Ultrastructural Changes in Normal and DFD Muscle Tissue during Electro-Mechanical Treatment of Beef

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SUMMARY: The aim of the present work was to study influence of electrostimulation and curing under conditions of electrical and mechanical processing on ultrastructure of NOR and DFD meat. Results of research showed changes taking place in muscle tissue with different character of autolysis during curing under above-said conditions; they agree with data of biochemical and physico-chemical research. Differences in structural changes of protein macromolecules of NOR and DFD meat are stipulated by action of different proteolytic enzymic systems, namely by catepsins and calpains.

INTRODUCTION: Research in the field of microstructure of meat showed that structure of muscle tissue, defining finished meat products quality, depends on methods of technological processing and on properties of initial raw material "Bolshakov A.S. et al. (1989), Kudryashov L.S. et al., (1989)". Last years electrical and mechanical treatment of meat are widely used for intensification of ageing and curing processes. However, data concerning influence of these stimulation methods on ultrastructure of muscle tissue with differing character of autolysis, are very scarce. The aim of the present work was to study influence of electrostimulation and curing under conditions of electrical and mechanical processing on ultrastructure of NOR and DFD meat.

MATERIALS AND METHODS: L.dorsi of beef animals 18-24 months old (weight approximately 400 kg) served as experimental material. Muscle was dissected from the beef half 45-60 min post mortem. Samples from right half were subsequently electrostimulated, brine-injected, mechanically treated under vacuum. Samples taken from left side,were brine-injected, then elecfrostimulated and at last processed in vacuum-mixer. After each type of treatment samples were subjected to ultramicroscope studies. In more details experimental method is given in scientific paper: "Kudryashov L.S. et al., (1990)".

RESULTS AND DISCUSSION: Results of ultrastructural research reveal opportunity to throw more light on biochemical and structuro-mechanical changes, occurring in meat with different character of autolysis during curing with electromechanical treatment. Fig. 1 shows that myofibrils of hot NOR muscle are in a relaxed state with apparent cross lines, among which Z-lines can be easily singled out. In some muscle zo nes stripes of muscle filaments shrinkage occur, this being indicative of response to mechanical damage. After electrostimulation we discovered progressive shrinkage of muscle fibers, thickening of Z-lines and their partial damage. We also saw that boundaries of myofibrillar separation into sarcomeres are difficult for determination (Fig. 2). However, cross lines of muscle fibers are preserved. During electrostimulation of cured meat muscle tissue (Fig. 3) fragmentation of

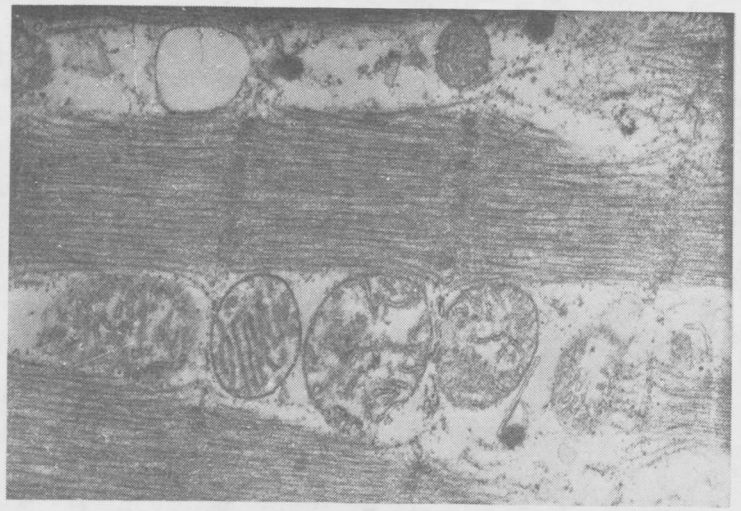

Fig. 3: Electron diffraction pattern of muscle fibers of electromassaged NOR hot meat (x 40000)

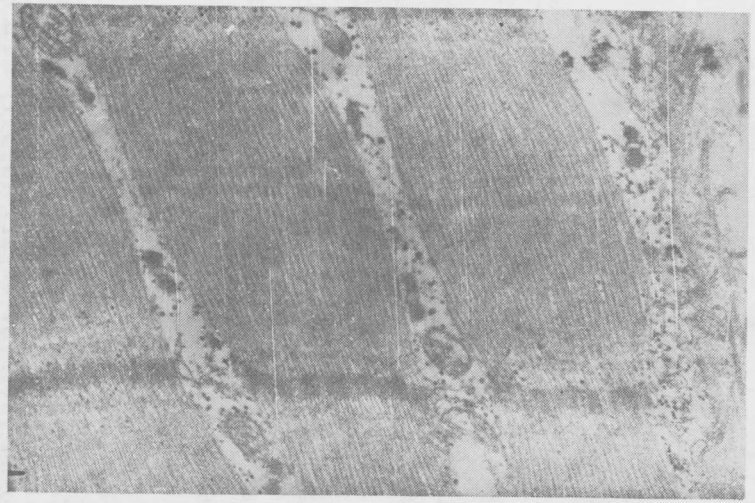

Fig. 1: Electron diffraction pattern of muscle fibers of uncured NOR hot meat (x 40000)

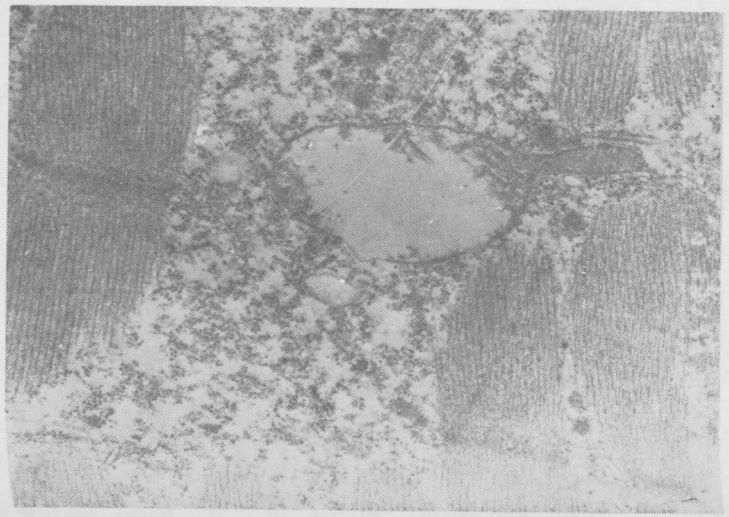

Fig. 4: Electron diffraction pattern of muscle fibers of NOR meat after mechanical treatment (x 40000)

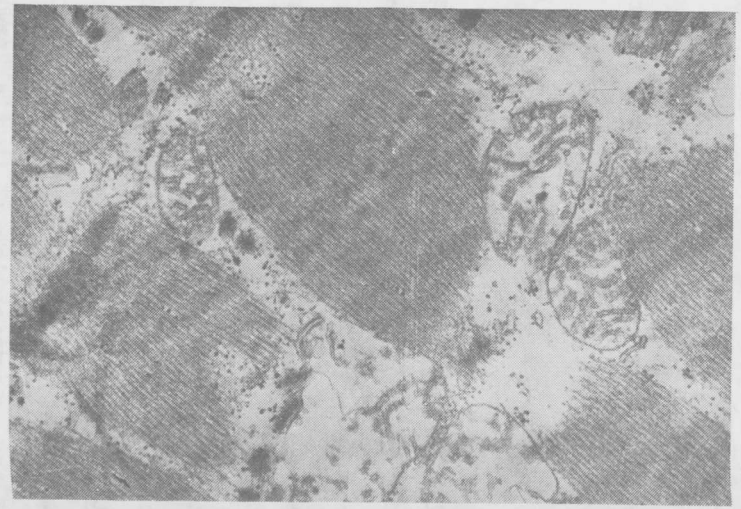

Fig. 2: Electron diffraction pattern of muscle fibers of electrostimulated NOR hot meat (x 40000)

Fig. 5 Electron diffraction pattern of DFD hot meat after mechanical treatment (x 40000)

Myofibrillar structure was observed as well as crosswise fringing lamination of Z-lines, increasing of space between fibers filled with brine, and damage of integrity of sarcolemma membrane. Revealed ultrastructural changes of skeletal muscle imply not only influence of brine ingredients but also more profound specific changes caused by electric current. Study of samples of hot muscle tissue after vacuum-mechanic treatment showed (Fig. 4) loosening of myofibrillar structure, damage and disrupture of protofibrils in Z-line zone, shift of structural elements of neighbouring myofibrils relative to each other. Further damage of sarcolemma integrity was observed. Myofibrillar structures were stretched and swollen. Accumulation of fine-grainy protein mass was observed in gaps, resulting from myofibrillar destruction. The obtained data confirm results of biochemical and histochemical research, evidencing about release of proteinase from lysosomes being cause of destructive changes in muscle tissue under electro-mechanical influence "Kudryashov L.S. et al., (1990)". However, our results showed (Fig. 5) that proteolytic changes in DFD muscle tissue after cure with mechanical massaging are less profound, this being proved by smaller destructive changes in Z-lines of myofibrils. This is probably connected with function of calpains active at high pH-values of meat, which, according to opinion of many authors "Trudlia A. et al., (1981); Nagainis P. et al., (1982)" cause limited proteolysis of actin in Z-lines and soften meat structure in a less degree compared to influence of catepsins.

CONCLUSIONS: Thus, results of research vividly demonstrated changes, taking place in muscle tissue with different character of autolysis during curing with electric and mechanical stimulation and agree with data of biochemical and physico-chemical research. Differences in structural changes of protein macromolecules of NOR and DFD meat are stipulated by action of different proteolytic enzymic systems, namely, by catepsins and calpains.

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