Influence of sex type, MH gene and diet on various pork quality characteristics

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Background: In the South African Pig Performance and Progeny Testing Scheme pigs are fed a diet in which fish meal is included as protein source (Diet 3). As the protein quality of this source is highly variable, it was decided to investigate the influence of substituting fish meal with soy bean oil cake on the performance of the pigs (Diet 2). It was also decided to investigate its influence on meat quality characteristics. As the influence of the stress susceptibility (halothane positive pigs; nn) on meat quality is known, it was also decided to investigate the influence of the Malignant Hyperthermia gene (heterozygous; Nn) on meat quality. Heterozygous pigs are not identified by the halothane test, hence producers perceive the Nn not to be detrimental to meat quality. Currently producers in South Africa are demanding a non-castration policy, whereas processors are unwilling to adapt such a policy due to possible boar taint problems. Hence it was decided to include sex type (gilts vs. boars) in the present project to gain background information and experience in the techniques for the determination of skatole and androstenone.

Objectives:
a. To determine the influence of the MH-gene (NN and Nn) on various meat quality characteristics.
b. To determine the influence of three different diets on various meat quality characteristics.
c. To determine the influence of sex type (gilts and entire boars) on various meat quality characteristics.

Methods: Twenty six boars and 32 gilts (approximately 3 boars and 3 gilts per litter) of two boars (Nn) mated with 10 unrelated sows were made available by a producer. As a result the influence of the diet (Diet 1) used by the producer was included in this investigation. The piglets (per litter) were divided into three groups, each group receiving a different diet. Diet 1 contained 18.2 % protein (13.6 % meal and soya oil cake (5.0 %), Diet 2 18.7 % protein (no fishmeal but 30.9 % soya oil cake) and Diet 3 18.0 % protein (12.0 % fish meal and 7.6 % soya oil cake).

The project was initiated as soon as the pigs reached a live mass of 27 kg. A hair sample of each animal was collected for the identification of its MH status using the DNA-PCR test. Pigs were kept in individual pens (2.0 - 2.5 m^2/pig). At 86 kg live mass the pigs were slaughtered according to normal slaughter procedures. pH values were taken 45 min. and 24 hours *post mortem (pm)*. At 24 hours *pm* the following measurements were taken: Minolta Chromameter (CIE L*a*b* *d*65, EEL reflectance and Fibre Optic Probe (FOP) of the *M. longissimus thoracis* between the 10th and 11th rib 15 min. after cutting through the muscle. The L*a*b* and EEL measurements were taken on three different positions of the cut muscle, namely dorsal, middle and ventral. Pigment concentration of the *M. longissimus thoracis* was determined (Hornsey, 1956). Backfat samples were taken, vacuum packed and frozen until analysis for skatole and androstenone, using a HPLC method (C18 column and a water/acetonitrile/tetrahydrofuran solvent gradient) after sample extraction with isopropanol (adaptation of a method from Hansen-Moller & Andersen, 1994). Fat samples in glass containers were heated on a sand bath (±150 °C) whereafter individual samples were evaluated by a trained panel for the aroma of the fat. Loin samples were roasted in an oven (180 °C) to an internal end-point temperature of 77 °C. Samples were scored by a 10 member trained taste panel for the aroma, flavour and general acceptability of the meat.

Results and Discussion: Thirty four pigs were identified as being NN, 24 as being Nn and 2 as being nn. The 2 nn pigs were not included in any of the statistical analyses. The results are summarised in Table 1.

MH-gene: As was expected the Nn pigs had a lower average pH_{45} value than the NN pigs, and this value was below 6.00, thus indicating potential PSE pork. A low pH_{45} has been correlated with a lower water holding capacity (Jensen & Barton-Gade, 1985) and increased drip loss, even in Nn pigs (Fisher & Mellet, 1995). The potential for PSE is further indicated by the higher L*-value in the middle portion of the *M. longissimus thoracis*, which would also be the section most likely to experience higher muscle temperatures. The L*-value of the ventral part also showed a trend towards meat of a higher colour lightness. The a*-value showed no significant differences in the middle part, although the Nn pigs showed higher a*-values in the dorsal and ventral regions, thus being more red. Although there was a tendency for the b*-value to be higher in the Nn pigs in the dorsal area, no such tendencies were found in the middle or ventral regions. These results generally agree with those found by Van der Wal *et al.* (1988) in that they also found PSE pork loins to have higher L*, a* and b* values. The Nn pigs also showed a tendency towards higher FOP values. The MH gene did not result in any significant differences regarding EEL values, nor did it influence any of the boar taint components Yet Nn pigs were scored lower on average than the NN pigs for all four the taste panel variables evaluated. Thus, it is clear from results that pork from NN pigs is more acceptable than that from Nn pigs.

Diet: Diet had no significant effect on any of the measured variables.

Sex type: Sex type had no influence on pH-values and L*a*b*-values. However, sex type influenced the EEL values significantly. The boars had higher EEL and FOP values, indication a lighter meat colour than those from gilts. Yet, this difference was not noticeable using the Minolta L* value. As was expected the boars had higher skatole values than the gilts, although the values were still very low compared to the Danish cut-off value of 0.20 μg/g. None of the carcasses had a skatole value exceeding 0.20 μg/g. Regarding the androstenone levels, it was clear that the boars had higher androstenone concentrations than the gilts, as was expected. Nonetheless, the average concentration was 0.8 μg/g, which is higher than the cut-off point accepted by the Germans (0.5 μg/g) (Branscheid, 1993). Thirty eight percent of the boar carcasses had androstenone concentrations in excess of the EU limit of 1.0 μg/g, and taking the German cut-off point into consideration, 73 % of the boar carcasses were unacceptable. It should be emphasised that all of the carcasses had a mass not exceeding 80 kg (with head). Therefore even carcasses with a mass of less than 85 kg with head on (in this study an average of 67 kg and a maximum of 72 kg) may have androstenone levels not acceptable to consumers. Regarding sensory evaluation the meat from boars received lower scores for all the taste panel variables tested, and is therefore less acceptable than meat from gilts.

Although the pigs were raised during the summer, which should result in higher skatole levels (Claus, 1993; Hansen *et al.*, 1994), this did not occur. The reason is probably that the pigs were raised in individual pens (2.0 - 2.5 m^2/pig) whereas the results indicating higher skatole levels during the hotter seasons were obtained when pigs were raised in groups at high stocking rates (0.6 m^2/pig, Hansen *et al.*, 1994; 0.65 - 1.13 m^2/pig, Potgieter *et al.*, 1996). In these conditions it is postulated that skatole could be absorbed from warm faeces trough the skin (Hansen *et al.*, 1994).

Warris *et al.* (1989) showed a high correlation between EEL and FOP values 24 hours pm, which was not noticeable in this study evaluating the influence of the MH gene. Only the FOP indicated differences between the NN and Nn pigs, and not the EEL. However, both the EEL and FOP showed differences between the boars and gilts. These differences were not as a result of pigment concentration differences (Table 1). Differences in colour may be of importance as consumers may discriminate against pale pork (Wachholz *et al.*, 1978).

Clear interactions between the MH-gene and sex type were evident from the results. Meat from NN gilts was generally scored higher than meat from Nn gilts. However, meat from NN and Nn boars were scored similar, and lower than that for NN gilts. The scores for the meat from Nn gilts were similar to that of the meat from boars (Table 2). Most desirable was therefore pork produced from NN gilts.

Table 1: Level of significance and mean values of the various variables as influenced by MH-gene, diet and sex type

Variable	MH gene (A)			Diet (B)				Sex type (C)			A x B	A x C	B x C
	P value	NN	Nn	P value	Diet 1	Diet 2	Diet 3	P value	Gilts	Boars	P value	P value	P value
pH 45 min *pm*	0.0001	6.22	5.79	0.9827	6.00	5.99	6.01	0.2640	6.05	5.95	0.7308	0.4315	0.7727
pH24 h *pm*	0.1337	5.67	5.61	0.5027	5.61	5.64	5.66	0.4552	5.62	5.65	0.6098	0.7689	0.4968
L*dorsal	0.1700	60.18	61.97	0.9324	61.35	61.00	60.88	0.8033	61.24	60.92	0.5877	0.9017	0.7140
L*middle	0.0306	58.22	60.95	0.8427	59.76	59.86	59.14	0.4246	59.10	60.07	0.7889	0.8863	0.6310
L*ventral	0.0962	57.78	59.61	0.9535	58.68	58.90	58.50	0.5956	58.41	58.97	0.9953	0.7459	0.4813
a*dorsal	0.0032	7.04	8.93	0.2557	7.50	8.72	7.74	0.6898	7.87	8.11	0.5194	0.2305	0.7757
a*middle	0.9946	7.01	7.02	0.7496	7.96	6.76	6.32	0.4859	7.76	6.26	0.8903	0.7061	0.8917
a*ventral	0.0646	7.35	8.53	0.9506	7.97	8.03	7.81	0.1258	8.41	7.47	0.3857	0.1083	0.7948
b*dorsal	0.0962	10.89	11.88	0.6256	11.10	11.79	11.27	0.9813	11.38	11.39	0.6386	0.5024	0.4959
b*middle	0.1812	9.97	10.86	0.8927	10.23	10.59	10.42	0.3962	10.69	10.14	0.9305	0.9673	0.6225
b*ventral	0.1308	10.33	11.06	0.9774	10.69	10.63	10.75	0.8973	10.72	10.66	0.4926	0.1375	0.4507
EEL dorsal	0.5800	41.	42.	0.5652	41.	43.	40.	0.0766	40.	43.	0.4301	0.8105	0.6088
EEL middle	0.3802	41.	42.	0.4195	40.	43.	40.	0.0046	39.	44.	0.4790	0.9626	0.5412
EEL ventral	0.3111	36.	38.	0.7407	37.	38.	37.	0.0365	35.	39.	0.9280	0.5654	0.7463
FOP	0.0636	54.	64.	0.9331	58.	60.	58.	0.0183	53.	65.	0.8945	0.1070	0.5335
Pigment (μg Fe/g)	0.1198	19.5	20.8	0.7020	19.9	19.9	20.6	0.7766	20.0	20.2	0.0903	0.8075	0.6355
Skatole**	0.6108	0.018	0.013	0.6895	0.01	0.021	0.016	0.0853	0.007	0.024	0.4248	0.9616	0.7167
Androstenone**	0.9833	0.474	0.476	0.6445	0.451	0.431	0.543	0.0000	0.123	0.827	0.9517	0.7408	0.4410
Aroma of fat***	0.0106	3.3	2.9	0.9350	3.1	3.1	3.1	0.0009	3.4	2.8	0.3524	0.0510	0.2848
Aroma of meat***	0.0842	3.3	3.0	0.8280	3.1	3.1	3.2	0.0109	3.4	3.0	0.4630	0.3135	0.6065
Flavour****	0.0099	3.5	3.0	0.7901	3.1	3.2	3.2	0.0140	3.3	3.0	0.6752	0.0231	0.3822
General acceptability*****	0.0325	3.3	3.0	0.8126	3.1	3.2	3.1	0.0037	3.4	3.0	0.7958	0.0141	0.2385

** μg/g fat

Sensory score 1 being extremely ***a-typical, ****unpleasant*****unacceptable;, and 6 being extremely ***typical, ****pleasant,*****acceptable

Table 2: Interactions of MH gene and sex type on various sensory characteristics

Variable	P value	NN gilts	Nn gilts	NN boars	Nn boars
Aroma of fat*	0.0510	3.8	2.9	3.0	2.8
Aroma of meat*	0.3135	3.6	3.0	3.1	2.9
Flavour**	0.0231	3.7	3.0	3.0	3.0
General acceptability***	0.0141	3.8	2.9	3.0	3.0

Sensory score 1 being extremely *a-typical, **unpleasant***unacceptable; and 6 being extremely *typical, **pleasant***acceptable

Conclusions: The MH-gene in carrier pigs (Nn) resulted in a paler meat colour than the NN pigs, with a more rapid pH decline 45 min. *pm*. Differences regarding colour can also be found within the muscle. Meat from NN pigs is more acceptable than meat from Nn pigs regarding its fat aroma, meat flavour and general acceptability.

Skatole was not a significant contributor towards boar taint, whereas androstenone was. Even with carcasses with a mass under 85 kg (with head), boar carcasses may have a higher androstenone than the 1.0 μg/g accepted within the EU (38 % of boar carcasses), or 0.5 μg/g as indicated by the German Ministry of Health (73 % of carcasses). Meat from boars is less acceptable than meat from gilts on the sensory characteristics examined. Meat from NN gilts is more acceptable according to taste panel results than meat from either Nn gilts, NN or Nn boars.

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