INVESTIGATION OF PSE AND DFD MEAT WITH THE HELP OF A TRACER - COLLOIDAL LANTHANUM

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During recent decades meat raw materials with syndromes of PSE and DFD are frequently encountered. It should be pointed out that animals with such defects are prevailing in the main livestock (Tatulov Yu.V., 1993).
The authors (Khvylya S. et al., 1995) have demonstrated changes of lamellar and fibrillar structures of muscle fiber in such kinds of meat. And together with them the development of autolysis is changed due to inability of cells to compensate for an increased energy consumption associated with stress reactions. These morphological manifestations of disorders in the processes of ageing are most clearly revealed 48 hours post mortem. The method of electronic-microscope tracers (Revel J., Karnovsky M., 1967, Sharov et al, 1980, Khvylya S.I., 1985) was developed previously and allowed to establish the increased penetrability of cell membranes much earlier than visual defects will appear. The proof of the presence of pathological penetrability of the sacrolemma of the raw materials with quality defects will allow to find the ways of their correction through the effects directly on cell membranes.

THE OBJECTIVE OF THE WORK

Investigation of penetrability of the sarcolemma in meat raw materials with quality defects and different times of ageing by the method of electronic-microscope tracers, i.e. - colloidal lanthanum hydroxide.

MATERIALS AND METHODS

The material studied was m. Longissimus dorsi of pigs and young bulls, taken at 10-12 rib. Warm and chilled raw materials with the time of ageing up to 6 days were chosen for the investigations. The meat was stored at 4 °C.
To find the changes in penetrability of the sarcolemma the material was fixed in glutaric aldehyde together with colloidal hydroxide of lanthanum as prepared ex tempore according to the method of the author. After treatment in osmium oxides the material was poured into epon-araldite according to common technique. The obtained sections were studied under the microscope BS-500 (TESLA) without contrasting.

RESULTS AND DISCUSSION

The tracer emerges as dark electron-dense particles, with the size, according to (Revel J., Karnovsky M., 1967) about 2 nm. The particles of the colloid have elongated form and can be placed both independently of each other, and by grouping into complex aggregates. In this case they can not be connected with any tissue or cell structures, or are associated with particular elements of the muscle fibre and connective tissue, or are localized in particular compartments of the cell, contrasting them in comparison to other structures. In the muscle tissue studied the weakened muscle fibers with expressed cross striation and elongated sarcomere are prevailing. Both the sarcolemma and the membranes of the cell organellas mainly keep their integrity. The amount of cross-slot disorders of the integrity of the fibers and ruptures of myofibrillas is insignificant. The nuclei sometimes have a slightly folded nucleolemma, suggesting initial autolityc processes in the meat. Vesiculation and fragmentation of canaliculuses of endoplasmic reticulum point out to this phenomenon. In mitochondira there are the first evidences of autolysis manifested in hydratation of matrix and partial fragmentation of crysts. Besides, swelling of the cytoplasm was observed.
Analysis of the structure of the particles of the tracer and the mode of their distribution in muscular tissue suggests: all previously described types of particles - both small and aggregated into complexes of different size - can be found. Individual particles of the colloid that are localized primarily in the zone of myofibrils prevail; they are practically absent in the substance of the sarcoplasm. Their arrangement is chaotic without connection with contractile proteins.
The second area of localization of the tracer is nuclei of muscle fibers. Here are revealed both the individual single particles and their aggregates of different size . Inside the nuclei of muscle fibers, colloidal lanthanum exclusively associated with heterochromatin is observed. Such specific arrangement of the tracer indicates a possible presence in the used solution of residues of its nitrite associated with chromatin.
The third area of muscle tissue, where there are significant amounts of tracer particles, is a T-system, which is a network of cross canaliculuses penetrating the muscle fibers. Their interior is associated with intercellular space and contains a substance, which is similar to the substance of the basal membrane, covering sarcolemma. There we observed the presence of colloidal lanthanum, forming large aggregates of the particles . The penetration of the tracer primarily to T-system indicates that its diffusion through the membranes of the muscle fiber is difficult. Some amount of lanthanum particles can be found in mitochondria also. However, such amount as was observed in other tissues (heart, liver, intestines) (Revel J., Karnovsky H., 1967, Sharov V.G. et al, 1979, Khvylya S.I., 1986) was not found.
The investigation of DFD meat has shown that its structure corresponds to previously described one. The muscle fibers are swollen with vague cross striations and closed myofibrilles. Differentiation of myofilaments in myofibrilles was difficult. The cellular organellas - are moderately swollen with slight evidences of destruction. Canaliculuses and vesicles of endoplasmic reticulum and those of T-system are often swollen. Mitochondria can be both swollen and condensed. Sarcolemma and other cellular membranes preserve their visual integrity. A basal membrane covering the muscle fiber of the side and being the part of a "thick" cellular membrane is largely preserved.

Analysis of interaction of colloidal hydroxide of lanthanum with structural components of muscle fibers of DFD meat indicates the following. Inside the muscular fibers small particles of a tracer are diffused. Similar to meat with normal pH, they are localized primarily in myofibrillas, however individual particles can be also detected in the sarcoplasm between bundles of contractile proteins. The tracer substance doesn't interact with the elements of sarcoplasmic reticulum. In the canaliculuses of T-system, similar to normal meat, one can detect the particles of lanthanum hydroxide. However, only small particles are detected in this case and their amount is much less. Of particular importance is a large amount of the tracer, adsorbed on the basal membrane. In this case not only small particles but their large conglomerates of different size are observed.

In PSE meat the muscle fibers are weakened, longitudinally elongated and cross striation is evident in them. In the sarcomeres a structure and all the zones are clearly seen. The fibers themselves are compact and divided by widened intercellular spaces. Sometimes the muscle fibers are ruptured that is followed by disturbance of intergrity of the sarcolemma and myofibrillas. The ruptures are almost always in the area of Z line. Sarcolemma may come off in layers from the sarcoplasm, the basal membrane is severely thinned. Processes of destruction are pronounced in intracellular organellas. The particles of colloidal hydroxide of lanthanum are observed everywhere in muscle fibers. They are predominantly of small diameter and localized diffusively through the whole fiber, most commonly in association with muscle fibers and the system of T- canaliculuses. The tracer did not interact with the membranes of endoplasmic reticulun as was observed in other cases. The most characteristic feature of distribution of lanthamun in PSE meat was the absence of their particles in the zone of a basal membrane on the external surface of the sarcolemma. Such distribution of the tracer points out to a sharp decrease of sorption capacities of the meat what, in spite of the increased penetrability, significantly reduces the amount of detected tracer.

When comparing the penetrability of the sarcolemma at different time of ageing it was established, that in warm meat the particles of the tracer don't penetrate under the sarcolemma, and are not detected with muscle fibers neither in the nuclei, nor in the cytoplasm.

As the time of ageing increases to 48 hours, the penetration of the tracer through the sarcolemma is observed, which is revealed best of all on cross sections of muscle fibers. Colloidal hydroxide of lanthamum infiltrates the sarcoplasm, localizing predomiantly in the field of myofibrills. Individual particles are encountered also between myofibrillas, but in that case they are connected with lipoprotein structures, being probably the initial products of autolisys of cellular organellas. Lamellar pseudomyeline corpuscles, the presence of which is characteristic of this stage of meat ageing, don't interact with the particles of the tracer, which suggests the full absence of glycoproteide sorption structures on them. Heterochromatin is also contrasted by compounds of lanthanum.

By 6 days post-mortem the degree of meat ageing is characterized by an increase of destruction processes in it. Muscle fibers are fragmented, a significant number of cross disturbances of their integrity appears. The evidences of destruction of sarcolemma are accumulated together with the breakdown of cellular organellas. As a result of destruction of cellular structures a fine-grained mass is formed. Exposure of such meat in the medium, containing lanthanum tracer, results in a mass penetration of particles into the depth of the muscle tissue. A large amount of tracer is inside myofibrillas, and much less of it is between them. A considerable part of lanthanum compounds is associated with the products of cellular breakdown both inside a muscle fibre and in intercellular spaces. These can be both the individual particles of the tracer, and the conglomerates of different size. Thus, it is found that meat of different quality groups differs both in the intensity of penetration of tracer particles through cell membranes, and in the degree of its binding with the components of glycocalyx. In the course of ageing a change in the penetrability of cellular membranes for particles of lanthanum hydroxide having the size about 2 nm is observed with simultaneous increase of tracer binding by the products of cellular breakdown. The indicated processes of change of morphological structure of cell structures, and first of all, sarcolemma, are undoubtfully followed by a change of the rate and volume of diffusion of hydrolytic enzymes, and thus, influence the process of meat ageing.

CONCLUSION

Muscle fibers of meat having quality defects considerably differ both in penetrability for tracers particles, and in sorption properties of the external part of the sarcolemma - a basal membrane.

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