ESTIMATION OF CHANGES IN BEEF MUSCULAR TISSUE AT DIFFERENT PROCESSING AND STORAGE CONDITIONS.

S.A. Yevelev, N.A. Golovkin, Leningrad Technological Institute of Refrigerating Industry, Leningrad, USSR.

The object of the study is to estimate changes in muscular tissue during its storage in the refrigerated, sub-refrigerated and frozen state with preliminary processing and without it.

The samples removed from half-tendon beef tissue along the fibres were selected as the objects of the investigation. Changes in meat were estimated by the reaction of pH medium, elasticity modulus E. and the value of moisture removal B, all these values being determined by electom-etric, quasistatic and pressing methods using the devices KP-2, pH-121 and ID-1.

The investigations showed that the application of variable temperature conditions of refrigerating, electric stimulation and mechanical tenderisation prevents from shrinkage of muscular tissue caused by refrigerating and accelerates mechano-chemical processes in beef during its subsequent storage in the refrigerated state 1.5 - 3.0 times, in the subrefrigerated state - 4 - 8 times in the frozen state - 16 - 100 times. Some ideas of the essence of mechano-chemical changes in muscular tissue are formulated, their basis being the mechanism of formation and propagation of solutions in myosin filaments.

The results of the study of changes in beef during its storage in the refrigerated, subrefrigerated and frozen state with the preliminary processing and without it are presented. Changes in beef were estimated by the reaction of pH medium, elasticity modules and the value of moisture removal. The investigations showed that the application of variable temperature conditions of refrigerating, electric stimulation and mechanical tenderisation prevents from shrinkage of muscular tissue caused by refrigerating and accelerates mechano-chemical processes in beef during its subsequent storage in the refrigerated state 1.5 - 3.0 times, in the subrefrigerated state - 4-8 times, in the frozen state - 16-100 times. Some ideas of the essence of mechano-chemical changes in muscular tissue are formulated, their basis being the mechanism of formation and propagation of salitons in myosin filaments.

INTRODUCTION

Intensification of refrigerated meat processing results in some cases in deterioration of its quality due to muscular tissue shrinkage caused by cold. This phenomenon and the ways to prevent it are still studied insufficiently. It is essential to carry out extensive research concerning the influence of different factors on changes in meat. The object of the study is to estimate changes in muscular tissue during its storage in the refrigerated, subrefrigerated and frozen state with preliminary processing and without it.

PROCEDURE

The samples removed from half-tendon beef tissue along the fibres were selected as the objects of the investigation. Changes in meat were estimated by the reaction of pH medium, elasticity modules E and the value of moisture removal B, all these values being determined by electrom-etric, quasistatic and pressing methods using the devices KP-2, pH-121 and ID-1 (1984). The technological process-ing and storage of muscular tissue were performed under the following conditions.

Condition 1. Refrigerating at temperature 0°C and air velocity 2 m/s up to 4°C, storage at 0°C.

Condition 1a. Refrigerating at 0°C and air velocity 2 m/s up to 12°C in the surface layer, holding at 12°C for 18-20 h. Recooling and storage under condition 1.

Condition 1b. Electric stimulation at voltage 150 V, frequencyχ = 25 Hz during 70-100 s, recooling and storage under condition 1.

Condition 1c. Mechanical tenderisation with power 7 x 10^2 j/kg. Recooling and storage under condition 1.

Condition 2. Subfreezing muscular tissue at temperature -28°C, air velocity V=2 m/s up to t = -2°-3°C in the surface layer, storage at 7t = -2°C.

Conditions 2a, 2b, 2c. Technological processing of meat under conditions 1a, 1b, 1c respectively. Freezing and storage under conditions 3. Electric stimulation was carried out by means of an impulse stimulator, mechanical tenderi-sation was performed with the use of destructor IA-2, refrigerated processing and storage was done in chambers Grünland, Frigera, P - 10.

RESULTS

The results of the investigation of changes in values of elasticity modules E, the factor of the reaction of pH medium and the value of moisture removal B for muscular tissue during its storage in the refrigerated, subrefrigerated and frozen after the preliminary processing with the use of variable temperature refrigerating conditions (1a, 2a, 3a), electric stimulation (1b, 2b, 3b) and mechanical tenderisa-tion (1c, 2c, 3c) are presented in Fig.1-9.

DISCUSSION

The results of the study show that the change of physico-chemical properties of muscular tissue has a phase character. (1985). The shelf of meat being increased, values E and B increase in the initial period at all conditions and later decrease. The change of pH has an opposite tendency. While under conditions 1, 2 and 3 stiffening of meat (maxi-mum values of E and B and minimum value of pH) is observed respectively on the second day, the eighth - ninth day and in the fourth month, with the use of conditions 1a, 1b, 1 c stiffening occurs on the first day, under conditions 2a, 2b, 2c - on the first-second day, under conditions 3a, 3b, 3c - on the first-sixth day. The use of the preliminary process-ing prevents from cold shrinkage of muscular tissue. The investigations showed that the application of variable tem-perature refrigerating conditions, electric stimulation and mechanical tenderisation promotes acceleration of mechano-chemical processes in meat during its subsequent storage in the refrigerated state 1.5 - 3 times, in the subrefrig-erated state - 4-8 times, and in the frozen state - 16-100 times.

The data obtained were applied in the development of meat processing methods maintained by two author's certificates (1983, 1985). Of particular interest is the study of the reasons causing changes in meat. Processing from the

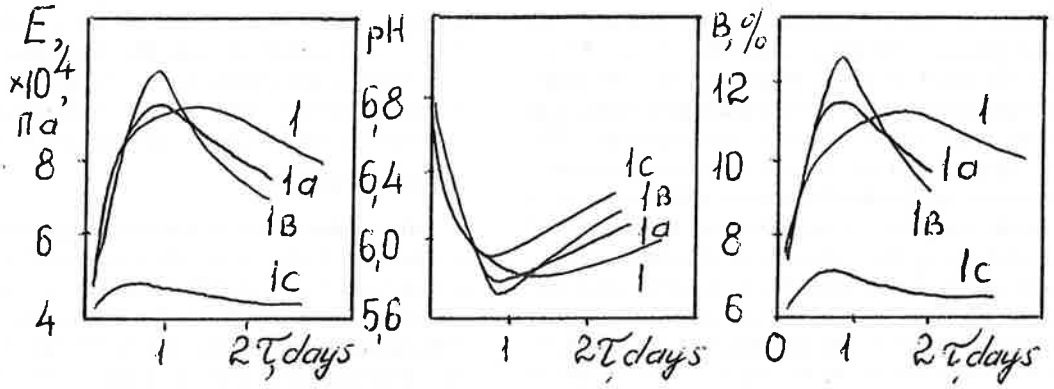

Fig.1 Fig.2 Fig.3

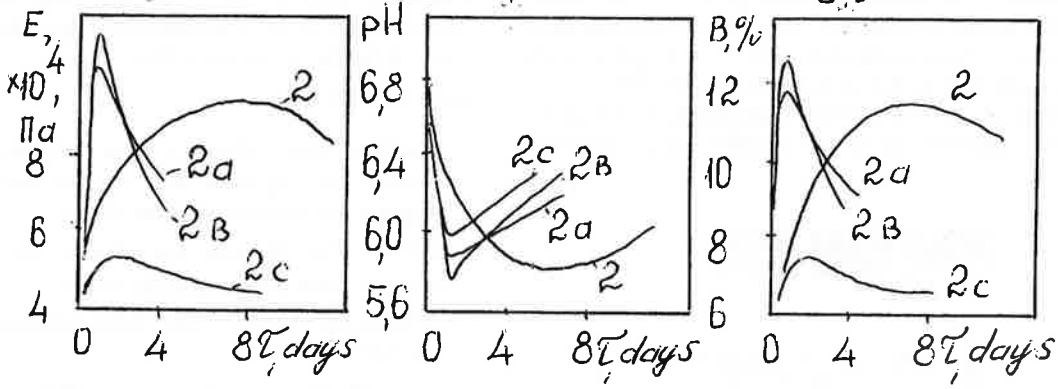

Fig.4 Fig.5 Fig.6

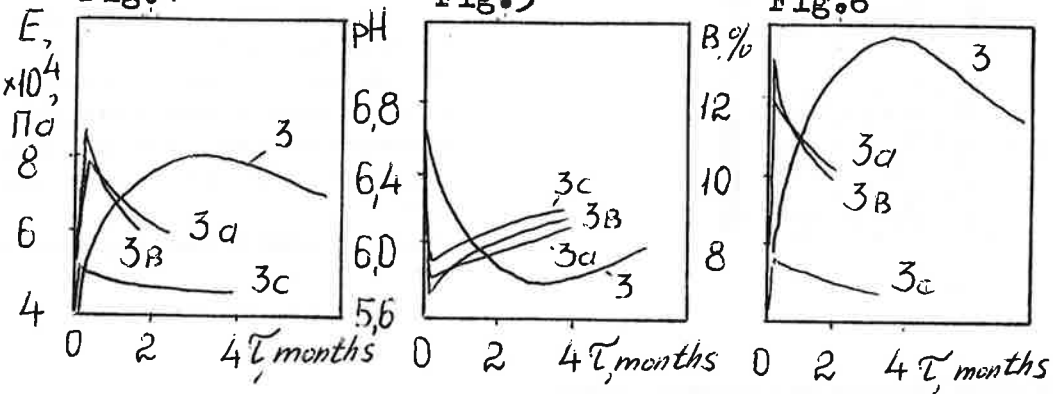

Fig.7 Fig.8 Fig.9

Fig. 1-9. The effect of the preliminary processing conditions on the change of beef muscular tissue properties during the storage in the refrigerated state (fig.1 - 3) subrefrigerated (fig. 4-6) and frozen state (fig. 7 - 9).

investigations carried out by us (1983) and the results obtained by a number of research workers (1978, 1980, 1982) the structural changes in muscular tissue can be account as follows (1985). Ceasing of an animal's life causes depolarisation of membranes in tissue systems containing ions and enzymes. Membrane depolarisation of end tanks of sacroplasmic reticulum causes the release of Ca^{2+} ions from them which results in hydrolysis of ATP molecules combined with myosin. In long spiral parts of myosin molecules the released energy gives rise to salitons. The latter are quasiparticles stable in nature (bound state of inner peptide excitation and local deformation) which more from molecule heads toward their ends located in the area of sarcomere centre (Fig.10). Movement of saliton along a protein molecule is accompanied by its local bending and increasing the diameter of a filament's pait formed by a beam of myosin molecules. The movement of the "swollen" part of the filament from its end toward the centre results in the displacement of actin protein filaments toward the centre of a sarcomere. An analogous phenomenon occurs on the other end of a myosin filament. The counter movement of actin filaments results in the reduction of the length of each sarcomere and thus in that of muscular tissue. Meat turns into the state of stiffening which is gradually followed by weakening. Electrolytes in myofibrillar space affect the penetrability of lysosome membranes, catepsins and other enzymes are released. The effect of enzymes on proteins results in the change of their physico-chemical properties increase of solubility, hydration and disturbance of saliton formation mechanism. All these processes develop in the proper period of time. The use of variable temperature refrigerating conditions, electric stimulation and mechanical tenderisation results in the change of penetrability of systems containing ions and enzymes and promotes acceleration of mechano-chemical processes in muscular tissue.

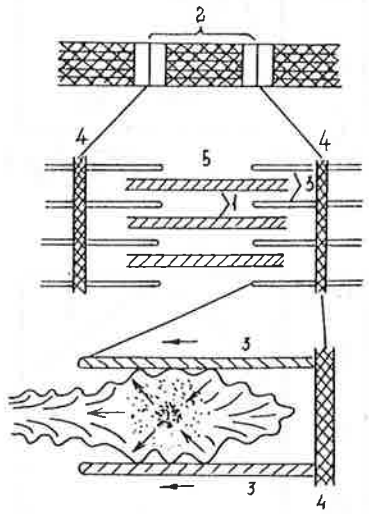

Fig. 10. Diaram illustrating the displacement of actine-filaments relative to miosin filaments due to the displacement of salitons inside miosine filaments: 1 - miosin filaments; 2 - sarcomere; 3 - actine filaments; 4 - cross-sectional membranes; 5 - the centre of miosin filaments.

CONCLUSIONS

It is shown that the use of variable temperature refrigerating conditions, electric stimulation and mechanical tenderisation prevents from cold fibre shrinkage and promotes acceleration of mechano-chemical processes in meat during its subsequent storage in the refrigerated state 1.5 - 3.0 times, in the subrefrigerated state - 4 - 8 times and in the frozen state - 16 - 100 times. The ideas of the essence of mechano-chemical changes in muscular tissue have been formulated. The mechanism of formation and propagation of salitons in myosin filaments serves as their basis.

REFERENCES

Блюменфельд, Л.А. Биофизика мембран (1982) Наука, 331

Головкин, Н.А., Воробьева, Н.Н. и Евелев, С.А. (1983) Авторское свидетельство №1026748 (СССР).

Головкин, Н.А., Воробьева, Н.Н. и Евелев, С.А. (1985) Авторское свидетельство №1145975 (СССР)

Головкин, Н.А. и Евелев, С.А. (1985) Холодильная техника 1:15.

Головкин, Н.А., Евелев, С.А. и Воробьева, Н.Н. (1984) Известия вузов, Пищевая технология 3:42.

Головкин, Н.А., Евелева, В.В. и Крайнова, Л.С. (1980) Холодильная техника 5:47.

Головкин, Н.А., Евелев С.А. и Савченко, А.Ф. (1983) Материали Европейского конгресса инженерно-технических работников мясной промышленности, Парма, Италия, 2:3.

Давыдов, А.С., Еремко, А.А. и Сергеенко, А.И. (1978) 23:983.

Евелев, С.А. (1985) Известия вузов, Пищевая технология 3:119.

Кяйвяряйнен, А.И. (1980) Наука, 271.