EFFECT OF GAMMA-RADIATION ON THE STRUCTURAL AND MECHANICAL PROPERTIES OF MEAT FROM RADIATED LAMBS

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SUMMARY: The effect of gamma-radiation on the structural and plastic strength and elasticity of lamb obtained from radiated animals was studied by the method of penetration. The changes in meat tenderness were determined by Grau's method.

It was established that the structural strength of lamb from radiated animals reached maximum value of 98.5 kPa on the 24th hour while in control samples the maximum of 109 kPa was reached on the 36th hour. The plastic strength values were lower than those of the controls. Elasticity reached a maximum of 34% in radiated lamb on the 24th hour, and 40% in control samples on the 36th hour. The same tendency was observed in meat tenderness studies. It was concluded that the changes in the structural and mechanical properties of lamb from gamma-radiated animals did not hamper its technological utilization.

INTRODUCTION: Beside the biological worth of lamb produced from gamma-radiated animals it is of interest to study the possibility for its technological utilization. There is very little information in specialized literature about the effect of gamma-radiation on the technological properties of meat, yet, there is certain knowledge about the changes in the lipid and protein composition of cells in radiated animals (Paskevich et al., 1971).

The aim of the present work is to determine the effect of gamma-radiation on the structural and mechanical properties of lamb from radiated animals.

MATERIALS AND METHODS: Four-month-old Merinofleisch lambs with a live weight of 10-18 kg were used in our study. The animals were divided into 2 groups: one was gamma-radiated with 3.3 Gy and the other was the control group. Both test and control animals were bred in identical conditions, the latter,

however, were subjected to no radiation. Samples were taken from the animals at the 20th day of radiation, and both control and test carcasses were processed according to the technologies established in our packing houses. The studies were carried out on m. Longissimus dorsi and m. Semimembranosus at the 12th, 24th, 36th and 72nd hour after slaughter. The muscles were cooled at -10° + -15°C ambient temperature and air velocity 2-3 m/sec, to a depth temperature of $+6^{\circ}$C. Then they were stored at $0^{\circ}$to 2°C ambient temperature.

The effect of gamma-radiation on the structural and mecha nical properties of lamb muscles was determined by reading the changes in the folowing parameters: tenderness, by Grau's method (Grau, 1964), structural and plastic strength, and elasticity, by the method of penetration (Voskresenski, 1958)

The results obtained were processed according to the methods of the variational statistical analysis (Gerasimovich et al., 1978) and (Dedenko et al., 1977).

RESULTS AND DISCUSSION: Figures 1 and 2 show the studied changes in the structural strength of m. Longissimus dorsi.

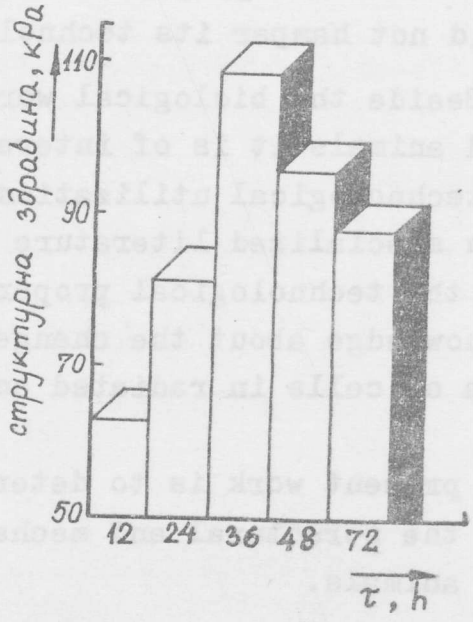

Fig.1. Change in the structural strngth of m. Longissimus dorsi from non-radiated lambs.

It can be seen that for the studied period the nature of the changes in the structural strength of m. Longissimus dorsi from animals that received 3.3 Gy gamma-radiation is simi-

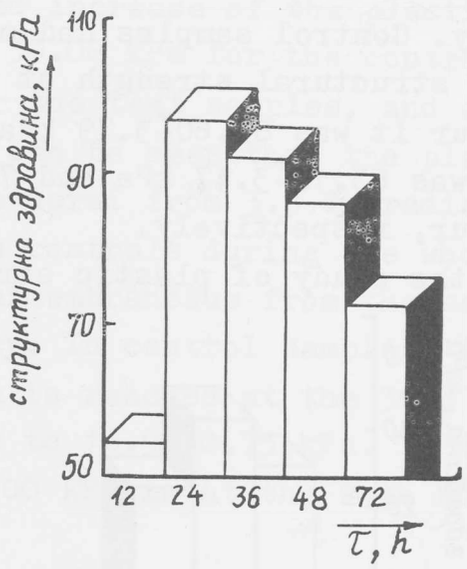

Fig.2. Change in the structural strength of m. Longissimus dorsi from lambs radiated with 3.3 Gy gamma-rays.

lar to that of the control. The established increase in the structural strength reaches maximum high values about the 36th hour after slaughter, 109.00 kPa, in muscles from non-radiated animals. It is at that moment that firming of the structure and shortening of muscle fibres occur characteristic of the postmortem rigidity due to the formation of an insoluble complex compound between the myofibrillar muscle proteins, actin and myosin. It can be noticed, however, that the above processes occur earlier in the muscles from the animals gamma-radiated with 3.3 Gy. The maximum value of 98.50 kPa is reached as early as the 24th hour. This is probably due to the accelerated metabolic processes in the bodies of the gamma-radiated animals resulting in depletion of the energy substances that sustain the free slippage between the myosin and actin fibres of myofibrils in muscles. As a result of the more intensive processes, the postmortem rigidity comes more rapidly and is manifested earlier. The further lowering of the structural strength of m. Longissimus dorsi in control samples, reaching 88.20 kPa at the 72nd hour, is related to the gradual passing of rigor mortis because of the partial dissociation of the actomyosin complex. These changes occur in the meat from 3.3 Gy radiated lambs after the 24th hour.

The studies of m. Semimembranosus from the same animals showed a similar tendency. Control samples had maximum increase of 92.00±3.92 kPa of structural strength at the 36th hour while at the 72nd hour it was 85.60±3.79 kPa; in samples from radiated animals it was 83.10±3.47 kPa and 74.67±3.10 kPa at the 24th and 72nd hour, respectively.

The results from the study of plastic strength are given on Figures 3 and 4.

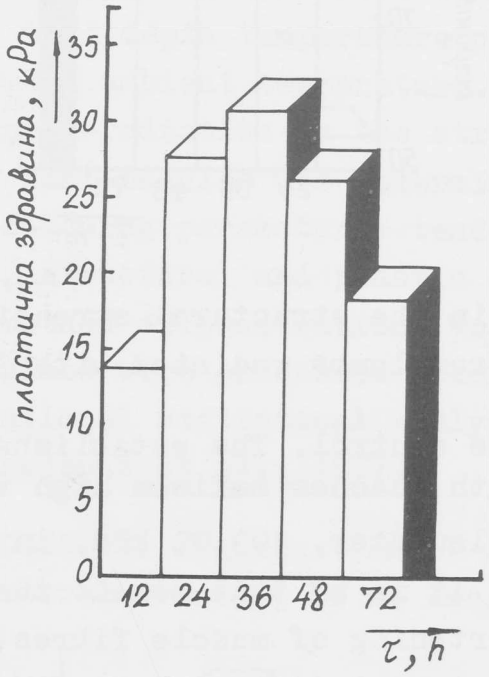

Fig.3. Change in the plastic strength of m. Longissimus dorsi from non-radiated lambs.

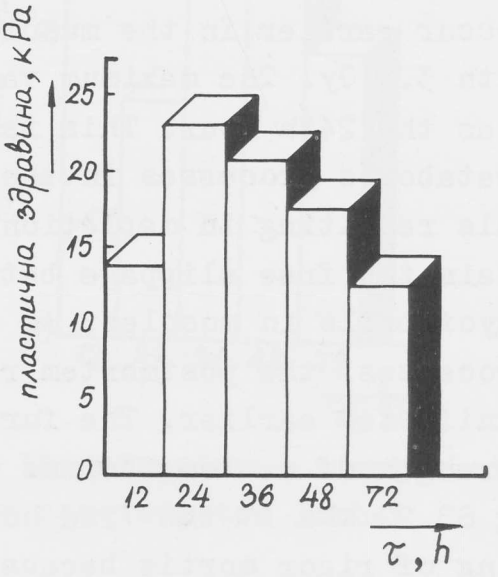

Fig.4. Change in the plastic strength of m. Longissimus dorsi from lambs radiated with 3.3 Gy gamma-rays.

The established increase of the plastic strength value by the 36th hour is 30.08 kPa for the control, and 22.60 kPa by the 24th hour for the test samples, and after that tends to become lower. It can be seen that the plastic strength values in m. Longissimus dorsi from 3.3 Gy radiated lambs are lower than those of the controls during the whole test period. The studies of m. Semimembranosus from the same animals indicate a similar tendency. In control samples, the maximum increase of 29.17 ± 1.20 kPa is reached at the 36th hour while at the 72nd it decreases to 16.94 ± 0.75 kPa. In test samples the maximum of 20.47 ± 1.00 kPa is at the 24th hour, and 11.30 ± 0.69 at the 72nd.

The results from the elasticity studies (Figures 5 and 6) show that the high dose of 3.3 Gy gamma-radiation causes faster deterioration in meat elasticity; at the 24th hour after slaughter it is maximum 34% compared to the 40% at the 36th hour of the controls. This result confirms the above result for the earlier occurence of rigor mortis that causes the poorer elasticity of meat. After the 36th hour there is slow restoration in elasticity, though the initial values are not reached.

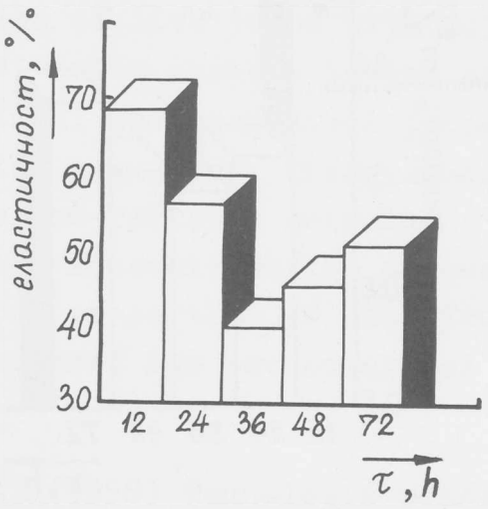

Fig.5. Change in elesticity of m. Longissimus dorsi from non-radiated lambs.

In the studies of m. Semimembranosus there are similar changes (12th h: control - 67.23 ± 3.00%, radiated - 60.49 ± 3.10

24th h: control - 53.14±2.90%, radiated - 34.21±1.42%; 36th h control - 36.63±1.67%, radiated - 39.12±1.65%; 48th h: control - 42.61±1.90%, radiated - 39.87±1.90%; 72nd h: control - 50.34±2.50%, radiated - 45.41±2.10%).

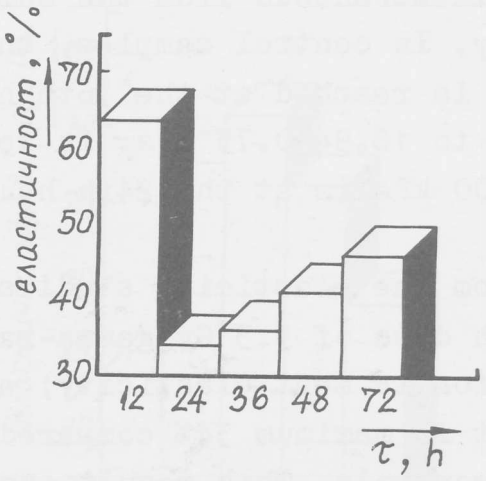

Fig.6. Change in elasticity of m. Longissimus dorsi from lambs radiated with 3.3 Gy gamma-rays.

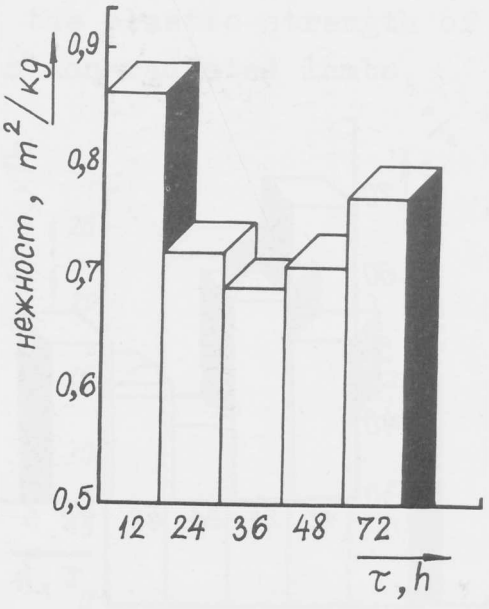

Fig.7. Change in tenderness of m. Longissimus dorsi from non-radiated lambs.

As far as changes in the tenderness of m. Longissimus dor-

si and m. Semimembranosus are concerned, it was established that in radiated samples tenderness values were lower than the controls, and were very much reduced at the 24th hour, then they slightly increased (Figures 7 and 8).

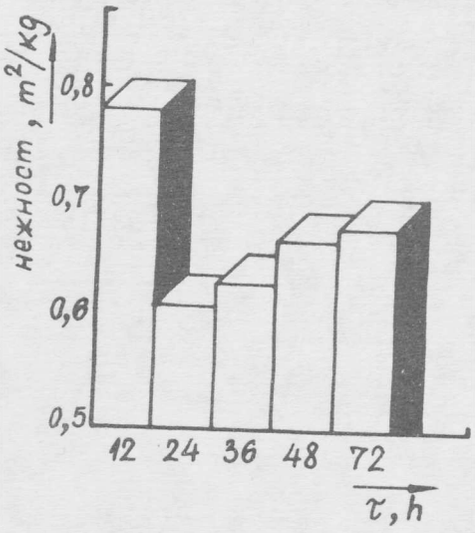

Fig.8. Change in tenderness of m. Longissimus dorsi from lambs radiated with 3.3 Gy gamma-rays.

CONCLUSION: Based on the studies and the summarized experimental results we made the following conclusions:

1. Gamma-radiation of live lambs with 3.3 Gy radiation dose causes more intensive changes in the parameters characterizing the structural and mechanical properties of meat in the first hours after slaughter. These changes, however, are similar to those in non-radiated animals.

2. The established intensification of changes in the structural and mechanical properties of lamb from gamma-radiated animals does not encumber its technological utilization.

REFERENCES:

- Voskresenski, N.A. (1958) Tehnologia posola, kopcheniya i sushki ribi. Pishtepromizdat, Moscow.
- Grau, G. (1964) Myaso i myasoproduktov. Pishtepromizdat, Moscow.
- Gerasimovich, A.K., Matveyeva, J.K. (1978) Matematicheska statistika. Vissha shkola, Moscow.

- Dedenko, L.G., Kordenchev, V.V. (1977) Matematicheskaya obrabotka i oformlenie rezultatov eksperimentov. Moscow University.
- Paskevich, P.F., Ishkhanova, M.A., Likhodet, V.S. (1971) Radiobiologia 1:42.

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