AUTOLYTICAL CHANGES OF HOT VACUUM-PACKED MEAT DURING CHILLING AND STORAGE

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The structuro- mechanical characteristics, changes in the ATP content, pH-value and muscle tissue microstructure as related to the chilling rate of hot-cut and packed boneless meat have been studied.

The dependance of the indices under study characterising the autolytic process has been experimentally proved.

The effect of ATP content and pH on the elastic deformation during the longitudinal stretching of muscle fibres in the process of vacuum-packed hot meat chilling has been determined.

With a similar pattern of autolysis, some specificity of this process during chilling and cold-storage of hot-cut and packed meat has been established.

Scientific papers in this and foreign countries have been devoted to the study of processes, characterising the quality of hot-cut packed meat. However, at present no optimum chilling conditions for hot boneless meat, as well as no complex research of autolytic process are available; the published data on the changes of some quality characteristics of packed hot meat are not sufficient to serve the basis of new technological process.

Survey and analysis of the available scientific literature have determined the direction of our experiments, viz., a study into the autolysis of hot vacuum-packed meat during chilling and cold storage.

The object of the study was meat from 18-month-old beef animals of the high finish belonging to the Red Steppe breed. Experiments were conducted on the M. longissimus dorsi, M. triceps scapuli and coxofemoral group of muscles. In every test both sides of the carcass were used; the left side serving as control, the right as a test one. Before cutting control sides were chilled with a one-step method according to the conventional conditions (at -1 up to 2°C, for 24 hours).

48 hours post mortem control sides were separated into cuts, the muscles were selected, portioned and packed. Muscles from test sides were dissected 1 hour post mortem, then they were portioned and packed similarly to controls.

Packing into thermoformable polyethylene-polyamide film was performed under vacuum (the pressure inside the package 13·2 kPa).

3 procedures of test samples chilling at -1 to 2°C down to the centre temperature of the average 4°C were tested: at the mean rate of average-volume temperature fall (Vav) 2·5°C/h; at V av = 1·0°C/h with packed samples pre-ageing time at 16°C for 12-14 hours. Pre-ageing and temperature were chosen on the basis of the analysis of temperature curves derived from a full bifactorial experiment (8, 16, 24 hours; 10, 12 to 14°C) with account for pH at meat temperature of 10°C (Honikel et al., 1983).

To judge on the intensity and pattern of fibre contraction in boneless hot-packed meat at the initial stage of autolysis in relation to the chilling rate, semitendinosus was studied, 1, 3, 6, 9,12, 15, 24, 48 hours post mortem by such characteristics as microstructure, pH, ATP content, the value of the plastic and elastic meat deformation of meat due to the load along muscle fibres according to a modified Locker method (Locker and Wild, 1982). The autolytical process and microbial growth during 28-day cold storage (at -1 to 2°C) of test samples were evaluated by the chosen characteristics as compared to controls.

A complex research of the processing characteristics of meat at the initial stage of autolysis made it possible to establish some specificity of rigor mortis dynamics and resolution as effected by the rate of average-volume temperature fall in packed hot meat. It was found that the test samples chilled at the mean rate of average-volume temperature fall of 2·5°C/hr are characterised with a prolonged rigor-mortis process, which deeply affects physico-chemical and biochemical changes in the tissue, and that the development of processes accompanying rigor mortis resolution is retarded.

At 3-6 hours post-mortem muscle fibres are greatly contracted, this lowering the elastic tensile deformation of samples. However, contrary to the post mortem contractions, the samples may be stretched again by applying more force. In this case the loss of elasticity by the samples typical of the rigor mortis is regained at 9-12 hours post mortem when ATP content constitutes 30% of the initial one (Shishkina and Kanevskaya, 1986). At 48 hours post mortem the muscle tissue of these samples is still in the rigor state, which is indicated by low waterbinding capacity and plasticity (Shishkina and Kanevskaya, 1985), as well as the impossibility of recording the plastic deformation of samples due to their rapid destruction under high loads.

Within this period the elastic deformation of samples during stretching is not increased yet which would be indicative of the rigor development in meat (see Figure). The table shows the strain causing plastic deformation of vacuum-packed meat samples, 6^{ϵ} 10^{3}N per m^{2} of sample conventional sectioned area.

Some retarding observed in the changes of physico-chemical and biochemical characteristics of such meat may be explained with a more intensive cold-shortening within the range of 15-10°C, the negative effects of which are eliminated in the process of further meat ageing in the package at -1 to 2°C. This is proved with statistically insignificant differences in the quality characteristics of control and test hot beef samples chilled in the package at V av = 2·5°C/hr, starting from the 14th or 21st day of storage.

In test samples, chilled with a one-step method at V ac = 1·0/hr without and with pre-ageing, rigor mortis is smoother and shorter and its resolution is faster.

Lower elastic deformation characteristic of rigor appears after 3-6 hours at 18°C and does not depend on the stretching force.

Microstructural changes of the test samples chilled at V av = 1·0°C/hours show that ageing proceeds more intensively than in controls, packed after chilling in sides. By the second day the initial stage of ageing effected by proteolytic enzymes is recorded, while in controls transversal slit-like breakage of muscle fibres occurs only at some spots. By the 7th day the second stage of ageing is observed in the deep of

test samples, while only first stage becomes obvious in controls.

Only by the 21st day of storage at -1 to 2°C these differences are levelled.

Microbiological results show that by the end of cold storage (28 days) the total microbial load in all the samples did not exceed $10^6/cm^2$ (the admitted sanitary standard for packed meat has been met); in all the cases lactobacilli prevailed, constituting 70-80% of the total load by the 21-28th day of storage.

Thus, the conducted study made it possible to reveal the effect of average volume temperature rate lowering on the physico-chemical, structuro-mechanical and biochemical processes of hot-packed meat.

It was established that improved technological properties of the test samples are achieved due to lower average chilling rate in packages from 2.5°C down to 1.0°C/hr.

Our investigations of the 3 versions of samples chilling rendered it possible to recommend one-stage chilling of packed hot meat at the mean rate of average-volume temperature fall 1.0°C/hour, while maintaining the technological properties of ready-to-cook meats.

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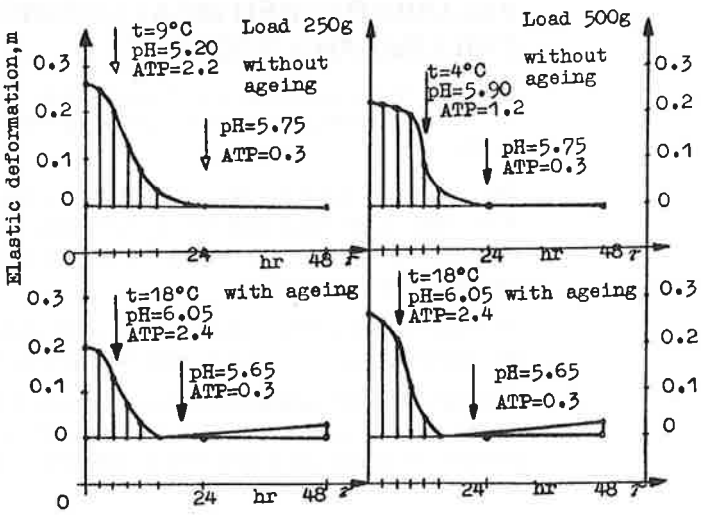

Fig. Elastic deformation resulting from stretching vacuum-packed hot meat during chilling.

↓ - the beginning and development of post mortem contraction

↓ - "cold-shortening"

Table

Hours post mortem, hr	Rate		
	2.5°C/hr	I.0°C/hr	control
I	0.8 ± 0.05	0.8 ± 0.05	0.8 ± 0.05
I6	I.I ± 0.08*	I.0 ± 0.07	-
48	I.0 ± 0.II*	0.6 ± 0.I0	0.9 ± 0.09
I68	0.7 ± 0.09	0.4 ± 0.08	0.6 ± 0.07
336	0.3 ± 0.05	0.2 ± 0.07	0.4 ± 0.I0
504	0.3 ± 0.07	0.I ± 0.05	0.3 ± 0.08

* Samples destruction under stretching