CRITICAL CONTROL POINTS LINKED TO PSE INCIDENCE IN KOREA PACKING PLANT

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Background

Pressure on selection and feeding programs for high cutability product inadvertently resulted in high incidence of pale, soft and exudative (PSE) pork in Korea. However, industrial attention has not been given to the incidence as the most demanding and economically valuable cut is belly in domestic market. On the other hand, export-oriented packers are facing a challenge to identify critical control points linked to the incidence. Our preliminary study revealed a spiky increase in frequency of PSE product over last 3 years (i.e., 19 % and 45 % in 1999 and 2001, respectively, Park et al., unpublished data). Grandin (1994) estimated that packer's practice accounted for 50% of variation in final pork quality. Apart from the genetic component such as fiber composition (Depreux et al., 2002), interaction between pH and temperature during rigor development has been shown to be the most contributing factor responsible for PSE occurrence (Offer, 1991). The rate and extent of pH decline is a function of many pre- and post-slaughter factors including the way of transportation, lairage, stunning and cooling carcasses. These elements determine pre-slaughter physiological status and post-slaughter glycolytic activity. It is practically difficult to segregate the confounding effects (i.e., lairage, stunning and cooling regime) to assess their relative significance since ultimate meat quality is a consequence of their continuous interactions. However, the current study attempted to determine the critical control points associated with the high incidence of PSE in Korea pork packing plants.

Objective

The current study investigated the effects of lairage time, stunning voltage and cooling rate on the incidence of PSE pork.

Materials and Methods

Four separated experiments were conducted over four weeks in summer season (ca. 28ºC). A total of 12,028 pigs (LYD) were sampled from four export-oriented packing plants located in Jeju island, South Korea. Average live weight and age were 115 ± 10 kg and 170 days, respectively.

Experiment 1 (lairage time). A group of 3,402 pigs were held in lairage overnight (18 ~ 19 h) prior to slaughter, whilst another group of 5,243 pigs were slaughtered within 1.5 h after unloading. Average transportation time was less than 1.5 h for both groups. Animals were stunned by an electronic stunning method (230 volts for 3 seconds, 1.25 A), scalded at 60ºC for 8 min, halved and chilled at -10ºC for 70 min. All carcasses were thereafter placed at a 2ºC chiller until the following day (approximately 20 h). Time from stunning to breeding, scalding and to washing after halving were approximately 40 seconds, 8 min and 15 min, respectively. The following day left side was ribbed between 4 and 5 ribs, and meat color, texture and drip formation were assessed by three meat graders after a 30 min blooming period. Each attribute had a three level classification (i.e., Normal, Moderate, Extreme). Based on the combined scores, carcasses were subsequently classified into one of the three quality groups (Normal, Moderate PSE or Extreme PSE). When more than one 'Extreme' was observed for the three quality characteristics, the carcass was marked as an extreme PSE. If more than two 'Moderate' was scored, the carcass was classified into a moderate PSE group. The rest group was considered as normal pigs.

Experiment 2 (stunning voltage). Fifty nine and forty five pigs were used for a low voltage (230 volts for 3 seconds, 1.25 A) and a high voltage (500 volts for 3 seconds) stunning treatments, respectively. Lairage time was less than 1.5 h and other experimental conditions were identical with experiment 1.

Experiment 3(cooling rate). A total of 2,169 and 201 pigs were sampled for a fast cooling (- 15ºC for 70 min) and a slow cooling (- 5ºC for 70 min) treatments, respectively. Pigs were stunned by the low voltage system after being held in lairage for less than 1.5 h. Other experiments conditions were same as experiment 1.

Experiment 4 (lairage time plus cooling rate). Based on the results obtained from the previous experiments, this experiment examined the combined effect of these treatments compared to a conventional method. Treatment group (n = 559) received the overnight lairage, the low voltage stunning (230 volts for 3 seconds) and the fast cooling (-15 ºC for 70 min) treatments. Control group (n = 350) was treated as usually in these plants (i.e., lairage shorter than 1.5 h, 230 volts stunning for 3 seconds and - 5ºC cooling for 70 min). Other conditions were identical with experiment 1.

The treatment effect on the incidence of PSE meat was examined by a frequency test using SAS program.

Results and Discussion

Table 1 summarises the incidence rate of PSE pork from each experiment. It was obvious that one of the overnight resting, the low voltage stunning and the fast cooling treatments substantially reduced the incidence of PSE meat. The apparent effect was more evidenced when these treatments were incorporated.

A 22% reduction in PSE incidence was observed when pigs were held in lairage overnight compared to these slaughtered within 1.5 h after unloading. Given to the transportation time (i.e., shorter than 1.5 h), the current result indicated that lairage time after the short time of transport was significantly associated with PSE incidence in this region, and emphasized the importance of proper lairage practice prior to slaughter. This observation was in agreement with early study (Grandin, 1994) who showed that lairage was more important after a short transportation. Warriss (1987) reported that extended lairage time increased DFD incidence, however no particular DFD problem was noticed during the experiment.

The low voltage stunning resulted in 42% incidence of PSE pork which was a 24% reduction compared to 67% for the high voltage system. The 42% of PSE incidence from the low voltage group was still higher than studies (e.g., Gradin, 1994). However, the tend in the low voltage system to result in a low frequency of PSE meat was similar to other studies (e.g., Larsen, 1982). During the experiment it was frequently noticed that the low voltage stunning failed to induce an epileptic seizure as evidenced by continuous moving and struggling after the treatment. This could be a significant factor hastening glycolysis companied by elevation of body temperature. In this regard, the current result was of interest and difficult to interpret. On the other hand, it was considered that the high voltage stimulation might have an association with a fast decline in pH despite the measurement was not made.

As expected, the fast cooling treatment (i.e., -15ºC for 70 min) lowered ham muscle temperature below 32ºC immediately after the cooling treatment and reduced a 13% of PSE incidence compared to the slow cooling regime (- 5ºC for 70 min). This slow cooling treatment showed an average muscle temperature higher than 38ºC at the same time. Incidence of PSE meat for the fast cooling group was 40%, and the reduction was relative small (i.e., 13%) when the significant effect of pH/temperature profile during rigor development was taken into

account. This in turn indicated that the -15ºC for 70 min was not severe enough to reduce cooling temperature-related PSE meat. In addition, this also emphasized cooling rate had a little effect on reducing PSE phenomenon when other factors (i.e., lairage time and stunning method) were not exercised appropriately.

On the basis of the previous experiments, we examined the combined effect of these factors. The combined treatment resulted in 22% PSE incidence which was a 46% reduction in comparison to 68% for control group. The result indicated that PSE meat can be reduced if lairag time, stunning method and cooling regime were excised properly. This again demonstrated that these factors were a part of the most crucial control points determining pork quality within packing plant, and careful management was required in every single aspect.

Conclusions

Collectively, the current study demonstrates that the incidence of PSE meat can be reduced if appropriate lairage time, stunning method and cooling regime are exercised. A combination of resting in lairage overnight, low voltage stunning and fast cooling rate effectively reduced PSE incidence from 68% to 22%.

Table 1. The effect of lairage time, stunning voltage, chilling rate and their combination on the incidence of PSE pork

	Lairage time		Stunning voltage		Cooling rate		Lairage time + cooling rate	
	< 1.5 h	18-19 h	230 V	500 V	- 15ºC	- 5ºC	Conventional$^{\Phi}$	Revised$^{\Psi}$
Extreme PSE (%)	27.72	12.71	27.12	46.67	23.37	18.91	32.9	13.1
Moderate PSE (%)	27.9	21.17	15.25	20.0	16.27	33.33	35.1	9.1
Normal (%)	44.38	66.12	57.63	33.33	60.36	47.76	32.0	77.8
Number of animal	5,243	3,402	59	45	2,169	201	350	559

$^{\Phi}$ lairage time: shorter than 1.5 h, stunning voltage: 230 volts, cooling rate: - 5ºC for 70 min.
$^{\Psi}$ lairage time: overnight, stunning voltage: 230 volts, cooling rate: - 15ºC for 70 min.

Pertinent literature

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