PROVING PORK QUALITY BY ELECTRICAL STIMULATION OR HIP SUSPENSION OF CARCASSES

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s investigation compares the separate and combined effects on the important meat quality attributes of electrical stimulation (ES) and hip pension of pig carcasses chilled rapidly or conventionally. Sides from 80 pigs, 80-90 kg live weight, were allocated to one of four atments followed by either conventional chilling (1°C for 24h) or rapid chilling (-20°C for 2-3h, before 1°C until 24h post-slaughter). The eatments were: (a) & (b) Achilles suspended, with and without high voltage ES and (c) & (d) Hip suspended, with and without ES. quality attributes, pH, colour and opacity, drip loss, instrumental and sensory texture were measured in M. *longissimus thoracis et borum*, at 10 d post-slaughter. Rapid chilling reduced evaporative weight loss by 0.5%. There were no significant effects from treatment colour or opacity, although ES samples were slightly paler. Drip loss was also slightly greater with ES, particularly when combined with suspension, but in no case was the meat PSE. Instrumental measurements of texture showed improved tenderness from both ES and hip pension, even after 10 d ageing. The improvement was less pronounced when ES and hip suspension were combined. Taste panelling firmed that samples treated by ES or hip suspension, separately or combined, were significantly more tender than samples from non-ES, chilles hung sides. ES and hip suspension were equally effective in improving tenderness of pork. Hip suspension did not suffer the advantage of increased drip loss that occurred with ES.

TRODUCTION

as been demonstrated by Taylor and Tantikov (1992) that pork tenderness can be improved significantly by applying high voltage ES at tin post-slaughter. The improvement has been attributed mainly to alleviation of cold shortening toughness resulting from rapid ling, but increased tenderness also occurs at slower cooling rates where cold shortening is less likely. Alternatively, muscle shortening be avoided by altering the method of carcass suspension during chilling. Hanging carcasses from the pelvis has been shown to increase f tenderness (Hostetler *et al* , 1975), and Moeller and Vestergaard (1986) have shown that this can also improve pork tenderness. s study compares the effects of ES and hip suspension (PEL) on meat quality attributes. Because both techniques are influenced by ling rate, two chilling regimes were used, a conventional 24h chill, and a rapid sub-zero air blast chill.

PERIMENTAL

a - A total of 80 pigs (40 boars and 40 gilts), were used. They were bacon weight (80-90kg live weight) of white breeding, low dence of halothane gene and P2 between 8-12 mm. Only one side of each pig was used in the experiment.

perimental design - The 80 sides were allocated to the following 8 treatments:

		Achilles hung (ACH)	Hip hung (PEL)
ventional chilling	ES	10 sides	10 sides
	NES	10 sides	10 sides
id chilling	ES	10 sides	10 sides
	NES	10 sides	10 sides

illing - Pig sides were chilled from 45 min post-slaughter, by one of two regimes:

a) Conventional: Air at + 1°C and <0.5m/sec until 24h post-slaughter.

b) Rapid: Air at - 20°C and 1-1.5m/sec until deep LTL <10°C followed by air at +1°C and <0.5m/sec until 24h post-slaughter.

ctrical stimulation - High voltage ES (700v peak, 12.5 pulses/sec for 90 sec), was applied to pig sides at 20 min post-slaughter.

rcass suspension - Sides were chilled until 24 hr post slaughter, hung either by the Achilles tendon (ACH) or by a hook through the *levator foramen* (PEL).

ight loss during chilling - Sides were weighed at 45 min post-slaughter (before chilling) and at 24h (after chilling). The evaporative ght loss during chilling was the difference between the two, expressed as a percentage of the 45 min weight.

kfat thickness - Fat thickness was measured at the P_2 position on the hot carcass using an intrascope.

ling rate - Temperatures were recorded during each chilling treatment by inserting thermocouples into LTL and deep leg muscle.

H - pH was measured in LTL at 10/11th rib at 45 min, 3h and 24h post-slaughter. For each measurement, 1g muscle was homogenised in ml iodoacetate solution and measured with a Radiometer pH meter and combined electrode.

ality assessment - At 24h post-slaughter, a section of loin was removed from each of the sides and cut to provide samples of LTL for lity assessment. All samples except those for drip and colour/FOP were vacuum packed and held at 1°C until 10d post-slaughter before g's blast-frozen at -20°C and stored until assessment. Samples were thawed at +1°C overnight before they were assessed.

Colour - Lightness (CIELAB L*) of a section of LTL next to the last rib was measured at 24h post-slaughter with a Minolta Chroma Meter.
Muscle Opacity - Opacity or light-scattering property was measured on the same sample by Fibre Optic Probe (FOP).
Drip loss - A section of LTL, 25mm thick was suspended inside a plastic bag at 1°C, and the drip accumulating over 48hr weighed.
Instrumental texture - Muscle samples were cooked in water at 80°C to a centre temperature of 78°C and cooled overnight. Six blocks (10 x 10 x 20mm) were cut from each, along the fibre direction, and texture assessed using Volodkevitch-type jaws mounted on a Stevens CR analyser. Two measurements of texture were recorded: force at first yield, compressive force (both in kg).
Taste panelling - Loins were thawed overnight at room temperature, before being cut into 2.5cm slices. These were cooked on a preheated griddle and turned every 3 minutes until their internal temperature reached 80°C. The lean was cut into 2 x 3cm blocks and served hot to 10 panellists who scored for tenderness on a 8-point scale ranging from "extremely tough" (1) to "extremely tender" (8).
Analysis of data - Data were subjected to analysis of variance. Samples from each chilling treatment were combined and analysed with stimulation and suspension as factors. Differences between treatments were tested for significance at the 5% level, based on the s.e.d. of means, obtained from the analysis of variance. These differences are indicated in the Results tables as superscripts, and those attached to any mean value, represent the treatments which are significantly different from that mean, using treatment identifiers a, b, c and d.

RESULTS

Carcass characteristics - There were no significant weight or backfat differences between the pigs used for each treatment.
Chilling rate - Conventional chilling of sides achieved 10°C within 7.5h in deep LTL and 12.5h in deep leg. Rapid chilling reduced deep LTL to 10°C in 3.5h and deep leg in 9.5h, conditions which might be expected to lead to cold-shortening at least in LTL, and possibly in the leg.
Evaporation weight loss - Rapid chilling reduced weight loss from 2.3% to 1.8% over the 24h period.
pH - Table 1 shows that pH at 45 min of ES sides was approx. 0.3 units lower than NES. By 3h, ES sides were significantly lower, with mean values of 5.75 against 6.16 for NES sides. There were no significant difference in ultimate pH.
Colour (Lightness) - The mean values of the CIELAB colour coefficient L* (lightness) are shown in Table 2, with little difference between treatments, although ES samples were slightly lighter, especially when they had also been hip-suspeded.
Muscle Opacity (FOP) - There were no significant differences in muscle opacity, and the FOP values gave no indication of PSE or DFD pork. ES gave slightly paler pork, especially when also hip-suspended.

Drip loss - Drip loss, shown in Table 2, was generally low, but was increased slightly by ES, more so when conventional chilling was used. Drip was highest where ES was combined with hip-suspension.
Instrumental texture - Table 3 shows mean values across treatments for the instrumental texture parameters, yield and compression, measured in LTL at 10d post-slaughter. By both parameters, the highest toughness values were for the NES-ACH pigs, regardless of rate of chilling, although rapidly chilled sides were slightly tougher. Measurement of yield force showed the greatest tenderising effect from treatments ACH-ES and PEL-NES, while the combination of ES and hip suspension was less effective. Compression force showed little difference between ES and PEL treatments, but these were all significantly more tender than the ACH-NES controls.
Taste panel assessment - The general level of tenderness (Table 4) was quite high, across all treatments, after 10d ageing. Although treatment had a significant effect on tenderness, scoring for individual treatments was not consistent. Nevertheless, the ACH-NES controls were scored tougher on almost every occasion, and in most cases, significantly so. Conventionally chilled samples were slightly more tender than rapidly chilled. Of the three treatments involving ES and hip-suspension, the most tender samples were produced by PEL-NES with conventional chilling, but by the combined PEL-ES when chilling was rapid.

DISCUSSION

Although the post-slaughter treatments, chilling, ES and hip-suspension were superimposed on one another, the experimental design allowed their main effects to be identified. Rate of cooling had two effects. First, the economical benefit of rapid chilling is clearly shown by the reduced evaporative weight loss. An overall saving of 0.5% over 24 h represents a considerable advantage over conventional cooling. Secondly, rapid chilling, adversely affected tenderness, with a distinct possibility of cold shortening in the loin. Although the general level of tenderness was high, instrumental and taste-panel assessments showed that conventionally chilled sides were more tender than rapidly chilled. The difference was still present after 10 days' ageing, suggesting that it may have been greater at an earlier time post-slaughter. The main interest in this trial was in ES and hip suspension and their effect on meat quality. The effectiveness of the ES procedure was shown by the lower pH values at 45 min and 3 h. Hip suspension had no effect on pH. The rapid pH fall with ES was the most likely reason for the slightly paler pork colour, although the difference between ES and NES samples was not significant, except when ES was combined with hip suspension. Even here, the difference was probably not great enough to be visible, and FOP values showed no PSE muscle. The effect of ES on waterholding capacity of muscle was most pronounced with conventionally chilled carcasses, where ES treatments gave significantly more drip. With rapid chilling,the difference with ES was no longer significant. Hip suspension had no effect on drip loss, although among rapidly chilled pigs, it gave the lowest values. The relatively high drip loss when ES and hip suspension were combined,

ds with that treatment giving the palest muscle and highest FOP readings. Dransfield *et al* (1991) found no such detrimental effect from ining the two treatments, but also no advantage over applying the two treatments separately.

effect of the four ES/suspension treatments on texture was not clearly defined by the instrumental measurements, mainly because by 10d, e samples were relatively tender, with little room for further improvement. Measurements of yield force and compression, while not ing consistent significant differences between treatments, indicated that ES and hip suspension were equally effective in improving erness. The improvement was greatest where rapid chilling had been used, where (ACH-NES) controls were consequently tougher than ventionally chilled. There appeared to be no advantage in combining ES and hip suspension in terms of tenderness, since PEL-ES ples tended to be slightly tougher than either ACH-ES or PEL-ES samples.

differences between treatments were more pronounced when the samples were assessed by taste-panel. In almost all cases,the ferising effects of ES and hip-suspension, singly or combined were highly significant. Samples from pigs which had been hip-ended, with and without ES, tended to be slightly more tender than those which had only been stimulated.

NCLUSIONS

e results show that, even after 10 days, tenderness was improved by ES. This advantage is offset to some extent by a slight increase in loss, although this was alleviated by quicker chilling,which had the additional benefit of reducing post-slaughter weight loss. Hanging sses by the hip instead of by the Achilles tendon was as effective as ES and, in some cases, more effective than ES in improving erness of pork. Furthermore, hip suspension did not increase drip loss.

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ble 1. pH values at 45 min, 3h and 24h post-slaughter in LTL muscle of 80 pigs within 4 treatments and 2 chilling rates. Mean values of igs per treatment with standard errors of difference (s.e.d.), variance ratio (v.r.) and significance.

		Treatment				s.e.d.	v.r.	Significance
	Chilling	ACH-NES	ACH-ES	PEL-NES	PEL-ES			
45min	Conventional	6.50	6.23	6.46	6.23	0.139	2.16	NS
	Rapid	6.54^{d}	6.25	6.42^{d}	6.04^{ac}	0.151	4.12	<0.05
3h	Conventional	6.18^{bd}	5.75^{ac}	6.08^{bd}	5.70^{ac}	0.131	6.80	0.001
	Rapid	6.22^{bd}	5.81ac	6.16^{bd}	5.71^{ac}	0.142	6.38	<0.01
24h	Conventional	5.62	5.54	5.57	5.56	0.039	1.54	NS
	Rapid	5.61	5.60	5.64	5.59	0.044	0.38	NS

Table 2. Lightness (L*), FOP value at 24h post-slaughter and drip loss over 48hr in LTL muscle of 80 pigs within 4 treatments and 2 chilling rates. Mean values of 10 pigs per treatment, with standard errors of difference (s.e.d.), variance ratio, (v.r.), and significance.

		Treatment				s.e.d.	v.r.	Significance
	Chilling	ACH-NES	ACH-ES	PEL-NES	PEL-ES			
Lightness (L*)	Conventional	53.73	55.45	54.60	56.04	1.171	1.48	NS
	Rapid	52.54^{d}	53.32	51.16^{d}	55.72^{ac}	1.204	5.04	0.01
FOP	Conventional	27.0	33.1	27.8	33.6	5.420	0.81	NS
	Rapid	21.8	24.9	23.1	32.9	5.601	1.58	NS
Drip loss (%)	Conventional	2.05^{d}	3.52	2.06^{d}	4.02^{ac}	0.776	3.37	<0.05
	Rapid	2.26	2.77	1.66^{d}	3.31^{c}	0.726	1.88	NS

Table 3 Instrumental texture of LTL at 10 days post-slaughter of 80 pigs within 4 treatments and 2 chilling rates. Mean values of 10 pigs per treatment, with standard errors of difference (s.e.d.), variance ratio (v.r.) and significance.

	Treatment				s.e.d.	v.r.	Significance
Chilling	ACH-NES	ACH-ES	PEL-NES	PEL-ES			
Yield (Yf)							
Conventional	5.42	4.84	4.83	5.25	0.446	0.88	NS
Rapid	6.00	5.08	4.88	5.23	0.547	1.58	NS
Compresion (Cf)							
Conventional	4.79^{b}	3.41^{a}	3.89	3.87	0.473	3.00	<0.05
Rapid	5.55^{bcd}	3.99^{a}	3.93^{a}	4.00^{a}	0.593	3.55	<0.05

Table 4. Taste panel assessment of tenderness of griddled loin slices at 10 days post-slaughter, of 80 pigs within 4 treatments and 2 chilling rates. Assessment on 8-point rating scales from "extremely tough" (1) to "extremely tender" (8). Mean values of 10 pigs per treatment, with standard errors of differences (s.e.d.), variance ratio, (v.r.) and significance.

	Treatment				s.e.d.	v.r	Significance
Chilling	ACH-NES	ACH-ES	PEL-NES	PEL-ES			
Conventional	3.87^{bcd}	4.41^{a}	5.06^{abd}	4.73^{a}	0.18	13.98	<0.001
Rapid	3.57^{bcd}	4.11^{a}	4.03^{ad}	4.48^{ac}	0.21	6.34	<0.001