Electrical stunning and meat quality of veal calves

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Introduction

In the Netherlands practically all pigs and the majority of sheep are stunned electrically before slaughter, but to stun adult cattle and calves the captive bolt is still the only method used.

The captive bolt pistol, however, is expensive in use. Electrical stunning is very cheap and works very quickly since the introduction of higher voltages (several hundreds of animals per hour). Therefore this method would be more suitable for slaughterhouses with a high capacity.

Although many methods for electrical stunning of adult cattle and calves in the abattoir have been described in the literature (FRICKINGER, 1928; TERVOERT, 1950; LUBADEL, 1960; WARRINGTON, 1974), none of these methods were generally introduced in practice.

Recent investigations at our Institute have shown, that electrical stunning of veal calves (up to 600 V) with the electrodes placed between the eye and ear, is not suitable for practice because of the very short duration of the epileptiform insult (a condition of unconsciousness) as well as the rapid onset of clonic spasms (LAMBOOY & SPANJAARD, 1981a). Therefore an electric stunning method is required, that will lengthen the duration of unconsciousness and decrease the clonic spasms. This was achieved under experimental conditions with a modified electro-sting stunning equipment with a high voltage (600 V) which kills the calves immediately (LAMBOOY & SPANJAARD, 1981a).

The purpose of this investigation was

a) to judge if the modified electro-sting stunning equipment is suitable for practical application in a slaughterhouse

b) to judge if the stunning method has any effect on the rate of post mortem glycolysis, meat colour and the occurrence of bloodsplashes.

Material and methods

In a veal calf slaughterhouse equipped with a restrainer for the stunning of the animals, 50 calves were electrically stunned and 50 control calves were stunned with the normally used captive bolt*. Their carcassweights were 131 ± 15 (s.d.) kg (n=50) and 129 ± 15 (s.d.) kg (n=50) respectively.

Before electrical stunning the skin of the calves was moistened to ensure good contact of the flat electrodes. A commercial stunning apparatus** (50 Hz) with a voltage of 600 V and with a stunning time of 3 seconds was used. The stunning tong was a modified electro-sting tong** with electrodes on the head and neck of the

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** Nijhuis B.V., Abattoir Equipment, Winterswijk, the Netherlands.

animal. Current and voltage were recorded* during stunning. The post-stunning behaviour of the animal especially the occurrence of spasms, exhaustion and recovery, was visually assessed. After stunning the animals were chained by two feet (in the restrainer), hoisted and debleeded.

Forty-five minutes after stunning the carcasses were inspected for blood splash. The pH and temperature of the M. Longissimus of the carcass was measured 1 hour, 2 and 24 hours after stunning.

At 24 hours after stunning the carcasses were visually evaluated for colour using an arbitary scale from one (dark) to ten (light) by a member of the slaughterhouse, experienced in colour judgement of veal carcasses for commercial purposes.

The superficial colour of the carcasses (M.rectus abdominis) was determined using a Japanese 6-point colour scale reference (1 = white and 6 = red). In addition, a sample of approximately 100 gr. of the M. rectus abdominis was collected and tristimulus values were measured by Hunterlab** (L, a, b). The meat samples were subsequently frozen until analysis of total haematine according to the procedure described by HORNSEY (1956).

Results and discussion

During stunning the animals showed a tonic cramp and relaxed after a while. It was necessary that the animals relaxed before they could be chained. Because of this and because of the lack of experience with electrical stunning, the time between electrical stunning and throat cutting varied from 50 - 110 seconds. In the control animals, the time lapse between captive bolt stunning and throat cutting was about 55 seconds.

The voltage used was 600 V and the amperage recorded 0.5 and 1 second after the start of the stunning was 5.4 ± 1.5 A (n=50) and 5.6 ± 1.7 A (n=50), respectively.

In the experimental group 7 animals recovered or started to recover before bleeding. An explanation for this could be that the animal fell from the restrainer onto a table, which is a reason for restarting of the heartbeat and the recovery of some animals. Another probable explanation is that it is very difficult to cause a permanent heartarrest in all of the animals. Thus it is necessary to cut the throat as soon as possible; within 30 - 40 sec.

No bloodsplashes were observed in the carcasses, although in the lungs in 98 % of the electrical stunned animals and in 0.5 % of the controls bloodsplashes were observed.

The results of pH and temperature are presented in table 1. The pH of the M. Longissimus at 1 hour and 2 hours after stunning was significantly ($P < 0.001$) lower in the electrical stunned animals than in the controls. The more rapid decrease of the pH of the M. Longissimus in the electrically stunned animals suggest that this treatment has an effect similar to early post mortem electrostimulation (EIKELENBOOM et al., 1981). This finding is remarkable since the stunning time is only 3 seconds and the animal is not immediately debleeded. It should be mentioned that after electrical stunning the animals show a tonic cramp of about 20 seconds and bloodflow is stopped because of the cardiac arrest (LAMBOOY & SPANJAARD, 1981a). After captive bolt stunning, however, the animals show a tonic cramp of only 5 - 10 seconds (LAMBOOY & SPANJAARD, 1981b) while the blood flow is not interrupted. These differences in reactions might be responsible for the observed difference in

* Elema Schönander, Stockholm, Sweden

** Hunterlab, Fairfax, Virginia

post mortem pH fall between both groups of animals.

The average colour measurements are presented in table 2. The carcasses of the electrically stunned animals, as judged visually, had a significant ($P < 0.001$) better colour than the control carcasses after 24 hours, although no significant differences were found in the M. rectus abdominis using the Japanese colour scale and Hunter L, a, b. The difference between the visual method and the other colour method is that a person is subjective (although experienced) and can observe the whole carcass, while the other methods only measure one muscle. The Japanese colour scale was made for pigs but can be used for calves if the scale has a wider range because in our experiment nearly all carcasses scored 2 or 3 on the scale.

In spite of the cardiac arrest which occurred in the electrical stunned animals the total haematine value was not different from the controls. Since the animals were exsanguinated in a hanging position the presence of normal cardiac activity is of lower importance for the degree of the debleeding. Moreover when the heart is fibrilating the debleeding is slower but not worse as found by WORMUTH et al. (1980) in chickens.

For the pooled data significant ($P < 0.001$) correlations were found between and among the various colour measurement methods and total haematine (table 3). Relatively high correlations found between Hunter L values and total haematine and between Hunter L values and visual colour score were 0.69 and 0.65 respectively.

Our results suggest that electrical stunning of veal calves is a stunning method which can be used in practice. Moreover electrical stunning points to an electricostimulation effect. Upon visual colour evaluation of the total carcass electrically stunned animals scored better than control animals, although no significant differences were observed with Japanese colour scale and Hunter L, a, b and total haematine between both groups in the M. rectus abdominis. Because of the advantages of both electrical stunning and electrostimulation it should be worthwhile to initiate further research into an optimum combination of both treatments.

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Table 1. Average values (± standard deviation) of pH and temperature of M. Longissimus of electrically and captive bolt stunned calves.

Stunning method	pH 1 hour	pH 2 hours	pH 24 hours	Temperature in °C 1 hour	Temperature in °C 2 hours	Temperature in °C 24 hours
electrical	6.55±0.31 n = 46	6.12±0.27 n = 40	5.57±0.12 n = 44	39.3±1.2 n = 45	31.8±2.4 n = 40	5.7±0.7 n = 44
captive bolt	6.78±0.29 n = 50	6.41±0.30 n = 40	5.60±0.21 n = 50	39.2±0.9 n = 50	31.8±2.9 n = 33	5.8±0.8 n = 50

Table 2. Average values (± standard deviation) of the colour measurement methods and total haematine of electrically and captive bolt stunned calves. (Hunter L, a, b, Japanese colour scale and haematine of the M. rectus abdominis and visual colour score of the whole carcass).

Stunning method	Colour: Hunter L	Hunter a	Hunter b	Japanese colour scale	Visual colour score	Haematine (mg/kg)
electrical	43.7±3.1 n = 44	13.1±1.0 n = 44	9.0±1.0 n = 44	2.5±0.6 n = 44	7.8±0.8 n = 44	61.4±14.7 n = 44
captive bolt	42.9±3.4 n = 49	13.3±1.3 n = 49	8.9±1.2 n = 49	2.5±0.6 n = 50	7.2±0.8 n = 50	61.5±16.0 n = 49

Table 3. Coefficients of correlations ($P < 0.001$) between and among the colour measurement methods and total haematine. (Hunter L, Japanese colour scale and haematine of the M. rectus abdominis and visual colour score of the whole carcass).

	Hunter L	Japanese colour scale	Visual colour score	Haematine
Hunter L	1.00	-0.38	0.65	-0.69
Japanese colour scale	-0.38	1.00	-0.50	0.43
Visual colour score	0.65	-0.50	1.00	0.59
Haematine	-0.69	0.43	-0.59	1.00