KAPITEL 4 / *CHAPTER 4* [4]
CATTLE UNDER THE EFFECTS OF RADIATION IRRADIATION

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Introduction

Based on the study of molecular mechanisms of action of ionizing radiation on animals and the role of radiation-induced adaptive response in the formation of mechanisms of radioresistance of living organisms, studies of biochemical indicators of the blood of cattle during their long-term stay in the territory contaminated with nuclides will be the basis for the formation of a system of measures for regulating mechanisms of adaptation of organisms under the influence of ecopathogenic factors [1-11].

Recently, generalizing works have appeared that systematize information on the agricultural aspects of livestock problems in radionuclide-contaminated areas [12-15]. However, insufficient attention has been paid to the problems of dairy cattle breeding during the period of danger of radioactive iodine isotopes, and this is the main link in the entry of radioactive iodine into the human body through milk. First of all, due to the lack of complete and generalized data on the possible consequences of radioactive iodine exposure on the body of cattle after the Chornobyl radiation disaster, miscalculations were made in assessing the biological effects of radioactive iodine exposure, as a result of which hundreds of thousands of cattle were killed and thus a new problem was created - the disposal of meat contaminated with radionuclides, which was solved within 10 years after the accident [3,16-18].

Thus, two problems of radiation hazard can be distinguished when nuclear fission products enter the environment.

The first is the biological effect of radioactive iodine isotopes, which is associated with damage to the thyroid gland of animals, and the consequences for the health of animals, which are associated precisely with damage to the structure and function of

[4]***Authors:*** *Lazarev Mykola, Klepko Alla, Kalachniuk Liliia*
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this organ. It is the uncertainty in the forecast estimates of these consequences that led to the above-mentioned problems.

The second is the problem of radioactive iodine isotopes entering livestock products, mainly milk since it is through milk that radioactive iodine enters the human body. These two problems are organically interconnected and cannot be separated when assessing the consequences of radiation emergencies.

It should also not be forgotten that the main medical problems in the post-accident period are also associated with the impact of radioactive iodine - this is the problem of the occurrence of neoplasms in the thyroid gland, in particular in children, which is also a consequence of underestimating the significance of the entry of radioactive iodine isotopes with cow's milk into the body of children. It is cow's milk that supplies the main "iodine" dose to humans [17,18].

In the case of an emergency radioactive release into the atmosphere, radioactive iodine is a critical component of environmental pollution, i.e., compared to other radionuclides, it poses the greatest risk of incorporated exposure to the population. This is shown by the experience of well-known precedents - the accident in Windscale, England, 1957 [19, 20], the Chornobyl disaster - in 1986 [21].

The aforementioned accidents are not the only cases associated with the release of radioactive iodine into the environment. It is now known about radiation accidents on submarines and plants for the processing of irradiated nuclear fuel, but these accidents did not require the implementation of special measures to protect the population over a significant area.

In the case of the Chornobyl disaster, the biological effects and consequences of the biological action of radioactive iodine isotopes were recognized by the world community only 10 years after the accident [22].

Thus, radioactive iodine causes the main danger to the population in the event of radiation incidents and acquires special importance in the modern period under the real conditions of the use of nuclear weapons.

The purpose of the study was to determine the main parameters of the physiological state of cattle in radionuclide-contaminated territories.

4.1. Hematological parameters of the blood of cattle

The results of research on cattle under conditions of production and artificial intake of radioactive iodine presented in this work were a logical continuation of experiments on the assessment of hematological indicators of cattle blood in the "iodine" pathology observed after the Chornobyl accident [11], which presented an analysis of data on the content of the natural stable element iodine (^{127}I) in radioactively contaminated territories of Ukrainian Polissya and the impact of its insufficient amount on the physiological indicators of the health of cattle kept in this territory. The territory of Polissya is characterized by a deficiency of biogenic trace elements (including iodine) in soils. It is radioactive iodine that plays a leading role in radiation damage to biological objects due to the entry of nuclear fission products into the environment both during the Chornobyl accident and during any other atomic incident. The scientific literature has well described the diagnostic signs and clinical picture of radiation damage to animals by radioactive iodine [1-11], but the issue of cases where ^{131}I populations of animals in regions endemic for stable iodine are affected is not sufficiently covered. According to the scientific literature [1-11], short stature, low weight, low productivity, characteristic changes in the hair coat (curlyness and great length), skin folds, bradycardia, rumen hypotension, decreased reproductive functions, and impaired erythropoiesis and leukopoiesis are characteristic clinical signs for cattle with ^{127}I deficiency. The same deviations in the health of cattle were observed in radioactively contaminated areas during the acute period of the Chornobyl accident. In experiments with the artificial administration of ^{131}I to cattle of different ages, changes in the physiological state of animals under the influence of various doses of thyroid irradiation were investigated and the hypothesis of the similarity of the biological effects of radioactive iodine damage and the clinical picture of stable iodine deficiency was confirmed [11]. Hence, the determination of both hematological and biochemical blood parameters can not only characterize the health status of animals but also guarantee correct assessments of the degree of damage to their body by radioactive iodine isotopes.

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The purpose of this ecperimental set was to determine the main parameters of the physiological state of cattle in iodine-endemic and radionuclide-contaminated territories.

For hematological and biochemical studies, heparinized blood was used. Blood samples were taken from 5-6 animals from each group. Heparin was used as a blood anticoagulant. During the experiment, the general clinical condition of the animals was assessed and individual records of cow productivity were made using the control milking method before the start of the experiment and then monthly. The general blood test included: counting the number of erythrocytes and leukocytes - in a chamber with a Goryaev grid; determination of hemoglobin content (hemoglobin cyanide method with acetone cyanohydrin); determination of the average hemoglobin content in erythrocytes (MCH); calculation of the leukogram by the calculation method according to Levchenko V. I.[28] and parameters of the clinical condition []. The study was conducted on black-and-white cows in production conditions and in conditions of an active experiment with artificial intake of radioactive iodine; an statistical analysis was performed using variational statistics methods [11].

When conducting a clinical examination and long-term observation of the clinical condition of experimental animals, we paid great attention to the fact that the animals were exposed to the radiation factor, but also to the lack of biogenic trace elements - iodine, cobalt, zinc, copper, manganese. For example, the iodine content in water is 4-50 times lower than optimal values. The imbalance of livestock diets could not but affect the general condition of the livestock. The results of the clinical examination of cows exposed to different radiation factors are presented in the article [11-28].

The results of the clinical examination of animals shown [11] indicate a profound disturbance of metabolic processes in the body of cows of different groups, but it is not possible to separate the influence of the radiation factor due to the similarity of processes in all experimental groups, which indicates a greater influence of environmental conditions and zoohygienic conditions of economic maintenance (primarily feeding) of livestock. Deviations in some parameters of the physiological state of animals, which is mainly characteristic of nutritional deficiencies of biogenic microelements, are confirmed by their low content in soils, and animal diets (Table 1).

Table 1 - The content of some macro and microelements in soils, diets, and the body of cows in the experimental farm

Object of investigation	Units	Elements				
		Co	Zn	Cu	Mn	I
Soil	mg/kg	0.8±0.1	0.1±0.01	2.9±0.3	115±15	1.7±0.2
	Norm	1.1-2.0	0.2-1.0	2.5-4.0	50-100	6-21
Diet	mg/kg	0.3±0.1	8.0±0.7	6.0±0.8	52.5±4.0	0.08±0.015
	Norm	0.6-1.0	30-60	5-10	40-60	0.3-0.6
The blood serum	μg/100ml	1.1±0.1	60±7	60±8	11±2	1.0±0.1
	Norm	2-4	100-150	60-100	2-8	6-11

It should be noted that 5 years after the accident, no visible changes in the metabolic processes in cattle were observed. The above-mentioned deviations in the clinical condition were at the same level and do not reliably depend on the levels of radioactive contamination of the territory within the specified limits.

The blood system of cattle in general, and peripheral blood in particular, is one of the radiosensitive systems of the body. Among the changes in the blood picture that occur in the peripheral blood of animals, the earliest and most convenient for detecting the biological effects of ionizing radiation are changes in its morphological composition.

However, it should be taken into account that the nature of hematological changes significantly depends on both the levels and dynamics of irradiation of the animal's body and the conditions of their maintenance. The results of hematological studies of the blood of cattle that were in a long-term area contaminated with radionuclides are presented in Fig.1 and 2. As can be seen from the data in Table 4, the picture of hematological parameters of animals that were in different conditions, in terms of dose load, is similar. In the peripheral blood of cattle, fluctuations in the level of white blood cells correspond to physiological parameters.

When analyzing the number of erythrocytes in the blood of cattle, it should be noted that their level in most cases corresponds to the lower limit of the physiological

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norm (5–7.5 according to V. I. Levchenko et al., [28], but there is no significant difference between groups of animals with different doses of radiation to the body as a whole and doses of radiation to the thyroid gland.

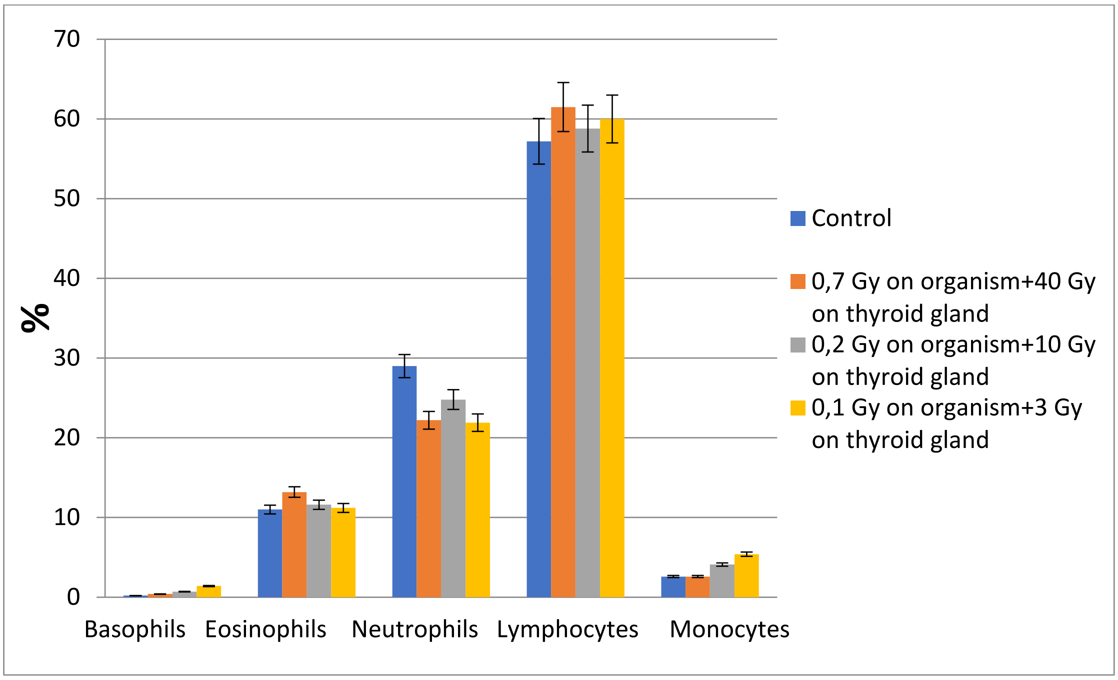

Figure 1 - Blood leukogram of cows in the area with different doses of radiation exposure in 1987

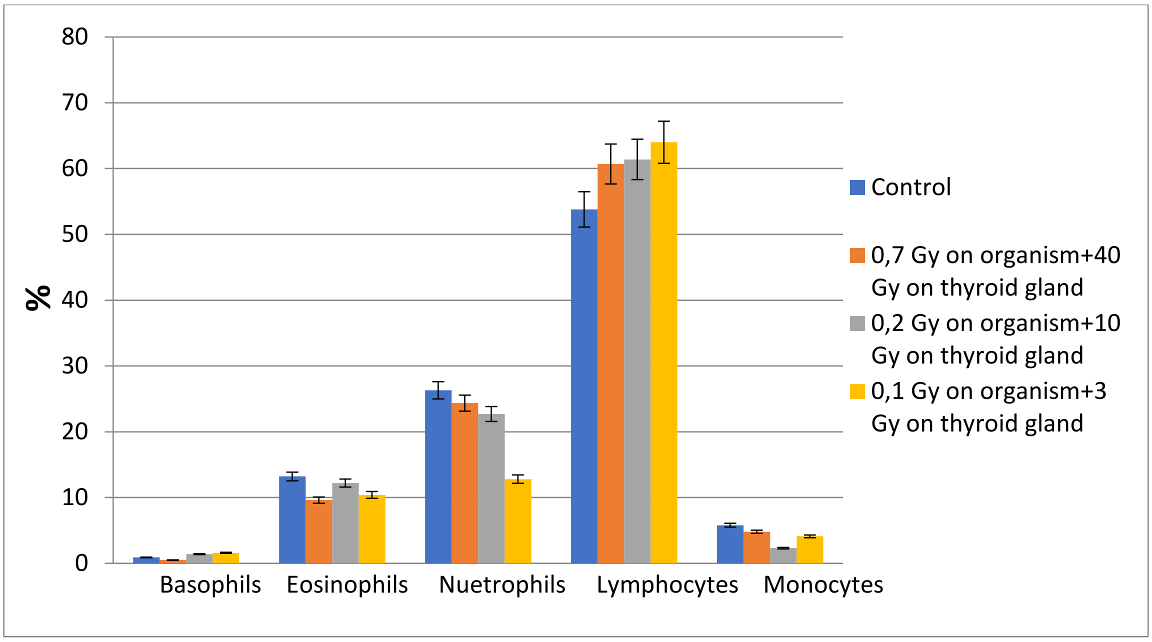

Figure 2- Blood leukogram of cows in the area with different doses of radiation exposure in 1990

More pronounced changes were noted in the analysis of the leukocyte formula of the blood of animals. The results show that the content of individual populations of cellular elements of the blood in some cases significantly differs from the accepted physiological norms. Thus, the content of eosinophil cells in the peripheral blood reached 12, instead of 5-8% according to the norm. The number of neutrophil cells in the blood of animals is at the lower limit of the norm, and the level of lymphocytes is increased. The increased number of eosinophils, as well as other changes we have identified in the quantitative composition of the blood in cows in the first years after the Chornobyl accident, were also noted by other researchers on various traces of radioactive fallout [17, 18, 23].

In the qualitative analysis of peripheral blood cells, such changes as the basophilic granularity of lymphocytes, necrosis, rhexis of lymphocyte nuclei, karyopycnosis and hypersegmentation of neutrophils should be noted. In blood smears, the presence of pathological forms of erythrocytes was noted - anisocytosis, and poikilocytosis.

Hematological studies conducted at the experimental farm "Poliske" repeat the general picture of hematological indicators obtained during studies of various farms in the Kyiv and Zhytomyr regions. Characteristic changes that were noted in the blood of cattle are a reduced level of erythrocytes and hemoglobin. In the leukoformula, a reduced level of neutrophils and an increase in the number of lymphocytes were noted.

4.2. Biochemical parameters of the blood of cattle

The second experimental set studies biochemical parameters of the blood of cattle under effect radiation irradiation. The study was conducted on two groups of black-and-white cows, 25 heads each, which were in the 3-5th lactation period in production conditions. The animals were kept in the same conditions on a commercial diet but were exposed to different doses of ionizing radiation on the thyroid gland (thyroid gland). The first group of cows was exposed to radioactive irradiation of the thyroid gland from ^{131}I at a dose of 40 Gy, and the second group of cows at a dose of 10 Gy.

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During the observations, the following were investigated: the general clinical condition of the animals, the recording of the productivity of the cows (by the method of control milking before the start of the experiment and then monthly), hematological indicators [11], the level of thyroid hormones and the spectrum of biochemical indicators, which indicated a characteristic dependence of the observed changes on the doses of irradiation of the thyroid gland and the conditions of detention, associated, in particular, with the lack of biogenic microelements in the animal feeding rations. For biochemical (as well as for hematological) studies, cattle blood treated with an anticoagulant - heparin was used, which was taken from 5-6 animals from each group.

Individual biochemical parameters: enzyme activity (amylase, AST and ALT, glutathione peroxidase), ceruloplasmin content, total protein, cholesterol, sialic acids, and lipid hydroperoxides, thyroid hormones were determined in the blood plasma of animals according to methods [29 - 32]. Statistical analysis was performed using variational statistics methods [11,29, 30].

Since the main factor of radiation damage to farm animals was radioactive iodine, we assessed the functional activity of the thyroid gland by the level of thyroid hormones in the blood plasma [31, 32]. Comparison of the indicators of the hormonal status of animals of the first group, with the greatest impact of the radiation factor - 40 Gy on the thyroid gland and about 1 Gy on the whole body, with the corresponding indicators of animals of the second group - 10 Gy on the thyroid gland, revealed a tendency to reduce the concentration of thyroid hormones in the blood in animals with higher doses of thyroid irradiation, although in both groups the levels of thyroid hormones were lower than the physiological norm (Fig. 3 and 4). The physiological norm of T4 and T3 concentrations in the blood of cows varies throughout the year within the limits: before calving it is 46-90 nmol/l and 1.2 - 1.6 nmol/l; at the beginning of lactation – 43 -125 and 2.0 -6.0; at the peak of lactation – 57-103 and 2.3 - 3.5; at the end of lactation – 43 -86 and 2.4 - 3.2 nmol/l, respectively [29].

Analysis of the content of thyroid hormones in the blood plasma of experimental cows shows that the level of hormones in cows of groups 1 and 2 fluctuates with almost the same pattern, but a significant difference is noted in the content of triiodothyronine

6 months after the administration of radioactive iodine, and in thyroxine 10 and 20 months after the administration of radioactive iodine.

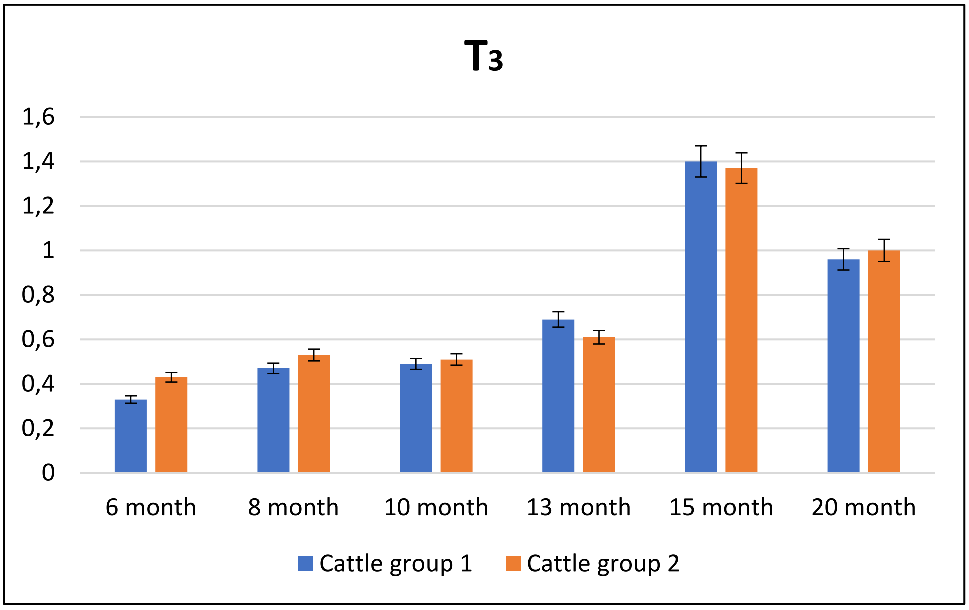

Figure 3 - The content of thyroid hormones (T3) in the blood plasma of experimental cows, nmol/l

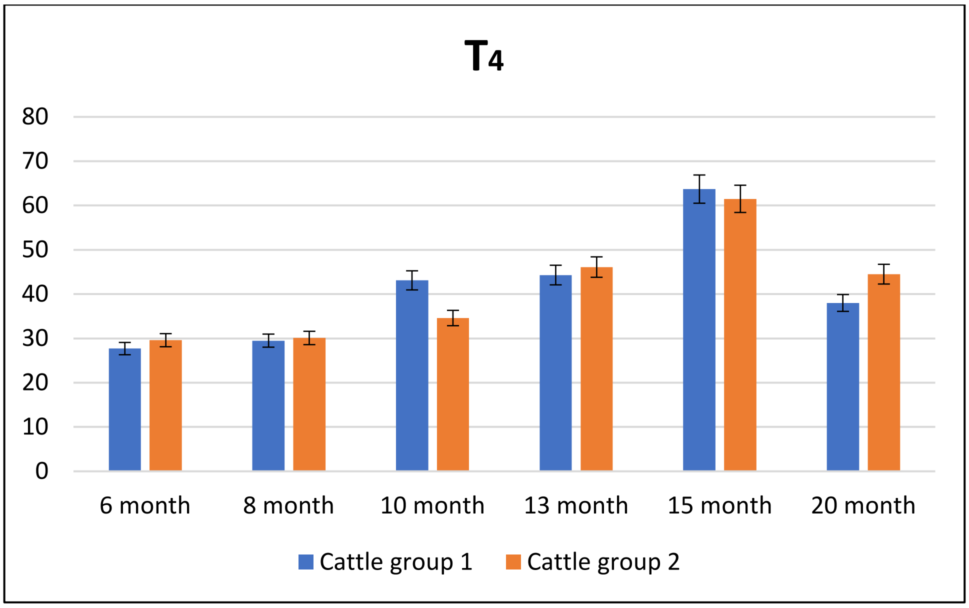

Figure 4 - The content of thyroid hormones (T4) in the blood plasma of experimental cows, nmol/l

Thyroid hormones (T3 and T4) are synthesized in the follicular cells of the thyroid gland (Fig. 1) by attaching iodine to the residues of the amino acid tyrosine molecules,

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which is part of thyroglobulin (TG), which is a soluble glycoprotein (660 kDa). The daily secretion of T4 by the thyroid gland is 80-100 μg, and T3 is about 5 μg. T3 is much more active. Hence, a significant part of T4 is a precursor of the T3 hormone. Part of triiodothyronine is synthesized in the thyroid gland, and from peripheral cells of the body as a result of monodeiodination from thyroxine by the action of the enzyme 5'-monodeiodidesidase (with the obligatory participation of such a trace element as selenium) (fig. 5). Hence, the study of T3 in serum or blood plasma may not always indicate a violation of thyroid function.

Under the action of protease and peptidase of the lysosomes of follicular cells, TG is cleaved, T3 and T4 are secreted into the blood, where they bind to plasma proteins. T4 has a high specificity for globulin (thyronine-binding globulin - TGB), less for prealbumin, and very weakly binds to albumin (75% with TGB and 15-20% with prealbumin and albumin, respectively). Only 0.5% of T4 remains in a free (unbound) state. T3 binds almost only to TGB, and the relative amount of its free fraction is 0.05%. The biological half-life of T4 is 7-9 days, and T3 is 2 days. The bound and free forms of hormones are in dynamic equilibrium. Free forms of triiodothyronine relatively easily penetrate the cell membrane, affecting all types of metabolism.

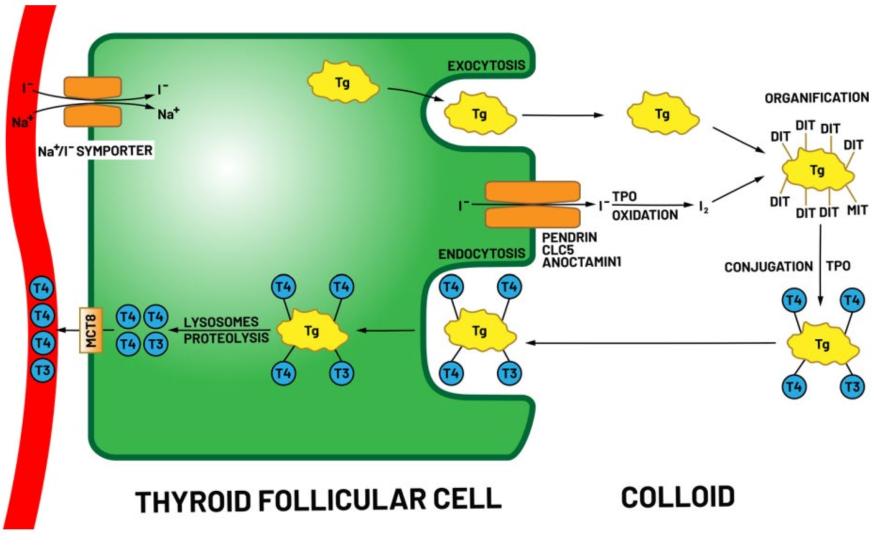


Figure 5 - Thyroid hormone production, where T3, triiodothyronine; T4, thyroxine; TG, thyroglobulin; TPO, thyroid peroxidase; MIT, monoiodotyrosine; DIT, diiodotyrosines; CLC5, chloride channel ClC5, adapted from [14].

The level of thyroxine and triiodothyronine, as is known, increases in the blood with hyperthyroidism, while a decrease in the content of T3 and T4 in the blood (fig.3 and 4) can be observed with hypothyroidism, liver diseases, kidney diseases, lipo mobilization syndrome, ketosis, sepsis, pneumonia, peritonitis, malignant tumors, as well as with the administration of iodine preparations, corticosteroids, some antibiotics and sulfonamides, heparin. That is why abnormal liver function can be one of the factors in changes in the state of the body of cows, as evidenced by the data presented in figures 3 and 4.

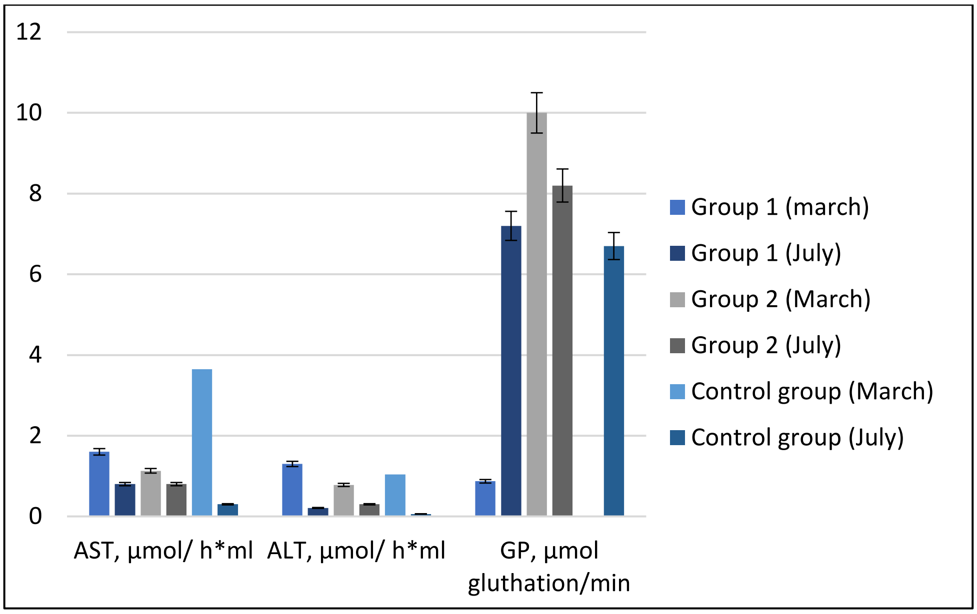
A biochemical blood test is a method of laboratory diagnostics that allows you to study the functioning of internal organs and their systems, as well as metabolic processes that occur in the body. For example, when studying liver diseases, ALT, AST, and bilirubin indicators are determined, and kidney diseases - creatinine and urea. In addition to pathologies of organ systems, a biochemical blood test is prescribed to diagnose the inflammatory process. In this case, attention is paid to the content of C-reactive protein, sialic acids.

Thanks to biochemical blood tests, you can study more than 500 substances that reflect normal and pathological processes in the body. The analysis allows you to assess carbohydrate, fat, protein, and mineral metabolism.

When deciphering a biochemical blood test, the following are studied: the level of glucose in the blood, which indicates the development of diabetes; transaminases (aminotransferases) are determined if there is suspicion of myocardial infarction, hepatitis; cholesterol is studied if there is suspicion of atherosclerosis of vessels and diseases of the cardiovascular system; bilirubin is studied to study the condition of the liver, impaired bile outflow; creatinine and urea indicate problems with the urinary system; the total protein level changes in severe pathological processes; amylase is studied to analyze the functioning of the pancreas, if there is suspicion of pancreatitis. Thus, a biochemical blood test allows you to establish or confirm the final diagnosis. A biochemical blood test studies the functional state and metabolic processes of internal organs. By studying biochemical blood parameters, you can conclude the quality of the work of the liver, kidneys, etc.

Figures 6 - 9 show the results of the analysis of biochemical parameters, which demonstrate various deviations under the influence of the season and different levels of irradiation of the thyroid gland of cows. As a control, the blood of cows that were not exposed to radioactive iodine was used.

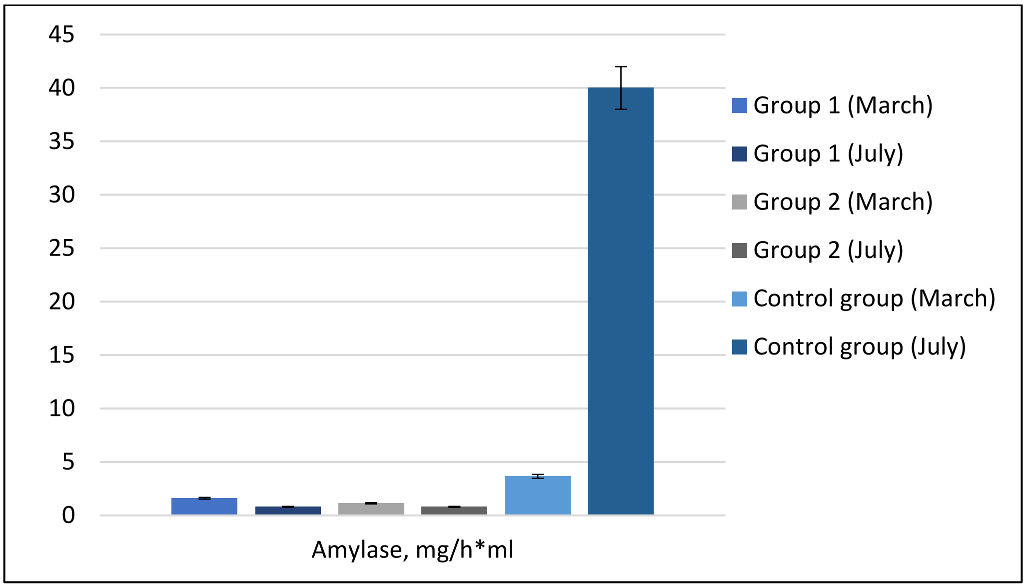
As can be clearly seen from the results presented in fig.6, the activity of the studied enzymes changes not only under the influence of radioactive iodine but also under a fairly pronounced influence of feeding conditions in the summer and spring periods of the year.



Figures 6 – Enzyme activity in the blood of cows with different levels of irradiation of the thyroid gland*p<0.05 – significant difference between the experiment and the control; enzyme activity: amylase, aspartate and alanine transferase (AST and ALT), glutathione peroxidase (GPO or GP)).

The data on the activity of AST and ALT in the blood of cows (fig.6) are within normal limits or are lower. Seasonal changes in these indicators are especially noticeable: in July, the activities of these enzymes in the blood of the experimental and control groups of animals are lower than the same indicators in March and below the norm (see below). In some cases, reduced AST activity may indicate pathological conditions: liver rupture, severe necrotic damage; chronic vitamin B6 deficiency. It is difficult to make an unambiguous conclusion about liver damage, etc., since other evidence is also needed. A rapid decrease in ALT activity with a simultaneous significant increase in bilirubin and an increase in prothrombin time indicates a poor prognosis and severe necrotic changes in liver tissue, but in the absence of information on the last two indicators, only predictions can be made to take into account in future studies.

AST 48-108 units/l or (2.8 – 6.5 μmol/(h*ml), or 0.80 – 1.80 μmol/s*l) and ALT (17 – 40 units/l or 1.02 – 2.39 μmol/(h*ml), or - 0.28 – 0.67 μmol/s*l) – enzyme activity in the blood of cattle. Transaminases are localized in the cells of most organs and systems [12, 13]. They transfer amino groups from aspartic acid (AST) and alanine to alpha-ketoglutaric acid. Transaminases are not specific tests for assessing the condition of individual organs, so it is necessary to determine the place of enzyme release into the blood. Both enzymes have high activity in the cytoplasm of cells (AST also in mitochondria) and even with minor tissue damage, they increase their activity in blood serum (plasma). Studies of AST and ALT activity in blood serum are used to diagnose liver diseases (hepatitis, hepatosis, etc.). For cattle and horses, studies of AST activity in blood serum are indicative, and for pigs, dogs, and cats - AST and ALT. This is explained by the degree of activity of these enzymes in the hepatocytes of animals of different species. AST has high activity in the cells of large animals, and ALT - in small ones.



Figures 7 – Amylase activity in the blood of cows with different levels of irradiation of the thyroid gland.

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The results of biochemical studies confirm the ideas of many researchers regarding the significant compensatory capabilities of the biochemical status of organisms and the intensity of individual indicators of the biochemical state precisely in unfavorable periods of the year, in particular, spring, when there is a significant deviation of the blood indicators of experimental animals from the control ones. It should be noted that the influence of the radiation factor is observed to a lesser extent than the conditions of keeping animals. Thus, the activity of amylase (g/h.l) in cows of group 1 (which underwent a higher dose of thyroid irradiation) was similar to the same indicator in the control, at the same time the indicators for animals of group 2 (the dose of thyroid irradiation was 4 times lower) were lower in the spring period (March) (fig. 7).

The amylolytic activity for cows of the three groups in March was higher than the same in July, which was caused mainly by the diet of cows in the spring and summer periods. It should be noted that in animals fed high-starch diets, amylolytic activity is higher than in animals fed low-starch diets. The activity of bacterial amylolytic enzymes is affected by some amino acids [33]. Methionine at a concentration of 1-2 mg/ml of the medium stimulates, and lysine, on the contrary, inhibits the amylase activity of bacteria and their growth. In the blood of cattle, the ceruloplasmin content is 25.0 - 36.0 mg% of the norm [31].

The values of the relative content of ceruloplasmin (fig.8) in the blood of animals of the experimental groups were slightly lower than the norm, regardless of the dose of thyroid irradiation (except for the control group in July). Ceruloplasmin, mg%, is one of the factors of neuroendocrine regulation and natural protection of the body in stressful situations, inflammatory, allergic processes, and other diseases. This protein is a Cu-containing glycoprotein, which belongs to the acute phase proteins. It participates in iron metabolism and hematopoiesis is an antioxidant. It has oxidase activity, due to which it destroys biogenic amines and other substrates and therefore is related to neuroendocrine regulation. Changes in ceruloplasmin activity usually correlate with changes in copper ions. A sharp disturbance in copper metabolism is observed in anemia when its concentration in the blood increases significantly due to a decrease in the content of deionized copper in the liver tissue.

A decrease in the content of ceruloplasmin in the blood (hypoceruloplasminemia) occurs due to such reasons as: reduced synthesis in severe liver diseases; increased loss from the gastrointestinal tract through the intestinal wall and stomach together with fractions of total plasma protein, kidneys (with urine in nephrotic syndrome); reduced absorption of copper: in severe absorption disorders, insufficient amount of copper in feed.

The reference values of total cholesterol (cholesterol) in the blood serum of cows vary within 2.3−6.6 mmol/l or 88.93 - 255.189 mg% [29]. Cholesterol indicators in all groups (experimental and control) vary within the reference values. Increased cholesterol concentration is observed in liver disease with impaired bile acid formation (hepatitis) and bile secretion (cholestasis), lipoid nephrosis, renal failure, ketosis, hypothyroidism, when animals consume excess carbohydrates and fats, etc. Hypocholesterolemia occurs with a prolonged lack of fats and carbohydrates in the diet, as well as in hyperthyroidism and liver diseases.

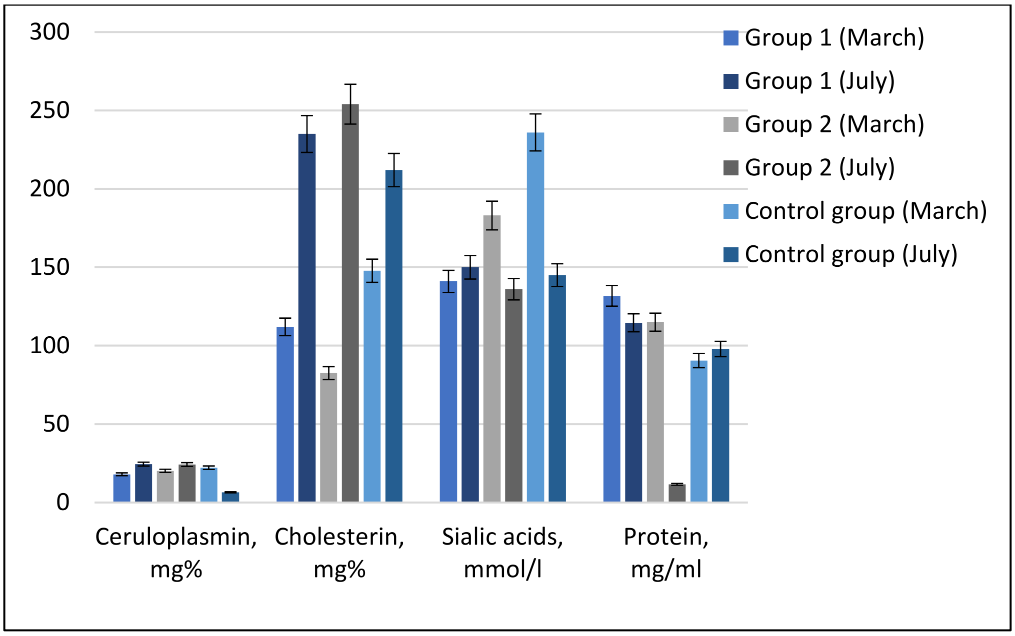

Figure 8 – Results of determining the content of some biochemical indicators in the blood of cows with different levels of thyroid gland irradiation*p<0.05; in the blood of cattle, the ceruloplasmin content is 25.0 - 36.0 mg%; concentration of ceruloplasmin, total protein, cholesterol (cholesterol), sialic acids

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Cholesterol levels (cholesterol, mg%) tend to "decrease" in spring and "increase" in summer. Cholesterol belongs to the group of steroids. It is synthesized mainly in the liver and also enters the blood from the intestines. Cholesterol in the blood can be free and bound to other substances. The cholesterol content in the blood serum depends on the condition of the liver [29, 30]. Increased cholesterol concentration (hypercholesterolemia) is observed in hyperlipidemia, an increase in serum triacylglycerols, liver diseases with impaired bile acid formation (hepatitis, hepatodystrophy), and bile secretion (cholestasis), glomerulonephritis, lipoid nephrosis, chronic renal failure, pancreatic tumors, ketosis, diabetes mellitus, hypothyroidism, gout, and when animals consume excess carbohydrates and fats.

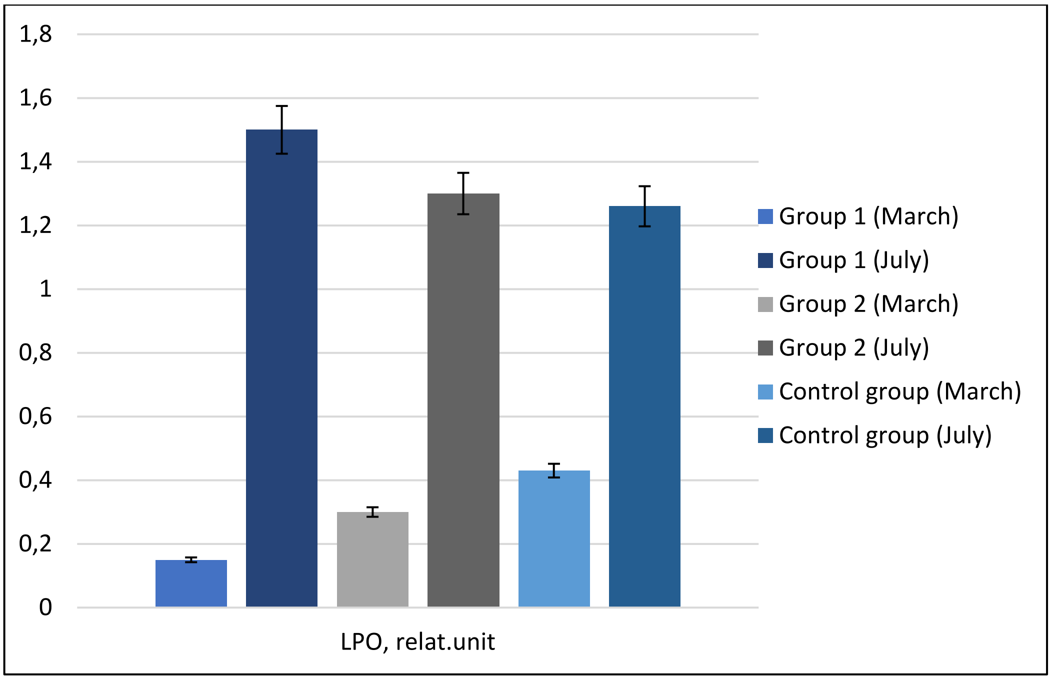

Figure 9 – Results of determining the content of some biochemical indicators in the blood of cows with different levels of thyroid gland irradiation; in the blood of cattle, lipid hydroperoxides - LPO, relative units.

The concentration of cholesterol in the blood serum, mainly the esterified fraction, decreases (hypocholesterolemia) in hepatitis, hepatodystrophy and cirrhosis of the liver, when the synthetic function of hepatocytes decreases, with a prolonged lack of fats in the diet in the diet of fats and carbohydrates, and a decrease in lipoprotein synthesis [29, 34]. In hyperthyroidism, energy metabolism increases, cholesterol consumption increases, as a result of which its level in the blood serum decreases

Sialic acids (mmol/l) there is a "tendency to decrease" in the indicators in the experimental groups of animals compared to the control. This is possible due to degenerative processes in the central nervous system, which is associated with impaired biosynthesis of carbohydrate-protein complexes [29, 35].

Protein (mg/ml) in the blood of the animals mainly demonstrates hyperproteinemia in the experimental groups of animals compared to the control, but there is also a separate case of hypoproteinemia in group 2 in July; from the analysis of the indicators and taking into account the general information on protein metabolism [29, 36], it can be assumed that hypoproteinemia occurred during prolonged malnutrition of animals or alimentary osteodystrophy, or hypocobaltosis, or chronic disorders of the gastrointestinal tract, or nephritis and nephrosis, or cirrhosis of the liver, or tuberculosis. At the same time, the state of hyperproteinemia occurs during protein overeating, or ketosis, or secondary osteodystrophy, or toxicosis, or dystrophy and inflammation of the liver; or during severe forms of diarrhea, or dehydration of the body or acute inflammatory processes.

Data on the activity of glutathione peroxidase (GPO or GP, μmol glutathione/min*mg protein) demonstrate that biochemical processes may tend to be stable in the summer [29, 37]. GP is a selenoprotein, present in the cytosol (70%) and mitochondria (20-30%). The highest activity of the enzyme is in the liver, lens, adrenal glands, erythrocytes and pancreas, the lowest in muscles, gastrointestinal tract, testes and connective tissue [38]. The enzyme protects erythrocytes from the formation of methemoglobin, premature aging and hemolysis, and neutrophils and macrophages - during the "respiratory burst". Enzyme inducers are selenium ions (which are part of the active center of the enzyme), copper, vitamins A, E, C, B2, female sex hormones catecholamines. GP is activated in the initial stages of stress, with a lack of vitamin E, under the influence of ionizing radiation, with the consumption of alcohol and fatty foods. GP activity is high in the liver and lungs of the mother, the placenta, and the liver of the fetus [38-40].

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Summary and Conclusions

Thus, hematological studies conducted in farms with different levels of radioactive contamination and different doses of animal radiation revealed some characteristic changes in peripheral blood, which, in our opinion, are associated to a greater extent with the conditions of maintenance and environmental conditions, primarily with the lack of biogenic microelements in the animal feeding rations. The lack of biogenic microelements in the rations and blood of animals can be the cause of a variety of disorders in the life support systems of the animal organism. Nevertheless, it should be emphasized that the existing eosinophilia, lymphocytosis, and qualitative changes in white blood cells can also be the result of the influence of the radiation factor, which is confirmed by fundamental studies in the works [23-27].

Studies of biochemical blood parameters of cows exposed to radioactive iodine, which led to the formation of different doses of thyroid irradiation at different doses (40 and 10 Gray), showed that, unlike hematological parameters (the number of leukocytes, erythrocytes, platelets, hemoglobin, hematocrit), biochemical blood parameters are less informative in terms of assessing their radiosensitivity. The individual biochemical parameters studied (activity of amylase enzymes, aspartate and alanine aminotransferases, glutathione peroxidase, the concentration of lipid hydroperoxides, ceruloplasmin content, the total protein level in the blood plasma of cattle) fluctuate within wide limits but do not always differ significantly and regularly between groups of animals in which different doses of thyroid irradiation were formed, and animals that did not undergo significant doses of irradiation (at the level of several mGy) of this important organ. The results obtained show that even under conditions of thyroid irradiation in large doses (40 Gy on the thyroid gland, which has a lethal effect under conditions of irradiation of the animal as a whole), powerful compensation (adaptation) mechanisms are triggered in the body, which allows at the organismal level to level out the negative effect of ionizing radiation and to preserve such important economic characteristics as reproduction and productivity.

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