Beef curing under electrical and mechanical effects

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As prospective procedures of raw meat curing can be considered mechanical treatment (MT) in installations having different designs and impulse electric treatment of pre-rigor brine-injected muscle or electromassaging (EM). These effects contribute to a faster redistribution of curing ingredients, to local changes in meat microstructure which result in favourable processes improving finished product quality.

The influence of curing conditions upon the course of enzymic processes in meat is an insufficiently studied aspect of modern curing technique. The available publications /1,2/ refer to a layer-by-layer distribution of NaCl in muscles, structuro-mechanical and physico-chemical features, microstructural changes, on the basis of which researchers assume faster enzymic processes in meat under various treatments of raw meat during curing which are due to meat enzymes release (cathepsins). According to Dutson et al. /3/, electrostimulation (ES) of ovine carcasses accelerates lysosomal enzymes release. At the same time NaCl injection into pre-rigor meat inhibits enzymic processes /4/.

The purpose of this paper is to study cathepsin action as influenced with electrical and mechanical effects during beef curing.

To establish a relation between biochemical and histological data, cathepsin activity was measured in parallel with histochemical detection of the enzymes. At the enzyme locus a visible fermentation product was found.

Cathepsins are known to localize in lysosomes. However it is difficult to find most endopeptidases histochemically. To detect their activity, an acid phosphatase was chosen since it is the basic enzymic marker of lysosomes due to a relative simplicity of its detection with histochemical methods /5/.

As a test object served longissimus dorsi muscles dissected from two beef sides of the same carcass within $2.7 \cdot 10^2$ s after slaughter and autolyzed as usual. One was treated with impulse current, 220 V, 1 Hz (impulse duration 0.4 s, impulse intervals 0.6 s); the total treatment time was $2.4 \cdot 10^2$ s. The other was injected with a brine pre-heated to 35-37°C (the injection level being 10% of the meat weight) and then treated as the first one. After EM the muscle was tumbled for 9 hr (tumbling for 0.5 hr at the rate of 4.2 rad/s, 1 hr pause). A pre-rigor green muscle was used as a control. Muscles were sampled after ES, EM and EM+MT.

Muscle lysosomes were isolated according to Stagni and De Bernard /6/. Free cathepsin D activity was measured by Caldwell and Grosjean's procedure /7/ slightly modified. Convergence of the results was found with mathematical statistical methods, tests having been repeated 5 times, at the probability level 0.95. Acid phosphatase was histochemically determined according to Gomori /8/. Precipitated lead sulphide coloured light-brown to dark-brown was used as the criterium of enzyme activity localization.

As a result of the tests carried out it was found that electrical and mechanical effects influence muscle cathepsin activity (Table), the highest activity (three times as high as compared to that of the initial meat) was observed in ES beef. The histochemical pattern indicated that the activity of acid phosphatase in pre-rigor meat was low and was demonstrated as single clusters and scattered tiny granules throughout the muscle (Fig. 1). In the ES samples acid phosphatase activity was much higher (Fig. 2). Dark-brown grains are obvious as multiple clusters located in the muscle fibre sarcoplasm. The enzymic activity is clear in the areas where muscles were broken. A considerable increase of the activity of tissue enzymes after ES can, probably, be attributed to the disruption of the lysosomal membranes due to current pulses and to a pH decrease of the pre-rigor meat (Table). Such conclusions agree with the results of Dutson et al. /3/ who believe that a low pH and a high temperature predetermine a faster hydrolase release from lysosomes.

Table

Sample	pH	Cathepsin D activity, %
Control	6.40 ±0.03	100 ± 25
Test:		
ES	5.86 ±0,04	300 ± 17
EM	5.91 ± 0.04	207 ± 24
EM+MT	6.06 ±0.04	135 ± 20

EM of pre-injected muscle tissue stimulated a more than two-fold increase of the cathepsin D activity as compared to pre-rigor green meat. It can be assumed that electrical treatment is a stronger irritant of lysosomal membranes, this resulting in the release of enzymes from their locations. Despite the fact that NaCl injection into meat inhibits the enzymic processes, the total effect remained high.

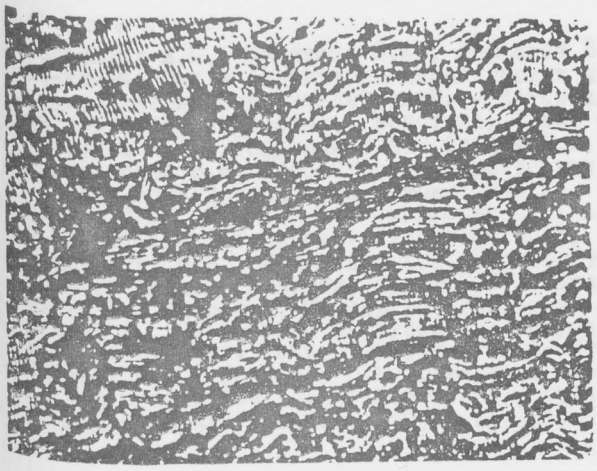

Fig.1. Acid phosphatase distribution in pre-rigor beef muscle (X 480)

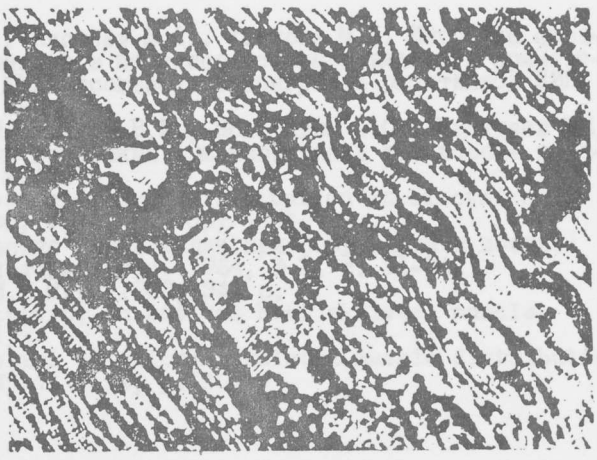

Fig.2. Acid phosphatase distribution in ES beef muscle (X 480)

In EM samples an increased acid phosphatase activity was histochemically determined as compared to controls (Fig. 3). At the enzyme locations lead sulphide precipitate is grouped as large grains, a few such groups being observed all along muscle fibers. Where sarcolemma is disrupted and in the spaces among the fibers a significant amount of enzymic activity granules are also detected within the grained protein mass. Thus, a correlation is established between biochemical characteristics and histochemical results. EM and cyclic MT decrease enzymic activity. We assume that the reasons for that may be environmental alterations in the system: the accumulation of electrolytes, i.e. an increased concentration of the inhibitor, and probably, the denaturation of the protein moiety of the enzyme due to intensive mechanical treatments. However, despite the presence of the inhibitory factors the activity in cured meat was still 35% higher than in the initial one. The histochemical detection of acid phosphatase activity showed that in the EM+MT samples the enzymic activity was lower as compared to EM samples. Fig. 4 illustrates a diffusive distribution of the precipitate in muscle fiber sarcolemma. Sometimes dark-brown clusters appear within the grained protein mass which is located in the interspaces of fibers.

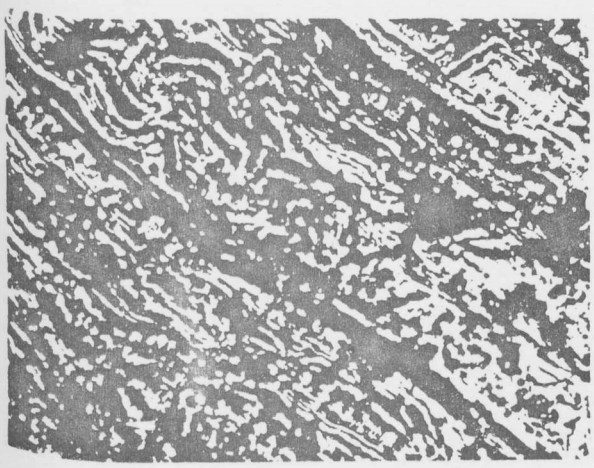

Fig.3. Acid phosphatase distribution in EM beef muscle . (X 480)

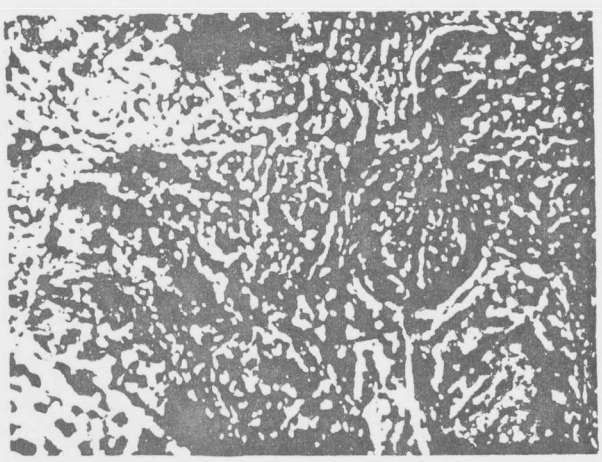

Fig.4. Acid phosphatase distribution in EM+MT beef muscle (X 480)

Comparisons of the data on the cathepsin activity in beef muscle, treated electrically and mechanically, with the histochemical data on the activity of acid phosphatase allow to conclude that the mentioned treatments stimulate the activity of tissue proteases.

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