EFFECTS OF ELECTRICAL HEAD-TO-CHEST AND CARBON DIOXIDE STUNNING ON MEAT QUALITY IN SLAUGHTER PIGS

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BACKGROUND

The current methods of stunning, such as electroanaesthesia and CO_2 exposure, are designed to induce physiological changes to the animal's brain so as to render it insensitive before slaughter. However, these methods lead to serious physical stress in the animal and can negatively affect the rate of the *post mortem* muscle glycolysis in pigs due to increased muscular activity and elevated release of cathecolamines into the blood flow (Troeger and Woltersdorf, 1990; 1991). In pigs, the high rate of *post mortem* muscle acidification leads to the condition of pale, soft and exudative (PSE) meat (Briskey, 1964). Several studies have demonstrated that the PSE increases after the application of electrical stunning due to the effect of the current on the degree of muscle contraction (van der Wal, 1979; Troeger and Woltersdorf, 1990), whereas CO_2 anaesthesia results in a reduction of the incidence of this quality defect (Larsen, 1983). To minimize the negative effects of the electrical stunning on the incidence of PSE meat, an automatic head-only and head-to-chest electrical stunner has been developed which induces a cardiac arrest cycle and eventually produces a reduction of the clonic convulsions of the animal at sticking due to the inhibition of the spinal nerve function (Gilbert *et al.*, 1984). The lower degree of muscular activity during the clonic phase would impede the onset of the PSE condition (Grandin, 1985). The aim of this study was to investigate under practical conditions the effect of the head-to-chest electroanaesthesia and CO_2 stunning systems on meat quality in pigs.

MATERIAL AND METHODS

A total of four commercial pig abattoirs were surveyed. They were chosen as representing the two new stunning methods for pigs. The abattoirs are located in different areas, with different access roads, lairage conditions and general handling. Two of them (A and B) were equipped with the MIDAS Stunning System (Stork RMS, Holland), that combines a chest belt with an automatically applied head-only followed by head to chest electrical stunner. The stunning current was applied by two electrodes between the eye and ear, spanning the brain at 220 volts with a frequency of 800 Hz for 2.4s. During the head application, a further electrode was applied to the chest of the pig and the cardiac arrest cycle (110 volts at 50 Hz for 1.7-2.0s) was induced via the chest and by the application of a contralateral head electrode. During stunning the pigs were moved out of the stunner falling onto a moving top table. The pigs were exsanguinated in a lying position within approximately five seconds after stun.
The other two abattoirs (C and D) used a Compact Carbon Dioxide Stunning Unit (Butina Aps, Copenhagen). The unit was a six-chair *paternoster* type conveyor loading manually two pigs at a time and then dispatching them to the base of a well which was filled with carbon dioxide (83%). Finally, animals were returned to an unloading position alongside the loading point and exsanguinated vertically on the bleed-rail.

Meat quality analyses

Each abattoir was visited for three days in order to evaluate meat quality. A total of 3,016 *Longissimus thoracis* muscles at the level of the last rib were evaluated at 2 hours *post mortem* (abattoirs A and C) and at 7 hour *post mortem* (abattoirs B and C). Meat quality was assessed by measuring the electrical conductivity (PQM-I-INTEK, Gmbh, Germany) and colour on the lateral surface using a chromameter (Minolta CR 200). Muscle samples were then taken, chilled (1-2°C) and frozen at -20°C at 24 hours *post mortem* pending ultimate pH determination (CRISON, micropH 2001) which was run according to the procedure described by Solomon (1987). The loins showing electrical conductivity (PQM) values higher than 6.0 µs were classified as PSE, whereas the loins presenting ultimate pH values above 6.0 were classified as DFD. The data were analyzed by the Statistical Analysis System (SAS, 1988), using the General Linear Models (GLM). The stunning method corresponding to the abattoir was considered as a main effect within each *post mortem* evaluation time (2 and 7 h).

RESULTS AND DISCUSSION

Meat quality variables were compared between abattoirs A and C and between plants B and D because of their different *post mortem* evaluation times (2 and 7 h, respectively). The lightness value was significantly higher in abattoirs A and B than C and D. Comparing the plants in this way, these differences show that the loins produced by the abattoirs equipped with electroanaesthesia were paler than those produced using CO_2. No significant difference was found between the plants as far as electrical conductivity was concerned. However, within our PSE parameters (higher than 6.0 µs), a higher incidence of PSE meat was observed in the plants equipped with electrical stunning. No difference was observed in the ultimate pH value. These results agree with the recordings made by Barton-Gade (1993) who observed a more elevated increase of the PSE incidence (range, from 10 to 19%) in plants equipped with electrical stunning than in plants operating CO_2 stunning (range, from 2 to 6%).

CONCLUSIONS

This study supports the evidence that the higher degree of muscle activity during the epileptic attack of electrically stunned pigs compared to gas stunned pigs led to a higher incidence of PSE meat in their carcasses.

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Table 1.- Least squares means and standard errors of meat quality[1] values and distribution of PSE and DFD carcasses according to the stunning method and *post mortem* times evaluation

	At 2 hours *post mortem*		At 7 hours *post mortem*	
	Head to chest A	CO_2 C	Head to chest B	CO_2 D
PQM	3.04 ± 0.24	2.68 ± 0.14	4.15 ± 0.13	3.70 ± 0.15
L*	42.43^{a} ± 0.31	40.58^{b} ± 0.15	44.39^{a} ± 0.16	42.10^{b} ± 0.18
a*	7.01 ± 0.17	6.07 ± 0.08	8.39 ± 0.08	7.81 ± 0.09
b*	3.06^{a} ± 0.10	2.14^{b} ± 0.05	3.26 ± 0.06	3.33 ± 0.07
pHu LT	5.69 ± 0.02	5.62 ± 0.01	5.52 ± 0.01	5.53 ± 0.01
PSE %	8.82	3.83	18.84	13.27
DFD %	16.08	8.19	8.03	3.83

[1] PQM: electrical conductivity (μs) ; L* a*, b*: Minolta values; pHu LT: ultimate pH; PSE: PQM>6; DFD: pHu LT>6
Means with different superscripts are significaly different ($p<0.05$).