ESTIMATION OF THE EFFICIENCY OF ELECTRICAL STIMULATION THROUGH MEASUREMENT OF CARCASS CONTRACTION STRENGTH

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INTRODUCTION

Tetanic muscular contractions are known to appear when applying electrical stimulation (ES) to beef and lamb carcasses. The more intensive the contractions the faster the energy stored in the carcass will be depleted.

Overstimulation and inadequate ES are not desirable in meat production and one of the ways to avoid them is by controlling the efficiency of ES and interrupting the treatment at the appropriate time. In order to control the efficiency of ES many investigators use the pH drop in representative muscles. Since measurement of pH during ES is not possible control of the efficiency of ES could be achieved by measurement of the alteration of the carcass impedance z (Tsankov et al. 1988). Some investigators use carcass contraction strength as a criterion for estimation of the efficiency of ES (Moisseenko et al. 1982, Chrystall et al. 1978, Asghar et al. 1982). Application of this criterion could result in elimination of some of the disadvantages of the other methods.

The aim of the present work was to study the possibility for automatic control of the efficiency of ES during stimulation on the basis of carcass contraction strength measured in a tensometric way.

MATERIALS AND METHODS

Thirty Thracian fine-fleeced Bulgarian breed lambs of live mass 24-30 kg (aged 6-8 months) were used. The animals were from one and the same herd and they were transported from a farm situated at about 20 km from the slaughterhouse. They were killed in the usual way within three hours after arrival and were divided into 3 equal groups (A, B and C) and each of the groups was further divided into 2 equal subgroups (A1, A2, B1, B2, C1, C2).

Electrical stimulation. After dressing, within 5 min after killing, all carcasses were stimulated for 1 min with square unipolar pulses (90 V peak; frequency - 10 Hz (A), 15 Hz (B), 25 Hz (C); duration - 5 ms (A1, B1, C1) and 10 ms (A2, B2, C2)). The negative electrode of stainless steel (length - 150 mm, diameter - 6 mm) was inserted in the muscles about the Achilles tendon of the hind legs. The positive one was a three-point electrode of stainless steel inserted in the neck muscles (diameter - 4 mm).

The stimulating unit ES-4 (made in Bulgaria) permitted control of the contact between electrodes and carcass. The stimulating pulses were monitored on the screen of a TEKTRONIX 2213 oscilloscope.

pH measurement. pH of all carcasses was measured before and after ES. The measurement was made in m. Supraspinatus, m. Longissimus dorsi and m. Semitendinosus with a portable digital pH-meter (METROHM AG 604 E) with a combined Ingold electrod (I 0641). Depth of measurement was about 2-3 cm. Before each measurement the electrode was rinsed with distilled water and between measurements it was kept at 38-39°C. Before pH measurement of each carcass the meter was calibrated against a 'buffer' solution of pH 7.00.

Temperature measurement. The temperature of the same muscles was measured with a portable digital thermometer (accuracy up to 0.1°C) in points close to the points of measuring pH.

Measurement of carcass contraction strength. A specially designed tensometric sensor was developed to measure carcass contraction strength. It consisted of a steel ring with 4 tensoresistors forming a bridge circuit. The signal from the tenso-ring was fed to a tensometer (IEMI N2301) which converted it to a standard electrical signal. It was demodulated by an electronic circuit and fed to a recorder (VAREG 2). Calibration of the system was done in a static mode by means of standard weights. The tenso-ring was located between the railway and the hook inserted in the hind legs of the carcass.

RESULTS AND DISCUSSION

The experimental results are given in Table 1 (temperature variations were within the range of 0.5-1°C). Initial pH of all carcasses ranged from 6.90 to 7.10.Additional statistical analysis showed that the differences between the values of pH and the differences between the values of carcass contraction strength of subgroups A1, A2, B1, B2 and subgroups C1, C2 were statistically insignificant (p=0.05). That is why in Fig.1 only the curves of groups A, B and C are presented.Our experimental results for pH and F showed that the effect of ES with frequencies of 10 and 15 Hz was almost the same, it did not depend on the pulse duration (5-10 ms) and it was greater than the effect of stimulation with frequencies of 25 Hz. This agreed with the results of Crystall et al. (1978).It was not in accordance with the results obtained by Moisseenko et al. (1982) who suggested that the best frequency for ES was 25 Hz. Our curves were unlike hers because they did not have any extremum points.

Table 1

t,s	F,N					
	A1	A2	B1	B2	C1	C2
0	46.9±2.9	48.3±3.0	47.1±2.5	45.4±2.3	44.0±3.1	44.5±2.7
15	18.2±1.3	20.2±1.5	16.7±1.4	16.1±1.6	6.5±1.1	6.8±1.1
30	8.1±1.0	7.6±0.8	5.8±0.9	6.3±1.1	1.5±0.4	2.1±0.5
45	3.3±0.6	3.1±0.6	2.4±0.5	2.0±0.4	1.6±0.3	1.9±0.4
60	2.1±0.5	2.4±0.5	2.1±0.4	2.0±0.4	1.5±0.3	1.8±0.4
ΔpH	0.50±0.06	0.48±0.06	0.44±0.05	0.47±0.05	0.28±0.06	0.30±0.04

F - carcass contraction strength at different moments t
ΔpH - difference between the values of pH measured immediately before and immediately after ES

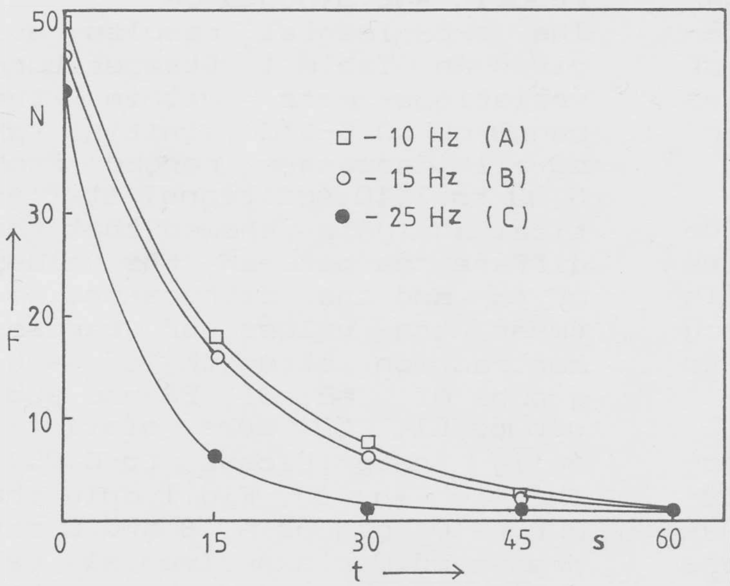

Fig.1. Alteration of carcass contraction strength F during ES.

It can be easily shown that our curves for carcass contraction strength are quite similar to the curves about pH obtained by Crystall et al. (1978) and the curves about the carcass impedance obtained by Tsankov et al. (1988).

Comparison of the results presented in Table 1 about pH drop after stimulation and the curves about carcass contraction strength from fig. 1 shows that there exists a good correlation between them.

CONCLUSIONS

We suggest that the speed of decrease of carcass contraction strength could be used as a criterion for estimation of the efficiency of ES. It is necessary to experimentally find the value of the first derivative of F (dF/dt) at which ES should be interrupted depending on the further processing of the meat. It is not difficult to design a unit for controlling the speed of decrease of carcass contraction strength and automatic interruption of ES when reaching the estimated value of dF/dt. If interruption occurs within 30 s after the beginning of ES the meat should be considered as meat of low quality.

The same approach could be used for estimation of the efficiency of ES of beef carcasses as well as for early detection of meat which is not DFD.

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