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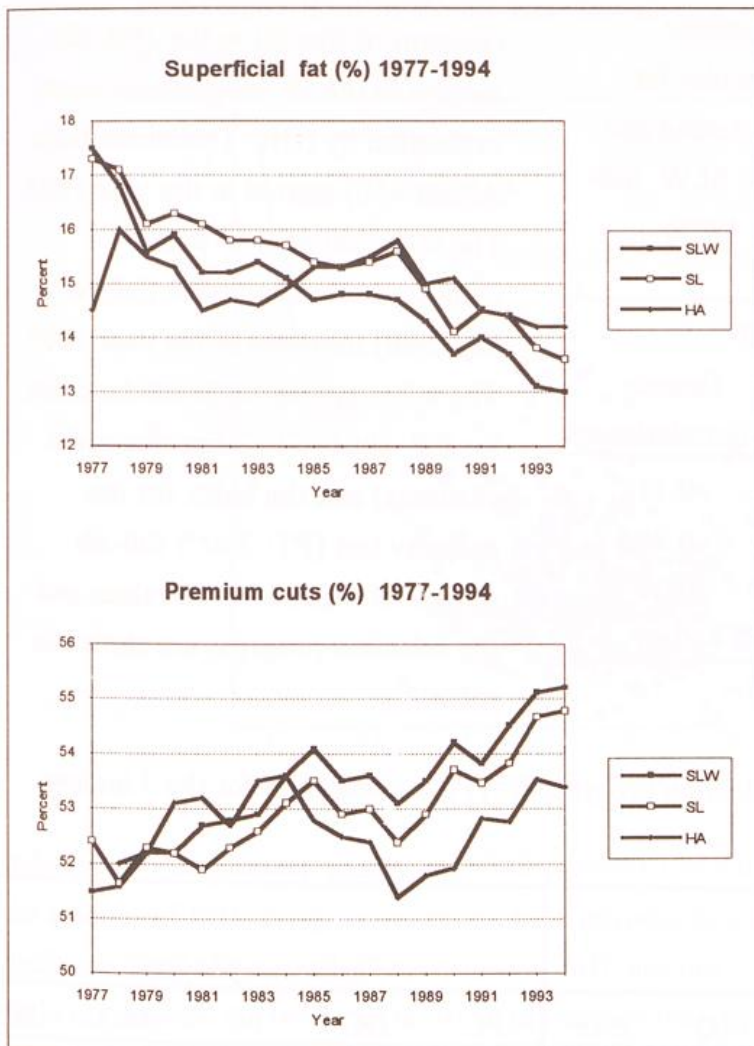
SELECTION ON INTRAMUSCULAR FAT IN SWISS PIG BREEDS AND THE IMPORTANCE OF FATTY TISSUE QUALITY

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In Switzerland intramuscular fat and fat quality of the fatty tissues are attracting a great deal of interest from the breeding as well as from the meat-technological and nutritional point of view.

Figure 1. Progress of the traits superficial fat and premium cuts in the years 1977 - 1994 (full-sib test)



MEAT QUALITY

Considerable progress has been made in pig breeding for fattening and slaughtering traits during the last three decades. To prevent the deterioration of meat and fat quality, steps were taken at the Swiss Pig Performance Testing Station since 1973 to improve meat quality: routine evaluation of PSE-, DFD-meat; construction of a meat quality score (MQ) (Schwörer et al., 1988a); inclusion of the MQ-score in a selection index consisting of premium cuts (PC), feed conversion (FC) and daily gain (DG); selection on stress resistance (halothane-, creatine kinase testing, evaluation of blood groups and enzyme types).

According to consumers, the trend in modern pork production is leading towards a lean pork and a reduction in the fat content of the pork carcass (*Figure 1*). Since 1977 the amount of superficial fat in Swiss Large White (SLW) and Swiss Landrace (SL) pigs has been reduced by around 4 %, the amount of premium cuts raised around 3 %. At the same time increasing

criticism has come from consumers about the eating quality of the meat; the most frequent complaints concerned the loss of juiciness, tenderness and flavour. With the reduction in carcass fatness, the presence of intramuscular fat (IMF) has also been reduced.

INTRAMUSCULAR FAT

The evaluation of the genetic parameters of IMF (Schwörer et al., 1986; Schwörer et al., 1989; Schwörer et al., 1990) indicated, that we had to direct our attention furthermore on the amount of IMF by selecting a better meat and fat quality. The heritability estimates (h^2 range SLW,SL: 0.49-0.58) showed the possibility of preventing a diminution of IMF by including it in selection. Recent estimations of variance components by REML (Table 1) confirmed earlier results, that in Swiss pig populations it should be possible to increase IMF without losing too much leanness of the carcass.

Table 1. Estimates of phenotypic and genetic correlations between intramuscular fat content (IMF) and growth, fattening and slaughtering parameters (4656 SLW, full-sib test; Hofer and Schwörer, 1995)

	IMF	
	Phenotypic correlations	Genetic correlations
Daily gain	0.07	0.11
Daily feed intake	0.20	0.21
Feed conversion ratio	0.20	0.16
Premium cuts	-0.25	-0.07

The routine evaluation of IMF (amount of free fat in the 10th rib section of the M. longissimus dorsi, evaluation by NIR: Technicon Infra Alyzer 450) started in the year 1985. The inclusion of IMF in the combined selection index (Morel et al., 1988) followed in the year 1989. The index system includes the index for full-sibs (FST: 2 females and 2 castrates) and the index for the progeny test (PT: 3 or 5 full-sib groups of 4 animals). B-values and the selection progress are shown in table 2.

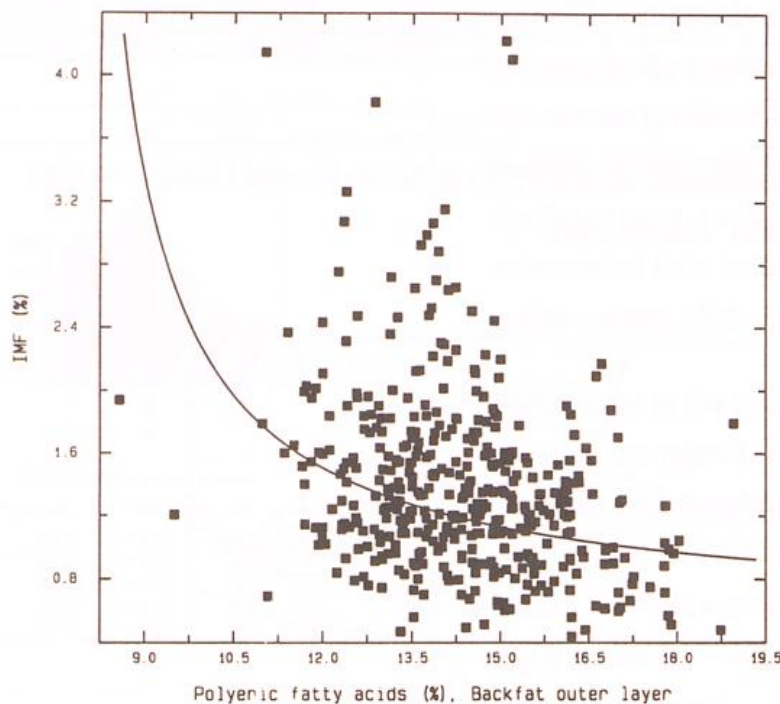
Table 2. B-values (sx=10, FST) and selection progress (i=1) per generation for the 3 indices (Morel et al., 1988)

Index SLW	b values					selection progress				
	FC	DG	PC	MQ	IMF	FC	DG	PC	MQ	IMF
FST	-27.73	0.029	3.035	4.84	13.12	-0.051	9.81	0.689	0.019	0.077
PT 3x4	-56.24	0.063	5.869	9.39	27.52	-0.071	14.27	0.938	0.028	0.118
PT 5x4	-70.94	0.082	7.209	11.39	35.24	-0.079	16.23	1.029	0.031	0.137

Index SL	b values					selection progress				
	FC	DG	PC	MQ	IMF	FC	DG	PC	MQ	IMF
FST	-21.40	0.037	3.662	10.47	6.05	-0.038	4.05	0.706	0.067	0.061
PT 3x4	-48.41	0.086	7.203	22.01	10.81	-0.056	7.42	0.968	0.098	0.082
PT 5x4	-64.83	0.113	8.936	28.35	12.40	-0.064	9.34	1.065	0.112	0.089

The inclusion of IMF in the combined selection index should not only improve the sensory quality, but should also indirectly reduce the reduction in carcass fatness and improve the fat quality of the fatty tissues (*Figure 2*).

Figure 2. Relationship between intramuscular fat (IMF, loin: 10th rib) and polyenic fatty acids of the outer layer of the backfat (full-sib test, random sample of SLW and SL: 416 animals)



Index selection on meat quality and IMF proves to be successful (*Figure 3*). Information about the amount of IMF in pig carcasses and the introduction into the selection index stopped the decline in IMF (*Figure 4*). The amount of IMF has not yet reached the optimum of 2.0 % free fat in our breeds. In 1994, 20 to 30 % of our breeding animals had an IMF value below the minimum of 1 %. The percentage of animals with more than 1.5 % IMF in the loin is increasing (*Figure 5*).

Figure 3. Partial index points (full-sib test) for meat quality score (MQ) and intramuscular fat (IMF) of SLW and SL pigs

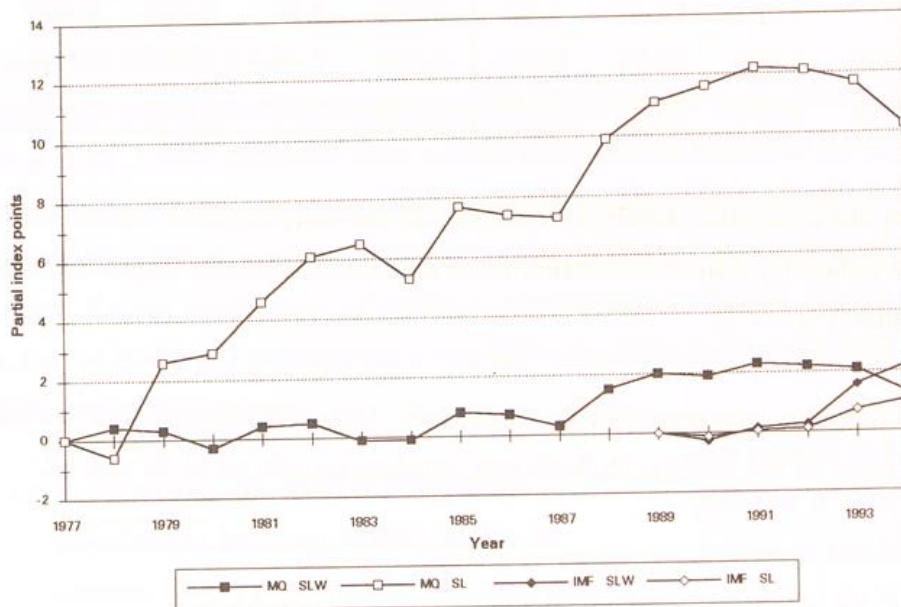


Figure 4. Content of intramuscular fat (IMF, %) in SLW, SL and Hampshire pigs (years 1985 - 1994, full-sib test)

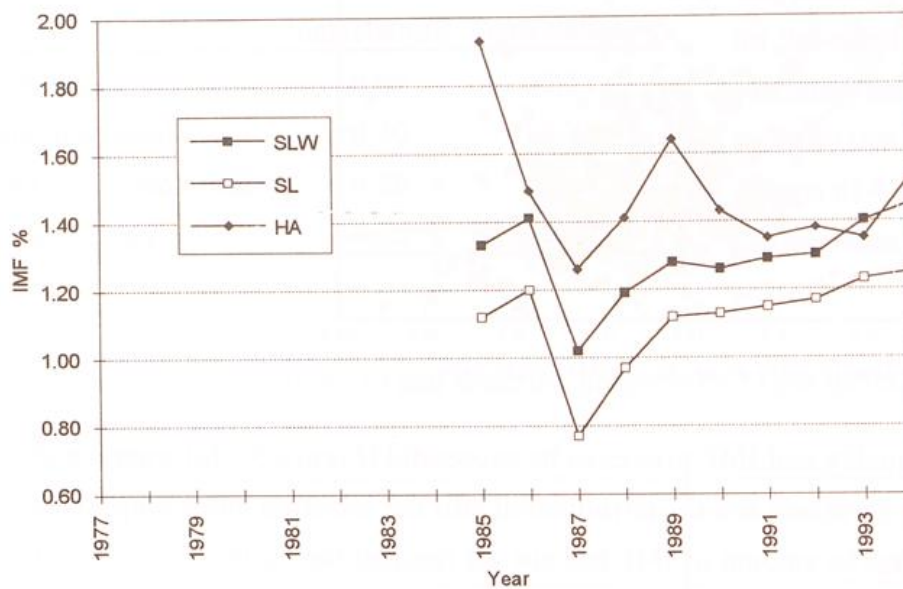
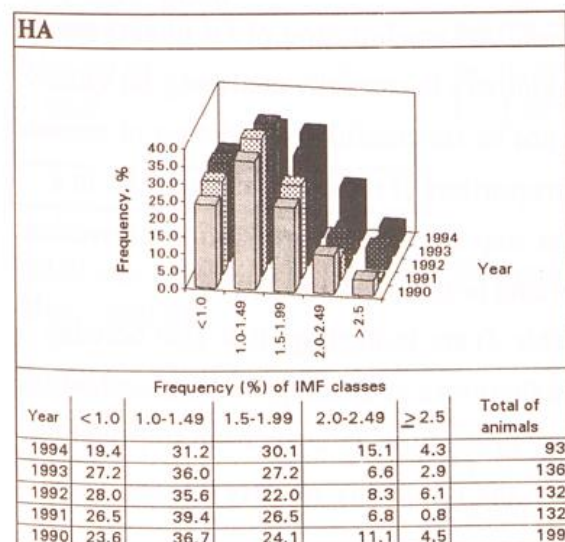
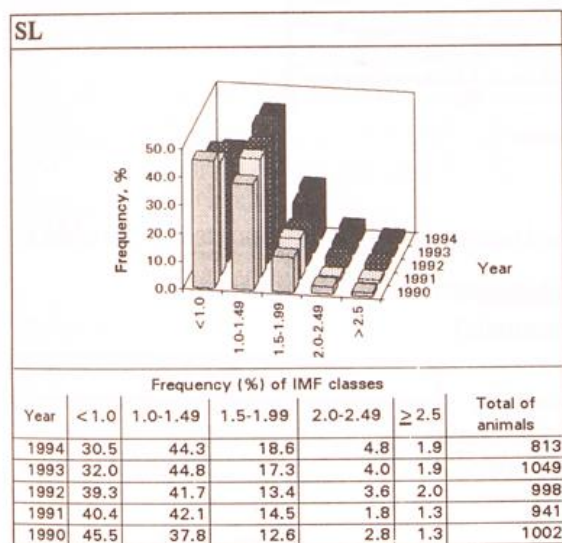
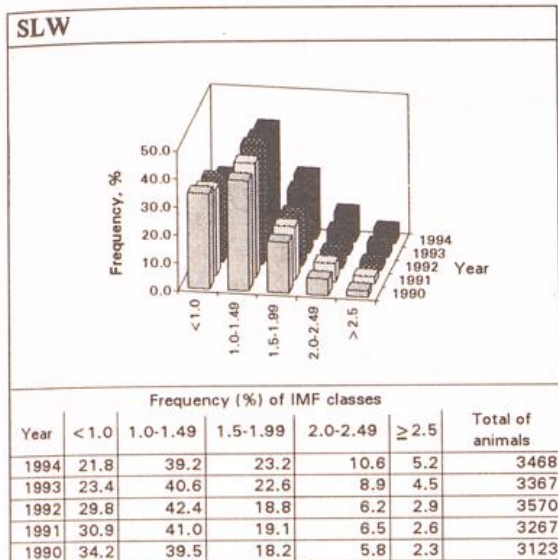


Figure 5. Frequency of IMF classes of full-sib tested SLW, SL and Hampshire pigs (years 1990 - 1994)



FAT QUALITY OF FATTY TISSUES

It is well known that the amount and fatty acid composition of the diet influences carcass fat quality in pigs. But also the strong reduction of the amount of fatty tissues leads to a considerable decline of fat quality. Butchers complain about floppy meat with tissue separation, soft fatty tissues, empty fatty tissues, difficulties in calculating sausage recipes (caused by the great variation in fat quality) and reduced storage stability of products.

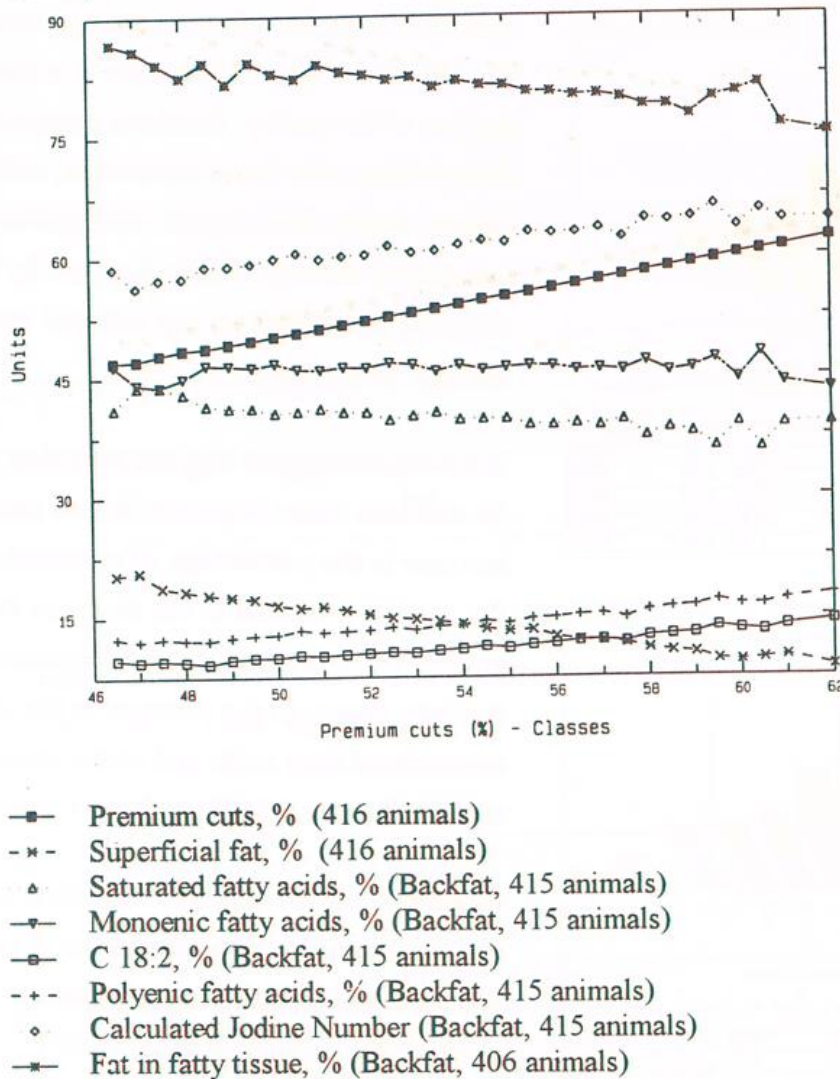
We have recognized that the adhesion between fat and lean tissue is poorer in lean carcasses. An increase in the percentage of premium cuts in the carcass is related to the decrease in the amount of fatty tissue, to the decrease of fat in the fatty tissue, to the increase in the amount of unsaturated fatty acids and to the increase in the water content of the fatty tissue (*Figure 6*).

Differences in the quality of the fatty tissues of our pigs are related to differences in race, sex, fattening and slaughtering parameters (Prabucki et al., 1985; Schwörer et al., 1985).

Today, there is a great variation in the amount of fat in the fatty tissues (*Figure 7*). There is also a great variation in the quality of the fatty tissues (*Figure 8*).

Some slaughterhouses in Switzerland have therefore introduced a payment system (*Table 3*) not only according to the amount of premium cuts, but also according to meat quality (pH-values from the slaughterline) and fat quality (jodine number of the backfat). At the moment this procedure is unique in Europe.

Figure 6. Influence of the increase in premium cuts on the amount of superficial fat (loin-, ham-, shoulder fat) and different fat quality parameters of the outer layer of the backfat (full-sib test, random sample of SLW and SL; class width of premium cuts: 0.5 %)



Leanness itself is not an indicator of quality. Our investigations indicate that we must direct our attention, besides meat quality, on fat quality as well. An amelioration of fat quality can be achieved by feeding and breeding measures. The feed industry is carefully analysing fat quality of feed products. Selection on a better fat quality can not be successful by selection of animals with a maximum of meat and a minimum of fat. The proportion of meat and fat must be in an optimum. Breeders therefore decided in 1992, as a first step against the production of overlean pigs, to introduce a temporary limitation for premium cuts in the selection index.

Heritability estimates of fatty acids in fatty tissues (Table 4) are indicating, that also heredity must be taken in consideration. At the moment we are therefore evaluating routine methods of fat quality for the station tests. Currently are alternative procedures in evaluation to predict breeding values (i.e. BLUP), which are considering also the fat quality of fatty tissues.

Figure 7. Frequency of full-sibs, according to the amount of fat in the fatty tissues (random sample of SLW and SL: 406 animals, class width of fat: 4%)

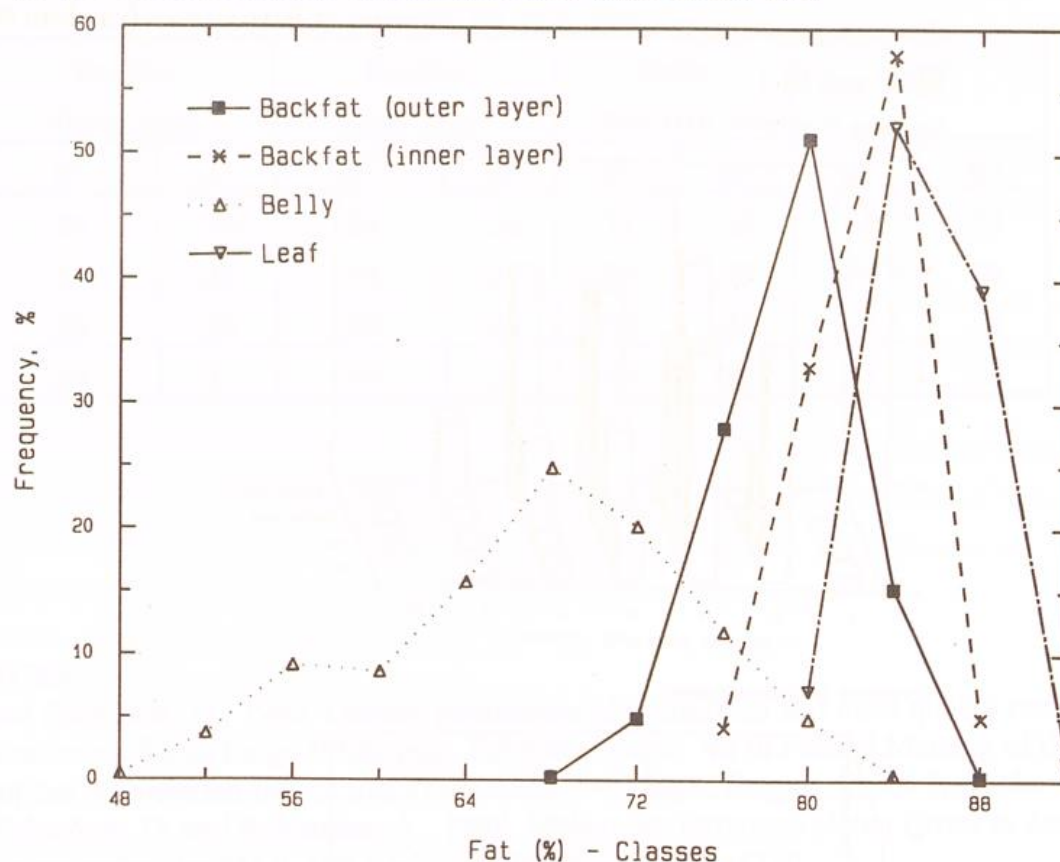


Table 3. Fat- and meatquality taxation in the Micarna slaughterhouses Bazenheid and Courtepin (Switzerland) in the year 1995

Fat quality

Jodine Number

Deduction

≤ 58.0 very good

58.1-62.0 good

62.1-64.0

64.1-66.0

> 66.0

Fr. 0.10 per kg Slaughterweight

Fr. 0.40 per kg Slaughterweight

Fr. 1.00 per kg Slaughterweight

Meat quality

pH30 min.p.m.

Deduction

Musc. semim.

≥ 6.00 good

5.80-5.99

5.60-5.79

< 5.60

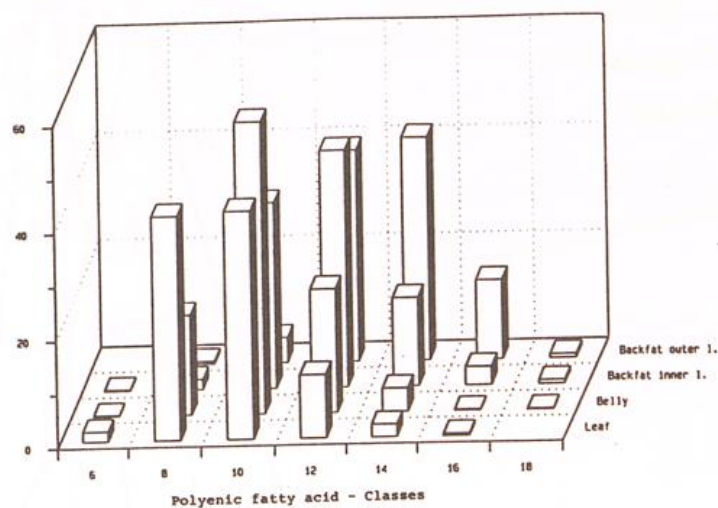
Fr. 0.20 per kg Slaughterweight

Fr. 0.40 per kg Slaughterweight

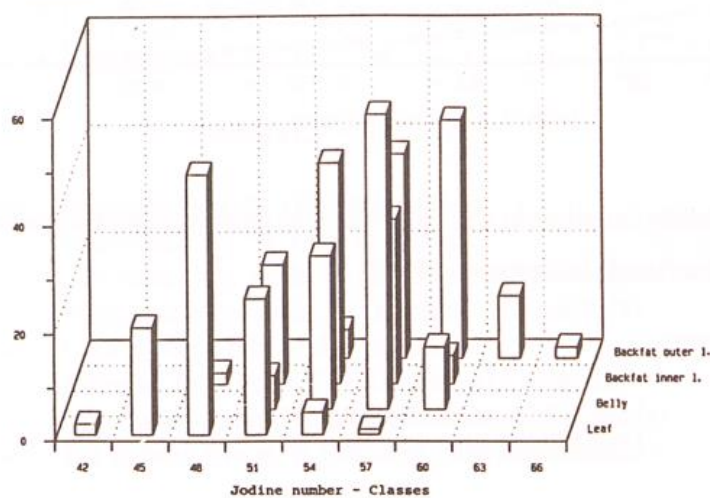
return to the producer or "freebank"

Figure 8. Frequency of full-sibs, according to the amount of polyenic fatty acids (class width: 2 %, 416 animals), the analysed iodine number (class width: 3 %, 96 animals) and the drop point (class width: 2 %, 95 animals) of fatty tissues (random sample of SLW and SL)

Frequency of polyenic fatty acids



Frequency of iodine number



Frequency of drop point (Ubbelohde)

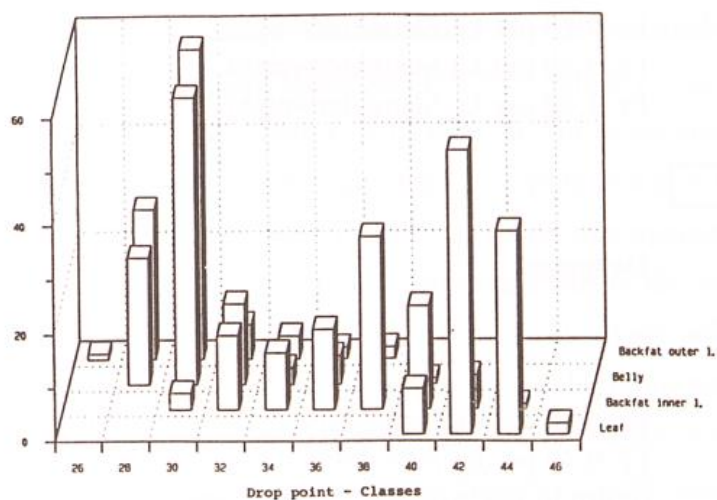


Table 4. Heritabilities (h^2 s) and standard errors (sh^2) of fatty acids in porkfat, according to localisation (Schwörer et al., 1988b)

	Backfat		Backfat		Belly		Leaf	
	Outer layer		Inner layer					
	h^2	sh^2	h^2	sh^2	h^2	sh^2	h^2	sh^2
C 16:0	.88	.26	.84	.26	.71	.25	.64	.25
C 18:0	.57	.24	.58	.24	.39	.23	.79	.26
C 18:1	.89	.26	.98	.27	.59	.24	.78	.26
C 18:2	.64	.25	.59	.24	.40	.23	.41	.23

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Effect of diet on intramuscular n-6 and n-3 polyunsaturated fatty acids in cattle sheep and pigs: implications for human nutrition.

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The polyunsaturated fatty acids (PUFA), are significant dietary components. They consist of the essential fatty acids (EFA) linoleic acid (C18:2 n-6) and α -linolenic acid (C18:3 n-3) and the C20 and C22 PUFA synthesised from them. Many metabolic processes depend upon a balance between the n-6 and n-3 PUFA; a balance which is now believed to be tilted too much toward the n-6 PUFA and resulting in the development or exacerbation of the so-called "diseases of western civilization" (Simopoulos, 1991). To correct the imbalance increased consumption of fish, particularly oily fish, has been recommended (Department of Health, 1994). These supply preformed C20 and C22 n-3 PUFA, thus bypassing the competitive block on their synthesis in man from α -linolenic acid exerted by the high consumption of linoleic acid. Since in the UK fish consumption is low, meat may be the only significant source of preformed longer-chain n-3 PUFA in the diet. However, as in man, the regulation of the fatty acid composition of tissue lipids in meat animals depends upon the composition of the dietary fatty acids to a considerable extent, particularly in respect of the EFAs. These effects occur not only in monogastric animals such as pigs (Enser *et al*, 1990; Morgan *et al*, 1992) but also in ruminants, despite the extensive hydrogenation in the rumen (Marmer *et al*, 1984). It is important, therefore, that production systems optimise the fatty acid composition of red meat particularly in respect of n-3 PUFA. In this paper we report the results of four studies on the PUFA content and composition of meat animals: 1. beef fed grass compared with a combination of grass silage and barley; 2. pigs fed constant amounts of fat in which the proportions of linoleic acid differed; 3. lambs finished off grass in the summer; 4. samples of beef, lamb and pork on sale in English supermarkets during February and March. The results from these studies are compared with other published quantitative results and considered in relation to their contribution to human nutrition.

Methods

1. Thirty steers, Hereford x Friesian and Angus x Friesian which had fed on grass were slaughtered in October and thirty Hereford x Friesian bulls which had eaten grass silage and barley were slaughtered in March.
2. Pigs consisted of five groups of eight fed isocaloric diets containing 40g/kg of added fat comprised of a mixture of soya oil and coconut oil such that the concentration of linoleic acid varied from 12.3 to 30.3g/kg feed.
3. Thirty Suffolk cross