Gamma-Radiation of Pigs and its Effect on the Structural and Mechanical Properties of Pork

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SUMMARY: It has been studied the effect of gamma-radiation on the structural and plastic strength and elasticity of meat from pigs that have been exposed to 2.2 and 3.3 Gy gamma-rays by applying the method of penetration.

The results obtained indicate that the elasticity of m. Longissimus dorsi from pigs radiated with 3.3 Gy gamma-rays decreases faster and reaches its minimum levels at the 24th h (63.59%). The structural strength of meat from 3.3 Gy gamma-radiated pigs remains high during the whole test period until the 72nd h, and reaches the maximum of 133.04 kPa at the 24th h compared to the controls and the meat from 2.2 Gy gamma-radiated animals (36th h - 122.19 kPa; 36th h - 126.15 kPa). It has been established that the plastic strength of the muscles radiated with a high dose gamma-rays (3.3 Gy) is higher during the whole test period, and the maximum is at the 24th h (40.96 kPa).

INTRODUCTION: The consumption of meat from animals that have been exposed to ionizing radiation may occur and be even unavoidable under conditions of elevated radioactivity (Belov et al. 1987). In relation to this, it is important to know the after-effects of ionizing radiation on animals. The effect of postmortem ionizing radiation on the lysosomic enzymes activity in beef muscles has already been studied (Lakritz et al. 1988). Of particular interest are the changes in the technological properties of meat from radiated animals with respect to its effective utilization.

The objective of the present work is to study the effect of gamma-radiation on the structural and mechanical properties of muscles from radiated pigs.

MATERIALS and METHODS: The study was carried out on m. Longissimus dorsi from three-month-old pigs with live weights of 55-60 kg. The animals were divided into 3 groups. The first two groups were exposed to single gamma-radiation with 2.2 Gy (variant I) and with 3.3 Gy (variant II). The third (control) group of animals were bred under the same conditions but were not exposed to radiation. Muscle samples were taken on the 30th day after radiation with the aim to determine their structural and mechanical properties. The control and test carcasses were processed according to the technology commonly practised in our meat packing houses. The samples of m. Longissimus dorsi and m. Semitendinosus were stored at 0°-2°C and were examined at the 12th, 24th, 36th and 72nd h post mortem in order to find out the effect of gamma-radiation on the structural and mechanical properties of these muscles. For that purpose, the changes in the following parameters were followed: structural, plastic strength and elasticity. The method of penetration was applied (Voskresenski, 1958).

The results obtained were analysed by the methods of mathematical statistics (Georgieva et al. 1987).

RESULTS and DISCUSSION: The results for the structural strength of m. Longissimus dorsi

are given in Fig.1. It has been established that in muscles from animals radiated with 2.2 Gy the changes in the structural strength are similar to those obtained for m. Longissimus dorsi from nonradiated animals (Fig.1). The structural strength levels remain low until the 12th h post mortem and after that hour become higher with a maximum at the 36th h (controls: 122.19 kPa; test: 126.15 kPa). After the 36th h, the muscle structural strength both from nonradiated and 2.2 Gy-radiated animals gradually decreases (Fig.1). In m. Longissimus dorsi from 3.3 Gy-radiated pigs there is no significant difference for this parameter until the 12th h post mortem when compared with the controls and variant I samples. Significant changes have been established after the 12th h; muscle structural strength remains high during the whole test period until the 72nd h and reaches maximum levels faster (24th h: 133.04 kPa) than the controls and 2.2 Gy-radiated muscles (Fig.1).

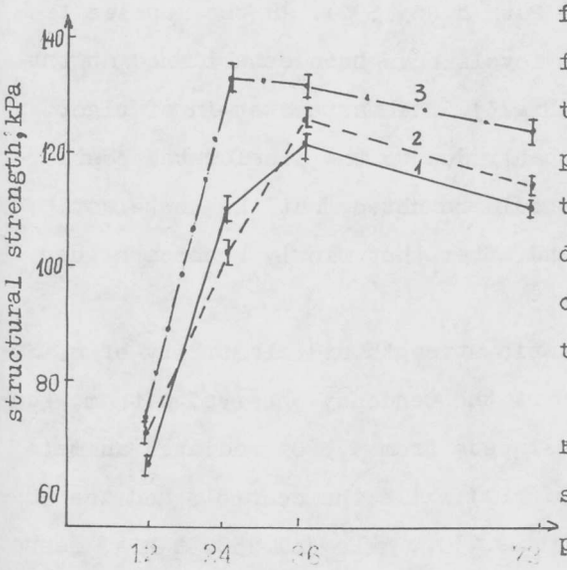

Fig.1. Changes in the structural strength (kPa) during storage of m.Longissimus dorsi from: (1) nonradiated pigs; (2) 2.2 Gy gamma-radiated pigs; (3) 3.3 Gy gamma radiated pigs.

The changes established in the muscle samples from high-dose-radiated animals (3.3 Gy) are probably due to an earlier set-in of rigor mortis at the 24th h post mortem.

The results from the plastic strength study of m. Longissimus dorsi from test animals are given in Fig.2 and show a tendency that is similar to that in the structural strength. It has been established that the plastic strength of the muscle samples from gamma-radiated animals (3.3 Gy) is higher than the controls and variant I samples; the maximum levels have been reached at the 24th h post mortem. 40.96 kPa (Fig.2). After the 24th h, the plastic

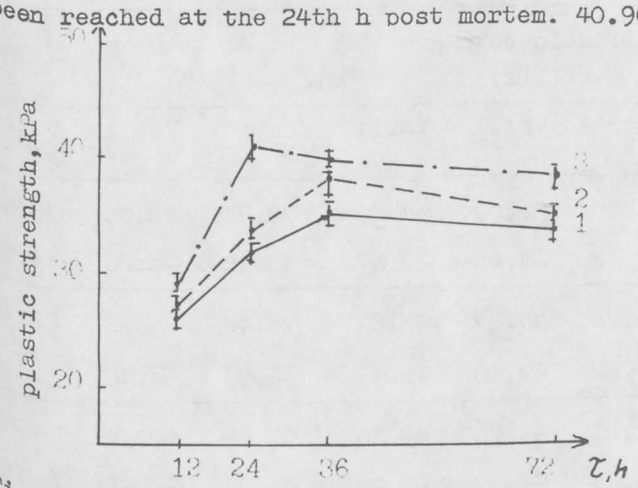

Fig.2. Changes in the plastic strength (kPa) during storage of m.Longissimus dorsi from: (1) nonradiated pigs; (2) 2.2 Gy gamma-radiated pigs; (3) 3.3 Gy gamma-radiated pigs.

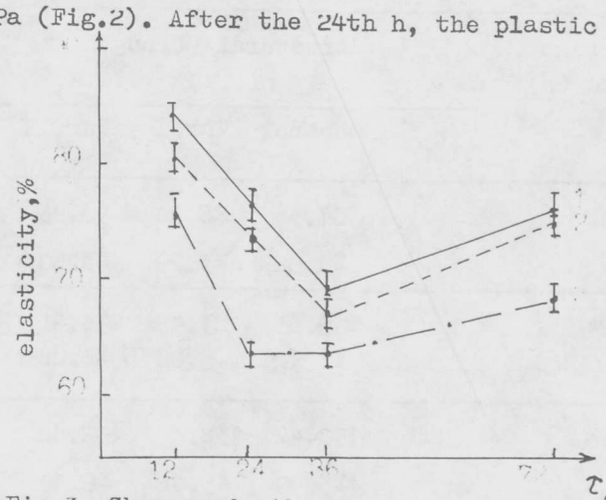

Fig.3. Changes in the elasticity (%) of m. Longissimus dorsi from: (1) nonradiated pigs; (2) 2.2 Gy gamma-radiated pigs; (3) 3.3 Gy gamma-radiated pigs.

strength slightly drops. The results for the changes in the elasticity of m. Longissimus dorsi are given in Fig.3. It can be seen that at the 12th h post mortem the elasticity is high both in the controls and in the samples from 2.2 Gy gamma-radiated pigs (84.51% and 80.79%, respectively) and remains high during the whole test period as compared to the samples from 3.3 Gy gamma-radiated animals (Fig.3).

In m. Longissimus dorsi from animals radiated with 3.3 Gy there is a faster decrease of elasticity levels while the minimum levels are at the 24th h (63.59%). In the muscles from 2.2 Gy radiated and nonradiated animals these minimum levels have been established at the 36th h post mortem, 67.08% and 69.54%, respectively (Fig.3). The faster set-in of rigor mortis in the samples with high dose radiation is probably due to the accelerated postmortal processes which result in lower elasticity. It should be noted that the low elasticity in these samples remains unchanged until the 36th h and after that slowly becomes higher, reaching 68.53% at the 72nd h.

The results for the changes in the structural, plastic strength and elasticity of m. Semitendinosus are given in Table 1. These results support the tendency observed with m. Longissimus dorsi. The structural strength of m. Semitendinosus from 3.3 Gy radiated animals (variant II) reaches its maximum at the 24th h (143.56 kPa) while the controls and the muscle samples from the 2.2 Gy radiated pigs (variant I) are 130.47 kPa and 138.31 kPa, respectively (Table 1). The changes in the plastic strength show similar tendency. The maximum levels for the controls and variant I samples have been registered at the 36th h, 42.61 kPa and 43.70 kPa, respectively, and for variant II at the 24th h - 46.84 kPa (Table 1). The elasticity of m. Semitendinosus from high dose (3.3 Gy) radiated animals decreases and reaches its minimum level at the 24th h (66.47%) compared to the controls (36th h, 67.54%) and the low dose radiated samples (36th h, 67.31%).

Table 1. Changes in the elasticity (%), structural and plastic strength (kPa) during storage of m.Semitendinosus from nonradiated (control) and gamma-radiated pigs with exposure doses of 2.2 Gy (variant I) and 3.3 Gy (variant II).

Storage Time (h)	Structural strength (kPa)			Plastic strength (kPa)			Elasticity (%)		
	Control	Var.I	Var.II	Control	Var.I	Var.II	Control	Var.I	Var.II
12	84.38 ±3.52	86.71 ±3.79	90.15 ±3.60	31.10 ±1.42	32.07 ±1.65	34.00 ±1.57	79.81 ±3.16	78.15 ±3.20	76.94 ±3.12
24	119.63 ±4.89	123.42 ±5.08	143.56 ±6.28	39.76 ±1.62	41.87 ±2.10	46.84 ±2.15	75.42 ±2.93	74.72 ±3.10	66.47 ±3.18
36	130.47 ±5.90	138.31 ±5.16	142.82 ±6.10	42.61 ±2.13	43.70 ±2.07	44.13 ±2.07	67.54 ±3.06	67.31 ±2.96	69.08 ±3.10
72	121.55 ±5.67	135.46 ±5.10	140.17 ±5.85	41.65 ±1.87	42.38 ±2.11	43.19 ±2.10	73.66 ±3.21	73.09 ±3.12	71.26 ±2.97

CONCLUSIONS: Gamma-radiation of pigs with exposure doses of 2.2 Gy does not cause significant changes in the structural, plastic strength and elasticity of m. Longissimus dorsi and m. Semitendinosus when compared to muscles from nonradiated animals. When the exposure dose is elevated to 3.3 Gy the structural and plastic strength reaches a maximum level at the 24th h, and elasticity reaches a minimum level at the 24th h in comparison with the controls and the 2.2 Gy gamma-radiated samples. We conclude that gamma-radiation of pigs with doses of 3.3 Gy accelerates the postmortal autolytic processes occurring in muscles which fact is related to the faster set-in of the postmortal rigour resulting in meat toughness.

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