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# MORPHOLOGICAL CHANGES IN MUSCLE TISSUE UPON THE HEAT TREATMENT OF STERILIZED CANS OF PORK AND BEEF

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In the manufacture of canned meats, heat treatment is an important part of the technological process. The correct application of high temperatures conditions the production of high quality sterilized canned meats: ones with highly preserved nutritive and biological values, and also the destruction of the microorganisms found in the canned product.
The method of the heat treatment of canned meats depends not only on the requirements towards the storage life of canned products, but also on their organoleptic qualities (5).
The same authors established the texture of meat after heat treatment to depend on the heating temperatures applied (120° or 130°C) rather than on heating time.
The choice of thermal treatment should be such as to avoid undesirable consequences in the finished product: chemical, physical or sensory changes deteriorating the quality of the product (3).
The necessary F-value upon the heat treatment of canned meats depends on many factors, such as aW-value, pH, microbial contamination, method of heating, the way of conveying heat, etc. (4). The effects of this treatment on the morphological changes of muscle tissue, the major component of canned meats, have been studied insufficiently and data on this problem are scarce. According to Skalinski and Belousov (1978) /1/, the microstructure of muscle tissue upon heat processing is directly dependent on the method of treatment. After cooking, they found histologically muscle fibres to increase in density, and to decrease in diameter. Their cross and longitudinal striation is well expressed or weakened. Among muscle fibres and under the sarcolemma, a fine-grain protein mass appears.
Upon grilling, more marked microstructural changes are observed. In the surface layers of meat, muscle fibres are fully attached to each other, with no longitudinal or cross striation. Deeper in, under the sarcolemma and among muscle fibres, a fine-grain mass is detected.
Upon the roasting of meat, irrespective of the treatment and the way of heat processing (at 120°-170°C), two zones are clearly differentiated: a surface zone and a deep one. In the surface zone, muscle fibres are slightly stained, they stick closely to one another, cross striation has almost completely disappeared. In the deep-lying zone, cross striation is generally preserved. A fine-grain mass occurs on muscle fibres.
The effects of heat treatment to an internal temperature of 60°, 70°, and 80°C on the ultrastructure of beef muscles are described by Cheng and Parrish (1976).
In the present work, we set ourselves the task to study the morphological changes of muscle tissue setting in upon the sterilization of cans of pork and beef.

## Material and Methods

Two sterilized canned meat products were manufactured, Pork in Natural Juice, and Beef in Natural Juice. The products were packaged in two sizes of lacquered white tinplate cans, 140 g or 220 g. The pork and the beef were cut in a grinder using a plate with kidney-shaped openings, to a particle size of 3-5 cm. Can filling was performed using an automatic doser and filler, FKF, a product of the Vemag company.
The thermal treatment applied in both sizes of cans, 140 or 220 g, was such as to attain an F-value of 8-10, but the time of obtaining that effect was different: for 140 g cans, the action of the sterilization temperature of 121,1°C was shorter by 3 minutes than in the 220 g cans.
Temperature measurement was done using thermocouples in the geometrical centre of the cans, and sterilization effect, F, was read off using the ELAB apparatus, a Danish product. Temperature registration was done at intervals of 5 minutes.
Light-microscopic analyses were made on samples of muscle tissue sized 1 x 1 x 1 cm, taken from different locations within the can of sterilized beef or pork. The samples were frozen in isopentane, cooled in liquid nitrogen. Out of them, cryostatic sections of a thickness of 10 microns were prepared using a Cryostat Minotome, made in U.S.A. After fixing, the sections were stained with hematoxylin - eosin. Stained sections were observed using a Docuval - Carl Zeiss light microscope.
Samples for electron microscopic studies were made in sizes of 1 x 1 x 2 mm, taken

from different locations in the cans of sterilized pork or beef and were fixed in 5% glutaraldehyde for 2 hours, post-fixed in osmium tetroxide in a Miloning buffer of a pH of 7,2-7,4 for 2 hours at a temperature of 4°C. After having passed through an ascending order of alcohols and through propylene oxide, the samples were embedded in Durcupan ACM. Ultrathin sections prepared using an LKB III ultramicrotome, after being contrasted with uranyl acetate and lead citrate after Reinolds, were observed using a Tesla-613 electron microscope at 80 kV.

## Results and Discussion

The light microscopic studies of pork from 140 and 220 g cans indicate that, in the process of sterilization, the high temperature denaturation of muscle proteins that occurred, resulted in different degrees of destructive changes in muscle fibres.
In the longitudinal sections from 140 g cans it can be seen that muscle fibres have a well pronounced longitudinal direction, they are swollen, their cross striation is only weakly showing in places, if any, along their length places can be observed where destructive changes are strongly pronounced and parts of the muscle fibres have turned into a finely granulated protein mass (Fig. 1).
The destructive changes described are considerably more pronounced in the pork from 220 g cans. Muscle fibres are also swollen to a different extent and have lost their cross striation, but here, significantly greater parts of them have turned into a finely granulated protein mass and the integrity of fibres is strongly impaired (Fig. 2). With regard to quality, muscle fibre destruction in large cans is identical to the one in smaller cans. Quantitatively, however, it is considerably more pronounced embracing larger sectors. This can be explained by the greater duration of the high temperature action to achieve a definite F effect in the core of the cans.
The microstructural changes of beef in 140 g cans in the process of sterilization are characterized by the following: muscle fibres have preserved their longitudinal direction and bright spaces of different width appear among them. Cross striation has either disappeared completely, or is expressed to a different extent, but is better pronounced when compared to pork. Destructive changes have affected some muscle fibres and in those places they have been reduced to a finely granulated protein mass (Fig. 3).
The destructive changes of beef muscles from 220g cans are qualitatively identical to those described for 140 g cans, and have the same trend, only more expressed quantitatively, as in pork (Fig. 4).
The ultrastructural changes of pork and beef muscles occurring under the action of heat denaturation in the process of can sterilization, are characterized by the fol-

Fig. 1. Section from a sample of canned pork in a 140 g can
Magnif. 25 x 3.2

Fig. 2. Section from a sample of canned pork in a 220 g can
Magnif. 25 x 3.2

Fig. 3. Section from a sample of canned beef in a 140 g can
Magnif. 25 x 3.2

Fig. 4. Section from a sample of canned beef in a 220 g can
Magnif. 25 x 3.2

lowing: the fractioning of Z-lines, the aggregation of actin protofibrils to the extent of complete degradation and brightening of isotropic sectors in some sarcomeres; myofibrils are closely sticking to one another with almost obliterated boundaries (Fig. 5).
Destructive changes in myofibrils vary depending on the duration of heat denaturation.
In individual sectors of the meat cans, myofibrils are converted into a finely granulated homogenous protein mass (Fig. 6).

## Conclusions

1. Two sterilized canned meat products were manufactured of pork and beef in two can sizes, 140 g and 220 g.
2. In the heat treatment, a sterilization temperature of 121,1°C was achieved, and F-values of 8-10.
3. Depending on the temperature reached and the time of its action, a gradation of destructive changes in muscle fibres is observed, from the disappearance of their cross striation to the degradation and conversion into a finely granulated mass in individual sectors.
4. The destructive changes occurring as a result of heat denaturation upon the sterilization of the canned products, are more marked and cover larger sectors in the 220 g cans, compared to those in 140 g cans. This could be of substantial importance if sterilized canned meats in larger volumes (1, 3, 5, or 10 kg) are tested or manufactured.

## References


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Fig. 5. Section from a sample of canned pork in a 140 g can
Magnif. 10000 x

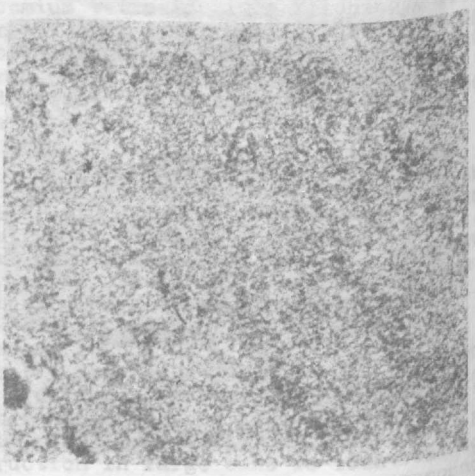

Fig. 6. Section from a sample of canned pork in a 220 g can
Magnif. 19000 x