

Electrical stunning and beef cattle slaughter in New Zealand.

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The production of beef to meet the halal slaughter requirements of the Malaysian, Middle East and other Muslim markets provides New Zealand with valuable flexibility in marketing.

The crucial issue is the means of stunning. While percussion stunning is accepted by some markets, difficulties arise in avoiding skull damage and ensuring that every animal is rendered insensible to pain, and yet can recover if the slaughter process is not completed. Also, contamination can occur when the weasand is cut with the animal hoisted. The heart must remain beating, and this must be obvious when the halal cut is made.

We have shown that electrical head-only stunning followed by animal electro-immobilization will avoid these difficulties and lead to a more easily controlled slaughter system. We have also developed the necessary equipment for animal restraint and electrical stunning. The animals receive a head-only stun, which ensures that the heart continues to beat and allows the animal to recover normal consciousness if the halal cut is not made. After stunning the beast drops onto a bleeding table and a single, uninterrupted cut severing the carotid arteries, jugular veins, trachea and oesophagus is made within 6 sec of the stun.

**The Process**

The following outlines the New Zealand process, which has been works tested at the Waitaki-N.Z. Refrigerating plant, Wairoa:

1. Restrain the animal in a head bail that contains one set of electrodes which contact the animal's neck behind the ears.
2. Raise the animal's head to within reach of a T-shaped electrode which drops to make contact across the nose of the animal.
3. Stun the animal across the brain with an electric current of 1.5 - 2.5 A, 400 V a.c. for 2-4 s.
4. Drop the animal onto a bleeding cradle and perform the halal cut (within 6 s of stunning).
5. Apply electro-immobilization clips to the nose and anus and turn power on (80 V d.c., 5 ms pulse at 70 ms intervals). These clips are applied by the shackler and the man opening and clipping the weasand.
6. Locate, rod and clip the weasand, and shackle.
7. Allow electro-immobilization/low voltage stimulation to time out (30 s) and remove immobilization clips.

8. Hoist to rail, and continue normal dressing.

**Electrical Stunning**

Electrical stunning involves passing an alternating electric current through the brain, producing a hypersynchronous overstimulation of nerve cells and immediate loss of consciousness. The animal experiences a grand mal epileptic seizure, which in cattle has the following symptoms:

- o First or tonic phase: The hind-quarters collapse, the forelegs flex and may stiffen; the eyeballs rotate downward and the eyelids close; the head is extended upwards and backwards; and respiration is inhibited. This phase lasts from 10 to 15 s.
- o Second or clonic phase: The animal gradually relaxes and makes walking movements. The eyelids open, but the eyeballs remain rotated. This phase lasts about 30 s.
- o Third or recovery phase: If the animal is not bled out, it will begin to regain consciousness and take an interest in its surroundings about 60 s from the stun initiation. The regaining of consciousness is rapid, although the animal may remain prone for some time before regaining its feet.

For stunning to be effective, a current of 1.1 amps must traverse the brain, for 1 s. Immediately after electrical stunning and for about 10-15 s thereafter, the animal must show signs typical of the tonic phase of the electroplectic fit.

To reduce the severity of blood splash, the stun current is kept low, and the halal cut made within 6 s of the stun initiation. At Wairoa stunning parameters are between 1.5 and 2.5 A for 4 s.

**Electro-immobilization**

Head-only stunning does not inhibit reflex movements. Because of this, electro-immobilization is used for safety and to facilitate shackling. Stunning-to-immobilization time is less than 10 s.

Low-voltage, nose to anus electro-immobilization controls movement after the animal has had its throat cut, masking the clonic phase of the stun. The pulsed current, continuously passed throughout the carcass, keeps the body muscles contracted, holding the carcass rigid and inhibits breathing. After 30 s reflex movement of the carcass is markedly reduced.

**Weasand Closure**

The oesophagus normally closes during the electrical stun and remains closed for 20-30 s after the stun; this closure is maintained during electro-immobilization. Clipping of the weasand is carried out before the carcass is hoisted.

The team involves men who:

- (a) Control stunning and opening of doors.
- (b) Make the halal cut.
- (c) Applies the nose clip of immobilization unit.
- (d) Shackles and applies anus clip of immobilization unit.

The mechanical and electrical systems are controlled by a programmable controller which sequences the operations. The stunner has a control panel from which he operates the head bail, which initiates the automatic stunning sequence. Control of water to aid stun contact, timing of stun, head bail release, door opening and carcass push out are automatic.

#### Bleeding

The main difference between halal and normal bleeding is a consequence of the cut. Blood is actively pumped from the carotid arteries during halal slaughter, whereas a thoracic stick yields blood passively from the venous side of the heart. Our studies on over 100 beef animals ranging between 155 and 300 kg carcass weight indicate that amounts and rates of bleeding after the halal cut are similar to those recorded for comparable thoracic-stuck animals.

British Meat Research workers (MIDAS, 1978) report that 60% of the animal's blood will be released during slaughter, leaving 20-25% in the viscera and 15-20% in the lean, fat and bone. Typical weights of blood obtained from cattle of 250-kg carcass weight would be 15 kg from normally stuck, compared to 14.7 kg from halal beasts in our study. Two-thirds of this blood, or 10 kg, will bleed out under immobilization, leaving around 5 kg of blood to bleed after the carcass is hoisted. Immobilization has no discernible effect on the bleeding rate of electrically stunned animals (Fig. 1).

#### Meat Quality

To study the meat quality of chilled steak destined for the Middle East. Twelve cattle were slaughtered using the halal process just described and 12 control animals were killed traditionally using a captive-bolt stunner. After dressing, the right sides of each carcass were electrically stimulated (ES), and both sides were chilled overnight to 10°C deep shoulder. The striploins were boned-out and halved: one half was wrapped in polythene and quick frozen and the other half was vacuum-packaged and chilled for 10 weeks at -1°C. Dark cutting carcasses were eliminated by pH measurement at boning out. At packaging and again after 10 weeks' chilling, microbiological samples were taken and aerobic mesophilic plate counts, incubated at room temperature, were determined. Steaks were cut from the frozen and chilled striploins. Frozen steaks were thawed and the steaks were then grilled, cut into samples and served to a taste panel of research staff. Tenderness was also measured objectively with a tenderometer.

#### Humane Aspects

The humaneness of electrical stunning of cattle depends on the duration of insensibility caused by stunning and, after sticking, the likelihood of the anoxic state being maintained in the brain until death occurs. The slaughter process at Wairoa is humane for the following reasons:

1. The electroplectic fit induced by electrical stunning produces a period of intense muscle tetany for 10 to 15 s, inhibiting respiratory movements.
2. Immobilization applied at 10 s maintains this muscle tetany. Blood gas analysis during exsanguination indicates an arterial oxygen level insufficient to maintain consciousness even if a normal blood supply is maintained to the brain via the vertebral arteries.
3. Electro-immobilization markedly increases the rate of muscle and nervous metabolism increasing demand for limited supplies of oxygen.
4. Electrical stunning releases neuropeptides in the brain, which have a strong analgesic effect.

These four factors effectively maintain the brain in an anoxic analgesic state until permanent insensibility is ensured by exsanguination before the end of the electro-immobilization period.

#### Plant Installation

A typical plant in New Zealand consists of a ramp into the stunning box, fitted with the normal stop gates; a stunning box with a vertical lift discharge door, on to which the head bail type stunning apparatus is mounted; a flat sticking cradle, with provision for blood collection underneath; facilities for the application of electro-immobilization current; and a hoist to the main rail, leading to the start of the dressing system.

An average time cycle is as follows:

	<u>Time from beginning of stun</u>
Stunning	4 seconds
Open door and time to halal cut approximately	6 seconds
Application of immobilization current at	10 seconds
Finding and clipping weasand, shackle	15-35 seconds
Electro-immobilization ends	40 seconds
Hoist to rail - clear area	40-50 seconds
Bring in next animal and restrain	10 seconds

### Eating Quality

Four treatment groups were evaluated. These had been either quick frozen (unaged) or chilled for 10 weeks at -1°C (aged). These groups are:

Halal  
Traditional  
Halal/ES  
Traditional/ES

)  
)  
)  
)

Quick frozen (unaged)

Halal  
Traditional  
Halal/ES  
Traditional/ES

)  
)  
)  
)

Chilled for 10 weeks at -1°C (aged)

The taste panel mean scores for aroma, texture, juiciness and overall acceptability are shown in Tables 1 and 2.

The halal and "traditional" steaks were not significantly different in terms of aroma, flavour or juiciness. The texture of the unaged halal striploin was significantly better (one taste-panel unit) than that of the unaged striploins from traditionally slaughtered oxen. This improved texture is the expected bonus from electro-immobilization. Although not equivalent to full ES, the 30-sec stimulation affords some protection from the moderately fast overnight chilling rate used at Wairoa, where striploin temperatures dropped to below 10°C after 11 hours chilling.

The results of the chilled (aged) steaks show a considerable improvement in eating quality for all groups. Texture and overall eating quality were no longer significantly different for the two slaughter techniques, indicating the excellence of these chilled products. The tenderometer readings reflected the taste-panel data for texture (Table 3).

### Microbiology

Very low counts (less than six bacteria/g) were found at packaging. These low counts continued throughout the chilling period. No count on striploins exceeded  $10^6/g$  after 10 weeks' chilled storage at -1°C. *Lactobacillus* was the prevalent bacterium identified.

Table 1. Eating quality characteristics of unaged striploins from halal and traditionally slaughtered oxen; mean scores of in-house panel.

Attribute	Taste panel mean score <sup>1</sup>		
	Halal	Traditional	Significance <sup>2</sup>
Aroma	6.37	6.28	NS
Texture	4.36	3.40	5%
Flavour	6.23	6.10	NS
Juiciness	6.22	6.14	NS
Overall	5.06	4.38	10%
Attribute	Halal/ES	Traditional/ES	Significance
Aroma	6.47	6.42	NS
Texture	5.00	5.12	NS
Flavour	6.54	6.44	NS
Juiciness	6.12	6.03	NS
Overall	5.67	5.68	NS

Table 2. Eating quality characteristics of aged striploins from halal and traditionally slaughtered oxen; mean scores of in-house panel.

Attribute	Taste panel mean score <sup>1</sup>		
	Halal	Traditional	Significance <sup>2</sup>
Aroma	6.55	6.68	NS
Texture	6.58	6.68	NS
Flavour	6.91	6.96	NS
Juiciness	6.79	6.95	NS
Overall	6.66	6.77	NS
Attribute	Halal/ES	Traditional/ES	Significance
Aroma	6.37	6.38	NS
Texture	6.51	6.95	NS
Flavour	6.73	6.92	NS
Juiciness	6.85	7.04	NS
Overall	6.60	6.88	NS

- Hedonic 9-point scale: 1 = couldn't be worse; 9 = couldn't be better; mean of 40 panelists per animal, tasting 9 animals.
  - Probability of difference between the two means.
- NS Not significant.

Table 3. Objective tenderness measurements of striploins from halal and traditionally slaughtered oxen.

	Unaged mean ± s.d. (n)	Aged mean ± s.d. (n)
Halal	57.9 ± 22.9 (60)	32.10 ± 7.46 (75)
Traditional	66.1 ± 13.5 (75)	33.10 ± 4.68 (76)
Halal/ES	45.7 ± 12.8 (70)	32.29 ± 8.98 (67)
Traditional/ES	48.3 ± 19.6 (79)	32.37 ± 9.61 (76)

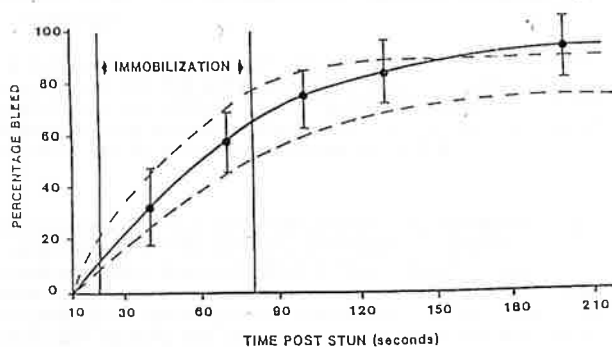


Figure 1. Bleeding rates of cattle after slaughter. Solid line: mean and standard deviation for 100 animals (155-300 kg carcass weight) after halal cut. Dashed line: range of values for thoracic-stuck cattle (MIDAS, 1978).