ACCELERATED TECHNOLOGY OF RAW-DRIED NON-COMMINUTED MEATS. ULTRASTRUCTURAL CHANGES

N. NESTOROV, P. VELINOV, M. CHAKUROV

Meat Technology Research Institute, Sofia, Bulgaria

RAW-DRIED meats from non-comminuted raw material of a high biological value are characterized by good nutritive and flavour qualities. One of the basic processes of their manufacture is curing: dry, brine, and mixed. In dry curing, some authors (13) rub the pieces of meat with only salt and saltpetre, and others, with sugar, too (5, 10, 11, 12). The rubbed meats are piled one on top of the other in layers, they are turned over at definite intervals of time and, if necessary, they are salted additionally. In that way the water extracted forms a solution with the salt. The duration of dry curing depends on the size of the pieces of meat, and the process takes usually 14 to 50 days (3, 4, 5, 13). A delay in the process of curing and ageing can be explained by the low temperature (+4 °C), and the absence of a mechanical action on the raw material, which slow down osmotic and diffusion processes and curing materials are distributed unevenly, so the ready product has a strongly salty taste and a hard texture. The morphological changes occurring upon brine curing have been studied by a number of authors (1, 7, 8, 9).

According to data by Chakurov et al. (2), an elimination of the defects of the known methods, an acceleration of the processes of dry curing, ageing and drying, and an increase in the nutritive value of ready product, are achieved using the method proposed by them.

The present studies were conducted with the object to follow the ultrastructural changes setting in when using that accelerated method for the manufacture of raw-dried meat delicacies from non-comminuted raw materials.

MATERIALS AND METHODS

CHILLED beef Semitendinosus muscles, trimmed of surface fats and fascia, were cured by rubbing them with salt, saltpetre and sugar and were processed according to the method described by Chakurov et al. (2).

Salt concentration in the periphery and the centre of the muscles was analysed according to the Bulgarian State Standard (6).

Samples for electron microscopy studies were taken before curing, and on the 6th, the 20th, and the 28th days. Pieces of muscle fibres, 2 x 2 x 1 mm, were placed into 5% glutaraldehyde, dissolved in Miloning buffer (pH 7,2 - 7,4) for 1 or 2 hours, washed with Miloning buffer, fixed in a 2% buffered solution of osmium tetroxide for 1-2 hours. After washing in Miloning buffer, the materials were dehydrated in alcohols and, after passing through propylene oxide, they were embedded into Durcupan - ACM "Fluka". Ultrathin sections prepared on an LKB-III ultramicrotome were stained using uranyl acetate and lead citrate. The preparations made were examined with a TESLA-BS 613 electron microscope at 80 kV.

RESULTS AND DISCUSSION

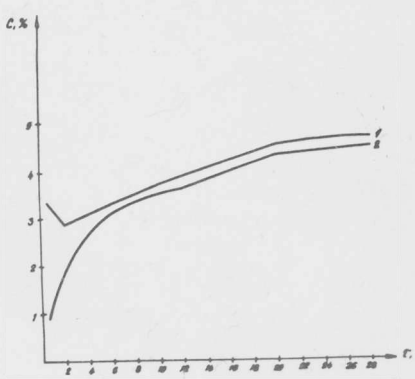

Fig. 1. Changes in salt concentration on the surface (1), and in the centre (2).

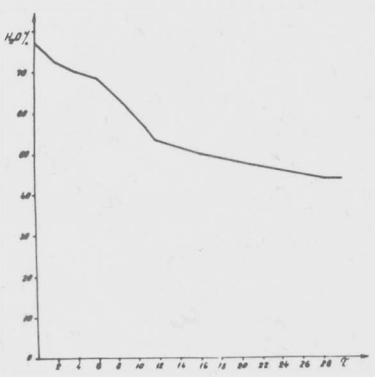

Fig. 2. Changes in water content.

The dynamics of salt penetration from the surface towards the inside of the muscles (Fig. 1) shows that, after the 8th day, changes in salt concentration on the surface and in the central parts of the muscles exhibit a pronounced linear dependence, which is preserved to the end

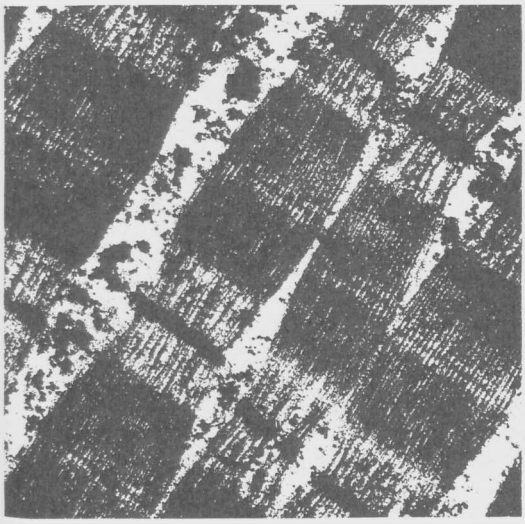

Fig. 3. Relaxation of myofibrils after the passage of rigor mortis. Magnification: 19000 x.

Fig. 4. Ultrastructural changes 6 days after curing. Destructive changes in the sarcolemma, the I-disks, and fragmentation of Z-lines. H-zones and M-lines in some sarcomeres cannot be observed. Magnification: 14000 x.

of the technological processing. Water content in the muscles (Fig. 2) is characterized by its fast reduction till the 12th day, and slower afterwards till the end of the technological process.

The electron-microscopic pattern of the muscles before curing (72 hours post mortem) is presented in Fig. 3, and it demonstrates a clearly expressed sarcomere structure. Myofibrils are parallelly oriented and separated by well expressed sarcoplasm strips. The I-disks are wide and emphasize the strong post-rigor relaxation of the myofibrils. The A-disks are well outlined and the individual protofibrils can be seen, the H-zones and the M-lines, as well as the Z-lines are clearly expressed. The described structure of muscle fibres provides good condi-

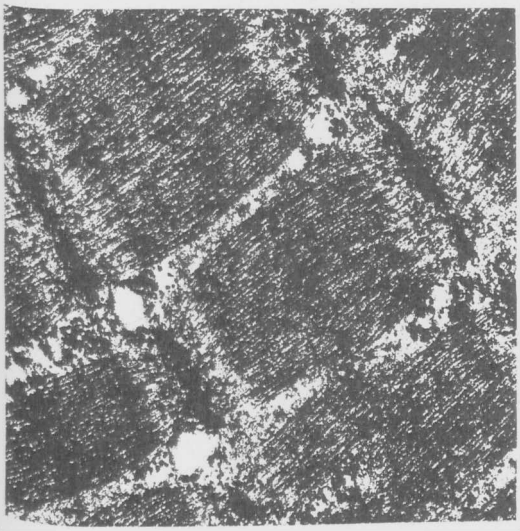

Fig. 5. Destructive changes in I-disks 6 days after curing. H-zones and M-lines are indistinct. Magnification: 19000 x.

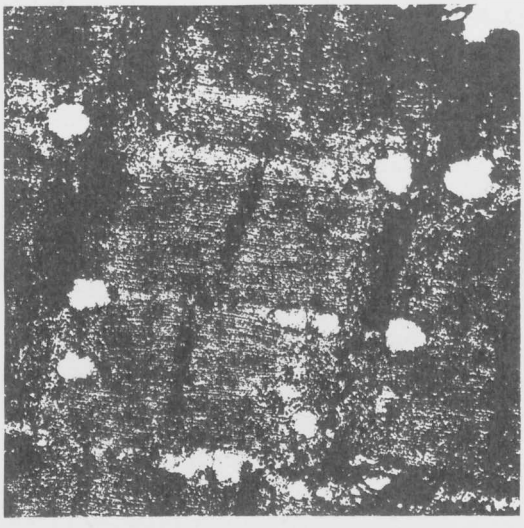

Fig. 6. Ultrastructural changes 20 days after curing. Close adherence of myofibrils, swelling of T-system tubules and destruction of the sarcoplasmatic matrix. Magn. 14000 x.

tions for a favourable technological process and for getting a high quality product.

The ultrastructural changes of the surface muscle parts 6 days after curing are illustrated in Fig. 4 and 5. A strong disintegration of sarcolemma can be seen. The latter is relatively granulated and is disrupted in some places. These changes provide good conditions for salt penetration to the inside of muscle fibres. Destructive changes of actin protofibrils, pronounced to a different extent, can be observed in the I-disks. A fragmentation of Z-lines can be seen, and sarcoplasm strips between the myofibrils are relatively reduced. In some places, the outlines of the H-zones and the M-lines are not clear enough.

The electron-microscopic changes of the central muscle parts 20 days after curing (Fig. 6) in-

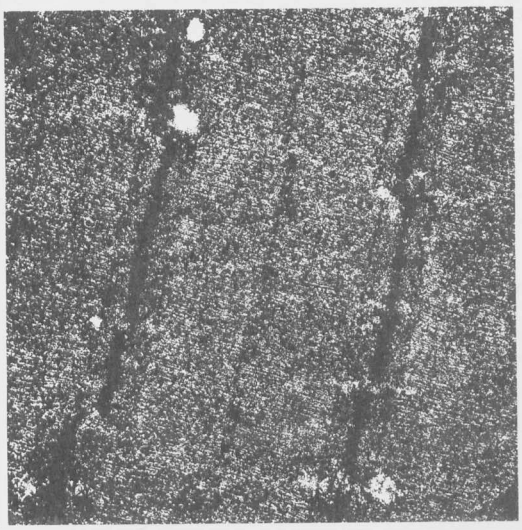

Fig. 7. Ultrastructural changes in the peripheral parts of muscles 28 days after curing. Magnification: 14000 x.

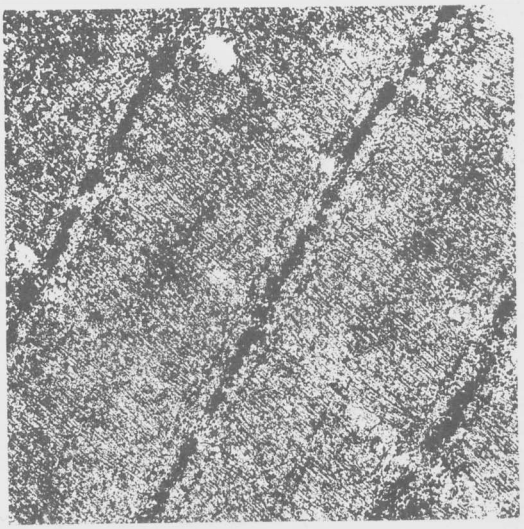

Fig. 8. Ultrastructural changes in the central parts of muscles 28 days after curing. Magnification: 14000 x.

dicate that the initial parallel orientation of myofibrils is preserved. They are closely adhering to one another, the sarcoplasmatic strips dividing them have disappeared. The Z-lines are pronounced, some of them being split or strongly destructed. Further, a swelling of the T-system tubules has set in, as well as a destruction of the sarcoplasmatic matrix. The H-zones can be observed, but not in their typical appearance.

The ultrastructural changes of the peripheral parts of the muscles 28 days after curing (Fig. 7) are characterized by a very close adherence of the myofibrils and it is difficult to distinguish them. The Z-lines appear as dark lines and, on both sides of them, the faint outlines are noticed of poorly differentiated further dark lines. Destructive changes have affected considerably myosine protofibrils, too, and they are disrupted, closely adhering to one another. In individual places, widenings of T-system tubules can still be noticed.

The electron-microscopic changes of the central parts of cured muscles 28 days after curing (Fig. 8) resemble strongly the ones described in Fig. 7. The congestion of myofibrils appears weaker. Fragmentations of the Z-lines can be observed and some more pronounced destructive changes of the actin protofibrils. Further, destructive changes can also be noticed in the myosine protofibrils, and they are better expressed. In the middle of the A-disks, the traces of H-zones and M-lines are comparatively clearer. We would explain those not too pronounced differences with the lower salt concentration, the shorter time of salt action, and the slower drying in the central parts of the muscles.

Changes in muscle ultrastructure during curing, pressing and drying are, in many respects, in good correlation with the ones described by Skalinsky and Belousov (1978) and by Rachelič and Milin (1979) for the brine curing of meat under different conditions. The differences in the technology applied by us lead to differences in the extent to which the similar ultrastructural changes are pronounced, and also to the occurrence of changes due to the processes of dry curing, pressing and drying. Interest is aroused by Rachelič and Milin's assertion (7), that disintegration changes of muscle fibre elements are a consequence of the effect of brines, and that the prolonged action of brines leads to a disintegration of sarcomeres to a greater extent. The results of the electron-microscopy studies conducted by us give us reasons to believe that the salt penetrating into muscle fibres causes disintegration changes in the structure elements of the muscle fibre, which are enhanced to a definite extent by massaging, pressing, and drying. The length of salt action on muscle fibre elements is of an essential importance, for which reason it is to be controlled in the course of the accelerated method applied by us for manufacturing raw-dried delicacies.

CONCLUSIONS

FROM the results obtained from these studies, the following conclusion can be drawn:

1. The disruption and the disintegration of the sarcolemma induced by the effect of dry curing and massaging the muscles, contributes to the faster penetration and distribution of salt in the muscle fibres.

2. Under the action of salt, disintegration changes of muscle fibre structural elements set in, and their extent depends on the duration of curing, massaging, pressing, and drying.

3. The ultrastructural changes in muscle fibres confirm that the applied accelerated technolo-

ey for the manufacture of raw-dried delicacies from non-comminuted meat can be completed successfully in 28 days.

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