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ECOLOGICAL STATEMENT OF THE WEST PART OF UKRAINE AND SPREADING OF INTERNAL PATHOLOGY OF SHEEP

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INTRODUCTION

The establishment of Ukraine as an independent food state has brought on the agenda the issue of the priority of the agro-industrial complex development, including agriculture, its key production and working potential. Animal husbandry is not only key, but also is one of the most economically and technologically vulnerable and risky type of agricultural activity. In addition to the unpredictability in animal feed supplying, which often depends on the agriculture level, there is a certain uncertainty in the demand for products and, accordingly, their prices[1].

Scientific studies have shown that changes of the animals' productivity on 50–80% is determined by the feed quality. With proper animal husbandry, the level of development of the fodder base, as usually, is ahead of the rate of growth of the livestock population. Unfortunately, the opposite trend is observed today in most of farms, which has caused an inefficient livestock feeding system and a significant increase in the cost of feed and livestock products[2],[3].

The sheep breeding industry is a complex production and economic activity with its goal to meet the needs of the population in unique and valuable food products, and to supply the industry (light, food, pharmaceutical, etc.) with raw materials. In terms of the products' types manufactured, sheep breeding occupies the leading position among other branches of animal husbandry. However, transformations in the agrarian sector of the Ukrainian economy, a decrease the purchasing power of the population, the cancellation of state purchases of wool and targeted support caused the increasing of the negative trends in the sheep breeding industry. A sharp reduction of sheep population, a decrease in the volume of production and sale of the industry's products, a breakdown in the relations between production and processing, the deterioration of material and technical equipment and scientific support, the unprofitability of the vast majority of producers of sheep products have become characteristic features of post-

[1] Кіт В.Г., Самойленко А.П. Збитковість тваринництва можна ліквідувати *Наук. вісн. Львів. акад. вет. медицини ім. С.З. Ґжицького*, Львів, 1999. Вип. 2. С. 199–204.

[2] Долішній М.І. Наукові основи розвитку тваринництва (економічний аспект) Наук. вісн. Львів. акад. вет. медицини ім. С.З. Ґжицького, Львів, 1999, Вип. 2. С. 195–199.

[3] Сапего В.И., Плющенко С.И., Берник Е.В., Ляхов Е.Н. Профилактика нарушения обмена веществ у телят микроэлементами Ветеринария с.-х. животных, 2006. № 7. С. 50–52.

reformed sheep farming. This led to the fact that it is one of the most unprofitable branches of agriculture[4].

And yet, sheep breeding is one of the branches of animal husbandry that can be profitable. Sheep have good wool and meat productivity, are multifertile, give a sufficient amount of highly nutritious milk, suitable for the production of cheese and other types of cheese. Rennet is taken from the lambs slaughtered on strips, from which rennet starter is made for the production of various types of cheese. Striped breeds give fur of unsurpassed quality, famous fur coats and coats are made from the skins of Romanov sheep. Sheep are excellent pastures users, eating grasses of the kind that cattle, horses, and pigs do not.

Many studies have proved that the level of blood components of the sheep body is unstable and depends on the breed, sex, physiological state, level of productivity and feeding, housing conditions, environment and other factors. Therefore, studying the status of various systems and organs of animals is important for the prevention of internal pathology and for improving the quality and safety of products[5].

1. Trace minerals content in the Luhansk Region soil

Mineral elements, depending on their biological role, can be divided into vitally important, conditionally important and elements with unexplored significance. Copper, zinc, manganese are part of the vital group, as they take part in most of the processes that take place in the body, in particular, in the construction of its tissues, maintenance of homeostasis and equilibrium of cell membranes, in the activation of chemical reactions by influencing direct enzyme systems or indirect action on the function of endocrine glands[6] .

These compounds activities in the body depends not only on their quantity in the ration, but also on their form. In this regard, the problem of microelements complex using organic substances (proteins, peptides and amino acids) becomes relevant in animal husbandry. It is important that the soil contains a sufficient number of mobile forms of trace elements.

Luhansk region is divided into 18 districts. Geographically, they can be divided into northern, central and southern districts (provinces). The first group includes Troitskyi, Bilokurakinskyi, Novopskovskyi, Markivskyi, Milovskyi, Bilovodskyi, Starobilskyi, Svativskyi and Kreminskyi districts. They are mostly bordering with the Donetsk region and the Russian Federation (except for Starobilskyi). The central districts of Luhansk region are Popasnyanskyi, Novoaidarskyi, Stanychno-Luhanskyi, Slovyanoserbskyi and Krasnodonskyi, which are located closest to the Luhansk city.

[4] Сухарльов В.О., Дерев'янко О.П. Вівчарство : навч. посіб. Харків : Еспада, 2004. 256 с.

[5] Braun G.P., Trumel C., Bézille P. Clinical Biochemistry in Sheep: A Selected Review. Small Ruminant Research. 2010. Vol. 92, Is. 1/3. P. 10–18.

[6] Wiwanitkit V. Minor Heavy Metal: A Review on Occupation and Environmental Intoxication. Indian Journal of Occupational and Environmental Medicine. 2008. Vol. 12, Is. 3. P 116–121.

The southern districts include Perevalskyi, Lutuginskyi, Antratsytivskyi and Sverdlovskyi.

Geographical zoning of Luhansk region in regard to the biogeochemical division depends on soil saturation with mobile forms of trace elements. Luhansk region is part of the Donbass three sub-districts, which correspond to the geographical division of the region. In general, the soils of eastern Ukraine have a high content of lead, zinc, copper, cobalt, and chromium.

Copper is one of the most important irreplaceable trace elements, which main function in the animal body is participation in the processes of tissue respiration and hematopoiesis[7]. Absorption of copper occurs in the upper part of the small intestine. After absorption, the element is deposited mainly in the liver, bone marrow, spleen, pancreas, and epiphyses of bones of young animals[8].

Table 1

The content of mobile forms of copper in the soils of the Luhansk region

Districts	Average content by district, mg/kg	Level
1. Bilokurakinskyi	5.5	Average 5–7
2. Troitskyi	5.7	
3. Krasnodonskyi	6.0	
4. Markivskyi	6.1	
5. Lutuginskyi	6.1	
6. Milovskyi	6.1	
7. Svativskyi	6.1	
8. Kreminsky	6.2	
9. Novoaidarskyi	6.3	
10. Perevalskyi	6.3	
11. Popasnianskyi	6.3	
12. Stanichno-Luhanskyi	6.5	
13. Bilovodskyi	6.6	
14. Sverdlovskyi	6.6	
15. Slovyanoserbskyi	6,7	
16. Antratsytivskyi	7.4	Elevated >7
17. Novopskovskyi	7.4	
18. Starobilskyi	9.7	

[7] Genetic Effects on Toxic and Essential Elements in Humans: Arsenic, Cadmium, Copper, Lead, Mercury, Selenium, and Zinc in Erythrocytes / B.J. Whitfield, et al. Environmental Health Perspectives. 2010. Vol. 118, Is. 6. P. 776–782.

[8] Genetic effects on toxic and essential elements in humans: arsenic, cadmium, copper, lead, mercury, selenium, and zinc in erythrocytes / B.J. Whitfield, et al. environmental health perspectives. 2010. vol. 118, is. 6. P. 776–782.

Copper is present in soils in a divalent form, it has a high migration ability in an acidic environment, however, at a very high level of acidity, it is fixed by soil organic matter. In an alkaline environment, copper is fixed in a hard-to-reach form, in the form of complex organic-mineral compounds[9].

The copper content in the soils of almost all districts of the Luhansk region is within the normal range. On average, copper content probably does not differ in all geographical regions. However, the concentration of this element in the soil exceeds the normal rate in the Anthracite region (Southern province), Novopskovskyi and Starobilskyi regions (Northern province) and is, respectively, 7.4; 7.4 and 9.7 mg/kg. The copper content in the soil of the northern regions is 6.03±0.13; in the central ones – 6.14±0.25; in southern ones – 6.33±0.15 mg/kg. Therefore, only the Novopskovskyi and Starobilskyi districts, which are located in the northern part of the region and have an increased content of copper in the soil, are geographically connected. Anthratsytivskyi – the southern part of Luhansk region, bordering the Donetsk region in the south, also contains an increased concentration of copper – 7.4 mg/kg. In our opinion, this inconsistency with the geographical principle of the mobile forms distribution of this essential element is linked to the geographical proximity of the Antratsytivskyi district to Donetsk region (table 1), where there is a lot of copper. The geographical proximity of regions does not always correlate with the same level of copper in their soil, although some neighbouring regions have similar levels of this trace element (for example, Troitskyi and Bilokurakinskyi regions – 5.7 and 5.5 mg/kg).

Manganese belongs to the trace elements that exist in eight different oxidation conditions, but in the body it is found only in the divalent and trivalent compounds form[10]. It activates alkaline phosphatase and the synthesis of glycosaminoglycans in the bone matrix[11].

Manganese is an element with high migration contrast. In the conditions of an alkaline environment, it is oxidized from divalent to tetravalent, the compounds of which are difficult to dissolve. In the acidic environment, it transforms to a soil solution and easily migrates[12].

Five districts of Luhansk region were identified, where the concentration of manganese is below the norm (350 mg/kg) and ranges from 264 to 333

[9] Вміст купруму, мангану і цинку у ґрунтах Луганської області / П.В. Шарандак, та ін. Наук. вісн. Луган. НАУ. Серія «Ветеринарні науки». Луганськ : Елтон-2, 2011. № 31. С. 235–243.

[10] Genetic Effects on Toxic and Essential Elements in Humans: Arsenic, Cadmium, Copper, Lead, Mercury, Selenium, and Zinc in Erythrocytes / B.J. Whitfield, et al. *Environmental Health Perspectives*. 2010. Vol. 118, Is. 6. P. 776–782.

[11] Вміст купруму, мангану і цинку у ґрунтах Луганської області / П.В. Шарандак, та ін. Наук. вісн. Луган. НАУ. Серія «Ветеринарні науки». Луганськ : Елтон-2, 2011. № 31. С. 235–243.

[12] Hristov A.N., Hazen W., Ellsworth J.W. Efficiency of Use of Imported Magnesium, Sulfur, Copper, and Zinc on Idaho Dairy Farms. Journal of Dairy Science. 2007. Vol. 90. P. 3034–3043.

mg/kg. In addition, four of them: Novoaidarskyi, Popasnyanskyi, Kreminskyi and Starobilskyi districts border each other. It is important to underline that the western part of the centre of Luhansk region is poor for essential forms of manganese and can be singled out as a separate biogeochemical province deficient in manganese (Table 2).

It was established that in the Stanychno-Luhanskyi and Troitskyi districts of the Luhansk region, there is an increased content of manganese compounds (473 and 428 mg/kg, respectively). Since these districts are not geographically connected with each other, it can be considered that they belong to the biogeochemical regions with which they border: Troitsky district – with Kharkiv and Belgorod regions, Stanichno-Luhanskyi – with Rostov region of the Russian Federation.

Table 2

The content of mobile forms of manganese in the soils of the Luhansk region

Districts	Average content by district, mg/kg	Level
1. Novoaidarskyi	264	Low < 350
2. Popasnianskyi	288	
3. Kremenskyi	320	
4. Starobilskyi	328	
5. Krasnodonskyi	333	
6. Bilovodskyi	355	Medium 350–420
7. Antratsytivskyi	396	
8. Slovyanoserbskyi	398	
9. Milovskyi	400	
10. Lutuginskyi	403	
11. Sverdlovskyi	407	
12. Novopskovskyi	410	
13. Markivskyi	412	
14. Perevalskyi	414	
15. Svativskyi	414	
16. Bilokurakinskyi	417	
17. Stanychno-Luhanskyi	428	Raised > 420
18. Troitskyi	473	

The average values of manganese content are the lowest in the central province of the region (320.8±29.45 mg/kg), there is a tendency to their increase in the northern province (382.0±14.48 mg/kg) and the maximum values in the southern province (405, 0±3.76 mg/kg). With the exception of Troitskyi district, most of the northern province of Luhansk region contains a sufficient amount of manganese. The same applies to the southern province.

Districts deficient in manganese form a common region of four districts bordering each other (Table 2). The Krasnodonskyi district has deficiency in manganese.

The distribution of manganese is more variable than for copper, as it includes regions with three variants of manganese concentration – increased, corresponding to the norm and decreased.

Zinc is present in soils in the form of chelated compounds, as a secondary compound with organic and inorganic compounds[13].

In the animal organism, the biological role of zinc is linked to activity of more than 200 metal enzymes participating in various metabolic processes[14 15].

We have established that in two regions of the Central province geographically bordering each other, Novoaidarskyi and Popasnyanskyi, the concentration of zinc in the soil is below the norm and amounts to 6.0 and 7.4 mg/kg (Table 3).

Table 3

The content of mobile forms of zinc in the soils of the Luhansk region

Districts	Average content by district, mg/kg	Level
1. Novoaidarskyi	6.0	Low < 7.5
2. Popasnianskyi	7.4	
3. Stanichno-Luhanskyi	7.6	Average 7.5–9.5
4. Bilokurakinskyi	7,8	
5. Krasnodonskyi	7,8	
6. Markivskyi	8.3	
7. Novopskovskyi	8.3	
8. Troitskyi	8.3	
9. Slovyanoserbskyi	8.7	
10. Milovskyi	9.3	
11. Perevalskyi	9.6	Increased > 9.5
12. Starobilskyi	9.7	
13. Antratsytivskyi	10.3	
14. Bilovodskyi	10.4	
15. Svativskyi	10.8	
16. Sverdlovskyi	11.2	
17. Kreminskyi	11.8	
18. Lutuginskyi	12.2	

[13] Вміст купруму, мангану і цинку у ґрунтах Луганської області / П.В. Шарандак, та ін. Наук. вісн. Луган. НАУ. Серія «Ветеринарні науки». Луганськ : Елтон-2, 2011. № 31. С. 235–243.

[14] Hristov A.N., Hazen W., Ellsworth J.W. Efficiency of Use of Imported Magnesium, Sulfur, Copper, and Zinc on Idaho Dairy Farms. Journal of Dairy Science. 2007. Vol. 90. P. 3034–3043.

[15] Neathery M.W., Miller W.J. Metabolism and Toxicity of Cadmium, Mercury, and Lead in Animals : A Review. Journal of Dairy Science. 1975. Vol. 58, N 12. P. 1767–1781

The soils of 8 districts of Luhansk region contain high concentrations of zinc compounds. According to zinc content, two biogeochemical provinces in the middle of Luhansk region can be distinguished according to the geographical principle: Northern and Southern. The Northern province includes Svativskyi, Kreminskyi, Starobilskyi, and Bilovodskyi districts, and the Southern province includes Perevalskyi, Lutuginskyi, Antratsytivskyi, and Sverdlovskyi districts of the Luhansk region (Table 3). That is, according to the zinc content in the Luhansk region, there are clearly limited «layers» of grouped territories with similar zinc content. On average, the Northern province contains 9.4±0.46 mg/kg zinc, Central – 7.5±0.44 mg/kg; Southern – 11.1±0.52 mg/kg.

Having analysed all the above data on the content of copper, manganese and zinc, it is possible to distinguish several biogeochemical provinces in the Luhansk region, which are characterized by different contents of the above-mentioned essential trace elements. However, in each of these provinces there are districts that are exceptional in terms of the content of elements.

Thus, we included Troitskyi, Svativskyi, Bilokurakinskyi, Novopskovskyi, Markivskyi, Milovskyi, Bilovodskyi, Starobilskyi and Kreminskyi districts to the northern province, which are characterized by the average content of copper in the soil (except for the Novopskovskyi and Starobilskyi districts), average or slightly reduced (up to 320 mg/kg) manganese content (except Troitskyi district) and average or high zinc content.

The central biogeochemical province of Luhansk region included Popasnyanskyi, Novoaidarskyi, Stanichno-Luhanskyi, Slavyanoserbskyi and Krasnodonskyi districts. This area is characterized by an average concentration of mobile forms of copper in the soil, an average or low content (except for the Stanichno-Luhanskyi district) of manganese, and a low or average zinc content.

We included the Perevalskyi, Lutuginskyi, Anthracytivskyi, and Sverdlovskyi districts as part of the Southern biogeochemical province, which are characterized by an average content (except for the Antracitivskyi district) of copper in the soils, an average content (except for the Krasnodonskyi district) of manganese, and an increased concentration of mobile forms of zinc (Table 4).

If we compare the absolute values of the copper manganese and zinc content, in the soils of different biogeochemical provinces of the Luhansk region, we come to the conclusion that the most essential trace elements are found in the soils of the Southern province. A significantly ($p<0.01$) higher concentration of manganese and zinc was found in the southern province of Luhansk region, compared to the central and northern provinces. Accordingly, in the northern biogeochemical province, the copper concentration is the lowest in the region, the number of mobile forms of manganese tends to increase, compared to the central regions, and the zinc content is probably

higher ($p<0.05$), compared to the Central biogeochemical province. In the central part of the Luhansk region, the lowest concentration of manganese and zinc in the soil was found, while the amount of copper practically does not differ from the indicators of other provinces (Table 4).

Table 4

The average content of essential trace elements in soils of different biogeochemical provinces of Luhansk region

Indicators	Copper, mg/kg	Manganese, mg/kg	Zinc, mg/kg
Northern Province	6.03±0.13	382.0±14.48	9.4±0.46
Central province	6.14±0.25	320.8±29.45	7.5±0.44*
Southern Province	6.33±0.15	405.0±3.76#	11.1±0.52*#

Note. * – $p<0.05$ compared to the Northern Province;

– $p<0.01$ compared to the Central Province.

2. Content of Lead and Cadmium in soil of Luhansk Region

Environmental problems in Ukraine came out because the structure of the economy, which had been developing for decades, did not correspond in many regions to their integral potential, the objective needs and interests of the people who lived here, and the ecological capabilities of a specific territory were not taken into consideration. The leading sectors of the economy of the eastern region of Ukraine are energy, engineering, mining and coal mining, and the chemical industry. Physically outdated equipment in these industries led to intensive use of energy, water, land, and sometimes uncontrolled emissions of pollutants into all components of nature[16].

Cadmium is not a vital trace element. It has a specific biological effect on the exchange of physiologically important chemical elements, such as zinc, copper and iron. Cadmium has a general toxic and specific effect, and its compounds reduce the body's resistance to diseases[17].

Cadmium cations are able to replace magnesium ions in the myosin active centre, as well as in areas essential for the actomyosin superprecipitation process. The main element accumulation occurs in the liver, where it is bound by a metalloprotein and this form enters the kidneys. The half-life of this toxicant from the specified organs in humans is more than 10 years, and the maximum intake of cadmium to the human body from the environment, according to WHO recommendations, should be no more than 1 μg/kg.

[16] Hristov A.N., Hazen W., Ellsworth J.W. Efficiency of Use of Imported Magnesium, Sulfur, Copper, and Zinc on Idaho Dairy Farms. Journal of Dairy Science. 2007. Vol. 90. P. 3034–3043.

[17] Neathery M.W., Miller W.J. Metabolism and Toxicity of Cadmium, Mercury, and Lead in Animals : A Review. Journal of Dairy Science. 1975. Vol. 58, N 12. P. 1767–1781.

The cadmium excess leads to restriction of zinc transport through the placenta due to excessive synthesis of metalloprotein in the mother's body. The toxic effect of cadmium induces the synthesis of metalloprotein, but since zinc is an even stronger inducer of it, it can increase the body's resistance to the toxic effect of cadmium. With nutritional deficiency of zinc in the body, the toxicity of cadmium increases. The content of cadmium in the blood of animals is almost 10 times higher than in endocrine tissues.

The main sources of cadmium entering the environment are enterprises for mining and processing of non-ferrous and ferrous metals, the chemical industry and agriculture. In the industrially developed areas, the concentration of cadmium exceeds the standards by tens of times, and almost a powerful sources of pollution – by hundreds and thousands of times[18].

Cadmium belongs to the group of metals with its high embryotoxicity and carcinogenicity. It comes to the mammals organs with food and water and accumulates in the kidneys, liver, spleen, and thymus. Cadmium has a high cumulative property and it removes from the body very slowly. Absorption of metal from the gastrointestinal tract is affected by gender, age, weight and lactation.

It was established that the chronic effect of cadmium in the antenatal and postnatal periods of development leads to the changes of the number of formative elements of blood and cells of organs, the intensity of the process of lipid peroxidation. The detected changes depend on the concentration of the metal in drinking water and the duration of its entry to the animals body[19].

Adaptation of animal body cells to the cadmium influence occurs through the activation of lipid peroxidation, mobilization of antioxidant protection and factors of non-specific immunity.

The increased concentration of this toxicant in the central and southern provinces is directly linked to the dense concentration of heavy industry facilities in these areas.

The presence of a large amount of cadmium in the soils of the Northern province of the Luhansk region is caused by intensive cultivation of crops, with the use of chemicals, as well as frequent cutting of the upper layer of the land.

[18] Шарандак П.В. Концентрація креатиніну та сечовини в сироватці крові кітних вівцематок у залежності від вмісту у ґрунтах кадмію. Науковий вісник НУБіП України. Серія «Ветеринарна медицина, якість і безпека продукції тваринництва». Київ, 2011. Вип. 167, ч. І. С. 252–256.

[19] Neathery M.W., Miller W.J. Metabolism and Toxicity of Cadmium, Mercury, and Lead in Animals : A Review. Journal of Dairy Science. 1975. Vol. 58, N 12. P. 1767–1781.

Table 5

The content of mobile forms of cadmium in the soils of the Luhansk region

Districts	Areas of Cadmium	
	M±m, mg/kg	% pollution
Stanichno-Luhanskyi	0.51±0.0001	6.3
Slovyanoserbskyi	0.51±0.0001	5.1
Belokurakinskyi	0.51±0.0001	2.9
Novopskovskyi	0.48±0.0001	4.8
Milovskyi	0.47±0.0001	4.7
Troitskyi	0.47±0.0001	3.7
Lutuginskyi	0.46±0.0001	10.7
Svativskyi	0.44±0.0001	2.6
Marivskyi	0.43±0.0001	2.6
Antratsytivskyi	0.41±0.0001	0
Perevalskyi	0.40±0.0001	0.75
Sverdlovskyi	0.40±0.0001	0.3
Popasnyanskyi	0.39±0.0001	2.7
Belovodskyi	0.36±0.0001	2.04
Krasnodonskyi	0.35±0.0001	2.9
Starobelskyi	0.34±0.0001	2.2
Novoaidarskyi	0.33±0.0001	1.0
Kreminskyi	0.28±0.0001	1.3
In the region	0.41±0.0001	3.0

As to our opinion, the most important changes in internal organs condition of domestic sheep (liver and kidneys) will be observed in the north, in the Troitskyi and Markivskyi districts, and in the South – in the Slavyanoserbskyi and Stanychno-Luhanskyi districts (Table 5). In these areas, there are no lands rich with manganese, and its deficiency provokes severe cadmium intoxication.

During the examination of sheep from the Slovyanoserbskyi district, we established hypercreatininemia comparing to the high cadmium concentration in the soil (0.51 mg/kg), i.e., there is a directly proportional relationship between the concentration of cadmium in the soil and creatinine in the serum blood. Persistent hypercreatinemia in sheep of the Krasnodonskyi district (cadmium content – 0.35 mg/kg), in our opinion, has a different nature – it is associated with a Manganese high level in the soil (333 mg/kg), which is a zinc antagonist, and also enhances the nephrotoxic effect of cadmium.

There is a relationship between the blood urea concentration and the number of cadmium-contaminated areas. Thus, in the Lutuginskyi district, we established hyperazotemia in domestic sheep against the exceeding the maximum permissible limit of cadmium by 10.7 % of the territory of the district. No increase in urea concentration was observed in the sheep blood

serum of the Markivskyi district, where 2.6 % of territories are contaminated with cadmium[20].

It is well known that lead belongs to the group of heavy metals, which concentrations above 10 mg/kg in the soil have a negative influence on metabolic processes in the alive organisms.

Natural sources of lead ate the waters with mineral dissolution processes. A significant increase in the lead content in the environment is associated with the coal burning, the use of tetraethyl lead in motor fuel as an anti-detonator, the waste originates from ore processing plants, metallurgical plants, chemical plants, mines, etc. with wastewater.

Lead is an industrial poison that can cause contamination under adverse conditions[21]. It comes to the animals body mainly via the respiratory and digestive organs, and eliminates from the body very slowly and accumulates in bones, liver and kidneys[22].

Table 6

The lead content in the soils of the Luhansk region

Districts	Areas of Plumbum	
	M±m, mg/kg	% pollution
Svativskyi	9.1±0.0003	17
Lutuginskyi	8.1±0.0011	8
Stanichno-Luhanskyi	7.7±0.0004	5.5
Slovyanoserbskyi	7.5±0.0001	6.4
Markovskyi	7.5±0.0009	0.6
Milovskyi	7.3±0.0010	0.5
Novopskovskyi	7.3±0.0007	1.8
Antratsytivskyi	7.3±0.0013	0.5
Perevalskyi	6.9±0.0033	19
Troitskyi	6.9±0.0004	6
Bilokurakinskyi	6.4±0.0004	2.6
Sverdlovskyi	5.5±0.0021	0.6
Krasnodonskyi	5.1±0.0006	0.4
Popasnyanskyi	4.2±0.0006	0
Novoaidarskyi	3.9±0.0003	0.16
Bilovodskyi	3.5±0.0003	0
Starobilskyi	3.5±0.0002	0
Kremenskyi	3.4±0.0002	0
In the region	5.3±0.0001	3.6

[20] Шарандак П.В. Концентрація креатиніну та сечовини в сироватці крові кітних вівцематок у залежності від вмісту у ґрунтах кадмію. Науковий вісник НУБіП України. Серія «Ветеринарна медицина, якість і безпека продукції тваринництва». Київ, 2011. Вип. 167, ч. І. С. 252–256.

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We found out that the highest concentration of lead was detected in the soils of the Svativskyi district on the border with the Kharkiv region – 9.1 ± 0.0003 mg/kg (2.7–17.2). We believe that it is due to the presence of a large number of mobile forms of compounds of this element in the soils of this area and water pollution, taking into consideration that there are no large industrial facilities here. It is possible that this province contains a large number of natural contaminants, namely lead-bearing ores. The lead high concentration in the Lutuginskyi, Stanychno-Luhanskyi, and Slovyanoserbskyi districts is linked to the high concentration of industrial facilities – environmental pollutants – in the south of the region.

The lead high content in the agrarian Markivskyi, Milovskyi, and Novopskovskyi districts is probably linked to the fact that oil and gas pipelines from the Russian Federation go through these areas, as well as the migration of lead compounds from the water arteries of the region.

Depending on the pollution of Luhansk region with lead compounds, it is possible to distinguish provinces with a higher (compared to the average indicator for the region) content of this element in the soil. In the north province it includes the following districts Troitskyi, Svativskyi, Bilokurakynskyi, Novopskovskyi, Markivskyi and Milovskyi. The southern province includes the Perevalsky, Slovyanoserbskyi, Stanichno-Luhanskyi, Lutuginskyi and Antracytivskyi districts. While looking at the region map, it is possible to see that these districts are separated from each other by Kreminskyi, Starobilskyi, Bilovodskyi, Novoaidarskyi and Popasnyanskyi districts in the north, and Krasnodonskyi and Sverdlovskyi in the south. This information creates a suggestion that such a demarcation, depending on the contamination of territories with lead, became possible in the southern districts due to the fact of the well-developed structure of the heavy industry. In the north of the region, the agriculture branch is dominating. We suggest that the pollution in the northern districts of the Luhansk region is linked to the presence of mobile forms of this heavy metal in the soil, due to the oil and gas pipelines transit on the territory of these districts, as well as the prevailing northern winds in the region, which brings the contaminated air to these territories.

A very important indicator is also the number of territories contaminated with lead exceed the maximum permitted concentration. The largest number of such lands is in Perevalskyi district – 19 %, Svativskyi – 17 %, Lutuginskyi – 8 %, Slavyanoserbskyi – 6.4 %, Troitsky and Stanichno-Luhanskyi – 6.0 and 5.5 %, respectively.

It is important to note that the soils of the Lutuginskyi district contain the highest level of lead (8.1 mg/kg) and the largest one territory with the content of lead (8 %) and cadmium (10.7%) that exceeds the maximum permissible levels (10 and 0,7 respectively mg/kg).

Attention is drawn to the pollution of the Slovyanoserbskyi district, which borders with Lutuginskyi district. The average content of cadmium in the soils is the highest comparing to all other five districts (0.51 mg/kg), lead is slightly less than in the southern region (7.5 mg/kg), and the area contaminated by both toxicants is the largest among the four districts (5.1 and 6.4 %, respectively).

3. Water quality in Luhansk Region

Water is the most important component of the life of all alive organisms. It serves as an integral indicator for the plant and animal worlds and man. Water quality is assessed by a complex of chemical, biological components, and physical properties that determine its suitability for certain types of water use. Its quality is evaluated according to the characteristics that are selected and standardized depending on the purpose of using water resources[23]. As a limiting factor, a feature characterized by the lowest harmless concentration of a substance in the sampled water. General numerical water quality testing is carried out according to the index, which is a set of main indicators by types of the used water. The water quality, composition and its properties in the reservoirs are regulated by hygienic requirements and sanitary standards[24].

An excess the norm of color and dry residue indicates an excessive amount of pollutants in drinking water[25]. The water of all 5 districts, where the study was implemented, contained an excessive content of chlorides and sulfates, which caused the development of uro– and cholelithiasis in animals due to the cumulation of insoluble salts of the above-mentioned acids. In addition to this, an excessive amount of chlorine compounds leads to the violation of the water-salt balance in the body and is a sodium antagonist, in case of binding with which the status of the sodium-calcium pump is disturbed. These processes lead to disruption of excitation processes in the muscle tissue and myocardium[26].

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Table 4

Indexes of chemical conditions of water of the Luhansk region farm

Index	Lutuginskyi district	Krasnodonskyi district	Slovyanoserbskyi district	Markivskyi district	Troitskyi district	Normal indexes, due to DSTU 2.2.4-171-10
Smell, in marks	2	2	2	2	2	2
Color in degrees	**44**	**73**	**34**	**32**	**37**	20
pH	8,3	8,3	8,4	8,4	8,5	6,5–8,5
Dry matter, mg/dm^3	**2010**	**2148**	**1136**	**1121**	**1132**	1000
Iron common, mg/dm^3	0,1	**0,29**	0,1	0,1	<0,1	0,2
Chlorides, mg/dm^3	**260**	**280**	**288**	**269**	**269**	250
Sulphates, mg/dm^3	**890**	**935**	**343**	**310**	**310**	250
Ammonia, mg/dm^3	0,1	**1,7**	0,02	0,08	**1,2**	0,5
Nitrates, mg/dm^3	18	15,3	0,91	1,0	3,8	45
Nitrites, mg/dm^3	**0,16**	0,34	0,03	0,03	0,04	0,1
Cadmium, mg/dm^3	0,001	0,001	0,001	0,001	0,001	0,001
Copper, mg/dm^3	0,012	0,001	0,02	0,01	0,001	1
Lead, mg/dm^3	0,003	0,001	0,001	0,001	0,001	0,01
Zinc, mg/dm^3	0,31	0,001	0,28	0,16	0,001	1
Nickel, mg/dm^3	0,003	0,001	0,001	0,001	0,001	0,02
Manganese, mg/dm^3	**0,058**	0,001	0,034	0,021	0,001	0,05

Note. Indicators exceeding the norm are highlighted in bold

Water containing more than 0.3 mg of iron in 1 liter is considered not suitable for human consumption. Livestock is also not tolerant to the high content of this element. Water iron is more available for absorption than feed originated, and therefore more toxic. An excess of total iron by 45 %, comparing to the norm, in the Krasnodon district water is the reason of bone damage in sheep raised on this territory. This conclusion is proved by the results of biochemical studies[27] .

Ammonia is an inorganic compound, a colorless gas with a pungent, suffocating odor, lighter than air, and highly soluble in water. In the case of ammonia poisoning, difficulty breathing is observed, mainly damage to the

[27] Xiao H.T., Wang L., Yu B. Superparamagnetic iron oxide promotes osteogenic differentiation of rat adipose-derived stem cells. International Journal of Clinical Experimental Medicine. 2015. Vol. 8, Is. 1. P. 698–705.

upper respiratory tract[28]. Such changes can occur in animals of the Krasnodon and Troitsky districts, where in the water the content of this toxicant is 3.4 and 2.4 times higher comparing to the norm (0.5 mg/dm^3).

Nitrites (salts of nitric acid) come to the water with domestic and agricultural runoff, and the highest concentration of nitrites is observed in surface springs, groundwater, and yard wells. Once in the body, nitrites cause the oxidation of divalent iron, contained in oxyhemoglobin and hemoglobin, into trivalent iron with the methemoglobin creation, a compound that does not transport oxygen and causes its deficiency in tissues (hypoxia)[29].

Water used for animals in the Lutuginskyi and Krasnodonskyi districts, contains the nitrites concentration which exceeds the normal indicators by 1.6 and 3.4 times, that can be detected by intestinal damage and an increase in the methemoglobin content in the animals blood.

Manganese is an essential element, but its excessive amount in water resources causes hepatotoxic and nephrotoxic effects[30]. Thus, in the water sampled in the Lutuginskyi district, the concentration of this element increased by 16% against the norm, which proves the causes of damage in the sheep liver and kidneys.

On the Ukraine territory, up to 90 % of used natural resources turn into waste, which after causes the environment pollution. The largest number of them is formed on the territory of Dnipropetrovsk, Donetsk, Zaporizhzhia and Luhansk regions. Water and soil contamination with heavy metals, salts of sulfate, chloride, nitrate, and nitric acids is one of the reasons of the internal pathology in animals[31].

4. Sheep internal pathology distribution

During the clinical examination of 385 sheep, no changes in the general condition were found, but signs of internal pathology were detected in the analysis of organs following the sheep slaughtering and liver biopsies. Base on these studies, analysis of feeding, changes in blood and urine, skin, color of the conjunctiva, the following diseases were established: hepatodystrophy, nephrosis, osteodystrophy, trace element diseases (cuprum, zinc and/or manganese deficiency), as well as combined pathology of the liver and kidneys (hepatodystrophy + nephrosis), hepato– and osteodystrophy and polymicroelement deficiency. Liver pathology (30.9 % of the examined

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animals) and hepatorenal syndrome (19.7 %) became the most common ones. The combined pathology of kidneys and liver in the group of lactating animals is on the first place, and their place in the non-infectious diseases structure is 29.7 %. The second most common position is hepatodystrophy (25.0 %), which includes high number of ewes, with combined pathology of the liver and bone tissue (15.6%) and microelementosis (14.1 %). Osteodystrophy is very common among sheep (18.6 %), hepatodystrophy and microelementosis – among some animals (41.1 and 18.6 %) (Fig. 7.1 a)). Nephrosis was the most often diagnosis in cats and single animals (7.8% in each group), and hepato-osteodystrophic syndrome was detected in lactating animals (15.6%) (Fig. 7.1 b), c)).

Among the total number of tested animals, liver diseases are the most common: hepatodystrophy presents 30.9% and hepatorenal syndrome presents 19.7%. Microelement diseases (both mono– and combined deficiencies of manganese, copper, and zinc), present 14.8%, osteodystrophy (9.6%), and combined pathology of the liver and bone tissue – 7.6% were diagnosed not very frequent (Fig. 7.2).

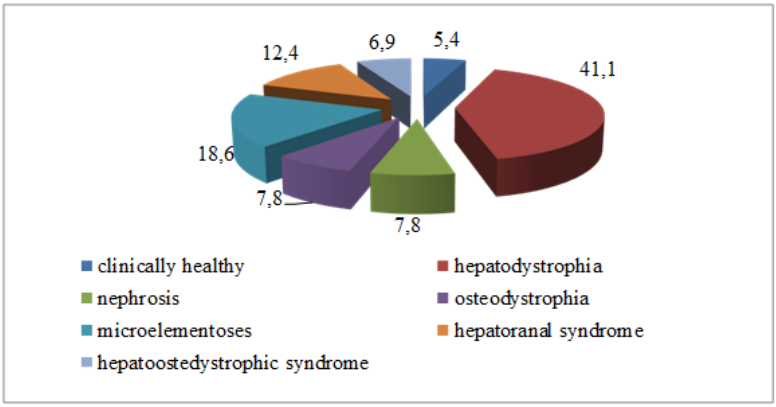

Fig. 7.2. Ewes internal pathology distribution, in %

CONCLUSIONS

Depending on the content of copper, zinc and manganese in the soil, three biogeochemical provinces can be distinguished in the Luhansk region territory: northern, central and southern. The northern biogeochemical province is characterized by the average copper content in the soil – 6.03±0.131 mg/kg (except for the Novopskovskyi and Starobilskyi districts), average or slightly reduced (up to 320 mg/kg) – manganese (except for the Troitskyi district) – 382.0± 14.48 mg/kg and average or elevated zinc

content – 9.4±0.46 mg/kg. The average content of mobile forms of copper in the central biogeochemical province soils is (6.14±0.251 mg/kg), average or low (except for the Stanychno-Luhanskyi district) – manganese (320.8±29.45 mg/kg) and zinc (7, 5±0.44 mg/kg). The southern province is characterized by an average content (except for the Antratsytivskyi district) of copper (6.3±0.15) and manganese (405.0±3.76 mg/kg) (except for the Krasnodonskyi district) and a high level of zinc (11, 1±0.52 mg/kg).

The highest concentration of cadmium was found in the soils of Slovyanoserbskyi, Stanychno-Luhanskyi and Bilokurakinskyi districts (0.51±0.0001 mg/kg), lead in Svativskyi (9.1±0.0003 mg/kg), Lutuginskyi (8 .1±0.0011 mg/kg), Slovyanoserbskyi (7.5±0.0001) and Markivskyi (7.5±0.0009) (limit permissible – 0.7 and 10 mg/kg, respectively). The most cadmium contaminated territories are in the Lutuginskyi (10.7%), Stanychno-Luhanskyi (6.3%) and Slovianoserbskyi (5.1%) districts, with lead – in the Perevalskyi (19%), Svativskyi (17.0%) %), Lutuginskyi (8.0%) and Slovyanoserbskyi (6.4%).

The water tests from the territories of the Luhansk region (where we tested animals, in Lutuginskyi, Krasnodonskyi, Slovyanoserbskyi, Markivskyi and Troitsky districts) showed that the water for animals consumption does not meet the Ukrainian standards from 4 to 7 indicators are out of 16.

According to the results of the ewes examination (in five districts of the Luhansk region) the following internal diseases and syndromes were diagnosed: hepatodystrophy (30.9 %), nephrosis (5.2 %), osteodystrophy (9.6 %), microelementosis (14.8 %), hepatorenal (19.7 %) and hepato-osteodystrophic (7.6 %) syndromes.

SUMMARY

Nowadays, at the threshold of the 21st century, the environmental problems got the global status. People aware of the danger of shortening life on Earth due to its influence on the scale of nature use, the intensity of management, and the pollution of the natural environment.

Geographical zoning of Luhansk region into biogeochemical provinces depends on soil saturation with mobile forms of trace elements. Luhansk region is part of three Donbass sub-districts, which correspond to the geographical division of the region. In general, the soils of eastern Ukraine have a high content of lead, zinc, copper, cobalt, and chromium. The northern biogeochemical province is characterized by the average content of copper in the soil – 6.03±0.131 mg/kg (except for the Novopskovskyi and Starobilskyi districts), average or slightly reduced (up to 320 mg/kg) – manganese (except for the Troitsky district) – 382.0± 14.48 mg/kg and average or elevated zinc content – 9.4±0.46 mg/kg. The central biogeochemical province soils contain the average of mobile forms of copper (6.14±0.251 mg/kg), average or low

(except for the Stanichno-Luhanskyi district) – manganese (320.8±29.45 mg/kg) and zinc (7, 5±0.44 mg/kg). The southern province is characterized by an average content (except for the Antratsytivskyi district) of copper (6.3±0.15) and manganese (405.0±3.76 mg/kg) (except for the Krasnodonskyi district) and a high level of zinc (11, 1±0.52 mg/kg).

The highest concentration of cadmium was detected in the soils of Slovianoserbskyi, Stanychno-Luhanskyi and Bilokurakinskyi districts (0.51±0.0001 mg/kg), lead in Svativskyi (9.1±0.0003 mg/kg), Lutuginskyi (8 .1±0.0011 mg/kg), Slovyanoserbskyi (7.5±0.0001) and Markivskyi (7.5±0.0009) (limit permissible – 0.7 and 10 mg/kg, respectively). The territories which are the most contaminated with cadmium are in the Lutuginskyi (10.7%), Stanychno-Luhanskyi (6.3%) and Slovianoserbskyi (5.1%) districts, with lead – in the Perevalskyi (19%), Svativskyi (17.0%)), Lutuginskyi (8.0%) and Slovyanoserbskyi (6.4%).

The water testing from the Luhansk region territories, where the animals were our subject of investigations – Lutuginskyi, Krasnodonskyi, Slovyanoserbskyi, Markivskyi and Troitskyi districts, showed that the water for animals consumption does not meet the Ukrainian standards from 4 to 7 indicators out of 16.

According to the results of the ewes examination (in five districts of the Luhansk region) the following internal diseases and syndromes were diagnosed: hepatodystrophy (30.9%), nephrosis (5.2%), osteodystrophy (9.6%), microelementosis (14.8%), hepatorenal (19.7%) and hepato-osteodystrophic (7.6%) syndromes.

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