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Research Article

BIOLOGICAL FULL VALUE OF MEAT RAW MATERIALS OF PIGS IN THE TECHNOGENIC POLLUTION CONDITIONS OF TERRITORIESA. G. Isaeva^{1*}, A S. Krivonogova², I. M. Donnik³, I. A. Shkuratova⁴, L. I. Drozdova⁵,
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Abstract:

In article influence of technogenic pollution of agricultural territories by heavy metals on quality of meat raw materials of pigs is described.

Also research results of heavy metals accumulation in bodies and tissues of pigs, their influences on amino-acid composition of meat raw materials, intensity of lipid peroxydation processes, features of a muscular tissue morphogenesis are given in article.

Keywords: *heavy metals, pigs, liver, muscular tissue, amino-acid structure, malondialdehyde (MDA), morphogenesis.*

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INTRODUCTION:

The threat of accidents and technogenic catastrophes constantly increases in the modern world. The research of 5 thousand major accidents showed that 90-95% from them occurred in industrialized countries of the world. Data of the United Nations (UN) show that technogenic catastrophes take third place among all types of accidents on a death toll, as well as make the most considerable impact on the environment [1, 3, 6]. Emergency situations on large industrial facilities lead to the inevitable pollution of the environment which is often not localized within production. Besides, emissions of dangerous substances happen also during the regular work of the enterprises that is connected with insufficient technological capabilities of their catching and neutralization. In industrial regions, as well as in the territories affected by major technogenic accidents one of the main negative factors is the combined pollution of land and fresh-water ecosystems xenobiotics of various origin [5, 8, 14]. Especially this problem is particularly acute in regions where the ecological situation is worsened because of industrial emissions of toxic substances, and the level of impurity of agrobiocenoses is very high [20, 24]. The increasing aggression of the environment which is followed by pollution of the microelement nature leads to saturation by dangerous contaminants of all links of a biota [18, 20, 22]. Collecting in plants, technogenic pollutant then on a food chain get to an organism of animals and the person, break functions of separate bodies and systems and reduce the general resistance of an organism [17].

In the conditions of constant toughening of requirements of quality and safety of food the livestock enterprises face a number of problems of economic, sanitary and hygienic, technological character [15, 16, 19, 21, 25]. Environmental

pollution by heavy metals causes essential changes of health of animals and influences quality of livestock production [5, 9, 10, 13].

METHODS:

For assessment of quality of meat of pigs from areas with different technogenic loading during slaughter at animals selected tests of a femoral, pectoral, iliac, longissimus muscle of a back. Also we have determined the content of heavy metals in a bone tissue, liver and kidneys. In total about 50 tests of each look are selected. The maintenance of CD, Pb, Zn, Cu, As determined atomic and absorbing and atomic and issue by spectrometry methods on the atomic and adsorptive AA6800F spectrophotometer (production Shimadzu, Japan).

RESULTS AND DISCUSSION:**Content of Heavy Metals in Muscles and the Liver of Pigs in Areas of Technogenic Issue**

It is established that at the increased content of heavy metals in sterns, there is their accumulation in an organism of pigs. Content of lead and cadmium in all samples of muscular tissue exceeded standard values for 10.7 – 12.8% respectively. The considerable accumulation of lead, arsenic, copper and zinc in a liver is noted. At pigs of the 10th monthly age contents in a lead liver in 3, arsenic by 1.3 times exceeded standard values. The similar picture is characteristic of zinc and copper which content by 1.85 – 2.2 times exceeded maximum allowable concentration. Content of cadmium in kidneys was above standards by 1.6 times. Content of lead in bones of pigs was 3.7 times higher (Table.1).

When determining content of heavy metals in muscular tissue and a liver of the pigs of 10-month age who are in 40-50 km to a zone from a source of technogenic issue, excesses of standard values on all pollutant it is not established.

Table 1: The contents of heavy metals at pigs from different territories.

Value, mg/kg	The maintenance of MS at pigs a "pure" zone				The maintenance of MS at pigs a technogenic zone			
	Muscle (n=10)	Liver (n=10)	Kidney (n=10)	Bone (n=10)	Muscle (n=10)	Liver (n=10)	Kidney (n=10)	Bone (n=10)
Lead	0,020* ±0,003	0,020 ±0,003	0,010 ±0,002	0,246* ±0,007	0,033* ±0,003	0,015* ±0,002	0,011 ±0,002	3,73* ±0,17
Cadmium	0,010 ±0,003	0,090 ±0,008	1,36 ±0,05*	0,010 ±0,003	0,019* ±0,004	0,032 ±0,001	1,56* ±0,04*	0,018 ±0,005
Arsenic	0,030* ±0,002	0,023 ±0,009	0,29* ±0,01	0,040 ±0,003	0,043* ±0,007	0,040* ±0,003	0,039 ±0,004	0,033 ±0,002
Copper	0,90* ±0,021	13,34* ±0,38	11,09* ±0,38	0,160 ±0,007	0,733* ±0,039	9,10 ±0,38	8,15 ±0,37	0,287 ±0,011
Zinc	43,98* ±1,01	73,93 ± 2,70	29,68 ±1,37	144,00* ±4,31	160,67* ±0,81	80,53* ±3,89	32,79 ±1,05	174,42 ±4,20

P < 0,05 * The difference is reliable.

Table 2: The contents of malondialdehyde (MDA) (mmol/ml) in muscles and liver of pigs from different territories.

Research period	"pure" territory				Technogenic territory			
	Liver	Femoral part	Iliac	Longissimus	Liver	Femoral Muscle	Iliac Muscle	Longissimus Muscle
After slaughter 24 h. (cooled.)	0,194 ±0,005	0,121 ±0,005	0,124 ±0,004	0,112 ±0,004	0,231 ±0,011	0,135 ±0,003	0,137 ±0,006	0,186 ±0,007
24 h after frost. (t °-18 °C)	0,271* ±0,008	0,143 ±0,004	0,131 ±0,004	0,130 ±0,004	0,314* ±0,007	0,159 ±0,005	0,135 ±0,005	0,199 ±0,007
48 h after frost. (t °-18 °C)	0,304 ±0,008	0,158 ±0,004	0,151 ±0,002	0,143 ±0,005	0,365 ±0,014	0,218 ±0,008	0,182 ±0,005	0,202 ±0,007
10 days after frost. (t °-18 °C)	0,318* ±0,007	0,174* ±0,005	0,163* ±0,003	0,160* ±0,004	0,521 * ±0,017	0,312* ±0,011	0,272* ±0,008	0,247* ±0,008

P <0.05 * The difference is reliable.

Peroxydation's Assessment Meat Raw Materials

One of indicators of process of elimination and utilization of a conclusion of toxic substances is the lipid peroxydation which also characterizes quality of meat raw materials [23]. Assessment was carried out on the content of malondialdehyde (MDA) in muscular tissue and a liver. Samples of a liver and muscular tissue from pigs of 10-month age from "pure" and technogenic polluted territories were selected. It is established that at pigs at technogenic loading processes of oxide oxidation of lipids proceeded more intensively that was expressed by increase in content of malondialdehyde (MDA) by 1,6 - 1,8 times in comparison with samples from a "pure" zone. Meat raw materials from animals, contaminated technogenic pollutant, had higher rates of lipid peroxydation (tab.2). In reactions of oxide oxidation a large amount of lipidic hydroperoxides which have high reactionary ability is formed and have the damaging effect on cellular structures, and it influences, in turn, quality and periods of storage of meat raw materials [4]. It is established that in tests of femoral, iliac, longissimus muscles and a liver of pigs processes proceeded with different intensity. With increase in periods of storage of samples processes of peroxydation were more intensive that was shown in increase in indicators of malondialdehyde (MDA).

Amino-Acid Composition of Meat Raw Materials

For assessment of biological full value of meat raw materials, the research of its amino-acid structure was conducted [11]. For the analysis of indicators of biological value of different groups of muscles and a

liver of pigs determined amino-acid structure of meat by measurement of a mass fraction of amino acids by method of a highly effective liquid chromatography on the chromatograph liquid LC - 20 Prominence production of Shimadzu (production of Japan) with the spectrometer detector (SPD - 20A). Division of Phenylthiocarbamyl derivative amino acids was carried out on a column with the turned phase C18 in the mode of gradient eluating and their spectrometer detecting on the wavelength of 254 nanometers.

It is established that at animals, contaminated heavy metals, in a femoral muscle expressed a tendency to decrease in amount of irreplaceable proteogenic amino acids (for 21.5%) and replaceable amino acids (for 13.3%) in relation to amino-acid composition of proteins of a femoral muscle of the animal not containing eco pollutant. So the content of phenylalanine in a femoral muscle and a liver was for 26.1% and 14% below, than at intact animals. Decrease in phenylalanine leads to a lack of tyrosine and the lowered amount of thyroid hormones. [3, 4, 6]. At the same time the quantity of valin, isoleucine, leucine which takes part in power exchange of muscle cells was respectively for 23.2%, 14.1%, 27.4% are less, than at control animals that indicated inferiority of power exchange in muscles of pigs with the increased level of contaminants. In the conditions of contamination of animals heavy metals the need of a liver for the threonine which participates in maintenance of own protective function as lipotropic factor increases. It is established that its contents in a liver increased, at the same time the quantity of threonine in a femoral muscle decreased by 11.1% in

comparison with "pure" samples. The maintenance of a lysine in a femoral muscle of pigs from technogenic territories was 27.3% lower, than in "pure" and made 1.36 g / 100r. The lysine is necessary for the normal growth and development of mammals, the lack of a lysine leads to immunodeficiency. In technogenic the polluted territories deficiency of a lysine led to delay of formation of muscle fiber that was confirmed by histologic researches.

The main limiting irreplaceable proteogenic amino acid is methionine. At contaminated heavy metals of animals, the content of methionine is reduced in a liver - by 14.8% and a femoral muscle - for 19.7%, in iliac and longissimus muscles - for 15.5% and 11.1% respectively that testifies to load of detox function of a liver and exhaustion of a pool of this amino acid. The quantity of a tyrosine in a liver of contaminated pigs was also twice lower, and made 0.31g/100g, also the content of tryptophane is reduced by 23.8%. Decrease in a liver of phenylalanine and tryptophane can be the cause of decrease in synthesis of catecholamines, thyroid hormones, as well as can lead to decrease in level of power processes that in turn leads to decrease in adaptation reserves of an organism. The ratio of tryptophane and oxyproline in a liver of contaminated animals made 3,2 c.u., this ratio of a stroma and a parenchyma that can demonstrate existence of an indirect sign of hepatosis (fibrosing and sclerous processes in a liver).

One of components of detox metabolite - glutathione, is glycine which is basic amino acid and a basis for synthesis of a number of replaceable amino acids. Content of glycine in a liver was 19.5% lower in comparison with control animals and made 0.62 g / 100. In technogenic territories processes of gluconeogenesis proceeded more intensively that was expressed in increase in maintenance of alanine in a liver for 26,7% in comparison with the control territory and made 1.09g/100g. Content of asparaginic and glutamic acid in a liver of animals from technogenic territories was for 13.9% and 18.1% above in comparison with samples of control animals and made 1.23g/100g and 1.70g/100g respectively.

In territories with anthropogenous loading the content of irreplaceable and replaceable amino acids in a femoral muscle of pigs is reduced by 21,5% and 13,3% respectively in relation to amino-acid composition of proteins of a femoral muscle of animals from the control territory. Decrease in quantity of valin, isoleucine, leucine which take part in power exchange of muscle cells for 23.2%, 14.1%, 27.4% in relation to control, demonstrated decrease

in power exchange processes in muscles. Decrease in quantity of a lysine in a femoral muscle of pigs for 27.3% led to violation of formation of structure of muscle fiber that was confirmed by histologic researches.

THE MORPHOLOGICAL CHARACTERISTIC OF MUSCULAR TISSUE OF PIGS AT TECHNOGENIC LOADING

For carrying out a comparative histologic research selected samples of bodies and muscular tissue from femoral, iliac, chest and longissimus muscles of a back of pigs were taken. Material was cut on the MIKROM-HM525 microtome cryostat (production Germany), receiving cuts 10-15 microns thick. Cuts painted Ehrlich's hematoxylin and dyed in 1% freshly cooked aqueous-alcoholic eosin; placed under integumentary glasses in glycerin-gelatin. Studying of a microstructure of samples on histologic medicines and their photography on digital photography equipment was carried out on a light microscope of Leica (production Austria) at different increases.

The comparative histologic research of muscular tissue from a femoral, iliac, pectoral and longissimus muscle from pigs from the background and urbanized territories is conducted. At a histologic research of all listed muscles the tendency of increase of muscle bulk is revealed that it was characterized by appearance of groups of the "young" not differentiated muscle fibers that testifies to an unfinished morphogenesis of muscular tissue. It is established that increase of muscle bulk happens generally at the expense of coxofemoral group of muscles at inclusion of the "young" not differentiated muscle fibers. Intermuscular cellulose contains insignificant amount of fat. The longissimus muscle contains conglomerates fatty a vacuole, located directly in muscular tissue, a muscle dense uniform. In intermuscular connecting tissue fatty vacuoles are generally large-drop. Muscles tend to increase at the expense of unripe muscle fibers. Fatty cellulose is presented by small fatty vacuoles which settle down in the thin intermuscular spaces occupied by friable connecting fabric. At pigs weighing 100 kg the separate not differentiated muscle fibers in all groups of the studied muscles are observed. Intermuscular connecting tissue contains bigger quantity fatty a vacuole which are presented by the large fatty vacuoles located perivascular. The comparative analysis of muscular tissue of pigs weighing 80 kg and 100 kg confirms fuller completion of formation of muscular tissue and a maturity of muscle fibers and the intermuscular connecting tissue including fatty cellulose at pigs weighing 100 kg. At a research

of meat of pigs from the urbanized territory the incomplete morphogenesis of muscular tissue and intermuscular cellulose as at pigs with a live weight of 80 kg, and weighing 100 kg is pronounced. Intermuscular fatty cellulose is accurately expressed. Wide layers of fatty cellulose. The structure of

muscular tissue is not uniform, but dense and friable. In a femoral muscle increase of muscle bulk is poorly expressed, only in separate muscular bunches single unripe muscle fibers are visible.

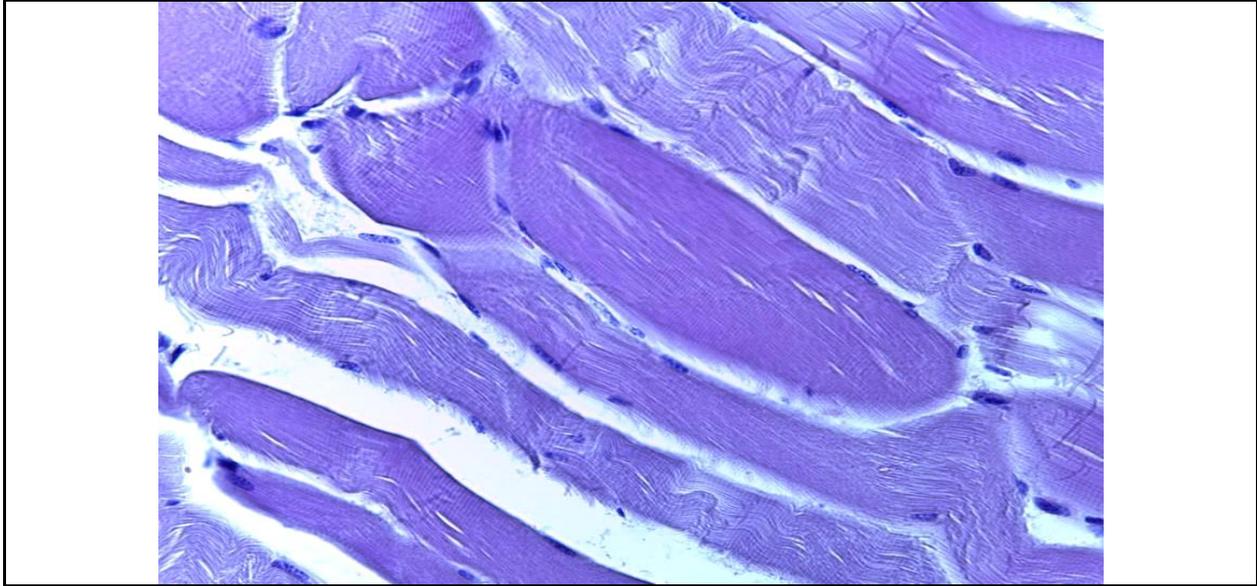


Fig 1: A femoral muscle of pigs from the technogenic territory. "Young" undifferentiated muscle fiber. Coloring by hematoxylin and eosin. Increase 400kh.

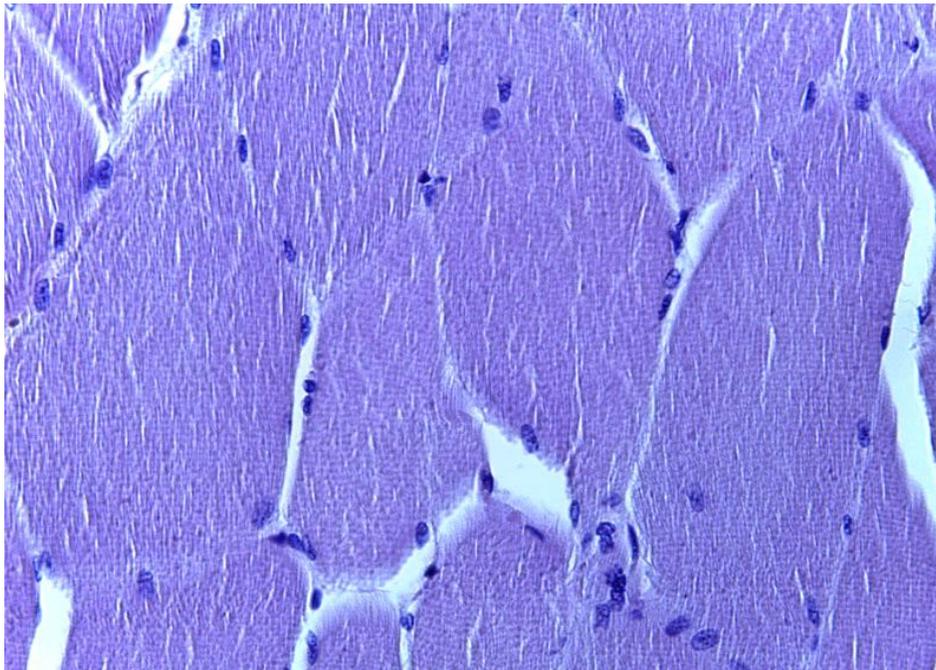


Fig 2: A femoral muscle of pigs from SHP control. Full completion of formation of muscular tissue. Coloring by hematoxylin and eosin. Increase 400kh

CONCLUSIONS:

Technogenic pollution of agricultural territories exerts impact on an organism of animals and quality of pig-breeding production. In areas of anthropogenous pollution heavy metals accumulation in an organism of pigs is established. In separate bodies and tissues of pigs from technogenic the polluted territories excess of threshold limit value is revealed: lead in bones - 3.7 times, cadmium in kidneys - by 1.6 times, zinc in muscles - by 1.6 times.

It is established that in muscular tissue and a liver of pigs from anthropogenically polluted territories processes of free radical oxidation proceed more intensively that influences periods of storage of meat raw materials.

In femoral group of muscles at animals from the areas subjected to technogenic issues the most essential changes of amino-acid structure are revealed. Inferiority of power exchange in muscles at pigs with the increased level of contaminants was shown in decrease in quantity of valin, isoleucine, leucine which take part in power exchange of muscle cells, and the lack of a lysine led to violation of formation of structure of muscle fiber and an incomplete morphogenesis of muscular tissue. The lowered content of methionine and at the same time high content of asparaginic and glutamic acids demonstrated increase in detox function of a liver. With reduction of content of amino acids in meat power and nutrition value of its proteins, and loss including irreplaceable amino acids significantly lowers the biological value of these proteins [12] goes down.

CONCLUSION:

On the basis of the conducted researches it is possible to conclude that technogenic pollution of agricultural territories has significant effect on quality of meat raw materials of pigs that demands development of a complex of the actions allowing to lower degree of anthropogenous loading.

CONFLICT OF INTERESTS

Authors confirm that the submitted data do not contain the conflict of interests.

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