LOW VOLTAGE ELECTRICAL STIMULATION OF BEEF. INFLUENCE OF PULSE TYPES ON POST MORTEM pH FALL AND MEAT QUALITY

H. RUDERUS

Swedish Meat Research Institute, S-244 00 Kävlinge, Sweden

INTRODUCTION

WE REPORTED EARLIER on the use of square wave pulses of low frequency and very low voltage for electrical stimulation of beef carcasses (Nilsson et al. 1979; Fabiansson et al. 1979). This work was done at the abattoir of Kristianstad-Blekinge Slakteriförening (KBS) with rather simple experimental equipment. Voltage and other pulse characteristics were measured with ordinary galvanometric instruments.

In other experiments, using more elaborate electronic circuitry for pulse generation, we were unable to reproduce the results obtained with the KBS equipment. Oscilloscope measurements revealed that the KBS equipment produced short bursts of high frequency peaks (or spikes) with peak voltages of about 80 volts. Since this equipment gave very efficient stimulation not found with pure square waves we found it necessary to reconsider the pulse characteristics for low voltage stimulation. The aim of this investigation was to test some distinctly different pulse types and to measure their relative efficiency in terms of pH fall in selected muscles.

MATERIALS AND METHODS

YOUNG BULLS were stimulated immediately after bleeding. Stimulation time was 1 min. Electric contact was made by a battery clamp connected to the muzzle. The bleeding rail served as the negative pole.

The following pulse types were used (peak voltage; pulse duration; pulse repetition time).

A: square wave pulses (20 V; 1 sec; 2 sec)

B: square wave pulses (40 V; 1 sec; 2 sec)

C: pulses made up of peak trains of frequency 100 Hz (65 V; 60 msec; 1 sec)

D: pulses made up of peak trains of frequency 100 Hz (80 V; 60 msec; 1 sec)

E: pulses made up of peak trains of frequency 14 Hz (80 V; 1 sec; 2 sec) individual peak width 5 msec

F: continuous stimulation, frequency 14 Hz (80 V; 1 min; -) individual peak width 5 msec.

pH was measured in three muscles at the end of the dressing line just before the cooler. Time after bleeding varied from 1.5 to 2 hours as indicated in the results. A portable pH-meter with a glass combination electrode was used. Points of measurement were M. triceps brachii, M. longissimus dorsi opposite to the first lumbar vertebra and M. biceps femoris.

RESULTS AND DISCUSSION

pH VALUES at the three points of measurement after different types of stimulation are shown in table 1.

The pH values after treatments A and B do not differ much from the unstimulated values notwithstanding that the values from treatment A were measured 20 min earlier than from the other two treatments. Treatments C and D are clearly more effective, 80 V peak voltage giving a slightly better result than 60 V.

Treatment E gives a marginally lower pH than treatment D while the continuous treatment F clearly produces a very fast pH fall.

Treatments E and F have a fairly high peak voltage but since the duration of each individual peak is very short (5 msec) compared to the total cycle time (72 msec) the effective (rms) voltage will be very low. Nevertheless, the stimulation effect is very good.

Treatment F has the further advantage that it will not cause any extra strain on the bleeding rail since the carcass will not twitch during treatment.

Since stimulation is performed directly after bleeding it is very likely that the nervous system is intact and thus the electrical pulses should be designed to give as effective depolarization of the nervous system as possible. Such a "physiological" type of stimulation would probably consist of very short peaks of some milliseconds dura-

Table 1. pH values in selected muscles after different kinds of electrical stimulation.

Type of stimulation	Time after bleeding	pH values						Number of animals
		M. triceps brachii		M. longissimus dorsi		M. biceps femoris		
	h	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	
Not stimulated	2	6.44	0.16	6.52	0.18	6.37	0.06	5
A	1.6	6.45	0.26	6.58	0.09	6.53	0.14	5
B	2	6.23	0.18	6.19	0.19	6.27	0.11	9
C	2	5.84	0.12	6.20	0.16	6.04	0.14	8
D	2	5.68	0.24	5.98	0.12	5.92	0.14	6
E	2	5.61	0.26	5.88	0.06	5.87	0.20	8
F	1.5	5.72	0.26	5.82	0.20	5.78	0.26	15
F	2	5.43	0.17	5.50	0.19	5.47	0.22	19

tion interspaced with recovery periods long enough for the nervous membrane potential to be reestablished. This gives a minimum recovery time of about 20 msec. However, it can be hypothesized that in order to produce as effective stimulation as possible the recovery time should also allow individual muscle cells to recover completely before the next contraction and thus consume a maximum of available energy. The recovery time necessary for this might be slightly longer. In fact, Chrystall and Devine (1978) found that the optimum frequency for stimulation was around 10-15 Hz. This was the reason for us to try only 14 Hz for the continuous stimulation.

That treatment F was very effective can be seen from the observation that when using treatment F we found signs of "overstimulation", i.e. rigor onset seemed to start already during dressing. Single cuts from some animals also showed signs of PSE conditions. "Overstimulation" however, could easily be checked by decreasing stimulation time, stimulation voltage or both.

REFERENCES

Chrystall, B.B. & Devine, C.E. (1978). Meat Science 2, 49.

Fabiansson, S., Jonsson, G. & Rudérus, H. (1979). 25th European Meeting of Meat Research Workers, 2.3.

Nilsson, H., Rudérus, H. & Fabiansson, S. (1979). 25th European Meeting of Meat Research Workers, 2.2.

ACKNOWLEDGEMENTS

The experimental work was performed at Kristianstad-Blekinge Slakteriförening by Mats Mågård, Agne Bergquist and Peter Hök and the electronic circuitry used was designed and built by Lars Svensson, all at the Technical Section of the Swedish Meat Research Institute. Prototype equipment was delivered by MIT AB, Simrishamn, Sweden.