The influence of environmental factors on the indicators of biological systems of dairy cows in anthropogenic zone conditions

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Abstract. The negative environmental situation in such a region of the Russian Federation as the Chelyabinsk region is due to the prolonged and intense impact of man on nature. The Magnitogorsk Iron and Steel Works (MMK) and other large industrial enterprises operate in the region. MMK is one of the leading global steel producers. This is one of the largest Russian enterprises in the metallurgical industry. The article presents the results of the analysis of the chemical composition of objects related to the natural environment of the region. A significant level of toxic effects on biological objects was noted. These objects are lactating cows. Pathomorphological, radiological, and clinical-hematologic features inherent in osteodystrophy are characterized. Based on these factors, a characteristic of the necessary therapeutic effect is presented. The results of the study of the clinical condition, blood serum and blood of twenty-four cows, water, feed, soil are presented. The study was conducted in the Nagaybak district of the region, in the Znamensky agricultural enterprise. The results of the analysis of the composition of chemical elements, such as Cd, Fe, Pb, Ni, presented in the bone tissue of animals suffering from the disease, and in other objects of research are characterized. The dynamics of the hematological and clinical state of the cows in the initial state and after the therapeutic effect was carried out was analyzed. According to the results of the study, it was found that the main toxic substances that pollute the area are Cd, Fe, Pb, Ni salts. Revealed changes in the blood composition of cows. In cows, dystrophy of bone tissue is observed, all metabolic processes are disturbed. According to the results of oral administration of vitartil, which is a mineral enterosorbent, and therapy with a drug, which contain calcium, positive changes in blood parameters have been established. Significantly increased milk productivity, the clinical condition of animals has become more favorable.

1. Introduction

In industry equipment may not be used properly. In addition, the equipment may be worn out. It should also be noted that discharges of enterprises into the natural environment may be insufficiently cleaned. As a result, significant amounts of harmful substances get into nature [1].

A significant amount of pollutants comes from vehicles. There are an average of two hundred sixty-one cars per thousand citizens in the region [2]. In winter, the concentration of Pb is highest. The reason...
is that in winter, additional emissions get into the air. In winter, weather conditions are unfavorable. As a result, more Pb is accumulated in the surface air [3]. Waste dumps (landfills) are located near settlements on large tracts of land. In the region, the number of legal landfills for waste is about thirty. The actual amount of land where waste is located is much larger. The area of land on which legal landfills are located exceeds 2.6 hectares in the region. These wastes rot. As a result, harmful substances get into the air, water environment. [4,5].

Nagaybak district of the region is characterized by significant winds. In the area, the terrain profile is steppe. These factors contribute to the spread of toxic substances, in particular, such as heavy metals. Human activity leads to the fact that natural objects are polluted with toxic substances. Toxic substances accumulate in animal tissues. In the body of animals, metabolic processes change. There is a decrease in the level of resistance of animals [6,7,8]. In areas where there is increased pollution, as a result, animals develop diseases of muscle and bone tissues. Lactating cows have osteodystrophy. If osteodystrophy is at the 2-3 stages, the treatment of animals is long and disadvantageous from an economic point of view.

Thus, for areas where there is a significant load on the environment, it is necessary to develop and put into practice a rational approach to the treatment of cows that have diseases of muscle and bone tissue [9, 10]. The aim of the study is to develop a reasonable approach to the treatment of cows during lactation for toxic contaminated regions of the Southern Urals.

2. Experimental
The study was carried out in the Nagaybak district at the Znamensky agricultural enterprise throughout 2008. The agricultural enterprise is located in the area where the emissions of the MMK enterprise fall. Within the framework of comprehensive dispensary examinations, the health of animals and the performance of their systems and organs were evaluated. We used the method of Sharabrin I.G.

At the initial stage, the composition of environmental objects, such as water, soil, was analyzed. The elemental composition of animal feed was also analyzed. The presence of blood and bones was studied for the presence of elements such as Mn, Fe, Co, Zi, Cu, and substances that are toxic - Cd, Pb, Ni.

A Micon instrument and an AAS-3 spectrophotometer were used to analyze the presence of toxic substances. Samples of feed were analyzed. The Institute of Veterinary Medicine conducted an analysis of zootecchnical parameters. The methodology provided for by the Russian state standard was used. The diet was determined according to the method of A. Kalashnikov. based on information regarding the needs for trace elements, nutrients according to the level of productivity, physiological state, value of live weight.

During the clinical examination, the state of the body systems (respiratory, cardiovascular, musculoskeletal, secretory, digestive) was analyzed; appearance (spatial position of the body, physique, fatness); the condition of the lymph nodes, hair, skin, mucous membranes; general condition (breathing, pulse, temperature). X-ray diffraction using an Arman 10L6-01 apparatus was carried out in order to confirm the diagnosis. In order to determine possible changes in the state of organs, blood was taken in the morning. Blood was drawn from the jugular vein. Further, a morphobiochemical analysis was carried out at the Institute of Veterinary Medicine. The rules of antiseptic and aseptic were followed.

An average sample of fresh milk was selected to detect changes in the body of lactating animals. Sampling was carried out in proportion to milk yield. Milk was investigated in accordance with the method of A. Kabysch. Calcium chloride was used, titratable acidity was determined. The difference in acidity was revealed.

Five cows were slaughtered because sick cows had low productivity and lost breeding value. Samples of sections of bone tissue, characterized by different levels of stress, were taken. Slices were taken from the femur, incisors, pelvic bones, fifth caudal vertebra and thirteenth rib. For these samples, chemical and histological studies were performed.

After the medical examination was completed, the data were compared with indicators corresponding to the average norm. Based on the identified changes and established signs of osteodystrophy, the formation of groups of cows was carried out. Groups were formed in accordance with the principle of
balanced groups. The groups were formed from cows at the initial stage of lactation (from zero to one hundred days from the moment when calving took place). Twelve cows were included in each group. When forming groups, age and live weight were taken into account.

The introduction of chalk into the diet of animals included in the control group was carried out in a dose of one hundred to one hundred and ten grams daily.

Therapy of animals included in the experimental group was carried out through vermiculite. The dose of the substance was one tenth of a gram per kilogram of body weight of the animal. The substance was fed once a day. The substance was fed as part of a feed - concentrate. The duration of treatment was fifteen days with a break of fifteen days.

The symptoms were eliminated by administering to the cows in the experimental group a five percent glucose solution, trivitamin, ten percent magnesium sulfate, and ten percent calcium chloride. Doses were determined according to the instructions. The treatment was carried out for sixty days.

During the study, the productivity and clinical condition of the animals were analyzed. Data processing was carried out using MS Excel, the arithmetic mean and the corresponding error were determined.

3. Results and considerations

Among the most significant problems of our time is significant environmental pollution due to human activities. Contaminants of organic origin are not redistributed in natural environments, which distinguishes them from heavy metals. About ninety percent of these metals accumulate in the surface soil layer. Further, these metals fall into water, plants. Thus, heavy metals enter the food chain.

An analysis of the soils on which forage grasses grow revealed the following. It was established that in each soil sample from the surface layer Pb, Ni, Cd, Fe are present in significant volumes. Then the content of such substances as Co, Cu, Mn, Zi is low.

It was revealed that the excess of the highest concentration of Pb is up to 28.7 percent, Fe up to 50.3 percent, Ni up to 22.6 percent, Cd up to 15.4 percent. The reason, we believe, is that in this region there are significant volumes of ores containing NH4 +, Ni, Fe. The reason also lies in MMC emissions.

A significant concentration of toxic substances in the upper soil layer causes the accumulation of these substances by fodder plants. In each feed sample, it was revealed that the balance of the mineral composition is impaired. The value of substances such as Pb, Fe, Ni, Cd is higher than the maximum permissible level. The most significant excess in Pb, Ni, Cd is observed in grain feed. The highest concentration of Fe was found in haylage from oats and vetch. The essential trace elements in each of the feed samples are contained in concentrations that are significantly lower than the level that is the maximum allowable.

The elemental composition of the water consumed by the cows is essential. It was revealed that in water bodies of natural origin Fe, Pb, Ni, Co are contained in concentrations that are significantly higher than the level that is the maximum allowable. The excess for Co is 15.1 percent, for Ni - 7.3, Pb - 4, for Cd - 2.5 times. For substances such as Zi, Mn, Cu, the level in each of the samples was below the level that is the maximum permissible. Accordingly, the analysis revealed that in the study area there is a high anthropogenic pollution of the environment with toxicants.Every day, the elements present in the water and feed enter the body of the cows. The diet of animals in an agricultural enterprise is based on hay, silage and hay. The proportion of these feeds is 57.4 percent. The diet is supplemented with molasses (5.3 percent), concentrates (37.3 percent).

A discrepancy with regulatory information of some indicators characterizing the nutrition of animals has been established.

It was established that Co, Cu, Fe are present in excess volume, while Ca, Zi, Mn, Mg are in insufficient quantity. The result of the imbalance is a violation of metabolic processes and an upset digestive system. In accordance with the concept, which implies the unity of macroorganisms and the natural environment, metabolic processes in the body are caused by changes in the composition of water, feed, soil. In areas where significant toxicant contamination is observed, animals develop various diseases.
A medical examination of the animals was carried out to assess the prevalence of non-infectious pathologies. In 61.2 percent of the cows, there was a deviation from the physiological norm. 32.2 percent of lactating cows showed osteodystrophy. 3.7 percent have kidney disease - nephrosis, nephritis. 7.9 percent have pericarditis and myocardial dystrophy. 17.4 percent have kidney damage, hepatosis and hepatitis.

Some cows have symptoms of a number of diseases. Studies of milk samples, radiography, hematological studies, which confirmed that the clinical status of animals are not normal.

Cows that have osteodystrophy are characterized by impaired functioning of the digestive system (its motor and motor-secretory activity). Meritsizin’s disorder is revealed. Productivity is reduced, there is no appetite. The qualitative characteristics of the mucous membranes, skin, and hair are reduced. The movement of cows that have the disease is intense. The joints are deformed, crunch, animals limp. Fractures of the costal processes with a bone disorder were established. Spinal prolapse revealed. Incisors are unstable. Oseolysis of the caudal region and the last pair of ribs was also established.

Radiography revealed a number of bone tissue disorders. Enlarged endostral cavities of the tubular bone, disk space. Bone density is reduced. Kabysh A.A. method used to determine the acidity of fresh milk. A four percent CaCl₂ solution was used for addition. The difference with titratable acidity without CaCl₂ was up to 4.8 ° T.

A change in morphobiochemical parameters in the blood of animals that have osteodystrophy was revealed. It was found that normative values for Ni are exceeded 2.2 times, for Fe - 11.5 percent, for Pb - 72 percent, for Cd - 8.8 percent. At the same time, the content of Zn is lower than the control values by 63.8 percent, for Mg - 74.3 percent, for Cu - 81 percent. It was revealed that a high level of Fe and toxicants in the blood negatively affects the blood forming organs, nephrons, and hepatocytes.

Reduced protective and respiratory functions of the blood. There is reduced lysozyme and bactericidal activity of inversion, anemia, decreased phagocytic activity of leukocytes, monocyteopenia and leukopenia. The body has inflammation. The dynamics of the leukogram confirms the results.

The presence of eosinophilia was detected. It seems that the reason is that the body is sensitized by toxicants.

In the study of biochemical parameters, it was found that the content of β-globulins is increased in serum. The level of albumin and total protein is also reduced. Liver function in protein synthesis is impaired.

Confirmation is hyperbilirubinemia, a change in the AST / ALT ratio, and the high activity of these enzymes. Based on this ratio, it was revealed that prolonged poisoning is accompanied by a significant hepatotoxic effect of xenobiotics. A violation of mineral metabolism was detected in animals suffering from osteodystrophy. The inorganic activity of alkaline phosphatase and phosphorus exceeds the norm by 34.8 and 43.7 percent. Mg in serum is lower than standard values by 27.2 percent, Ca - by 41 percent. 42.8 percent lower than the standard alkaline plasma reserve. Pb is able to accumulate in bone tissue. As a result of this ability, it can be present for a long period in the blood, including when the exposure from the outside has stopped. Pb is the most dangerous heavy metal.

Deposition of Pb is characterized by the ability to form bonds that are covalent, and high affinity for bone tissue molecules. In this case, lead accumulation in the bone marrow does not occur. Accordingly, in areas where there is a high concentration of toxic substances, osteodystrophy acts as one of the most common non-infectious pathologies. This disease is detected radiologically, hematologically and clinically.

Five cows were slaughtered because sick cows had low productivity and lost breeding value. A histological analysis of the femur, incisors, pelvic bones, fifth caudal vertebra, thirteenth rib was performed. In the thirteenth rib and caudal vertebrae, which are the most remote areas of secondary motor importance, the presence of changes is established.

Bone tissue samples were chemically tested. It was found that the level that is the maximum allowable is exceeded for Pb, Cd, Ni. In the incisors, caudal vertebrae and the thirteenth rib, an increased concentration of heavy metals was established. Pb in the tissues of these bones exceeded the normative value by 8.8, 8.8 and 10.8 times.
A similar excess was found for Ni and Cd. The results are consistent with the belief that a stable fraction of Pb is present in the body that is ninety percent bound to bone tissue. The stable fraction of Pb contains inert and labile components. The latter is an intermediate link between the exchange and inert components. The inert component is presented in the form of deposits in the bone tissue of salts that are insoluble. The inert component in the blood occurs when mobilization of this component due to physiological stress is observed. A decrease in the alkaline reserve of blood plasma is evidence of the development of acidosis in animals suffering from osteodystrophy. Accordingly, toxicants present in significant concentrations in water and feed enter the body and accumulate in bone tissue.

As a result, digestion, hematopoiesis, and kidney and liver activity are disrupted. The body’s defenses are reduced. The immune system is sensitized. Osteodystrophy occurs. Veterinarians indicate that during treatment secondary pathologies develop in the form of paresis, laminitis, atony and hypotension of the forelimbs, pericarditis, bursitis. The therapeutic effect of treatment is limited in time. In general, the effectiveness of treatment is poor. Reproduction is impaired, veterinary and sanitary-biological indicators are deteriorating, productive qualities are declining. Premature rejection occurs. During the first stage of lactation, these changes are more pronounced. The result is significant economic damage. Of the animals in which the disease is detected, two groups are formed. An experimental group of animals was formed, in the feed of which vermiculite was introduced. A control group was also formed. The groups were formed in order to evaluate the effectiveness of treatment of cows, which revealed signs of the presence of diseases of the musculoskeletal system.

Vermiculite is mined in the Potaninsky field located in the region. This mineral is hydromica. The composition includes compounds of substances such as K, Si, Ca, Al, Mg, Mn, Fe.

The elimination of the deficiency of vital elements in cows is ensured by the introduction of vermiculite in the diet. Enriched vermiculite used in veterinary medicine is a substance that has ion-exchange, catalytic, and sorption properties.

Microelements present in the substance, macroelements are absorbed in the intestines of animals. In this case, the substance allows you to remove salts of heavy metals from the body, because it has a significant ability to adsorption.

The treatment carried out during the study led to the fact that the values of morphological and biochemical parameters in the animals participating in the experiment changed. On the sixtieth day of the study, the changes were most significant. The table shows information on the content of salts of heavy metals in the blood of cows.

| Chemical element | Groups of animals | Day of study | 1st | 60th |
|------------------|------------------|--------------|-----|------|
|                  |                  |              | 2   | 3    | 4    |
| Iron             | Control          | 277.7±0.7    | 270.6±0.2 |
|                  | Experimental     | 278.8±0.6    | 252.9±0.5 *|
|                  |                  | 0.34±0.03    | 0.32±0.02 |
| Lead             | Control          | 0.34±0.03    | 0.22±0.02 ***|
|                  | Experimental     | 0.28±0.03    | 0.26±0.02 |
| Nickel           | Control          | 0.28±0.02    | 0.13±0.02 ***|
|                  | Experimental     | 0.11±0.01    | 0.10±0.02 |
| Cadmium          | Control          | 0.012±0.02   | 0.002±0.001 ***|

Validation of results between groups * - P <0.05; ** - P <0.01; *** - P <0.001.

The level of toxicants and Fe in the blood of animals decreased due to the fact that vermiculite was used in the treatment. Moreover, in the control group, the decrease was insignificant. Whereas in the experimental group the content of Cd decreased in comparison with the control value by 83.3 percent,
Ni by 50.0 percent, Pb by 31.3 percent (for all indicators P < 0.001), Fe by 6.7% (P < 0.05). It should be noted that the Ni concentration slightly exceeded the standard value.

The chemical composition and structure of vermiculite determine its ion-exchange properties. It was revealed that the use of this substance on a regular basis reduces the speed of movement of the chyme. Trace elements in the blood of animals belonging to the experimental group increased. Compared to the control group, Mg growth amounted to 93.0 percent, Zn - 2.4 times, Cu - 4.0 times (for all indicators P < 0.001).

The animals included in the control group, whose therapy was symptomatic and who received chalk, changed the morphological parameters and hemoglobin content. It was revealed that the content of monocytes, nuclear neutrophils, eosinophils, basophils decreased in comparison with the initial values by 2.1, 2.0, 3.4 and 6.5 percent, respectively. At the same time, hemoglobin exceeded the initial values by 1.9 percent, lymphocytes - by 1.6, leukocytes - by 2.7, erythrocytes - by 1.0 percent. The noted dynamics is indirect evidence of the insufficient effectiveness of the use of chalk and symptomatic treatment.

A consequence of vermiculite therapy was that the effect of toxicants on parenchymal targets - the kidneys, liver, gastrointestinal mucosa, and digestion of the scar decreased. The composition of trace elements has also changed. It was established that the redox processes inherent in the red brain hematopoietic function intensified. On the sixtieth day, the number of leukocytes exceeded the control indicators by 12.3 percent (at P < 0.001), the number of red blood cells - by 10.0 percent (at P < 0.01). An increase in hemoglobin saturation was also detected (4.6 percent, p <0.05). Accordingly, a prerequisite has been formed for enhancing tissue respiration.

The redistribution of leukocytes in the leukogram was revealed. The segment of nuclear neutrophils decreased by 10.7 percent (at p <0.01), eosinophils decreased by 26.1 percent (at p <0.001), neutrophils - by 4.6 percent (at p <0.05), basophils - by 27.6 percent (at p <0.01).

The reason for these changes seems to be due to the fact that desensitization has occurred. Non-specific protective factors have increased. The level of lymphocytes exceeded the initial value by 11.2 percent (with P <0.01), the level of monocytes - by 22.2 percent (P <0.01). Normalization of protective forces with the introduction of vermiculite in the diet is confirmed by changes in the leukogram and the growth of leukocytes to the physiological norm.

The hypothesis is supported by the analysis of indicators characterizing non-specific defense factors. The use of chalk in therapy, the treatment of symptoms in animals belonging to the control group, led to an increase of 3.7 percent in the bactericidal activity of serum, and by 17.9 percent in the phagocytic activity of leukocytes in comparison with the background. Animals of the experimental group showed more significant results - an increase of 28 percent bactericidal activity, and an increase of 66.7 percent of phagocytic activity compared to the background.

The growth of serum lysozyme and bactericidal activity in comparison with the control amounted to 21.7 and 23.9 percent, the growth of leukocyte phagocytic activity - 40.9 percent (at p <0.001). Accordingly, the use of vermiculite in the complex treatment of animals suffering from osteodystrophy provides a more pronounced effect on the protective factors of humoral and cellular nature. Animals of the control group did not demonstrate significant dynamics in metabolic parameters. The serum albumin and protein levels decreased, the concentration of urea and protective proteins increased. The changes were insignificant, statistically unreliable.

Indicators of protein metabolism in animals included in the experimental group increased. During the study, a decrease in total protein was found in the serum of experimental animals. In comparison with animals included in the control group, the value was 5.3 percent. The reason seems to be the slow movement of feed through the digestive tract. The proteinogram revealed an increase in albumin of 18.8 percent.

The activity of ALT, AST decreased to the control level. The revealed dynamics of proteins in the blood serum of animals belonging to the experimental group confirms that the function of protein synthesis of the liver has recovered. A significant excess of carbohydrate metabolism in the blood of
animals of the experimental group was revealed. These results also confirm that the metabolism has recovered.

A change in the metabolism of minerals in animals suffering from osteodystrophy was revealed. In animals in the control group, therapy led to an increase in the values of such substances as total Mg, inorganic P, total Ca. At the same time, the values did not reach the physiological norm.

On the sixtieth day of therapy in the blood serum of animals belonging to the experimental group, the ratio of P-Mg-Ca normalized. Inorganic P decreased, total Ca increased. Upon completion of therapy, the level of inorganic P in the experimental group exceeded the indicators in the control group by 19 percent, Mg by 27.6 percent, and total Ca by 57.7 percent (all estimates at P <0.001).

In serum, the alkaline plasma reserve exceeded the control level by 49.4 percent, and the level of alkaline phosphatase activity was lower than the control level by 21.4 percent (all estimates at p <0.001). The revealed changes allow us to note that the proposed therapy is effective. The ion-exchange properties of vermiculite make it possible to restore acid-base balance in animals, restore the bone tissue of lactating animals, and normalize the state of the parathyroid glands.

Accordingly, in the animal organism, with the proposed therapy, blood functions are activated (protective, hematopoietic, respiratory); improvement of all metabolic processes; normalization of indicators characterizing the clinical condition (qualitative characteristics of the hairline improved, lameness, crunch of joints went away). Correspondingly, therapy allows us to form the basis for animals to realize the genetic potential of milk production.

In the process of determining milk productivity, a positive effect was revealed from the proposed treatment of animals with osteodystrophy. The indicated therapy made it possible to establish that the milk productivity of the animals participating in the experiment increased. According to the results of the second month of therapy, the excess of the average in the experimental group with the indicator of the control group was twenty-eight percent. As a result, the volume of milk obtained during the experiment period increased by 6.2 percent. There has also been an improvement in veterinary and sanitary indicators and the qualitative characteristics of milk.

4. Conclusion
The study of the results of the study allows us to note that under the conditions of anthropogenic impact on the natural environment, the chemical composition of environmental objects changes significantly. Animals located in areas confirmed by the effects of toxicants are characterized by impaired functioning of the cardiovascular system, kidneys, liver, digestive system, metabolic disorders. The number of cows that are healthy, according to the study, is in the range of 15.1-32 percent. Among noncommunicable diseases characterized by the highest prevalence in animals, osteodystrophy stands out.

In the objects of the environment and blood of cows, the presence of high concentrations of Fe and salts of heavy metals was revealed. In this regard, it was proposed to introduce into the diet a zeolite-containing mineral having high ion-exchange and adsorption properties. The introduction of this mineral stabilizes digestion and hydrolysis, enriches the chyme with minerals for which there is a shortage, and eliminate toxic substances. The conducted experiment revealed the positive effect of therapy and economic effect. Productive qualities of cows included in the experimental group, in the diet of which enterosorbent of mineral origin was introduced as part of therapeutic measures, increased.

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