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Low voltage electrical stimulation of sheep carcasses. Ultrastructural investigations.

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Electrical stimulation of meat immediately after slaughtering of animals accelerates glycolitic processes and the setting in of rigor mortis, avoids cold shortening and increases meat tenderness /Houlier and Sale, 1984; West 1982; Ruderus and Fabiansson 1982; Christin 1982; Deston 1982/.
The worldwide interest towards electrical stimulation is great and according to Savell /1982/ there is not probably another field as regards meat investigations which is more widely studied in the course of seven years, the years from 1975 till 1982.
Electrical stimulation causes ultrastructural changes, expressed in the appearance of unregulated contraction streaks, stretching of myofibres aside of them, an absence or not clearly expressed J and A disks and Z-lines, tearing of myofibrils, presence of empty bubbles and myofibrils fragmentation at the Z-lines /Sornimade et al, 1982; Voyle, 1981; Savell et al, 1978; Will et al, 1980/.
Georgakis et al, 1982 have watched strong contractions in electrically stimulated sheep muscles of myofibrils, reaching such a degree that the identification of sarcomers is not possible and the Z-lines are hardly noticeable or are not established. The contractions are more strongly expressed at the 5-th hour in comparison with the 1-st hour after the electrical stimulation and are more intensive in m.semitendinosus as compared to m.longissimus dorsi.
Our purpose here is to study the ultrastructural changes coming in the muscles under the action of low voltage electrical stimulation of sheep carcasses.

Materials and Methods

The experiments have been carried out with sheep carcasses in industrial conditions. After skinning the carcass m.semitendinosus and m.longissimus dorsi from the left control samples have been cut off and utilized. The carcasses have been electrically stimulated at 90 V electrical current with rectangular pulses, grouped in series and duration of about 2 minutes.
The samples for electronic microscopy taken from the control and electrically stimulated muscles at the 1-st and 24-th hour after the slaughtering of animals have been processed according to conventional methods and included in Dureupan. Ultrathin cuttings, prepared on a ultramicrotome KB III after contrasting /colouring/ accrording to Reynolds /1963/ have been studied under an elecronic microscope B-613 at 80 kV.

Results and Discussion

In the control samples of m.semitendinosus at the 1-st hour after the slaughtering of animals the myofibrils are rectangularly located and the J and A disks /sectors/, H-zones, Z-lines and M-lines are clearly outlined. A large amount of glycogen granules /Fig. 1/ can be seen in sarcoplasmic spaces between the myofibliles. In the control samples on some parts of them there is myofiblis contraction, disappearing of H-zones, M-lines and Y-sectors. On some other places however, A and Y sectors and Z-lines, H-zones and M-lines are well outlined. In sarcoplasma glycogenic granules /Fig. 2/ can be seen. In the control and experimental mm.semiteninosus, 24 hours after slaughtering of the animals some myofibrils contractions can be seen which are strongly expressed only in some places in the electrically stimulated muscles.
In the cotrol mm.longissimus dorsi 1 hour after the slaughtering of the animals the myofibrils are located paralelly and rectangularly. The sectors A and Y /disks/, H-zones, M and Z-lines are well outlined. A great number of glycogen granules /Fig. 3/ cane be seen in the sarcoplasma. In the respective electrically stimulated muscles contraction streaks strongly expressed can be seen where the outlines of A and Y sectors /disks/ have disappeared, as well as H-zones M and Z-lines /Fig. 4/.
In the control mm.longissimus dorsi, 24 hours after the slaughtering of the animals wavelike curves of myofibrils, Z-lines segmenting, destructive mitochondrial crists and absence of glycogenic granules in sarcoplasma /Fig. 5/ can be seen. IN the respective electrically stimulated muscles there is a dislocation of myofibrils in the area of contraction bands. There are physical disruption of protofibrils which according to some authors explain one of the reasons for increasing the tenderness of electrically stimulated meat. We also think that these changes explain scientifically such a statement /Fig. 6/.
Voyle /1981/ demonstrate by means of electrical microscopy bovine mm.semitendinosus showing uniform length of sarkomers of myofibrils and well preserved structure. In the electrostimulated mm.longissimus dorsi he illustrates strong contractions of myofibrils, partial tearing of Y-sectors and complete disruption of parts of myofibrils.

Conclusion : The analysis of the results obtained from the electrical stimulation of meat from small ruminant animals shows us that the operating mode utilized by us has a considerably greater influence on the structure of m.Longissimus dorsi than with m.Semitendinosus. These differences in the intensity of ultrastructural changes is possibly due to the different type of muscle fibres building up both muscles, as well as to a certain difference of the electric field in which the studied during the stimulation muscles.
These results affirm once again that on the effect of electrical stimulation different factors have an influence which imposes the investigations in this field to be continued.

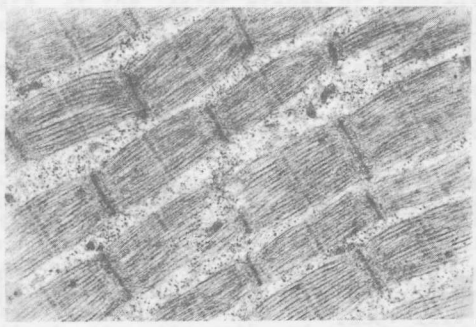

FIG. 1. Electronic microscopic photo of a control sample of m.semitendinosus 1-st hour after the slaughter of animals. Magnification 14,000 x.

FIG. 2. Electronic microscopic photo of electrically stimulated m.semitendinosus 1-hour after the slaughter of animals. Magnification 10,000 x.

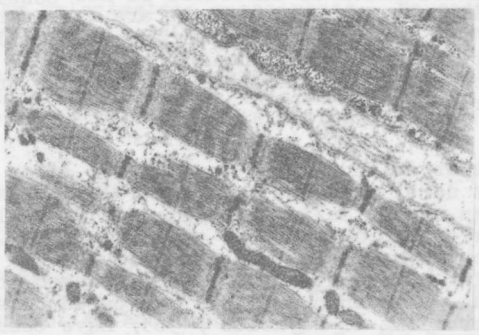

FIG. 3. Electronic microscopic photo of control m.longissimus dorsi 1-hour after slaughter of animals. Magnification 10,000 x.

FIG. 4. Electronic microscopic photo of electrically stimulated m.longissimus dorsi 1-hour after the slaughter of animals. Magnification 4750 x.

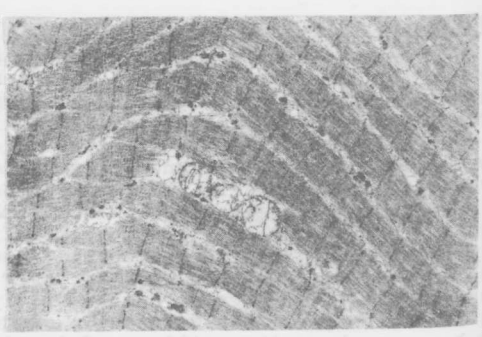

FIG. 5. Electronic microscopic photo of control m.longissimus dorsi 24-hour after the slaugher of animals. Magnification 4750 x.

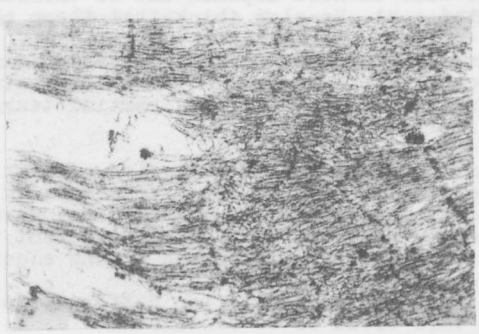

FIG. 6. Electronic microscopic photo of electrically stimulated m.longissimus dorsi 24-hour after the slaughter of animals. Magnification 14,000 x.

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