EFFECT OF LOW VOLTAGE ELECTRIC STIMULATION ON THE HYDROPHILIC AND ORGANOLEPTIC PROPERTIES OF BEEF

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SUMMARY

Postmortal changes in the hydration ability of muscle tissue are of great importance for meat processing and an important factor for the quality of the final meat products. The effect of low voltage electric stimulation on the hydrophilic and organoleptic properties of meat from calves was studied. Calves of the "Black-motley" breed, 20 months of age and of 440-40 kg live weights were electrically stimulated immediately after slaughter with square monopolar pulses of 10 ms duration, 14,3 Hz frequency and 90 V amplitude. The time of ES was 2 minutes. Following ES the test and control samples were fast chilled at -10+-15 °C, air velocity 2-3 m/s, up to a temperature of +6 °C(in depth) and stored at an ambient temperature of 0 ° to 2 °C.
It was established that the ES performed here did not increase the amount of water liberated during storage or during heat-processing after the first 24 hours, while it contributed for a more intensive improvement of meat tenderness and preservation of a better colour of muscle tissue.

INTRODUCTION

One of the major technological properties of meat is the ability of muscle tissue to retain its own as well as the water added during the boiling process, refrigeration, etc. In most cases the results from the studies on the effect of ES on meat juiciness did not point to any differences between the juiciness of stimulated and non-stimulated meat(18,19). In other studies, however, some authors found that the meat from electrically stimulated carcass sides was less juicy compared to the meat from the control samples(5, 15).
The low pH levels observed after electric stimulation together with the high meat temperature create the possibility for certain denaturation of the sarcoplasmic proteins that gives PSE meat with reduced water-holding capacity with some swine breeds(7). Regardless these conditions, ES does not increase the hydrophilic properties of meat(4, 18). The rapid changes that happen within the muscles of ES meat are supposed to increase the osmotic pressure in the intracellular space, thus equilibrating the reduced water-holding capacity of muscular proteins(6).
According to Honikel et al.(10) the slight decrease of the water-holding capacity is mainly due to pH drop, regardless the temperature, and is not directly influenced by the contractions during ES or development of rigor mortis. These conclusions contradict the earlier statement of Hamm(10), namely that 2/3 decrease from the overall water-holding capacity of muscle tissue in the postmortal period results from the ATP amount drop. In another study Honikel et al.(12) establish that actually A 2/3 decrease from the overall water-holding capacity of cured meat is due to the development of rigor mortis, and 1/3 is due to pH drop.
The studies of the effect of ES on the organolepticproperties of meat also suffer certain variance. Many authors do not find significant differences between the juiciness of stimulated and non-stimulated meat(9, 14). Still in other studies the same authors state that ES lessens meat juiciness (5, 15). Similar are the positions with respect to flavour and palatability of ES meat. Some authors point out that flavour and taste values improve after ES by approximately 10 %,(16, 17), while others do not find any difference between stimulated and non-stimulated meat(9, 18). As far as meat tenderness and colour are concerned, the prevailing opinions support the favourable influence of ES on these characteristics(5, 8, 13, 14, 20, 21).
All this gives good reason to carry out the investigation with the aim of establishing the effect of the chosen regime of electric stimulation on the hydrophilic and organoleptic properties of stimulated meat.

MATERIALS AND METHODS

For the purpose of the present study we used calves of the "Black-motley" cattle breed, of about 20 months of age and 440-40 kg live weights. Immediately after slaughter and disemboweling the animal carcasses were longitudinally cut into two sides, and the left ones were electrically stimulated 10 minutes post mortem with square monopolar pulses of 10 ms duration, 14,3 Hz frequency and 90 V amplitude, for 2 minutes. Following ES test samples and controls were fast chilled at -10+-15 °C and air velocity of 2-3 m/s up to a depth temperature of +6 °C, then were stored at an ambient temperature of 0+2 °C.
The effect of ES on the hydrophilic properties of muscle tissue was determined by establishing the drip losses during storage and heat-processing. The organoleptic assessment of the effect of ES on the organoleptic properties of meat was performed by a nine-member taste panel on M. longissimus dorsi samples, stored at +2 °C for 7 days. Organoleptic assessment included the fillowing characteristics: colour, tenderness, juiciness, taste and general acceptability, according to an eleven-grade scale. The marks are between +5(rather good), 0 (neither good, nor bad) and -5(rather undesirable).
The test results thus obtained were processed according to the variance statistical analysis(1, 2, 3).

RESULTS AND DISCUSSION

The results received from the study on the effect of ES on the hydrophilic properties of muscle tissue are given in Tables 1 and 2. Drip losses in M. longissimus dorsi were determined on the 3rd, 7th, 10th and 14th day after vacuum package storage at 0+4 °C(Table 1), and after heat-processing on the 1st, 2nd and 7th day(Table 2).
During the whole period of storage at 0 °C no reliable differences in the drip losses between stimulated and non-stimulated samples were established.
The electric stimulation of meat used here causes an intensive contraction of the muscle fibres and a rapid degradation of the energy carrying substances. This results in a sharp

drop of pH levels compared to the non-stimulated samples, and in a more intensive formation of the actomyosin complex.

Table 1. Effect of ES on the hydrophilic prperties of M. longissimus dorsi after storage (n=15)

Type of sample	Mass losses at storage (%)			
	3 d	7 d	10 d	14 d
Non-stimulated	0,7±0,1	1,1±0,4	1,3±0,3	1,4±0,3
Stimulated	0,9±0,2	1,2±0,3	1,4±0,2	1,6±0,5

Under these conditions the water-holding capacity of the muscle tissue is reduced during the first hours after meat production(Table 2)

Table 2. Effect of ES on the hydrophilic properties of M. longissimus dorsi after heat-processing (n=19)

Type of sample	Mass losses at heat-processing, (%)			
	3 d	7 d	10 d	14 d
Non-stimulated	24,7±2,8	27,9±1,9	21,1±1,4	18,9±1,8
Stimulated	32,3±3,1	22,6±2,3	18,5±1,8	16,7±1,5

The reduced hydrophilic properties of ES meat found after heat-processing 1h after meat production improves rapidly and on the first day already the losses are considerably smaller compared to the non-stimulated meat. The more intensive performance of the autolytic processes in the muscle tissue after ES causes considerable accumulation of the autolysis products, relaxation of the muscle fibres after the first day and significant improvement of its hydration capacity. The hydration improvement achieved on the 2nd day with ES samples is the same as the one achieved on the 7th day with non-stimulated samples.

The results thus obtained evoke the conclusion that ES does not increase the amount of water liberated during storage at lower positive temperatures, as well as during heat-processing performed one day after meat production.

The organoleptic assessment made on the 1st and 7th day after meat production (Table 3) indicates that ES samples receive reliably higher values for general acceptability on the first day. This advantage derives from almost all characteristics-primarily from differences in tenderness and colour, and, to a less degree, from differences in juiciness and taste. At sensory evaluation on the 7th day after meat production ES samples receive also higher total value that is obviously due to the more tender ultrastructure and the fresher colour of the muscle tissue.

The results obtained give reason to conclude that the low amplitude electric current used here for stimulation contributes for the more intensive improvement of the structural-mechanical properties of muscle tissue and preservation of a better colour.

Taking into account also the fact that this technological process is easily adaptable to the conventional technological lines in the meat producing factories, it is expedient to be introduced in industrial practice.

Table 3. Effect of ES on the organoleptic properties of the muscular tissue, m. of calves on 1 and 7 day(n=9)

Type of sample	Time	Organoleptic properties				
		colour	tenderness	juiciness	taste	general acceptability
Non-stimulated	1 d	2,1±0,3	2,4±0,09	0,5±0,03	0,2±0,01	0,3±0,0
Stimulated		3,9±0,5	3,4±0,7	0,9±0,02	0,5±0,01	1,9±0,2
Non-stimulated	7 d	1,9±0,4	1,4±0,2	2,4±0,7	1,4±0,6	1,1±0,2
Stimulated		2,7±0,5	3,6±0,3	2,7±0,3	1,9±0,4	2,4±0,3

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