THERMOGRAPHIC METHOD OF DETERMINATION THE EFFECT OF LOW VOLTAGE ELECTRIC STIMULATION OF SHEEP

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SUMMARY

Determination of temperature kinetics during electric stimulation could possibly serve as an accurate analysis of the stimulation effectiveness.
To ascertain that possibility, Merinofleisch sheep with live weights of 42 to 48 kg were used. After slaughter, the animal carcass was cut into two sides, and one side was stimulated for 2 minutes with square monopolar pulses having 10 ms duration, 14,3 Hz frequency and 90 V amplitude. The temperature change dynamics were determined by a special measuring equipment including personal computer, semi-conductor temperature sensors, 32-bit analog-to-digital converter and respective software including control program and digital filtering program. The system's resolution was 0.001°C. This measuring system ensured recording data from both channels on a floppy disk, approximation of sensors'indications by a third degree polynominal, and automatic graphic display of the dependance of both temperatures, and their difference, on the cooling time. Temperature differences were followed up to 24 hours post slaughter in 5 sec intervals.
The results obtained indicate temperature differences between the two sides, these differences having a clearly marked maximum in the interval 1 to 3 hours post slaughter.

INTRODUCTION

The consumption of part of the muscle energy reserves during the process of rigor mortis is accompanied by liberation of heat which may cause temperature increase in the depth of meat from 0.2 to 2°C (Bendall, 1973). This is mainly due to the anaerobic catabolism of glycogen resulting in heat liberation. Morley (1984) was able to measure the temperature increase in the postmortal period, his results confirming Bendall's expectations.
Practically, when they occur, these reactions lead to temperature increase up to 39 ÷ 40°C in the deep musculature a few hours after slaughter, while in the cases of PSE meat the temperature increase reached 43°C (Sybesma, 1966).
Electric stimulation performed immediately after slaughter accelerates muscle metabolism (Bendall, 1976; Carse, 1973; Christal, 1978). Accelerated postmortal metabolism creates conditions for a temperature rise that, combined with the low pH, contributes for an improved tenderness through the liberation and activation of the lisosomal enzymes (Sorinmade, 1978). Determination of temperature kinetics in the ES carcasses could be used as an express method of establishing the effectiveness of the electric stimulation used. The aim of the present study was to establish the possibility to use a sensitive termographic method of determination of the effect of low voltage electric stimulation.

MATERIALS AND METHODS

A sheep with a live wight of 48 kg was used in the experiment. The animal carcass was split in two sides. One side was stimulated

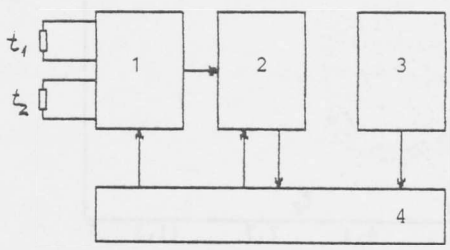

Fig. 1. Block-diagram of the experimental apparatus: t_1, t_2 - thermometers; 1) Multiplexer; 2) ADC; 3) Clock card; 4) Personal computer

with a 90 V electric stimulator giving pulses of 1 sec duration and 1 sec interval. The filling pulses had 14 Hz frequency. The temperature sensors were positioned prior to switching on the stimulator. The experiment was performed at an ambient temperature of 18°C. The block-diagram of the experimental apparatus is given in Fig. 1.
For temperature measuring, miniature thermistors placed in thin glass tubes, 3 mm of diameter and 40 mm long, were used. The temperature sensors' converting characteristics were precalibrated in 5 points in the range 15°C - 45°C using reference thermometer placed in a thermostat.
A special program in BASIC performed the characteristics approximation for each channel independantly. The requirement that the measurement is carried with a high resolution within a relatively wide range of temperature change, without range switching, made impossible the use of current 8- or 12-bit analog-to-digital converters. Because of that a special 16-bit analog-to-digital converter was developed with the possibility to connect two of these blocks in succession to achieve 32-bit resolution. That was possible at the expense of the reduced speed of responce of the measuring system. The real-time response with programs in BASIC was 7 measurements per sec, and that, for the needs of the present experiment, was enough. Eightbit personal computer of the APPLE 2 type was used here. The software included control program, data-processing program and program for automatic scaling and drawing the dependance of temperature (in degrees) on the time (in minutes). TIME II clock card of Applied Engineering was used for time reading. Temperature reading started 8 min post slaughter. Temperature indications, one for each channel, were received every 30 sec. These values were the arithmetical mean of 200 single measurements. Data from both channels were recorded in the two separate sequential text files on a floppy disk for further processing.

RESULTS AND DISCUSSION

The results obtained during ES for the temperature change in the ES side indicate significant dispersion of temperature values in a considerably wide range. Muscle temperature, immediately after switching of the electric stimulator, was found to be about 39.5°C for both sides (Fig. 2). The diagram on Fig. 3

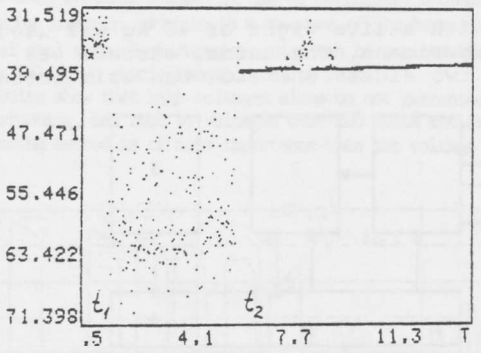

Fig. 2. Temperature change in the stimulated side during electric stimulation: T_1 - beginning of ES; T_2 - end of ES

presenting the temperature condition in the ES and NS sides indicates that the ES side temperature remains higher in the period between the 15th and 270 th minute. This temperature difference can be followed in detail for separate intervals after stimulation on Figures 4 and 5. The diagram on Fig. 6 shows that the temperature difference has a maximum about the 80th minute and amounts to 1.3°C. The results given in Fig. 7 are of particular interest, where the temperature change is followed after the 210th minute. It can be noticed that temperature changes set in the NS meat only about the 240th min leading to significant temperature rise that, after the 270th min, equals and subsequently exceeds the temperature of the ES meat. This is connected with a significant

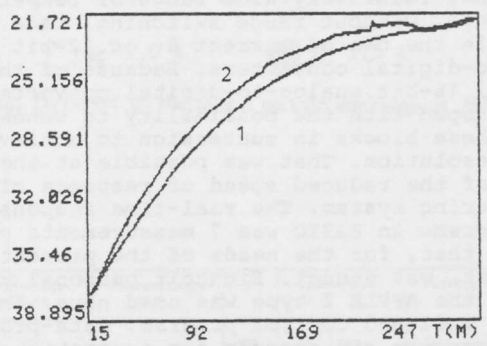

Fig. 3. Temperature change in both sides in the interval 15th to 325th minute: 1) Stinulated; 2) Non-stimulated

delay of the biochemical processes of degradation of the substances with high-energy bonds like ATP, CP, glycogen, etc. The results obtained indicate that the low voltage ES used here significantly accelerates the degradation of the above-mentioned substances.

LITERATURE

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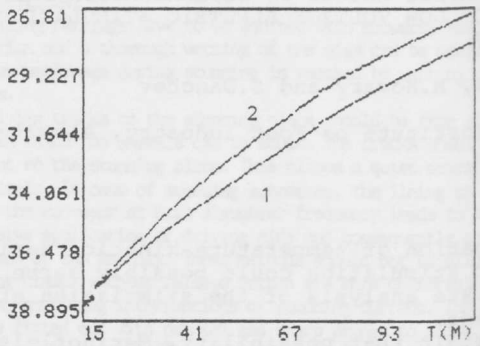

Fig. 4. Temperature change in both sides for the interval 15th to 120th minute: 1) Stimulated; 2) Non-stimulated

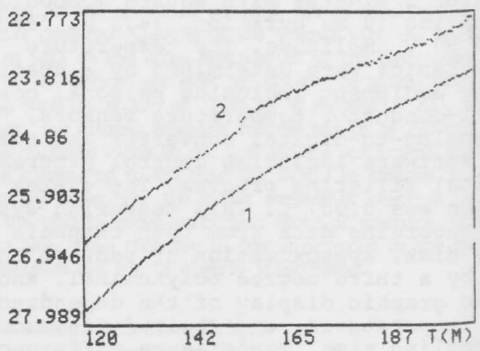

Fig. 5. Temperature change in both sides for the interval between the 120th and 240th minute: 1) Stimulated; 2) Non-stimulated

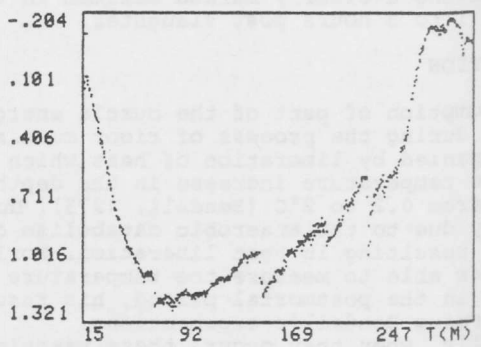

Fig. 6. Change in temperature difference in the interval between the 15th and 325th minute

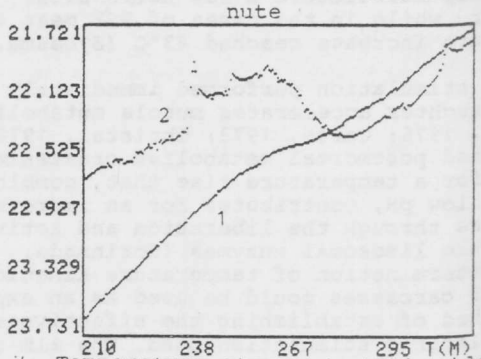

Fig. 7. Temperature change in both sides in the interval between the 210th and 325th minute: 1) Stimulated; 2) Non-stimulated

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