

THE EFFECT OF BREED ON MEAT QUALITY CHARACTERISTICS IN PIGS

P.A. Barton-Gade, Danish Meat Research Institute, Maglegårdsvej 2, DK-4000, Roskilde, Denmark.

SUMMARY

Breed affected meat quality characteristics to a high degree. Landrace had the highest incidence of PSE- and DFD-meat, Duroc and Hampshire the lowest. Duroc pigs had by far the best eating quality. Shear force values were lower, sarcomeres longer and the intramuscular fat content higher than in the other breeds. Landrace had the best raw material for processed products - in spite of its higher PSE incidence. The protein and pigment content was higher than in Large White, Duroc and Hampshire and the intramuscular fat content was low. The difference in protein was such that processing yields in USA ham production were 0.6, 2.2 and 4.0% lower in respectively Large White, Duroc and Hampshire.

Thus, the breeds have some advantages and disadvantages with respect to meat quality and a crossbreed which is ideal for all purposes cannot be found. However, a knowledge of their meat quality differences opens up the possibility of matching the crossbreed to the product, ensuring optimum consumer satisfaction and profit for the industry. Crosses between Landrace and Large White are clearly best for processing, whereas the use of Duroc - and to a lesser degree Hampshire - as boar breed is best for fresh meat consumption.

INTRODUCTION

Four breeds are used in Denmark: Landrace, Large White, Duroc and Hampshire. Landrace is used mainly in the production of Landrace-Large White sows. Large White is also as a boar breed, while Duroc and Hampshire are only used as boar breed, sometimes alone, sometimes as a crossbreed boar. The breeds are known to be different with respect to meat quality (Barton-Gade, 1981) and the aim of this work was to investigate the pure breeds for meat quality, so that the optimal crossbreed for various productions could be ascertained.

METHOD

The experimental material consisted of 530 pigs from 3 of the progeny testing stations: 140 Landrace, 173 Large White, 142 Duroc and 75 Hampshire. Pigs were fed ad libitum to a live weight of about 90 kg increasing to 100 kg during the last 3 months of the experiment. All pigs received a standardised pre-slaughter treatment designed to provoke PSE in susceptible pigs (Barton, 1974) but with CO₂-stunning in the compact equipment. The pigs were sampled every week over the year concerned, i.e. October 1985 - September 1986.

All pigs were investigated for:

- probe values in *biceps femoris*, *semimembranosus* and *l.dorsi*
- ultimate pH-values in these 3 muscles and *semispinalis capitis*
- sol. sarcoplasmic-myofibrillar proteins in *b.femoris* and *l.dorsi*
- shear force value and % intramuscular fat in *longissimus*

Table 1. Meat quality characteristics in relation to breed

Average values (LS-means) with different superscripts are significantly different, *** = p < 0.001, ** = p < 0.01, * = p < 0.05.

Probe values: Higher values = poorer structure. **KK-index:** Values \geq 5.0 = acceptable quality. **Soluble sarcoplasmic and myofibrillar proteins:** Higher values = better structure. **Shear force values:** Higher values = tougher meat.

Description	Breed				Significance
	Landrace	Large White	Duroc	Hampshire	
No. of pigs	140	173	142	75	-
Daily gain, g	898 ^b	937 ^a	914 ^{ab}	864 ^c	**
% meat in side	65.4 ^a	65.9 ^a	63.6 ^b	65.7 ^a	***
KK - index	5.86 ^b	6.09 ^{ab}	5.89 ^b	6.52 ^a	*
Probe-biceps femoris	78.7 ^b	77.7 ^b	82.0 ^b	80.0	**
Probe-semimembranosus	73.2 ^b	72.2 ^b	73.3 ^b	64.7 ^a	***
Probe-long. dorsi	60.9 ^c	57.2 ^{bc}	55.0	45.6 ^a	***
Soluble prot.-b.femor.	0.173	0.172	0.171	0.168	
Soluble prot.-semimem.	0.177	0.178	0.177	0.174	
Soluble prot.-l.dorsi	0.172 ^{bc}	0.175 ^{ab}	0.179 ^c	0.175 ^a	***
pH ₂ -biceps femoris	5.53 ^{bc}	5.51 ^{ab}	5.56 ^c	5.47 ^a	***
pH ₂ -semimembranosus	5.60 ^c	5.56 ^b	5.54 ^b	5.47 ^a	***
pH ₂ -long.dorsi	5.48 ^a	5.49 ^a	5.57 ^b	5.51 ^a	***
pH ₂ -semispinalis cap.	5.98 ^b	5.94 ^b	5.86 ^a	5.82 ^a	***
Shear force - l.d.	87.7 ^b	95.4 ^c	71.1 ^a	90.9 ^{bc}	***
Sarcomere length -l.d.	1.79 ^b	1.81 ^{ab}	1.83 ^a	1.81 ^{ab}	*
% intram.fat - l.d.	1.58 ^a	1.59 ^a	3.21 ^c	1.86 ^b	***
% protein-semimemb.	21.77 ^a	21.62 ^a	21.24 ^b	20.76 ^c	***
% water-semimemb.	75.54 ^b	75.85 ^a	74.49 ^c	75.61 ^{ab}	***
% fat-semimembranosus	2.05 ^{ab}	1.90 ^a	3.50 ^c	2.24 ^b	***
% fat-b. femoris	1.65 ^b	1.50 ^a	2.98 ^d	1.98 ^c	***
Pigment-b. femoris	40.8 ^a	34.9 ^c	35.6 ^{bc}	37.2 ^b	***

dorsi

- % protein, % water and % fat in *semimembranosus*

- total pigment content and % intramuscular fat in *biceps femoris*

as described by Barton-Gade, (1987). In addition, daily gain, % meat in the side and KK-index (Barton-Gade and Olsen (1987) were obtained from the progeny test results.

The results were investigated using an analysis of variance (S.A.S., 1982). As the two pigs in a litter group cannot be considered as independent of one another, breed effect was tested against the variation between litter groups, as follows. The differences between the two sexes within a litter group was used to investigate the effect of sex. Then the sum of the litter results were used to investigate breed effect.

RESULTS

The results of the analysis of variance are shown in Table 1. Breed significantly affected most of the characteristics measured. Sex also had a significant effect on a number of characteristics, but this is not considered in this paper.

PSE-/DFD-status: Both probe values and soluble sarcoplasmic and myofibrillar proteins were used as an indication of PSE-status, the one measuring a limited area, the other an average of a 2 cm thick slice of the whole cross sectional area. Using probe values as a measure, differences were found for two of the muscles, *semimembranosus* and *longissimus dorsi*. Probe values were lowest (best) in Hampshire pigs. Landrace had the highest value in *longissimus dorsi*. The average values for soluble proteins were not significantly different for the breeds, but the PSE-incidence based on soluble proteins (values lower than 0.150 units) was different:

	Landrace	Large White	Duroc	Hampshire
l.dorsi	12.1	7.0	0	1.3
b.femoris	10.7	4.1	2.9	0
semimem.	5.7	2.9	1.4	0
pig	17.9	9.2	4.2	1.3

Landrace had the highest PSE-incidence, Hampshire the lowest. Figures are %PSE.

KK-index values, which are the three probe values combined, follow the PSE-incidence results very well with the exception of Duroc, which had a lower value than expected. The reason for this is that probe values are still slightly affected by intramuscular fat level, which is much higher in Duroc than in the other breeds.

Ultimate pH-values were in general lowest in Hampshire pigs. Duroc/Landrace had the highest value in *semimembranosus*, Duroc the highest in *longissimus dorsi*. Landrace/Large White had the highest value in *semispinalis capitis*. The incidence of higher than normal pH-values was, as could be expected with the short standardised pre-slaughter treatment used, rather low but followed the average values very well:

	Landrace	Large White	Duroc	Hampshire
%semimem. ≥ 580	7.9	2.9	1.4	0
%b.femoris ≥ 590	3.6	3.5	0.7	0
%l.dorsi ≥ 570	3.6	5.2	14.3	0
%semisp. capitis ≥ 630	10.0	4.1	0	1.3

Landrace had the highest incidence in *semimembranosus* and *semispinalis capitis*, Duroc the highest in *longissimus dorsi*, while only one Hampshire pig had higher than normal pH-values and then only in *semispinalis capitis*.

Overall, Landrace had the highest incidence of both PSE- and DFD-meat, followed by Large White. Duroc and Hampshire had very few pigs showing PSE-/DFD-meat.

Eating quality in *longissimus dorsi*: Shear force values are a direct measure of tenderness and correlate rather well with taste panel scores for tenderness for meat with a good water holding capacity. Large White had the highest average value and Duroc the lowest. Values of 100 correspond to the transition from acceptable to unacceptable tenderness and at 125 the meat is decidedly tough. The percentages above these limits showed that Large White and Hampshire were equally poor, Landrace intermediate and Duroc much better than the others:

	Landrace	Large White	Duroc	Hampshire
Shear force % > 100	32.1	37.0	10.8	41.3
% > 125	8.6	16.8	2.9	16.9

PSE-meat with an intramuscular fat content below 2% generally has an unacceptable eating quality, whereas non-PSE meat with sufficient marbling (2% and above) generally has an excellent eating quality. The percentages of pigs in these two categories confirmed the supremacy of Duroc:

	Landrace	Large White	Duroc	Hampshire
%PSE, fat < 2.0	9.3	5.8	0	0
%non-PSE, fat ≥ 2.0	10.7	17.9	93.5	32.0

It is perhaps a little surprising that Hampshire pigs have such high shear force values, considering that 32% had the ideal combination of meat quality and marbling. The reason for this probably lies in the fast chilling process used on many Danish abattoirs. Fast chilling can cause cold-shortening in susceptible pigs i.e. meaty pigs with a slow post mortem glycolysis (Barton-Gade et al., 1987). Hampshire pigs having only a low PSE incidence as well as a high meat content seem to be particularly susceptible. Cold shortening, however, must also have occurred in the other breeds.

Overall, Duroc has by far the best eating quality, whereas the other breeds are probably more or less equal with respect to eating quality with the chilling process used.

Processing characteristics: For processing, meat with a high protein content, low marbling and a good water holding capacity is required. In addition, the pigment content should be as high as possible to give the best possible colour in the finished product.

Landrace had the highest protein content and Hampshire the lowest and the difference between Landrace and the others was as follows:

	Landrace	Large White	Duroc	Hampshire
%protein in semimem.	21.77	-0.15	-0.53	-1.01

These differences amount to respectively 0.6, 2.2 and 4.0 lower yield for USA-ham production.

Marbling was lowest in the white breeds and highest in Duroc. The percentages of pigs with an unacceptably high marbling for processing showed that the white breeds only rarely exceeded the limit, whereas Duroc often did:

	Landrace	Large White	Duroc	Hampshire
l.dorsi				
≥ 3.0	0.7	0	52.5	2.6
b.femoris				
≥ 3.0	0	0	45.7	4.0
semimem.				
≥ 3.5	0.7	2.3	42.4	4.0

Figures represent % fat.

Landrace had a higher pigment content in biceps femoris compared to the other breeds and the differences amounted to:

	Landrace	Large White	Duroc	Hampshire
Pigment content	40.8	-5.9	-5.2	-3.6

Overall, Landrace has the best characteristics for processing, even though the PSE-frequency is higher than in the other breeds. Processing yields are higher, fat levels in the finished product lower, allowing the declaration of max. 2% fat in hams, and colour is stronger. Large

White lies rather close to Landrace, but Duroc has major disadvantages with a much higher degree of marbling and a lower protein and pigment content. Hampshire's disadvantages lie mainly in the lower protein content.

DISCUSSION

The results clearly show that the four breeds investigated have advantages and disadvantages with respect to meat quality, some being especially suitable for fresh meat consumption, some for processing. The differences do, however, make it difficult to find a crossbreed which is ideal for all purposes, but opens up the possibility of matching the crossbreed to the product, ensuring

optimum consumer satisfaction and profit for the industry.

Crosses between Landrace and Large White are clearly best for processing. Processing yields will be higher and the finished product of better appearance than when the coloured breeds are used as boar breed. In addition, marbling will be low and the finished product can be declared 98% fat free.

On the other hand Duroc will be the best boar breed if fresh meat is to be produced, as the eating quality of the crossbreed will be superior to Landrace-Large White crosses. Hampshire as boar breed will also give a good eating quality in fresh meats if the chilling process does not cause cold shortening.

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