EFFECTS OF NEW SYSTEMS FOR PRE-SLAUGHTER HANDLING AND CO_2-STUNNING OF PIGS ON MEAT QUALITY ASSESSED BY THE HENNESSY GRADING PROBE (GP2Q)

T. Frøystein[1], M. Røe[1], O. Alvseike[1], M. Wahlgren[2] and M. Granhaug[2]

[1] Norwegian Meat Research Centre, PO Box 396 Økern, N-0513 Oslo, Norway; [2] Norway Meat, Production, Oslo, Norway

Background

CO_2-stunning has been the method of preference for stunning of pigs at Norwegian abattoirs since the 1980s (Butina Compact back-loading systems; Holbæk , Denmark). These systems gave satisfactory stunning effects, but were hampered by extensive use of force, including electrical goads, to make the pigs enter the CO_2-chamber. The development of a new "low-stress" group stunning system (1) offered an attractive alternative for replacement of the existing stunning systems, and during 1999–2001 six abattoirs installed the new group stunning system. This eliminated the problems related to driving the pigs into the stunning chamber, as documented by Ethical Audits (EA) at all plants prior to and after the installations.

The effects of the new systems on meat quality have not been evaluated. However, all abattoirs use the Hennessy grading probe (GP2Q) for classification of pig carcasses, thus offering information regarding meat quality ("early PSE") and possible effects of pre-slaughter handling and stunning practices, as documented in reports from Sweden (2).

Objectives

The aim of the present study was to use classification data, including early internal reflectance values obtained by Hennessy grading probe to evaluate the effects of the new group stunning system on meat quality.

Materials and methods

CO_2 stunning system: All six slaughter plants had variants of Butina CO_2 Compact back loading stunning system with 3 – 5 gondolas holding 1 – 2 pigs per gondola. In the new system, developed by Danish Meat Research Institute, pigs are moved in groups of 3 - 5 pigs in semi-automatic races and operated by one person (1). All plants use > 90 % CO_2 (in bottom position) and an exposure time of 120-150 seconds. Five of the plants have 4 gondolas, each holding 3-5 slaughter pigs. One plant has installed a CO_2 chamber with a single gondola for 4-6 pigs.

Meat colour: All pig carcasses are classified using the Hennessy grading probe (GP2Q) equipped with a meat quality mode recording light scatter at every 0.4 mm in two cross sections of the loin muscle (*M. longissimus dorsi*) at the level of the last rib. Classification data, including "meat colour", are stored and available from a central data base. For five of the six plants, data were available from periods prior to and after the new installations.

Statistical methods: The non-selected data has been analysed using the SAS Versjon 8.2 (SAS Institute Inc, Carry, NC). "Means" and "Freq" procedures were used for descriptive characterisation, and the General Linear Model (GLM) was used for the analysis of variance, calculating partial sums of squares (Type III). The material is also analysed using the Least squares method (LSMeans).

Results and discussion

The main variables which describes the total data material comprising 1 722 176 pigs are given in Table 1.

As shown in Table 2, the reconstructions have caused slight increases in average meat colour (0.1 – 2.0) at four of the plants, while the opposite trend (-1.9) was observed at one plant (one plant had only records from after reconstruction). Standard deviations showed slight reductions (0.10 – 0.99) at three plants and a similar increase (0,23 – 0,30) at two plants. The frequencies of carcasses having colour values over 60, indicating "early PSE", were halved at plants B and E, while plant F showed a marked increase in "early PSE". All three parameters in Table 2 indicate that the variation both within and between plants has been reduced following the reconstruction of the CO_2-stunning system.

The GLM model explains 19.3 % of the overall variation in reflectance (meat colour) values. The analysis of variance (Table 3.) shows that "plant" is by far the greatest contributor to variation in the material. The reflectance measurements is included in this variable, and there are indications that the calibration routines for the colour function of the GP2Q instruments are insufficient. Reconstruction of the CO_2-stunning systems was the second most important variable.

The LSMeans analysis indicates that the meat colour becomes darker with increasing slaughter weight, with a difference between carcasses <70 kg and >90 kg of 3.2 GP2Q-units, a pattern that is almost identical at all plants. An increase in meat percentage tend to have a similar effect on meat colour as that of increasing slaughter weight.

Despite a relatively large variation in transport structure between the plants, transport distances does not seem to have a marked effect on meat colour, the exception being plant D where pigs transported 200-300 km have 2.5 units higher (lighter) meat colour compared to pigs with shorter transport distances.

Over all 66 % of all pigs were slaughtered on the day of transport, while 33 % were slaughtered after one nights lairage. Despite the fact that the percentage of pigs slaughtered after overnight lairage varied from 22.6 % (plant B) to 43.3 % (plant F), this factor did not have major effect on meat colour.

Despite a marked reduction of the visible stress level during the immediate pre-stunning period, the average meat colour was relatively stable throughout the whole period. However, there are marked differences in the percentage of carcasses showing high internal reflectance (> 60) prior to and after installation of new stunning systems. Carcasses with GP2Q reflectance values in the normal range accounts for more than 90 % of the material both prior to and after the new installations, and does not have the potential for marked improvements as measured by early post mortem reflectance value. Efforts should be made to further reduce the number of carcasses with high reflectance values.

Conclusions

- In addition to a marked reduction of the visible stress level during the immediate pre-stunning period, the new system for "low stress" pre-slaughter handling and CO_2 stunning of pigs has resulted in an overall reduction of carcasses with high reflectance values (indicative of "early PSE") as measured by the Hennessy grading probe (GP2Q).
- The Hennessy grading probe (GP2Q) offers a useful tool for surveillance of pre-slaughter handling and stunning factors which might influence meat quality.
- Particular attention should be paid to the calibration procedures of the Hennessy grading probe (GP2Q) in order to improve its use for meat quality monitoring.

References

1. Barton Gade P., Blaabjerg L. & Christensen L. (1995). New low stress system for pig slaughter: Effect on pig behaviour and meat quality. Proc. 41st. ICOMST, San Antonio, USA, August 20-25, 1995. Vol. 2. 98-99

2. von Zweibergk A-J., Lundström K. & Hansson I. (1989) The incidence of high internal reflectance 45 minutes pm with different stunning methods. Proc. 35th. ICoMST, Copenhagen, (vol. 3) 1145-1148.

Table 1. Average, standard deviation, minimum and maximum for continuous variables

Variable (N = 1 722 176 observations)	Average	Standard deviation	Minimum	Maximum
Meat color (GP2Q)	48.91	6.50	20.0	198.0
Carcass weight (kg)	76.57	7.83	40.0	115.0
Weight group (1 – 7)*	3.24	1.65	1.0	7.0
Meat percentage (GP2Q)	55.14	2.79	35.0	65.0
Meat percentage producer (1–5)**	3.62	0.85	1.0	5.0
Transport distance (km)	40.14	38.8	0.0	861.0
Transport distance (sone 1- 5)***	1.35	0.62	1.0	5.0
Lairage time (days)	0.35	0.49	0.0	9.0
Time of slaughter (hr.)	10.83	2.55	1.00	23.00

* Weight group: 1= <70 kg; 2=70-74 kg; 3=74-78 kg;.....6=86-90 kg; 7= >90 kg.
** Meat percentage producer: Producers grouped according to average meat percentage of all pigs delivered (1= <53%; 2= 53-54%; 3=54-55%; 4=55-56%; 5=>56%).
*** Transport sone: 1= <50 km; 2= 50-99 km; 3=100-199 km; 4= 200-299 km; 5= >300 km.

Table 2. Meat colour (Average, standard deviation, and percent carcasses with Colour values >60) before and after reconstruction of the CO_2 stunning systems at the plants.

Plant	Before			After		
	Average	Standard Deviation	% >60	Average	Standard Deviation	% >60
A	46.8	5.09	0.8	48.8	5.39	1.7
B	53.9	7.09	10.1	52.0	6.26	5.6
C	45.7	5.82	1.0	46.7	5.72	1.3
D	*	*	*	46.3	6.38	1.0
E	50.5	6.28	5.3	50.6	5.31	2.8
F	50.2	5.53	3.4	51.3	5.76	5.4

*Data only available after reconstruction.

Table 3. Analysis of variance using the GLM model (Partial Sums of Squares).

Variable	F_{ratio}	p-value
Plant	51136	<0.0001
Before or after reconstruction	17068	<0.0001
Slaughter weight	4773	<0.0001
Meat percentage producer	1775	<0.0001
Meat percentage	765	<0.0001
Overnight lairage	280	<0.0001
Time of slaughter	218	<0.0001
Transport distance	115	<0.0001
Breed (Noroc or non-Noroc)	89	<0.0001