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Ecological Bases of Ethiology and Therapy of Hemolytic Anemia in Cattle During Piroplasmosis

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***Abstract*—Hemolytic anemia in cattle on the background of piroplasmosis is the most common disease that causes economic losses to livestock farms of the Republic of Dagestan. Treatment and prevention of this pathology should be carried out taking into account the biology and ecology characteristics of pathogens and their carriers – the ixodid ticks. Stable functioning biotopes of ixodid ticks have formed in plain areas, due to a decrease of arable lands; enzootic foci of piroplasmosis have appeared – with a stable quantity of different phases of development of ixodite and piroplasmids circulating in them. The aforementioned led to the ixodid ticks expansion, and the improvement of the biotopes' ecological conditions; enhancing the biological activity of pathogens and a sharp increase in the number of diseased animals. In connection with the changed climatic conditions, economic and environmental factors, the occurrence of this pathology has also become more frequent in the foothill zone of the republic. The ecological bases of etiology, pathogenesis and symptoms of hemolytic-toxic anemia in cattle during piroplasmosis were studied and an effective symptomatic treatment regimen was developed. Our proposed scheme for the comprehensive treatment of patients with piroplasmosis, with a specific iron-containing drug, Ferroglucinum and Catosal, was more effective, as was indicated by recovering of blood cell forming organs and a shorter recovery period.**

Keywords—ticks, biotopes, cattle, anemia, piroplasmosis, Ferroglucinum, Catosal.

I. INTRODUCTION

Changes in agriculture over the past decades have led to a reduction in the area of sowings, an increase in natural pastures and, as a result, an increase in the area of biotopes and the number of parasitic ticks on animals. In the conditions of Dagestan – mainly in the plain and foothill zones, blood-parasitic diseases (piroplasmosis, francaiellosis, theileriosis) are widespread. Cattle, sheep, goats, horses and other animals are affected. This group of parasitoses causes enormous economic damage to animal husbandry, which is manifested in a decrease in the quality and quantity of milk and meat production, the commercial quality of raw hides is reduced, and mortality is often observed [1-3]. According to researchers, mortality among patients with piroplasmosis and fransaillosis is from 8% to 11%, and with theileriosis – 40-45% [4].

Piroplasmosis are difficult of treating; the duration of the rehabilitation period after treatment are the most environmentally and epizootiologically significant and malignant among the entire parasitic pathology, according to the severity of health state of animals that already went through this disease. This is due to the biology and ecology of the pathogens in the body – the ixodid tick carriers, their development in the cells of the lymph nodes, spleen, bone marrow, tick mite activity, season, ecological factors of biotopes where the ixodid tick develops, as well as the anti-pathogenic effect on ecosystems.

The harmful value of ixodid ticks, both as external blood-sucking parasites, and as carriers of pathogens of many dangerous human and animal diseases, has long been known. Through the eggs of the tick affected by the infection, further infection of the larvae occurs, which, in turn, after the molting passes into the nymph and infects healthy animals, as well as imagos. Natural and climatic conditions of the republic favor such a cycle of tick development. This explains the interest of veterinary and medical workers, ecologists and biologists in the study of ixodid ticks and the study of their species composition, the identification of the most harmful and the development of effective measures to combat them [5].

Due to the decrease of arable lands, stably functioning biotopes of ixodid ticks have now been formed. In newly formed pastures, enzootic foci of pyroplasmidoses appeared, with a stable number of different phases of the development of ixodite and piroplasmids circulating in them. The aforementioned led to the expansion of the areola of ixodid ticks, and the improvement of the ecological conditions for them in biotopes. All this led to an increase in the biological activity of pathogens and their carriers.

During piroplasmosis, all organs are involved in the pathological process: cardiovascular, digestive, excretory systems; most noticeable pathologies develop in the hematopoiesis system. When prescribing treatment and preventive measures, the state of one of the most suffering hematopoietic system is not taken into account, which mainly leads to the death of animals.

Piroplasmosis, especially the biology, ecology of ixodid ticks – carriers of their pathogens, epizootology, pathology, clinic, diagnosis, treatment and prevention in the Republic of Dagestan have always been the focus of researchers [1-4], [6-12].

32 species of ticks of the family Ixodidae were recorded in Dagestan. Pioroplasmosis is recorded in the lowland zone of Dagestan by three enzootic outbreaks, which is associated with the formation of 3 generations of *Boophilus annulatus*: the first in April-May (13.8%), the second in July-August (84.9%); the third is in September-October (1.3%).

In July-August, the largest quantity of *B. annulatus* develops; therefore, the incidence of animals with piroplasmidosis and fransaillosis is significant. The tick of *B. annulatus* is single-hosted; all three phases of development are done on one host – the cattle. According to a number of authors, cattle piroplasmosis treatment outcome depends on timely diagnosis and therapy, but there are still cases of complications, since the functions of vital systems and organs of recovered animals recover for a long time. It has been established that milk yield of dairy cattle does not reach potential values in this lactation [6-8].

An analysis of the situation on piroplasmosis in the farms of Dagestan shows that the fauna of tick mites and pathogens of piroplasmosis has been studied comprehensively and everywhere.

In parallel with scientific research on the study of etiology and pathogenesis, scientists develop and carry out effective preventive measures. Veterinary specialists of the state veterinary network and farms conduct measures against piroplasmosis and carriers of their pathogens according to a plan drawn up and approved by the veterinary service of the district. The beginning of spring anti-mite treatments and chemoprophylaxis annually depends on environmental and weather conditions and can be changed in connection with the establishment of optimal temperatures and pasture of animals. In addition, in the fall, anti-mite bathing-treatment of cattle ends according to the weather, and not according to the schedule. Such an approach to this work is extremely important, because it is necessary to stop bathing after ticks disappear.

The extermination of ticks on animals is of dominant importance, since treating animal tick biotopes with acaricidal agents is difficult and expensive. Sodium arsenate, SK-9, Sevin, metrifonate, trichloromethaphos-3 are currently the approved means for combating ixodid ticks in cattle. Significant agri-reclamation works, creation of cultivated pastures, natural meadows and private transfer of livestock on the industrial basis also have a great impact on the current state of piroplasmosis.

II. Objective

To study the ecological foundations of etiology, pathogenesis and symptoms of hemolytic-toxic anemia in cattle during piroplasmosis and develop an effective symptomatic treatment regimen taking into account the climatic conditions, economic and environmental factors.

III. Methods

The work was carried out on the farms of Khunzakhsky (located in the plain zone of the republic) and Levashinsky districts (located in the foothill zone of the republic) in 2016-2018. The object of the study was 20 cows of the red-steppe cattle breed infected with piroplasmosis, of which subsequently, observing the principle of analogues, two groups of experimental animals were formed (experimental and control groups).

The diagnosis was made on the basis of epizootological data, clinical signs, hematological studies and morphological analysis of blood smears (where the damage of red blood cells was 15-20% or more).

Animals of the control group were treated with the traditional method: Granulatum “DAC” was administered intramuscularly, which has a good chemoprophylactic effect for piroplasmosis; 20% sodium caffeine benzoate solution subcutaneously; tincture of white hellebore per os, glucose solution intravenously; antimicrobial drug “Nitox-200” intramuscularly. To improve digestion, it was recommended to give sour milk in amount of 2-3 liters with chopped garlic for 3-4 days, twice a day: in the morning and evening.

In addition to the complex of therapeutic measures, the cows of the experimental group included an iron-containing preparation – Ferroglucinum, and Catosal –containing butafosfan and vitamin B12, which activate erythropoiesis and improve metabolism. All drugs were dosed and used according to the instructions attached to these drugs, depending on body weight. For a more effective treatment of intoxication, care conditions of diseased animals were improved, as well as maintenance; the diet was enriched with proteins and vitamins, and we also organized keeping of patients outside – in the clear air.

Morphological blood analysis was performed according to the generally accepted methodology before and after the treatment.

IV. Results

Clinical studies noted the following symptoms in the diseased animals: general depression, feed refusal, animals lag, lose weight quickly, lie more often, sometimes grind their teeth, disordered heat regulation and the appearance of one of the first and constant signs – the fever. Body temperature rises and often stays firmly at a high level over a long period. Pronounced clinical signs of hemolytic anemia appear: anemia and yellowness of the visible mucous membranes and integuments, tachycardia, hemoglobinuria, shortness of breath, weakness during physical exertion, impaired digestive system function (atony, pre-ventricular hypotension, often omasum chemostasis (blockage), mucous hemorrhage on the mucous membrane), a sharp decline in milk yield.

In connection with the hemolysis of red blood cells, the blood becomes watery, the number of red blood cells decreases to 2.5 10^{12}/l, the hemoglobin content decreases from 25% to 35%, the number of leukocytes increases by 70% or more, and blood serum acquires a saturated golden color. The amount of bilirubin is increased, the content of urobilin in urine is increased, giving it a reddish-brown tint. One of the characteristic symptoms of hemolytic poisons in cattle infected with piroplasmosis is an increase in blood cholesterol, which indicates impaired liver function. A striking symptom of severe hemolytic poisoning is the abundance of lipids in the blood, as well as sugar, as a result the temporary glycosuria appears sometimes.

Cattle of the plain zones infected with piroplasmosis had more positive clinical signs after the treatment: restoration of the pulse and respiration rate within the physiological level, the appearance of rumination – but liver pain during palpation remained.

Clinical signs of experimental cows in the foothill zone after treatment already reached the physiological level on the 5-6th day: restoration of the pulse rate and respiration was noted already on the third day of therapy. The appearance of rumination was observed already at the end of the 2nd day of treatment. Liver pain at the end of therapy was not established.

The results of a blood test of patients with piroplasmosis in the conditions of the plain and foothill zones of the republic

before and after treatment, where there are completely different environmental and climatic conditions, are shown in Tables I and II.

Attention was drawn to the parameters of parasitemia in blood smears and the number of ticks on the studied animal. With a weak parasitemia in the blood in the conditions of the foothill zone (1-2 specimens), *Piroplazma bigeminum* in erythrocytes on the field of view, *B. annulatus* on the patients' body varied between 11-14 specimens.

During severe parasitemia in patients from the plain zone, 3-5 specimens of parasites in red blood cells and 20-35 specimens on the body were detected.

TABLE I. HEMATOLOGICAL PARAMETERS OF CATTLE INFECTED WITH PIROPLASMOSIS IN THE PLAIN ZONE (BEFORE AND AFTER TREATMENT)

Experimental groups	**Indicators (at the beginning and at the end of treatment)**		
	Hemoglobin, g/l	***Erythrocytes, 10^{12}/l***	***Hematocrit index, %***
Initial indicators			
	145.9 ± 3.4	6.1±0.3	39.5±2.8
1st experimental group	61.3 ± 1.7 / 99.8 ± 2.1 ***	2.90±0.7 / 3.3±0.5	21.6±1.9 / 25.4±2.2
2nd experimental group	63.9 ± 1.5 / 107.9 ± 1.3 ***	2.7±0.7 / 4.7±0.3 *	24.1±1.5 / 32.6±2.6 *

*Note: indicators of control group as the numerator / indicators of experimental group as the denominator; * - p≤0.05; ** - p≤0.01; *** p <0.001.*

TABLE II. HEMATOLOGICAL PARAMETERS OF CATTLE INFECTED WITH PIROPLASMOSIS IN THE FOOTHILL ZONE (BEFORE AND AFTER TREATMENT)

Experimental groups	**Indicators (at the beginning and at the end of treatment)**		
	Hemoglobin, g/l	***Erythrocytes, 10^{12}/l***	***Hematocrit index, %***
Initial indicators			
	139.7 ± 2.1	5.8± 1.1	36.5± 1.9
1st experimental group	72.8±2.2 *** / 102.8±2.1	3.6±0.7 / 4.1±0.5	28.6±1.9 * / 34.4.±1.6
2nd experimental group	69.9±1.7 / 127.9 ±1.3 ***	3.2±0.7 / 5.4±0.6 *	29.1±1.5 / 37.6±2.4 **

*Note: indicators of control group as the numerator / indicators of experimental group as the denominator; * - p≤0.05; ** - p≤0.01; *** p <0.001.*

The digital data of Table 1 shows that there is a sharp decrease in hemoglobin concentration (61.3±1.7 g/l), the number of red blood cells (2.9±0.2 x 10^{12}/l), and hematocrit index (21.6±1.9%) in cattle infected with piroplasmosis with severe parasitemia of the plain zone, which indicates the development of hemolytic anemia.

Results of similar blood studies of cattle in the foothill zone (Table II) with mild parasitemia also indicate a decrease in hematological parameters: (72.8±2.2 g/l), (3.6+0.7 x 10^{12}/l), respectively, and hematocrit index (28.6± 1.9%), while they are significantly higher compared the plain zone.

The results showed that the inclusion of Ferroglucinum and Catosal, in the complex of therapeutic measures of experimental cows, positively affects hematological parameters: the number of red blood cells, hemoglobin concentration, and hematocrit were significantly higher than in animals of the control groups (12-15%; P≤ 0.001).

Furthermore, these indicators did not reach the level of physiological norm in animals of the experimental group of the plain zone, while similar data did not differ from the normative parameters (hemoglobin concentration – 127.9±1.3 g/l, the number of red blood cells – 5.4±0.6x10^{12}/l, hematocrit index – 37.6±2.4%.) in cattle of the experimental group of the foothill zone. The morphology of red blood cells (anisocytosis, poikilocytosis, etc.) has also changed.

V. CONCLUSION

The rational exoparasites treatment should be based on the etiopathogenetic ideas about the incidence, modern concepts of the biology of pathogens and environmental conditions, as well as on the choice of means and methods of treatment that provide high therapeutic and preventive efficacy, taking into account the time of year; natural and climatic conditions, species characteristics, economic and environmental factors.

Ferroglucinum and Catosal containing vitamin B12, which were additionally included in the complex of therapeutic measures, had a positive effect on hematological parameters of animals with piroplasmosis (hemoglobin, erythrocytes, hematocrit). These parameters significantly increased against the background of the therapeutic measures, which indicates their high therapeutic efficacy.

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