EFFECT OF ELECTRICAL STIMULATION ON THE MICROBIOLOGICAL QUALITY OF BEEF

Lucyna Klębukowska, Ryszard Żywica[1], Jolanta Sienkiewicz

University of Warmia and Mazury, Chair of Industrial and Food Microbiology, [1]Chair of Basics of technique of Energy Management, pl. Cieszyński 1, Olsztyn, Poland

Key words: electrical stimulation, beef, microbiological quality

Background

Electrical stimulation is technological treatment administered in the meat industry to improve the microbiological quality of meat, especially its sensory properties such as tenderness (Budny et al. 1995, Cierach et al. 1995, Geesink et al. 2001, Mirgadat et al. 1980).

The mechanism of a direct effect of electrical stimulation on the inhibition of growth or reduction in the number of bacteria has not been fully investigated yet. The treatment causes a decrease in pH of muscles immediately after slaughter, which constitutes a barrier to the development of technologically harmful and potentially pathogenic microflora. Moreover, electric current has a destructive effect on cells (Kornacki et al. 1998), which plays an important role in inhibiting the growth of meat microflora. During the treatment, increased amounts of proteolytic enzymes are released from lysosomes. Those enzymes may also show bacteriostatic activity (Kwiatek et al. 1987). Positive results of electrical stimulation in inactivation of numerous groups of microorganisms, e.g. *Salmonella typhimurium* have already been confirmed (Yanbin et al. 1994).

Objective

The aim of the studies was to determine the effect of electrical stimulation on the microbiological quality of beef.

Methods

Meat from the dorsal muscle (m. longissimus dorsi) of lowland Black-and-White cattle (heifers and cows) constituted the experimental material.

The experiment was performed on an industrial scale at the Meat Plant in Ostrołęka, using an electrical stimulation device designed at the Chair of Basics of Technique and Energy Management, University of Warmia and Mazury in Olsztyn (patent claim 1997).

Immediately after slaughter, evisceration and skinning, the carcasses were subjected to electrical stimulation for 90 seconds, at the following parameters: voltage - 360V, frequency - 17Hz, pulse duty factor - 0.9.

Directly after the treatment, and after 1 and 2 weeks of meat storage at a temperature of 4°C, a microbiological analysis was carried out.

This included the determination of:

- the count of aerobic mesophilic bacteria – a nutrient agar,
- the count of fungi – a synthetic medium, acidified with citric acid to pH 3.5,
- the count of coli rods – a medium VRB-Agar,
- the count of psychrotrophic microorganisms - a nutrient agar,
- the count of enterococci – a medium with TTC (Slanetz and Bartley),
- the presence of coagulase-positive staphylococci – a selective-differentiating PFI medium
- the presence of *Salmonella* rods – pre-proliferation in buffered peptone water, proliferation – media with sodium tetrathionate, and a SF medium, presence confirmation – media with diamond green and phenol red, and a SS agar,
- the presence of *Proteus* rods – Nogrady's medium.

pH was measured directly after the process of electrical stimulation and 2 hours later.

Results

The concentration of hydrogen ions was measured in 10 control heifers and in 10 heifers subjected to stimulation; the procedure for cows was the same. Table 1 presents the average decrease in pH. In the case of heifers, the average decrease in pH immediately after electrical stimulation was equal to 0.6, and remained at this level for 2 hours after the process.

As concerns cows, the value of pH decreased by 0.4 directly after the treatment, and its further decrease (by 0.3) was observed after 2 hours of cold storage. Żywica (1994) presented similar results in his dissertation. A fast pH decrease caused by the changes taking place in muscles after electrical stimulation was noted before rigor mortis.

The results of a microbiological analysis are shown in Table 2. No differences in the count of particular microorganism groups were found immediately after electrical stimulation. Differences were only observed in the case of meat stored for 7 days at a temperature of 4°C. The number of aerobic mesophilic bacteria was in this sample lower in stimulated carcasses - $5.4 \cdot 10^3$ cfu/g, compared with $2.4 \cdot 10^4$ cfu/g in control beef. The situation was similar in the case of psychrotrophic microorganisms and coli rods. No significant differences were noted in the counts of the other microorganisms.

Table 1

Average pH changes in control and electrically stimulated carcasses

Carcasses	pH	
	directly after slaughter and stimulation	2 hours after slaughter and stimulation
Cow carcasses not subjected to electrical stimulation	6.82	6.75
Cow carcasses subjected to electrical stimulation	6.43	6.13
Heifer carcasses not subjected to electrical stimulation	6.75	6.60
Heifer carcasses subjected to electrical stimulation	6.15	6.15

Table 2

Microflora of beef not subjected and subjected to electrical stimulation during storage at a temperature of 4°C

TIME OF INOCULATION	DIRECT INOCULATION		1ST WEEK		2ST WEEK	
Determination	ES	K	ES	K	ES	K
Count of aerobic mesophilic bacteria [cfu/g]	$3.3 \cdot 10^3$	$1.0 \cdot 10^3$	$5.4 \cdot 10^3$	$2.4 \cdot 10^4$	$6.4 \cdot 10^4$	$3.0 \cdot 10^5$
Count of enterococci [cfu/g]	<10	<10	<10	<10	<10	<10
Count of fungi[cfu/g]	<10	<10	$2.2 \cdot 10^3$	$3.2 \cdot 10^3$	$5.7 \cdot 10^4$	$3.0 \cdot 10^5$
Count of psychrotrophic microorganisms [cfu/g]	<100	<100	$6.0 \cdot 10^3$	$2.2 \cdot 10^4$	$3.0 \cdot 10^5$	$3.0 \cdot 10^5$
Count of coli rods [cfu/g]	<10	<10	$9.2 \cdot 10^1$	$2.4 \cdot 10^2$	$1.1 \cdot 10^3$	$1.1 \cdot 10^3$
Presence of coagulase(+) staphylococci in 0.1g	np	np	np	np	np	np
Presence of *Salmonella* rods in 25 g	np	np	np	np	np	np
Presence of *Proteus* rods in 0.1 g	np	np	np	np	np	np

ES - stimulated beef, K - not stimulated beef, np - not present

Conclusions

Despite slight changes in the quantitative and qualitative composition of microflora in meat subjected to electrical stimulation, a fast decrease in the pH of muscular tissue seems to be the key factor in improving the microbiological quality of beef and extending its storage life.

References

1. Budny J., Cierach M., Żywica R. 1995. *Niektóre efekty zastosowania wysokonapięciowej elektrostymulacji półtusz bydlęcych.* Gospodarka Mięsna, 47(5): 22-24.
2. Cierach M., Majewska K., Żywica R. 1995. *Tekstura Miesa peklowanego pod działaniem prądu elektrycznego.* Acta Acad. Agricult. Tech. Olst., Techn. Aliment., 28: 73-80.
3. Geesink G.H., Mareko M.H.D., Morton J.D., Bickerstaffe R. 2001. *Electrical stimulation – when more is less.* Meat Sci., (57): 145-151.
4. Kornacki K., Żywica R., Kłębukowska L., Budny J. 1998. *Effect of electrical stimulation, starter culture and glucono-δ-lactone on microbiological quality of fermented salami-type sausage.* Natural Sci., 1: 215-227.
5. Kwiatek H., Wojtoń B., Ockerman H. 1987. *Wpływ poubojowej elektrostymulacji tusz zwierząt rzeźnych na właściwości mięsa.* Życie Weterynaryjne, 11: 365.
6. Mirgadat B., Smith G., Dutson T., Hall L., Hanna M., Vanerzant. 1980. *Bacteriology of electrically stimulated and unstimulated rabbit, pork, lamb and beef carcasses.* J. Food Protec., 43(9): 686-693.
7. Yanbin Li, Yeong-Weon K., Slavik M.F., Griffis C.L., Walker J.T., Wang H. 1994. *Salmonella typhimurium attached to chicken skin reduced using electrical stimulation and inorganic salts.* J. Food Sci., 1(59), 23-25.
8. Żywica R. 1994. *Energetycazno-organizacyjne aspekty zastosowania nowej konstrukcji wysokonapięciowego elektrostumulatora mięsa.* Praca dysertacyjna, ART. w Olsztynie.