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MORPHOLOGICAL ASPECTS OF FORMING SOME QUALITY INDICES OF MEAT AND MEAT PRODUCTS

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Objective

The objective of the present investigation was to reveal the character and degree of change of meat microstructural indices during its processing, what is urgent for improvement of manufacturing technology of meat products and development of new estimating methods of meat and finished product quality.

Results and their Discussion

As a result of long-term scientific investigations, differentiation of muscular tissue microstructural changes, underlying positive and negative effects on forming separate quality indices of meat and meat products was carried out; means influencing the above processes were outlined.

Among positive structural changes are, first of all, weakening of muscular fiber myofibrils (Fig. 1), which increases fermentative accessibility of their structures to the effect of endogenic and directionally used exogenous enzymes, as well as of curing ingredients introduced into meat.

Retention of the integrity of sarcolemma basal membrane during the technological process (Fig. 2), which makes possible reduction of protein and moisture losses in meat at heat treatment, also should be attributed to positive factors.

To negative structural changes should be attributed contraction of myofibrillar structures of muscular fibers, due to the development of post-mortem rigidity of meat (Fig. 3), which is accompanied by actomyosin complex formation within this period, decrease of water-retaining capacity and increase of meat rigidity. The negative influence of this factor on raw material quality can be weakened by selection of shock-absorbing stunning methods.

Formation of supercontracted muscular fiber areas underlying decrease of meat water-retaining capacity is the last degree of manifestation of myofibrillar structure contraction.

It should be noted, that irregular contraction of muscular fibers due to formation of supercontracted areas leads to fundamental destructive changes connected with full or partial rupture of myofibrillar substance and muscular fiber sarcolemma in adjoining areas (Fig. 4). Electron-microscopic investigations have shown, that formation of such areas is connected with conformational changes in actin protofibrils in the area of the A-disks (Fig.5). Formation of contraction knots and bands in muscular tissue is an additional factor of protein hydrophily decrease, as available bonds are partially used in formation of compact protein complex with aggregation of its structures. In this case it is necessary to consider that moistute unbound in these areas escapes from muscular fibers through the damaged sarcolemma, and the structure of the compact protein complex is not subjected to any significant changes during a long-term autolysis (11-15 days).

Investigations have shown, that formation of contraction knots and bands within the period after slaughter and post-slaugter processing of fresh meat takes place due to rapid accumulation of lactic acid in muscular tissue (PSE meat), during intensive cooling of meat («cold»muscle contraction), electric stunning and electric muscle stimulation by power currents (50 Hz) at 220 V.

It has been determined, that multiple aggregation of fibrillar proteins, together with development of mechanical destruction of the muscle structure, is also observed during the long-term storage of frozen meat and grows with the increase of its storage period, mainly, at the expense of moisture recrystallization, and is particularly expressed in the absence of protective coatings (Fig. 6).

Among negative changes in muscular tissue structure are sarcolemma ruptures, manifesting themselves in the areas adjoining supercontraction zones, as well as in the areas of excessive influence of enzyme preparations and mechanical actions on meat.

Another morphological factor, negatively influencing quality characteristics of meat and meat products, is profound destruction of muscular fiber structures due to excessive mechanical effect on the muscular tissue during pickling or due to the long-term influence of enzyme preparations.

Here it is necessary to underline, that the degree of mechanical or enzyme effect on meat structures must have certain limits, under which destructive changes develop inside muscular fibers and the yield of fine-grained protein mass from them doesn't reach critical values. So long as sarcolemma is preserved as a whole and destructive processes inside the muscular fiber grow on, gradual increase of meat water-retaining capacity occurs. In case of excessive yield of fine-grained protein mass from the fiber (excessive processing by enzyme preparations or overmassaging) it begins to sharply decrease. Thus, the beyond limit massaging stage is characterised by multiple destruction of myofibrils, break of membrane structures and rupture of sarcolemma with the yield of great amount of fine-grained protein mass in the interfiber space (Fig. 7). Water-retaining capacity in this case is reduced by 5-7 %, as compared with the samples processed under optimal operation regimes.

The next factor negatively influencing the quality of raw material and finished products is lysis of muscular fiber structures, which can be connected with the influence of enzymes of putrifactive microflora on muscular fibers (sharp weakening of expressiveness of cross and longitudinal streakiness, swelling and color nonuniformity) (Fig. 8), as well as with overdosage of enzyme preparations of microbial, vegetable and animal origin or a long-term period of their influence.

The materials presented in the above paper give evidence of the necessity of a wider introduction of morphological analysis methods into the practice of scientific investigations.

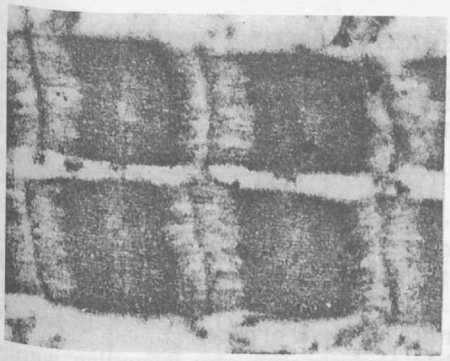

Fig. 1. Electron diffraction pattern of the muscular tissue area in the weakened state. Myofibrils with well-expressed A- and J-disks of sarcomere *(x 50000)*.

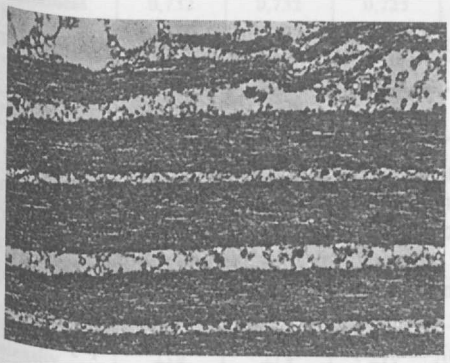

Fig. 3. Electron diffraction pattern of the muscular tissue area in the contracted state *(x 25000)*.

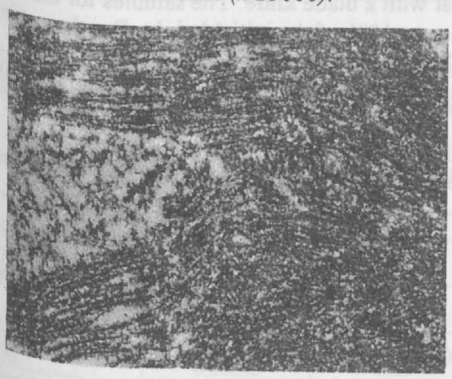

Fig. 5. Electron diffraction pattern of the muscular fiber area in the supercontracted state. Union and deformation of myofibrils with aggregation of their protein structures *(x 50000)*.

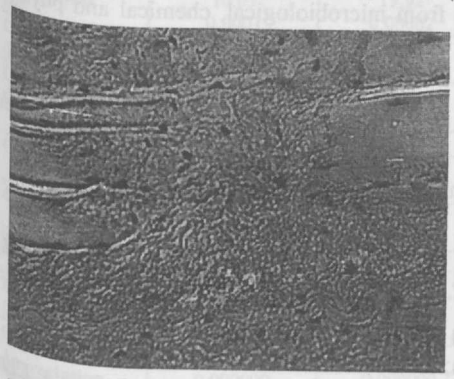

Fig. 7. Microstructure of the muscular tissue area from deep layers of cured and massaged meat. Beyond limit stage of influence (re-massaging) *(x 200)*.

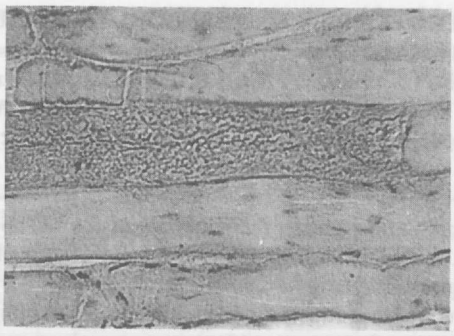

Fig. 2. Microstructure of the muscular tissue area from deep layers of cured and massaged meat. Retention of decomposition products within the fiber due to keeping integrity of sarcolemma. Rational stage of mechanical action *(x 200)*.

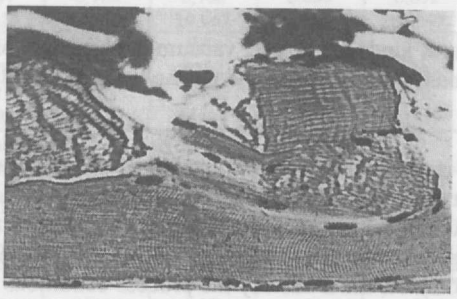

Fig. 4. Microstructure of the muscular tissue area with contraction knots and bands in supercontracted muscular fiber (PSE meat). Ruptures of sarcolemma and contractile substance in the adjoining area *(x 400)*.

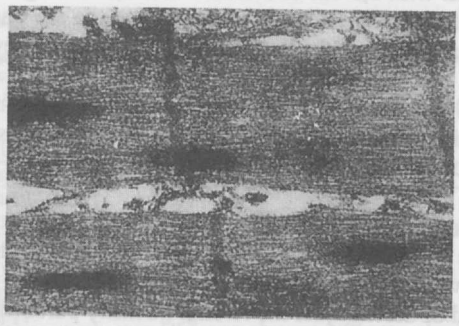

Fig. 6. Electron diffraction pattern of the muscular fiber area from deep layers of frozen meat after 12 months of storage. Aggregation of protofibril groups *(x 50000)*.

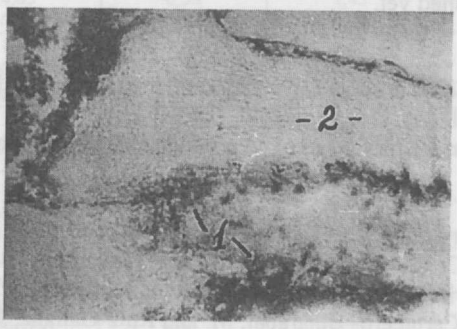

Fig. 8. Microstructure of the muscular tissue area exposed to profound microbial putrefaction: 1 - microorganisms; 2 - lysis of the muscular fiber structure *(x 400)*.