1:3 Influence of halothane genotype on meat quality in pigs subjected to various pre-slaughter treatments

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Introduction

The ultimate meat quality of a pig can be considered to be an interaction between pre-slaughter treatment and genotype (Nielsen, 1980). The effect of a given pre-slaughter treatment will therefore vary according to the genotype of the pigs concerned. Different genotype is in fact one of the reasons for the often conflicting results found in the literature in experiments to investigate the effect of pre-slaughter treatment on meat quality.

In general, pigs which are stress susceptible are thought to be relatively insensitive to changes in pre-slaughter treatment, giving PSE-meat with shorter treatments and DFD-meat with longer treatments. Pigs which are stress resistent on the other hand will be more sensitive to changes in pre-slaughter handling and will give good meat quality with an optimal treatment.

Direct proof of these general statements has however in general been lacking, and the experiment reported in this paper seeks to remedy some of this deficiency by describing the effect of some pre-slaughter treatments on the meat quality of pigs with known halothane genotype.

Materials and methods

The experimental material consisted of 259 Danish Landrace pigs slaughtered at bacon weight. The pigs originated from a selection experiment carried out by the Department of Animal Genetics, The Royal Veterinary and Agricultural University and the National Institute of Animal Science, Jensen (1981). Parent animals were homozygous Hal^n, Hal^n or Hal^N, Hal^N, so that the genotype of the experimental animals was known exactly. As the pigs were those remaining from the respective litters after 4 pigs had been used for progeny testing, the number of pigs from any one litter varied considerably and precluded direct within-litter comparison of different pre-slaughter treatments. Moreover, the supply in any one week was also variable and generally low, which precluded large scale direct comparison of pre-slaughter treatments. For practical purposes, therefore, the following experimental procedure was adopted.

All pigs received the same pre-slaughter treatment as progeny testing pigs in Denmark up until the point of driving to stunning, Barton (1974), i.e., a short, considerate transport with no waiting period in the lairage. For the first year of the experiment the pigs were slaughtered at abattoir A, where low-voltage electrical stunning in a restrainer was used. Conditions at the entrance to the race were less than optimal at this factory, so that a considerable amount of stress was unavoidable at this point. During the next year of the experiment the pigs were slaughtered at abattoir B, where low voltage electrical stunning on the floor was used. Conditions on abattoir B, which was used for training apprentices, were relaxed, and stress before slaughter was minimal. For the last two years of the experiment stunning at abattoir B alternated between electrical stunning on the floor and CO_2-stunning in the compact equipment. The pigs were generally driven singly or in small groups into a short (ca. 5 m) race leading up to the CO_2-equipment, so that stress was also minimal for CO_2-stunned pigs up until entering the equipment itself. As far as possible litters were divided equally during this phase of the experiment.

All pigs were investigated for rigor development, pH_1-values and subjective evaluations of colour and structure on the slaughter line as described by Barton-Gade (1980). 1-2 days after slaughter water holding capacity (soluble sarcoplasmic and myofibrillar proteins) was determined in longissimus dorsi and biceps femoris and pH_2-values in 7 muscles in the carcass (Barton-Gade, 1981).

The results were investigated using an analysis of variance with halothane genotype, pre-slaughter treatment and sex as variables.

Results

The results of the analysis of variance (Table 1) showed that genotype and pre-slaughter treatment had a highly significant effect on most of the meat quality characteristics measured, whereas sex had little effect. There were only a few significant interactions -between genotype and pre-slaughter treatment for colour/structure in semimembranosus on the slaughter line and pH_2 in semispinalis capitis, and between genotype, pre-slaughter treatment and sex for rigor at 45 mins. after slaughter. Apart from the first interaction, where pigs of genotype nn had a better colour and structure when stunned with CO_2 than when electrically stunned regardless of abattoir, the interactions seemed to be random and will not be discussed further.

Influence of pre-slaughter treatment

Slaughter line. Both genotype and pre-slaughter treatment affected slaughter line measurements. Pigs with nn-genotype showed the fastest rigor development, were often PSE 45 mins. after slaughter and showed the lowest pH_1-values, while pigs with the NN-genotype showed the slowest rigor development, were always normal in colour and structure 45 mins. after slaughter and showed the highest pH_1-values. Pigs with the Nn-genotype were intermediate but closest to NN.

Electrically stunned pigs showed a faster rigor development (stunning in a restrainer slightly faster than stunning on the floor) and were more often PSE 45 mins. after slaughter than were CO_2-stunned pigs. pH_1-values showed a more variable picture but were lowest in semimembranosus and longissimus dorsi for pigs electrically stunned in a restrainer and lowest in semispinalis capitis for CO_2-stunned pigs.

Very fast rigor development was only found in pigs with the nn-genotype, where 7-18% were already in full rigor 6 mins. after slaughter. The percentage in full rigor increased rapidly up to 45 mins. after slaughter and the differences between the various pre-slaughter treatments became more and more apparent:

% pigs in full rigor at	Abattoir A el.restrainer			Abattoir B el.floor			Abattoir B CO_2		
	nn	Nn	NN	nn	Nn	NN	nn	Nn	NN
6 mins.	18	-	-	7	-	-	10	-	-
15 mins.	50	4	-	30	-	-	14	-	-
45 mins.	63	31	8	48	17	-	19	-	-

Very fast development of PSE was also especially associated with nn-genotype, wh… between 10-31% were already PSE 45 mins. after slaughter and a further 19-31% w… slightly PSE at this time:

45 mins. after slaughter	Abattoir A el.restrainer			Abattoir B el.floor			Abattoir B CO_2		
	nn	Nn	NN	nn	Nn	NN	nn	Nn	NN
% PSE	31	2	-	24	1	-	10	-	-
% slightly PSE	31	-	-	31	1	-	19	-	-

Pigs, which develop PSE so quickly can risk partial or total rejection by the veteri… control in Denmark, due to "abnormal appearance", and in fact 9% of the nn-pigs w… rejected in this way. None of the pigs with Nn- or NN-genotypes were rejected for … PSE-development.

Very fast pH-fall after slaughter was particularly associated with the nn-genotype, … Nn - and to a lesser extent NN - also showed significant percentages with low p… values:

% with pH_1 <5.9	Abattoir A el.restrainer			Abattoir B el.floor			Abattoir B CO_2		
	nn	Nn	NN	nn	Nn	NN	nn	Nn	NN
Semimembr.	69	17	25	69	25	-	62	6	-
L. dorsi	100	62	25	97	30	15	95	41	-

Although the interaction was not significant nn-pigs showed relatively little effe… pre-slaughter treatment, whereas NN-pigs showed a relatively large effect.

Day after slaughter. Both genotype and pre-slaughter treatment affected WHC. Pi… the nn-genotype had the poorest WHC and pigs of the NN-genotype the best. Nn… were intermediate but closest to NN-pigs. Electrical stunning in a restrainer (aba… A) gave a poorer WHC capacity than electrical stunning on the floor or CO_2-stun… (abattoir B). pH_2-values were affected by genotype and pre-slaughter treatment … lesser extent and the differences were only significant for some of the muscles… general, pigs with the nn-genotype had slightly higher pH_2-values than pigs with … NN-genotype with Nn intermediate. There were no systematic differences in p… values with pre-slaughter treatment.

Very few pigs with the nn-genotype had a normal meat quality the day after slaugh… whereas many of the pigs with the NN-genotype had a good meat quality:

	Abattoir A el.restrainer			Abattoir B el.floor			Abattoir B CO_2		
	nn	Nn	NN	nn	Nn	NN	nn	Nn	NN
% PSE	100	33	33	74	17	8	79	13	-
% doubtful	-	20	8	19	8	-	11	-	-
% not PSE	-	46*	58	6	75	92	11	87	100

* 2% were DFD i.e. with pH_2 in at least 5 of the 7 muscles higher than normal.

All of the genotypes showed the highest PSE-frequencies with electrical stunning … restrainer (abattoir A), but there were differences with the other types of stu… (abattoir B). nn-pigs showed more or less the same PSE-frequency with elec… stunning on the floor and CO_2-stunning, whereas both Nn- and NN-pigs showed a … improvement from electrical stunning on the floor to CO_2-stunning. If the 3 types … pre-slaughter treatment are compared relatively i.e. with a population compo… 25% nn-pigs, 50% Nn-pigs and 25% NN-pigs then the differences become quite cl… relatively little difference between the two types of stunning at abattoir B but … difference between these two and stunning at abattoir A:

	Abattoir A	Abattoir B	
	el.restrainer	el.floor	CO_2
% PSE	50	29	26
% doubtful	12	9	3
% not PSE	38*	62	71

* 1% DFD i.e. with at least 5 of the 7 muscles with pH higher than normal

Discussion and conclusion

In general the results of this experiment have confirmed that stress susceptible … are relatively insensitive to changes in pre-slaughter treatment, while the meat qu… of Nn- and NN-pigs is more highly affected by changes before slaughter. Thus Nn … to a greater extent NN-pigs showed a great improvement in meat quality … electrical stunning in a restrainer at abattoir A to electrical stunning on the flo… more particularly CO_2-stunning at abattoir B. nn-pigs showed a relatively … differences between the 3 pre-slaughter treatments with respect to meat quality.

There were some small differences between the two abattoirs with respect to slau… line with traditional chilling in both cases, but these differences were not such as … be expected to affect meat quality to the extent seen here. Moreover, the fact … there were clear differences in rigor development a short time after slaughter poi… the treatment immediately before slaughter as the main factor of importance. It s… therefore that a stressful treatment immediately before slaughter in pigs which … otherwise received a short considerate treatment can increase the incidence of … meat - for all genotypes but especially Nn and NN.

In addition, it seems that there is no important difference between electrical and CO_2-stunning with respect to meat quality, when the treatment before stunning is extremely considerate. This observation is, however, of academic interest only, as treatments before stunning can never be as considerate under normal abattoir conditions, where slaughter rates of about 300 pigs per hour are the rule. Under these conditions Danish experiments have shown unequivocally that CO_2-stunning gives a better meat quality than electrical stunning in a restrainer, whatever the voltage used (Larsen, 1982).

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Table 1.

Effect of genotype and pre-slaughter treatment on meat quality characteristics

Within genotype and pre-slaughter treatment LS-means with different superscripts are significantly different (p at least <0.05)

Rigor (subj.) at 6 & 15 mins: 1 = stiff, 2 = partly stiff, 3 = relaxed.

Rigor (obj.) at 45 mins: Higher values = greater degree of rigor.

Colour/structure: 1 = extremely PSE, 2 = PSE, 3 = slightly PSE, 4 = not PSE.

WHC: Higher values = better WHC. Values lower than 0.125 = PSE meat.

Description	Genotype			Pre-slaughter treatment		
	nn	Nn	NN	A el-re-strainer	B el-floor	B CO_2-comp.
No. of pigs	66	158	35	73	127	59
Rigor (subj.)-6 mins.	2.71[a]	3.49[b]	3.54[b]	3.20[a]	3.08[a]	3.46[b]
Rigor (subj.)-15 mins.	2.10[a]	3.40[b]	3.68[c]	2.83[a]	2.95[a]	3.41[b]
Rigor (obj.)-45 mins.	8.99[a]	6.32[b]	4.18[c]	7.55[b]	6.11[a]	5.84[a]
Colour/struct.-semimembr.	3.28[a]	3.96[b]	4.00[b]	3.64[a]	3.72[a]	3.88[b]
Colour/struct.-glutus m.	2.86[a]	3.92[b]	4.00[b]	3.46[a]	3.62[ab]	3.71[b]
pH_1-semimembranosus	5.68[a]	6.23[b]	6.45[c]	6.01[b]	6.13[a]	6.21[a]
pH_1-l. dorsi (13th rib)	5.36[a]	5.87[b]	6.20[c]	5.70[b]	5.89[a]	5.83[a]
pH_1-semispin. capitis	5.71[a]	6.00[b]	6.13[c]	6.00[b]	6.04[b]	5.79[a]
WHC - l. dorsi	0.104[a]	0.164[b]	0.181[c]	0.130[b]	0.156[a]	0.163[a]
WHC - biceps femoris	0.144[a]	0.170[b]	0.172[b]	0.152[b]	0.165[a]	0.169[a]
pH_2 - l. dorsi	5.40[a]	5.37[b]	5.39[ab]	5.35[b]	5.41[a]	5.40[a]
pH_2 - bicep femoris	5.59[a]	5.55[ab]	5.51[b]	5.57	5.54	5.54
pH_2 - semimembranosus	5.54	5.52	5.49	5.54	5.50	5.50
pH_2 - quadriceps	5.84	5.77	5.74	5.75	5.77	5.81
pH_2 - semispin. capitis	5.88	5.83	5.82	5.88	5.81	5.84
pH_2 - serratus ventralis	5.88	5.86	5.85	5.91[b]	5.82[a]	5.85[a]
pH_2 - triceps brachii	5.64	5.62	5.62	5.59[b]	5.62[a]	5.67[a]