Changes in ATP of pre-rigor vacuum-packed meat as related to refrigeration parametres

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Changes in ATP at refrigeration and cold storage is one of the main parametres characterizing meat quality that is taken into account at rational regiemes of pre-rigor vacuum-packed beef chilling development. ATP decomposition at pre-rigor meat chilling was studied; autolytic changes of vacuum-packed meat as related to refrigeration regieme were determined.

Meat of I category "Red Steep" steers of without rope maintenance was investigated. Average carcass weight was 140÷160 kg, age - 16-18 months. Studies were made on semitendinosus round bottom muscle. The latter was selected taking into account anatomic peculiarities of its structure - longitudinal direction of muscle fibres. Test was made on 5 steers with selection of semitendinosus round bottom muscle of right half - test I and of left half - test 2. Time intervals were 1,3,6,9,12,15,24,48 hours after slaughter. Heat-shrinkable film Poviden was used for packing. Samples were packed in an hour after slaughter under vacuum. Residue pressure in packs was 13.2 g • Pa. Heat shrinkage was fulfilled in hot water 98°C for 2-3 sec.. Samples' temperature in the deep was controlled with a meat temperature measuring device with the accuracy ±0.5°C. A universal ionometer EV-74 was used for pH measurement in water extract 1:10 after standing for 30 minutes.

Boneless ready-to-cook products are manufactured in a packed form with a portion weight from 0.5 kg to 1.0 kg. For the need of 15 tests for one experiment (from one animal) samples were packed as a portion of 0.2 kg, taking one sample for each investigation. Refrigeration regiemes were determined in advance /1/. Comparing surface and in the centre temperatures of 0.2 and 1 kg samples process character identity at the selected regiemes was proved. 2 refrigeration regiemes were used for vacuum-packed meat samples in shirred packs: test I - slow chilling in a chamber with natural air circulation at 0÷2°C to 4°C in the deep;

test 2 - preliminary holding of packed meat samples for 16 hours at 12÷14°C followed with chilling up to 4°C at air temperature 0÷2°C.

All samples were stored at air temperature 0÷2°C.

Initial ATP value, its accumulation and decomposition are judged by the difference between inorganic P content after hydrolysis and initial P content in solution with recalculation for ATP concentration /2/. At P content determination for each investigation parallel measurements repeatability was multiple to average results getting, with the difference between the latter being no more than 10 mg of P per 100 g of tested muscle /3/.

The rate, 5000 rpm, and time, 15 minutes, of centrifuging providing sufficiently complete separation of residue and filtrate were selected at the procedure specifying. P was determined by a photometric method /3/ after two times washing of the residue with alcohol and its dissolution in 0.5n HCl. Before samples painting, according to Golovkina and Pershina /4/, suspended particles were determined by solutions' centrifuging for 20min. at 8000 rpm. Calibration graph was plotted using the results of tests with standard solutions of potassium dihydroortophosphate of the known concentration /3/ for a cell with 2 cm light absorbing layer. Solution colour intensity was determined on photocolorimeter FOU-I with a red light filter at wave length 630 ± 10 nm. Test data were processed by "Nairi-K" computer using mathematical statistics methods /5/.

At the experiment it was found that pH significantly changed during 2 days storage ($t_p > t_T$ at $f=8$, $\alpha = 0.95$) at the selected variants of test.

Mathematical relations of pH changes on time were determined:

$pH = 0.8\ e^{-0.085\tau} + 5.65$ - test I

$pH = 0.9\ e^{-0.09\tau} + 5.55$ - test 2.

More rapid pH change is observed at meat holding before chilling for 16 hours at 12÷14°C comparing to immediate chilling of pre-rigor packed meat. Apparently, this is connected with a more intensive glycolysis at increased temperatures.

ATP change more intensively at meat chilling without preliminary holding. These differences are significant to 24 hours after slaughter (Fig. I). In the case of samples holding at positive temperatures ATP decomposition rate slows down. This, obviously, may be explained by prevailing processes of ATP resysnthesis from creatinephosphate in comparison to its decomposition in the increased temperatures conditions. ATP changes in the tested samples are identical at the further storage after 24 hours.

Mathematical relations of ATP changes on time are found:

$$ATP = 2.65\ \frac{2.45}{1 + 70\ e^{-0.28(\tau + 5)}}$$ - test I

$$ATP = 2.60\ \frac{2.40}{1 + 40e^{-0.3\ (\tau - 1)}}$$ - test 2.

Average values of ATP decomposition rate for the samples without preliminary holding (9.4% of ATP per hour) and with it (8.8% of ATP per hour) are determined(Fig.2). Decrease of the average ATP decomposition rate is explained by "delay" phase of the process at meat pieces holding for 16 hours at 12÷14°C. However, maximum values of ATP decomposition rate, irrespective of, samples chilling regiemes, reach 16% of ATP per hour.

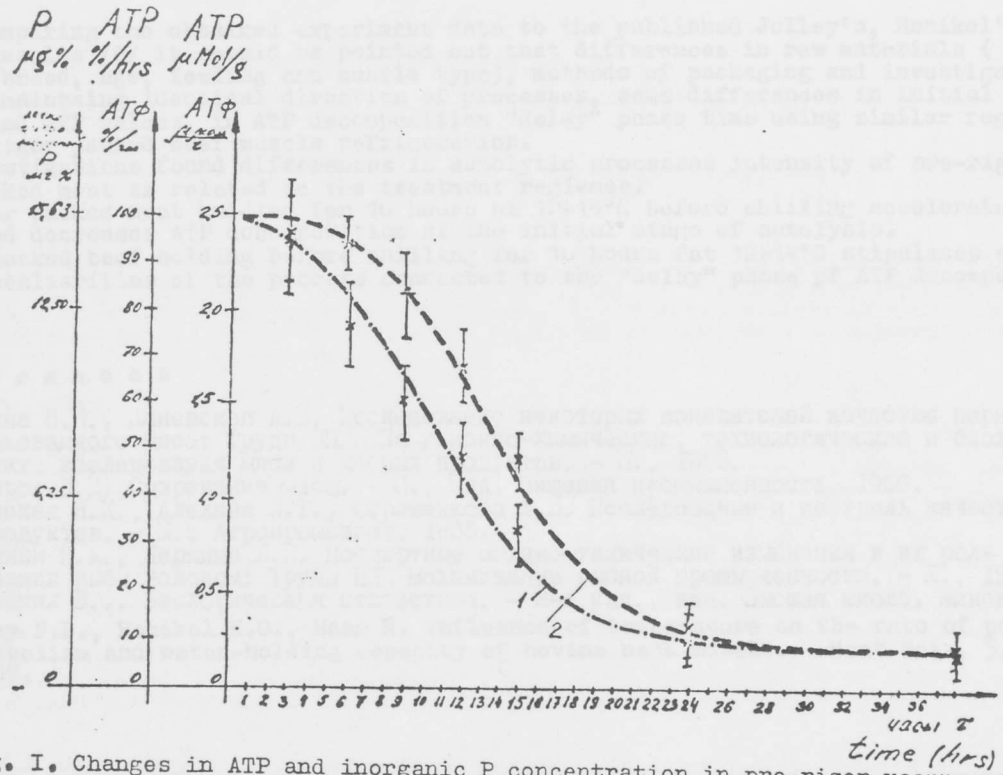

Fig. I. Changes in ATP and inorganic P concentration in pre-rigor vacuum-packed beef as related to post mortem time

I - chilling at 0÷2°C without preliminary holding;
2 - chilling with pre-holding for 16 hours at 12÷14°C followed with final chilling at 0÷2°C.

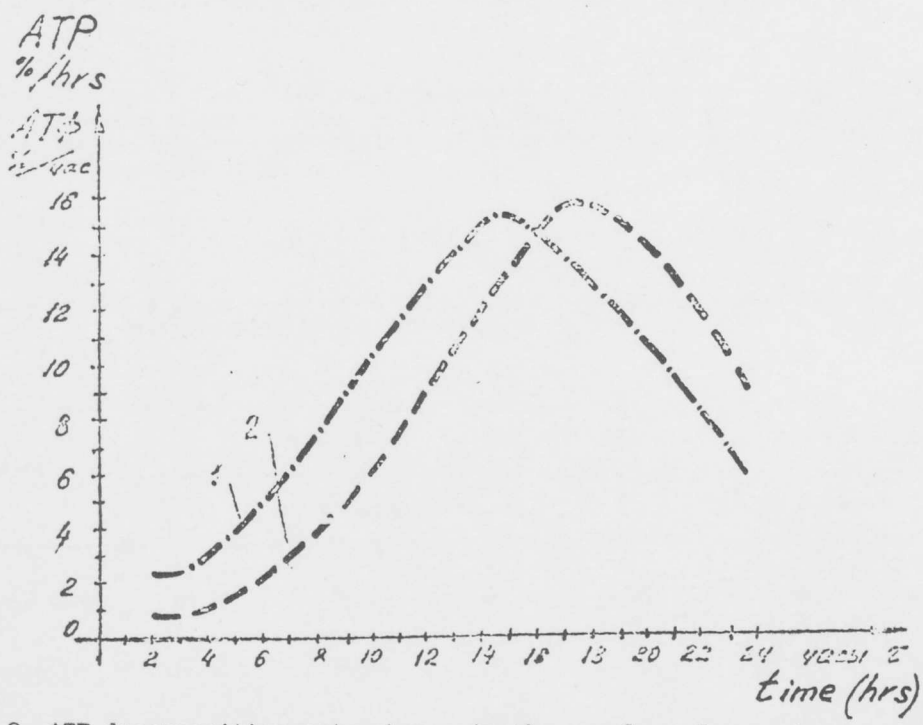

Fig.2. ATP decomposition rate change in the samples of pre-rigor vacuum-packed beef (%/hrs) as related to post mortem time

I - chilling at 0÷2°C without pre-holding;
2 - chilling with pre-holding for 16 hours at 12÷14°C followed with final chilling at 0÷2°C.

While comparing the obtained experiment data to the published Jolley's, Honikel's and Hamm's results /6/ it should be pointed out that differences in raw materials (in respect to breed, age, feeding and muscle type), methods of packaging and investigation caused, maintaing identical direction of processes, same differences in initial and final pH and ATP values, in ATP decomposition "delay" phase time using similar regiemes of pre-rigor packed beef muscle refrigeration.
The investigations found differences in autolytic processes intensity of pre-rigor vacuum-packed meat as related to the treatment regiemes.
Pre-rigor packed meat holding for 16 hours at 12÷14°C before chilling accelerates glycolysis and decreases ATP decomposition at the initial stage of autolysis.
Vacuum-packed beef holding before chilling for 16 hours fat 12÷14°C stipulates some specific peculiarities of the process connected to the "delay" phase pf ATP decomposition.

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