Studies on some factors affecting pig meat quality

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INTRODUCTION

The quality of pig meat is influenced by genetic and environmental factors. Genetic studies indicate a moderate heritability for various meat quality traits (Sybesma & Eikelenboom, 1978). Besides selection against PSS (porcine stress syndrome), improvements in environmental factors such as feeding time vs. stunning time, loading, transport, lairage and stunning would be the quickest way to reduce the meat quality problems such as PSE and DFD (Lundström et al., 1980). The energy level within the muscles at the moment of stunning is a key factor in the development of these abnormal conditions. The relationships between genetic disposition, various environmental factors, the energy level of the muscles at stunning and the development of PSE and DFD have been discussed by Nielsen (1981).

In three different experiments, certain environmental factors affecting pig meat quality have been studied at the Meat Research Section. The purpose was

- to study the combined effect of varying transport distance and duration of lairage on the incidence of PSE and DFD (1)
- to study the relationship between pig meat quality and the visually judged degree of stress just prior to slaughter (2)
- to study the effect on meat quality of stunning order within a limited number of pigs (3)

It was decided to carry out the experiments at the farmers' cooperative (FARMEK) abattoir in Uppsala, as the Meat Research Section has a close working relationship with this abattoir. We considered it of value to compare the experimentally obtained incidences of PSE and DFD with "normal" figures under actual slaughterhouse conditions. Such figures were obtained in a survey covering 12 months, comprising nearly 3000 carcasses.

(1) Combined effect of varying transport distance and duration of lairage on incidence of PSE and DFD in pig carcasses

About 600 ordinary slaughter pigs from several producers at varying distances from the abattoir were used in this experiment. After arrival at the slaughterhouse the pigs were randomly divided into three groups (i) for immediate slaughter, (ii) 4 hours' lairage, and (iii) 24 hours' lairage. The meat quality was recorded by measuring pH_{45} and pH_{24} in *M.longissimus dorsi*. Carcass weights, grading results and liver weights were also registered.

In Table 1 PSE and DFD frequencies are presented for different combinations of transport distance and lairage duration.

Table 1. Combined effect of varying transport distance and duration lairage on the incidence of PSE[1)] and DFD[2)] in pig carcasses

Transport distance	Lairage, hours					
	0		4		24	
	PSE%	DFD%	PSE%	DFD%	PSE%	DFD%
Short <35 km	22	1	10	3	10	7
Medium 60 km	14	4	9	3	8	8
Long >90 km	12	3	9	5	9	11

[1)] PSE limit: $pH_{45} \leq 5.9$. [2)] DFD limit: $pH_{24} \geq 6.2$.

As is evident from Table 1 the PSE frequency was very high, 22%, when pigs were slaughtered immediately after being transported a short distance. When pigs had to wait 24 hours at the lairage after a long transport the DFD frequency reached as high as 11%. There were significant differences ($P \leq 0.05$) between the lairage periods for the meat quality traits, something which could not be demonstrated between the three transport distances. There were also significant differences ($P \leq 0.05$) between the lairage periods for weight of liver. The livers became smaller (lighter) when the pigs had to wait for 24 hours. The average weight difference between the 0 hour group and the 24 hours group was 115 g, or 8%.

The overall deviation (PSE + DFD) from "normal" meat quality is an excellent measure of the studied effect(s) on meat quality. In this experiment it was obvious that a lairage period of 4 hours - irrespective of transport distance - was beneficial for meat quality. The overall deviation was relatively small in comparison with the other lairage periods. This result is in agreement with other investigations, e.g. Nielsen (1981).

The experimentally obtained incidences of PSE and DFD (Table 1) were also compared with "normal" figures obtained under actual abattoir conditions. In a survey covering 12 months, and comprising nearly 3000 carcasses, the PSE and DFD frequencies were 12% and 3% respectively.

(2) *Relationships between pig meat quality and visually judged degree of stress just prior to slaughter*

In the lairage and just prior to slaughter the pigs were grouped by two experienced pig handlers into four groups according to actual degree of stress. The reason why the pigs were agitated was not considered. The pigs in the first group were deemed to be not stressed. In the fourth group the animals were deemed severely stressed. The pigs were delivered from herds of varying size and geographical location. The experiment comprised 309 ordinary slaughter pigs.

The meat quality was recorded by measuring pH_{45}, pH_{24}, meat colour (EEL reflectance spectrophotometer, Y-filter) and drip loss (*M.longissimus dorsi*). The drip loss was recorded by weighing a standardized part of *M.longissimus dorsi* before and after 24 hours in a cold-storage room. Moreover carcass weight, commercial grade and sidefat depth at the last rib were also recorded.

Overall means and standard deviations and levels of significance for the meat quality traits are presented in Table 2.

Table 2. Overall means and standard deviations for pH_{45}, pH_{24}, meat colour (EEL units), drip loss (*M.longissimus dorsi*) and sidefat depth for the different stress groups

Trait	Stress group: Not stressed $\bar{x}$	Not stressed S.D.	Somewhat stressed $\bar{x}$	Somewhat stressed S.D.	Stressed $\bar{x}$	Stressed S.D.	Severely stressed $\bar{x}$	Severely stressed S.D.	Level of significance
No. of animals	84		85		94		46		
pH_{45}	6.33	0.16	6.14	0.14	5.91	0.20	5.68	0.17	***
pH_{24}	5.73	0.29	5.59	0.21	5.61	0.20	5.54	0.20	**
Meat colour, EEL units	21.2	2.8	23.6	3.2	25.0	3.2	28.6	3.2	***
Drip loss, %	0.70	0.51	1.01	0.56	1.48	1.01	1.67	0.94	***
Sidefat depth, mm	20.8	3.8	20.1	3.6	19.3	3.6	18.4	3.9	**

Levels of significance: ** = $P \leq 0.01$; *** = $P \geq 0.001$.

The means for pH_{45} and meat colour for the unstressed group were 6.33 and 21.8 respectively. Corresponding figures for the severely stressed pigs were 5.68 and 28.6. In the latter group the weight loss for *M.longissimus dorsi* was 1.0 percentage unit higher than for the first group. The stressed (stress susceptible) pigs were leaner, as indicated by the sidefat depth.

The overall differences between the stress groups were tested and proved highly significant ($P \leq 0.001$) for pH_{45}, meat colour and drip loss. The differences between individual stress groups were also tested and also proved significant ($P \leq 0.05$) for all traits.

It is obvious that the pig handlers were capable of detecting stressed pigs as well as of correctly judging the degree of stress. It is not particularly difficult to distinguish between unstressed pigs and severely stressed ones. There are several typical signs of a stressed pig. It shivers, its skin turns red, the frustrated-looking eyes bulge out, the tail hangs limp and the animal will try to hide itself anywhere. Frequently the severely stressed pigs have recently been involved in fighting. According to Grandin (1980) fighting and agitation are psychological stressors which often have a more detrimental effect on meat quality than physical stressors (such as fasting, or cold weather).

Thus it is relatively easy to detect the severely stressed pig. However, finding the "somewhat stressed" and "stressed" pig respectively is much more difficult. The criteria just mentioned are also valid for these pigs but it is a question of difference in degree. However, the results indicate that it was quite feasible for trained staff to distinguish even between the intermediate degrees of stress.

It is possible to utilize the findings in this experiment in practice? Technically it is quite feasible to separate the severely stressed pigs from the other animals. This can be done (1) at unloading, (2) at a gate just before the pigs enter the restrainer funnel. Separating severely stressed pigs in a crowded lairage pen is not advisable. After the separation the stressed pigs should find a real opportunity to rest in a special pen. These animals should preferably be stunned without passing the ordinary restrainer.

(3) *Effect on pig meat quality of stunning order within a lairage pen*

In this pilot experiment 214 ordinary and randomly chosen slaughter pigs were used. They were divided into three subgroups at the stunning point, depending on the stunning order within the lairage pen. There were on average 50 pigs in each pen and it took about 30-35 minutes to stun them. The meat quality was recorded according to the procedure used in the last reported experiment (2).

Overall means and standard deviations for the quality traits are presented in Table 3.

Table 3. Overall means and standard deviations for pH_{45}, pH_{24}, meat colour (EEL units), and drip loss (*M.longissimus dorsi*) for stunning order groups within a lairage pen

Trait	Stunning order group 1		2		3		Level of significance
	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	
No. of animals	66		63		85		
pH_{45}	6.15	0.24	6.09	0.28	5.99	0.27	**
pH_{24}	5.76	0.26	5.67	0.22	5.67	0.28	n.s.
Meat colour, EEL units	22.9	3.2	24.3	3.6	25.7	3.8	*
Drip loss, %	0.69	0.64	0.86	0.74	1.22	0.93	**

Levels of significance: n.s. = $P > 0.05$; * = $P \leq 0.05$; ** = $P \leq 0.01$.

With the exception of pH_{24}, the meat quality traits of the last stunned group (no. 3) were inferior to the other groups. For pH_{45}, meat colour, and drip loss, significant differences were found between groups.

The results obtained clearly demonstrate that the meat quality of the first-stunned pigs in a lairage pen was superior to the last-stunned animals. Reducing the number of pigs driven along for stunning would appear to be the practical implication of this. Using small lairage pens each holding about 15-20 pigs could be another proposal. The benefits of such a system have been reported by Gallwey and Tarrant (1978).

CONCLUDING REMARKS

The results of our experiments will hopefully extend our knowledge of the reasons for differences in pig meat quality. This knowledge, which is already quite considerable, is based on numerous experiments. Even so, it has not yet been found possible to avoid the occurrence of PSE and DFD, due to practical limitations and deficiencies of various kinds within the present slaughter system.

The future programme for improving pig meat quality should concentrate continuously on two simultaneously acting measures:

- selection against PSS
- improvements of environmental conditions in order (i) to minimize the stress factors, and (ii) to optimize the energy level of the muscles for each individual pig at the moment of stunning.

In order to implement these measures, we must ensure that our present knowledge is put to practical use. This will require a vigorous and sustained effort to bring the information to the notice of all those who work at the abattoir in order to bring about the desired improvements.

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