GENETIC PARAMETERS OF FATTY ACIDS OF PORK FAT

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SUMMARY

Fat localisations show characteristic differences in the proportion of fatty acids. The correlations between the proportion of C 18:2 in the fatty tissues and the slaughtering parameters are indicating, that selection on a better fat quality (consistency, keeping quaity) 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.

As generally known, fatty acids of pork fat are influenced by the amount of fatty acids in the ration. The results of this investigation reveal, that also heredity must be taken into consideration.

INTRODUCTION

Fat quality is depending to a great part to the fatty acid composition of the fat. Particularly consistency and keeping quality are influenced by the degree of unsaturation of the fat.

The influence of nutrition on the fatty acid composition of fat is well known. Indications of genetic effects are rare (Metz 1983). Therefore the objective of this work was to estimate the heritabilities of fatty acids and to evaluate the genetic correlations between fatty acids and fattening and slaughtering performances. Preliminary results (fatty acids of pork fat in Swiss pig breeds, phenotypic parameters) are cited by Prabucki et al. (1985) and Schwörer et al. (1985).

MATERIAL AND METHODS

From a total of 585 randomly chosen animals from nucleus breeding herds 405 animals (257 Swiss Landrace-SL- and 148 Swiss Large White-SLW-pigs) were considered in the genetic evaluation.

The animals passed through the full sib testing program at the Swiss Pig Performance Testing Station. They were kept in groups of two gilts and two castrates under standardised conditions and ad libitum feeding (25-103 kg liveweight) until delivery to the slaughter-house. Management and feeding conditions are explained in detail in the annual report 1984 of the Testing Station (Rebsamen et al. 1985). Feed was under control especially with regard to the constancy of the fatty acid composition.

From each animal fat from 4 localisations (backfat: outer and inner layer, bell, leaf; time of fat collection 26 h p.m.) was analysed at the Federal Institute of Technology on 13 different fatty acids. Fatty acid composition was obtained by gaschromatographic analysis.

Fattening and also slaughtering performances were considered. Dissection of the left carcase was done 26 h p.m. Carcase judging included the evaluation of premium cuts (loin + ham + shoulder) and superficial fat (loinfat + hamfat + shoulderfat). Proportions are calculated as percentage from the cooled carcase.

Meat quality was evaluated as follows:

pH_1 45 min p.m., loin pH-Meter (Wintion 11.)

Reflectance 26 h p.m., loin EEL 2000 Unig Readout, EEL 11 Reflectometer MK_3 Head

Obj. meat quality score: Score, including pH_1, pH_{30} and reflectance.

The data were analysed by analysis of variance (Harvey 1976) and corrected according to model 1:

$$Yij = \mu + G_i + b\,(SG_{ij} - \overline{SG}) + e_{ij} \quad \text{(model 1)}$$

where Y_{ij} = trait of the j^{th} animal, μ = least square mean, G_i = effect of the i^{th} sex (fixed), $b(SG_{ij}-\overline{SG}$ = correction for carcase weight as a regression and e_{ij} = random error.

Heritability estimates and genetic correlations were estimated by paternal half sib correlations. To estimate the genetic parameters, model 2 was used after correcting the data by model 1.

$$Y_{ijkl} = \mu + R_i + S_{ij} + D_{ijk} + e_{ijkl} \quad \text{(model 2)}$$

where Y_{ijkl} = trait of the l^{th} animal, μ = least square mean, R_i = effect of the race i (fixed), S_{ij} = effect of the j^{th} boar within the race i (random), D_{ijk} = effect of the k^{th} sow which was mated to the boar j of the race i (random) and e_{ijkl} = random error.

Heritability estimates are obtained from the following formula:

$$h^2s = \frac{4\,\delta^2 s}{\delta^2 p}$$

Standard errors of heritabilities were calculated according to Graybill and Robertson (1957). Phenotypic

Table 1: Fattening and slaughtening traits (LSQ-mean, standard error). 405 animals.

	LSQ-Mean	SE
Daily gain (25-103 kg) (g)	838	5.4
Lean tissue growth rate (g)	355	2.6
Rest growth rate (g)	482	3.4
Slaughter weight (kg)	101.9	2.9
Superficial fat (%)	15.36	0.15
Premium cuts (%)	53.17	0.20
pH1	5.94	0.02
Reflectance (Unigalvo)	32.87	0.26
Obj. meat quality score	3.48	0.05

Table 2: Fatty acid composition (%) of pork fat, according to localisation. 405 animals.

	Backfat Outer layer		Backfat Inner layer		Belly		Leaf	
	LSQ-Mean	SE	LSQ-Mean	SE	LSQ-Mean	SE	LSQ-Mean	SE
C 16:0	23.19	.09	24.16	.09	24.19	.08	26.75	.08
C 18:0	12.14	.09	14.86	.10	13.24	.09	18.13	.12
C 18:1	40.87	.13	39.41	.14	41.40	.13	37.87	.15
C 18:2	14.01	.10	12.75	.10	11.82	.09	9.60	.10

Table 3: Significance of several effects on fatty acids of pork fat, according to localisation.

		Race	Sex	Slaughterweight
C 16:0	Backfat			
	Outer layer	***	***	n.s.
	Backfat Inner layer	***	***	n.s.
	Belly	***	***	n.s.
	Leaf	***	***	n.s.
C 18:0	Backfat			
	Outer layer	n.s.	***	n.s.
	Backfat Inner layer	*	***	n.s.
	Belly	**	n.s.	n.s.
	Leaf	n.s.	n.s.	*
C 18:1	Backfat			
	Outer layer	***	n.s.	n.s.
	Backfat Inner layer	***	n.s.	n.s.
	Belly	***	***	**
	Leaf	***	***	n.s.
C 18:2	Backfat			
	Outer layer	***	***	n.s.
	Backfat Inner layer	***	***	n.s.
	Belly	n.s.	***	n.s.
	Leaf	n.s.	***	n.s.

n.s. = not significant
* = $p < 0.05$
** = $p < 0.01$
*** = $p < 0.001$

Table 4: Phenotypic correlations between the linoleic-acid and fattening and slaughtering traits, according to localisation. 405 animals.

	Fatty acid C 18:2			
	Localisation			
	Backfat Outer layer	Backfat Inner layer	Belly	Leaf
Daily gain	-.29 ***	-.21 ***	-.27 ***	-.29 ***
Lean tissue growth rate	-.01 n.s.	.10 *	.05 n.s.	.02 n.s.
Rest growth rate	-.44 ***	-.39 ***	-.45 ***	-.46 ***
Superficial fat	-.54 ***	-.60 ***	-.61 ***	-.59 ***
Premium cuts	.52 ***	.58 ***	.59 ***	.56 ***
pH1	-.09 n.s.	-.06 n.s.	-.05 n.s.	-.12 *
Reflectance	-.04 n.s.	-.04 n.s.	-.03 n.s.	.06 n.s.
Obj. meat quality score	-.08 n.s.	-.06 n.s.	-.06 n.s.	-.14 **

Table 5 : Genetic correlations between linoleic-acid and fattening and slaughtering traits, according to localisation. Standard errors in brackets (s_{r_g}). 405 animals.

	Fatty acid C 18:2			
	Localisation			
	Backfat Outer layer	Backfat Inner layer	Belly	Leaf
Daily gain	-.43 (.27)	-.08 (.26)	-.29 (.32)	.01(.29)
Lean tissue growth rate	-.07 (.21)	.17 (.21)	.15 (.25)	.46(.25)
Rest growth rate	-.64 (.34)	-.29 (.31)	-.63 (.42)	-.42(.38)
Superficial fat	-.54 (.28)	-.48 (.30)	-.78 (.40)	-.84(.39)
Premium cuts	.45 (.16)	.41 (.17)	.68 (.15)	.84(.13)
pH1	-.77 (.55)	-.38 (.47)	-.42 (.54)	-.41(.55)
Reflectance	-.08 (.32)	-.07 (.33)	-.28 (.39)	-.21(.37)
Obj. meat quality score	-.45 (.41)	-.35 (.40)	-.06 (.44)	-.30(.47)

Table 6: Heritabilities (h^2's) and standard errors (s_{h2}) of fatty acids in porkfat, according to localisation.

	Backfat Outer layer		Backfat Inner layer		Belly		Leaf	
	h^2	s_{h2}	h^2	s_{h2}	h^2	s_{h2}	h^2	s_{h2}
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

Degrees of freedom: 1 race, 81 boars/race, 121 sows/boars/race, total 404

and genetic correlations between observations x and y are obtained from the following formulas:

$$r_{pxy} = \frac{\delta_{pxy}}{\delta_{px} \cdot \delta_{py}}$$

$$r_{gxy} = \frac{\delta_{sxy}}{\delta_{sx} \cdot \delta_{sy}}$$

Standard errors of phenotypic and genetic correlations were calculated according to Fisher (1956) and Robertson (1959). Only boars mated with at least 2 sows were accepted.

RESULTS

Fattening and slaughtering traits as also fatty acid composition of different fatty tissues are shown in table 1 and Table 2.

Between fat localisations are characteristic differences in the composition of fatty acids. The outer layer of the backfat shows the highest proportion of linoleic-acid, followed by the inner layer of the backfat, the belly and the leaf. The firmestdepot fat was in the leaf (more C 16:0 and C 18:0, less C 18:1 and C 18:2), the softest in the out layer of the backfat.

Influences of race and sex on fatty acids are for the most part of the fat localisations significant. Slaughter weight (in the evaluated range) is of no account as component variance (Table 3).

Correlations between the proportion of fatty acids in the examined localisations and the slaughtering performances are the closest, regarding the linoeic-acid. An increase in premium cuts or a decrease in the amount of superficial fat is followed by an increase in the amount of C 18:2 in the examined fatty tissues (Tables 4 and 5):

premium cuts /C18:2 rp: .54 to .59 rg: .41 to .84
superficial fat /C18:2 rp: -.54 to -.61 rg: -.48 to -.84

By improving daily gain, the amount of C 18:2 in the examined fatty tissues is decreasing (Tables 4 and 5):

daily gain /C18:2 rp: -.21 to -.29 rg: .01 to -.43

Heritability estimates of fatty acids in pork fat are shown in Table 6. The values for the C 18:2 of the examined fatty tissues are between $h^2 = 0.40$ ($s_{h2} = 0.23$) and $h^2 = 0.64$ ($s_{h2} = 0.25$).

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