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Effects of dietary fat of different sources on growth and slaughter performance as well as on fatty acid pattern of backfat and intramuscular fat of pigs differing in their genetic construction.

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1. Introduction

Selection of superior genotypes has been almost exclusively for growth parameters and carcass quality with lean meat production as the major selection criterion. However, the decreased fat content in the carcass is associated with a reduced intramuscular fat content, which is regarded to contribute substantially to meat quality. The optimal concentration is widely accepted to be in the range between 1.5 and 2.0% in the M. long. dorsi, but in modern genotypes the concentration is sometimes analysed to be 1% only. Additionally, the fatty acid profile contributes to carcass quality. The genetic construction of the modern genotypes and feeding strategies are recognized as starting-points for improvement. To deal with the effectiveness of both parameters a combined feeding/digestibility study completed with slaughter investigations was designed to test the effect of different fat sources as feed supplements on growth and slaughter performance of progeny from different sire lines as well as on the transfer of the dietary fatty acids into the intramuscular fat and backfat.

2. Experimental

The experiment was conducted with 48 castrated males and 48 females coming from one piglet production unit. They were progeny of BHZP sows mated to Duroc, Hamshire x Duroc or BHZP (Pietrain x Hamshire) boars.
One standard diet was fed over the whole growing-finishing period between 30 – 120 kg live weight, which only differed in the fat source. Dietary treatments were supplements of tallow, olive oil, soybean oil or linseed oil, which were incorporated in the diet at a level of 2.5%. The diets were formulated meeting the nutritional requirements according to the guidelines published by the GfE (1997).

Table 1: Composition and feeding value of the experimental diets

Fat source		Tallow	Olive	Soybean	Linseed
Wheat	%		43.0		
Barley	%		32.0		
Soybean meal	%		19.5		
Dietary Fat	%	2.5	2.5	2.5	2.5
Premix (Min.-Vit. AA)	%		3.0		
ME*	MJ/kg	13.54	13.62	13.68	13.61
Lysine/ME	g/MJ	0.76	0.74	0.73	0.74

* as determined in digestibility experiments

The feeding regime was a restricted scale for all groups starting with 17 MJ ME/d at 30 kg and limiting with 38 MJ/ME at 80 kg live weight, corresponding to 2.5–3.0 maintenance requirements.

The official VDLUFA methods were applied to analyse the chemical composition and the digestibility of the experimental diets as well as the fat and fatty acids in the various tissues of the carcass (Naumann and Bassler, 1999). The sensorial properties of the M. long dorsi were analysed by a taste panel (6 persons) after grilling the deep-frozen samples to a temperature of 75°C in the centre. Data were subjected to variance analysis applying a 2-factorial design for the treatments "sire breed" and "dietary fat source", using the GLM-package of SAS/SAT version 6.12.

3. Results and discussion

Due to the supplements of the different fat sources, which varied in their fatty acid profile, high concentrations of $C_{18:0}$, $C_{18:1}$, $C_{18:2}$, $C_{18:3}$ fatty acids were realized in the experimental diets. The data shown in Table 2 assume the portion of glycerine in the ether extract to be 10% (Kratz, 2003).

Table 2: Fatty acid content in the experimental diets (g/kg air dried matter*)

Fat supplement	Tallow	Olive	Soybean	Linseed
Palmitic $C_{16:0}$	10.3	8.4	8.2	5.2
Stearic $C_{18:0}$	<u>3.9</u>	0.8	0.9	0.8
Oleic $C_{18:1}$	11.6	<u>18.6</u>	8.9	7.6
Linoleic $C_{18:2}$	11.9	13.3	<u>21.8</u>	15.3
Linolenic $C_{18:3}$	1.1	1.2	2.5	<u>11.4</u>
PUFA	13.0	14.5	24.3	26.7

* 88% dry matter

The data obtained for growth and slaughter performance which are arranged according to the two treatments are summarized in Table 3.

Table 3: Results of growth and slaughter performance

		Daily weight gain/g	Energy conversion MJ ME/kg LWG	Lean meat percentage %	Meat : fat 1:
Sire line	Du	889^{a}	34.32^{b}	58.1	0.413
	Ha x Du	863^{b}	35.16^{ab}	58.7	0.410
	Pi x Ha	856^{b}	35.64^{a}	58.8	0.422
Fat source	Tallow	856	35.40	59.2	0.395
	Olive	863	35.46	58.5	0.409
	Soybean	884	34.45	58.8	0.406
	Linseed	876	34.82	57.0	0.448

Mean values in the same column not followed by the same superscript are significantly different ($p < 0.05$)

The results demonstrate a significant effect of the sire breed on growth performance, but the fat source did not show a significant influence on growth and slaughter performance, what was expected.

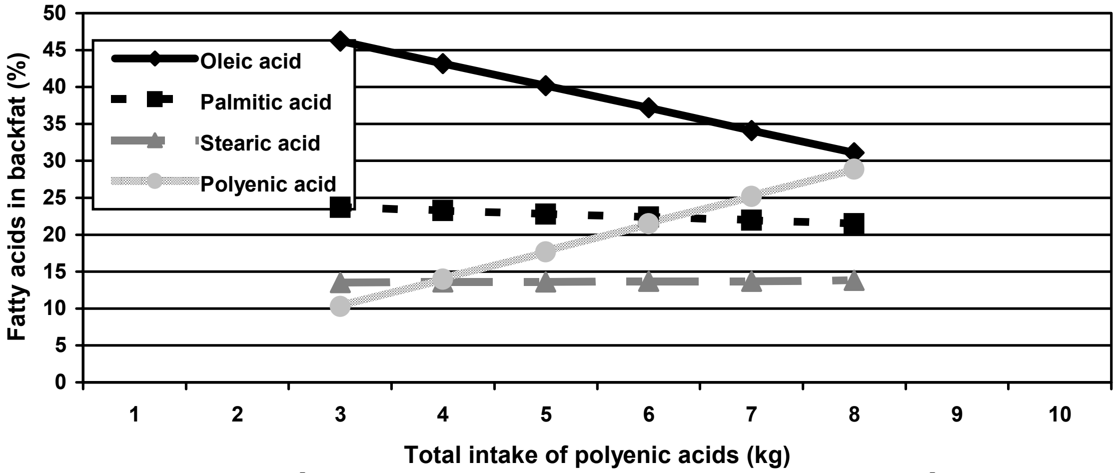
However, as outlined in Table 4, progeny of Du-sires showed higher portions of linoleic and linolenic acids at the expense of palmitic and oleic acid in backfat. However, the maximal difference of polyunsaturated fatty acids due to the genetic construction was found to be 1.7 %U only. Compared to this, the fat source was observed to influence the fatty acid profile in the back fat even higher.

Table 4: The fatty acid profile of back fat from pigs differing in their genetic construction and fed different fat sources

Fatty acid		Palmitic	Stearic	Oleic	Linoleic	Linolenic	PUFA
Sire line	Du	22.9^{ab}	13.9	40.9^{b}	12.1^{a}	3.3^{a}	15.4^{a}
	Ha x Du	22.7^{b}	13.7	40.9^{b}	12.7^{a}	3.3^{a}	16.0^{a}
	Pi x Ha	23.4^{a}	13.2	42.0^{a}	11.4^{b}	2.9^{b}	14.3^{b}
Fat source	Tallow	24.7^{a}	14.6^{a}	44.6^{b}	8.2^{d}	0.7^{c}	8.9^{c}
	Olive	22.7^{b}	12.3^{b}	48.3^{a}	9.3^{c}	0.7^{c}	10.0^{c}
	Soybean	22.7^{b}	13.7^{a}	36.5^{c}	18.8^{a}	1.8^{b}	20.6^{d}
	Linseed	22.0^{b}	13.8^{a}	35.6^{c}	11.9^{b}	9.5^{a}	21.4^{d}

Mean values in the same column not followed by the same superscript are significantly different ($p < 0.05$)

The extent to which mono-and polyunsaturated fatty acids are incorporated in the backfat depends principally on their intake, but displacement effects can be also observed (Fig. 1).



$C_{18:1}$ y=-3.04x+55.4 R^2=0.74 $C_{18:0}$ y=0.0483x+13.4 R^2=0.003
$C_{16:0}$ y=-0.433x+25 R^2=0.22 $C_{18:2,3}$ y=3.73x-0.910 R^2=0.85

Figure 1:The fatty acid profile of back fat of slaughter pigs as related to the intake of polyenic fatty acids

The regression analysis shows in detail that an additional intake of 1 kg polyenic fatty acids during the whole growing-finishing period results in an additional increase in back fat of 3.73 %U. The percentage of palmitic acid decreases slightly and that of stearic acid remains unaffected, whereas the oleic acid percentage almost decreases to the same extent as the polyenic acids increase.

The analysis of the M.long dorsi data for intramuscular fat resulted in a substantial effect of the "sire line", although not significant. Using boars of Du or Du x Ha, increases the intramuscular fat content by 0.37 %U as compared to Pietrain x Hamphire boars, what is in accordance with observations of Glodek (1996) and Laube (2000). Additionally, a significant effect of the sire line on the fatty acid profile was detected, especially on the percentage of stearic and linolenic acid (Table 5).

Table 5: Intramuscular fat content (IMF) and fatty acid profile in the M.long dorsi of pigs, differing in their genetic construction and fed different fat sources.

		IMF	Fatty acids (in % of total fatty acids)			
		%	Stearic	Oleic	Linoleic	Linolenic
Sire line	Du	1.47	13.0[a]	41.5	8.4[b]	1.1
	Ha x Du	1.45	12.2[ab]	41.7	11.6[a]	1.1
	Pi x Ha	1.09	11.7[b]	39.6	12.4[a]	1.2
Fat source	Tallow	1.41	11.8	42.3[ab]	8.9[b]	0.3[c]
	Olive	1.29	12.1	44.3[a]	9.5[b]	0.3[c]
	Soya	1.08	12.3	38.0[c]	13.9[a]	0.6[b]
	Linseed	1.36	12.8	39.2[bc]	10.6[b]	3.5[a]

Mean values in the same column not followed by the same superscript are significantly different ($p < 0.05$)

The transfer of dietary fatty acids into the intramuscular fat was found to be not so distinctly as into back fat. The content of saturated fatty acids in the M. long dorsi remained unaffected. The mono- and polyenic fatty acids were influenced in the same direction as in backfat, but the effect was less pronounced. The fatty acids dominating in the various dietary fat types are apparently deposited more excessively in back fat than in muscular tissue. The percentage of polyenic fatty acids in the M. long. dorsi was also linearly correlated with their intake, but the coefficient was found to be only R^2=0.32. On average, an additional content of 1g polygenic acids in 1 kg diet increased their concentration in the intramuscular fat by 0.43% U.
Data analysis of the sensorial traits of the M. long. dorsi, as shown in Table 6, resulted in a significant effect of the sire line and the dietary fat source as well.

Table 6: Sensorial traits of the M. long. dorsi of pigs, differing in their genetic construction and fed different fat sources

		Juiciness	Tenderness	Flavour
Sire line	Du	2.7^{b}	3.0^{b}	2.8
	Ha x Du	3.0^{ab}	3.6^{ab}	2,9
	Pi x Ha	3.3^{a}	3.8^{a}	2.9
Fat source	Tallow	3.1	3.7	3.2^{a}
	Olive	3.0	3.6	3.1^{a}
	Soybean	2.9	3.3	2.9^{a}
	Linseed	2.8	3.3	2.3^{b}

1= lowest; 6= highest score (optimal quality)

Mean values in the same column not followed by the same superscript are significantly different ($p < 0.05$)

The sire line was analysed to influence juiciness and tenderness, indicating that increasing the portion of Du in progeny influences these parameters negatively. The dietary fat type showed a significant effect only on flavour. The loin of pigs fed tallow or olive oil were tested to be superior compared to those from pigs fed soybean- or linseed oil. However, a direct relationship between fatty acid pattern and sensorial quality traits was not detected.

4. Conclusions

From this study the following conclusions can be drawn:

- As a restricted feeding system was applied the influence of the “sire line” on growth and slaughter performance was limited

- Progeny with a higher portion of Du in their genetic construction showed a tendency towards increased contents of intramuscular fat. The effect of the sire line on the fatty acid profile was found to be low only although significant for some fatty acids.
- The content of polyenic fatty acids in the carcass of pigs can be increased, independently from their genetic construction, by feeding because the correlation to the intake is very high.
- Feeding olive oil results in an increase oleic acid in the carcass and a decrease of saturated fatty acids, while the concentration of polyenic acids remains low.
- For all genetic constructions the intramuscular fat content was found to be low. On this level the influence on sensorial parameters was found to be limited only.
- The fat source affected only the flavour of meat significantly.

5. References

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