Influence of stunning method on pH-decrease and meat quality

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Background

Two methods are today used internationally for commercial pre-slaughter stunning of pigs: Electric stunning and CO_2 anaesthetisation. CO_2 stunning is used more and more, but electric stunning is still widely used. The arguments for choice of method relate to animal welfare and meat quality. The physiological effect of the two methods differs. CO_2-anaesthetisation results in a lowering of the blood pH which leads to loss of consciousness (Eisele *et al.*, 1967) and the electric current used in electric stunning produces an epileptiform activity in the brain leading to unconsciousness without a simultaneous lowering of the blood pH (Hoenderken, 1978). Electric stunning will on the other hand be followed by an acute fall of the muscle pH due to the powerful activation of the glycolysis in the muscles. It is not known whether the lowering of the blood pH by CO_2 stunning also influences the intercellular pH in the muscles.

It is still controversial whether the same meat quality can be expected from animals stunned with the two methods. Change from one method to the other nearly always influences lairage conditions, pre-slaughter handling and sometimes also the subsequent slaughter process. Such changes can often have an effect on the meat quality.

Objective

It was the aim of this experiment to investigate the influence of the stunning method on muscle pH development, drip loss and colour under conditions where the genetic and environmental influences on meat quality were controlled.

Methods

12 litters of crossbred DDLY pigs from the same pig producer were used in the experiment. Two pigs were selected from each litter, one for electric stunning and one for CO_2 stunning. The 24 pigs were slaughtered at the experimental slaughterhouse at the Danish Institute of Agricultural Sciences, Research Centre Foulum. For 10 minutes prior to stunning the pigs were made to run on a conveyor belt at a speed of 4 km per hour to standardise levels of physiological state within groups. This was to simulate the acute stress slaughter pigs are normally exposed to before they are stunned. CO_2 anaesthetisation was carried out in a dip-lift installation with a CO_2 concentration of 90%. The pigs spent 3 minutes in the bottom position. The electric stunning was carried out with a tong with one prong placed behind one ear and the other at the opposite eye. The voltage was 250 Volt with a current of minimum 1.3 Amps. The electric stunning lasted for 10 seconds; shackling and hoisting thus took place with the stunning tong applied. After sticking and exsanguination the carcasses were scalded for three minutes, dehaired and flame treated. After evisceration (approx. 35 minutes after sticking) the carcasses were transferred to a ventilated area and then (approx. one hour after sticking) to a carcass chill room at 4°C and 30% ventilation.

Temperature and pH were measured in the *longissimus dorsi* muscle (LD) 1, 15, 30, 45, 60, 180 and 1440 minutes after sticking. At stunning, a biopsy was taken from LD for analysis for glycogen and lactate. The samples were frozen immediately at -80°C.

24 hours *post mortem* the colour was measured after blooming for one hour on a chop cut from LD (at 5-6 lumbar vertebra) using Minolta CR 300 (L*a*b*) equipment. Meat samples were taken from LD (between 2nd and 4th vertebra) for determination of drip loss (Rasmussen & Andersson, 1996).

Results and discussion

The pH development 1-180 minutes after sticking was described by a polynomium of 2nd power where the time coefficient depended on stunning method and carcass weight. The stunning method influenced the pH development. The electrically stunned pigs had a significantly lower muscle pH than the CO_2 stunned pigs in the period 60-150 minutes after sticking (figure 1). 1440 minutes (24 hours) *post mortem* there was no difference in pH level.

The stunning method did not influence the temperature development. The temperature fall in LD only depended on the carcass weight. The temperature 2 and 3 hours after sticking in carcasses weighing less than 85 kg was significantly 3-5°C lower than in the other carcasses.

Maribo *et al.* (1998a) have shown that the variation in meat quality due to different slaughter processes can be described by the maximum temperature, the time to reach 37°C and the rate of pH fall at the same point in time. This investigation showed no difference in max. temperature or in time to reach 37°C, but a significant difference between the two stunning methods in the rate of pH fall (table 1).

The results of the meat quality measurements (table 2) showed that the drip loss of the electrically stunned pigs was nearly twice the loss of the CO_2 stunned pigs. The glycogen and lactate contents at stunning and pH 24 hours *post mortem* were at the same level (table 3). Maribo *et al.*(1998b) also found that a fast pH fall 60-120 minutes after sticking led to a higher drip loss in LD independent of the glycolytic potential.

Table 1. Temperature, pH and rate of pH fall (V_{pH}) at critical control points after sticking.

	Stunning		Sign.
	CO_2	El	
Max. temperature, °C	39.5	39.7	ns
V_{pH} at max. temp.	-0.003	-0.001	***
Min. to 37°C	78	82	ns
pH at 37°C	6.12	5.97	ns
V_{pH} at 37°C	-0.003	-0.005	**

Figure 1. pH development 1-180 minutes after sticking

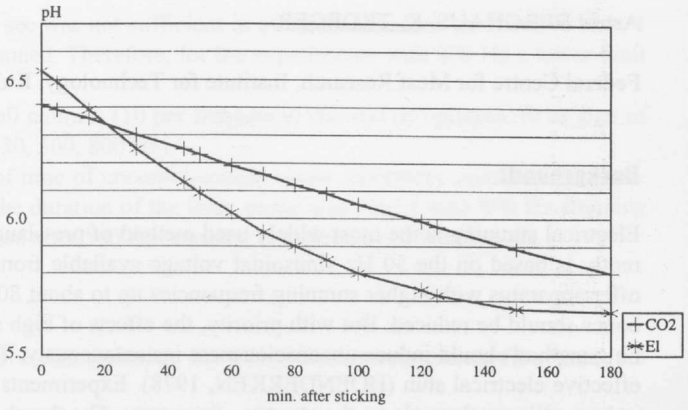

Table 2. Meat quality measurements

	Stunning		Sign.
	CO_2	El	
Drip loss, %	4.4	8.5	***
L*	53.7	55.5	**
a*	6.5	7.6	**
b*	5.0	5.9	*

Table 3. Glycogen and lactate at stunning and pH_{24}

	Stunning		Sign.
	CO_2	El	
Glycogen, µmol/g	53	59	ns
Lactate, µmol/g	32	27	ns
pH 24 hours *post mort.*	5.6	5.6	ns

The objective colour measurements with the Minolta equipment showed that the electrically stunned pigs had lighter meat (a significantly higher L*-value) but the a*-value was also significantly higher. There was therefore no difference in the subjective colour.

Conclusions

For pigs with similar genetic background (free from the Halothane gene) and with the same environmental exposure prior to stunning, electric stunning resulted in twice the drip loss in LD with the same ultimate pH and subjective meat colour. The higher drip loss was due to a faster pH fall caused by the electric stunning and thus a lower pH level in LD 60-150 minutes after sticking. There were no differences in the contents of glycogen and lactate before stunning in the two groups. The difference in drip loss can therefore not be caused by a difference in glycolytic potential.

Muscle pH 1 minute after sticking was not significantly different for the 2 stunning methods. A tendency for a lower pH in the CO_2 stunned pigs was, however, displayed and this may have been caused by a lower blood pH. Due to the faster rate of pH decrease in the electrically stunned pigs, this difference was equalised within the first twenty minutes, and from 60 to 150 minutes after sticking the pH was significantly lower in the electrically stunned animals.

Literature

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