Institute of Organic Farming

F. Weißmann
G. Biedermann
A. Klitzing

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Performance, carcass and meat quality of different pig genotypes in an extensive outdoor fattening system on grass clover in organic farming

F. Weissmann[1], G. Biedermann[2] and A. Klitzing[2]

Introduction

Until now there have only been a few examples in organic livestock production where fattening pigs have been integrated as a part of the crop rotation. Outdoor keeping on grass clover in the crop rotation could be an interesting solution in terms of animal welfare, environmental aspects and economic performance (Weissmann, 2003). The objective of the present study was an estimation of different genotypes under extensive fattening conditions in an organic outdoor system in respect of some aspects of fattening performance and carcass and meat quality.

Materials and methods

The trial took place at the experimental organic farm of the Institute of Organic Farming of the Federal Agricultural Research Centre in Trenthorst, Germany. The whole farm and the keeping and feeding system of this trial are in accordance with Regulation 2092/91/EEC and IFOAM Basic Guidelines.

Keeping

The fattening period was divided into an outdoor and an indoor period. The outdoor period lasted from 12th May to 21st October 2003. A total of 5.2 ha of grass clover were divided into 4 paddocks with the aid of solid and flexible pens. The fattening pigs were offered 3 wooden huts (3 m x 4 m) with an adjustable awning between two huts and wallows in a rotational grazing system. The 4 paddocks were linked with a feeding paddock where weighing also took place. The indoor period lasted from 21st October to 11th November 2003. The remaining fattening pigs were housed in a loose house with deep litter.

All the fattening pigs were kept together in a single group during the fattening period.

Feeding

The feeding ration consisted of coarse meal made up of farm grown cereals and grain legumes with an intended content of 12.5 MJ ME and 145 g crude protein per kg air dried matter. No optimisation was carried out concerning the amount of the amino acids Lysin and Methionin and their relation to the energy content. Neither supplementary mineral feed nor vitamins were offered.

All animals had simultaneous access to wooden troughs and were manually fed. The daily amount of feed was calculated in accordance with the feeding standards of the *Deutsche Landwirtschafts-Gesellschaft* (DLG, 1991) for an intended level of about 600 g daily weight gain. Grass clover was offered *ad libitum* but not taken into consideration either in terms of consumed amount or of feed quality.

Drinking water was offered *ad libitum* in both periods.

Animals

A total of 60 fattening pigs of different genotypes and sex were kept (Tab. 1).

Each of the 5 genotypes came from a different farm. The genotypes Pi x GLW x GLR, Pi x Du x GLR and Pi x AS were of organic origin whereas the genotypes Du x GLR and Du derived from conventional farms. Du x GLR were male siblings of crossbreed sows whereas Du were castrates not used as sires in crossbreeding programs. Therefore the allocation of sex was inhomogeneous.

Deworming of all fattening pigs took place around time of delivery. Bulk faeces samples were obtained for inspection of endoparasites 3 times during the fattening period. On the day of delivery all animals received a first vaccination against swine erysipelas (diamond-skin disease) which was repeated 4 weeks later.

Experimental design and analysis

The fattening period started on the day of delivery (May 12th 2003) when all animals came on grass clover, and ended indoor on 11th November 2003 with slaughter of the last 3 animals the next day.

Initial live weight (LW) ranged between 27 kg LW and 45 kg LW. Slaughtering was intended at 115 kg LW and ranged between 109.5 kg LW and 125.0 kg LW. All animals were individually marked with electronic ear tags.

Every 4 weeks all the animals were weighed with an electronic pig scale in the feeding paddock. After the weighing, the daily amount of feed was revised if necessary. When the first pig reached its slaughter maturity, weighing occurred each Tuesday morning to determine animals for slaughter (> 114kg LW) and the final live weight for the calculation of the daily weight gain. Those pigs came indoors with feed withdrawal in the afternoon but with *ad libitum* access to drinking water.

[1] Federal Agricultural Research Centre, Institute of Organic Farming, D-23847 Westerau, Germany, Email: friedrich.Weissmann@fal.de
[2] University of Kassel, Department of Animal Breeding, D-37213 Witzenhausen, Germany

Table 1: Allocation of genotypes and sex (n)

Sire	Dam (sire x dam)	Notation	Castrates	Females	Total
Pietrain	German Large White x German Landrace	Pi x GLW x GLR	3	7	10
Pietrain	Duroc x German Landrace *	Pi x Du x GLR	10	10	20
Pietrain	Angler Saddleback	Pi x AS	7	3	10
Duroc *	German Landrace *	Du x GLR	10	- -	10
Duroc	Duroc	Du	10	- -	10

* Sow of genotype Du x GLR is a *Schaumann*® breeding product

On Wednesday morning pre-slaughter fattening pigs were weighed once more in order to determine both live weight loss and dressing rate, and in order to fix the individual carcass identification (numeral punch). The subsequent transport to the abattoir of about 20 min was carried out by the personnel of Trenthorst. The resting period at the abattoir was 45 min to 60 min.

Slaughtering took place in a commercial abattoir (Nordfleischzentrale Lübeck) after CO_2 stunning. Determination of PSE-status (pH_{45} between the $13^{th}/14^{th}$ rib), weighing, and carcass classification by FOM (Fat-O-Meater) was about 45 min after slaughter according to commercial procedures.

On Thursday the data on carcass and meat quality were collected according to the routine of the *Deutsche Leistungsprüfungsanstalten* (ZDS, 2000). Neither the determination of intramuscular fat content nor the determination of sensory meat quality are part of these procedures.

The present paper deals with the following aspects of fattening and carcass performance:

- Fattening performance: Daily weight gain, feed conversion ratio, live weight loss
- Carcass performance:
  - Carcass quality: Dressing rate, lean meat content (FOM)
  - Meat quality: PSE-status (pH_{45}), meat colour (meat lightness by *optostar*)

The feed conversion ratio was calculated over all fattening pigs as the total amount of feed in relation to the total amount of body weight gain.

The measurement of meat colour took place by *optostar* 24h p.m. at the 13^{th} rib (*M.l.d.*) of the dried cut about 5 min to 10 min after cutting (ZDS, 2000).

Statistical procedures

SPSS 12.0 for Windows was used for statistical analysis.

Statistical analysis for daily weight gain (dwg) follows the model:

$$Y_{ijk} = \mu + \overline{GEN_i} + SEX_j + (GEN \times SEX)_{ij} + b_1 (LWB_{ijk} - \overline{LWB}) + b_2 (LWE_{ijk} - \overline{LWE}) + e_{ijk}$$

Statistical analysis for lean meat content (lmc), PSE-status (pse) and meat colour (mc) follows the model:

$$Y_{ijk} = \mu + GEN_i + SEX_j + (GEN \times SEX)_{ij} + b_3 (CW_{ijk} - \overline{CW}) + e_{ijk}$$

where

Y_{ijk}	observation variable: dwg, lmc, pse, mc
μ	overall mean
GEN_i	fixed effect of the i th genotype (i = 1, 2, 3, 4, 5)
SEX_j	fixed effect of the j th sex (j = 1, 2)
$(GEN \times SEX)_{ij}$	interaction genotype i * sex j
b_1 , b_2 , b_3	linear regression coefficient on LWB, LWE, CW, respectively
LWB_{ijk}	live weight of the k th animal at the beginning of the fattening period
$\overline{LWB}$	average live weight at the beginning of the fattening period
LWE_{ijk}	live weight of the k th animal at the end of the fattening period
$\overline{LWE}$	average live weight at the end of the fattening period
CW_{ijk}	carcass weight of the k th animal
$\overline{CW}$	average carcass weight
e_{ijk}	random error

Results and discussion

Tab. 2 shows the results of the feed analysis. There were two different types of concentrates which dif-

fered in the fraction of grain legumes due to the lack of field beans. Feed A was offered from May until August, feed B was offered from August until the end of the trial. On the occasion of feed preparation about every 10 days, an aliquot retain sample was gained and collected to create an aliquot bulk feed sample for feed A and B respectively.

Table 2: Characterisation of concentrates

I t e m	Feed A May – Aug.	Feed B Aug. – Nov.
n	1	1
C o m p o s i t i o n		
Winter wheat, %	70	70
Field pea, %	15	30
Field bean, %	15	- -
C o n t e n t s		
Dry matter (DM), g / kg	888	888
Metabolizable energy, MJ / kg DM	15.5	15.9
Crude protein, g / kg DM	151	146
Lysin, g / kg DM	8.1	8.1
Methionin, g / kg DM	1.8	2.0
Crude fibre, g / kg DM	43	36

Data show that the intended contents of ME and CP were almost achieved. On the basis of the contents of Lysin and Methionin, especially in the first period (May – August), neither outstanding growth rates nor augmented lean meat contents were to be expected.

In spite of the extremely sunny and warm summer there were no problems with sunburn. It is particularly remarkable that even the genotypes without pigmentation such as Pi x GLW x GLR, Pi x Du x GLR, and Du x GLR had no problems even at the very sensitive back of the ear. First of all it seems to be an effect of the fully functional and well-accepted wallows (Laister, 2002).

In an analogous fattening trial in 2002 at Trenthorst there were severe problems with sunburn due to the lack of functional wallows (Weissmann, 2002).

During the whole fattening period there were no problems with endoparasites. All bulk samples of faeces and the autopsy of two animals (see below) showed negative results. This is a main effect of deworming and of keeping on grass clover as an unaffected part of the crop rotation, where (re)contamination seems impossible (Weissmann, 2003). This moving of grass clover and animals for many years within crop rotation over the land is completely contrary to outdoor keeping on permanently stocked areas such as pasture or paddocks adjacent to the stable, even when they are divided and stocked at temporal intervals.

Three animals were lost. Two pigs (Du x GLR, Du) had to be emergency slaughtered a short time after the second vaccination against diamond-skin disease due to severe joint problems. The subsequent autopsy diagnosed swine erysipelas with severe injuries of different joints. No endoparasites were found. A third animal (Du x GLR) was lost at the end of the fattening period due to an accident with a tractor.

Thus a total of 57 animals were analysed for fattening performance, lean meat content and PSE-status. Due to the disappearance of one carcass (Du x GLR) subsequent to classification, 56 carcasses remained for analysis of meat colour.

Fattening performance

A survey of selected characteristics of fattening performance gives Tab. 3.

Table 3: Aspects of fattening performance (n = 57)

I t e m	Mean	SD	SD%
Initial live weight, kg	36.6	5.1	14.0
Final live weight, kg	116.4	3.6	3.1
Live weight loss, %	2.2	1.4	62.5
Feed/meat conversion ratio, kg/kg	5.1		
Fattening period, d	156.6	15.7	10.0

Initial live weights showed a huge variation. Consequently a requirement satisfying individual feed offer was more or less impossible. Apart from this, trough feeding provoked evident feed losses (the amount was not measured!). On the basis of these findings, the feed conversion ratio was very high (Tab. 3).

A mean fattening period of 157 days (Tab. 3) indicated an extensive fattening regime. The resultant daily weight gain was significantly ($p \leq 0.05$) influenced by initial and final live weight, genotype and sex (see statistic model). The consequent resultant values are shown in Tab. 4.

Tab. 4: Daily weight gain (g/d) in relation to genotype and sex

	Pi x GLW x GLR		Pi x Du x GLR		P i x A S		Du x GLR	Du
	Sows	Castrates	Sows	Castrates	Sows	Castrates	Castrates	Castrates
n	7	3	10	10	3	7	8	9
LSQ	484[b]	552[a]	475[b]	505[b]	475[b]	503[b]	578[a]	538[a]
S.E.	19	27	16	16	26	17	19	17

Different letters indicate significant differences at level $p \leq 0.05$

With a range between about 500 – 600 g daily weight gain, the data of Tab. 4 demonstrate an acceptable level of fattening intensity, i.e. daily weight gain was in accordance with an extensive outdoor fattening regime. Among the feed and feeding associated effects, group size and the extremely warm summer period could have accounted for the existing level of daily weight gain (Bremermann, 2001).

The data also show the well-known superior fattening ability of castrates according to findings of e.g. Biedermann et al. (2000). Concerning the females there were no differences between rather intensive genotypes like Pi x GLW x GLR and Pi x Du x GLR or the rather extensive genotype Pi x AS.

Carcass quality

In Germany the full price is paid in the range of 84 kg - 100 kg carcass weight according to corresponding classification (lean meat content). Data (Tab. 5) show that some of the carcasses failed to meet this economically important lower limit of 84 kg.

Tab. 5: Aspects of carcass quality (n = 57)

I t e m	Mean	SD	SD%
Carcass weight, warm, kg	86.6	3.4	4.0
Dressing rate, %	76.1	1.8	2.4

The mean dressing rate of 76 % (Tab. 5) was below the level of around 80 % which is common in intensive concentrate-rich fattening systems. This indicates that on the one hand the offer of grass clover could have led to an augmented development of the intestinal tract and on the other hand that more adipose carcasses provoke augmented cuts of adipose tissues. During the cuts for classification mainly abdominal and pelvic fat is removed. This last mentioned interpretation is supported by the data concerning the lean meat content of the fattening pigs (Tab. 6).

Tab. 6: Lean meat content (%) in relation to genotype and sex

	Pi x GLW x GLR		Pi x Du x GLR		P i x A S		Du x GLR	Du
	Sows	Castrates	Sows	Castrates	Sows	Castrates	Castrates	Castrates
n	7	3	10	10	3	7	8	9
LSQ	54.8[a]	50.6[bcf]	54.3[a]	50.6[bc]	52.8[ac]	48.6[be]	47.5[de]	48.2[def]
S.E.	0.8	1.3	0.7	0.7	1.3	0.8	0.8	0.8

Different letters indicate significant differences at level $p \leq 0.05$

The data of Tab. 6 show rather poor lean meat contents compared with carcass-quality dominated intensive fattening systems. However, the findings were basically congruent with the chosen fattening intensity and the fact of the dominance of castrates, mainly of the last three genotypes.

The significantly higher lean meat content of Pi x GLW x GLR and Pi x Du x GLR emphasises the superiority of the carcass quality of specialised modern fattening crossbreed genotypes, especially with Pietrain as sire (Biedermann et al., 2000). It was not astonishing that less intensive old breeds

such as saddleback pigs, even crossed with Pietrain, showed worse results (Pi x AS). Du x GLR and purebred Duroc, particularly as castrates, showed insufficient carcass quality due to their role as mating partners in crossbreeding.

On the other hand, as shown in Tab. 6, augmented lean meat contents of the first two genotypes were due to the presence of sows in these groups. Sows have a higher protein synthesis rate than castrates and this causes higher lean meat contents (Volk, 2003).

Meat quality

Meat quality was described in terms of PSE-status (measured as pH_{45}) and meat colour (measured as meat lightness by means of *optostar*) as seen in Tab.7. Due to homogeneous allocation, the presentation of data was not divided for females and castrates.

Tab. 7: Aspects of meat quality in relation to genotype

	Pi x GLW x GLR	Pi x Du x GLR	Pi x AS	Du x GLR	Du
PSE-status (pH_{45}) of M.l.d. ($13^{th}/14^{th}$ rib)					
n	10	20	10	8	9
LSQ	6.3^{a}	6.4^{ab}	6.5^{b}	6.4^{ab}	6.4^{ab}
S.E.	0.1	0.1	0.1	0.1	0.1
Meat colour (meat lightness by *optostar*) of M.l.d. (13^{th} rib)					
n	10	20	10	7	9
LSQ	68.8^{a}	70.5^{a}	68.1^{a}	70.2^{a}	77.4^{b}
S.E.	2.1	1.5	2.1	2.6	2.6

Different letters indicate significant differences at level $p \leq 0.05$

There were no PSE problems on the basis of pH_{45}. This finding was in accordance with the measurement of electrical conductivity (EC) 24h p.m. (results not presented). Values of pH_{45} and EC_{24} of M.l.d. for exclusion because of PSE suspicion are < 6.0 and ≥ 6.00 respectively (Weissmann und Honikel, 1998). High *Optostar* values stand for dark-coloured meat, low values for light-coloured meat. Values below 60 indicate susceptibility for PSE, values above 80 are associated with DFD conditions (ZDS, 2000). The data in Tab. 7 represent the favoured range of meat lightness as reported by Haas et al. (1997). For the genotype Duroc, a higher value i.e. relatively dark meat colour and slightly augmented pH_{24} is normal and not necessarily associated with DFD (Laube, 2000). There were no DFD-cases (pH_{24} > 6.0; Fischer, 2001) of M.l.d. and ham with pH_{24} of 5.53 ± 0.08 (5.37 – 5.72) and 5.57 ± 0.08 (5.44 – 5.91) respectively (detailed results not presented).

Conclusion

According to the extensive feeding regime, the fattening performance was characterised by acceptable daily weight gains (castrates quite high, sows quite low) but an unacceptable feed conversion ratio.

The carcass quality showed inconsistencies: whereas the lean meat content of castrates was definitely too low, the sows showed good to acceptable lean meat contents in relation to the capacities of intensive and extensive genotypes respectively.

The meat quality in terms of PSE-status and meat colour showed good results for all genotypes and sexes.

To achieve a better congruence between fattening and carcass performance it is concluded that the feeding strategy could easily be enhanced by (slightly) higher contents of grain legumes and by phase-associated feeding in terms of protein-energy-content and the amount of feed. A separation of castrates and sows could be advantageous.

The analysis of intramuscular fat content and sensory meat quality will show whether these findings are of such an outstandingly high value that they can justify and compensate adipose carcasses as these cannot be sold in marketing systems which rely almost exclusively on quantitative carcass qualities such as lean meat content.

References

Biedermann G, Jatsch C, Peschke W, Lindner JP, Wittmann W (2000) Mast- und Schlachtleistung sowie Fleisch- und Fettqualität von Pietrain-Schweinen unterschiedlichen MHS-Genotyps und Geschlechts. Arch Tierz 43(1):151-178

Bremermann N (2001) Vergleichende Untersuchungen zur Gesundheit, Mastleistung und Fleischqualität von Schweinen in der Stall- bzw. Freilandhaltung. Dissertation. Freie Universität Berlin

DLG (1991) DLG-Futterwerttabellen – Schweine. Frankfurt: DLG-Verlag, pp 18, ISBN: 3-7690-0484-1

Haas B, Hoppenbrock KH, Adam F (1997) Warentest für Mastferkel – 1997. Münster: Landwirtschaftsverlag GmbH, Schriftenreihe Warenteste, Heft 2

Fischer K (2001) Bedingungen für die Produktion von Schweinefleisch guter sensorischer und technologischer Qualität (Conditions for the production of pork with high sensory and technological quality). Mitteilungsblatt BAFF Kulmbach 40(151):7-22

Laister S (2002) Mastschweine-Freilandhaltung: Vergleich verschiedener genetischer Herkünfte unter besonderer Berücksichtigung des Verhaltens. Diplomarbeit. Universität für Bodenkultur Wien

Laube S (2000) Die Eignung spezieller Schweinekreuzungen zur Qualitätsverbesserung von Markenschweinefleisch unter besonderer Berücksichtigung von MHS-Status, Hampshirefaktor und intramuskulärem Fettgehalt. Dissertation. Tierärztliche Hochschule Hannover

Volk B (2003) Einfluss der genetischen Herkunft auf die Mast- und Schlachtleistung, die Fleisch- und Fettqualität sowie das Fettsäuremuster der Phospholipide von Mastschweinen beiderlei Geschlechts bei unterschiedlicher Fütterungsintensität. Dissertation. Universität Kassel (Witzenhausen)

Weissmann F (2002) Unpublished data

Weissmann F (2003) Aspekte der Mast- und Schlachtleistung von Schweinen unterschiedlicher Genotypen in Freilandmast auf dem Fruchtfolgeglied Kleegras. In: Freyer B (ed) Ökologischer Landbau der Zukunft – Beiträge zur 7. Wissenschaftstagung zum Ökologischen Landbau. Wien: Universität für Bodenkultur, Institut für Ökologischen Landbau, pp 265-268, ISBN 3-900962-43-X

Weissmann F, Honikel KO (1998) Zur Frage einer Referenzmethode zum Ausschluss von PSE-Fleisch in der Wareneingangskontrolle. Mitteilungsblatt d. Bundesanstalt f. Fleischforschung 37(141):300-303

ZDS (2000) Richtlinie für die Stationsprüfung auf Mastleistung, Schlachtkörperwert und Fleischbeschaffenheit beim Schwein. Zentralverband der Deutschen Schweineproduktion, Bonn