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EFFECT OF LOW VOLTAGE ELECTRICAL STIMULATION ON PH, COLOUR AND WATER-HOLDING CAPACITY OF BEEF

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Key words: meat electrostimulation, water-holding capacity, muscle pH and colour

The influence of low voltage electrical stimulation on some atributes of beef quality was studied. The strongest reaction of muscles (the biggest pH fall at 2 h *post mortem*) was observed using 28 V peak voltage, 175-230 mA peak current and pulse repetition frequency of 12.5 or 25 Hz. Increased fall of pH was followed by increased colour lightness of meat and decrease of WHC.

Advantages of electrical stimulation (ES) applied to beef carcasses are widely recognized and slaughterhouses where this new procedure has been introduced constantly grow in number. At present high voltage electrostimulation (HVES) equipment is more frequently installed as with this method better consistency and uniformity of quality improvements is claimed [1]. However, in some countries use of HVES is restricted for safety reasons and there low voltage electrostimulation (LVES) method is prefered. There has been considerably less research work done on parameters of electric current (optimal frequency, peak current and so on) used in LVES and on its effects on meat quality [2, 4, 5, 6, 7] There are no reasons to suppose that if optimal conditions are found, the results of LVES should be inferior to results of HVES. In our preliminary studies some experiments were performed according to data given by Fabianson et al. [4, 5]. Results were not satisfactory perhaps to lack of full information on parameters of current applied. The results of experiments reported here are more succesful and they form a part of research being still in progress.

MATERIAL AND METHODS

In all experiments only heifer carcasses were used. Carcasses of young bulls were eliminated because of high incidence of DFD meat, which could distort an influence of ES on postmortem glycolysis. Each experimental group was accompanied by control group of the same size. The stimulated carcass was usually followed by one not stimulated. In all six experiments 185 carcasses undergone LVES with parameters as follows:

I : 27 V peak voltage, DC, pulse repetition frequency 0.5 Hz
II : 28 V peak voltage, DC, pulse repetition frequency 12.5 Hz
III : 28 V peak voltage, DC, pulse repetition frequency 25 Hz
IV : 28 V peak voltage, DC, pulse repetition frequency 50 Hz
V : 14 V peak voltage, DC, pulse repetition frequency 25 Hz
VI : 20 V RMS, AC, frequency 50 Hz.

The form of pulses was sinusoidal and pulse width was 10 ms. The stimulation was done with the aid of apparatus of our own design. One of the electrodes (positive) in the form of tongs was applied to a nose (nostrils) and the other — 180 mm long metalic bar — was inserted in restum. Each carcass hanged by the hind leg was stimulated for 90 s immediately after bleeding. Polarity of electrodes was not changed.

The effect of stimulation was examined in *longissimus dorsi* (LD), *biceps femoris* (BF) and *triceps brachii* (TB) muscles. Value of muscle pH was measured at 2, 24 and 48 h *post mortem*. Lightness of meat colour was estimated by measuring of reflected light at 730 nm on cross-section of LD. Samples were taken from 6th — 8th rib of thoratic region. The water-holding capacity (WHC) of the muscle was measured at 48 h *post mortem* (loose water expressed as percentage of total water, removed from meat by centrifugation at 200 × g). All carcasses were chilled at +10°C for the first 3 to 4 hours and at +4°C afterwards.

RESULTS AND DISCUSSION

As it is shown in Fig. 1 all treatments had marked influence on acceleration of pH fall in examined muscles. Less affected were muscles in experiment V where the voltage was the lowest and in experiment I where the voltage was comparatively high but pulse repetition frequency was extremaly low. There is a consistent difference in reaction to stimulation between muscles. In all cases the strongest reaction was observed in BF and the weakest in TB muscle. With regards to parameters of stimulation, most effective were treatments with direct current at 28 V and pulse rate from 12.5 to 50 Hz. On the average mean differences at 2 h *post mortem* between stimulated and unstimulated carcasses from experiments II, III and IV were 0.51, 0.60 and 0.93 in TB, LD and BF muscle, respectively. The ultimate pH of meat was not influenced by ES. Average pH values 24 h *post mortem* in different muscles are collected in Table.

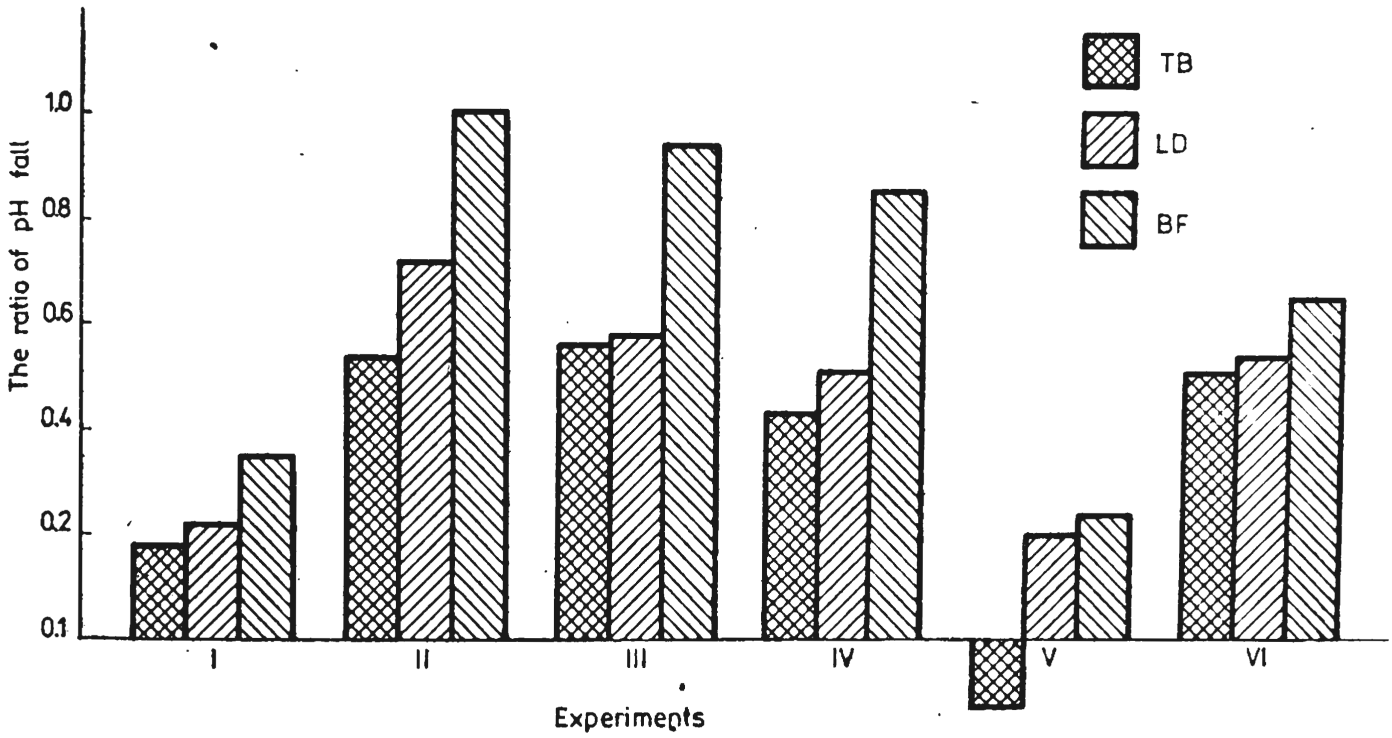

Fig. 1. The ratio of pH fall in TB, LD and BF muscles at 2 h *post-mortem*

Table. The ultimate pH of meat from stimulated and unstimulated beef carcasses after 24 h *post mortem*

Muscle	Group	Experiments					
		I	II	III	IV	V	VI
TB	exp.	5.69	5.61	5.63	5.69	7.78	5.61
	control	5.74	5.68	5.69	5.71	5.85	5.62
LD	exp.	5.67	5.65	5.72	5.70	5.79	5.66
	control	5.83	5.76	5.68	5.82	5.77	5.66
BF	exp.	5.53	5.59	5.62	5.60	5.67	5.58
	control	5.65	5.60	5.61	5.59	5.76	5.61

The observed acceleration of pH fall affected lightness of meat colour and WHC of meat. The results presented in fig. 2 and fig. 3 were collected only for LD muscles because BF and TB muscles were not available for laboratory examination. Statistically significant difference in colour and WHC was only found in the third experiment. The remaining differences though not significant show the same trend. From the coincidence of accelerated pH fall with an increased colour lightness and bigger amount of loose water in meat it follows that the observed changes are similar to those observed in PSE pork meat. Thus, there

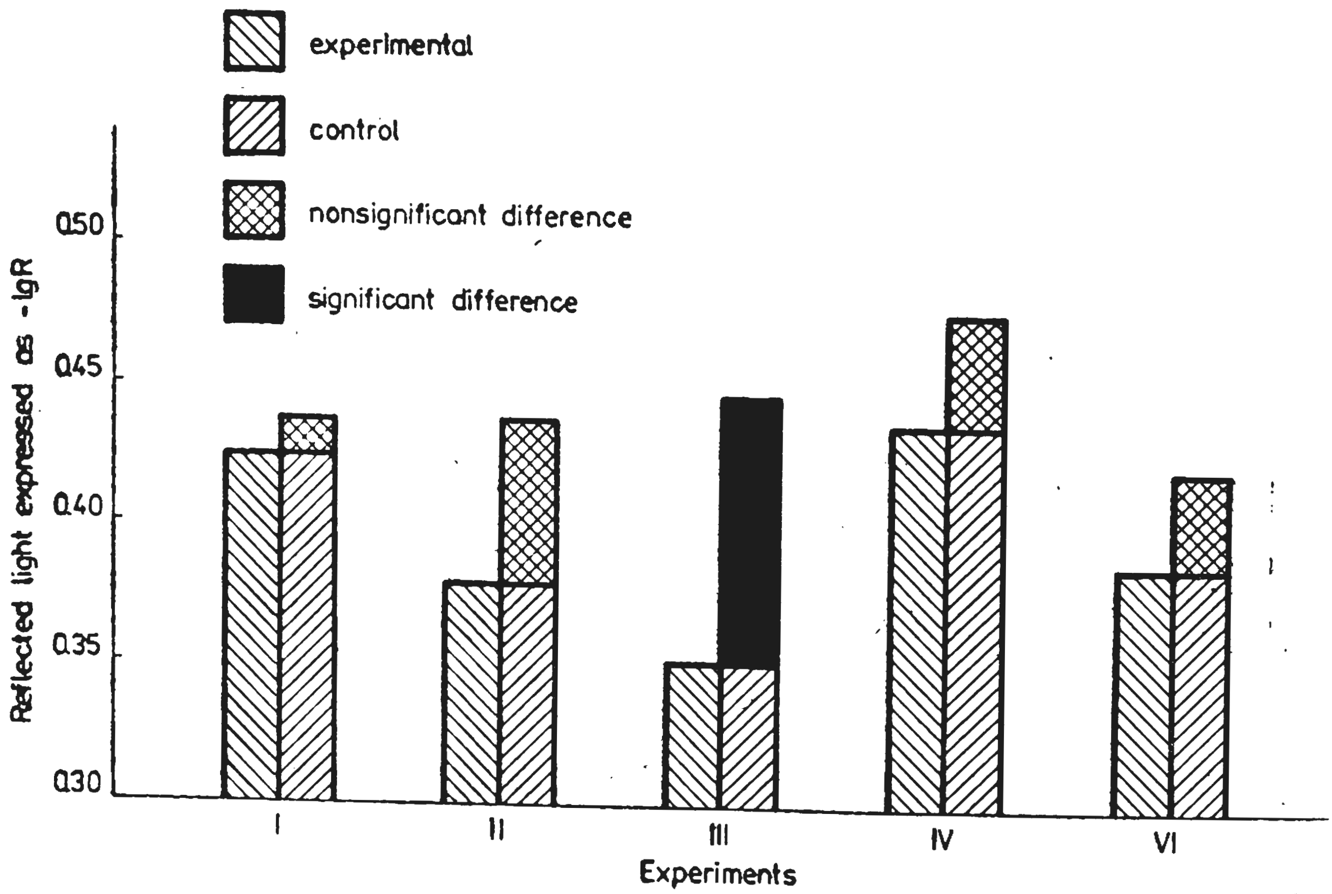

Fig. 2. Lightness of meat colour at 730 nm on cross-section of LD at 24 h *post-mortem*

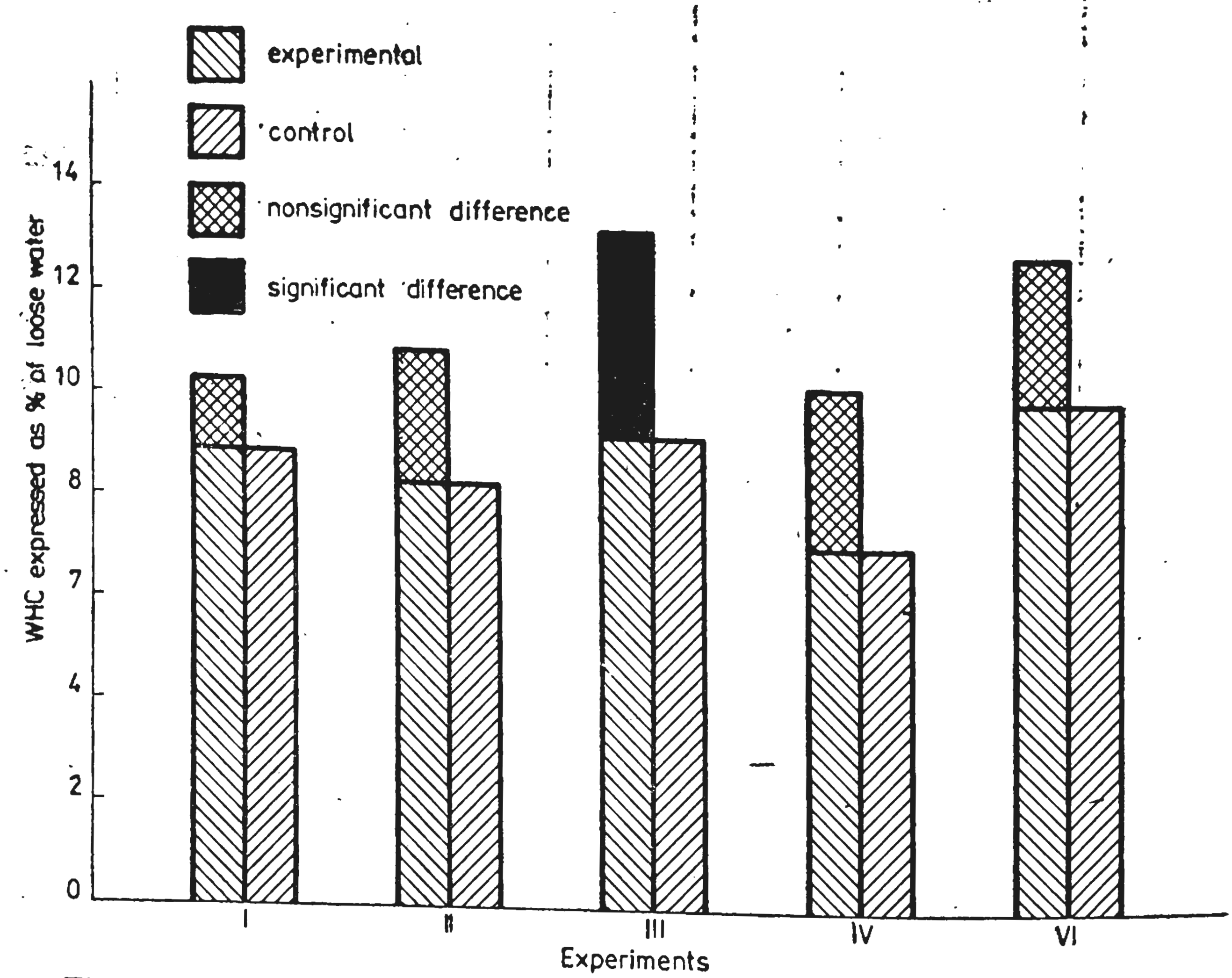

Fig. 3. Water-holding capacity of LD muscle at 48 h *post-mortem*

may exist a real danger of increased drip in muscles where stimulation provokes particilary intense rate of glycolysis. So far, there are no reports showing substantial increase of drip from meat as a result of ES [1], but our experiments indicate the need for careful choice of ES conditions in order to obtain optimal quality improvement. We have not got enough data to explain varied response of examined muscles to stimulation. One may suppose that this response is related to the position of electrodes which in turn determines nervous track responsible for conducting electric stimulus. Change of electrodes polarization can also be of some importance as in the case of HVES [1, 3]. Research work along these lines will be continued.

CONCLUSIONS

1. The strongest reaction of muscles to LVES was observed under following conditions:
peak voltage 28 V, DC
peak current 175 to 230 mA
pulse repetition frequency 12.5 or 25 Hz

2. Conditions studied, the reaction of muscles to stimulation varied, being strongest in BF muscle and weakest in TB muscle.

3. Increased fall of pH was followed by increased colour lightness of meat and decrease of its WHC. When above given parameters of LVES used, amount of reflected light had risen from 35% (control) to 45% (experimental) and loose water from 9 to 13%.

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WPŁYW NISKONAPIĘCIOWEJ ELEKTROSTYMULACJI NA PH, BARWĘ I POJEMNOŚĆ WODNĄ WOŁOWINY

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Streszczenie

Zbadano wpływ elektrostymulacji niskonapięciowej na niektóre cechy jakościowe mięsa bydlęcego. 185 tusz jałówek podzielonych na 6 grup doświadczalnych poddano elektrostymulacji bezpośrednio po wykrwawieniu. Jako porównania użyto tę samą liczbę niestymulowanych tusz kontrolnych. Największą reakcję mięśni objawiającą się największym spadkiem pH mierzonym w 2 h po śmierci zwierzęcia zaobserwowano w przypadku zastosowania napięcia szczytowego 28 V dającego prąd szczytowy 175-230 mA przy częstotliwości powtarzania impulsów 12,5 lub 25 Hz. Spadkowi pH towarzyszył wzrost jasności barwy mięsa oraz pogorszenie wodochłonności. Najsilniejszą reakcję zaobserwowano w mięśniach *biceps femoris* (BF) a najsłabszą — w *triceps brachii* (TB).