Changes in the content of certain macro- and microelements in the blood of karakul sheep exposed to helminth infestation

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Abstract. Comprehensive studies of livestock, their feeding conditions and maintenance allow us to obtain the data necessary for the development of medical strategies and tactics in the treatment of sick animals and the prevention of endemic diseases. Considering that Uzbekistan belongs to a country where Karakul sheep are raised, and the soil is rich in eggs and larvae of geohelminths, the infection rate of lambs in the spring and summer is high. Our research was conducted taking into account the infestation of animals and how many micro- and macronutrients are lost during the disease. Lambs infected with helminths were selected using a latex agglutination reaction with a diagnosticum. With marshallagiosis, nematodyrosis and habertiosis, the content of macro– and microelements in the blood of Karakul sheep decreases (potassium – by 190.5; sodium - 552.5; calcium -9.5; copper – 0.56; zinc – 0.5 and iron - by 74.2 mg/l) especially significantly in the prenatal period of helminth development; in the imaginal period– the content of macronutrients increases, and trace elements remain at a low level. According to the results of the study, the absorption of macro- and microelements depends not only on the balance of the diet in nutrients, mineral salts and vitamins. The effect of macro- and microelements on the body is largely complicated by the conditions of animal husbandry. It is necessary to have a medical examination that allows you to control the harvesting, storage and quality of feed, detect diseases in animals, in the subclinical period and timely carry out the necessary medical measures, as well as identify agrotechnical measures to improve the fodder base of the farm.

1 Introduction

The study of changes in the levels of macro- and microelements in the blood of Karakul sheep infected with helminths is an important aspect of the study. Such a study allows us to determine the dynamics of the content of these elements and their impact on animal health. Helminths are parasitic organisms that infect the organs of farm animals, including Karakul sheep. Their presence in the animal's body causes metabolic disorders and the development

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of various pathological conditions. One of the indicators that are additionally significant when studying this problem is the levels of macronutrients in the blood. Trace elements such as sodium, potassium, calcium and magnesium play an important role in the regulation of many physiological functions in the animal body. When affected by helminths, the levels of these trace elements in the blood may change, which may indicate the presence of disorders in the body of animals.

Another important aspect of studying changes in the levels of elements in the blood are trace elements. Trace elements such as iron, zinc, copper and selenium are also essential for the normal functioning of the body. Their deficiency or excess can lead to the development of various diseases and disorders. Tracking the dynamics of these trace elements in the blood of Karakul sheep affected by helminths will allow you to determine the presence of an imbalance and take timely measures to correct it.

Thus, the study of changes in the levels of macro- and microelements in the blood of Karakul sheep affected by helminths is important for understanding the effects of parasitic infection on the animal body. This will make it possible to develop effective prevention and treatment strategies and, ultimately, improve the health and well-being of these animals. In the conditions of desert pastures of Karakul sheep in Uzbekistan, such helminths as marshallagiosis, nematodirosis and habertiosis are registered [1], therefore, the improvement of livestock farms from these helminths and the prevention of economic damage caused by them is one of the reserves for the development of animal husbandry.

Thanks to the enormous achievements of helminthological science and practice, many helminthiasis, although they have ceased to be a scourge of sheep farming, however, further study of their pathogenesis can become the basis for developing issues of early diagnosis and more effective methods of combating them [2-3].

The similarity of the structure of the egg shells of ascaridates and trichocephalates has been established. Both have a dense middle shell that protects the embryo from adverse factors, and it is much more durable than strongylate eggs. This circumstance determines the greatest resistance of eggs of these types of helminths to environmental factors and allows them to be used as test objects in the development of disinfection products. Thus, grazing animals are more likely to become infected with helminths, especially young animals [4].

Calcium, phosphorus, potassium, magnesium, sulfur, chlorine and sodium are present in the body in the largest amounts (after organogens). These elements belong to the macronutrients. Macronutrients are essential nutrients that are absolutely necessary for the vital functions of organisms. They are involved in various enzymatic processes; they are regulators of osmotic pressure and acidity of all body fluids; they are intracellular and intercellular mediators; they are necessary for the processes of excitation and inhibition; they are structural components of some tissues, etc. Macronutrients are not distributed in food as evenly as organogens. In addition, phytic acid and other inhibitors of the absorption of many cations are present in plant foods, which significantly reduces the bioavailability of calcium and magnesium. Plant foods rich in magnesium and fiber accelerate the passage of intestinal contents, which also reduces the absorption of minerals. At the same time, plant foods contain significantly more magnesium and potassium. Sodium and chlorine are widely present in food products. This explains that when infecting young animals with helminths, the health of Karakul lambs, which are on a walk in nature, deteriorates. due to helminths, there is a lack of micro- and macronutrients in the body [5].

It was found out that intestinal parasites - cestodoses and strongylatoses - are widespread among sheep and goats in the vertical zone of this region. The largest number of infections was found in animals living in flat areas: respectively, 26.04% and 19.3% were infected with strongylates, 28.0% and 24.6% with nematodes, and 33.1% and 29.16% were infected with monesias. In the foothill areas, the percentage of infection is 26.8% and

23.28% for strongylates and 26.4% and 22.9% for nematodes. In mountainous areas, sheep and goats are significantly less infected with cestodes and strongylates. The proposed new composition is highly effective in the treatment and prevention of cestodoses and strongylatoses of the digestive tract in sheep and goats. Thus, with 64% infection with trichostrongils before the experiment, deworming was effective in 96% of cases. After deworming, strongylate eggs were found in 6% of sheep and goats. Effectiveness in the fight against nematodirus sp. it was 98%, and with monesia spp. - 100%. [6].

The authors found some patterns of the influence of time elapsed after calving on the content of macro- and microelements in colostrum. The differences in the available data on the mineral composition of cow colostrum are explained, among other things, by different livestock keeping technologies, different feed compositions, as well as animal breeds and many other factors. Comparisons are made with respect to micro- and macronutrients, since it is the young that are exposed to micro- and macronutrients when infected with helminths [7].

Other authors, when studying helminths, drew attention to the fact that enzootics and epizootics of marshallagiosis in sheep in the arid zone of the Kalmyk steppe have not been registered over the past 50 years. During sheep autopsies in 1962-1970 and later, an interesting feature of AI and EI in marshallagiosis was noted: the peak incidence of sheep occurred in the winter months (in December, an average of 15 specimens /head were detected, in January – 204, in February - 327), in spring there was a decrease in EI (in March 50 specimens / head., in April – 13, in May - 0), in summer the EI is about 0 (in June – 0.8; in July – 0.6; in August – 0.1), in autumn there was a slight increase (in September – 1.1; in October – 5; in November - 9) [8].

According to the authors, micronutrient deficiency and toxicity in animals cause a wide range of clinical effects, although only some of them are specific enough to make a diagnosis without additional investigation of changes in the content of trace elements in tissues or the activity of metabolic processes affected by the consumption of trace elements. The study of such trace element-dependent processes has shown that extensive changes often occur before the appearance of obvious signs of the disease. Some of these subclinical effects have pathological consequences and, therefore, cannot be ignored when looking for correlations between geochemical anomalies and disease incidence. Recent data indicate that such antagonists affect both the absorption and the subsequent fate of essential and toxic elements in body tissues, and these processes must be taken into account when investigating the etiology of disorders that are believed to be associated with deviations in the consumption of trace elements. Their presence is not always detected if attention is limited to the analysis of trace elements in body tissues or the nature of clinical lesions. Provided that the interpretation of the data fully takes into account the complexity of the relationship between soil, plants and animals with respect to the intake of trace elements, a geochemical approach to the initial identification of areas associated with a high risk of anomalies in the intake of trace elements by animals and humans has significant potential value. This is already evident from studies of cases of problems with trace elements in animals [9].

The authors of this article consider the impact of worm infections on grazing ruminants from a European perspective and identify scientific and applied priorities to mitigate these effects. Infections with parasitic helminths (nematodes and trematodes) represent a significant economic and social burden for the global ruminant industry. The increasing prevalence of anthelmintic drug resistance means that existing control programs are expensive and unsustainable in the long run. Recent changes in the epidemiology, seasonality and geographical distribution of helminthic infections are explained by climate change. However, other changes in the environment (for example, in land use) and in animal husbandry, such as intensification and changes in management methods, will also have an impact on helminthic infections. Sustainable control of helminthic infections in a changing world requires detailed knowledge of these interactions. In particular, there is a need to develop new, sustainable strategies for effective control of helminthiasis in ruminants in the context of global changes. Complex changes in the epidemiology of helminths will require innovative solutions. By developing and using new technologies and models, it is possible to optimize the use of anthelmintic agents in order to limit the development and spread of drug resistance and reduce the overall economic damage from worm infections [10].

The authors conducted a cross-sectional study of sheep and goats kept in the conditions of the extended detention system in Haramaya. To this end, 768 stool samples were taken from 384 sheep and 384 goats. The studied stool samples revealed a total prevalence of 472 (61.4%) among small ruminants, while 259 (67.75%) in sheep and 213 (55.47%) in goats contain one or more genera of helminths, with nematodes being the most common helminths (59.89%). During the coproscopic examination, strongyl helminths were the most common parasites (36.20%) in this area in both households. The study revealed a significantly higher ($p<0.05$) prevalence of helminths in sheep than in goats, and in young animals than in adults. In sheep and goats, 7 and 6 genera of helminths were identified, respectively. The results of this study show that, despite its subclinical nature, gastrointestinal worms are one of the main problems that can affect the health and productivity of sheep and goats [11].

In a study conducted in the Northeastern Free State, the authors studied the intensity, seasonal morbidity and spread of helminth parasites in cattle, sheep and goats. The study was conducted from March to May. Fecal samples taken from cattle of various breeds, Merino sheep and Angora goats were used for analysis. McMaster and Visser methods were used to count eggs and identify nematode larvae at stage 3. It was found that Haemonchus and Oesophagostomum were the dominant genera of nematodes infected with animals. This suggests that in the spring season, helminth eggs become more active and infection occurs after grazing animals [12].

The authors carefully studied the mixed invasions of strongylatosis of the digestive tract and anoplocephalosis of sheep in the context of the vertical zone of Dagestan. Mixed helminthiasis is recorded in sheep in all climatic zones of Dagestan. The greatest species diversity, high rates of invasion intensity (EI, 15.0-43.3%) and invasion intensity (EI, 16-3860 individuals) were noted in the plain belt by strongylates of the digestive tract, anoplocephals. Of the pathogens in the lowland and foothill belts, habertia, bunostomes, trichostrongils, hemonchs and nematodes dominate in mixed invasions; from anoplocephalic monesia. In the mountain belt at an altitude of more than 2500 m above sea level, the II and EI indicators are significantly lower - 25-8.3% and EI 43-32 instances. Lambs of the first year of life are infected in the lowland and foothill belts with habertii, bunostomes (B. trigonocephalum), trichostrongils (T. axei, T. vitrinus), hemonches, nematodes (N. spathiger). This suggests that lambs of the first year of life are more susceptible to invasions, unlike adults [13-14]. In this regard, our research is relevant in the regions of Uzbekistan.

The purpose of the work: To study the dynamics of the content of macro- and microelements in the blood of Karakul lambs infected with strongylates.

2 Materials and methods

Materials and methods of research: Methods of helminthological, morphological, hematological, biochemical and serological studies were used in the work.

Lambs from a flock of Karakul sheep infected with marshallagiosis and nematodyriosis were selected for the study, 14 anthelmintic Karakul lambs of 6 months of age were also taken, of which 5 (1-18 kg; 2-16.5; 3-18 kg; 4-15.5 kg; 5 - 14.8 kg) were infected with invasive marshallagia larvae, the following 5 larvae of invasive nematodes weighing (1-19 kg; 2-18 kg; 3 - 16.5; 4- 17 kg; 5- 20 kg), 4 lambs weighing (1-16 kg; 2-18 kg; 3 -15 kg; 4 - 20 kg) are not infected.

To study the habertiosis of sheep, 18 anthelmintic lambs of the Karakul breed aged 3-4 months were selected, of which 13 were infected with invasive habertiosis larvae, 5 sheep heads served as controls.

The distribution of lambs into experimental and control groups was carried out according to the principle of analogues, taking into account the sex, breed, age, body weight and fatness of the animal.

The animals of the experimental and control groups were kept in similar conditions, they were fed at 9, 14 and 18 o'clock. The diet of lambs was calculated for the age group and consisted of concentrated (compound feed), coarse (hay) and juicy (alfalfa) feeds. Lambs received 1-2 ml of fish oil enriched with minerals and vitamins daily, as well as chalk and table salt from a special feeder in accordance with the needs of the animal. The places where the animals were kept were regularly cleaned in the morning and evening, and disinfected by physical method.

Data collection was carried out in spring and summer during the walking of a flock of sheep in the Zarafshan River valley, since at this time a lot of sheep become infected with geohelminths. Two devices were used to study blood and macro- and microelements.

Blood samples from the control and experimental groups were taken in the laboratory using BC-5000 - hematological analyzer (general blood analysis), ECL 760 - coagulometer (blood coagulation- coagulation coagulation), developed on the basis of the most modern hematological diagnostics. In the study (screening) of macro- and microelements in blood serum, Mindray technology and a biochemical analyzer were used - The BC-5000 hematology analyzer, developed on the basis of the most advanced technology of hematological diagnostics Mindray, is the lightest, compact and convenient for conducting hematological analyses and counting leukocytes in the laboratory.

With this device, 23 whole blood parameters, 3 histograms and 3 different scatter plots can be obtained. Three-vector laser scattering, focusing of the flux and chemical staining of leukocytes make it possible to better differentiate populations even in samples with high levels of eosinophils. Blood samples from the control and experimental groups were taken in the laboratory using BS-5000, a hematology analyzer (general blood test), ECL 760, a coagulometer (blood coagulation- blood clotting) developed on the basis of the most modern hematology diagnostics. In the study (screening) of macro- and microelements in blood serum, Mindray technology and a biochemical analyzer were used - The BC-5000 hematology analyzer, developed on the basis of the most advanced technology of hematological diagnostics Mindray, is the lightest, compact and convenient for conducting hematological analyzes and counting leukocytes in the laboratory. With this device, you can get 23 whole blood parameters, 3 histograms and 3 different scatter plots. Three-vector laser scattering, focusing of the flux and chemical staining of leukocytes make it possible to better differentiate populations even in samples with high levels of eosinophils.

Blood samples were taken in the morning and evening from Karakul lambs. The blood test was performed on a BC-5000 hematology analyzer (general blood test), an ECL 760 coagulometer (blood coagulation meter) and a biochemical analyzer - the XL-200 user manual was used to determine macro- and microelements in blood and serum (screening). This method allows you to obtain more accurate data when examining the blood of lambs infected with geohelminths.

During the entire period, morning and evening, observations were made on the general condition of infected and control lambs (temperature, pulse, respiration, chewing, condition of visible mucous membranes and conjunctiva), as well as appetite and defecation, taking into account the dynamics of live weight.

3 Results and Discussion

3.1 The dynamics of potassium content in the blood

In marshallagiosis, the concentration of potassium in the blood decreased significantly on the 5th day of invasion from 468.7 ± 4.1 initial to 352.2±0.8 mg/l, then a noticeable increase in its level was observed, which peaked on the 20th day, when the content of this element was 745.0 ± 2.6 mg/l, which is 1.5 times higher the original one. Starting from the 30th day of invasion, the amount of potassium in the blood of lambs gradually decreased, but maintained a high value compared to the baseline level, up to the 70th day of invasion (507.2 ± 0.3).

In nematodyrosis, changes in the potassium content in the blood are very similar to those observed in marshallagiosis. In this case, there is a similar decrease in the concentration of potassium in the blood of lambs in the first 5 days after invasion, followed by a sharp increase on the 10th day and a high level of potassium compared to the baseline level and control throughout the entire period of invasion.

In habertiosis, the level of potassium in the blood of healthy lambs 3-4 months old compared with 6-7 months old lambs is significantly higher; the change in its concentration differs from changes in marshallagiosis and nematodirosis.

After infection, on the first day of the invasion, lambs showed a significant decrease in potassium content in the blood, unlike previous invasions; its concentration remained throughout the entire period of parasitization of helminths in the body.

The results of the research indicate an uneven change in the potassium content in the blood of lambs with various experimental helminthiasis. With marshallagiosis and nematodyrosis, at the beginning of the pre-diagonal period of parasite development, a decrease in potassium concentration in the blood is observed, however, in other periods of parasite development, this indicator increases and eventually remains higher than the initial one. These changes are caused by the migration of larvae into the submucosa of the abomasum and intestines, parasitization and subsequent transitions into the lumen of the gastrointestinal tract, as well as with the onset of the chronic course of the disease.

In the case of experimental habertiosis, a uniform decrease in the potassium content in the blood was found from the earliest days after infection and throughout the entire period of invasion. This phenomenon is explained by the more intense pathogenic effect of helminths on young lambs, which are less resistant to pathogenic factors than six-month-old young.

3.2 Dynamics of sodium content in the blood

In marshallagiosis, during the period of predominant development of parasites, a decrease in the sodium content in the blood of lambs was observed compared with baseline and control indicators. So, on the 5th day of invasion, it decreased to 1780.3 ± 2.4 mg/l, i.e. 144 mg/l less than the initial one, and on the 10th day of invasion, respectively, 58 mg/l less than the initial one. On the 15th day of the invasion, the sodium content in the blood decreased to 1725.05 ± 0.6 mg/l, which is less than the initial 200 ml/l. Starting from 20-30 days of invasion, this indicator began to increase, and this increase was observed until the end of our studies, reaching the level of indicators of control animals.

With nematodyrosis, there was a sharp decrease in the sodium content in the blood of lambs (on the 5th day of invasion to 1429.8 ± 8.1 mg/l or 528 mg/l less than the initial one), which lasted until the 15th day. Then it began to rise markedly (already on the 20th day to 1859.0±1.6 mg/l) and at the end of our studies it almost reached the initial and control values (1954.02±0.5 mg/l).

In habertiosis, in 3-month-old lambs with invasive haberti larvae, the sodium content in the blood, compared with previous experimental animals, was significantly higher and amounted to 2232.5 ±47.9 mg/l.

From the first days of infection, the sodium concentration in the blood of experimental lambs began to decrease and amounted to 2046.60 ± 43 mg/l, on the 5th day of invasion this indicator was 2060.0 ± 40.7 mg/l, and on the 10th day it was equal to 1840.0 ± 72.5 mg/l or 433 mg/l less the original value.

On the 15th day of habertia parasitization in the lambs, the sodium content in the blood increased slightly and amounted to 2045.33 ± 40.1 mg/ l, further a decrease in the sodium content in the blood was observed. So, on the 25th day of the invasion, it decreased to 1955.38 ± 47.7 mg/l, on the 40th day of the invasion to 1789.65 ± 63.5 mg/l and on the 70th day of the study, this indicator was 1933.6 ± 15.8 mg/l, which was significantly lower than the baseline and control values.

3.3 The dynamics of calcium content in the blood

In marshallagiosis, the calcium content in the whole blood of experimental lambs was normally 28.7 ± 0.5 on average. On the 5th day of the invasion, the calcium content in the blood of lambs decreased to 20.5 ± 0.5 mg/l in infected lambs. On the 10th day, this indicator decreased to 19.4 ± 0.3 mg/l, which is 9 mg/l lower than the baseline level, and on the 15th day it was 21.5 ± 0.36 mg/l. Starting from the 20th day of the invasion, an increase in the calcium content in the blood was observed, and on the 30th day it reached the initial and control levels. Subsequently, starting from the 40th day and until the end of the experiment, the calcium content in the blood increased and on the 65th day of invasion amounted to 42.0 ± 0.2 mg/l or 14 mg/l more than the initial one.

In nematodyrosis, the dynamics of changes in the calcium level in the blood of lambs with nematodyrosis practically did not differ from that in marshallagiosis. There was a decrease in calcium content in the pre-vaginal period of parasite development, and with the onset of the imaginal period, these indicators increased quantitatively, significantly increasing the initial values.

In habertiosis, as our studies have shown, the calcium content in the blood of lambs 3-4 months of age is significantly reduced compared to 6-month-old lambs and was normally equal to 15.9 ± 0.5 mg/l.

From the very first day of habertiosis invasion, unlike previous invasions, there was a significant increase in calcium content by 20.0± 0.55 mg/l, and this continued until the 25th day of invasion. From the 25th day of the invasion, the amount of calcium in the blood began to decrease and by the 70th day of the invasion almost reached the initial value of 18.0± 0.60 mg/ l, although it was slightly higher than the indicators of control animals.

During the development of imaginal marshallagias (30-60 days), the amount of calcium in the blood of lambs increases significantly. Similar changes occurred in nematodyrosis.

With habertiosis, we observe the opposite pattern. Apparently, the age of the experimental animals is important here. From the very first days of invasion, during the entire period of pre-vaginal development of parasites, we observed a slight increase in calcium content compared to the initial data, and with the onset of the imaginal period of parasite development, this indicator almost equaled the initial one.

3.4 Dynamics of copper content in the blood

In experimental lambs before infection, the copper content in the blood was normal at 1.07 ± 0.06 mg/l.

In marshallagiosis, after infection from the 10th invasion, the amount of copper in the blood began to decrease and on the 15th day its level was significantly lower than the initial one. In the following days of the disease, the concentration of copper continued to decrease sharply and by the end of the observations (on the 65-70 th day of the invasion), its content was two times less than the initial and control, as well as significantly below the permissible normal values.

In nematodyrosis, the nature of the change in the level of copper in the blood of lambs did not differ from that in marshallagiosis. However, in this case, the decrease in the amount of copper in the blood, which began on the 10th day of the invasion, was more dramatic already from the 20th day of the disease, and its very low concentration persisted until the 65th day of the invasion.

With habertiosis, a significant decrease in the copper content in the blood of lambs was observed from the very first days. However, unlike marshallagiosis and nematodyrosis, the level of copper in the blood decreased more moderately throughout the entire period of the disease, was significantly lower than the baseline and control levels, but there was no sharp decrease.

3.5 Dynamics of zinc content in the blood

With marshallagiosis, the zinc level in the blood of lambs decreased on the fifth day after infection, but subsequently practically did not differ from the initial value and the value in the control group until the 30th day of the disease. However, 40 days after infection, there was a decrease in the concentration of zinc in the blood, which persisted until the 65th day of the invasion.

In nematodyrosis, the zinc level in the blood of lambs decreased significantly only between 5 and 20 days of the disease, on the remaining days of the studies, its concentration did not significantly differ from the initial value and the value in the control group.

In habertiosis, a similar dynamics of changes in the zinc content in the blood of lambs was observed, as in nematodirosis. There was also a decrease in zinc content until the 25th day of the disease, then it was restored to its original value and remained at this level until the 70th day of the experiment.

In marshallagiosis, the iron content in the blood of lambs averaged 194.5±4.9 mg/l. There was a sharp decrease in the level of iron in the blood from the first days of the disease, especially characteristic in the pre-terminal period of the parasite development. On the fifth day, the concentration of iron in the blood decreased to 160.3 ± 1.0 mg / l, on the tenth day this indicator decreased even more - by 35%. Only starting from day 30, the concentration of iron in the blood increased slightly, but did not reach the initial value until the end of the study.

In nematodyrosis, the dynamics of iron content in the blood of lambs was similar to that described above in marshallagiosis.

In habertiosis, the iron content in lambs aged 3-4 months was equal to 370.5 ± 7.5 mg/l, which is about twice as high as in lambs aged 6-7 months.

In habertiosis, as well as in marshallagiosis and nematodyrosis, there was a decrease in iron content in the pre-terminal period of the parasite's development, and in subsequent periods of the disease, the iron content remained at the initial level.

4 Conclusion

Thus, the sodium content in the blood of lambs with experimental marshallagiosis and nematodyrosis, as well as with experimental gaberthiosis, is reduced. However, this decrease was most intense in marshallagiosis during the introduction of invasive larvae into the wall of the abomasum (day 5) and during the reverse migration of the predominant marshallagias from the wall of the abomasum into its cavity (day 15). The same decrease in sodium content in the blood was observed in lambs infected with nematodes, but in them this decrease is more pronounced on the 5th, 10th and 15th days of invasion, and during the period of imaginal development of parasites, the sodium concentration begins to increase and by the end of the experiment reaches the initial value. Unlike other helminthiasis, in experimental gaberthiosis, the sodium content decreases during almost all periods of invasion, and this is especially noticeable on the 10th day. Also, an analysis of the results of our research shows that with helminthiasis, along with other macronutrients, the calcium content in the blood of lambs also undergoes changes. The decrease in blood calcium in helminthiasis occurs in different ways. Thus, in marshallagiosis during the period of premaginal development of parasites, the calcium content was reduced compared with the initial values and the indicator of control lambs.

The content of trace elements, respectively, zinc in the blood of lambs during experimental helminthiasis did not significantly change towards a decrease in its amount in the blood, and this occurred during the prenatal period of parasite development. It is also worth noting that with helminthiasis, profound changes in the iron content in the blood occur and this is especially evident in the preimaginal period of the parasite's development, this is apparently due to a change in the number of red blood cells and hemoglobin during these periods, respectively, with marshallagiosis from 8.9 and 9.02 to 5.29 million and 6.78 g%, with non–papillose - from 8.8 and 9.08 to 5.27 million and 6.37 g% and with habertiosis – from 10.5 and 11.9 to 4.62 million and 6.9 g%.

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