THE USE OF ULTRA-RAPID CHILLING AND ELECTRICAL STIMULATION ON LAMB CARCASSES

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Background : To avoid irreversible toughening of lamb, it is recommended that carcasses should not be cooled below 11°C in under 8 hours or until the muscle pH has reached 6.2 (Bendall, 1972). In recent years, evidence has been growing that rapid chilling of lamb in a pre-rigor state can be achieved without subsequent toughening of the meat (Bowling *et al.* 1978; Jaime *et al.* 1992; Sheridan, 1990). Absence of toughening, using rapid chilling, may be related to fast glycolysis. Electrical stimulation (ES) will rapidly reduce pH, which should facilitate the use of ultra-rapid chilling (Smulders *et al.* 1990).

Objectives: A better understanding of the behaviour of muscle pH during rapid chilling, could bring about the successful use of ultra-rapid chilling in lambs. This study investigated the effect of chilling, combined with electrical stimulation, on the tenderness and quality of lamb carcasses. The relationship between pH and tenderness, as a result of the above treatments, was assessed. The effect of rapid chilling on carcass weight loss was also measured.

Methods: Forty lambs were slaughtered in batches of four and assigned to one of four treatments, as follows: 1) CNES - control chilling at 4°C with an airspeed of 0.2 m/s for 24 hours, with no electrical stimulation (ES); 2) CES - control chilling with electrical stimulation; 3) UNES - Ultra-rapid chilling at -20°C using an airspeed of 1.5 m/s for 3.5 hours, with no electrical stimulation; 4) UES - Ultra-rapid chilling with electrical stimulation. After Ultra-rapid chilling for 3.5 hours, carcasses were moved into control conditions (4°C) for the remainder of the 24 hours. Low voltage ES (90v DC) was applied for two 1 minute intervals, with a 1 minute delay between intervals. Internal carcass temperatures were measured every 15 minutes. The pH of *M.longissimus dorsi* was measured at 1, 4 and 24 hours. Carcasses were weighed before and after chilling and the percentage weight loss calculated. Samples were removed from carcasses after 1 and 5 days storage at 4°C and frozen until required for Warner-Brazler tenderness assessment.

Results : Temperature dropped below 11°C after 4.25h and 10.75h for Ultra-rapid and Control carcasses, respectively (Fig. I). The mean pH values for carcasses from CNES, CES and UES treatments were below 6.2 before muscle temperature fell below 11°C. Muscle temperature in the UNES treatment had fallen below 11°C (4.25h) before pH had reached 6.2 (6.0h). This effect is summarised in Table I. The mean pH values of ES treatments were significantly lower than those of non-ES treatments at 1 and 4 hours post-mortem (Fig. II). The mean 24 hour pH value for Ultra-rapid carcasses was higher than that of the Controls by 0.2 pH units ($P < 0.001$), but the 4-hour differences between ES and non-ES carcasses were no longer evident. Weight losses from Control carcasses (CNES and CES) were on average about 0.4% higher ($P < 0.001$) than those of Ultra-rapid carcasses (UNES and UES). Loins from electrically stimulated carcasses were found to be significantly more tender ($P < 0.001$) on day 1 than those from non-stimulated carcasses (Fig. III). On day 1 there were no differences between mean tenderness values from non-stimulated carcasses (CNES and UNES), and this was also observed in stimulated carcasses (CES and UES). By day 5 there was no difference in tenderness between treatments, but overall tenderness had significantly improved for all treatments compared to their day 1 values ($P < 0.05$). It was also noted that the improvement in tenderness between days 1 and 5 was greater for the non-stimulated carcasses (CNES and UNES).

Discussion : The UNES treatment did not conform with Bendall's guidelines on avoiding toughening of lamb. However, this treatment did not produce meat which was ultimately tougher than the other 3 regimes. Previous work has shown that although mean Ultra-rapid tenderness values were similar to those of Control, unacceptably tough carcasses were occasionally produced (Mc Geehin *et al.*, 1996). In the present study however, the toughest day 1 loins were produced by Control chilling in both ES and non-ES carcasses (58N for ES, 71N for non-ES), while the most tender loins were produced by Ultra-rapid chilling (30N for ES, 38N for non-ES). It was also shown

that ES carcasses produced more tender loins than non-ES carcasses after 24h but further ageing to 5 days eliminated this effect. These data suggest that using ES to prevent toughening in lamb, in the present chilling regimes, is of little value, an observation made in the past (Sheridan, 1990). This has also been observed by Dransfield *et al.* (1992) who stated that ES produced more tender meat at 24 hours, but did not give any permanent tenderisation effect with time. However, these authors went on to say that muscle temperature was important in determining toughness, but in the present study temperature had no effect on tenderness. It should be pointed out however that the temperature regimes examined by Dransfield *et al.* (1992) were very different to those in the present study.

Conclusions : Ultra-rapid chilling of lamb carcasses produces loins as tender as those from conventionally chilled carcasses. Electrical Stimulation improves meat tenderness initially, but ultimate tenderness will be the same as non-ES meat.

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Fig. I Deep round temperatures under different chilling regimes.

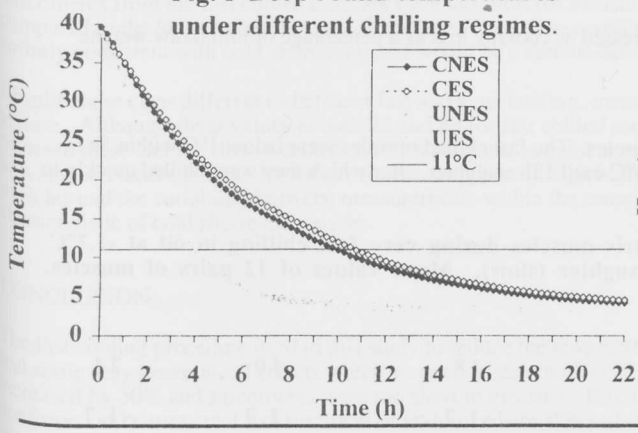

Fig. II pH decline of striploin under different chilling regimes

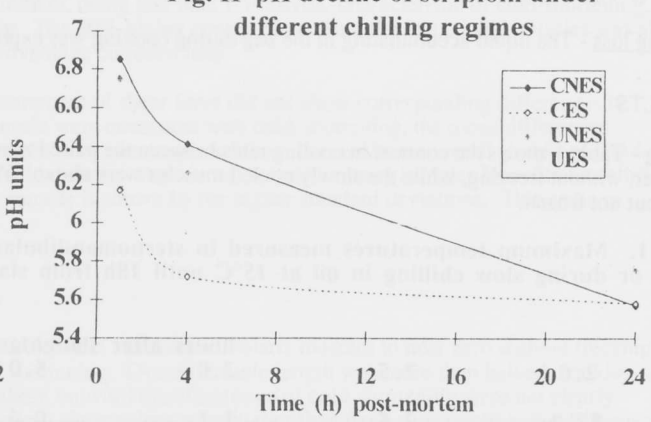

Table I Compliance of the chilling regimes to Bendall's (1972) guidelines

	Time to pH 6.2		Time to 11°C	
CNES	8.0 Hr	<	10.0 Hr	✓
CES	1.0 Hr	<	10.75 Hr	✓
UNES	6.0 Hr	>	4.25 Hr	✗
UES	1.0 Hr	<	4.25 Hr	✓

Fig. III Effect of chilling on striploin tenderness