tissues is thus assimilated from the food. The linoleic acid which is isolated from the swine depot fat, is identical with the one occurring in the plants (*Hilditch* 1956).

If we accept that the assimilation is constant and that there is a linear correlation between the content of linoleic acid (Y) and body weight (X) the formula $Y = \alpha + \beta X$ can be used. The regression coefficient β is calculated according to the formula

$$\frac{\Sigma\ (X - \overline{X})\ (Y - \overline{Y})}{\Sigma\ (X - \overline{X})^2}$$

RESULTS AND DISCUSSION

The regression coefficients characterizing the correlation between the linoleic acid content in the examined tissues and the body weight are shown in Fig. 1.

In the depot fat, the coefficients are negative as a rule. Out of 31 coefficients only 4 are positive. For liver and skeletal muscle the coefficients are either positive or negative. In experiment V 77 group 3, there is a positive coefficient for coronary fat, contrary to the subcutaneous and perirenal fats. The experiments V 77 and V 74 are similar with regard to the diets which contained barley as main component, 88.8 and 80 % respectively. The diets are different with regard to the protein addition, which consisted in V 77 of casein and in V 74 of skim milk powder. The regression coefficients for depot fats in V 74 are all negative. One should expect that the experiments would give the same results here. Variations in the deposition of linoleic acid in depot fats are known, however. Linoleic acid was found to be assimilated and deposited to a greater extent in slowly growing than in fast growing pigs (*Hilditch et al.* 1939; *Shorland & de la Mare* 1945). *Callow* (1935) expressed a "growth

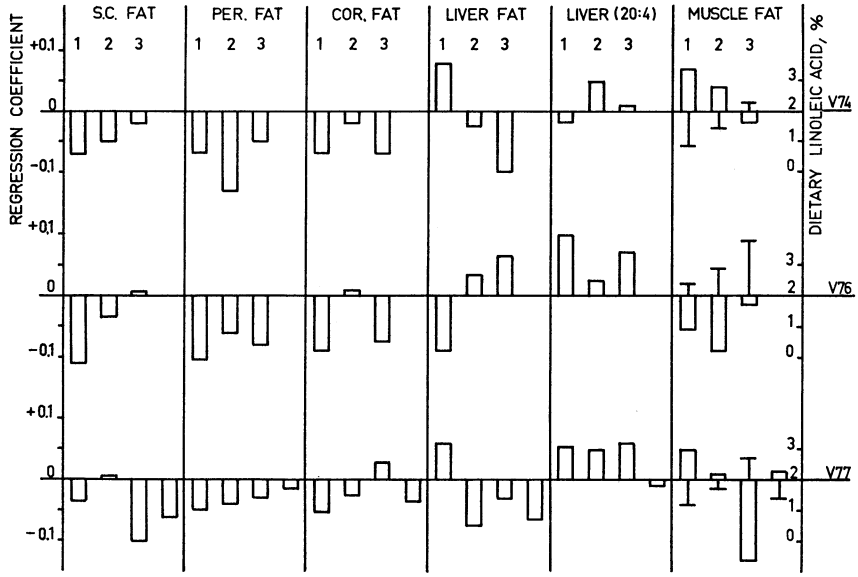

Figure 1. Regression coefficient of body growth and relative linoleic acid content of depot and tissue fats in pigs. The linoleic acid content of the diets is shown as vertical crossed bars in the muscle fat section. The bars start the 2 % level, coinciding with the zero line of the regression coefficients, and consequently show the deviation, positive or negative, of the actual linoleic acid content from 2 %. It is noted that the bars thus constructed are regularly inverted as compared with the corresponding regression coefficients of muscle fat.

rate theory" as follows: "It appears probable that the faster the rate at which the fat is deposited in fatty tissues, the more saturated the fat becomes". Group 3 in experiment V 77 showed a significantly slower body growth than group 3 in V 74. The mean body weight increase per day in the first mentioned group was 525 $\pm$ 15 g ($n = 4$) and in the last mentioned group 664 $\pm$ 14 g ($n = 5$) during the first 42 and 70 days of the experiments, respectively.

Sink et al. (1964) examined the fatty acid composition of perirenal and subcutaneous fat of pigs. They found a relative increase of the saturated fatty acids with increasing body weight. The content of unsaturated fatty acids behaved in the opposite way. The change in the composition of the fat depots occurred at about 60 kg of body weight. This is related to the increasing

deposition of fat, which occurs in fattening pigs and which is due to the intensive synthesis of palmitic, stearic and oleic acids from carbohydrates and protein in the food. Linoleic acid is transported rather continously to the depot fats and the relative proportion will become less.

Ellis & Zeller (1930) showed that the linoleic acid content of body fat sank from 6.9 rel. % in young pigs (body weight 8.5 kg) to 1.3 rel. % in heavy pigs (body weight 130 kg).

There are no great quantities of fat deposited in the organs of healthy animals. The uptake is regulated by the demand of the tissues. Linoleic acid is needed for structural purposes in the cell membrane (*Singlair* 1958).

The regression coefficient for skeletal muscle in experiments V 74 and V 77 is negative for both groups 3, which is contrary to the 2 other groups of the experiments. The coefficient seems to change from positive to negative when a certain level of dietary linoleic acid is exceeded. In experiment V 76 all coefficients are negative. The linoleic acid content of the diet in these experiments varied from 9.2 to 38.5 g per kg of dry substance. The regression coefficient changes from positive to negative somewhere between 17.6 and 23.6 g of linoleic acid per kg of dry food substance. This corresponds to a linoleic acid content of 10—12 rel.% of the skeletal muscle. It seems to show that the skeletal muscle of the young pig is able to assimilate a larger amount of linoleic acid than the muscle of the older pigs. The importance of this observation is at present difficult to evaluate, however.

In the livers there is no corresponding tendency for the coefficients. Here the synthesis of arachidonic acid from linoleic acid interferes. The same applies to the coefficient for arachidonic acid.

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SUMMARY

The correlation between body growth and linoleic acid in subcutaneous, perirenal and coronary fat and in skeletal muscle and liver fat of pigs was examined. The pigs were killed at about 2 weeks' intervals when weighing between 40 and 90 kg. The linoleic acid content of the diets varied in 10 diets from 9.2 to 38.5 g per kg of dry substance. In depot fat the relative linoleic acid content decreased with increasing body weight independently of the linoleic acid content of the food. In skeletal muscle fat the coefficient was negative in groups which received 23.6 g of linoleic acid per kg of dry substance of the food or more, but zero or positive in groups which received 17.6 g of linoleic acid or less.

ZUSAMMENFASSUNG

Das Verhältnis zwischen dem Körpergewicht und der Linolsäure bei einigen Gewebefetten des Schweines.

Es wurde das Verhältnis zwischen dem Körpergewicht und der Linolsäure beim subkutanen, perirenalen und koronaren Fettgewebe, als auch beim Muskel- und Leberfett untersucht. Die Schweine wurden in zweiwochigen Abständen getötet, wobei sie ein Körpergewicht von 40 bis 90 kg hatten. Bei zehn Versuchsdiäten variierte die Menge der Linolsäure von 9,2 bis 38,5 g/kg Trockensubstanz im Futter. Mit steigendem Körpergewicht sank die relative Menge der Linolsäure im Depotfett unabhängig von der Linolsäuremenge in der Diät. Der Regressionskoefficient war im Muskelfett negativ bei Gruppen, die 23,6 g oder mehr Linolsäure/kg Trockensubstanz im Futter erhielten, dagegen war er Nul oder positiv bei Gruppen mit 17,6 g oder weniger Linolsäure.

SAMMANFATTNING

Sambandet mellan tillväxt och linolsyrahalt i vissa vävnadsfetter hos grisar.

Sambandet mellan tillväxt och linolsyrahalt i subkutant, perirenalt och koronart fett samt i muskel- och leverfett undersöktes i försök där grisarna dödades med c:a 2 veckors mellanrum, när de vägde mellan 40 och 90 kg. I 10 försökskoster varierade linolsyrahalten från 9,2 til 38,5 g per kg torrsubstans. I depåfettet sjönk linolsyrahalten med stigande kroppsvikt oberoende av halten linolsyra i kosten. I muskelfettet var regressionskoefficienten negativ i grupper, vilka erhöll 23,6 linolsyra per kg torrsubstans av fodret eller mera, men noll eller positiv i grupper, som erhöll 17,6 g linolsyra eller mindre.

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